Popular Electronics®

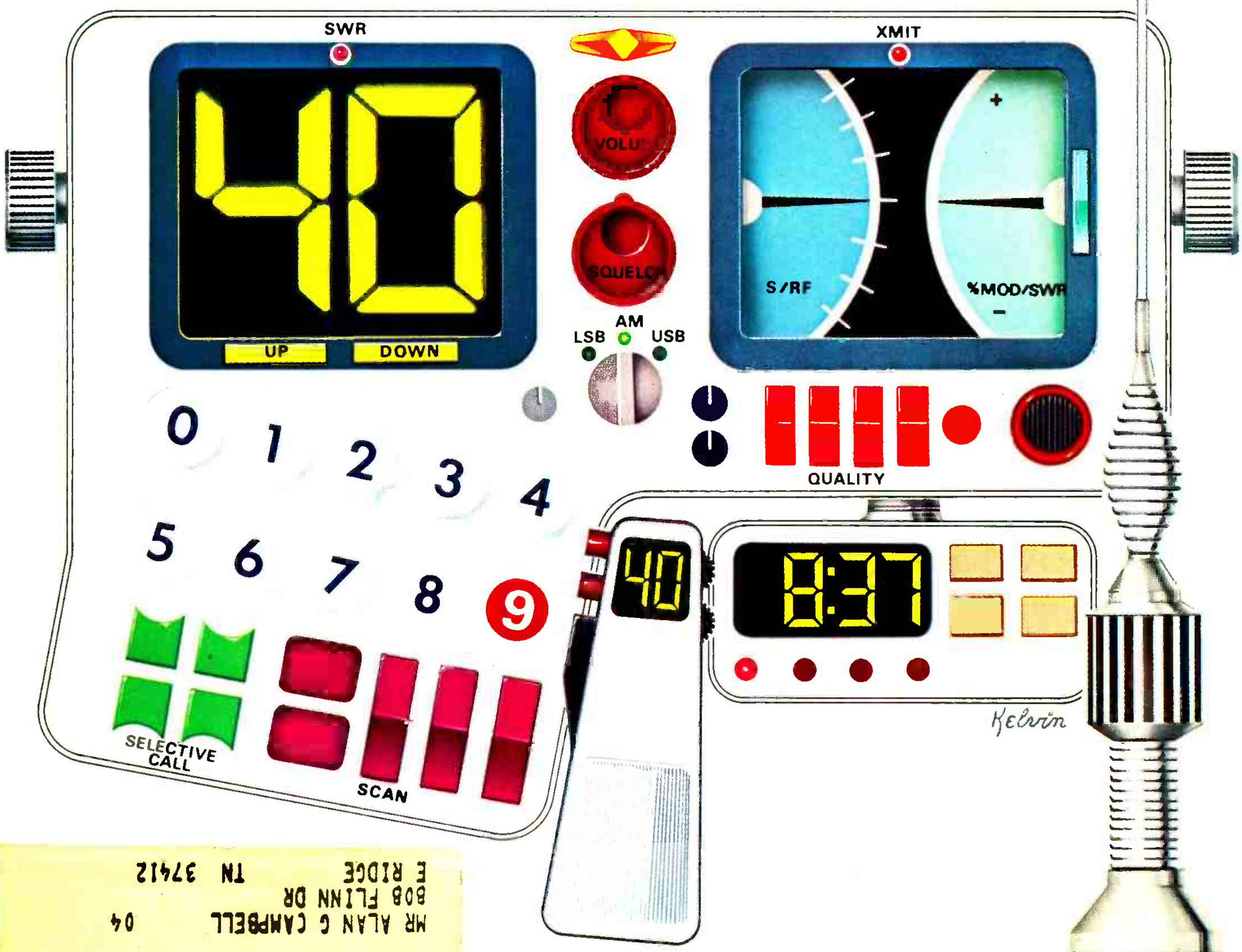
WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

APRIL 1978/$1

How to Design Power Supplies
Easy-to-build LED Projects
Microprocessor Microcourse, Part II

16-PAGE CB RADIO SUPPLEMENT, INCLUDING

Buyers Guide to Super CB Mobile Transceivers



In This Issue

Sharp RT-3388 Computer-controlled Cassette Deck

Wharfedale E-50 High-efficiency Speaker System

Harman-Kardon Model 730 AM/Stereo FM Receiver

Introducing the mobile that can move you out of the world of the ordinary and into the world of the serious CB'er. The Cobra 138XLR Single Sideband.

Sidebanding puts you in your own private world. A world where there's less congestion. More privacy. More time to talk.

It's all possible because instead of 40 channels you get your choice of 120 channels. Both AM and SSB. And instead of 4 watts of legal power you get 12 watts of legal power. So you get almost double the range of AM.

With the 138XLR Single Sideband there's less background noise and less interference. So there's cleaner, clearer reception. Because like all Cobras, the 138XLR SSB is engineered to punch through loud and clear. Even in crowded metropolitan areas.

And like all Cobras it comes equipped with such standard features as an easy-to-read LED channel indicator. Switchable noise blanking and limiting. An RF/signal strength meter. And Cobra's exclusive DynaMike gain control.

You'll find the 138XLR SSB wherever Cobras are sold. Which is almost everywhere. Because Cobra's got a nationwide network of dealers and Authorized Service Centers offering sales, installation, service and advice. So come on in. And move on up.

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Punches through loud and clear.

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UPWARD MOBILITY.

FREQ. OUT.

CSC's done it again.

Broken the price and performance barriers with new MAX-100. The multimode, professional portable frequency counter that gives you more range, visibility, accuracy and versatility than any comparable unit anywhere near its low, low price.

MAXimum performance. MAX-100 is a cinch to use. It gives you *continuous readings* from 20Hz to a *guaranteed 100MHz*, with 8-digit accuracy. Fast readings with 1/6-sec. update and 1-sec. sampling rate. Precise readings, derived from a crystal-controlled time base with 3ppm accuracy. High-sensitivity readings from signals as low as 30 mV with diode overload protection up to 200V peaks.

Input signals over 100MHz automatically flash the most significant digit. And to indicate low-battery condition and extend remaining battery life, the *entire* display flashes at 1Hz.

MAXimum versatility. Wherever and whenever you need accurate frequency readings, MAX can do the job. Use it with clip-lead cable supplied. Mini-whip antenna. Or low-loss in-line tap with UHF connectors. For AM or FM; CB, ham, business radio and R/C transmitter or receiver alignment. Monitoring audio and RF generators. Checking computer clocks and other digital circuits. Repair of depth sounders and fish spotters. Troubleshooting ultrasonic remote controls. For these, and hundreds of other applications, you'll find it indispensable.

MAXimum visibility. MAX-100 features a big, bright 0.6" multiplexed *8-digit* LED display, with leading-zero blanking. So you don't have to squint or work up close. And MAX's flip-up stand is *built-in*.

MAXimum flexibility. MAX-100 operates from *four* power sources for use in lab or field. Internal alkaline or NiCad batteries. 110 or 220V with charger/eliminator. 12V with automobile cigarette-lighter adapter/charger. And external 7.2-10V supply.

MAXimum value. With all its impressive specs, you'd expect MAX to cost a lot more than a low $134.95, complete with clip-lead cable and applications/instruction manual. But that's another nice thing about MAX: though it's accurate enough for lab use, it's well within the reach of hobbyists' and CB-ers' budgets.

Order today. Call 203-624-3103 (East Coast) or 415-421-8872 (West Coast): 9 a.m.-5 p.m. local time. Major credit cards accepted. Or see your CSC dealer. Prices slightly higher outside USA.

Specifications.

Range: 20 Hz to 100 MHz, guaranteed. **Gatetime:** 1 sec. **Resolution:** 1 Hz. **Accuracy:** ± 1 count + time base error. **Input Impedance:** 1 MΩ/56 pF. **Coupling:** AC. **Sine Wave Sensitivity:** 30 mV RMS @ 50 MHz. **Internal Time Base Frequency:** 3.579545 MHz crystal osc. **Setability:** ± 3 ppm @ 25°C. **Temp-Stability:** Better than 0.2 ppm/°C, 0-50°C. **Max. Aging:** 10 ppm/year. **Display:** Eight .6" LED digits; anti-glare window. **Lead-zero blanking:** decimal point appears between 6th and 7th digit when input exceeds 1 MHz. **Overflow:** with signals over 99,999,999 Hz most significant (left hand) digit flashes allowing readings in excess of 100 MHz. **Display update:** 1/6-second plus 1 sec. gate time. **Low Battery Indicator:** When power supply falls below 6.6 VDC, all digits flash @ 1 Hz rate. Flashing display extends battery life. **Power:** 6 AA Alkaline or NiCad cells (internal); **External:** 110 or 220/VAC Eliminator/charger; Auto cigarette lighter adapter; 7.2-10 VDC ext. supply; **Bat. Charging:** 12-14hr. **Size (HWD):** 1.75" x 5.63" x 7.75" (4.45 x 14.30 x 19.69 cm.) **Weight:** Less than 1.5 lb. (0.68 kg) w/batteries. **Accessories Included:** Clip-lead input cable, manual.

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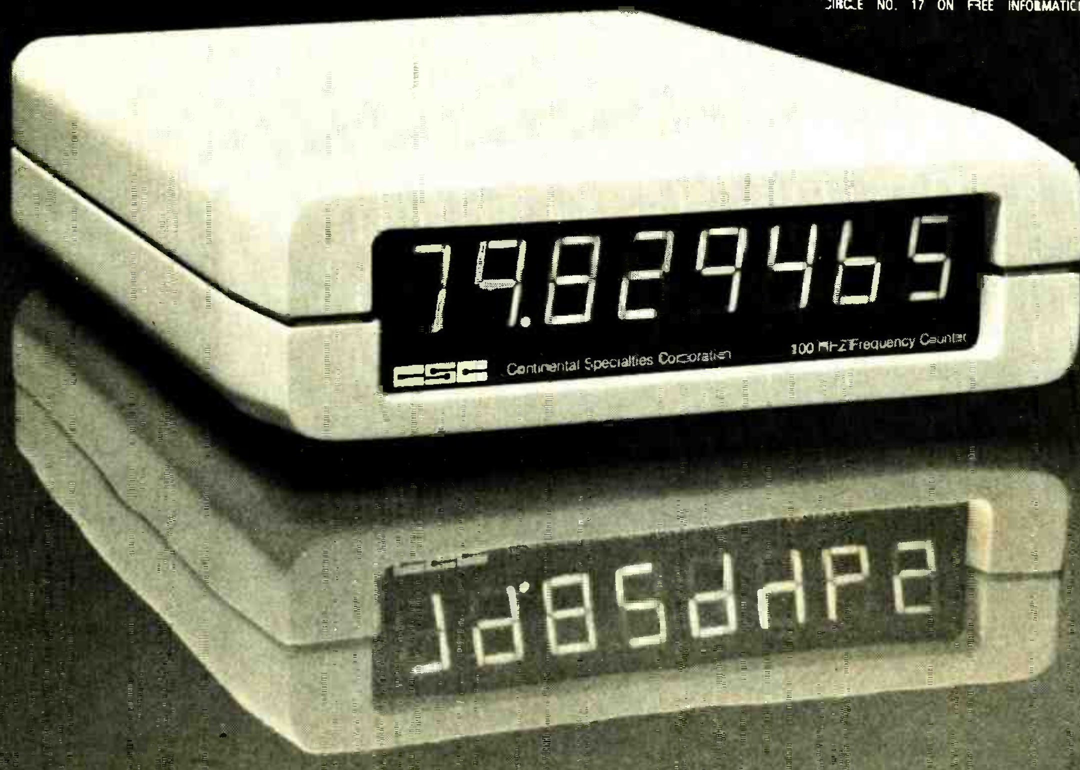

APRIL 1978

Popular Electronics®

VOLUME 13, NUMBER 4

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

Coming Next Month

- MAGNETOMETERS FOR INVESTIGATING UFO'S
- MICROPROCESSOR MICROCOURSE, PART 3
- ADDING TRIGGER SWEEP TO AN OSCILLOSCOPE

TEST REPORTS:
Dynaco Stereo 416 Power Amplifier
Philips AH-673 AM/Stereo FM Tuner
Heath HW-2036 2-meter AM Transceiver
Sencore CB41 CB Performance Tester

Cover Art by George Kelvin

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Feature Articles

Construction Articles

Special Focus on CB Radio

Columns

Julian Hirsch Audio Reports

Electronic Product Test Reports

Departments

Editorial

ELECTRONICS AT WINTER CES

CB radio was big at the giant Winter Consumer Electronics Show in Las Vegas. Many CB manufacturers unveiled their plans for the coming year: high-technology CB transceivers. This means that there will be a greater proportion of SSB models than before, and more models with microprocessor-based circuitry that makes possible keyboard entry functions, channel memory storage and scanning.

Furthermore, there were large exhibits of mobile underdash models, remotely controlled models, and indash models of every description. The latter included combined CB/AM/stereo FM models, many with a choice of cassette or 8-track tape players, adjustable shafts, and universal installation kits. Of particular note was the rising number of models with a channel-9 priority function.

A host of sophisticated base stations was displayed, too, extending in price to about $1000. These included microprocessor-based types with keyboard entry; models with three large, independent meters; SSB models with a VFO for receive that include a separate digital *frequency* readout; a base station with a large, blue fluorescent/digital display; and so on.

CB antenna manufacturers were not content to simply lead with dressed-up versions of last year's line, either. For example, antenna specialists showed a mobile antenna with a solid-state circuit that displayed the traditional loading coil; GTE Sylvania displayed an electronic self-tuning trunk-mount antenna that's said to automatically maintain minimum VSWR; Avanti's new "Saturn" selectable vertical/horizontal base station omni floated high in the exhibit area; Shakespeare displayed its fiberglass "City Stick" for indoor use; American Antenna's exhibit showed its K-40 models mounted in a variety of locations on an actual automobile; and two manufacturers which were formerly OEM-only makers—Harada and True Temper—entered the consumer area.

Other personal communications highlights at the show included Prime Electronic's PR-1000 variable audio filter with 40-3000-Hz Peak, Notch, Low-Pass positions; Stoner's matching-cabinet console system that adds a ham radio and an AM CB adapter to its SSB-only base station; Wilson's WR-500 rotor, with a disc-type brake; and Panasonic's 49-MHz "Walkie Talkie" entry.

Rumors were rife, too. They included development of a computer interface adapter so that CB'ers can communicate computer-to-computer over the air (there's a legality question on this, though); an FCC proposal to permit ASCII as well as Baudot; and illegal use of 27.505 MHz for Morse code practice (as if the FCC didn't have enough trouble with other violations).

In other product categories, highlights were TV receivers with dual viewing channels; a raft of high-quality auto-sound products which included power boosters and graphic equalizers for car use, scanners with microprocessors, an X/K band radar detector from Convoy that uses a parabolic antenna in a standard fog-lamp housing; no-solder BNC connectors from Cambridge; innumerable projection TV systems and VCR's; calculators with new twists such as Toshiba's LCD-display pocket notebook that stores names, addresses, and phone numbers; Cannon's mini desktop with dual displays to show memory content or calculating process figures; Casio's pocket calculator/alarm clock/timer; and Sinclair's $34.95 programmable with a library of 290 programs. Computers and games essentially joined microprocessors at the show. This will be noted next month in our "Computer Bits."

In short, this was a most exciting show, with some 550 exhibitors who used more than 300,000 sq ft of space. (About one third of the show was devoted to hi-fi equipment, covered by Ralph Hodges in this month's Stereo Scene.) So it looks like a good year coming up!

Art Salsberg

Letters

CHEERS FOR "EXPERIMENTER'S CORNER"

Until I read the February, March, November, and December 1977 "Experimenter's Corner," I was in the dark about the digital IC's discussed. Now, I see the light. Thanks POPULAR ELECTRONICS and Forrest Mims. Let's have more, more. *—C. Britton, Scarborough, Canada.*

INTERNATIONAL LAW ON LICENSING

I take exception to the comments made by Gil Duddles in the "Letters" column in the October 1977 issue. It is international law—not the choice of the American citizen—that gives hams license to operate on the airwaves. The US is just one of the hundreds of member countries of the International Telecommunications Union (ITU) that make up the rules and regulations by which radio operations are governed. The suggestion that a technically competent person who does not demonstrate ability in Morse Code should be given a license is covered by Article 41 Section 3 Paragraph 1 of the ITU regulations: "Any person operating the apparatus of an amateur station shall have proved that he is able to send correctly by hand and to receive correctly by ear texts in Morse code signals. Administrations may, however, waive this requirement for stations making use exclusively of frequencies above 144 MHz."

Again quoting from the ITU regulations, Article 41 Section 3 Paragraph 2: "Administrations shall take measures as they judge necessary to verify the technical qualifications of any person operating the apparatus of an amateur station."

So according to the ITU, an applicant for an amateur license must prove technical competence *and* ability to send and receive code before a license can be granted. *—Dr. Jerrold L. Patz, K1PKT, Wrentham, MA.*

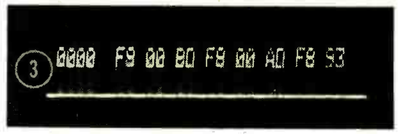
LIKES SWL ARTICLES

I was very pleased to discover the SWL features in the November 1977 issue of POPULAR ELECTRONICS. Mr. Woods' SWL schedules are accurate and extremely useful. Mr. Hauser's article is also most interesting. It is gratifying to see the emphasis placed on the program material instead of the search for rare DX. *—Arthur Crookshank, New York, NY*

ELF ADDITIONS

I would like to add my name to what I am sure is a long list of satisfied subscribers who have built the "COSMAC Elf Microcomputer" (August 1976). Being an experimenter, I would like to show off my addition to the original Elf. The photos shown here are representative programs that demonstrate my 32-character oscilloscope display. The circuit I am using for this display is an adaptation of the "Scopewriter" featured in the August 1974 issue of POPULAR ELECTRONICS.

Photo 1 is self-explanatory. An ASCII keyboard was the input device for this line write/edit program. Photo 2 is the word guessing game "Hangman" in progress. The secret word is "COSMAC," the player has de-



pressed "G," which is incorrect, and another letter has been added to HANGMAN. Photo 3 illustrates what I call a memory-map program. The eight bytes represent what is in memory, starting at the displayed address. This program allows inspection and correction of any part of memory. *—Lynn R. Clock, Lompoc, CA.*

RADAR DETECTOR ADVOCATE

I was quite distressed to read your Editorial comments in the November 1977 issue of POPULAR ELECTRONICS. There is one important point that you didn't mention, legally referred to as probable cause. Your home cannot be searched or your telephone tapped without a search warrant. A warrant is issued only if the police can show probable cause that a crime has been committed. When a "Smokey" is beaming his MR7 moving radar at you on the road with it on all the time and does not wait for probable cause, he technically violates your right to privacy.

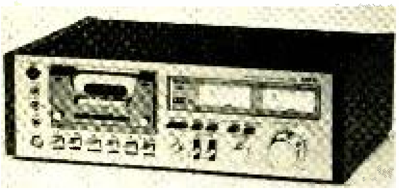
As used by most states, radar is for revenue purposes. The 55-mph law has not been effective in saving lives or resources, a fact documented by the Comptroller of the United States and various state agencies. If our police were instructed to go hard on drunk drivers who account for 40% of all fatal accidents, reckless drivers, and "junk" cars, the roads would be safer, especially with a return to previous speed limits. *—Bence D. Boelcskevy, Vice President, BMW Car Club of America, Inc., Cambridge, MA*

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 Reader Service Card inside the back cover or write to the manufacturer at the address given.

Aiwa Stereo Cassette Deck

Aiwa has developed a mechanism that measures the reel rotation speed of the cassette and displays the remaining time for the tape. This device is incorporated into the company's Model AD-6550 stereo

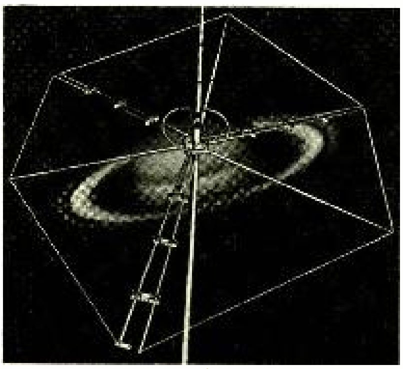


cassette deck with built-in Dolby noise-reduction system. The time is shown in minutes to the left of the meters. The deck's ratings include a wow and flutter of 0.05% weighted rms and a S/N ratio of 65 dB. Its specified frequency responses are: 30 to 13,000 Hz for LH and 30 to 15,000 Hz for CrO_2 and FeCr tape. A bias fine adjustor is provided for LH/normal tape. A two-step peak-indicating LED system is designed to activate at +3 and +7 dB. Additionally, there is a memory rewind system. $450.

CIRCLE NO. 92 ON FREE INFORMATION CARD

Avanti CB Base-Station Antenna

The Avanti Saturn CB base-station antenna is a coinductive system that combines four antennas that operate on two polarities in what is claimed to be the most unique antenna yet devised. The vertical radiator section is 22′ (6.7 m) in height, giving it the desirable radiation of a 5/8-wave design. While using vertical polarity, the horizontal section automatically serves as a ground plane for the radiator. The horizontal section consists of three half-wave dipoles that are electronically co-phased to



yield an omni-directional radiation pattern. The feed system is arranged so that equal power is applied to each dipole, via separate multipurpose balun coils. The method by which the power is equally divided and transferred to the dipole radiators is the heart of the Saturn's design.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Ballantine 80-MHz Frequency Counter

Ballantine's Model 5720A frequency counter covers a direct-count range of 10 Hz to more than 80 MHz. It features an audio tone multiplier circuit that provides a claimed resolution of 0.01 Hz in only a 1-second measurement time. Frequency and ratio measurements are read out from an eight-digit jumbo LED display. Direct readings are in megahertz, kilohertz, or

hertz as selected by a front-panel switch. The POWER and range switches are the only controls required for operation of the counter. The instrument's 1-megohm input impedance is shunted by 25 pF of capacitance. The input is fully protected against over-voltage to 250 volts rms from 10 to 1000 Hz, decreasing to 10 volts rms beyond 10 MHz. Sensitivity over the entire range is specified at 50 mV. $195.

CIRCLE NO. 94 ON FREE INFORMATION CARD

Dual Direct-Drive Turntable

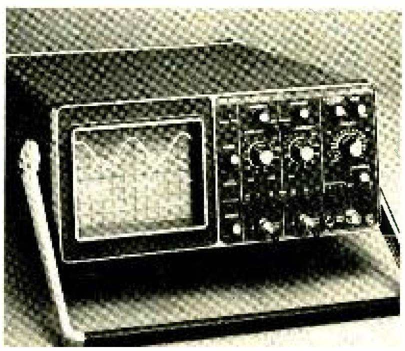
Dual's Model 604 semiautomatic turntable is direct-driven by a dc electronic motor whose speed is electronically regulated by a digital reference circuit. The tonearm is mounted in a four-point gyroscopic-type gimbal suspension. Two mechanical anti-resonance filters are housed in the counterbalance to attenuate acoustic feedback and parasitic resonances. The straight-line tubular tonearm offers what is claimed to be maximum rigidity with minimum mass. Other features include: mechanical sensor to locate lead-in grooves on 12″ and 7″ (30.5 and 17.8 cm) discs; damped cueing system; automatic tonearm return and

shutoff at end of play; 10% pitch control and illuminated strobe; and die-cast platter. Rumble is rated at greater than 70 dB and wow and flutter at less than 0.03%. Supplied with low-profile base and dust cover. $250.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Philips Portable Oscilloscope

A portable 15-MHz/2-mV oscilloscope, designated the Model PM 3211, is available from Philips Test & Measuring Instruments, Inc. The scope features comprehensive display and triggering facilities and a double-insulated power supply that requires no grounding to eliminate hum and spurious signals. Triggering can be in AUTO or level set and multi-sourced, eliminating the need to change probes. Channel B can be used as an X input to facilitate



X-Y displays with calibrated attenuation of both X and Y inputs. It can also be inverted and, with the scope's ADD function, can display A ± B. An 18-speed timebase has a vernier control for simplified phase and timing measurements. $875, including two probes.

CIRCLE NO. 96 ON FREE INFORMATION CARD

Genesis Speaker System

The Model 3 speaker system from Genesis Physics Corp. employs three specialized drivers, each of which is claimed to be engineered for extremely long linear excursion relative to cone size. This approach is said to provide the large power handling capability of larger-diameter drivers with the sonic superiority of small, lightweight drivers with respect to transient response, suppression of resonance distortion and coloration, and full frequency dispersion. A passive radiator extends the system's low-frequency limits. The midrange driver is housed in an acoustically isolated enclosure, and the tweeter is damped by a viscous magnetic ferrofluid. A specially designed crossover network is said to preserve a high degree of phase integrity. $299.50.

CIRCLE NO. 97 ON FREE INFORMATION CARD

SJE Morse Code Typewriter

S.J. Engineering's Model SMCT simulated Morse-code typewriter lets an aspiring ham radio operator learn and send Morse code simply by touching a built-in probe to selected letters and numerals. Once a character is touched with the probe, the typewriter self-produces and completes the equivalent Morse-code output for that character. Speed is adjustable from 5 to 60 wpm. Also adjustable are the volume level and tone. The typewriter features two outputs: audio for learn/practice and reed relay for making on-the-air contacts. Power for the CMOS circuitry is from two 9-volt batteries (not supplied). $99.95, wired and tested; $69.95, kit.

CIRCLE NO. 98 ON FREE INFORMATION CARD

Heath Electronic Cruise Control

According to the Heath Company, its new Model CS-1048 electronic cruise control

CIRCLE NO. 29 ON FREE INFORMATION CARD

can provide increased fuel mileage and promote driving safety by reducing fatigue on long trips. The device is completely electronically controlled. Accuracy is reported to be within 2 mph of the preset speed regardless of load and other variables. A "resume" memory holds the preset speed. In addition, the cruise control is said to be capable of operation with both manual and automatic transmissions. It can also be removed from one vehicle and reinstalled in another vehicle with a minimum of changes. The device comes assembled, ready for installation in vehicles having open driveshafts, as most cars do. Catalog price is $79.95.

CIRCLE NO. 90 ON FREE INFORMATION CARD

Pioneer AM/Stereo FM Receiver

The Model SX-1280 AM/stereo FM receiver from Pioneer is rated at 185 watts/channel minimum into 8 ohms from 20 to 20,000 Hz at no more than 0.03% THD. Its power amplifier section employs a direct-coupled OCL design, while separate power supplies are used for the two channels. The AM/FM tuner uses a MOSFET in the r-f mixing stage and a JFET in the mixing buffer stage. FM sensitivity is 9.8 dBf; capture ratio, 1.0 dB. Two of the four meters in the receiver are used for indicating power, separately for each channel. They respond to output powers from 0.01 to 370 watts without requiring sensitivity switching. The volume control is a 32-step attenuator type. Built-in are high and low filters, audible multipath switch, 25-µs FM deemphasis switch, stereo adapter in/out terminals and switch. $900.

CIRCLE NO. 99 ON FREE INFORMATION CARD

CPI AM/SSB CB Base Station

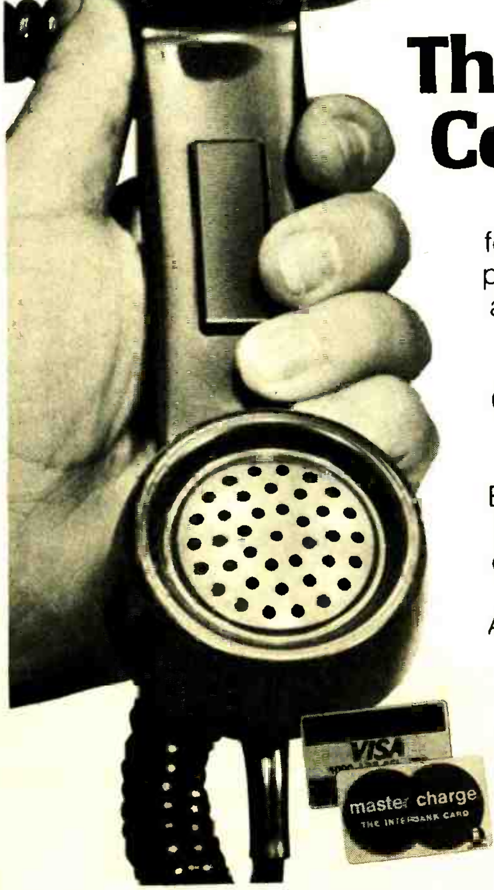
The Ultra CP-2000B "limited-edition" CB base station from Communications Power, Inc., employs a modulator that is said to provide an unusually high level of modulation without exceeding FCC specifications. Spurious response is rated at −70 dB. The transmitter is said to have an infinite SWR mismatch tolerance. Specifications for the single-conversion receiver include −70 dB i-f rejection, −80 dB adjacent-channel rejection, and −85 dB intermodulation characteristics. Built in are a switchable speech

compressor, switchable anl/noise blanker, r-f gain control with automatic override, and microphone gain control. Separate r-f output power/S and SWR calibration meters are provided. An optional Model BC-2000 base-station console provides: 7-digit frequency counter; 6-digit 12/24-hour clock; FET receive preamplifier; dual antenna tuner; dual antenna switch; and −50-dB TVI filter. $600.

CIRCLE NO. 100 ON FREE INFORMATION CARD

MORE than just a base station!

The New Realistic CB-Fone Communications Console



Realistic® invents the base CB that's also a control center. Perfect for home, office, small warehouse or dispatcher-type operations. The push-to-talk phone-type handset is great for private listening or noisy areas. Add a remote speaker — the CB-Fone becomes a paging/PA amplifier that lets you monitor incoming CB calls simultaneously. Emergency? Push the red priority button and you're instantly on Channel 9. Channel selection is electronic. Two buttons — count-up and count-down — replace rotary switches. Push once to change channels, hold down for rapid movement through all 40 channels. Big LED readout displays the channel number and indicates "PA" in public address mode. Flip-switches for delta-tune, blanker, handset or handset-plus-console speakers, mode selection. RF gain control. Lighted SWR and S/RF meters. On-the-air and modulation lights. AC and 12VDC versatility, positive or negative ground. U.L. listed. The CB-Fone — just 249.95* buys you a station that's something else!

These two credit cards honored at most Radio Shack stores.
*Price may vary at individual stores and dealers.

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New Literature

TELEX CB MIKE BOOKLET

"The CB Power Mike Fact Book" explains and discusses basic points and facts regarding CB power microphones. One important feature discussed is how a CB noise-cancelling mike keeps unwanted sound out. Other basic points covered include "Why the Microphone is a Most Important Part of Your Transmitter"; "Will a Power Mike Work With My 40 Channel Radio?"; and "The Special Advantages of CB Power Mike Headsets." The booklet, with drawings and photos, may be obtained by writing to Telex Communications, Inc., 9600 Aldrich Avenue South, Minneapolis, MN 55420.

JENSEN TOOL CATALOG

A new 144-page catalog of tools for electronic and mechanical assembly is offered by Jensen Tools and Alloys. It includes over 3,000 tools in categories such as micro-tools, test equipment, soldering equipment, tweezers, screwdrivers, cutters, drafting supplies, and power tools. Another section features tool kits and cases. Address: Jensen Tools and Alloys, 1230 South Priest Drive, Tempe, AZ 85281.

SIGNAL TRANSFORMER CATALOG

"Transformers," a 16-page publication from Signal Transformer Co., Inc., combines a short-form catalog and an application guide. It presents specifications and mechanical data on the company's line of transformers. Schematics are included. Among the components featured are the conventional power transformers, filter chokes, rectifier, high-current, step-down auto, step-up or step-down power-isolation transformers and low-cost Split/Tran[R] and Flathead[R] printed-circuit board transformers. Address: Signal Transformer Co., Inc., 500 Bayview Ave, Inwood, NY 11696.

MOTOROLA TWO-WAY RADIO TEST EQUIPMENT CATALOG

Thirty-one additions to Motorola's line of two-way radio test equipment appear in the company's new catalog. Featured are the models R-1200A service monitor, R-1010A signal generator, and S-1338A FM station monitor. Other test instruments for the maintenance of FM two-way radio communications equipment are included. Address: Motorola Literature Distribution Center, 1301 E. Algonquin Road, Schaumburg, IL 60196.

NATIONAL SEMICONDUCTOR LED CATALOG

National Semiconductor has prepared a catalog describing its line of opto-electronic products. The catalog contains photographs, outline drawings, and specifications of red, yellow and green light emitting diode (LED) lamps, multi-digit numeric displays, small calculator-type numeric arrays and watch display die. An application section is included on mounting techniques for numeric displays. The catalog also contains a list of National's LED segment drivers and digit drivers, with specifications and ratings. Address: National Semiconductor Corp. 2900 Semiconductor Drive, Santa Clara, CA 95051.

MALLORY GENERAL CATALOG

A new general catalog lists over 8,000 electronic components and related products made by P.R. Mallory & Co., Inc. Information on lines of capacitors, controls, switches, semiconductors, audible signal devices, security products, and cassette recording tape is provided. Address: Mallory Distributor Products Co., Box 1284, Indianapolis, IN 46206.

OEI COMPONENT CATALOG

The 1978 catalog of Optical Electronics, Inc., contains 41 data sheets on 18 operational amplifiers, 22 fast analog function modules, and a microcomputer. A selection guide indexes op amp modules by slewing rate, by gain-bandwidth at X100, and by settling time to 0.1%. The selection guide for function modules is arranged by model number and function: logarithmic amplifiers, sample and hold, peak sense and hold, V-F-V, D-A-D, power supplies and others. Address: Optical Electronics, Inc., Box 11140, Tucson, AR 85734.

AUDIO-TECHNICA MICROPHONE GUIDE

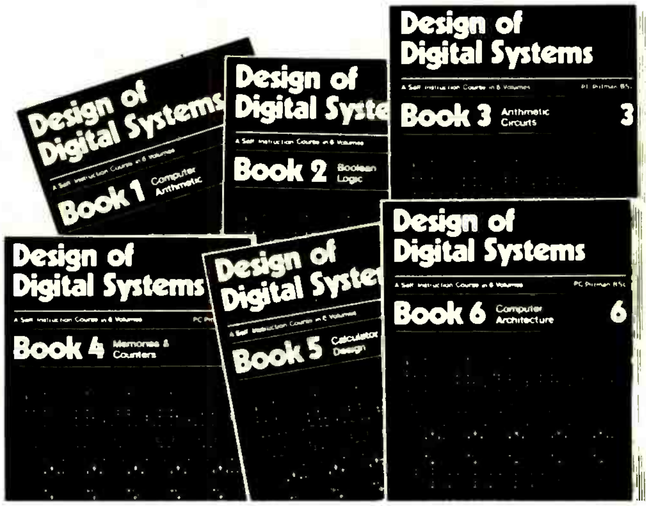
Available from Audio-Technica, "A Brief Guide to Microphones," is an instructional booklet applicable to all brands of microphones. The 15-page publication explains microphones through 8 basic terms: dynamic, condenser, omnidirectional, unidirectional (or cardioid), proximity effect, feedback, impedance and sensitivity. Address: Audio-Technica U.S., Inc., 33 Shiawassee Ave., Fairlawn, OH 44313.

INTERFERENCE INFORMATION

Interference and power-line surge damage common to audio equipment and FM receivers are described in a new flyer from Electronic Specialists. Problems such as lightning protection, ac power-line hash, and loudspeaker interference pickup are included. Cures for these problems are offered. Address: Electronic Specialists, Box 122, Natick, MA 01760.

Understanding Digital Electronics

New teach-yourself courses



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Book 2 OR and AND functions; logic gates; NOT, exclusive-OR, NAND, NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic.
Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.
Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).
Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.
Book 6 Central processing unit (CPU); memory organization; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.

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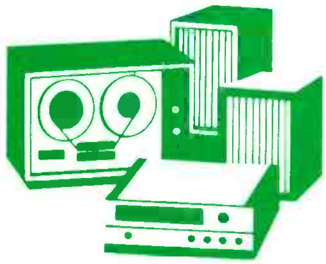


Stereo Scene

By Ralph Hodges

WITH THE HIGH ROLLERS IN VEGAS

FOR SOME TIME, the Winter Consumer Electronics Show (WCES) has been overshadowed by its much larger summertime brother. If this past January's installment was any different, it is probably because a change of venue from frigid Chicago to the comparatively benign climate of Las Vegas piqued enthusiasm, curiosity, and deeply harbored desires for a brief vacation after a grueling Christmas. It did not seem like much of a vacation from this side of the footlights, however.

The new WCES (it will return to Las Vegas next year) proved considerably enlarged in attendance and square yardage, particularly since it sprawled well beyond the official Convention Center headquarters and into a host of neighboring hotels and motels in true summer CES fashion. This raised certain tactical problems. For security reasons, the hotels refused to divulge room numbers, so that my search for some exhibitors simply had to be abandoned for lack of sufficient time or a competent wilderness guide. Next year I shall be more familiar with the territory.

As usual, the show offered no challenge to its summer counterpart in sheer numbers of new audio product introductions, but several of the debuts that did take place were provocative. A sampling follows.

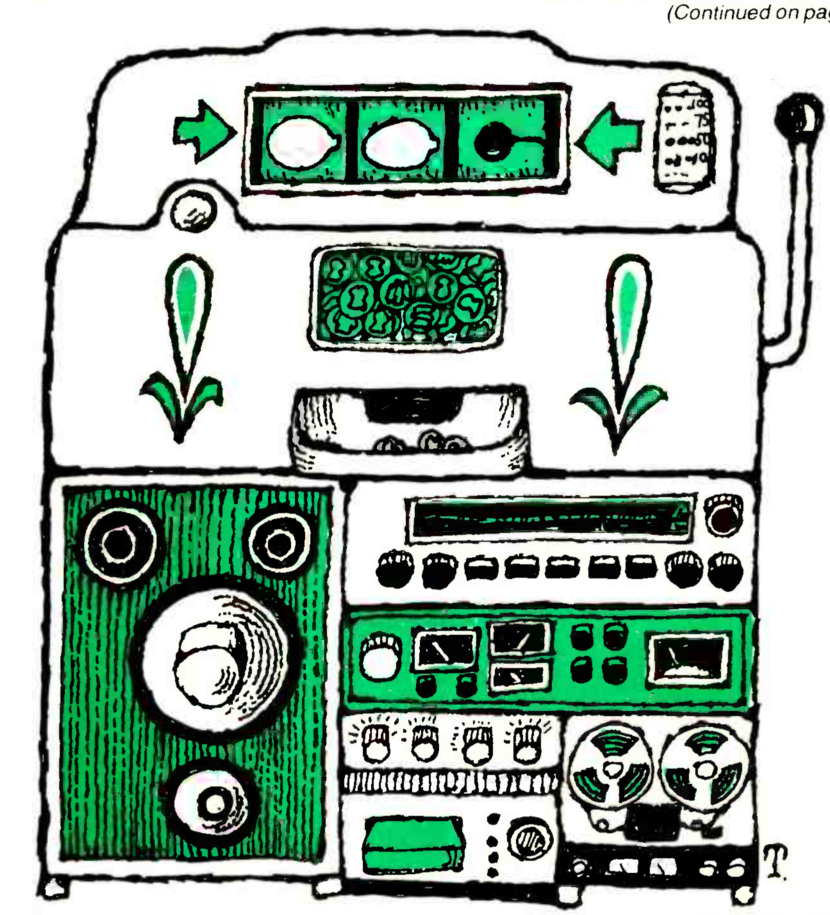
Musclemen. Thanks to Pioneer's new SX-1980, receivers are now up to 270 watts per channel and very probably still climbing. Happily, the newer super receivers are not growing much in size over the largest models of yesteryear. Instead, the problems involved with cooling units of this capacity are being solved on the engineering level. Pioneer's solution is a power transistor with a new body style that makes more surface area available to contact the heat sink. Combined with an internal "chimney" that encourages efficient flow-through of air, the transistors evidently can throw off heat rapidly enough to obviate the need for forced-air cooling– an impressive achievement at a time when pundits have only half-humorously predicted that the helium-cooled receiver is just around the corner. Clearly, the super-power receiver is well on its way to becoming commonplace. Even Sanyo, a company heretofore associated with middle-fi equipment and clock radios, has broken new ground with the 120-watt-per-channel JCX2900K.

In another accelerating trend, receivers, having been threatened somewhat by the growing popularity of separates, are now in the process of becoming separates themselves. Rotel introduced a receiver with a "docking" power-amplifier section a year or so ago, and Mitsubishi applied the same concept to an integrated amplifier. At WCES, Sansui joined in with the G22000, the top model of the G Series at 220 watts per channel. The forerunners of the G Series appeared at last June's show, and this new addition continues the interesting styling that distinguishes the line.

Many of the new amplifier introductions clustered around the mid-power level, an example being the Marantz 300DC power amplifier at 150 watts per channel. The Marantz unit is also indicative of a growing concern about slew rate and transient intermodulation distortion; the manufacturer lays heavy emphasis on the efforts made to control these performance parameters. Besides being augmented by a new 500-watt-per channel (!) stereo power amplifier (the Dual 500) and an analog time-delay/reverberation unit (Model 6000), the Phase Linear line has been completely restyled. The restyling included circuit modifications to virtually all the existing Phase Linear models, with FET inputs being much in evidence.

Hitachi has employed MOSFET output devices in two new power amplifiers, the HMA 7500 and HMA 9500, with 75 and 100 watts per channel, respectively. The $500 price of the HMA 7500 would appear to be a bargain for FET amplifiers. The company also introduced a matching preamplifier, two new three-

(Continued on page 20)



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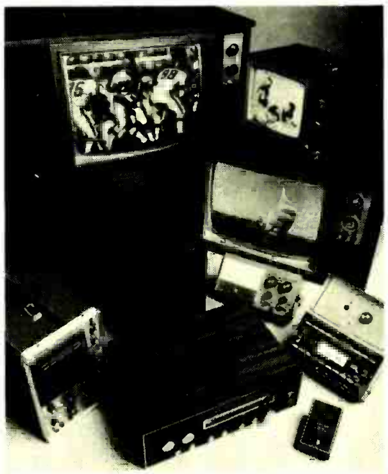

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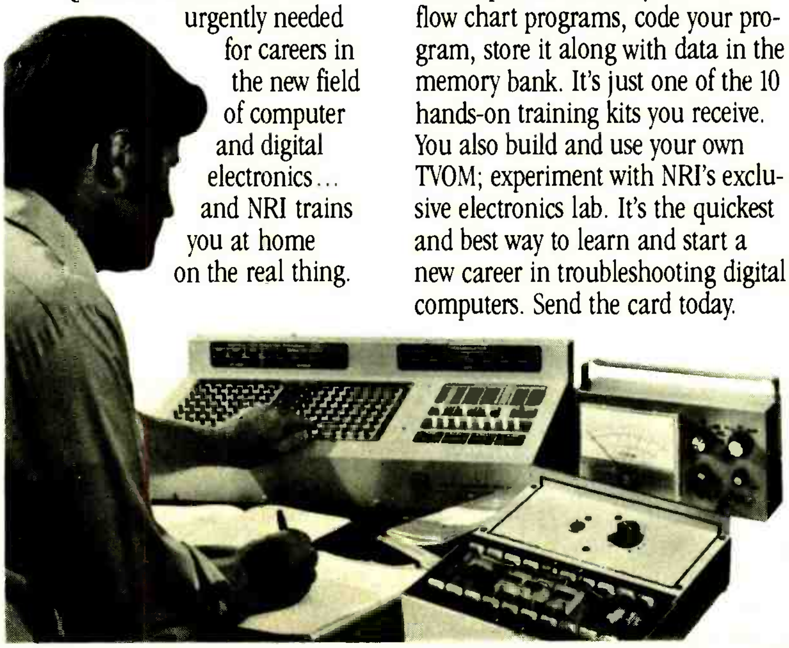

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(Continued from page 14)
head cassette decks, and a novel direct-drive turntable. Sony's pulse-width modulation amplifier has now been designated the TA-N88 and is rated at 160 watts per channel. And among SAE's new introductions is a combined integrated amplifier and parametric equalizer, the Model 2922.

Loudspeakers. Helium-cooled amplifiers we may not have, but helium-cooled speakers may finally be here. A company called Plasmatronics exhibited a mid- and high-frequency driver consisting of a small quartz cell with a small square opening in its frontal surface. A continuous stream of helium is bled into the cell in the presence of a high polarizing voltage. An eery violet glow with tinges of green and yellow promptly appears; and when an audio signal is applied (from an internal vacuum-tube amplifier), what comes out is sound.

The designer, Alan Hill, is not yet able to be totally specific about the operating principle (patent considerations are involved, I imagine); but this is clearly an ionized-gas loudspeaker with an unusually wide frequency response (down to 700 Hz) and dynamic range. Speculation about the purpose of the helium continues. Some believe that it assists in high-frequency propagation (ever heard a man speaking in a helium-oxygen atmosphere?) while others suspect it is merely a coolant (the cell radiates an impressive amount of heat). In any case, a tank of the gas lasts an estimated 300 hours, after which you must return for a refill. The Plasmatronics speaker has a conventional dynamic woofer and some very impressive frequency-response and impulse-response specifications. The associated preamplifier offered by the company is highly recommended; it has a switch to halt the helium flow.

Acoustic Research has a new top-of-the-line model, the AR9, standing over 4 feet tall and equipped with dual side-firing woofers (12 inches each) placed for optimum acoustic coupling with the nearest room boundaries. It is a four-way design with what AR says is the flattest response and highest power-handling capability it has ever achieved.

Infinity's latest speaker system, the Quantum Reference Standard, is likewise a top-of-the-line model, offered on a custom-order basis at a projected price of $6500 the pair. They make use of vertical arrays of the EMIT film-diaphragm tweeters, to which the manufacturer is now fully committed; and they have a multi-faceted cabinet that is certainly one of the largest ever introduced to the consumer market.

JBL's new products consisted of the L50, the lowest-price three-way design in the JBL catalog, while KLH launched several additions to its Baron series. In addition, ESS presented quite a few modifications to many of its existing products and unveiled a production-ready version of the Transar loudspeaker with the unique Heil woofer.

And Elsewhere. Kenwood's new top-of-the-line turntable, the KD-750, follows a number of acclaimed successes in turntable design by that manufacturer, and also incorporates a 20-pole dc motor. (Multi-element motors are becoming increasingly favored by designers of direct-drive systems as the fight to eliminate any trace of cogging continues.) The Harman-Kardon/Rabco ST-8 is a thoughtful redesign of the ST-7, using the same radial tracking principle but benefitting from various refinements. AR has a rather special turntable in the works as well, but in the meantime the company offers the AR77-XB, the latest evolution of its classic AR turntable.

Listeners to older 78-rpm records—which in many cases were not quite 78 rpm—have long bemoaned the lack of turntables that are continuously variable in speed. They will be glad to learn that the elusive Lenco record players are now back and firmly entrenched with Neosonic Corporation of America acting as importer and distributor. The three Lenco variable-speed models operate at anything from 30 to 86 rpm, and can be bought with and without bases.

Turntables, tuners, and cassette decks are the areas in which automation and computer techniques have found their happiest consumer application so far, and this tradition continues with a new cassette deck from Sharp/Optonica. Incorporating all of the program-search features of previous models from this manufacturer, the new machine also has a liquid-crystal display that indicates the operating function and the time of day, as determined by a 24-hour quartz-crystal clock with a seven-segment digital readout. Perhaps needless to say, the clock also functions as a timer. Therefore, the deck can be set to record any program at any time and then turn itself off, all without any operator's attention.

Another interesting cassette development is the re-emergence, of the cassette changer/player. Lenco's RAC-10 machine, capable of handling up to ten cassettes at a time, has returned to the U.S. It is not a device for everyone, but it appears to be the single survivor of a possible trend that showed promise some years ago.

Accessories is a product category that has grown from an afterthought to a major center of consumer attention, and few accessories were as popular at this show as racks—equipment-holding racks, that is. Kenwood, Sansui, Mitsubishi, and Harman-Kardon are a few of the major companies that have followed the lead of Pioneer and Nakamichi in introducing vertically tiered equipment cabinets, some with casters, that will readily accept the 19-inch front panels of much current equipment. Whether they will accept the varying depths and heights of different manufacturers' amplifiers, preamplifiers, and tuners is still an unanswered question, as are such matters as ventilation and provision for interconnecting cables. Optonica showed a variety of other types of cabinets to house hi-fi components. They feature push-to-open glass doors for the LP record storing section.

In the meantime, record-care accessories are proliferating beyond any hope of keeping track of all of them; even tape companies like Memorex have devised extensive lines of stylus-force gauges, record-tracking dust removers, and hand-held record decontaminators. So far, none of these new products conspicuously demonstrates any new thinking about the problem of dirt on record surfaces, but neither does any of them seem ill-suited to its purpose.

Many are calling the new ADS 10 Acoustic Dimension Synthesizer the best of the available reverberation devices for the home user. It is an entirely digital processor with a frequency response (at −20 dB) of 30 to 13,000 Hz and a continuously variable decay time of up to 1.6 seconds. ADS has built in a 100-watt-per-channel stereo amplifier, and includes a pair of L10 speaker systems for rear-channel use with the package. The operation of the A-to-D/D-to-A converter is still classified, but it was revealed that a special circuit is built-in to limit the reverberation enhancement afforded to mono signals when desired. Consequently, FM programs can be listened to without the announcer sounding as if he were speaking from a cathedral floor.

All of these products should be getting some attention in these pages in months to come. And from first appearances, they will deserve it. ◇

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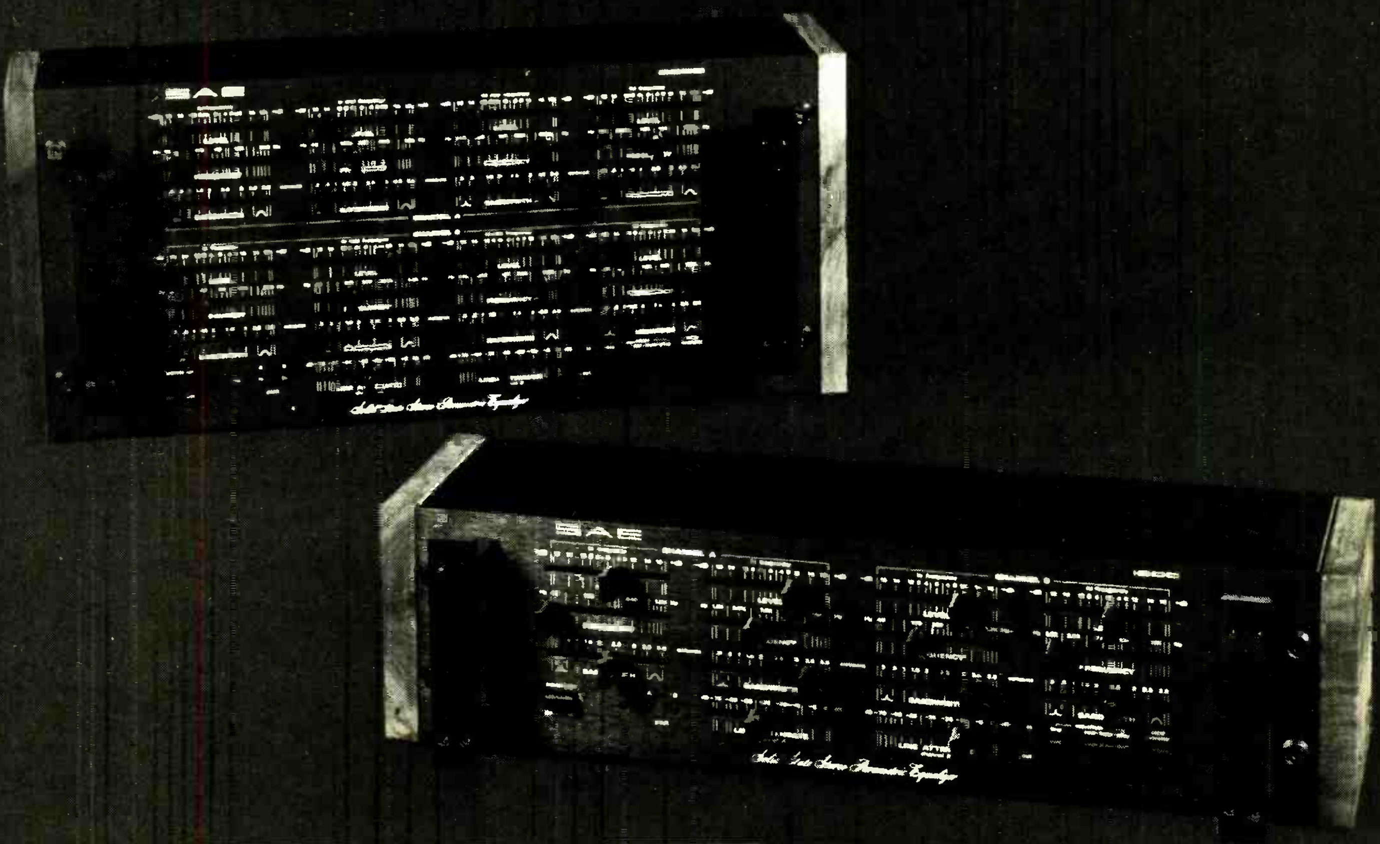

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Julian Hirsch Audio Reports

HIRSCH/HOUCK LABORATORIES

THE POWER RACE—WHEN WILL IT END?

IT IS EASY to be carried away by the ever-increasing power ratings of today's receivers and amplifiers. Not long ago, a basic power amplifier that could deliver 100 watts/channel rated the name "super power." (Such power levels were unheard of in receivers.) Then amplifiers began to have ratings of 200 to 250 watts, and receivers crept up to 120, 150, 160, and 180 watts. Last year, the leader in the receiver power race was a giant from Marantz, rated at 250 watts/channel, but a 270-watt receiver from Pioneer now threatens its position. In basic power amplifiers, a 500-watt/channel Rotel amplifier currently leads the race, but similarly rated amplifiers from Phase Linear and possibly others are in the offing. Apparently the end of the race is not yet in sight.

The justification for this race to greater and greater power is multifaceted. Partly, it is merely because technology now makes it possible, at reasonable cost, to generate such huge power outputs. Some of today's power transistors can dissipate hundreds of watts per device, yet are priced low enough for use in consumer products. Manufacturers can hardly be blamed for attempting to convert some of this new technology into saleable hardware. And the prices of some of these products are not unreasonable in view of their performance, though some may find the size and weight excessive for their homes.

Another side to the question of "how much power" is one of need, or at least, utility. No one will claim that a power level of hundreds of watts per channel is always necessary for good reproduction. However, there are convincing arguments that prodigious power can be used to advantage under some circumstances. If it can be utilized and if it can be generated without prohibitive expense, why not have it available in our deluxe amplifiers and receivers?

One of the two questions most often posed to me is what amount of power is needed for a good hi-fi system? Even after I narrow down the scope of the question by establishing what type of speaker systems will be used in what size room, etc., the answer is still necessarily vague and unsatisfying. What it boils down to is that you need as much power as is necessary to play music as loud as you like to hear it. While this is the literal truth, it is of little help in selecting system components. Under most home conditions, reasonably high acoustic levels can be generated with only 1 or 2 watts of amplifier power. It is, therefore, difficult for a layman, or even an experienced audiophile, to understand how a reserve of hundreds of watts can be beneficial or justifiable.

The explanation for this "need" for high power lies in two different, though related, aspects of sound. Most natural sounds, either music or speech, are non-sinusoidal. They consist of a multitude of frequencies whose combined waveform usually has a high crest factor. The maximum instantaneous peak amplitude is many times the rms value of the waveform, computed through a complete cycle of its fundamental frequency. (In contrast, the instantaneous peak value of a sine wave is only 1.41 times its rms value.) The perceived loudness of a sound is roughly related to its average or rms value, the two usually being of the same order of magnitude. Brief peaks that exceed the rms level by a factor of 10 or 100 times are not heard as being louder. The effect is familiar to everyone who has heard the greatly increased apparent loudness of TV or radio commercials, as compared to the average program levels. The peak modulation levels are unchanged (any transmitted increase would result in illegal overmodulation), but the average level of the commercial is raised by compression so that it is heard at a much higher volume.

The second factor is the intermittent nature of music and speech. Regardless of the wave shape of the sound, it is characterized by large variations in level during the program. Musical passages may be very soft, or there may be periods of complete silence, followed by periods of very high program levels. The average level, over the entire duration of the program, is normally very much less than the maximum level attained during that interval. Thus, to reproduce either music or speech in a natural manner, the amplifier must have the capability of delivering peak outputs many times the average power.

The amount of reserve "headroom" needed in an amplifier varies widely with the program material, since all recorded and broadcast programs are limited to keep their peak levels within the limits set by the transmission medium. A headroom of only 10 dB may be adequate in many cases, but for most realistic reproduction, 20 dB is preferable.

The 20-dB headroom is a power ratio of 100 times. If the average power during a musical passage is

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about 1 watt (it could range from a few milliwatts to several watts), the amplifier will be called upon to handle an occasional peak of as much as 100 watts. "Occasional" here means as infrequently as a few milliseconds out of a half hour of playing, or perhaps as often as 10% of the time, but more likely the former. If the amplifier cannot deliver those peaks, the result will be clipping, which may be audible.

Most of us manage to enjoy our music systems without undue distress from amplifier peak clipping, even with considerably less than 100 watts of power available to us. Recorded programs rarely have more than a 10-dB peak-to-average ratio, since they are designed for playback on mass-produced record players with very limited power capabilities. Some speaker systems are so efficient that they require only a tenth as much power as others for the same volume level.

With the foregoing in mind, why do we need "super-power" amplifiers, and what possible justification can there be for receivers or amplifiers that can deliver hundreds of watts per channel? The answer, or part of it, lies in the logarithmic nature of human hearing. To make a program sound twice as loud, we must increase the power ten-fold. Another doubling of apparent loudness, and we require 100 times the original average power level (and as much as 100 times *that* level to handle the peaks).

It might appear that there is no practical solution to the power "shortage." If our hypothetical 1-watt average program, heard at a comfortable level (and requiring from 10 to 100 watts of amplifier power in reserve just to avoid peak clipping) is to be played "just a little bit louder," we can easily find ourselves running out of power, even with a 200– or 300-watt amplifier. This is not as far-fetched as it may seem. I find it very easy to clip the outputs of an amplifier rated at 200 watts/channel or more, at levels far below those that exist at a discotheque or in the vicinity of a small instrumental combo when using speakers of average efficiency.

Not surprisingly, the equipment manufacturers' answer to the clipping problem is to make more powerful amplifiers. Unfortunately, this is no answer at all, since a 500-watt amplifier will play only a barely detectable 3 dB louder than a 250-watt amplifier. It is also much more likely to blow out one's speaker systems if used carelessly. Speaker systems can not handle unlimited power.

The reason for public acceptance of less-than-ideal program dynamic range in home music reproduction, in my opinion, lies in the ready availability of a knob, usually labelled VOLUME or LOUDNESS, and found on every receiver and amplifier. We turn this knob clockwise to increase the loudness. Perhaps, if we are lucky, the program reaches what we consider a natural level and is free of unpleasant sounds. Well and good, since this is what hi-fi is all about. Suppose that before this level is reached, however, we hear obvious and unpleasant distortion. Rather than try for higher levels, most people react by turning down the volume until the distortion becomes acceptable.

In turning down the volume, we have adapted the reproduced program level to the limitations of our equipment, and are willing to accept a less-than-natural listening level. In a very short time, most of us no longer find such levels unnatural, which is very fortunate, since it is manifestly impractical to generate concert hall levels in one's home unless the neighbors are distant or deaf or both.

The foregoing is why hundreds of thousands of people are very satisfied with 20-watt receivers, thousands more find the 60 to 80 watts of a good middle-priced receiver more than satisfactory, and only a few can justify the considerable expense of the super-power variety. Personally, I appreciate having 200 watts or so on tap when needed, but recognize that the listening benefits of even an increase to 300 or more watts will often be judged too subtle for the added cost. Of course, that will not stop manufacturers from creating such amplifiers or receivers, or dedicated audiophiles from buying them. I can only say, more power to them!

HARMAN-KARDON MODEL 730 AM/STEREO FM RECEIVER

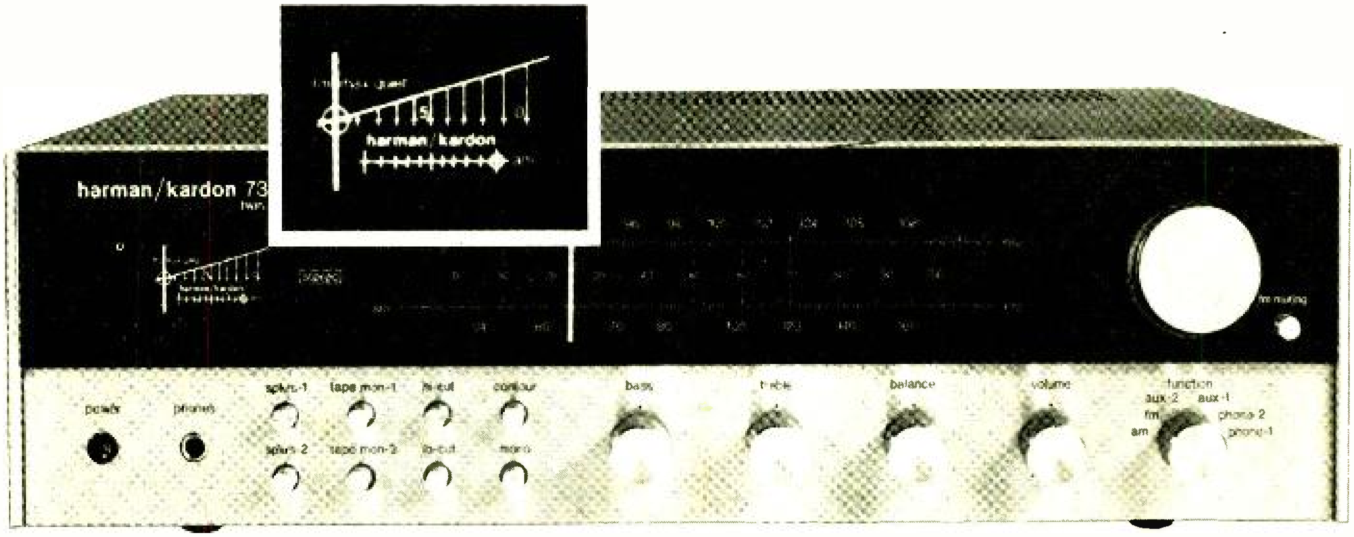
Medium-power receiver features unusual tuning meter.

HIRSCH-HOUCK LABS REPORT

Transient performance has long been an important part of Harman-Kardon's design approach to its high-fidelity products. To this end, the company has espoused amplifiers with very wide-band, low phase-shift circuits, and, as in the latest crop of H-K receivers, separate power supplies for the two channels. The Model 730 AM/stereo FM receiver that heads the current H-K receiver line embodies these design aims, although its 45-watt output power is barely moderate by present standards.

The styling of the Model 730 is distinctive, with the front panel presenting an uncluttered, utilitarian appearance. The most unusual external feature of the receiver is its tuning meter that, on FM, is actually a quieting indicator. It indicates the reverse of the usual signal-strength meter, with its pointer deflecting down-scale as signal-strength increases and noise level decreases. In effect, the meter indicates S/N in a qualitative, rather than a quantitative, manner. When the pointer enters a small circle at the lower limit of its travel, the receiver is fully quieted. For AM reception, the meter's pointer swings up-scale with increasing signal strength, as is usually the case with most of the conventional signal-strength meters.

Dimensions of the Model 730 are 5½" H × 17" W × 14½" D (14 × 43 × 37 cm). Suggested manufacturer's price for the Model 730 is $399.95.



Inset shows FM quieting indicator also used for AM signal strength.

Product Focus

Traditionally, the tuning meters in FM tuners and receivers indicated received-signal strength and/or center-channel tuning. Harman-Kardon has made a change from tradition by having its Model 730 stereo receiver's meter indicate relative signal quality so that, when nulled, tuning is as near perfect as possible for maximum S/N.

The signal-quality meter system employs a discrete transistor amplifier and two tuned resonant circuits. Each resonant circuit is tuned to about 100 kHz. The signal that drives this filter/amplifier combination is derived from an amplifier stage that follows the tuner's discriminator.

The amplifier/filter combination amplifies the noise that appears at 100 kHz at the discriminator's output. The 100-kHz frequency was chosen to minimize the effects of audio modulation on the meter's reading. (It prevents the meter pointer wobble common to multipath meters.)

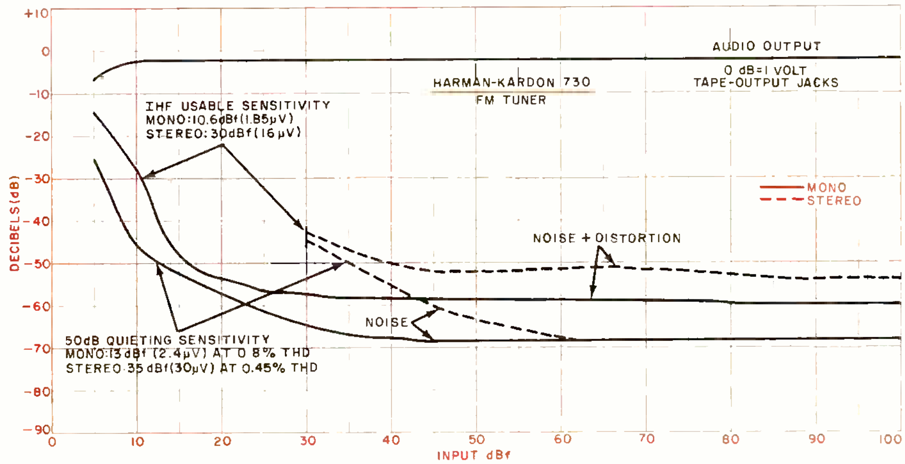
Since it is tuned to 100 kHz and "looks" only at that frequency, the metering system is quite selective and is thus able to give a pretty good indication of S/N. (If the frequency selected were more than 100 kHz, the discriminator would roll off the response.)

The system is not a true signal minus noise meter. Rather, it indicates noise itself. The circuit employs an agc system to prevent the meter from becoming crowded at one end, which linearizes the meter scale.

General Description. During the past year or so, we have seen several amplifiers and receivers with separate power supplies for the two audio channels, some of which utilized a single common power transformer and others with separate transformers. Doing this is supposed to eliminate interaction between channels that results when a common power supply impedance is used, especially at very low frequencies. The benefits of such isolation are difficult to demonstrate by objective or subjective means. Judging from the size of the power transformers and filter capacitors used in the Model 730, there is probably little difference in material cost between the Harman-Kardon approach and simply making a single, heavy duty supply with sufficient output capacitance to provide adequate isolation. Of course, with separate power supplies there is absolutely no difference in the performance of one channel whether or not the other channel is driven. The FTC-mandated preconditioning period of one hour at one third power, with both channels driven, is still necessary to bring the amplifier to a fully heated condition.

Harman-Kardon's wide-band philosophy is illustrated principally in the low-frequency response of the Model 730, which extends to 4 Hz and below. Clearly, most of the amplifier stages are direct-coupled. In a brochure furnished with the receiver, a 20-Hz square-wave response with only a 3% tilt is displayed to emphasize the receiver's extended low-frequency response.

On the rear apron of the receiver, there are pushbutton reset circuit breakers that protect the speaker outputs and a control shaft that permits adjustment of the FM muting threshold over a wide range. The ventilating slots at the rear of the top cover run across the width of the receiver. The output transistors and their heat sinks extend from front to rear, at the center of the receiver's chassis. Thus, the ventilating holes have very little direct cooling effect. Even so, despite the relatively large size of the receiver (for its power rating), it runs notably cool at all times.



Noise and sensitivity curves for FM section of receiver.

WHAT THE EXPERTS CALLED THE BEST LAST YEAR WASN'T GOOD ENOUGH FOR US.

"IT CANNOT BE FAULTED."

SA9500 — *Stereo Review*

"AS NEAR TO PERFECT AS WE'VE ENCOUNTERED."

TX9500 — *Popular Electronics*

"CERTAINLY ONE OF THE BEST... AT ANY PRICE."

TX9500 — *Modern Hi Fi*

SA9500II

Last year, the experts paid Pioneer's integrated amps and tuners some of the highest compliments ever.

The challenge was obvious: to build even better amps and tuners. Amps and tuners that would not only surpass anything we'd ever built before, but anything anyone ever built before. Here's how we did it.

THE NEW PIONEER TX9500II TUNER: EVEN CLOSER TO PERFECT.

When Popular Electronics said our TX9500 tuner was "as close to perfect" as they'd encountered, they obviously hadn't encountered our TX9500II. It features technology so advanced, some of it wasn't even perfected until this year.

Our front end, for example, features three newly-developed field effect transistors that work to let you pull in beautiful FM reception no matter how far you live from the transmitter. And no matter how much interference there is in your neighborhood.

Where most tuners give you one band for all FM stations, the TX9500II gives you two. A wide band with a new surface acoustic wave filter to take advantage of strong stations, and a narrow band with *five* ceramic filters to remove the noise and interference from weaker ones.

And where conventional multiplex circuits accidently cut out frequencies that add depth and presence to music, the multiplex circuit in the TX9500II doesn't. It features a Pioneer-developed integrated circuit that's far more accurate than anything else around. So the music begins to sound as if it's coming live from your living room, instead of from some radio station miles away.

THE NEW SA9500II AMPLIFIER: HOW TO GET THE MOST OUT OF THE BEST.

After building one of the world's best tuners, we had no choice but to create an amplifier that could match it.

The result is the new SA9500II. An 80* watt integrated amp that was designed to let you get everything out of your tuner. Perfectly.

Our output stage, for example, features a new parallel push-pull circuit that reduces total harmonic distortion to less than 0.1%. Well below the threshold of human hearing.

To all but eliminate cross-talk, the SA9500II comes with a separate power transformer for each channel, instead of the usual single transformer for both.

And where some amps give you two, or three tone controls, the SA9500II gives you four. Two for regular treble and bass, and two for extended treble and bass. They're calibrated in 2 dB click stops, which means you have a virtually endless variety of ways to get the most out of your music.

Obviously, both the SA9500II and the TX9500II are very sophisticated pieces of equipment. But all of the engineering skill that went into making them has gone into every tuner and amplifier in our new series II. No matter what the price, no matter what the specifications.

And that's something you don't have to be an expert to appreciate.

SA9500II—TX9500II

POWER MIN. RMS, 20 TO 20,000 Hz	80	SIGNAL TO NOISE RATIO	Mono 82dB Stereo 77dB
TOTAL HARMONIC DISTORTION	0.1%	FM SENSITIVITY (IHF '58)	1.5uV
PHONO OVERLOAD LEVEL	300mV	SELECTIVITY	(wide) 35dB (narrow) 85dB
INPUT: PHONO/AUX/TAPE	2/1/2	CAPTURE RATIO	(wide) 0.8dB (narrow) 2.0dB

*Minimum RMS continuous power output at 8 ohms, from 20 to 20,000Hz, with no more than 0.1% total harmonic distortion.

High Fidelity Components

PIONEER®

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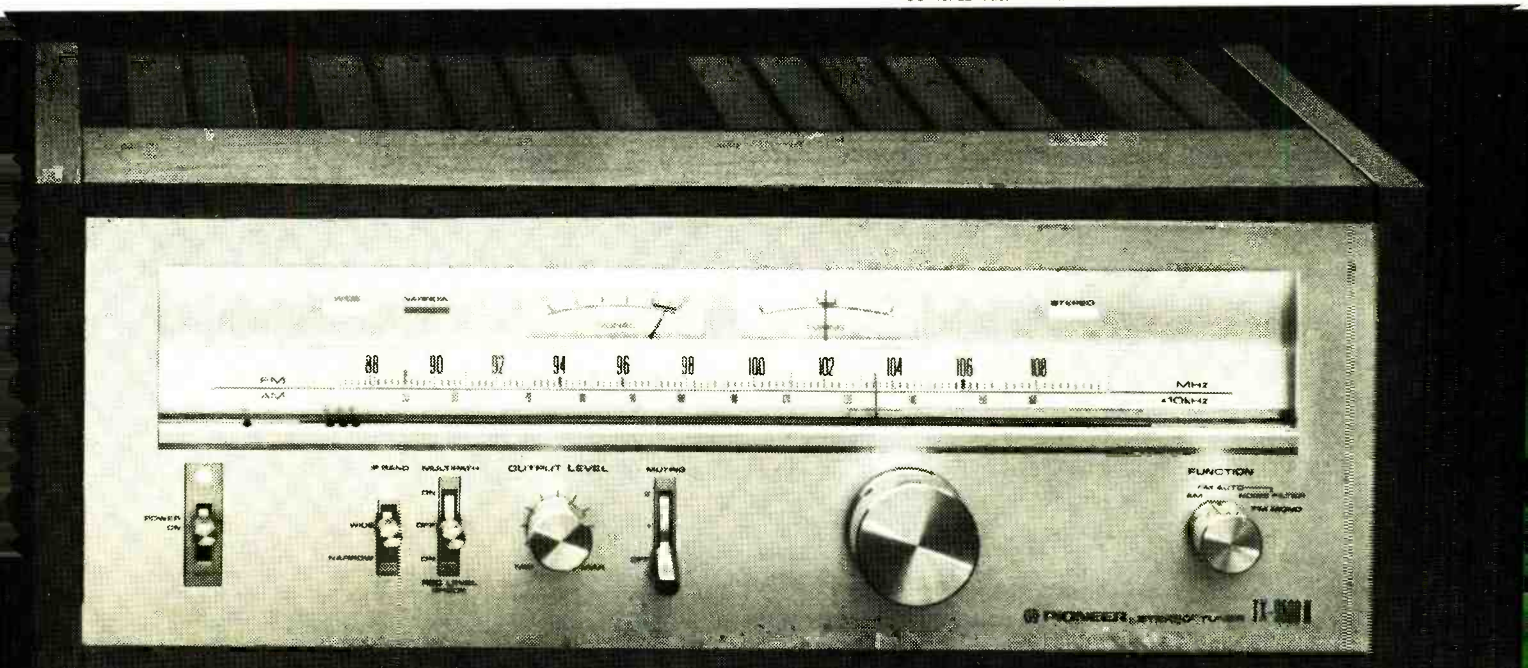
U.S. Pioneer Electronics Corp., 85 Oxford Drive, Moonachie, New Jersey 07074



TX9500II

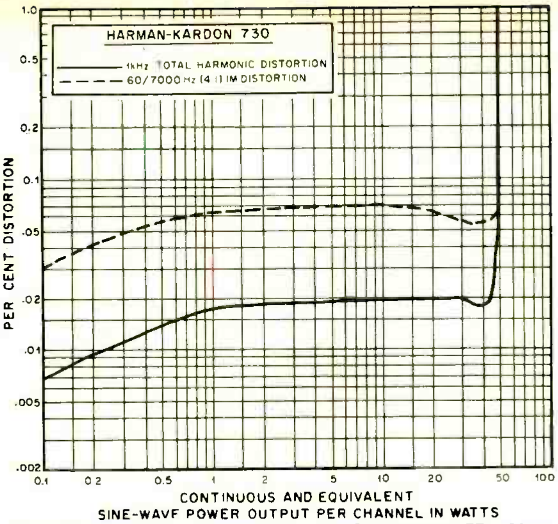
CIRCLE NO. 63 ON FREE INFORMATION CARD

PERFORMANCE SPECIFICATIONS

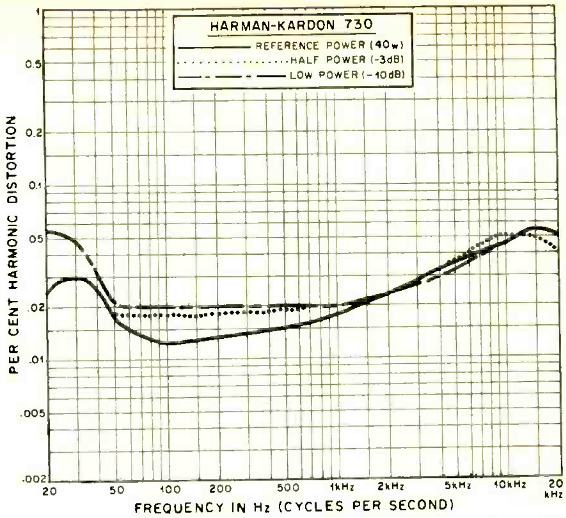
Specification	Rating	Measured	Comment
Power Output (8 ohms, 20–20,000 Hz)	40 W @ 0.1%THD	40 W, 0.05%THD	
Clipping Power (1000 Hz)	N/A	51 W (8 ohms) 64.8 W (4 ohms) 33.6 W (16 ohms)	
Frequency Response (1-watt output)	4Hz–140kHz ±0.5 dB	5Hz–220kHz ±0.5 dB	5 Hz is lower test limit
Rise Time	1.5 μs	1.5 μs	
Slew Rate	N/A	9 V/μs	
IM Distortion (60/7000 Hz, 4:1)	0.12% @ 40 W 0.15% @ 1 W	0.056% @ 40 W 0.065% @ 1 W	
Hum & Noise (unweighted)	−60 dB re 40 W	−83.6 dB (AUX) −81 dB (PHONO)	
Input Sensitivity (for 40-watt output)	150 mV (AUX) 2.5 mV (PHONO)	136 mV (AUX) 2.2 mV (PHONO)	1000 Hz
Phono Overload (1000 Hz)	95 mV	105 mV	
RIAA Equalization Accuracy	±1 dB	±1 dB	30–15,000 Hz
FM Sensitivity: IHF MONO −50 dB MONO −50 dB STEREO	 1.9 μV 3.5 μV 35 μV	 1.85 μV (10.6 dBf) 2.4 μV (13 dBf) 30 μV (35 dBf)	
Ultimate S/N	70 dB	68.5 dB (MONO) 68 dB (STEREO)	
Capture Ratio	2 dB	1.76 dB	
Image Rejection	80 dB	85 dB	
AM Rejection	60 dB	70 dB	
Alternate Channel Select.	80 dB	71.4 dB	
Adjacent Channel Select.	N/A	7.8 dB	
Stereo Separation (1000 Hz)	40 dB	47 dB	
FM Distortion (1000 Hz)	0.2% MONO 0.3% STEREO	0.11% MONO 0.29% STEREO	65 dBf
Pilot Carrier Leakage	N/A	−75 dB	

User Comment. The RIAA phono equalization is not only very accurate over the defined range of 30 to 15,000 Hz (it falls off somewhat at the lowest frequencies), but it is totally unaffected by cartridge inductance. The audio distortion of the receiver was quite insignificant, and the clipping power of about 50 watts should be adequate for most home installations, with speakers of normal efficiency.

Although the tone controls have a satisfactory range and choice of turnover frequencies, the high-cut filter is essentially useless. (It virtually duplicates the response of the treble tone control near its minimum setting.) A 6-dB/octave filter with a −3-dB response at 3000 Hz is



Total harmonic distortion and 60/7000-Hz distortion.



Harmonic distortion at three power levels.

really not worth the control space allotted to it on the panel. The low-frequency filter, although not ideal, is considerably better; it has a 12-dB/octave slope and a −3-dB frequency of 50 Hz. The loudness compensation boosts only low frequencies, to a moderate degree, yet manages to sound undesirably heavy because it affects almost the entire range below 1000 Hz.

The FM tuner section was excellent, handily meeting or surpassing almost every specification. The quieting meter proved to be a very accurate tuning indicator. Although this point is not mentioned in the instruction manual we noted that the meter's pointer fluctuated with multipath distortion and gave a steady indication on signals free of that effect. This represents the first triple function FM tuning meter we have used (center channel, as shown by a definite minimum reading; relative signal strength; multipath distortion). Its only drawback, compared to conventional meters, is that one must tune quite slowly through a station to establish the minimum reading, and then tune back to that point—again, slowly—since the meter seems to respond with a lag. In contrast, a typical center-channel meter allows one to stop tuning as soon as the pointer reaches the indicated center.

Although the FM tuner had a ruler-flat frequency response to 15,000 Hz, the 19-kHz pilot carrier leakage was a very low −75 dB. This speaks well for the design of the multiplex filters in the tuner section. The stereo channel-separation characteristic was unusual, with a very wide separation of more than 60 dB at 30 Hz, which decreased smoothly to 24 dB (still good) at 15,000 Hz. As a whole, the tuner's FM performance was excellent. The AM tuner was as limited in its frequency response as most we have used, but was exceptionally quiet and free of the buzzes and noises that usually accompany a scan of the AM broadcast band.

In listening tests, the Model 730 did a first rate job. Like most good receivers, it sounded as good or as bad as the program material allowed. When we transmitted a high-quality signal to it through our laboratory signal generator, it left nothing to be desired. The muting circuit has a slight delay that allows the dial to be twirled from one end of the FM band to the other in perfect silence; about a second after a station is tuned in, its modulation appears. In slow tuning through a station, we heard only a faint click as the muting operated.

One of our two criticisms of the Model 730 (both relate to its FM tuner section) concerns a basic design factor and the other is certainly due to a fault in our test sample. The pointer of the tuning meter is not illuminated or even colored white for contrast against the black and dark green background of the meter scale. As a result, it can hardly be seen, except at point-blank range. On our test unit, the FM dial calibration was poor, showing the result of a misalignment. It was accurate below 94 MHz but had an error of 300 kHz at 96 MHz, and 700 kHz at 106 MHz. As a result, tuning was approximate over much of the band.

The Harman-Kardon Model 730 is convincing evidence that a medium-priced receiver can deliver top-quality sound, combined with all the operating flexibility most people will ever need and an attractive appearance.

CIRCLE NO. 101 ON FREE INFORMATION CARD

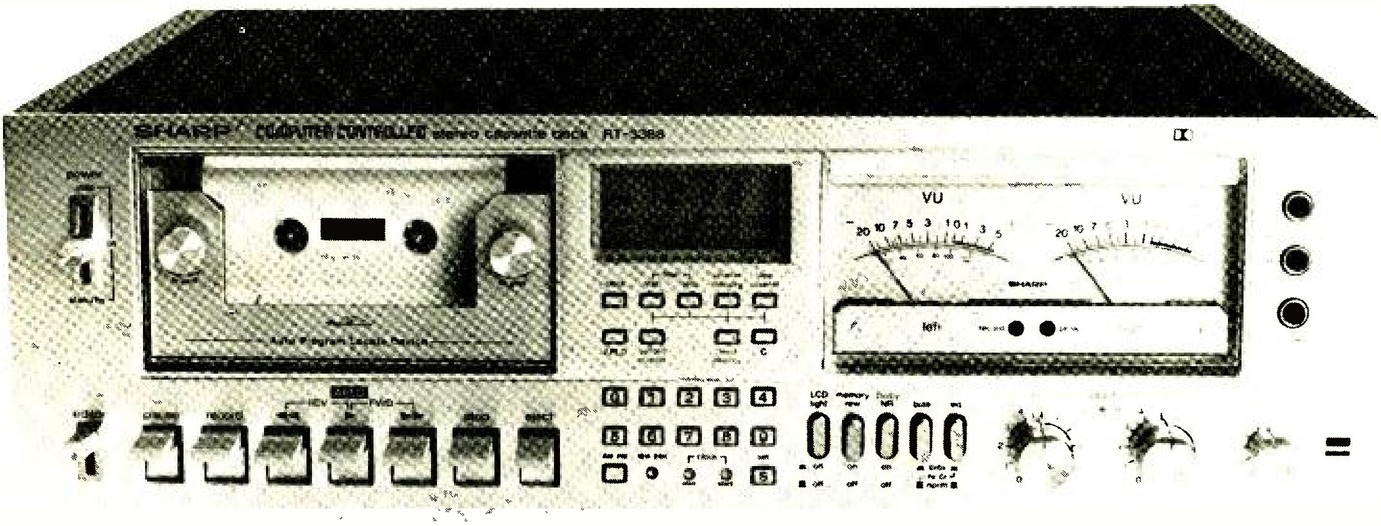
SHARP MODEL RT-3388 FRONT-LOADING CASSETTE DECK

Built-in "computer control" system and LCD display are featured.

The Sharp Model RT-3388 is a basic cassette deck of conventional design and good quality. Where it differs from other cassette decks is in its built-in "computer control" system that gives it an operating flexibility and convenience previously unavailable in a consumer deck. The cassette deck proper is a two-head, single-motor transport with a servo-controlled dc motor. The front-loading mechanism provides excellent visibility of the entire cassette through its clear plastic window that makes up almost the entire cassette compartment door. The door can be removed by loosening two thumbscrews to provide complete access to the tape heads for cleaning and adjustment. The operating controls are mechanical "piano-key" levers that are solenoid assisted for certain functions.

The cassette deck measures 17 ⅜"W × 12 ⅞"D × 5 ⅜"H (44.1 × 32.7 × 13.7 cm) and weighs 20 lb (9.1 kg). Its nationally advertised retail value is approximately $350.

General Description. The deck has separately switchable bias (HIGH/LOW) and equalization (70/120 μs). The manual that accompanies the deck lists recommended settings for most popular tape brands and formulations. Unlike the case with most recorders, the manual



also identifies the specific tapes for which the deck was adjusted at the factory. They are Maxell UD (normal), Maxell UD-XL II (HIGH/70 μs), and Sony Ferrichrome (LOW/70 μs).

The recorder has built-in Dolby noise reduction, separate microphone and line inputs that can be mixed, and large illuminated level meters supplemented by a PEAK LED indicator. While this is conventional, the rest of the deck is far from conventional, as is immediately obvious.

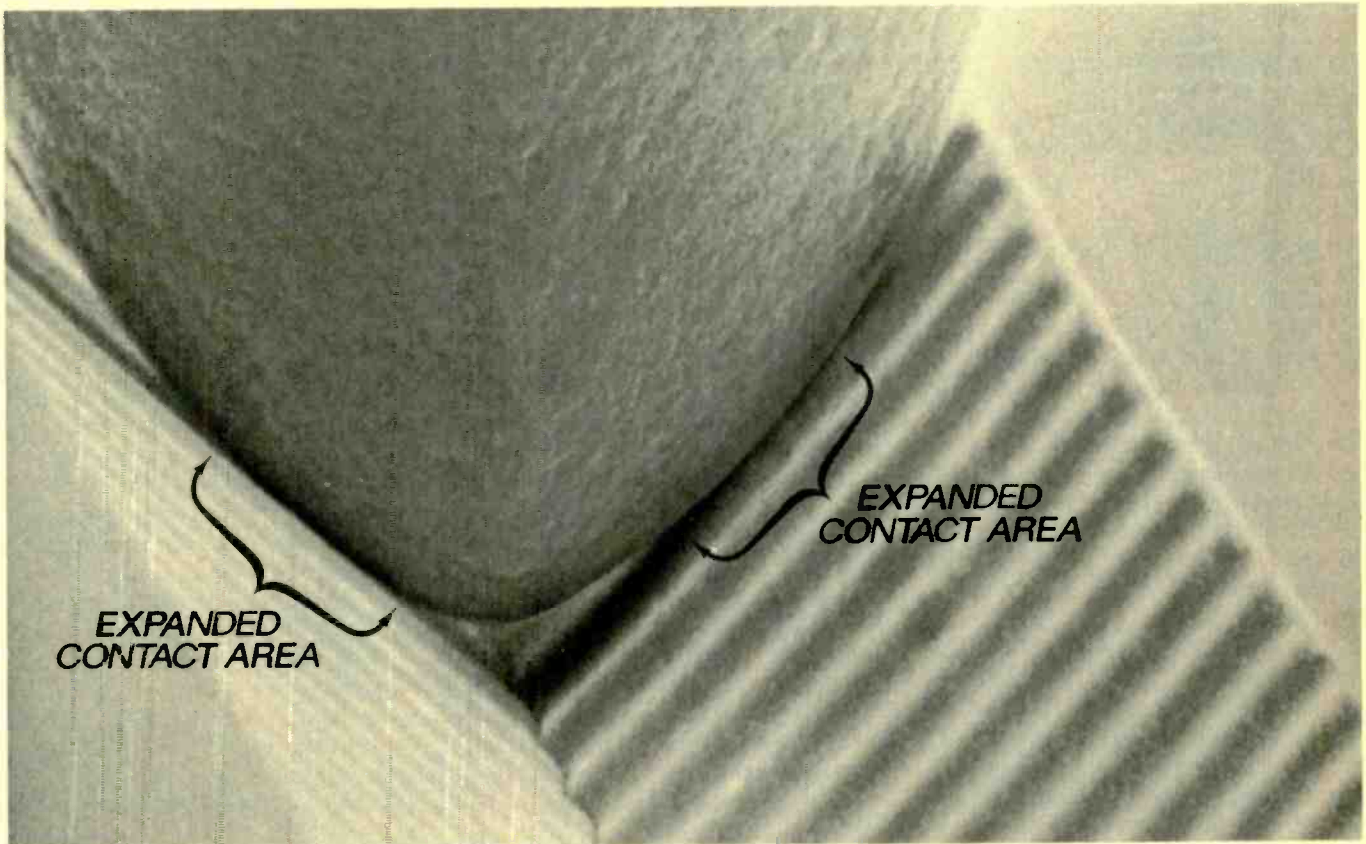
A "computer" keyboard and display panel dominate the center of the front panel. The "computer" that controls the operation of the deck provides memory functions for stopping the tape at a preselected point, either in normal or fast speeds. It also supplies the tape index counting function usually performed by a belt-driven mechanical counter. It controls Sharp's Automatic Program Locator Device (APLD) that can be set to skip any number of separately recorded selections (up to 19 in all) on a tape, stopping and playing a preselected piece that occurs later in the tape. The APLD contains a quartz controlled digital clock that is constantly in operation. When the machine is plugged into the power line, the clock is powered whether or not the recorder is turned on. Internal batteries can power the clock for up to a year without recourse to the ac power line. The clock can turn the deck (and anything plugged into its single switched outlet) on and off at preset times with split-second accuracy and time the running of a tape in minutes and seconds. It also provides the usual index-counter function. As a timepiece, it can be set for a 12- or a 24-hour format and automatically provides AM and PM identification in the 12-hour mode.

All the display functions appear on an LCD (liquid-crystal display) panel located above the keyboard. When the recorder is turned off, the display automatically reverts to its clock function. Seconds are indicated by the blinking of the colon that separates the hours and minutes digits. When the deck is turned on,

SPECIFICATION	RATING	MEASURED	REMARKS
Wow & Flutter	0.06% wrms	0.065% unweighted rms	
Frequency Response	30-13,000 Hz ±3 dB (normal)	25-14,200 Hz ±1 dB UD-XL I (LOW/120 μs)	
	30-15,000 Hz ±3 dB (UD-XL II)	24-14,600 Hz ±1 dB UD-XL II (HIGH/70μs)	
	30-16,000 Hz ±3 dB (FeCr)	22-15,000 Hz ±3 dB Sony FeCr (HIGH/120 μs)	
Playback Response	N/A	40-12,500 Hz ±2 dB TDK AC-337 (120 μs)	
		40-10,000 Hz ±0.5 dB Teac 116SP (70 μs)	
S/N Ratio	55 dB (normal)	47.4 dB UD-XL I 45.3 dB UD-XL II 44.7 dB Sony FeCr	3% playback distortion, unweighted
		56.0 dB UD-XL I 58.8 dB UD-XL II 56.0 dB Sony FeCr	CCIR/ARM weighted
		65.6 dB UD-XL I 66.5 dB UD-XL II 64.4 dB Sony FeCr	CCIR/ARM weighted, with Dolby
Noise Increase		+6.5 dB	MIC input at maximum gain
Sensitivity	50 mV (LINE) 0.2 mV (MIC)	54 mV 0.2 mV	
Output Level	775 mV at 0 dB (LINE) 89 dB (8-ohm PHONES)	Varies with tape; 700 to 800 mV	Phones not measured
Playback Distortion (0-dB record level)	N/A	0.45% UD-XL I 0.25% UD-XL II 0.80% Sony FeCr	1000-Hz test tone
Crosstalk (L – R at 1000 Hz)	N/A	−51 dB TDK AC-352	
PEAK indicator ON	N/A	+6.5 dB	
METER BALLISTICS	N/A	10% overshoot	0.3-s, 1000-Hz tone bursts
METER CALIBRATION	N/A	within 0.5 dB	
FAST FORWARD AND REWIND TIME	N/A	94 s	C-60 cassette

Note: Manual specifies LOW bias and 70-μs equalization for FeCr tape. These settings yielded sharply rising high-frequency response; flattest response was obtained with HIGH bias and 120-μs equalization.

Better stereo records are the result of better playback pick-ups



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Scanning Electron Beam Microscope photo of Stereohedron Stylus; 2000 times magnification. Brackets point out wider contact area.

Enter the New Professional Calibration Standard, Stanton's 881S

Mike Reese of the famous Mastering Lab in Los Angeles says: "While maintaining the Calibration Standard, the 881S sets new levels for tracking and high frequency response. It's an audible improvement. We use the 881S exclusively for calibration and evaluation in our operation"

The recording engineer can only produce a product as good as his ability to analyze it. Such analysis is best accomplished through the use of a playback pick-up. Hence, better records are the result of better playback pick-up. Naturally, a calibrated pick-up is essential.

There is an additional dimension to Stanton's new Professional Calibration Standard cartridges. They are designed for maximum record protection. This requires a brand new tip shape, the Stereohedron®, which was developed for not only better sound characteristics but also the gentlest possible treatment of the record groove. This cartridge possesses a revolutionary new magnet made of an exotic rare earth compound which, because of its enormous power, is far smaller than ordinary magnets.

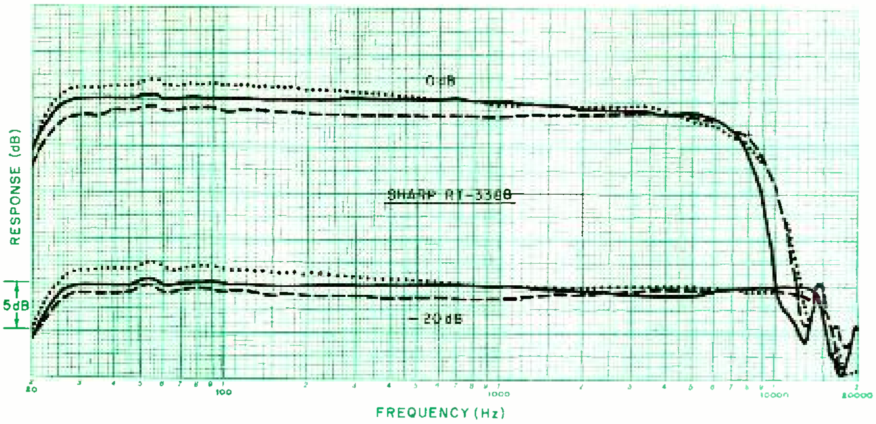
Stanton guarantees each 881S to meet the specifications within exacting limits. The most meaningful warranty possible, individual calibration test results, come packed with each unit.

Whether your usage involves recording, broadcasting or home entertainment, your choice should be the choice of the professionals ... the STANTON 881S.

STANTON

For further information write to Stanton Magnetics, Terminal Drive, Plainview, New York 11803

CIRCLE NO. 60 ON FREE INFORMATION CARD



Frequency response for three types of tape at 0 and −20 dB.

Product Focus

The unique feature of the Sharp Model RT-3388 cassette deck is its one-chip microcomputer/liquid crystal display (LCD). Commands and numbers for the memory are activated by a 24-key matrix.

The microprocessor chip that controls the deck is a single, square 60-pin CMOS LSI device. It has a built-in clock, 54 commands, 2268 bytes of ROM, and 96 words of RAM. A crystal oscillator supplies energy for the clock, timer, and counter that indicates tape time in seconds.

The timer serves as an alarm clock and sleep-time indicator. It also permits unattended recording and can switch on and off the tape deck and a device plugged into the deck's accessory outlet. The timer features two-stage operation: one for independent timer stop; the other for switching from timer start to timer stop and vice versa.

When the tape counter is set, the deck plays to the present point and automatically shuts off. Also in fast forward and rewind, the deck automatically stops at the preset point.

The tape counter keeps track of the tape passing the heads but cannot accurately register absolute values. A second counter is provided for more accurate indications.

Setting the number of a selection on the tape puts the deck into fast forward or rewind to locate the desired selection. This automatic locating device can be keyed for as many as 19 program steps ahead of or behind the desired selection.

the display becomes a tape counter, although any of its other functions can be selected at that time by pressing the proper buttons. Arrows in the display indicate direction of tape motion and tape speed (the latter by blinking on and off when a fast speed is selected). A Dolby trademark symbol appears in the display when the DOLBY switch is on. Short bars above each column of keys indicate which function has been selected, and a letter M appears above a bar when specific memory data has been entered for a given function.

The computer-controlled functions of the Model RT-3388 are so diverse that most of the very comprehensive instruction manual is devoted to them, with the aid of copious illustrations and photographs. Only nine of the 36 pages in the manual deal with normal tape recording functions. In general, the desired information, whether it be an index counter reading or a time, is fed into the computer by sequential operation of the keys, followed by a touch of the S (set) key. Previously set functions, which are not incompatible with the new one, remain unchanged and in use. Thus, one can switch between index counter, seconds counter, and actual time display at will while the tape is running without miscounting or affecting the operation of the machine. When the recorder is turned on, the LCD panel is back lit for full visibility. With the power switch off, a separate switch can be used to activate only the display lights so that the clock can be used at any time.

The "computer" section is physically very similar to a hand-held calculator in its size and configuration of keyboard and display. It extends only about ½" (12.7 mm) behind the panel and cannot be seen without extensive disassembly. According to the manual, a single LSI chip supplies all computer functions. Most of the remaining electronic circuits are on a single large circuit board that is very clearly labelled with individual circuit reference symbols for all components and the function of each section of the board (Dolby, Preamplifier, etc.). A second large board contains the power supply and control circuitry. The tape transport occupies only a small fraction of the internal space of the recorder.

User Comment. This is a most impressive product, largely because it offers so much for such a moderate price without appearing to have sacrificed any significant aspect of its performance. The tape saturation characteristics at a 0-dB recording level, compared to the −20 dB response, suggest that the heads are of only ordinary efficiency, neither better nor worse than one would expect on a machine in the $250 to $300 price range. On the other hand, the measured wow and flutter were about as low as we have measured on any cassette recorder and are better than we would expect to find at this price.

The recorder delivered excellent sound quality, both from prerecorded tapes and from recordings we made off the air and from records. We also recorded FM tuner interstation hiss at a −10-dB level and compared the playback to the original sound. This test simultaneously checks frequency response and tape saturation effects and reveals even slight deviations from an accurate recording. With Maxell UD-XL I tape, the results were good, but not quite perfect; we could hear a slight dulling of the highest frequencies. The "chrome equivalent" Maxell UD-XL II, on the other hand, yielded perfect reproduction of the highest frequencies. In the case of ferrichrome tape, we are not certain how to judge the machine's performance. With the HIGH bias and 120-μs equalization that gave flattest frequency response, we could hear a slight difference between the input and output of the recorder. Using the recommended settings of LOW bias and 70-μs equalization, the results were audibly perfect, as good as with UD-XL II, in spite of the measured low-level frequency response being far from flat. Obviously, some user experimentation would be in order if FeCr tape is to be used. We also obtained completely acceptable results

with a number of comparable tapes of all kinds, using the appropriate switch settings. The tapes chosen for testing were those specified by Sharp; they gave the flattest response in our tests.

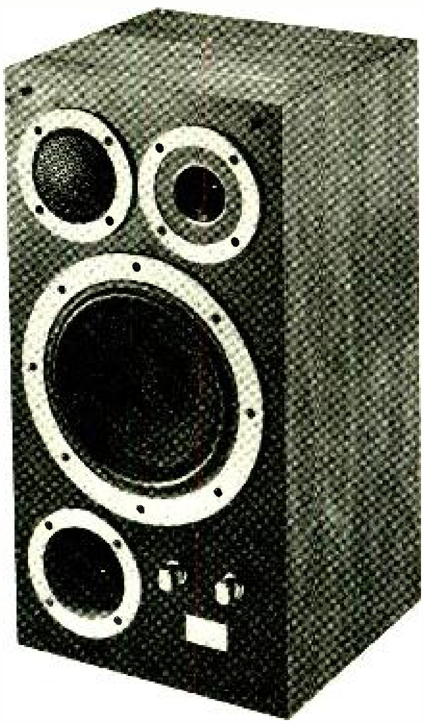
The computer functions were fascinating to use. Space does not permit a full account of what this machine can do (many pages of the manual are devoted to that), but we were continually impressed by the accuracy with which it responded upon reaching a preset point on a tape, whether in a memory mode or on the APLD function. The latter counts the silent intervals between recorded selections to locate the desired point, so it cannot be "foolproof" in its operation (when making one's own recordings, an EDITOR switch cuts off the program while a short blank section is recorded between program segments). All in all, we found that the APLD worked correctly in the vast majority of cases, even with commercially recorded tapes. To fully utilize the capabilities of the deck, one must only study the manual carefully and practice extensively with its controls to become familiar with it.

In sum, the Sharp Model RT-3388 is an above-average tape recorder for its price in all basic performance aspects and is unique at this time in its operating features. It is as much fun to use and to look at as it is for listening. Once you have been exposed to the comprehensive LCD panel, mechanical counter and function display indicators on other recorders appear old fashioned.

CIRCLE NO. 102 ON FREE INFORMATION CARD

WHARFEDALE MODEL E50 SPEAKER SYSTEM

High-efficiency system produces crisp sound and tight bass.



HIRSCH-HOUCK LABS REPORT

Wharfedale has re-entered the U.S. hi-fi market after an absence of several years with a new line of highly efficient speaker systems. The British Company's new Model E50 speaker system resembles some of the recent products from Japan with its drivers surrounded by machined aluminum rings set against a flat black speaker board. The grille is an open-mesh plastic that appears to be equally transparent to light and sound. Cutouts provide access to the two level control switches, labelled HIGH and LOW, even with the grille in place.

The Model E50 speaker system measures 32"H × 14"D × 13½"W (81.5 × 36 × 43.2 cm) and weighs 70 lb (32 kg). Nationally advertised value is $390.

General Description. The Model E50 ("E" stands for efficiency) is designed to deliver high acoustic levels without dynamic compression or other distortion when driven at moderate power levels. Its 10" (25.4-cm) woofer operates in a vented enclosure, the 4" (10.2-cm) port of which has been designed to operate as a fourth-order, maximally flat Butterworth system. At 800 Hz, there is a crossover to a 4" (10.2-cm) cone driver, while at 7000 Hz, there is another crossover to a horn-loaded compression driver that has a 1" (2.54-cm) diaphragm. The frequency response is rated at 55 to 18,000 Hz ±3 dB.

The system's level controls are five-position switches, with their 0 (maximum) settings providing the flattest response. The frequency ranges affected by these switches do not correspond exactly to the range of any single driver. For example, the LOW control, which should really be called MID, varies the output between 200 and 2000 Hz, with a maximum reduction of 5 dB. The HIGH switch produces a shelf in the response above 2000 Hz, with a maximum range of 5 dB. The system impedance is normally 8 ohms, and it has been designed to be greater than 6.8 ohms at all audible frequencies.

Laboratory Measurements. We measured the low-frequency response, up to about 300 Hz, with a closely spaced microphone. We separately recorded the response of the port and the woofer cone and combined the two to obtain a single reading. The highs were measured in the reverberant field of the room, using a swept warble tone signal and averaging the curves obtained from the two speakers in a normal setting for stereo listening.

With due allowance for the very different measurement techniques used by Wharfedale and ourselves, it was clear that the speaker system easily met its response rating. A moderate high-frequency peak was the only part of the composite response curve that exceeded the ±3-dB limits. From 45 to 8000 Hz, the response was smooth and uniform, within ±3 dB. It rose to about +5 dB at 11,000 or 12,000 Hz. The woofer's response, from 50 to 300 Hz, was exceptionally flat, attesting to the success of the computer design employed.

The low-frequency distortion at a 1-watt input was a mere 0.5% or so down to 60 Hz. It rose to only 5% at 30 Hz. At a 10-watt drive level, the distortion was less than 2% down to 50 Hz, rising to 6.7% at 35 Hz. When the input was adjusted to maintain a 90 dB SPL at 1 meter with changes of frequency, the result was similar to the 10-watt measurement except that the distortion rose more rapidly below 50 Hz.

The level controls had approximately the specified effects. (Typical response curves as well as fairly complete system specifications are on a nameplate affixed to the rear of the cabinet.) The HIGH control began to take effect at about 1000 Hz, overlapping the LOW control, which modified the response between 150 and 1500 Hz. The system

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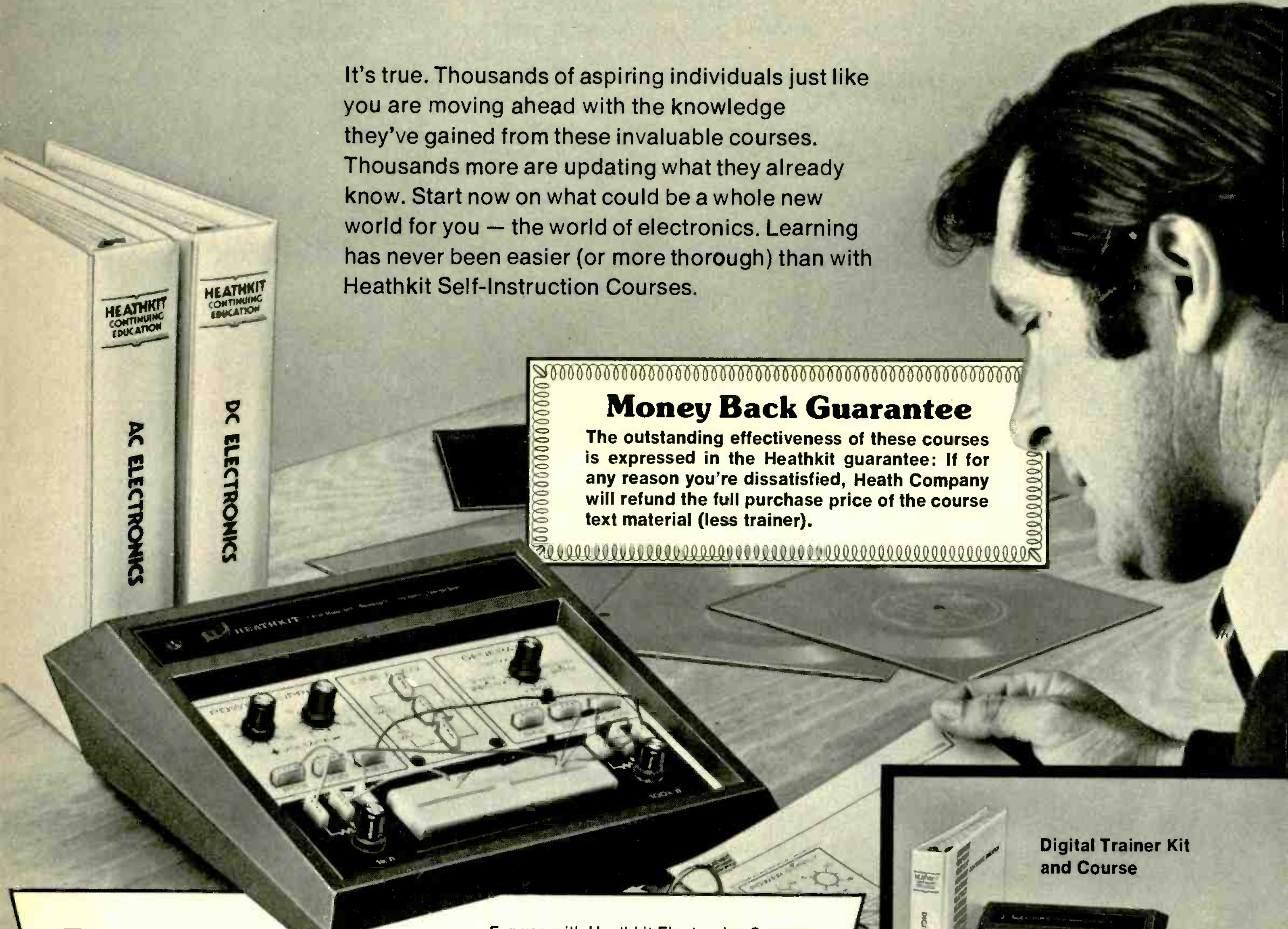

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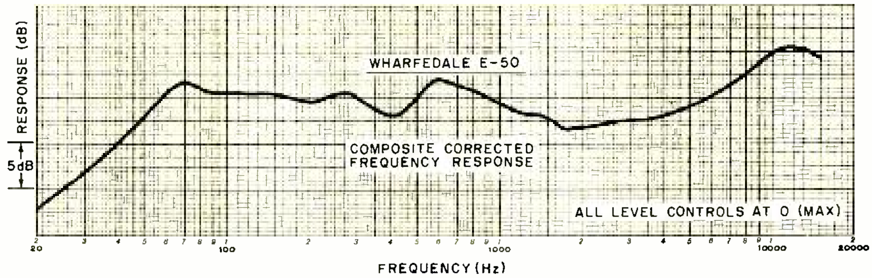
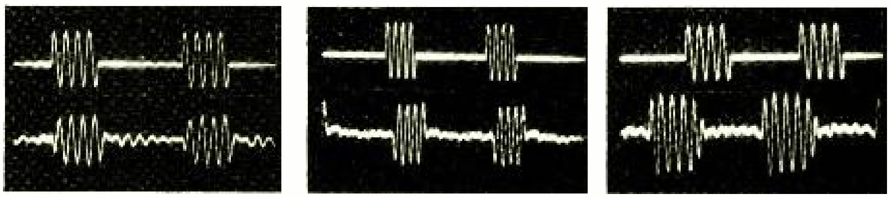


Composite corrected frequency response with all level controls at zero.



Tone burst responses at frequencies (left to right) of 100, 1000, and 7000 Hz.

impedance varied considerably with frequency, with a maximum of about 40 ohms at 22 Hz and a minimum of about 6 ohms at 200 and 1500 Hz.

The tone-burst response was exceptionally good, with nearly perfect burst shapes at most frequencies. The high efficiency of Wharfedale's computer-designed speaker system was dramatically illustrated by the Model E50's ability to deliver a 95-dB SPL at 1 meter when driven by 1 watt of random noise in the octave centered at 1000 Hz.

The simulated "live-versus-recorded" listening test confirmed that the measured smoothness and range of the system's frequency response was quite real. The chief difference between the sound of our "live" source (a reference speaker system that reproduced a specially taped program) and the sound of the Model E50 attempting to imitate it was an added brilliance in the sound of the latter. This could have been inferred from its slightly rising high-frequency response characteristic. Its effect was to add "sizzle" or "bite" to the sound of wide-range program material that contained appreciable high-frequency energy. The most accurate reproduction was with the HIGH switch at its minimum setting, but the highs were still "hot."

User Comment. The sound of the Wharfedale Model E50 might appeal more to the pop or rock music listener than to the classical enthusiast, especially since it can produce prodigious levels of very clean sound when driven by a modestly priced receiver or amplifier. It lacks the deep bass response favored by some people (although it is by no means shy of bass). However, it is outstandingly flat and true over most of the audio range.

The speaker system seemed to us to have a razor-sharp, almost clinical quality. This may be related to its notably good transient response, as confirmed by our tone-burst tests, as well as to its accentuated top-end response. As a rule, we prefer to set a speaker system's balance controls only once, upon installation. In this case, we found it desirable to readjust the HIGH level control according to the program content. With most FM broadcasts and records, we found that one or two steps of high-frequency reduction gave the best results. With programs containing exceptionally strong high-end content, such as the Sheffield direct-disc recordings played with a good moving-coil cartridge, we had to cut the speaker system's highs all the way down. (The LOW switch was left at maximum.)

We found the Model E50 to be an exceptionally clean and easy-to-listen-to speaker system. Since its emphasis was principally at frequencies above 10,000 Hz, its high-frequency response was never audible as stridency or even as "presence." Instead, it gave a crispness or edge to the sound that seemed well matched to the very tight and non-boomy bass reproduction of the speaker system. The ability to operate effectively at any usable listening level from an amplifier rated at, perhaps, 20 watts output is a major advantage of this speaker system over most of its competitors.

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HOW TO DESIGN & BUILD POWER SUPPLIES

PART 1

Basics of transformers, rectifiers, filters, voltage regulators and protection circuits.

WHEN YOU design or build projects, particularly large-scale designs in which many transistors and/or IC's are used, most of the effort goes into creating the final circuit and the printed circuit board. All too often, the power supply is just an afterthought. This is unfortunate because even a well-designed and assembled project may operate borderline if the power supply is not delivering the correct voltage at the required current. This problem is compounded when the supply must deliver large amounts of current, as in multi-IC digital circuits, especially microcomputers. Hence, the power supply deserves special attention, since it is often critical to the success of an electronic project.

In this first of a two-part article we will discuss power supply basics, some design concepts, etc. By the end of Part II, you should be able to design low-voltage, high-current power supplies that can perform as required for just about any project.

Transformers. The transformer is generally a voltage converter. It reduces the standard 117-volt ac power line potential to the lower voltages required in solid-state electronics. Most discrete circuits operate with potentials in the 1.5-to-28-volt range; linear IC systems operate in the range from ±4.5 to ± 18 volts; CMOS circuits require between 4 and 18 volts; and TTL requires the use of a tightly regulated 5-volt supply line.

Because a transformer is very efficient, stepping the line potential down in the secondary winding increases the current available for any given voltage level. The primary VA (volts times amperes) rating is very nearly equal to the VA rating of the secondary. Simply stated, $E_{pri} \times I_{pri} = E_{sec} \times I_{sec}$, where E_{pri} is the potential in the primary winding (117 volts ac); I_{pri} is the primary current; E_{sec} is the voltage in the secondary; and I_{sec} is the secondary current.

Rectifier. The rectifier converts the alternating current from the transformer's secondary into pulsating direct current (dc). The simplest of rectifiers is the half-wave circuit shown in Fig. 1.

All rectifiers operate on the same principles, whether they are solid-state or vacuum-tube types. They conduct current in only one direction. When an ac sine wave is applied to the input of this circuit, current passes through the rectifier only when its anode is more positive than its cathode, as in Fig. 1A. On the other half of the ac cycle, the rectifier

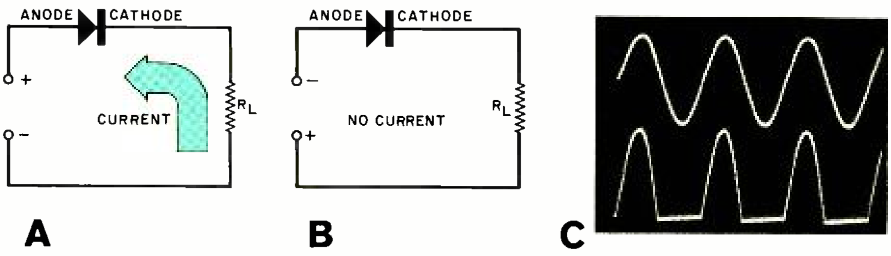


Fig. 1. Forward-biased diode (A) conducts current while reverse-biased diode (B) does not. In (C), upper trace is ac input, lower trace is pulsating dc across load.

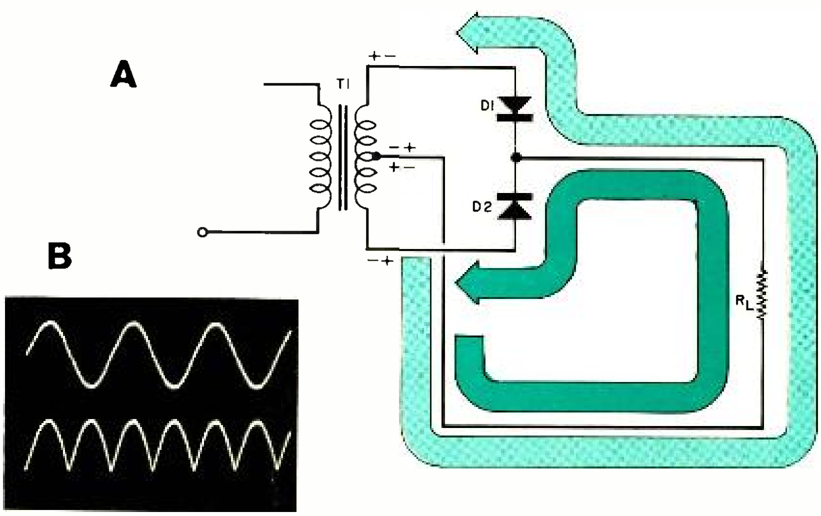


Fig. 2. At (A) is fullwave rectifier. Ac in primary of T1 is upper trace in (B), pulsating dc is at bo'tom.

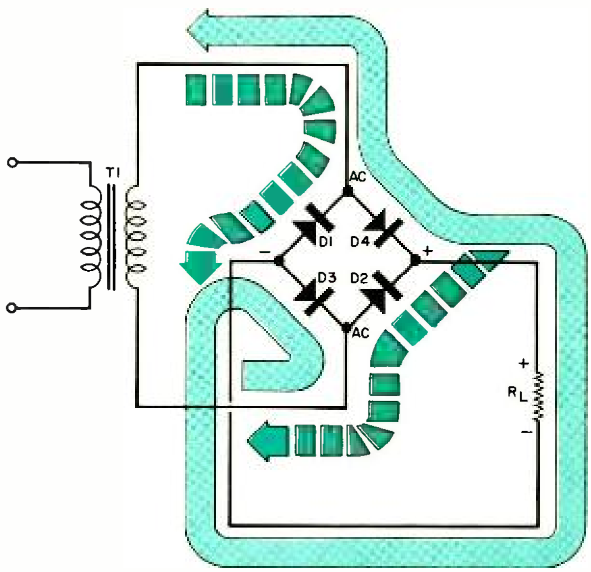


Fig. 3. A full-wave bridge rectifier. Broken lines show current flow during each half of the ac input cycle.

is reverse-biased (Fig. 1B), thus preventing the flow of current through the external load, R_L.

The waveforms associated with the half-wave rectifier are shown in Fig. 1C. The top waveform is that of the ac sine wave applied to the input, while the bottom waveform shows the rectified pulsating dc output across R_L. Note that the pulsating dc output exists only when the input waveform is in its positive alternation. Because half of the input waveform is not used, the half-wave rectifier is very wasteful of electrical energy. And half-wave rectification presents difficulties in filtering the output to pure dc with no ripple component.

The half-wave rectifier has an average output potential of approximately 0.45 times the applied rms potential and its ripple amounts to 120%. To add to the problems of this design, the transformer used must have a primary VA rating 40% greater than is required if full-wave rectification were used.

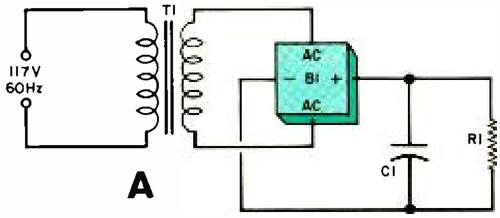
A basic full-wave rectifier using a center-tapped transformer is illustrated in Fig. 2A. At any given ac peak, one end of the transformer's secondary is positive, while the other end is negative. The center tap is at a potential that is half that across the entire secondary. Therefore, if the center tap is used as the common reference, equal and opposite polarity potentials will be found at either end of the secondary with respect to the center tap.

Let us consider the case when the top of the secondary is more positive than the bottom. Current flows from the common center tap through R_L and forward-biased rectifier *D1* (whose anode is more positive than its cathode) and then back to the transformer. During this period, *D2* is reverse-biased due to the negative potential at its anode so that no current can flow through it.

On the alternate half-cycle, *D1* becomes reverse-biased and *D2* conducts. Current then flows from the center tap through R_L and forward-biased *D2* and back to the secondary of the transformer. Note that, in both cases, the current flows through the load in the same direction. This produces the "double-humped" waveform across R_L shown in the lower trace of Fig. 2B. In essence, the negative-going portion of the applied ac sine wave has been "folded up" to produce the double-frequency waveform shown in the figure.

The bridge circuit shown in Fig. 3 is another type of full-wave rectifier. It employs a diode "ring" (*D1* through *D4*) for rectification. The secondary of the transformer is not center tapped; the diode ring provides the negative (sometimes ground) reference point. The two "corners" of the bridge labelled "+" and "−" and go to the positive and negative sides of the filter capacitor.

Since the bridge rectifier circuit em-



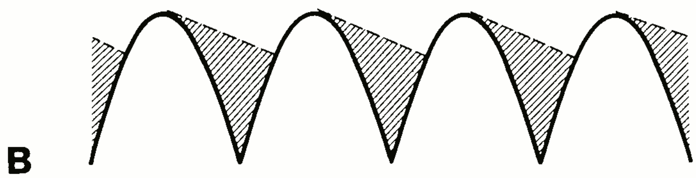


Fig. 4. Simple power supply with capacitance filter (A). Waveforms in (B) show how capacitor fills in between humps to smooth ripple.

ploys the entire secondary potential, it produces an output potential (pulsating dc) of twice that of the ordinary full-wave rectifier using the same transformer. There is one catch, however. The bridge rectifier supply delivers only half the current of the full-wave rectifier for a given primary VA rating. There are occasions when it is possible to exceed this and draw nearly the full rated current from the transformer's secondary without causing damage, but this is not dependable in all cases.

The average dc output potential in an unfiltered full-wave supply is approximately 0.9 times the applied rms potential, or about twice the voltage obtained with the half-wave rectifier. Both types of full-wave rectifiers have an output ripple component of about 48% and, thus, need filtering to produce the dc required by the electronic circuits. Also, the ripple frequency in the full-wave rectifier circuit is 120 Hz, which is twice the frequency of the line power.

Filters. The filter smoothes out the pulsating dc output from the rectifier to create the nearly pure dc required by the electronic circuitry load.

The half-wave rectifier produces one dc pulse for each ac cycle (Fig. 1C), while the full-wave supply produces two dc pulses per cycle (Fig. 2B). These waveforms illustrate the difference in ripple frequency—60 Hz for the half-wave and 120-Hz for the full-wave rectifiers—and implies that the higher frequency of the half-wave rectifier's output is easier to filter.

The usual high-value capacitor found in power supplies is shown in Fig. 4A. In this circuit, the bridge rectifier is shown in block form, since it is most often a bridge-rectifier assembly rather than a set of four discrete rectifier diodes. Filter capacitor *C1* is connected directly across the rectifier.

The value of *C1* is critical to the performance of the power supply. It should be no less than 1000 μF per ampere of output current; many authorities claim that 2000 μF per ampere should be the minimum. In any event, it is good practice to use not less than 1000 μF in projects that draw 1 ampere or less current. A typical 5-volt, 4-ampere dc power supply for a small digital computer would require not less than 8000 microfarads for a good filtering.

The waveform shown in Fig. 4B illustrates how the filter capacitor reduces the level of the pulsations in the rectified output waveform. Capacitor *C1* charges up as long as the pulsating dc applied to it is rising. Once the peak potential has been reached and the rectified waveform begins to drop toward zero, the capacitor dumps its charge to fill up the spaces (shaded area in Fig. 4B) between the pulses. Obviously, the greater the charge dumped, the smoother will be the top of the output waveform from the filter. The five waveforms shown in Fig. 5 were obtained from a low-voltage, 5-ampere supply using different amounts of filter capacitance. The circuit employed was that shown in Fig. 4, using a transformer rated at 13 volts and 10 amperes.

The Fig. 5A waveform shows the unfiltered output across the load resistor. The base line represents the 0-volt level, while the peak of the pulsating dc waveform is just short of 19 volts. The result of connecting a 150-μF capacitor across the load is shown in Fig. 5B. Note that the ripple has been reduced and has taken the shape of the filtered output shown in Fig. 4B. A dc voltmeter connected across the load indicated approximately 13 volts when there was

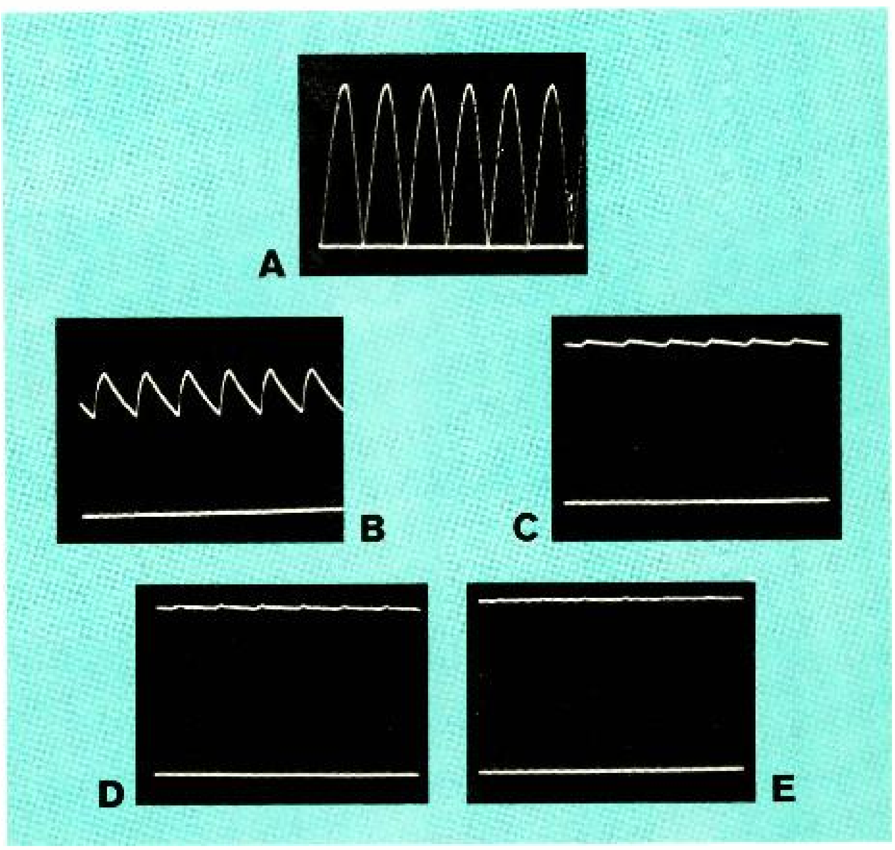


Fig. 5. How capacitors smooth waveform. Lower trace is zero volts. (A) is full-wave dc without filter; (B) has 150-μF capacitor; (C) 2000 μF; (D) 5000 μF; (E) 18,000 μF.

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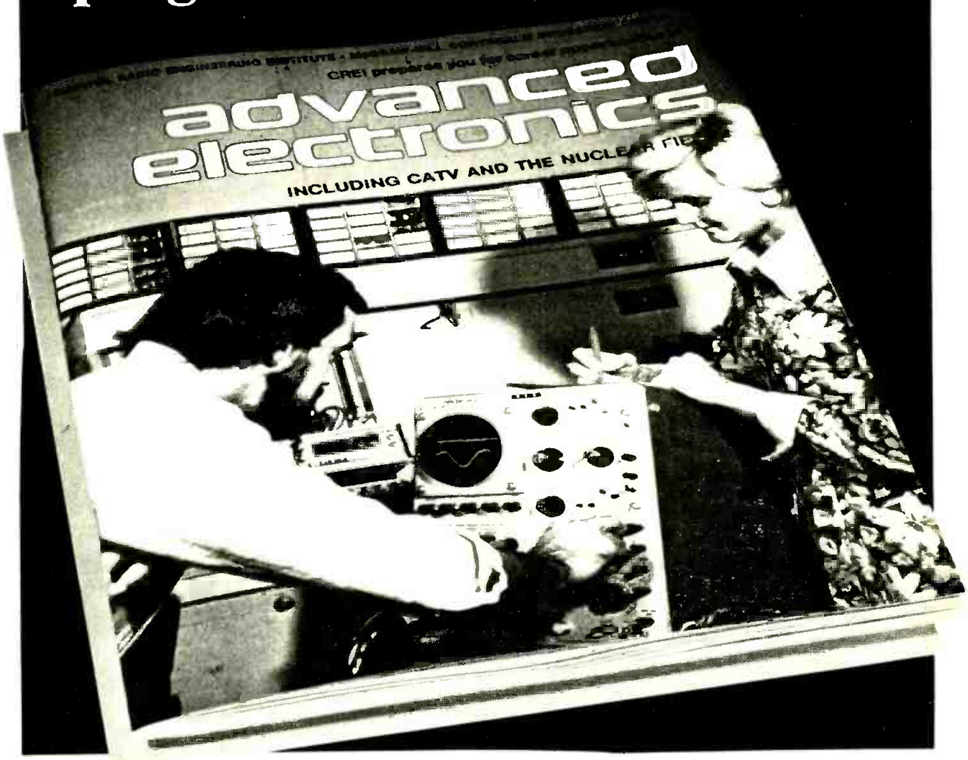

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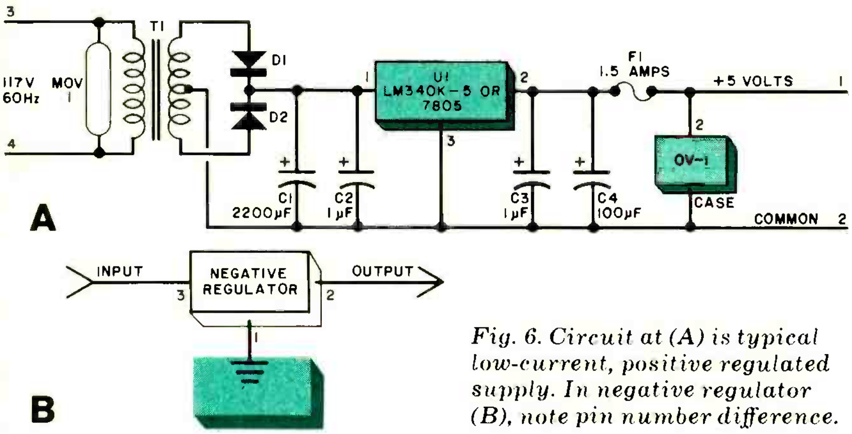


Fig. 6. Circuit at (A) is typical low-current, positive regulated supply. In negative regulator (B), note pin number difference.

no filtering. With the 150-μF capacitor installed, it indicated 16.8 volts.

Connecting a 2000-μF capacitor across the load produced the Fig. 5C waveform. The ripple is substantially reduced and the average dc potential has risen to about 18 volts. The situation is even better in Fig. 5D, where the capacitance is 5000 μF. The ripple has lessened to the point of almost disappearing. The dc potential has risen only an additional 0.7 volt, to 18.7 volts. In the Fig. 5E waveform, an 18,000-μF capacitor is across the load, which results in less ripple but no increase in the dc output potential. Bear in mind that this is for a 4-ampere power supply in which the formula capacitance should have been 8000 picofarads.

Voltage Regulators. Circuits that maintain their output potential constant over a wide range of load variations are termed "voltage regulators." Most computers and all TTL circuits fare better on such regulated power supplies.

Voltage regulators for low-current levels are reasonably simple. Up to 5 amperes, conventional low-cost three-terminal IC regulators can be used. The circuit of a power supply in which a three-terminal regulator is used is shown in Fig. 6A.

Several different but essentially similar families of three-terminal IC regulators exist. Probably the most familiar is the LM309 series, the LM309H being a 100-mA device in a TO-5 package and the LM309K a 1-ampere device in a TO-3 case.

There is also the LM340 series in which the output voltage is indicated by a number suffix added to the basic series number. For example, the LM340-5 is a 5-volt regulator, while the LM340-12 is a 12-volt device. These devices are available with outputs up to 24 volts. They come in two package styles—the K package for 1-ampere and the T package for 750-mA capacity.

The LM320 devices are essentially the same as the LM340 devices, except that they are designed for negative output voltages. Note that the pinouts for the negative regulator shown in Fig. 6B are different than for the positive regulator. Failure to observe this fact can result in catastrophic damage when the power supply is turned on.

Another well-known regulator family is the 7800 (positive) and 7900 (negative) series. The output potential is given by the last two digits in the type number (7805 for +5 volts and 7812 for +12 volts output, for example).

As shown in Fig. 6A, all three-terminal regulators should have noise bypass capacitors (*C2* and *C3*) across their input and output terminals. Various manufacturers specify different values for these bypass capacitors, the most common being between 0.33 and 2 μF. These noise filters should be wired as close to the terminals of the regulator as possible. If you use the lower value, the capacitor should be of ceramic disc construction. If the higher value is used, select a tantalum capacitor.

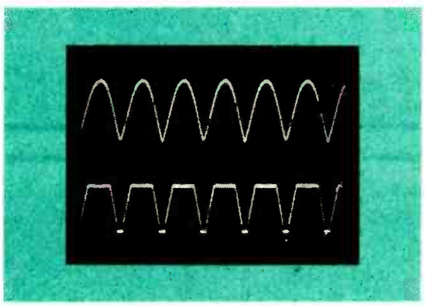


Fig. 7. Bottom waveform shows how a regulator "limits" peaks on rectified pulsating dc.

Capacitor *C4* is optional but desirable, especially where output current demands are very dynamic. The capacitance usually specified is on the order of 100 μF per ampere, or about a tenth of the value of the main filter capacitor. This added capacitor is not specifically used for filtering but to provide a "hedge" against output voltage droop under transient load conditions.

It is necessary to use a filter capacitor before a regulator; and Fig. 7 reveals why. The upper trace is the pulsating dc obtained from the rectifier, while the lower trace is the output of the regulator when filter capacitor *C1* is disconnected from the circuit. The unfiltered but regulated output waveform rises in each cycle until it reaches the cutoff point of the regulator, at which point it clips. Now, examine the waveform shown in Fig. 8. Although these waveforms appear to be similar to those shown in Fig. 5, they are different. In Fig. 5, the lower trace was used to indicate the 0-volt base line, while in Fig. 8 they illustrate the input (upper) and output (lower) of a three-terminal regulator. These traces are accoupled to the oscilloscope so that the dc component is suppressed and to permit the 5000-μF ripple component to be shown on a larger scale. The preregulation waveform of the upper trace was taken using a 0.2-volt/cm sensitivity in the scope's vertical channel, while a 0.01-volt/cm sensitivity was used for the lower trace. Even at 20 times sensitivity, no apparent ripple appears in the output waveform on the scope.

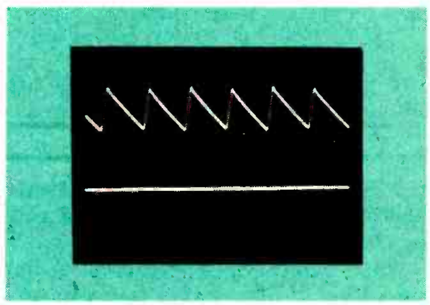


Fig. 8. Waveform at top is before regulator. Lower trace shows how ripple is eliminated.

Overvoltage Protection. Unfortunately, there are occasions when "something happens" in the regulator that permits the output voltage to rise above the required level. This potentially disastrous situation can be averted with an overvoltage protection circuit like that shown in Fig. 9. This circuit is called a

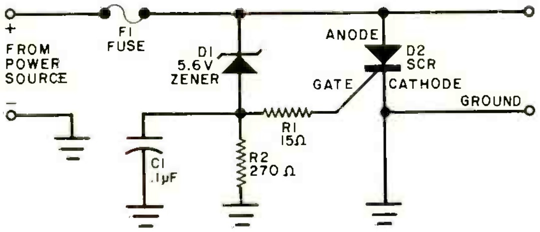


Fig. 9. Crowbar overvoltage protection circuit "fires" when 5-volt line exceeds breakdown voltage of zener diode.

"crowbar" because it operates by shorting the output to ground in the same manner as a conducting metal crowbar would if it were actually connected across the supply.

Normally, the supply potential (in this case +5 volts) is too low to allow zener diode *D1* to conduct. Consequently, the SCR presents a high impedance that makes it "invisible" to the dc line. When the potential on the supply line exceeds 5.6 volts, *D1* conducts and generates a voltage across *R2*. This voltage is then applied, via *R1*, to the gate of the SCR, which triggers on. When this occurs, the short circuit that results causes fuse *F1* to blow and shut down power. Although this circuit appears to be a little crude, it is extremely effective and can prevent damage to an expensive system connected to the power supply.

If you decide to use the crowbar protection circuit shown in Fig. 9, select an SCR that can handle about twice the current normally delivered by the power supply. Also, use a conventional fast-blow fuse for *F1*.

Some of the circuits we will discuss in Part II employ commercially available overvoltage protection devices, such as the OV-1 shown in Fig. 6A.

Current Limiting. This feature is usually found in supplies that employ more sophisticated voltage regulator circuits than those described above. Essentially, a small-value resistor is connected in series with the output lead of the regulator and the current drawn by the load generates a small voltage drop across this resistor. This voltage is applied to a comparator/amplifier that shuts down the power supply if excess current is drawn by the load.

Coming Up. In Part II of this article, we will discuss further design criteria. We will also present four construction projects: a +8-volt, 15-ampere power supply for Altair (S-100) bus microcomputers; +5-volt, 4-ampere power supply; ±12-volt, 1-ampere power supply; and a sophisticated 5-volt, 10-ampere power supply with overvoltage protection and current-limiting shutdown. ◇

BY FORREST M. MIMS

Micro- PROCESSOR MICROCOURSE

PART 2. BASIC DIGITAL LOGIC

The Basic Logic Gates. All digital logic circuits, from the simplest counter to the most sophisticated microprocessor, are made from interconnected combinations of simple building-block circuits called logic gates. There are four basic gates, and they are designated according to their function as YES, NOT, AND, and OR circuits. Each of these basic gates has one or more inputs, a single output, and a couple of power supply terminals.

Various combinations of the binary bits 0 and 1 can be applied to the inputs of a gate by allowing a low voltage to represent logic 0 and a high voltage logic 1. This is called positive logic. In negative logic, the definitions are reversed.

The YES gate transmits the logic state (0 or 1) at its single input directly to its output. It's often used to interface logic circuits that are otherwise electronically incompatible. For this reason it's often called a *buffer.*

The NOT gate inverts or complements the logic state at its single input so it's often called an inverter. The NOT function is often indicated by a bar or vinculum over the symbol for an input or output that's been inverted. Thus if A is 0 and B is 1, then $A = \overline{B}$. (The $\overline{B}$ is read and sometimes written "not B.")

The AND gate is a decision making circuit with two or more inputs. The output of the AND gate is logic 0 unless *all* the inputs (inputs A *and* B *and* C . . .) are logic 1.

The OR gate is also a decision making circuit with two or more inputs. Its output is logic 0 unless *any* or *all* of its inputs (input A *or* B *or* C . . .) are 1.

The operation of a gate can be defined by a table that shows the combination of input bits that produces a particular output bit. Such a table is called a truth table. The truth tables and standard symbols for each of the four basic logic gates are shown in Fig. 1.

Compound Logic Circuits. Combining two or more of the basic gates into a compound logic circuit can provide some very important operating features. The two most important compound logic circuits are the AND-NOT and OR-NOT combinations. These are called the NAND and NOR gates and their symbols and truth tables are shown in Fig. 2.

As shown in Fig. 3, various combinations of NAND (or NOR) gates *alone* can simulate YES, NOT, and AND circuits. This is important, but the most fascinating characteristic of the NAND and NOR functions is their logic equivalence. Thanks to a rule known as DeMorgan's theorem, a positive logic NAND gate is equivalent to a negative logic NOR gate and vice versa.

You can prove this for yourself by writing the appropriate truth tables and finding that they are indeed identical. DeMorgan's theorem simplifies digital logic to the point where combinations of only NAND gates or NOR gates can implement any logic function. Figure 4, for example, shows how NAND gates alone can implement both the OR and NOR functions. Notice how NAND gates are used as inverters to change the inputs from positive to negative logic.

Complex Logic Systems. Simple and compound gates can be tied together to implement a countless variety of logic functions. Some of the resulting logic systems contain only a handful of gates; others may use dozens or even hundreds of gates. All of these complex logic systems can be divided into two broad categories: combinational and sequential.

Combinational circuits are characterized by their fast acting operation. Exclusive of the brief time delay required for its gates to react to an incoming logic 0 or 1 (the propagation time), the output(s) of the most complex combinational circuit instantaneously reflects the pattern of 0's and 1's at its input(s).

Sequential circuits include storage or delay elements that permit the logic result of a previous input to directly influence a new input. This makes sequential circuits slower than combinational circuits. But it also makes possible important applications such as memory registers, counters, dividers, sequencers, and microprocessors.

Combinational Logic Circuits. The simplest combinational logic circuit is the Exclusive-OR gate. The symbol and truth table for this circuit are shown in Fig. 5.

Look at the Exclusive-OR truth table for a moment. The Exclusive-OR function is just that; it gives a logic 1 output *only* if one *or* the other of its two inputs is logic 1. Otherwise the output is 0. This is identical to the binary addition rules with the exception of the carry output needed for 1 + 1.

It's easy to generate the carry output bit needed to use the Exclusive-OR circuit as a binary adder. Look at the logic

A	OUT
0	0
1	1

A	OUT
0	1
1	0

A	B	OUT
0	0	0
0	1	0
1	0	0
1	1	1

A	B	OUT
0	0	0
0	1	1
1	0	1
1	1	1

Fig. 1. The four basic logic gates: YES, NOT, AND, OR.

A	B	OUT
0	0	1
0	1	1
1	0	1
1	1	0

A	B	OUT
0	0	1
0	1	0
1	0	0
1	1	0

Fig. 2. A NAND gate and a NOR gate, with their repective truth tables below.

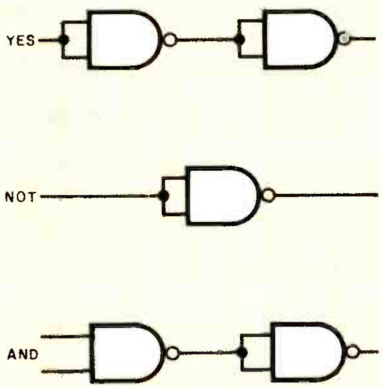


Fig. 3. Using NAND gates to simulate other gates. At top, YES; middle, NOT; bottom, AND.

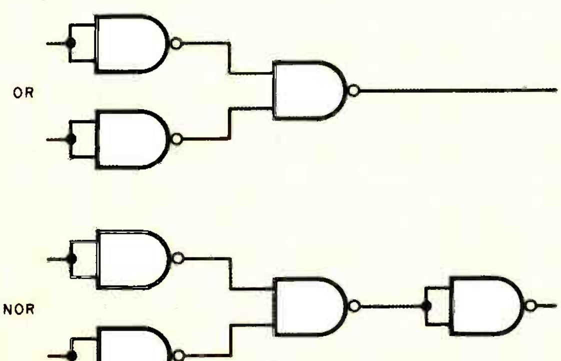


Fig. 4. Using NAND gates to prove DeMorgan's theorem. At top, OR; on the bottom, NOR.

circuit for an Exclusive-OR in Fig. 6. If you'll study the operation of this circuit, you'll find that the output of AND gate 1 provides the carry output we need. In the other circuit in Fig. 6, we use this carry output to form a circuit that can add any two binary bits. It's known as a *half adder.*

A half adder is useful, but it can only accept two input bits. To complete the binary addition rules, we need an adder circuit that will accept a carry bit as well. The circuit that accomplishes this goal is the *full adder.* As you can see in Fig. 7, a full adder can be made from two half adders and an OR gate.

It's possible to connect a string of adders together to form a binary adder capable of adding multiple-bit binary words. Figure 8, for instance, shows a 4-bit adder that will sum two words applied to its inputs. Try adding 1101 + 0101 using this adder to prove to yourself it really adds.

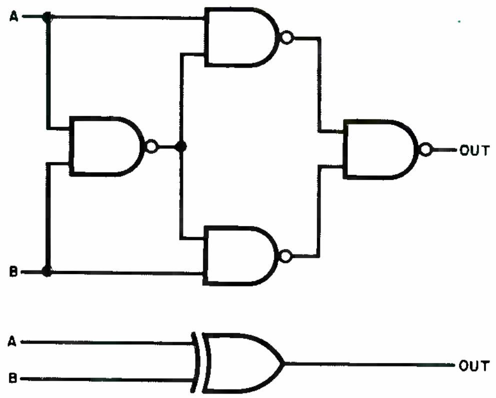
A binary adder forms part of a microprocessor's arithmetic-logic unit (ALU), a combinational circuit that performs addition, subtraction, and various logic operations upon two incoming words. The ALU is instructed what operations it is to perform by binary signals applied to its control inputs. We'll learn more about the ALU later in this course.

Encoders and Decoders. An encoder is a combinational network of OR gates that converts or encodes a nonbinary input into binary. For example, an octal-to-binary encoder has eight inputs (one for each octal digit) and three outputs (one for each binary bit). A logic 1 at one of the inputs produces the binary equivalent at the output.

Encoders can provide other conversion operations, too. Keyboard encoders, for instance, convert individual key positions into their assigned binary words. An example is the ASCII (American Standard Code for Information Interchange) encoded keyboard, which generates the 7-bit word 0100101 when the % key is pressed.

A decoder is a combinational circuit that converts a binary number at its inputs into a logic 1 at one or more of its outputs. In digital electronics it's often necessary to convert a binary number into some other format, and one common decoder application is the conversion of binary numbers into the format required to activate the appropriate segments in a 7-segment decimal display.

Decoders are also used to decode binary instructions in a microprocessor,



A	B	OUT
0	0	0
0	1	1
1	0	1
1	1	0

Fig. 5. The combinational circuit at top provides an Exclusive-OR, as shown in the middle. The truth table is below.

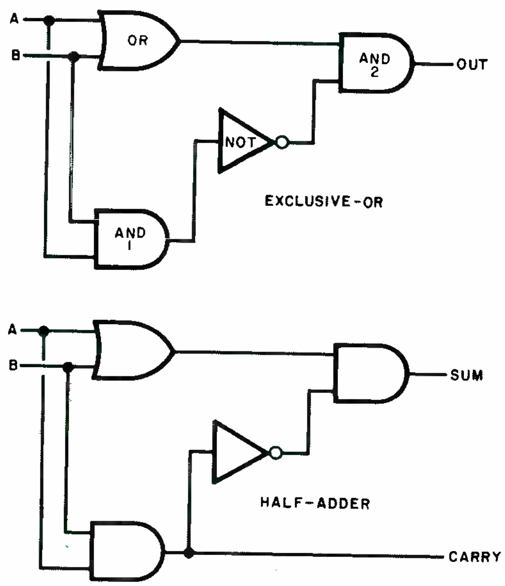


Fig. 6. How an Exclusive-OR can be used to make a half-adder combinational circuit.

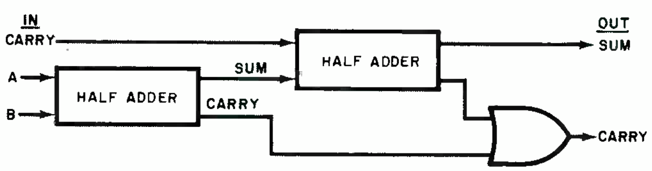
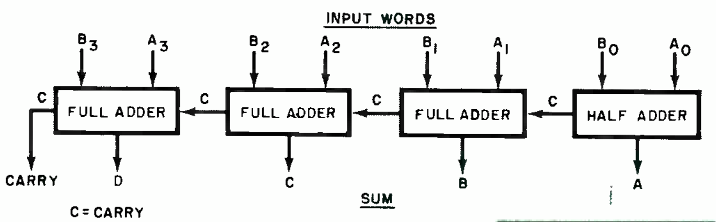


Fig. 7. Two half adders and an OR gate can be used to make a full adder circuit.



EXAMPLE: 1101 = WORD A
+ 0101 = WORD B
10010 = SUM

Fig. 8. A string of full adders connected together can be used to form a binary adder, capable of adding binary words.

assist in the production of sequential timing signals for advanced logic circuits, and convert binary numbers into their octal, decimal, and hexadecimal counterparts. Figure 9 summarizes the operation of encoders and decoders.

Multiplexers and Demultiplexers. The multiplexer is the digital logic equivalent of a multiple-position rotary switch. A typical multiplexer is a combinational logic circuit that selects one of several input lines and applies any data on that line to a single output. A special set of address inputs determines which input line is selected.

One typical multiplexer has eight data inputs, three address inputs, and a single data output. When the address 101 is applied to the multiplexer, input 5 is connected to the output.

A common application for multiplexers is driving the readouts of pocket calculators to reduce the number of pin connections on the calculator's chip. The multiplexer lets all the digits in the readout share a common set of terminals. It activates each digit or one segment in all the digits in rapid succession to fool the eye into thinking the display is continually illuminated.

The demultiplexer transfers the binary data at its input onto one of two or more output lines. Like the multiplexer, an address input controls the output.

Demultiplexers are used with multiplexers to convert multiplexed data back to its original form. They can even function as decoders by applying a logic 1 to the single input and using the address inputs as data inputs. Figure 10 summarizes the operation of multiplexers and demultiplexers.

Sequential Logic Circuits. Unlike combinational logic circuits, sequential circuits have memory. Their output(s) can reflect the effect of an input that occurred seconds or even days earlier.

The simplest sequential circuit is the flip-flop. A microprocessor together with a read/write memory incorporates dozens—perhaps thousands—of flip-flops.

There are several different kinds of flip-flops, but all are capable of storing a single binary bit. This makes possible such applications as counters, dividers, memory registers, and others. Here are the four basic kinds of flip-flops.

The RS Flip-Flop. The simplest flip-flop is made from two NAND or NOR gates with crisscrossed inputs and outputs as shown in Figure 11. This basic circuit is called a reset-set (RS) flip-flop

or simply a *latch*. Figure 11 also shows the truth tables for NAND and NOR gate versions of the RS flip-flop.

Notice that the two outputs of the RS flip-flop complement one another. When Q is logic 1, the flip-flop is *set*. When Q is logic 0, the flip-flop is *reset* or *cleared*.

Clocked RS Flip-Flop. The basic RS flip-flop is *asynchronous*; it responds to inputs as soon as they occur. A way to synchronize the operation of the RS flip-flop with other logic circuits is to gate its inputs so they can respond only when activated by a logic 1 from a *clock*. A clock is a sequential circuit that produces a stream of alternating 0's and 1's. Fig. 12 is a clocked RS flip-flop.

The Data or D Flip-Flop. The D flip-flop is a further modification of the clocked RS flip-flop. As shown in Figure 13, an inverter is added to one of the two inputs of the flip-flop and the remaining input and the inverter's input are tied together. This guarantees that the inputs to the RS section of the flip-flop will always complement one another. And it insures that the logic state of the Q output will always correspond to the logic state of the D input.

The JK Flip-Flop. The JK flip-flop is a clocked RS flip-flop with a refinement that allows a logic 1 to be simultaneously applied to both inputs. Figure 14 shows the logic circuit and truth table for this flip-flop. The JK flip-flop can easily simulate any of the other kinds of flip-flops, so it's commonly used in sequential logic circuits.

The JK flip-flop can be used to make a toggle or T flip-flop. The J and K inputs are tied together and called the T input. When a logic 1 is applied to T, the flip-flop changes state or toggles each time a clock pulse arrives.

Storage Registers. A string of D flip-flops called a *register* can be used to store a binary word. A register like this can be made far more useful by adding some combinational logic to simultaneously clear all the flip-flops to 0 when a logic 1 is applied to a *clear* input. A *load* input can also be added to force the register to ignore incoming data. When the load input is logic 1, the input data will be accepted by the register when the next clock pulse arrives.

Data storage registers like this are sometimes called *buffer* registers. They're used in logic circuits and in microprocessor units to temporarily hold a data word.

Shift Registers. Considerably more

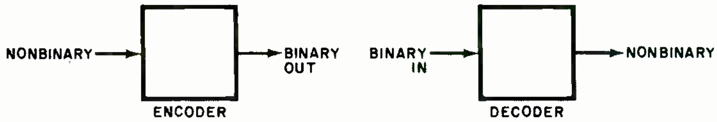


Fig. 9. An encoder is a combinational network that converts a nonbinary input to a binary output. A decoder does just the reverse.

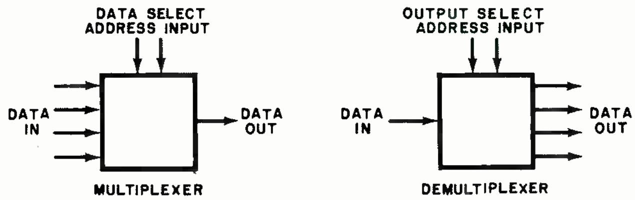
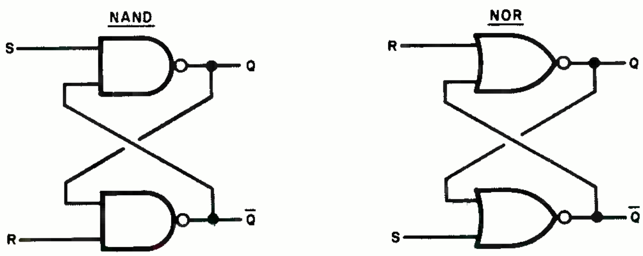


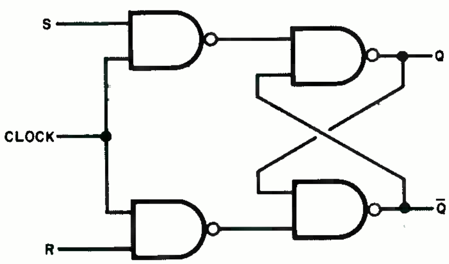
Fig. 10. A multiplexer is the equivalent of a multiple-position switch. A demultiplexer converts multiplexed data back to original form.



S	R	Q	$\overline{Q}$
0	0	NOT ALLOWED	
0	1	1	0
1	0	0	1
1	1	NO CHANGE	

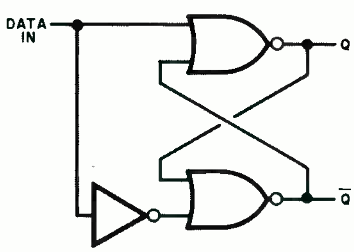
S	R	Q	$\overline{Q}$
0	0	NO CHANGE	
0	1	0	1
1	0	1	0
1	1	NOT ALLOWED	

Fig. 11. Simplest flip-flop is made from two NAND's or two NOR's with truth tables as shown.



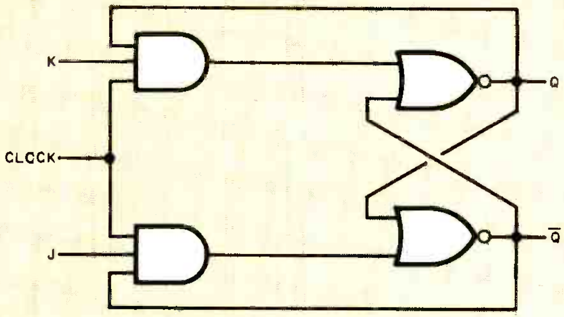
CLOCK	S	R	Q	$\overline{Q}$
0	0	1	NO CHANGE	
0	1	0	NO CHANGE	
1	0	1	1	0
1	1	0	0	1

Fig. 12. A clocked RS flip-flop is a sequential circuit with truth table as shown here.



D	Q	$\overline{Q}$
0	0	1
1	1	0

Fig. 13. A data, or D, flip-flop is made by adding an inverter to input of one flip-flop.



Q=0

J	K	Q*
0	0	0
0	1	0
1	0	1
1	1	1

*(after clock pulse)

Q=1

J	K	Q*
0	0	1
0	1	0
1	0	1
1	1	0

*(after clock pulse)

Fig. 14. The JK flip-flop is a clocked RS flip-flop that allows a logic 1 to be simultaneously applied to both inputs. Shown here is a NOR gate version with truth tables for Q = 0 and Q = 1.

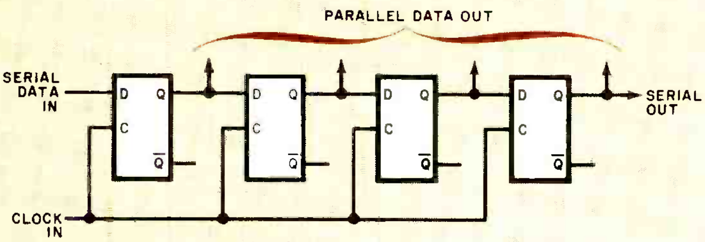


Fig. 15. This shift register made from D flip-flops accepts data a bit at a time and has a serial output as well as parallel outputs from each flip-flop.

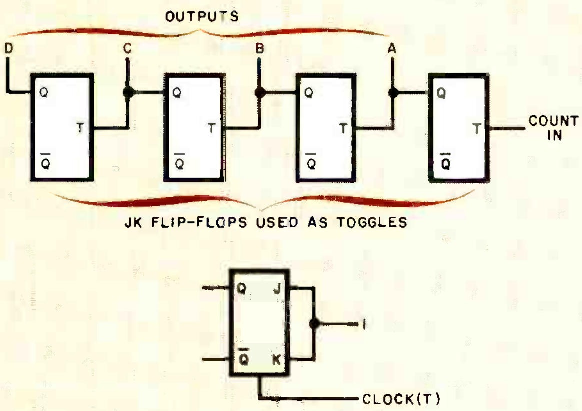


Fig. 16. A four-bit counter made from T flip-flops that will count from 0000 to 1111 and then recycle.

versatile than the buffer register is the shift register shown in Fig. 15. This particular register accepts data a bit at a time (serial input) while making available the contents of all its flip-flops simultaneously (parallel output). The data bits in the register are shifted right a bit at a time by clock pulses to make room for incoming bits.

Universal shift registers that can accept and output data as serial bits or parallel words as well as shift the data left or right are available. The various operations of a universal shift register are selected by applying logical 0's and 1's to an array of control inputs. Microprocessors incorporate at least one shift register to perform some of the data manipulation required to multiply and divide binary numbers.

Counters. Remember the toggle or T flip-flop we discussed earlier? The Q output of this flip-flop alternates between logic 0 and 1 for each incoming clock pulse: 0 . . . 1 . . . 0. . . 1 . . . In other words, the Q output is logic 1 for *half* the incoming clock pulses. This means a single flip-flop can be used to divide an incoming stream of bits by two. The Q output of a toggle flip-flop also counts! Thus, 0 . . . 1 . . . 0 . . . 1 . . . is the same as counting from 0 to 1 in binary over and over again.

Higher capacity binary counters (and dividers) can be made from a string of T flip-flops. Just connect the Q output of one flip-flop to the clock input of the next flip-flop. Figure 16, for instance, shows a 4-bit counter made from four T flip-flops. This counter will count from 0000 to 1111 and then recycle.

There are many different kinds of flip-flop counters. The *modulo* of a counter specifies the maximum count it reaches before recycling. Modulo 10 counters are very popular because they recycle after the tenth input pulse and therefore provide a convenient way to count in decimal. They are often called BCD (*bi*nary *c*oded *d*ecimal) counters. Their count sequence is 0000 (0_{10}) . . . 0001 (1_{10}) . . . 0010 (2_{10}) . . . . . . 1001 (9_{10}) . . . 0000 (0_{10}) . . . .

Counters can have a variety of control inputs. A typical counter, for example, can count up *or* down. It may also have control inputs for clearing the count to all 0's, presetting the count to any desired value, and enabling the counter to count. Finally, since counters store the accumulated count until the next clock pulse arrives, they can be considered storage registers. ◇

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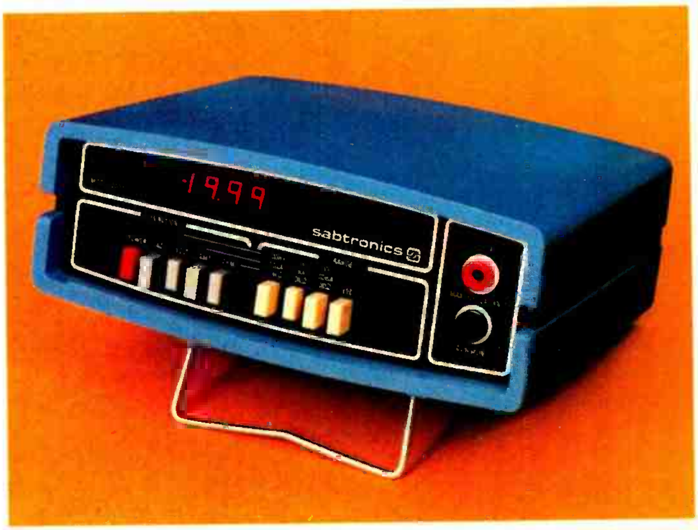

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CIRCLE NO. 55 ON FREE INFORMATION CARD

how electronic music synthesizers work

BY JOHN S. SIMONTON, JR.

Examines noise generators, instrument dynamics, and voltage control.

THE ELECTRONIC music synthesizer has changed the face of recorded music and live rock-band performances. This "instrument" can produce a myriad of unconventional, sometimes weird or eerie sounds. Yet it can also emulate the sounds of any conventional instrument.

There are two basic types of synthesizers: studio and performance. Modern studio synthesizers are made up of modular sections that consist of voltage-controlled amplifiers, filters, oscillators and noise generators, modulators and other devices. These modules can be interconnected in virtually any order by plugging their inputs and outputs together with "patch" cords. The output of almost any given module can be used either as part of the tone you eventually hear, or as the control voltage for another module. It all depends on how one "patches" the elements together.

Synthesizers designed for live performances do not use patch cords, as the time lost in changing patches during a performance would ruin the musical continuity. Here, the various modules are hard-wired together and the sounds are changed by a host of conveniently located switches and potentiometers, used much as stops are on an organ. Since a player can handle only a limited number of controls efficiently, performance synthesizers can't be made as flexible as the studio type.

How It Works. A synthesizer's output waveforms and control signals can be considered as a vast kit of parts from which musicians can assemble any desired sounds. The different parameters of each note—pitch, overtone structure, attack time, duration, and decay—are, in conventional instruments, fixed within narrow limits. In the synthesizer these parameters are independently, and almost infinitely, variable.

The modules that control those parameters are shown in Fig. 1. Pitch and overtones are controlled by the voltage-controlled oscillator (vco) and by the voltage-controlled filter (vcf). The note's attack, sustain, decay and release—its "envelope" in time—are controlled by the voltage-controlled amplifier (vca), which in turn is controlled by the envelope generator. The latter is sometimes called ADSR, the initials of the four parameters it governs—attack, delay, sustain and release. The musician's control input for these modules is usually a keyboard.

Normally, pitch is governed by the voltage-controlled oscillator. As the name implies, its frequency varies with the control voltage fed to it. But the vco also has an effect on overtone structure, or timbre. Its output can, on most synthesizers, be a pure sine wave, with no overtones at all, or a ramp, triangle, pulse, or square wave (see illustrations in Fig. 2), each of which has a different mixture of overtones.

Conventional instruments have somewhat similar overtone structures. A violin note, for instance, begins as a ramp waveform, the bow grabbing the string and deflecting it until the string's tension overcomes the friction of the bow, and the string snaps back again. A saxophone reed's opening and closing makes the equivalent of a square wave.

Don't think that these waveforms fully represent the sound of the instrument. They don't. The actual sound produced depends on the instrument's resonances, which accentuate or attenuate

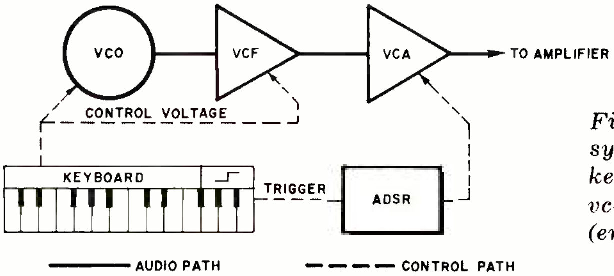


Fig. 1. "Classic" synthesizer consists of keyboard controller, vco, vcf, vca, ADSR (envelope generator).

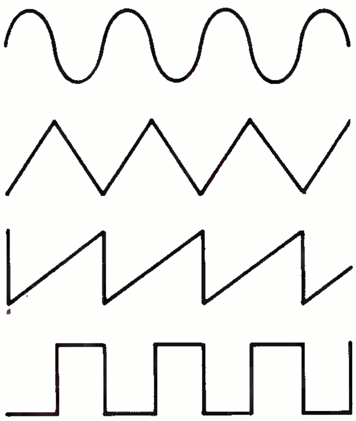


Fig. 2. Typical vco waveforms.

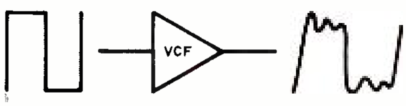


Fig. 3. Filter modifies timbre.

individual harmonic components in the raw waveform. The sound of a saxophone may begin as a square wave, but after passing through the instrument, it appears rather like the "ringing" waveform shown in Fig. 3.

The synthesizer's voltage-controlled filter has a similar effect to that of the saxophone's bell or the violin's hollow body. Whereas the resonators of mechanical instruments are reasonably fixed, a synthesizer's equivalent module (its vcf) can be used as either a low-pass, band-pass or high-pass filter over a frequency range of many octaves, while its "Q" (curve sharpness) is adjustable, too.The vcf can also give pitch to the output of an unpitched signal source, the 'noise generator.' At first it may seem odd to include such a module in a synthesizer, since so much attention is paid to eliminating noise in electronic systems. There are many applications, though, as illustrated in the next section.

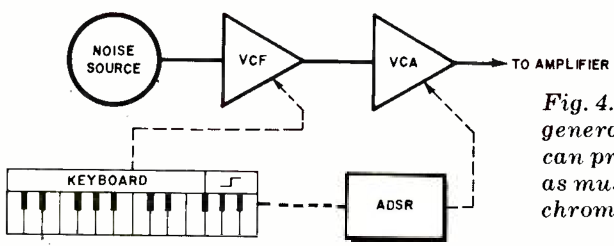


Fig. 4. "Tuning" noise generator output with vcf can produce such affects as musical wind and chromatic high-hat cymbals.

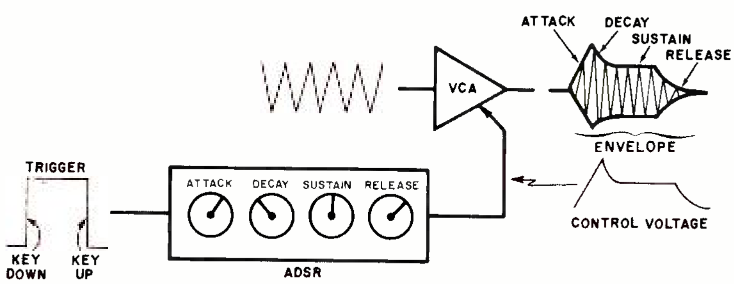


Fig. 5. The combination of a vca and ADSR.

The Noise Generator. The noise generator is used in simulating such instruments as the snare drum and the high-hat cymbal, or such natural sounds as wind, surf, explosions and thunderclaps. Using the synthesizer's other resources, it's also possible to create sounds that a real drum or real surf could never make. Let's try, for example, to invent a new musical instrument, with a voice like the wind. With enough experimentation, I'm sure that would sound much like the wind—perhaps a pipe with a plugger of some kind in it. With enough practice, we might even learn how to play it so that we were on pitch (and so that it didn't break into oscillation, which would ruin the effect). But it would take some work.

With a synthesizer, this type of task is almost ridiculously simple. First, we substitute a noise generator for the vco (Fig. 4). Then we recover pitch information from the noise (which contains all possible pitches) by passing it through the filter. To play this new instrument, we apply the keyboard's output voltage to the vcf's control input. Now, each keystroke will shift the filter's frequency range, controlling the pitch of the note.

Since the wind usually builds and dies away slowly, we'll want our instrument to have a slow attack and decay, and to sustain as long as we hold down the key. This is where the attack, delay sustain and release, or envelope generator, comes in.

Instrument Dynamics. Every instrument's note varies in amplitude over time. This variation—the instrument's "dynamics"—is one of our chief clues to which instrument we're hearing. (Note how odd most instruments sound when recordings of them are played backwards, even though pitch and overtones are the same.) In some instruments, the sound of each note builds up (attacks) quickly, and dies away (decays) slowly. In others, the attack may be slow, and the decay rapid. Some instruments' outputs begin to die away as soon as a peak is reached; others "sustain" for a time before decay begins.

Though it may not be immediately apparent, all of these characteristics are functions of the way energy is added to each instrument's mechanical system. In instruments where the energy is added all at once (whether by hitting it with a stick or strumming it with a plectrum), the note's volume will be at a peak immediately after striking; and since all of the energy goes in at once, there will be

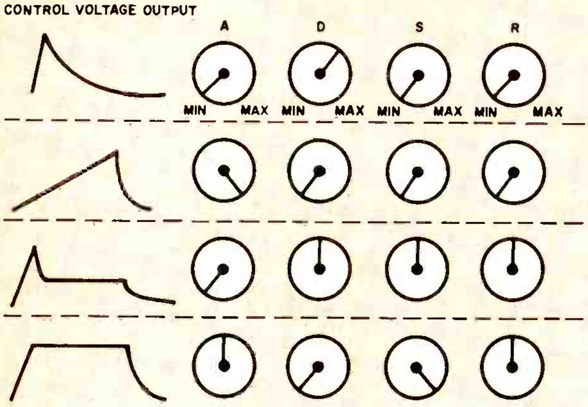


Fig. 6. By varying its **ATTACK, DECAY, SUSTAIN** *and* **RELEASE,** *envelope generator can produce different output waveforms.*

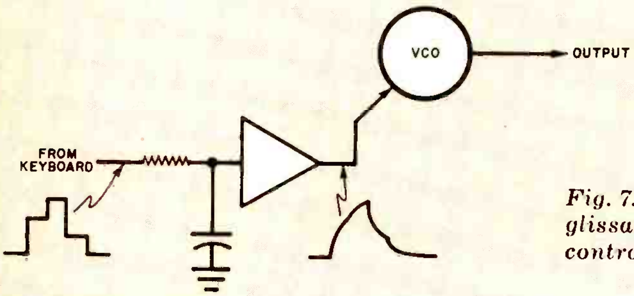


Fig. 7. An integrator adds glissando to a voltage controlled oscillator (vco).

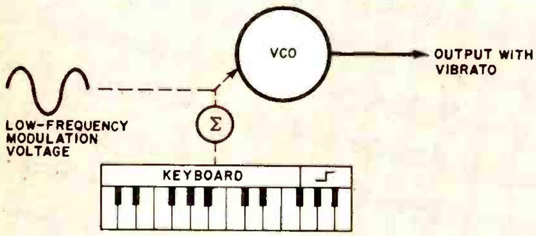


Fig. 8. Summation of control voltages results in special effects like vibrato.

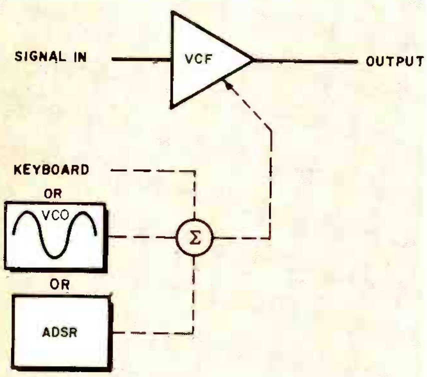


Fig. 9. Varying control voltages from vco or ADSR produce unusual effects.

none left over to sustain the sound—it's downhill all the way until the next note is played. This quick attack and moderate-to-slow decay is typical of instruments in the percussion family: guitar, piano, drums, xylophone, the heads of contestants on the "Gong Show," and such.

It would be natural to assume that we similarly "strike" the oscillator somehow to simulate this type of sound. But natural as this may seem, that's not how it's done. There's an easier way.

In a synthesizer, the oscillator runs all the time. Whether we hear it or not depends on whether the voltage-controlled amplifier (the last element in our "classic" patch) is on or off. And we control the dynamic shape of the note we're building by controlling the rate at which that vca turns on or off.

What controls the vca is the envelope generator or ADSR (Fig. 5). When it receives a trigger signal (usually from the keyboard), the ADSR's control voltage rises to a peak at a rate determined by the setting of the ATTACK control.

After reaching this peak, the control voltage begins to decrease at a rate set by the DECAY control. It doesn't fall all the way back to ZERO, though, just to a level set by a third control, SUSTAIN, where it holds for as long as the original triggering signal is present. Only when the trigger signal goes away (usually when the key on the keyboard is released) does the control voltage fall from the sustaining voltage to zero, and then at a rate set by the RELEASE control.

By adjusting these four controls—ATTACK, SUSTAIN, DECAY and RELEASE—we can cause the ADSR to generate a control voltage which, when used to determine how much signal passes through the vca, simulates the dynamics of any natural instrument (Fig. 6). It can also produce dynamics that would be difficult to produce with a mechanical instrument. An example would be combining the percussive attack of a drum with the sustaining properties of an oboe.

A synthesizer's oscillators and filters operate over an impressively wider frequency range than their mechanical counterparts, and have more modes of operation. A single electronic unit can even simulate a number of properties that might be mutually inconsistent in a mechanical device. But that's only part of the story.

Voltage Control. The real story is voltage control. A synthesizer's oscillator and filter frequencies and amplifier gain are all functions of the control voltages applied. That's more significant than it may look at first.

The keyboards used with most synthesizers are nothing but switch-selectable voltage dividers. Press a key, and a voltage that represents that key appears at the keyboard's output. Press another key and the voltage instantaneously changes to a new level. If the voltage from the keyboard is being used to set the pitch of the oscillator, the output instantly steps from the first note to the second. There will be times, though, when it will be desirable to produce a sound that doesn't instantly change from one pitch to another, but rather glides (glissandos) between notes. Because of voltage control, a simple integrator (nothing more than a register, capacitor and buffer amplifier) placed in the keyboard-to-oscillator control voltage path will produce this effect by slowing down the change (Fig. 7).

Other special effects can be added easily by summing control voltages from several sources. Vibrato, for example, which is a slow-speed modulation, is realized by summing a slowly varying (7–12 Hz) control voltage into one of the

control voltage inputs of the vco (Fig. 8). Applying this same modulating voltage to the vca produces tremolo, a slow variation in the output amplitude.

Since the center or corner frequencies of the filters used are also functions of summed control voltages, several vastly different acoustical instruments can be simulated simply by changing the source of the control voltages that we apply to this element.

If the voltage comes from a fixed source, the output would simulate an instrument with a fixed resonator such as a guitar or piano. However, changing the control voltage allows one to instantly change the properties of the resonator (try *that* with a piano). Moreover, if the control voltage comes from the same source that is supplying pitch information to the oscillators, we can simulate the properties of instruments with variable resonators, such as reed and wind instruments (Fig. 9).

Filter control voltages that vary with time can vary independently of the voltage that controls the oscillator, allowing the filter to sweep the harmonic content of the oscillator's output cyclically (a cross between tremolo and vibrato that is rare among natural instruments). Or, the control voltage can be derived from an ADSR, for a "waa-waa" effect.

Getting back to our "wind" instrument, the desired sighing quality can be easily attained by simply adjusting the envelope generator for a slow attack and decay, a high sustain level, and a slow release. Tiring of that, one need only change the settings of the ADSR to fast attack, no sustain, and moderate decay, to set up an entirely new "instrument." This one will sound like a "chromatic high hat cymbal," one that is played from a keyboard. This would not be only for rhythm, but also as a lead voice in a composition. (Try *that* with your pipe and plugger!) The pitch and range of the filter can be changed, too. Bring an oscillator in, and begin simulating snare drums that can be played in pitch. There's no end to the possible variations achievable with patch-cord type synthesizers.

If you have access to a synthesizer, you'll have instrumental and other sound available for recording right at your fingertips. And if you think that you don't like synthesizer sounds, perhaps you should begin listening more carefully to modern pop, jazz and rock recordings. The next time you hear what appears to be a chorus of violins, read the album's liner notes—they might not be real violins at all! ◇

Build a COMPUTER MUSIC BOX PERIPHERAL

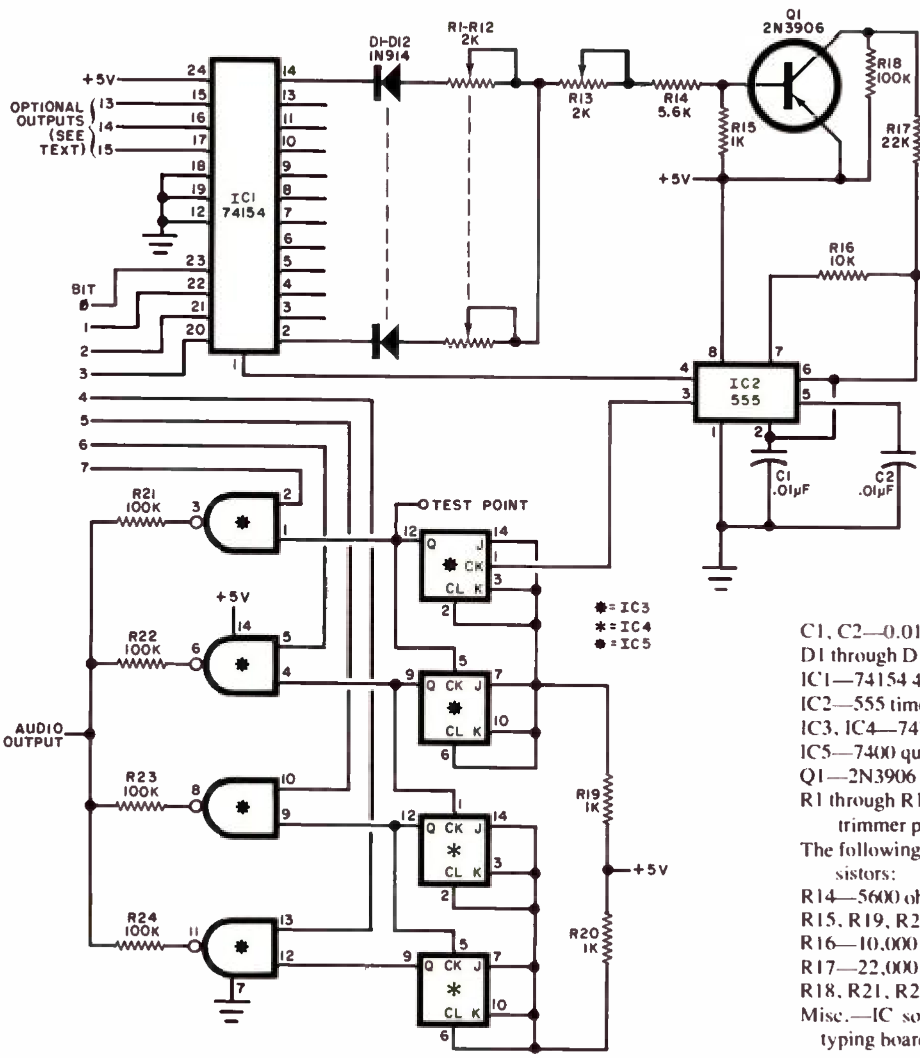
BY MARTIN SMAHA

Low-cost, 12-tone, 4-octave music generator also produces test signals.

JUDGING from the many commercial plug-ins available, computer-generated music appears to be the "in" thing today. If you have found the single-bit method is too limited and the digital/analog converter approach too expensive, the low-cost (less than $30) Music Box described here may be just for you.

The Music Box has a 12-note, four-octave range. It can be used with any computer that has a parallel output port. And to simplify its use, no strobes or other handshake signals are required.

The Music Box circuit is not limited to making music. It can easily be pro-



PARTS LIST

C1, C2—0.01-µF Mylar capacitor
D1 through D12—1N914 diode
IC1—74154 4-line to 16-line decoder
IC2—555 timer
IC3, IC4—7473 dual JK flip-flop
IC5—7400 quad NAND gate
Q1—2N3906 transistor
R1 through R13—2000-ohm linear-taper pc trimmer potentiometer
The following are 1/4-watt, 5%-tolerance resistors:
R14—5600 ohms
R15, R19, R20—1000 ohms
R16—10,000 ohms
R17—22,000 ohms
R18, R21, R22, R23, R24—100,000 ohms
Misc.—IC sockets (optional); suitable prototyping board; suitable enclosure; etc.

As bits 0 through 3 from computer change, the vco changes frequency. Other four bits (4 through 7) determine the octave of the audio output.

grammed to generate a mix of tones, up to a total of 16, for use as test and remote-control signals.

Circuit Operation. The circuit (see schematic diagram) can be broken down for discussion purposes into three major subsections: note decoder/selector, voltage-controlled oscillator (vco), and octave decoder/selector.

The note decoder/selector consists of integrated circuit *IC1*, a 4-line to 16-line decoder. As the four control bits from the computer (bits 0, 1, 2, and 3) are entered into *IC1*, one of the 16 output lines is driven low. When the output line goes low, it allows its associated diode *(D1* through *D12*) and series potentiometer (*R1* through *R12*) to control the voltage and, hence, the frequency of the vco made up of *IC2*, *Q1*, and their associated components. Since only 12 tones per octave are used in music, output lines 13, 14, and 15 of *IC1* (pins 15, 16, and 17) are not used. (These three lines can be used to control an external device, as we will discuss later.) When *IC1*'s output 0 at pin 1 is low, the vco is cut off to provide a no-note condition.

Timer *IC2* is configured as an oscillator, with transistor *Q1* serving as a voltage-controlled resistor that works in conjunction with frequency-determining capacitor *C1*. By varying the bias applied to the base of *Q1*, the output frequency of the vco system can be made to vary.

Resistor *R18* determines the low- and *R16* and *R17*, the high-frequency ends of the range. Capacitor *C1* can be changed to select the desired frequency range. The output of the oscillator at pin 3 is fed to the flip-flops in *IC3* and *IC4* for octave generation.

The four octaves of square waves generated by *IC3* and *IC4* are summed with the four octave-control bits (bits 4, 5, 6, and 7) by the four AND gates in *IC5*. The resulting selected octaves are mixed in *R21* through *R24* for application to an external audio system. Any combination of four octaves can be selected simply by changing the status of bits 4 through 7. If all octave bits are low, no tone appears at the output. Note that no status signals are required.

Since the audio output consists of square waves, it is not difficult to introduce various types of filters to create different sounds.

Construction. The entire circuit can be assembled on any prototyping board that can be connected to the parallel output port of the computer in which the Music Box is to be used. The power for the Music Box can be taken from the +5-volt and ground lines in the computer. Alternatively, you can use an external power supply rated at 100 mA minimum. In either case, a common ground must be used between the Music Box and computer.

You can use sockets for the IC's if you wish and small board-mounted trimmer potentiometers for *R1* through *R13*.

Calibration. Although the Music Box was designed for use with a computer, it does not require a computer for calibration. All you need is a 5-volt dc power source and an audio system. A frequency counter will simplify calibration but is not a necessity.

Before applying power to the Music Box, set *R1* through *R12* to their maximum series resistance and *R13* to its center of rotation. If you have a frequency counter, connect it to the TEST POINT. Otherwise, connect the output of the Music Box to an amplifier/speaker combination so that the pitch of the output signal can be compared with the sound of a known musical instrument.

Using temporary jumpers to the +5-volt (1) and ground (0) lines, set the control bits to the values given in Table I and adjust the corresponding trimmer potentiometer (*R1* through *R12*) to obtain the indicated frequency (or the correct tone when compared with the sound from a musical instrument). If the entire range cannot be obtained, readjust *R13* and perform the above procedure again.

TABLE I—THE WELL-TEMPERED MUSICAL SCALE

Control bit 76543210	Frequency (Hz)	Note 5th Octave
10000000	0	Off
10000001	523.25	C
0010	554.37	C#
0011	587.33	D
0100	622.25	D#
0101	659.26	E
0110	698.46	E#
0111	739.99	F
1000	783.99	G
1001	830.61	G#
1010	880.00	A
1011	932.33	A#
1100	987.77	B

TABLE II—TEST VALUES

Note	Number value (n)
Off	0
C	1
C#	2
D	3
D#	4
E	5
E#	6
F	7
G	8
G#	9
A	10
A#	11
B	12
Octave	**Number value**
5	n + 128
4	n + 64
3	n + 32
2	n + 16

Note: B_5 is the highest note (n=140)
C_2 is the lowest note (n=17)
C_5 is middle C
A_4 is A_{440}

Operation and Use. Since there is no data latch, the Music Box tracks the data that appears at the parallel output port. Connect the common ground and eight data lines between the Music Box and the output port. To test the system, execute an output of the number value that corresponds to that note as given in Table II.

The software program you write will depend on the music requirements. Arrays can be used to store melody information and loops can be used to control the length of the note.

The four-octave range of the circuit can be shifted by halving the value of *C1* to raise the pitch one octave or it can be doubled to lower the pitch one octave.

Other Uses. The three decoded outputs from *IC1* at pins 15, 16, and 17 can be used to trigger a percussive device (such as the "Cabonga" featured in the August 1977 issue of POPULAR ELECTRONICS) or to latch an external control device. These decoded output signals are TTL level. If music is not what you want, you can use the circuit to provide 16 preadjusted tones for use in testing or remote-control applications (see "Computer Bits," August 1977). To obtain all 16 tones, you must add diodes and potentiometers to the circuit as shown for the other outputs. ◇


40
ZACHARY T

CB Today & Where It's Going

• An introduction to a special 16-page report.

EXAMINING a CB radio mobile handbook published in 1962 underscores how far this low-cost, two-way radio communications system has traveled . . . and how much the same it is today. One striking sentence published fully 16 years ago in this book (four years after the CB band was moved to 27 MHz from higher frequencies authorized in 1947) was: ". . . the Commission never envisioned the CB'er who owns one set and talks to other licensees!" That was the reason given then for the FCC's initiation of the famous five-minute conversation limit rule.

The Citizens Band Today? It's a more meaningful form of short-distance radio communications than ever for the general public. There are said to be some 25-million CB transceivers spread around the U.S., creating a viable local network for emergency communications, informational assistance for motorists, and social conversations. And it's got a new name—the Citizens Band Radio Service, which is a subdesignation in the Personal Radio Service.

The new 17 CB channels added last year will most certainly be used more and more since the FCC banned sales of new or used 23-channel transceivers as of January 1, 1978 (excepting handheld types, which may be marketed without 40-channel capability until August 1, 1978). Although there was an increase of 74 percent in channel availability that now stretches from 26.96 to 27.41 MHz, channel 9 remains the emergency calling channel.

A host of modified rules and decisions over the past year or two has changed the complexion of CB for the better. For example, one can get on the air legally without waiting for a station license by using Form 555-B packed with each new CB transceiver; subpart D of the FCC's Part 95 Rules and Regulations has been broken out as a separate publication to be packaged with new transceivers; there is no charge for a CB license; new 40-channel transceivers must meet more stringent technical requirements; and, most recently, proceedings on creation of a Class E (224-225 MHz) CB band have been terminated.

Other decisions attest to CB radio's growing importance in our lives. The U.S. Coast Guard, for instance, announced it would install CB gear at Coast Guard Search and Rescue stations throughout the U.S. in time for the 1978 recreational boating season. Federal funds are now issued to states with organized CB programs, with the National Highway Traffic Safety Administration stating that the "Citizens Band offers the only existing method convenient to the public by which the motorist can enter the emergency response system from his/her vehicle." As a consequence, it will be progressively easier to reach a highway patrolman for aid as time goes on. Right now, in fact, CB radio public safety programs have been established by 94 percent of the nation's state police organization's, with CB radios already installed in 48 percent of the police vehicles in 34 states. Supporting the federally funded NEAR (National Emergency Aid Radio) program, REACT, the largest voluntary CB emergency service organization, was recently awarded a contract to develop a CB channel-9 monitor training program for public safety officers and volunteers.

The foregoing does not mean that CB radio is cleansed of all its problems. There are still violators of FCC rules, the most important being: (1) Out-of-band communications; (2) Overpowered transmitters; (3) Indecent language; (4) Communication over 150 miles away (skip); and (5) Failure to identify by callsign. Furthermore, CB-caused TV and audio interference is still a challenge.

The CB industry itself is in the process of stabilizing. The problems it had appear to have been precipitated by the FCC's announcement in July 1976 that 40-channel CB transceivers could be sold as of January 1977. While people waited for the introduction of new 40-channel models, 23-channel inventories mounted. The result was a drastic reduction in prices of 23-channel models that proved irresistible to the public, which, in turn, caused discounted prices on 40-channel models. The upshot was that most CB manufacturers lost money during this period, while the public was getting the best values in memory. With a more mature market, you can anticipate that selling prices will edge upward.

Where Is CB Going? In the short term, more and more single-sideband and increasingly sophisticated AM CB transceivers are likely to be purchased. The reasons are multifold. For one, advanced technology presents prospective users with a better rig, both in raw performance and in convenience features: electronic digital readouts, calculator-type control keypads, memory, automatic channel scan, separate VFO for receive-only with a second digital channel display, improved front-end overload circuitry, superior selectivity, precision SSB tuning, remotely controlled mobiles, and so on. Secondly, many millions of CB'ers are ripe for upgrading their present equipment, having tasted the benefits of two-way radio communication. (It's also expected that many CB'ers in this group will turn to amateur radio, expanding their communication horizons while maintaining CB rigs for emergencies.)

Technological developments do not necessarily mean exhorbitant cost, either. For example, National Semiconductor's single-chip frequency synthe-

sizer/programmer for CB radio use is claimed to reduce component count by as much as 60–70 percent. Features include two-speed-slew, up/down channel selection capability, busy or clear channel scan, channel memory, LED blanking control in the event an auto clock circuit is added, channel 9 selectability, and more. ECL and I^2L transistors are fabricated on the same chip.

You can expect standardization of selective calling signals somewhere down the road for CB radio. A technical committee of the EIA is already working on this for add-on to existing models and incorporation into future ones. There will be ongoing efforts to reduce interference on TV sets, too. CB radio manufacturers have already suggested that CB harmonic emissions be limited to −75 dB as compared to the present −60 dB. Further, FCC Commissioner Lee told TV manufacturers to get ready for an FCC drive to upgrade interference capabilities of TV receivers.

With few FCC enforcement personnel, it's expected that self-regulation efforts will be pursued to minimize communication violations by CB'ers. The FCC may well utilize the services of volunteers in a program of first-level screening and offender identification, a proposal already being considered. Also, a new series of radio Public Service Announcements has been prepared to remind CB'ers on proper usage of personal communications equipment. The on-again/off-again ATIS (automatic transmitting identification signal) proposals appear to be shelved for now.

There are many spectrum alternatives being analyzed to cover future growth of personal radio services. None seem imminent at this time, but somewhere down the road such a decision would have to be made to avoid channel congestion. Right now, though, the new 17 channels are essentially clear and clean, providing users with farther-reaching signals than they got with the older channels.

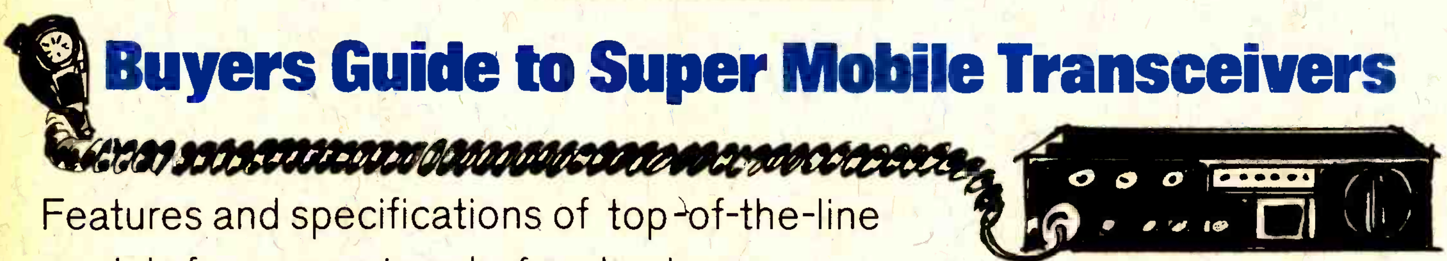
At some distant time, one may also expect a CB rig to perform as a true mobile telephone. Interestingly, International Resource Development Inc., a market research company, does indeed project a future merger between CB and the telephone, as well as skyrocketing growth in personal radio use after a short pause. Among other prospects is the use of repeaters in sparsely populated areas to extend a CB radio's range.

It would seem appropriate, too, in future planning to carve out SSB-only channels. To take full advantage of the spectrum-saving function of SSB, even at present, would require tighter technical specifications so that both lower (most popular) and upper sidebands on one channel can be used optimally.

Clearly, CB radio is no longer a fad. The over-riding reason for purchasing a CB rig, in fact, is to handle distress situations, as borne out by a recent study by the International Trade Commission. This isn't surprising since more than 40 million emergency and assistance requests are reported to be handled annually by the CB Radio Service. Equally impressive, the former Superintendent of the Missouri State Highway Patrol advised that lapsed time between occurrence and notification of accidents was almost halved when reported by CB radio as compared to conventional means.

See "Editorial" for report on CB at the 1978 Consumer Electronics Show. ◇

Buyers Guide to Super Mobile Transceivers



Features and specifications of top-of-the-line models for comparison before buying.

BY IVAN BERGER *Senior Editor*

A NEW breed of super mobile CB transceivers has been introduced to the marketplace this year. They feature higher performance capabilities than ever before, lower interference emission and more convenience features. Each CB manufacturer's best AM/SSB and AM model is listed in the buyer's guide on the following pages.

Specifications. All of the top-of-the-line SSB and AM mobiles listed in our chart cover 40 channels and virtually all manufacturers claim 100% modulation and the maximum power that the law allows: 4 watts on AM, 12 watts PEP on SSB. All have squelch, on-off-volume knobs and external speaker jacks; nearly all (except most of the control-in-the-mike remote-mount models) have S/r-f metering, and virtually all have digital channel displays. Because of these similarities, you won't find those features in the table. Sensitivity figures for about 90% of these rigs are 0.5 μV for 10 dB (S+N)/N on AM and 0.25 μV for SSB, and most makers rate audio power output at the 10%-distortion point. Exceptions to these specifications are noted under "Remarks."

Two specifications measure a CB rig's ability to reject unwanted signals. *Adjacent Channel Rejection,* as the name implies, tells how well the rig can reject signals of channels on either side of the tuned-in one. It's measured at ±10 kHz, of course. The higher this number, the better. *Selectivity* here is the bandwidth or i-f "window" at which the receiver's response falls by 6 dB. The narrower this frequency range, the greater the immunity to "splatter" from overmodulating stations on adjacent channels. If it's too narrow, however, voices will sound unnatural and that's not good either.

Image Rejection measures the receiver's ability to attenuate an undesired image signal generated by the converter stage. *Spurious Response Rejection* measures the transceiver's resistance to spurious signals created by the interaction within the tuner front end of strong external signals. The higher both figures, the better.

Most mobile sets will operate on both negative-ground cars (the most common type) and positive-ground ones. Where the manufacturers supplied the information, we show the permissible ground polarities as either "±" or "−".

About This Month's Cover

Although the CB mobile transceiver illustrated on our front cover doesn't exist, most of its features are available in one or another of the new CB models available today. With more and more CB manufacturers limiting much of their development and manufacturing efforts to "high-end" models, it would not surprise us to find all the features in our imaginary model combined on one chassis at some future time.

Like virtually all of today's top CB transceivers, our dream model has electronic tuning and LED digital channel readout. This permitted us to include several tuning options that are currently available (though not all on the same model), plus a few practical approaches we haven't seen yet.

The UP and DOWN buttons (duplicated on the mike) let you scan manually to any desired channel, while the keyboard lets you jump to any channel directly. If you're trying to hold a conversation, but find the channel is crowded, press our dream rig's SCAN VACANT rocker switch. (It's one of the controls in the group labelled SCAN on our drawing—detailed switch designations aren't shown.) This will find and display the nearest vacant channel number. After you tell the party with whom you were modulating what channel is vacant, pressing the switch the other way, to TUNE VACANT will move you directly to that channel. If you're looking for a conversation, the SCAN ACTIVE button will find it for you. SCAN MEMORY looks for activity, too, but only among the stations you've programmed into either of the two memories: M1 for the channels you use within your normal driving area, or M2 for channels you use when driving elsewhere.

SELECTIVE CALL facilities like our dream rig's should be available soon: one button, under the numerical keypad, programs in the selective-call number to be transmitted; the button beneath it is used to transmit that calling code. Two other keys work with the number pad to set your own call number and the channel or channels you expect to be called on. After that, any properly coded calls on any of those channels automatically take priority over the one you're using.

ON-OFF and VOLUME controls are separate, so you needn't reset the volume control whenever you turn the rig on. The VOLUME, SQUELCH and AM/SSB selector settings can be determined by touch, for safety, and the two SSB controls—the sideband selector and the clarifier—are grouped together. SQUELCH control setting can be determined by touch, as can that of the AM/SSB selector just below it. The CLARIFIER control is to the AM/SSB selector's left.

Grouped under QUALITY are: an ANL switch; a two-position NOISE BLANKER (for a choice of blanking time), a WHISTLE FILTER and a BROAD/NARROW i-f selector. To the left of the foregoing are RF GAIN and MIKE GAIN knobs; to the right is a TONE control. Still further right is the TALK TIMER It squawks when you've exceeded the statutory 5-minute limit on talking time, and its surround ring blinks as you approach that limit.

The optional clock module counts down from 5 minutes whenever you press the talk switch on the mike. It also tells you the time of day, between transmissions; and has an elapsed-time mode, too. A separate HOURS reset button simplifies resetting when you drive from one time zone to another. An interlock button prevents accidental resets.

The meters, of course, are as large as practical. In addition to the switch-selectable SWR metering, there's an alarm LED to warn you when the SWR approaches limits that could damage your transmitter—if the antenna is damaged, for example.

If our dream rig looks unusual, it's because we paid more attention to human engineering than to styling. Hence, the wide variety of controls' shapes and sizes (for easy touch identification) and the angled keypad (a more natural angle for the driver's hand with center buttons recognizable by touch.

Maximum current drawn by the rig is shown in the chart, too.

Listed Features. In addition to the basic features found on virtually all CB transceivers, there are several fairly common extras noted here. (For rarer ones, see "Remarks".) The *Automatic Noise Limiter* (ANL) circuit clips noise pulses that ride in on the received signal, but not noise which was part of the signal as it was transmitted. The *Noise Blanker* circuit momentarily squelches noise within the signal. It is more effective than ANL on AM, and quite a bit more effective on SSB. Where manufacturers have specified that their ANL or noise blanker controls are switchable, we've marked them with an "S". Switching out the ANL will usually increase volume and decrease distortion slightly. Switching out the noise blanker should have no audible effect (save for an increase in noise.) All too often, however, this will increase the receiver's apparent sensitivity, rather as if the squelch had been turned down a bit.

Some rigs have *R-F Gain* controls to prevent strong-signal overload; an "S" here means a two-position switch (sometimes labelled LOCAL/DISTANT) instead of a variable knob. *Mike Gain* controls assure maximum legal modulation even if you're speaking softly—on most sets, automatic level controls perform this function). Next comes a *Tone* control, followed by *Up/Down Tuning* (as in our dream rig).

Remote-mount means that the bulk of the transceiver circuitry is in a featureless, concealable box, with most or all controls on the microphone. (Some sets have a few controls or indicators on a separate speaker box.) *PA* switches are found on virtually all CB rigs; where the makers specified a *Separate PA Speaker Output*, that column is checked. A *LED Dimmer* brightens the channel numbers for daytime viewing and dims them at night to prevent glare.

Many sets today have various *Priority Channels*, allowing you to switch instantly to channel 9 for emergencies, to channel 19 for traffic advisories, or perhaps to some other channel or channels of your choice. (These are given only in the table for AM rigs.) Some will also scan the priority channels ("S" in our chart). Switching to one when there's activity. Others will, like our dream rig, scan for active channels ("Sa") or for vacant ones ("Sv"). Since this feature is rare on SSB rigs, we've used *Clarifier Range* for that column in the SSB table—priority and scan features, if any are also under "Remarks."

Indicators for *Percent Modulation* and SWR may be either meters ("M") or LED's ("L"). Modulation meters differ from the usual "RF" meters primarily in being calibrated in percentages, rather than in arbitrary units. If LED's are used for SWR, they usually serve only to warn when SWR has become high enough to possibly damage the transmitter. ◇

SUPER SSB MOBILE TRANSCEIVERS

Manufacturer and Model	Price	Automatic Noise Limiter	Noise Blanker	R-F Gain Control	Microphone Gain Control	Tone Control	Up/Down Tuning	Remote-Mount: Controls on Mike	Separate PA Speaker Output	LED Dimmer	Clarifier Range (kHz)	SSB	Indicators: Percent Modulation	Indicators: SWR	Adjacent Channel Rejection (-dB)	Selectivity: Bandwidth for 6 dB (kHz)	Image Rejection (-dB)	Spurious Response Rejection (dB)	Audio output (watts)	Maximum current consumption (A)	Ground Polarity	Approximate Dimensions (inches)	Remarks
Boman CB-950	$390		S	✓						✓	±0.6		L	M	50				3.5^u				
Browning Baron	$300	S	S	✓						✓	±1.5			M	50				6^u		±	2-3/8 x 7 x 12	AM r-f output 3.5W.
Cobra 132XLR	$330	S	S	✓	✓				✓	✓	±1.0	L	M	M	50	3.8 2.2^s	50		3.5^u		±	2-3/8 x 7-1/2 x 11	
Colt 480	$200	S	S	S											50		50		5	1.5	±	2-1/2 x 7-1/2 x 10	
Convoy CON-460	$385		S	✓					✓	✓											±	2-1/2 x 8 x 10-5/8	PA indicator light and level metering.
Cornell-Dubilier Mk. 26	$375		S	✓							±1.5			M	50^a 80^s	±2				2.2	±	2-3/8 x 7-1/8 x 10-7/8	
Courier Gladiator Model PLL-40	$400		S	✓					✓		±0.8			M	80	±2.5 $±2.1^s$	50	-60	5	2.2	±	3 x 10-5/8 x 12-3/8	SSB Sens. 0.15μV.
CPI CP-400	$499		✓								±1.5				80		70	-70	2*	2.5		2-1/4 x 9 x 11-3/4	Distortion 3%.
Craig L131	$360	S	S	S						✓	±0.6		L	M	60		60		3.5	2.4	±	2-1/4 x 8-1/2 x 10-1/4	SSB Sens. 0.18μV; Slide-out mount.
General Electric 3-5825	$330	S	S	✓		S*			✓		±0.8		L	L	50		35	-40	3.5	1.2	±	2-1/2 x 7-1/2 x 10-1/2	
Hy-Gain 2705	$370	✓	S	✓							±0.6				50	±3 $±1.2^s$	35	-40	3		±	2-3/4 x 8-1/2 x 11-1/2	AM Sens. 1μV.
Johnson Viking 4740	$360	✓	S	✓						✓		L			60	±2	40	-50	2^u		±	2-3/8 x 7-1/2 x 10-3/4	SSB Sens. 0.3μV.
Lafayette LMS40	$230	S	S	✓					✓		±1.5			L	60		60	-60	3^u	3	±	2-3/8 x 7-1/2 x 11	Sens. 0.7μV(AM), 0.35μV(SSB).
Midland 79-892	$340		S	✓		✓															±		
Motorola CM550	$320	✓	S	✓	✓						±1.4	U&L	L	M	60	4.1	70	-60	3	2.3	-	2.6 x 7.1 x 9.4	Mic gain doubles as PA volume control.
Pace 8092A	$270	S	S	✓					✓		±1.4	U&L		L	60		70	-60	3^u		±	2-1/2 x 8 x 10-1/4	Digital display doubles as clock.
Palomar SSB-2900	$300	S	S	S							±0.8		M		50^a 60^s		50^a 80^s	-65	3*	1.5	±	2-1/2 x 7-1/2 x 10	AM Sens. 0.7μV; Dist. 5%
Panasonic RJ-3700	$300	S	S	✓									L		55 60	5	45	-45	2	3	±	2-1/2 x 8-3/4 x 12-3/8	Quick-release mount.
President "Adams"	$370	S	S	✓	✓	✓			✓	✓	±1.3		M	M	70	±2.1	70	-60	3	3	±	2-1/2 x 9 x 10-5/8	AM Sens. 0.75μV; scans priority channels 9,19, plus one programmable.
Realistic TRC-449	$300	S	S	✓					✓	✓	±1.3		L		65		80		4		±	2 x 8 x 10-1/2	
Royce SSB 639	$200	S	S	✓	✓				✓	✓	±1.5		M	M		5 1.8^s			3.5^u		±	2-1/8 x 7-3/4 x 8	SSB Sens. 0.2μV; Ch-9 priority.
SBE Sidebander V	$420	S	S								±1.5				70^a 75^s		60	-60	4				Keyboard control; memory scan; Ch-9 priority; Sv.
Sharp CB-5470	$250		S	✓					✓		±0.7				50		60	-50	3.5	1.9	±	2-3/4 x 7-7/8 x 9-5/8	SSB Sens. 0.15μV; flashing Ch-9 indicator.
Teaberry 4012 Ranger	$330		S	✓					✓		±1.5				70	±2	40		3		±	2-3/8 x 7-7/8 x 9-7/8	SSB Sens. 0.3μV.
Tram D-62	$350	S	S	✓	✓				✓		±1.5		L	L	70	3.5 $±1.3^s$	60		4	2.5	±	2-3/8 x 7 x 10-3/4	Quick-release mount.
TRS Challenger 850	$300	S	S	✓								U&L	L		50				4^u	2.5		2-3/8 x 7-3/4 x 10	Sens. 0.7μV (AM), 0.3μV (SSB); SSB select. -50 dB @ ±25 kHz.

See next page for symbols and abbreviations.

SUPER AM MOBILE TRANSCEIVERS

Manufacturer and Model	Price	Automatic Noise Limiter	Noise Blanker	R-F Gain Control	Microphone Gain Control	Tone Control	Up/Down Tuning	Remote-Mount. Controls on Mike	Separate PA Speaker Output	LED Dimmer	Priority Channel	Indicators: Percent Modulation	Indicators: SWR	Adjacent-Channel Rejection (-dB)	Selectivity: Bandwidth for 6 dB (kHz)	Image Rejection (-dB)	Spurious Response Rejection (dB)	Audio Output (watts)	Maximum Current Consumption (A)	Ground Polarity	Approximate Dimensions (inches)	Remarks
Aircommand CB-640	$230	S	S	✓		✓					9+1	M	M	60		50		6	1.5	±	2-1/2 x 7-5/8 x 9-1/8	Ch.-9 alarm; Aux. input plays car stereo over PA speaker.
Alaron PD-7000	$150	✓			✓		✓	✓	✓			L		70		70	-65	3*	1.5	-	2-3/8 x 4 x 7	Sens. 0.4μV; Dist. 5%
Arthur Fulmer 15-4035	$190	✓		✓											6			3[u]		±	2 x 6-1/4 x 7-3/4	Sens. 0.7μV
Audiovox MCB-5000	$220						✓	✓														Standby.
Automatic Radio BBM-3444	$205	S		✓	✓			✓				L		50				4.5	2	-	1-3/8 x 7 x 7-7/8	Sens. 1.0μV; Standby.
Beltek Enduro 40A	$160								✓			L			6	60	-40	4*		-	2-1/2 x 5-7/8 x 9-1/8	For motorcycles; has intercom capability; 3.5W r-f; Sens. 0.7μV; Dist. 5%; Boom mike.
Boman CBM-6000	$330				✓		✓	✓														R-f output 3.5W
Bristol BCB-227	$160	S										L		50	±3	60	-50	3[u]		±	2-3/8 x 6-1/2 x 7-3/4	Sens. 0.7μV.
Clarion RJC-003	$200						✓	✓								60				-		Standby.
Cobra 32XLRA	$200	S	S	✓	✓				✓	✓	1,S				±4	40		3[u]		±	2-3/8 x 7-1/2 x 9-3/8	Ch.-9 indicator.
Colt SX 33	$150	✓					✓	✓						50	±4	50		5	1.5	±	2-1/4 x 5-1/2 x 6-3/4	
Convoy CON-450	$220	S	S	✓		✓			✓					60		40	-40	2	1.6	-	1-7/8 x 6-1/2 x 7-1/4	Sens. 2μV.
Cornell-Dubilier Mk.16	$230		✓	✓									M	50	±2				1.3	±	2-3/8 x 7-1/8 x 9-1/8	
Cornell-Dubilier Mk.17	$230							✓			5S,Sv,Sa			50				3	1.2	-	1-1/4 x 7 x 7	Sens. 1μV.
Courier Blazer 40D	$100	S		✓					✓	✓				50	±3	50	-60	3	1.3	±	2 x 5-7/8 x 8-1/4	
Craig L102	$160	S	S	✓					✓	✓		L	M	60	±3	60		4	2	±	2-1/4 x 8-3/4 x 10	Slide-out mount.
Fanon Fanfare 184DF	$100	S		✓					✓	✓				50	±3	50	-60	3	1.3	±	2 x 5-7/8 x 8-1/4	
Fujitsu Ten CAS231	$190						✓	✓						60		45	-50	2.5[u]		-		Sens. 0.7μV; standby opt
General Electric 3-5821	$240	S	[s]S	✓		✓			✓		1S	L		50		40	-40	2.2	1.2	±	2-3/8 x 7-1/2 x 9-3/4	Sens. 1μV; priority channel with signal and separate squelch; Ch-9 priority crystal, others optional.
Handic 199	$190	S					✓	✓						60				3.5	1.6		2 x 6 x 8	Selective-call option, $80.
Hy-Gain 2716	$250		S				✓	✓	✓		9+1			40	±3	35	-40	3			2-1/2 x 8 x 8-3/4	LED digital clock, "S" and r-f display.
Johnson 4360	$230						✓	✓		✓					±3		-42	3[u]		-	2-1/4 x 6-1/4 x 9-3/8 4-3/8 x 5-1/4 x 5-3/4	Telephone-type handset; readout in speaker box.
Kraco 4060	$200							✓	✓		9			100		100	-50	2.5	2	+		

Symbols and abbreviations: [a]AM; L=LED indicator; M=meter; S=switched; [s]SSB; Sa=scan for active channel; Sv= scan for vacant channel; S=scan(in Priority-Channel column); [u]Distortion unspecified; U&L=Upper & Lower sideband indicator lights; *See "Remarks" for distortion level;

SUPER AM MOBILE TRANSCEIVERS *Continued*

Manufacturer and Model	Price	Automatic Noise Limiter	Noise Blanker	R-F Gain Control	Microphone Gain Control	Tone Control	Up/Down Tuning	Remote-Mount; Controls on Mike	Separate PA Speaker Output	LED Dimmer	Priority Channel	Indicators: Percent Modulation	Indicators: SWR	Adjacent-Channel Rejection (-dB)	Selectivity: Bandwidth for 6 dB (kHz)	Image Rejection (-dB)	Spurious Response Rejection (dB)	Audio Output (watts)	Maximum Current Consumption (A)	Ground Polarity	Approximate Dimensions (inches)	Remarks
Kris XL-50	$260		S	✓	✓	✓				✓		M		60	5	45	-55	3	2.5		3 x 8-7/8 x 9-1/2	3 separate meters
Lafayette LM-300	$150	✓	S	✓					✓		1	L/M	M	60		60	-55	3	1.6	±		Sens. 1μV; Priority-channel alert.
Lake 750	$120		S										L	50		70		3^u		±		
Midland 77-861	$208	✓																		±	3-1/4 x 4-5/8 x 7-5/8	Combination mobile/portable model with batt., batt. meter, telescoping antenna, carry case; 3½ lb.; Sens 0.7μV; r-f output in portable mode switchable 3.1/1.5 w.
Motorola T4009	$190	✓	S							✓	9,S		M	55		10	-50	2.5*		+	2.5 x 7.3 x 9.4	Priority channel with defeat (Ch-9 crystal supplied, others optional) and separate squelch Dist. 5%.
Pace 8040	$150	S	S	✓	✓	✓	✓			✓	S		L	55				4^u		±	3-1/2 x 6-3/4 x 7	Keyboard entry; channel selector on mike.
Palomar 4100	$240	S	S	✓					✓					60	±3	60				±	2-1/4 x 7-1/4 x 7-1/2	
Panasonic RJ-3450	$230	S	S				✓	✓			9,Sa, Sv			55	5	45	-45	4*	2		2-7/8 x 7-5/8 x 8-3/4	Audio output through built-in speaker, 0.2W.
Pearce-Simpson Lion 40	$250	S	S	✓		✓							M	50	5	90		3			2-1/4 x 7 x 8-1/2	Sens. 0.7μV.
President "Teddy R"	$190	✓	S	✓	✓				✓	✓		M	M	60			-55		1.5	±	2-3/4 x 7-3/4 x 9-5/8	Switchable high filter.
Ray Jefferson CB-845	$200	✓	✓	✓									M					3^u			2-1/2 x 7 x 8-1/2	
Realistic TRC-456	$200	S	S	✓					✓			L		60	±3		-65	3.5		±	5 x 7 x 8-1/2	
Regency CB-501	$150	S								✓				55		50		4		±		Quick-release connectors
Royce CB613	$190	S		✓		✓	✓		✓		9		L/M	60	5		-50	2.5		±	2-1/8 x 7-3/8 x 7-5/8	Sens. 1μV; Quick-release mount.
SBE Key-Com 1000	$260	S	S	✓			✓		✓	✓	9+10, Sa			70		60	-60	4	1.9	±	2-1/8 x 5-7/8 x 8-3/4	Keyboard entry; 10-channel memory with scan; auto transfer to programmed priority channels and Ch. 9.
M.H. Scott DAK Mk. V	$160	S	S	✓					✓	✓		L								±	2-1/4 x 7-3/4 x 9	
Sharp CB4670	$190	S						✓	✓		9			50		60	-50	3.5	1.4	±	2-1/2 x 6-3/4 x 7-1/4	S/r-f meter in speaker cabinet.
SparkOmatic CB-4100	$170	✓		✓			✓	✓			S			50		55	-60	3		±	1-3/8 x 5-3/8 x 6-1/2	
Teaberry 4004 "T" Bear	$200		S	✓		✓			✓	✓		L		70	±3	50		3		±	2-1/4 x 7-1/2 x 10-1/4	Sens. 1μV.
Tram D-42	$160	S	S	✓	✓	✓			✓			L	L/M	80	±3	60		4	1.8	±	2-3/8 x 7 x 9-1/4	Quick-release mount.
TRS Challenger 730	$230	S	S	✓			✓	✓				L		50				4^u	2		2 x 7 x 8-1/2	Sens. 0.7μV; PA gain control.

Symbols and abbreviations: [a]AM; L=LED indicator; M=meter; S=switched; [s]SSB; Sa=scan for active channel; Sv= scan for vacant channel; S=scan(in Priority-Channel column); [u]Distortion unspecified; U&L=Upper & Lower sideband indicator lights; *See "Remarks" for distortion level;

Choosing a Mobile CB Antenna

● How to Select and Install Mobile CB Antennas.

BY JOHN J. McVEIGH, Asst. Technical Editor

WHERE range is concerned, the only factor truly under the control of the CB'er is the antenna—its type and where it is installed.

Antenna Basics. All antennas employed in two-way communications perform two functions: (1) accept r-f power from the transmitter and radiate it into space, and (2) capture a portion of the radio signals passing by and present them as small voltages to be processed by the receiver. For maximum range, antennas should perform these two functions as efficiently as possible.

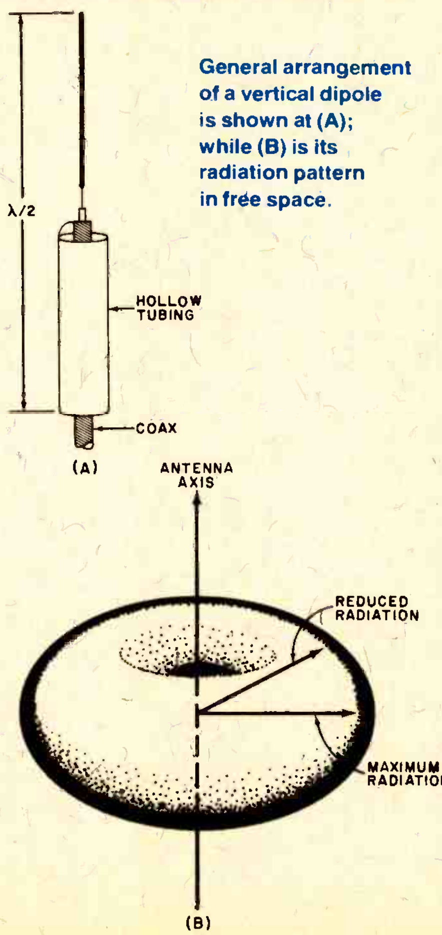
The elementary antenna from which most others are derived is the half-wave dipole. It is composed of two quarter-wavelength conductors and is fed in the center by a transmission line. The dipole can be installed so that its conductors lie in the horizontal or vertical plane.

Although a horizontal dipole possesses some qualities desirable in CB mobile communications, such as its greater ability to reject ignition noise, it's size makes it impracticable. Only a small fraction of all the vehicles on the road could accommodate a dipole 17.2′ (5.2 m) long! The vertical dipole, shown in Fig. 1A, is a more realistic alternative.

One of the characteristics of a dipole is *directivity*. That is, the antenna works better in some directions than others. If it is mounted in free space, the dipole's radiation pattern is as shown in Fig. 1B. It is most effective at right angles to itself, and least effective off its ends.

To an observer in the same plane as the antenna (standing upright and looking directly at it), the antenna appears to be omnidirectional. For a given *radiation angle* (the angle at which the signal takes off from the antenna), the horizontal radiation pattern of the vertical dipole is circular—the antenna receives signals from or radiates them to all points of the compass with equal facility. In other words, it is *omnidirectional*. Keep in mind, however, the three-dimensional aspect of the pattern. The vertical dipole is most effective when signals strike or leave it at right angles.

The vertical dipole's omnidirectionality in the horizontal plane means that no loss in signal will occur if the mobile you're talking with up ahead makes a left or right turn or follows a curve in the road. If horizontal dipoles were employed, each would end up in the null of the other's radiation pattern. It is true that the described patterns are those of antennas in free space, and that proximity to the earth and metallic objects distort them. But even real-life horizontal dipoles display some directionality.



General arrangement of a vertical dipole is shown at (A); while (B) is its radiation pattern in free space.

Another beneficial quality of the vertical dipole is its low angle of radiation, especially when mounted near ground. If it is mounted at right angles to the earth's surface, it is most sensitive to (and best radiates) ground-wave signals—those travelling parallel to the surface of the earth. In line-of-sight communications, the ground wave predominates. The vertical dipole will therefore reject skip signals to some extent, and will be most efficient for ground-wave mobile-to-mobile and mobile-to-base communications.

There are, however, some disadvantages associated with vertical antennas. Because they are omnidirectional in the horizontal plane, they will bring in stations from all points of the compass—both wanted and unwanted. On transmit, signal power will be radiated in all directions, not only toward the stations with whom you are communicating, but also areas where there are no stations.

The major disadvantage associated with the vertical half-wave dipole is its *size*—about 17.2 feet (5.2 m) at CB frequencies. A mobile antenna of that size would not only be physically unwieldy, but would also be highly vulnerable to damage from shocks inflicted by highway overpasses, overhanging tree branches, etc. Full-size, half-wave "coaxial" vertical antennas are commonly employed at base stations and on CB-equipped pleasure craft, but their dimensions rule out their use for mobiles.

Ground Planes provide a solution to the vertical dipole's height problem. If a quarter-wave vertical conductor is placed over a large horizontal conductive sheet, a "phantom" quarter-wave element is generated. The conductive sheet, called a *ground plane*, acts like a mirror and supplies the antenna element necessary to form a half-wave radiator. Ideally, the ground plane should be a perfectly conducting disc with a radius large as compared to the wavelength at the operating frequency.

Practicality imposes several limits on the structure and composition of the ground plane. Even at base stations, a metallic disc with a radius of only a quarter wavelength (about 8.6 feet or 2.6 m)

would be unwieldy. Four radial wires, each one-quarter wavelength, provide a ground plane at many CB base installations. The mirror image produced by the ground plane permits the use of an antenna only a quarter wavelength high.

In mobile applications, four radial wires are impractical. Instead, the metallic vehicle body is used. Although a far from ideal ground plane, the car body will work—to an extent—and is eminently practical. However, the vehicle body must be metallic.

Loading. Even though the use of a ground plane reduces the height of a vertical antenna by one half, a quarter-wave whip at CB frequencies (104" or 2.6 m) is rather large. Some CB'ers install such antennas on their vehicles, but for practical reasons they can mount them only on a bumper. (That is not a very good mounting location, as will be developed later.)

When positioned over a ground plane, a vertical whip will *resonate* at the frequency for which its length is one-quarter wavelength. That is, its feedpoint impedance will be purely resistive. If the whip is too short to be a quarter wavelength at the operating frequency, its feedpoint impedance will contain some capacitive reactance. CB transceivers, however, operate optimally when looking into purely resistive 50-ohm loads. By adding the right amount of inductive reactance—supplied by a loading coil—to precisely cancel out the antenna's capacitive reactance, only the resistive component is left. The antenna's *electrical length* is such that it resonates at the operating frequency.

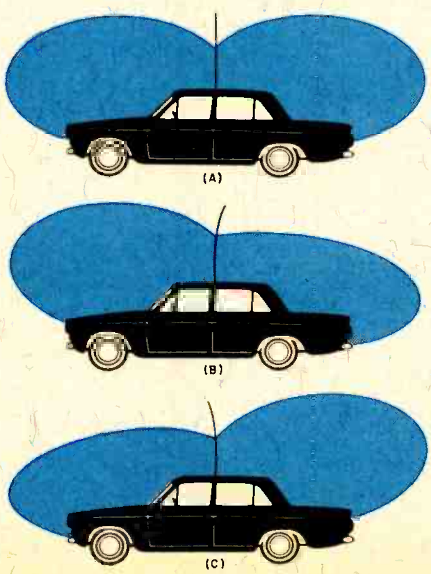
A loading coil, in effect, supplies the missing physical length required for resonance. For a given operating frequency, more and more inductance is required for resonance as the antenna is physically shortened. Some CB mobile antennas are only 18" (45.7 cm) long—quite a reduction from 104" (2.6 m)! They require a lot of loading inductance. Most mobile whips designed for roof or trunk mounting use less loading and longer whips, keeping element length in the physically manageable 48-to-54-inch (1.2-to-1.37-meter) range.

Loading is a compromise solution to the antenna height problem, not a perfect one. Two of its principal drawbacks are a reduction in antenna efficiency and a narrowing of bandwidth. The degradation of antenna efficiency is caused by the resistance of the wire which forms the coil. Some of the transceiver's r-f output will be wasted heating the coil, rather than being radiated by the antenna. For a given wire composition, more inductance means more turns of wire, hence more resistance and increased power loss. A mini-whip, requiring a large loading coil, will therefore be less efficient than a longer antenna with a smaller loading coil. Manufacturers try to keep this power loss low by using low-resistance wire in their loading coils.

Reduced bandwidth is a natural consequence of antenna loading because the introduction of inductive reactance raises the "Q" of the antenna. As the operating frequency moves away from that of resonance, the feedpoint impedance of the antenna changes, producing a mismatch between the antenna and feed line. Standing waves then appear on the line and the transceiver sees a reactive load.

Some impedance mismatch is inevitable and is tolerable up to a point. A mismatch of impedances by a factor of two (by definition, a standing wave ratio or SWR of 2:1) is acceptable, but greater mismatches can cause problems to the transmitter and a loss of antenna efficiency. Just how much the antenna's impedance changes with frequency determines how far above or below resonance it can be used before the mismatch becomes intolerable.

Fig. 2. Radiation pattern of vertical whip (A) is distorted when antenna sways backward (B) or forward (C).



A full-size quarter-wave whip working against a good ground plane will easily cover the 40 CB channels while maintaining an acceptable match. However, a very short miniwhip will have difficulty presenting a matched impedance over even the original 23 channels. Most mid-size whips can be used on 40 channels if tuned for the best impedance match at the center of the band.

Apart from physical convenience, there are two compelling reasons for using inductively loaded, less-than-full size vertical whips in mobile CB communications. One deals with ground-plane effects, and will be considered later. The other results from the physical behavior of a large whip on a moving car. With the vehicle stationary and the antenna upright, a radiation pattern like that shown in Fig. 2A is produced.

If the whip is long and springy, onrushing air will deflect it once the car is moving, resulting in the radiation pattern shown in Fig. 2B. This pattern indicates that some of the radiated r-f will be sent up into the blue—at the expense of the ground wave, the real medium of communications! If the car hits a bump or sharply decelerates, the whip can pitch forward, again producing an undesirable radiation pattern (Fig. 2C). Of course, distortions in the pattern will also occur if the whip sways from side to side.

As the whip bounces around, the signal received by another CB'er will flutter in strength. The same effect will be experienced on receive by the operator using the tall whip. Also, the load impedance as seen by his transmitter output stage and the SWR on the line will vary. These undesirable effects can be minimized by either shortening the antenna and inductively loading it or constructing it so that it is rigid.

Loading, within limits, is a good solution. Making the antenna rigid will cure the problem, but makes the antenna susceptible to damage from overhanging objects. Those manufacturers who produce stainless steel antennas use special alloys and element tapers to enhance the antenna's ability to remain upright while maintaining the flexibility necessary for absorbing shocks. Loaded fiberglass whips are more rigid than stainless steel and thus have less flutter.

Fiberglass antennas are also less susceptible to the buildup and discharge of static electricity, which can produce a hissing noise in the receiver. (Stainless steel whips usually have tip-mounted balls to inhibit static discharge.) The principal drawback to the use of a rigid

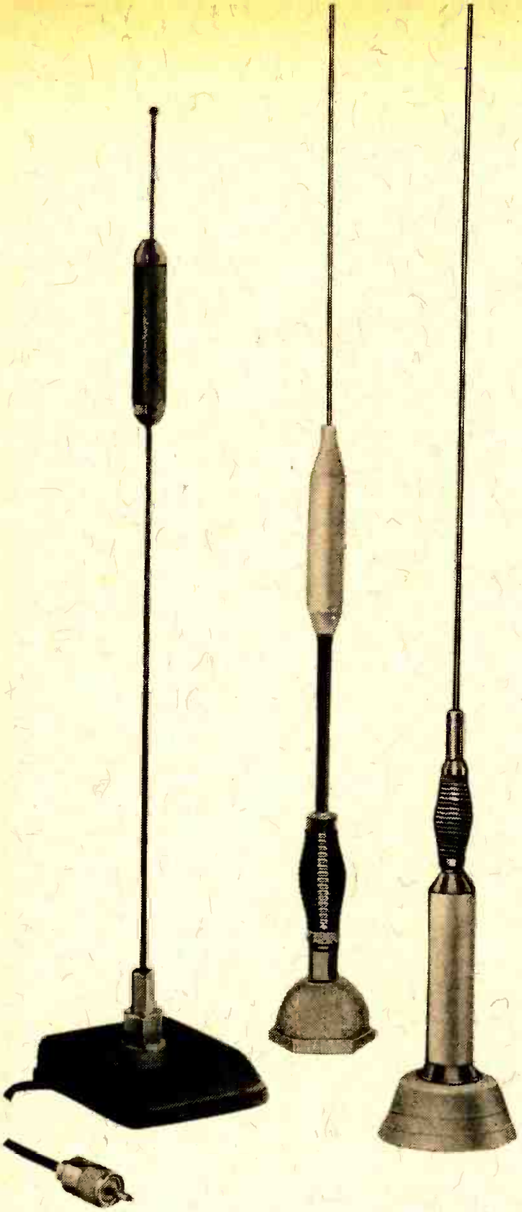


Fig. 3. Top-loaded antenna (A) is shown at left; center loading (B) in middle; base loading (C), right.

fiberglass whip is vulnerability to impact from overhanging objects.

A stainless steel shock spring can be inserted at the base of a long whip to make it more shock absorbent. The spring must have a braid-shorting strap fastened internally between its two ends. Otherwise, the spring will act as a coil and upset the feedpoint impedance of the antenna.

Types of Loading. An antenna designer has three choices as to the location of the loading coil—at the base, in the center, or at the top of the whip. Each has advantages and disadvantages, and we will examine them in turn.

Base loading is shown in Fig. 3C. The plastic cylinder at the base of the antenna houses the loading coil, isolating it from the detuning and corrosive effects of the environment. Base loading requires the least amount of inductance for a given antenna length, so coil resistance can be kept to a minimum. Also, base loading results in a physically sturdy structure because the weighty loading coil is at the bottom of the antenna. The light weight of the whip minimizes pendulum-like oscillations. An electrical benefit is also obtained. Keeping the coil fixed in relation to the ground plane reduces variations in feedpoint impedance as the whip flutters.

Most antennas that employ base loading are at dc ground. That is, there is a direct short from a dc point of view between the whip and the ground plane. Dc grounding is introduced to bleed off the hiss-producing static charges that accumulate on a stainless steel whip before they can discharge into the atmosphere.

The major disadvantage associated with base loading is a distortion in the distribution of voltage and current along the radiating element. Compare Fig. 4A, the V-I distribution along a full-size vertical radiator, with Fig. 4B, the distribution along a base-loaded antenna. This distortion in voltage and current distribution means that the base-loaded antenna has a fairly low radiation resistance—lower, in fact, than that exhibited by center- or top-loaded whips. Radiation resistance, a concept developed by antenna theorists, is a fictitious resistance that accounts for the power radiated by the antenna. The higher the radiation resistance, the greater the portion of the r-f delivered to the antenna that is actually radiated into space. Base loading, therefore, is less efficient than other loading techniques.

Center loading (Fig. 3B) offers improved V-I distribution along the radiator and greater radiation resistance than base loading. However, for a given whip length, more loading inductance is required. This implies greater coil losses than those experienced with base loading. There is a compensatory factor: a base loading coil is situated at the current maximum, but a center loading coil is positioned at a point where there is less current in the radiator. Heat losses are determined by the familiar relationship $P = I^2R$, where I is the rms current and R the dc resistance of the coil. That less current flows in a center loading coil compensates, somewhat, for the greater resistance of the larger loading coil.

Top loading (Fig. 3A) improves the V-I profile and increases the radiation resistance even more. This loading technique requires the most inductance and thus introduces the most coil resistance. However, the top of the radiator is where the least current flows, so coil losses are not as severe as you might first think. The trade-off of some coil losses for increased radiation efficiency is more than a break-even proposition.

The real problem that center or top loading introduces is whip sway. This adversely affects the radiation pattern and causes variations in feedpoint impedance. Whip sway is more likely with center or top loading because the coil housing increases the wind resistance of the whip. Impedance variations are more severe than with base loading because the relationship between the ground plane and the loading coil is not fixed but dependent on the deflection of the whip. As mentioned earlier, whip sway can be prevented by making the antenna rigid, but again, a stiff upright radiator is more susceptible to impact damage. However, if an antenna up to about 60" (1.2 m) is mounted on an auto roof or trunk, the likelihood of its coming in contact with overhanging objects is not too great. Vans and trucks are a different story.

Another loading technique is *continuous loading*. No discrete loading coil is employed. Rather, the inductance is distributed along the entire radiator. The continuously loaded antenna is formed by helically winding one quarter-wave length of wire on an insulating pole (Fig. 5). Epoxy or a fiberglass sheath is used to secure the helix in place.

Continuous loading produces better voltage and current distribution than lumped constant (discrete coil) loading. It's feedpoint impedance is also a better match for 50-ohm coax. If a tapered pitch is employed when the helix is wound, a very good match will be obtained. The radiation resistance of a continuously loaded antenna is comparable to that of a top-loaded whip. Because of these advantages, many of the fiberglass antennas on the market (except, of course, full-size whips) employ continuous loading.

Mounting the Antenna. We have already seen that a vehicle's body falls short of fulfilling a required ground plane. This has a significant effect on the performance of a mobile whip. Recall that the ground plane is analogous to a mirror. If it has high resistance, it will act like a dirty mirror, giving a faint reflection. If it is too small, the entire image will not fit in it. If the ground plane is not symmetrical, it will act like one of those

Choosing Mobile Antennas *continued*

trick mirrors in an amusement park, producing a distorted reflection.

The size of the ground plane (the auto body) is fixed once you have acquired the vehicle. There is not much you can do about the resistance of the car body except to ensure that all its components are bonded together by low-resistance, metal-to-metal connections. The one ground plane characteristic you can determine, to some extent, is its symmetry. This is done by your choice of the antenna's mounting site.

The best place to mount a mobile whip is at the center point of the vehicle's body, midway between the front and back and equidistant between the two sides. This will usually be located on the roof of the vehicle. If the antenna is mounted here, it will have a polar radiation pattern like that shown in Fig. 6A. (The arrow points towards the front of the automobile.) Although this pattern is not the ideal circle, it is a fair approximation. Because a car is longer than it is wide, the antenna is more effective fore and aft than it is side to side.

Mounting the antenna on the trunk lid results in the pattern shown in Fig. 6B. The distortion introduced by shifting the antenna from its ideal mounting position is obvious. It is due to the lack of ground plane symmetry. However, the pattern is acceptible and its imperfect shape is considered by many CB'ers to be less objectionable than drilling a hole in the vehicle roof for an antenna mount.

The polar response of an antenna mounted on the left corner of the rear bumper is shown in Fig. 6C. The antenna strongly favors the front right, and its overall performance is degraded. It is clear from these plots of field strength near the antenna that an unsymmetrical ground plane produces a polar response that is also unsymmetrical. If possible, this should be avoided.

Types of Mounts. CB'ers can choose either permanent or temporary antenna mounts. The final decision will be guided by performance, theft protection, and aesthetic considerations.

Permanent mounts include hardware-secured roof, trunk-lid, and bumper installations. Roof mounts require a 3/8"-to-3/4" (9.5-to-19-mm) hole, but offers the best antenna performance. Trunk-lid mounts do not require drilling because they are held in place by two set screws which grip the inside edge of the trunk

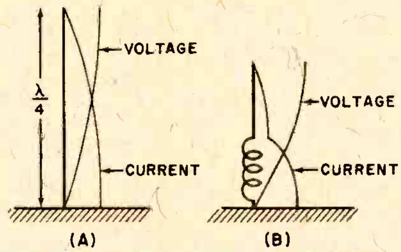


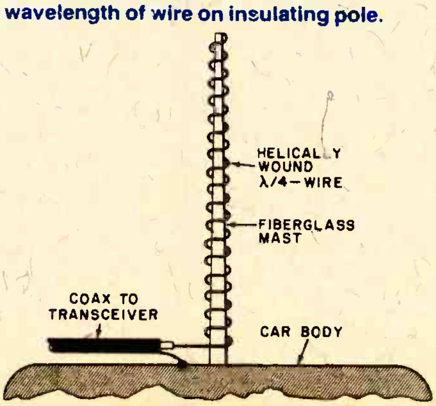
Fig. 4. Voltage and current distribution along a full-size quarter-wave antenna (A) is distorted when a loading coil is introduced at base of antenna (B) and the whip length is reduced.

lid. As noted earlier, antenna performance is somewhat degraded as compared to roof mounts. Bumper mounts usually employ straps which wrap around the bumper. The new "safety bumpers," however, have a lip which allows a clamp mount to be used with no straps or chains. Bumper-mounted antennas will not perform as well as those on the trunk or roof. The same is true of mirror- and cowl-mounted whips.

These permanent antenna mounts offer a solid connection to the ground plane, which is desirable, but they present security problems.

You can minimize calling attention to your CB gear by either removing the antenna and its mount each time you leave the car. (A quick-disconnect device is useful for this purpose) or by using antennas that are self-stowing. Using a multi-purpose antenna for AM and FM reception as well as for CB work is one way to do this. Such "disguise" antennas, if properly designed, look like a standard auto antenna. Electrically powered antennas that retract at the touch of a switch (some actuated by turning off the transceiver or ignition) similarly reduce the risk of loss while adding to convenience. Some of these, though, still leave a tell-tale 1/2" jutting through the opening. "Hideaway" trunk mounts, hinged to allow the antenna to be swung down into the trunk when not needed, also reduce antenna visibility.

Fig. 5. Continuously loaded antenna is made by winding one-quarter wavelength of wire on insulating pole.



Though these anti-theft measures reduce the chance of theft, they do degrade antenna performance somewhat. Because "disguise" antennas are mounted on a fender, and "hideaway" trunk mounts must be placed along one side of the trunk, they work against an unsymmetrical ground plane and have a skewed polar pattern.

Antennas with temporary mounts include those that clip on the rain gutter and those with magnetic mounts. There are several disadvantages associated with gutter mounts. First, gutters are not sturdy so the antenna must not have large wind resistance. This dictates the use of short whips and large loading coils, resulting in coil losses and decreased antenna efficiency. Second, rain gutters do not always have low-resistance connections to the rest of the car body (ground plane). Third, the ground plane is highly unsymmetrical.

A magnet-mounted antenna can be effective both as a radiator and an anti-theft device. It can be tossed in the trunk when not needed, and placed on the trunk or roof in a few seconds. A good magnet-mount antenna meets the following requirements. It must resist being dislodged when the whip is deflected. It must not "walk" along the roof or trunk as the car body vibrates and the whip sways. The mount must display a relatively high capacitance to the car body. The last requirement is electrically important because a magnet mount, unlike the others that have been mentioned, does not offer a direct connection to the vehicle body. Although the braid of the coaxial cable is grounded at the transceiver, for best results it should also be grounded at the mount. If the magnet mount is properly designed, there will be sufficient capacitance between it and the vehicle body.

No matter what type of mount you are thinking of using, be sure that it will keep the antenna upright. For example, if you are mounting the antenna on a fastback or other angled surface, choose a mount that will permit you to compensate for the mounting angle and adjust the whip so it is upright.

Co-Phasing. If two vertical antennas are spaced one quarter wavelength or

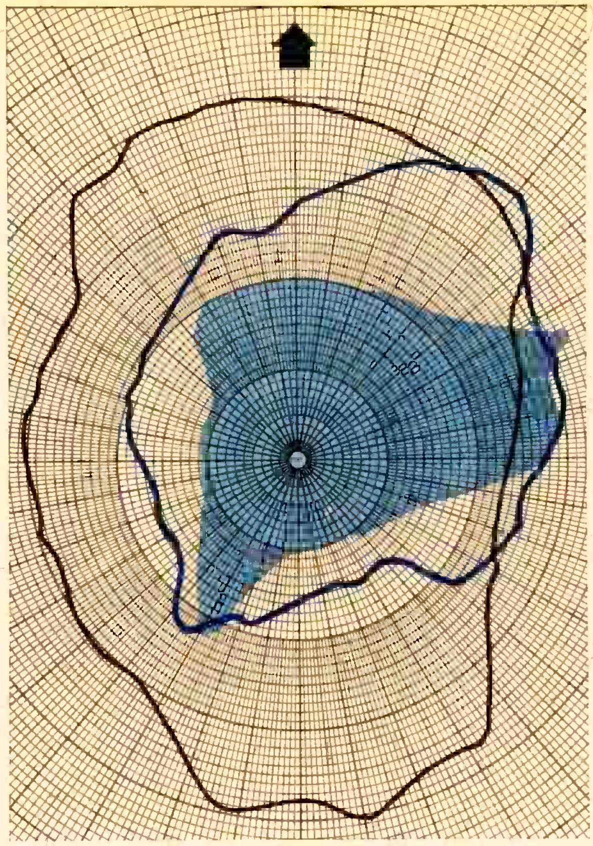


Fig. 6. Polar radiation patterns for roof (black line), trunk (colored line), and bumper (solid color), mounted antennas. Arrow points toward the front of the vehicle.

more away from each other, fed with properly phased feedlines, and there are no vertical conductors within a two-wavelength radius, some gain and a figure-eight radiation pattern (favoring fore and aft) will be obtained. CB'ers have attempted to take advantage of this by mounting twin whips on truck or camper mirrors, car bumpers, etc. Unfortunately, it doesn't work! Except, perhaps, on some very large trucks, a whip spacing of 104" (2.6 m) cannot be obtained. Also, there are enough intervening metallic elements within two wavelengths (72.8' or 22.2 m) to upset the carefully phased electromagetic fields.

The two mirror- or bumper-mounted antennas together will, however, have a better polar response than one by itself (recall Fig. 6C) because of the complementary phasing between them. But one antenna mounted on the vehicle roof or trunk displays a pattern superior to that of the phased twins, and will usually give superior performance!

Antenna Materials. Choosing a given type of loading, mounting position, etc. must be guided by factors that are unique to a given situation. Therefore, we can't recommend a specific antenna type. But we should say a word about antenna materials. If you want a metallic whip, be sure that it is "17-7 PH" type stainless steel. This alloy is very strong, does not corrode, and will flex but is resistant to permanent deformation. Shock springs and similar components should be triple-chrome plated.

Finally, mounting hardware should be heavily plated to resist corrosion.

In Conclusion. A properly installed and tuned antenna is your transceiver's best friend. Therefore, take care to mount it so that its ground plane is symmetrical. Make sure that the antenna has provisions for adjusting its length so that it can be fine tuned for the CB channels. Tune the antenna in accordance with the manufacturer's instructions and you'll ensure that it and your transceiver are giving you their maximum performance capabilities. ◇

How to Install

• Mobile CB Transceivers
• Mobile CB Antennas

BY IVAN BERGER
Senior Editor

WANT to make $25 or more, tax-free, for about an hour's easy work? Then install that new CB mobile radio in your car yourself, and you'll save at least that much. You don't need special knowledge or unusual tools.

You can mount a CB transceiver almost anywhere within reach of the driver's seat and mount an antenna almost anywhere outside the car. But it pays to look first for the best and easiest places to install them. For example, be sure that there is sufficient room under your dash to accommodate the transceiver's depth *before* you buy it!

For a typical mobile setup, we'd recommend that the transceiver be mounted on a quick-release slide bracket beneath the center of the dash. Also, the antenna should be mounted so it can be flipped down into the trunk for concealment when necessary. That combination offers easy access to the set's controls, reasonably good signal output and reception, straightforward installation, and excellent theft protection.

The reasons for the dashboard site are obvious: next to a combo CB/stereo unit that's built into your dash (and such equipment is difficult to install), a centered, under-dash mount is easiest for both driver and passenger to reach and is least likely to get in anyone's way.

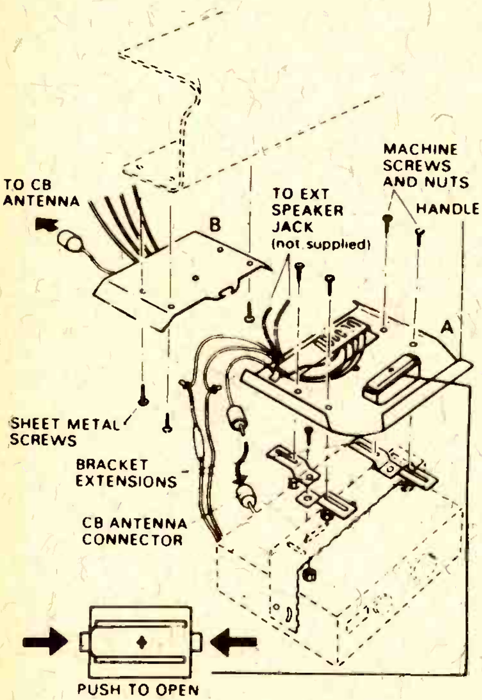
Slide mounts come in two parts: a stationary section that attaches to the bottom part of the dashboard, and a sliding section that holds the transceiver. Ideally, you'll find a mounting spot for the stationary section where the transceiver's controls will be easy for every driver in your family to see and reach, where the rig can be easily and securely mounted, and where there will be space to install the rig with clearance for attachment of its plugs and fasteners.

Mounting Surfaces. With a little bit of luck, you may find some screws already on the underside of the dash that can be used to hold the slide or the transceiver's mounting bracket (although you might have to replace those screws with slightly longer ones). If not, check the available surface to be sure it is strong enough to carry the transceiver's weight and to determine what techniques will be needed to drill through it.

Plain, painted metal is an ideal surface. It can support the radio securely and you can use short, self-tapping sheet-metal screws. With an electric drill, clean holes are easy to make. Just be sure to mark each hole with a centerpunch before you drill so the bit won't slip while you're working and scratch the paintwork—or your skin.

Metal with a padded covering requires a bit more care when drilling. Fabric covers or wooly underpadding may wrap themselves around your drill bit. Even foam padding, although less of a problem, must be treated cautiously.

If you can, it's best to punch your way through a padded metal underdash. An alternative approach is to cut an "X" in the top covering where you want to make the hole, peel back the four flaps made by the cut, and carefully dig or cut out any underpadding. Then smear Vaseline on the bit to make it slippery and drill in short bursts, watching carefully so you can stop the drill at the first sign of cloth or padding wrapping itself around the bit. After installing anything on a padded surface, check and re-tighten the screws from time to time to compensate for any gradual compression of the padding.



A typical 2-part slide mount for easy removal of an under-dash CB transceiver. Note that copper finger contacts on part A (that attaches to transceiver) makes power and signal connection to part B (affixed to underside of dashboard) so that the user need not physically disconnect or connect wires to remove unit.

Plastic and fiber panels are less secure mounting surfaces than metal, but sometimes they're all you have. Check behind such panels to see if there are metal structural supports that you can reach with longer bolts or screws. If not, the main problem is a tendency for the transceiver's weight to cause screw holes to enlarge until the screws pull out, CB rig and all. To prevent this, drill very carefully, with a sharp, fresh bit and gentle pressure to avoid cracking the panel. Then spread the weight over as much surface area as possible, using several, widely spaced screws and placing the largest possible washers under each nut. (Use lockwashers or Loctite to prevent your mountings from vibrating loose.) If you can't get your fingers behind the panel to insert nuts and washers, use Molly screws. For screw holes near the edge of a thin panel, Tinnerman nuts can hold the mounting bolts, although larger washers will spread the load more.

If your mounting surface is an underdash, plastic parcel shelf, rest your rig atop the shelf instead of hanging it below; here, the screws only maintain the transceiver in position, rather than supporting its weight.

Before you drill the first hole, make a final position check: Have someone hold the slide and transceiver in place and check for such often-overlooked details as cords that might get tangled in the gear-shift or pedals, side-mounted microphone plugs that poke the driver's leg, etc. Double-check behind the dash to make sure the drill bit won't hit wires, puncture air-conditioning ducts, or hit ashtrays. Often you can move some of the obstacles out of the way before you drill. If they are not too close to the panel you're drilling, you can also protect them by slipping a drill stop (available at hardware stores) over the bit to limit the depth of its penetration, or improvise a stop with duct tape. Otherwise, you'll have to pick a new location.

Determine which half of the slide mount attaches to the car and use it—not the mounting bracket supplied with the transceiver—as your template. (The transceiver bracket then bolts to the other, sliding half of the mount.) Make sure the bolt heads don't protrude enough to prevent sliding the transceiver into place. After you have drilled the first hole, attach your bracket to the car and double check the position you've marked for the second one.

Other Mounting Spots. If your dashboard is not a suitable or convenient spot for your transceiver, you might consider mounting it on the car's transmission hump. It's best to use speaker/rig-mount combinations in this situation. They're designed specifically for floor use, incorporating better speakers than those in mobile units. Moreover, since most mobile rigs have downward-facing speakers, this accessory avoids a sound-output problem. They usually disconnect easily for storage in the trunk when not in use, but they do take up some floor space.

Although the dash and the hump are the most popular locations for a CB rig, they are not the only ones. Some CB'ers

mount their sets, controls up, between front bucket seats; others mount them in their cars' center consoles. A small transceiver can even be installed in the car's open well that serves as a glove compartment. Then, too, there are temporary setups where the rig rests on the seat, lifted at the edge so as not to muffle speaker output. Power here is obtained from a lead plugged into the cigar lighter socket, while the antenna is either attached to a rain gutter or by a magnet mount in the middle of the roof.

Many new transceivers are built for concealment, with all controls in the microphone head and the rest of the circuitry in a featureless box that can be locked in the trunk or hidden elsewhere (mounted on the firewall, for example).

Extension Speakers. Most mobile sets have one or two extension speaker jacks on their rear panels. These allow the use of external speakers for better sound within the car, for PA use outside the car, or both. In rigs with two jacks, one feeds the stations you are listening to through an extension speaker in the car, while the other, when you switch the transceiver to its "PA" mode, feeds whatever you say into the mike through a speaker outside the car or under its hood. Don't use hi-fi car-stereo speakers since their frequency range is too wide for voice radio communications, which rarely exceed 3 kHz.

Slide-Out Bracket Details. Not all slide mounts are alike (although some models may show up under several brand names). Insist on a bracket that has a built-in coaxial socket and plug for the antenna, so you don't have to disconnect that separately when you slide out the transceiver. If you don't have this feature, you're sure, someday, to forget to re-attach the antenna and blow your power transistors.

The flimsy locks often found on slide mounts don't discourage thieves, who can often snap them in seconds. Even if the lock is a robust one, why invite a thief to try and rip up your car? So it's best to throw away the key and remember to remove and store your rig, perhaps in the trunk, when you leave the car unattended.

Most slide-mount sets have an extra pair of contacts for extension or PA speakers. At least one has two pair, so you can use both extension *and* PA speakers with your transceiver, or use the same mount for a car stereo (which needs connections for two speakers).

Installing a mobile CB rig is not usually a major undertaking. It can be challenging, though, when an AM/FM electric-powered antenna is replaced by a CB/AM/FM one since auto radio must be removed to make power connections.

Power Connections. Your mobile transceiver will get its power from the car's electrical system. It's easiest to make these power connections while the transceiver is in the car, but before it's actually bolted in place. You may connect it either to a circuit that is always "live" or to one which only carries power when the ignition key is turned. The owner's manual for your car should tell you which circuits are which and may—especially if it's a foreign car—include a circuit diagram to help you find the wires you'll need.

Running the power leads to a switch-controlled circuit ensures against accidentally draining the battery by leaving the car with the transceiver turned on. It also prevents unauthorized use of the radio while you're out of the car. (Remembering to remove and hide the rig each time you get out would also take

This external speaker-system/CB-rig mount is positioned on top of the car's transmission hump for enhanced sound. It is removable and can be hidden in the trunk for safety.

care of these two problems.) If you want to listen or transmit with the engine off, most car's ignition switches have "accessory" positions to allow this.

The easiest place to connect the CB power leads is to one of the terminals or wires already in the dash. You can tap into an existing wire, to a terminal of the ignition switch (if that's not buried out of reach), or to a terminal on one of the other dashboard switches or controls. (If you do use a switch terminal, make sure you have the switch's "hot" side—you don't want a CB radio that only operates if the headlights are on.)

The best place to tap in is usually the car's fuse box—there's less chance of picking up interference there. Whether you get your power directly from the fuse box or from another power source under the dash, make sure the fuse involved has enough capacity to handle your transceiver plus other devices it's already powering. If not, select a circuit with some spare capacity—don't just install a larger-amperage fuse. And never connect your transceiver or other accessory to the same circuit as the headlights or other vital systems.

Which Side is Ground? Virtually all cars today have 12-volt electrical systems, with the negative side of the circuit grounded to the car's frame. But some older ones and many trucks have positive-ground systems. Most current transceivers will operate on negative-ground, 12-volt systems, with many also capable of working on positive-ground systems. The instruction manual accompanying the CB transceiver will note which type you have. But if you don't have that information, you can use the ohmmeter function of a multimeter to determine it. Measure resistance between the transceiver's case and each of its two power leads. If you read zero ohms or very low resistance between the negative (usually black) lead and a bare metal area or screw on the case, your radio is for negative-ground use only. If the positive (usually red) lead is connected to the case, the transceiver is suitable only for positive-ground systems. But if you read high resistance between the case and both leads, you can use that radio with either grounding system as long as you connect the wires properly.

If you don't know which system your car uses, you can usually tell just by looking at the battery to see which of its terminals is connected by a woven-wire strap to the car's chassis; this would be the ground side.

The fuse block will sometimes have an unused tab to which you can attach a slip-on "quick disconnect" terminal that crimps onto your radio's power lead. If there are no unused tabs, you may be able to find an adapter that combines two male tabs with one female quick-disconnect. Remove the wire now connected to the tab on the fuse box, slide the adapter's female connector over the tab and one of the adapter's male connectors into the wire's female terminals. This leaves an extra tab to which you can attach the wire from the transceiver. Some fuse blocks may have screw terminals instead, or points to which you can solder your power wire.

If you have to splice into an existing wire, there are several possible ways of doing so. Auto-parts and electronic stores often stock small connectors from 3M and AMP which can be used to splice a lead into an existing wire without cutting it. The only tool needed to attach these is a common slip-joint plier. If you have to cut and splice wires, make sure the joint is mechanically strong, soldered if possible (those new, rechargeable cordless soldering irons are very handy for this), and properly insulated. (Heat-shrinkable plastic tubing is ideal for this purpose.)

Once your rig is connected to the car's electrical system, you'll want to try turning it on to make sure it lights up. Do this *after* you've rechecked the wiring for correct polarity—but *don't press the microphone's talk button* until the antenna system is connected! Transmitting without the antenna's load can damage output transistors.

Antenna Locations. In most CB installations, the antenna cable must run from a transceiver near the driver's seat to an antenna at the rear of the car. Peo-

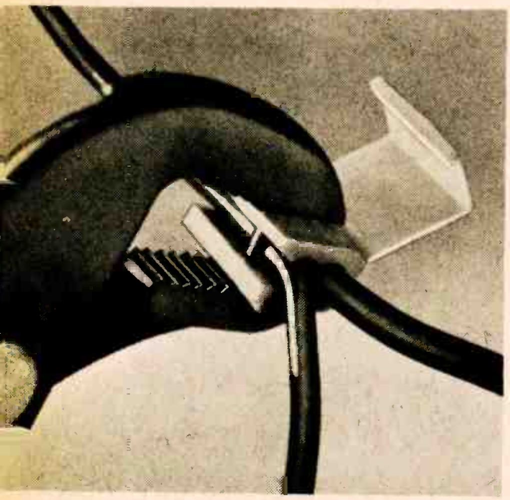
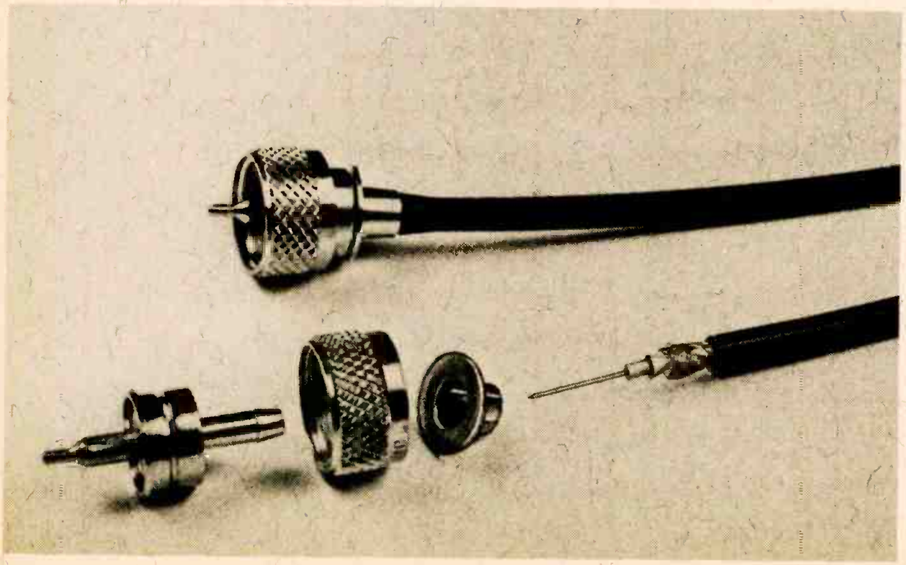
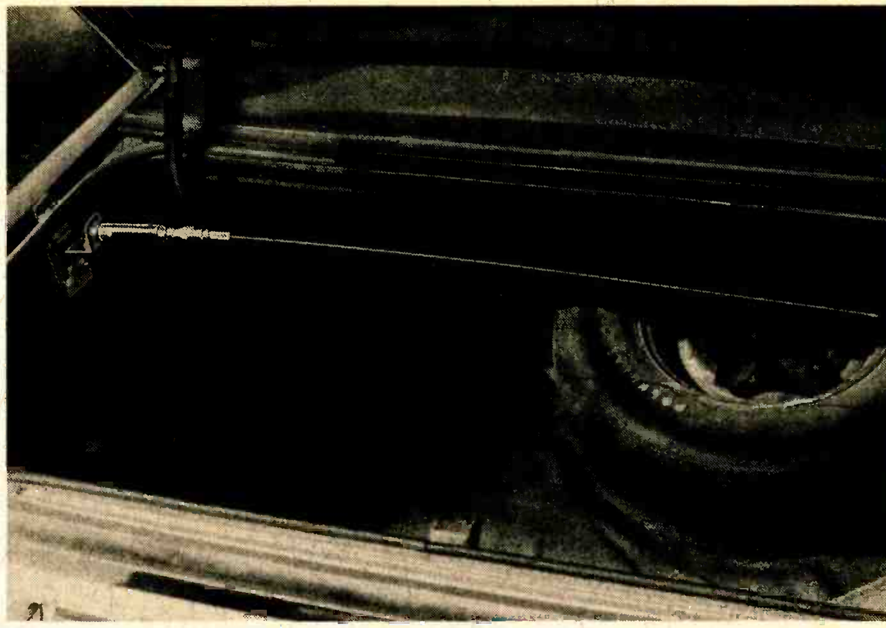


Photo at left shows a new type of 3M connector that comes in handy for making power connections to your mobile CB rig. Below, is an Amphenol PL-250 plug to show how easily RG-58A/U antenna coax wire can be connected without soldering.



ple mount their antennas back there for a variety of reasons. One is that short, coil-loaded antennas that clamp onto the trunk lid are about the easiest to install, since no holes have to be drilled in the car's outer body. Also, an antenna mounted to the front, hinged edge of the trunk is in a fairly efficient location, especially if the car's a hatchback with its "trunk lid" hinged at roof level. Nine-foot whip antennas can only be mounted conveniently on a car's rear bumper.

Antennas serve to alert would-be thieves that there's probably CB equipment inside that is worth stealing. So more and more installations take this into account. Quick-disconnect attachments are often used for easy removal of the vertical antenna section, though this still leaves the antenna base. To completely hide an antenna, more and more CB'ers have turned to the electric-powered type or to an antenna mounting device that permits one to manually swing the antenna down into the trunk. Both are side-mounted types.



A fold-away trunk mount makes it easy to conceal a mobile CB antenna when leaving an automobile.

Flip-down mounts may clamp on, without drilling, or may require some small screw holes in the rain gutter that surrounds the trunk opening. Since signal radiation from a mobile antenna is greatest toward the farthest point of the car, mounting the antenna by the side of the trunk opening will send most of your transmitted power towards the car's opposite front corner. But there will still be substantial radiation in most directions, so that is not a serious problem—especially compared to the performance you get if your rig is stolen!

Whether you have a trunk mount, a bumper-mounted whip, or a flip-down, your biggest problem will be getting its lead out to the transceiver. You're most likely to run your antenna cable from the trunk toward the dash.

Getting the lead into the trunk should be easy. Bumper-mount whips may require a hole drilled in the trunk wall (remember to line it with a rubber grommet, both to protect the cable and keep rain out), although it is sometimes possible to bring the cable through a hole that now carries wire to your back-up or license-plate lights. Antennas that mount on the edge of the trunk opening require only a little care to ensure that the cable won't kink when the lid closes.

Coming from the trunk, your first obstacle will likely be the partition between the trunk and the passenger compartment. If there's a gap between the partition and the trunk's floor, or if the car is a wagon or hatchback whose seat folds down, half the problem is already solved for you. You may also find a channel that carries tail-light and other wires, with enough space left to carry your antenna cable too. More often, though, you'll have to make a hole. If the partition is of metal, you'll have to drill. If it's of fiberboard or a similar substance, you may be able to punch a hole through it instead. It's probably best to drill, using gentle pressure. Again, be sure to line the hole with a rubber grommet. Check out the area on the other side of the panel before locating the hole to be sure your drill won't chew into upholstery or encounter other problems where it comes through. If the rear seat cushion has to come out, it's generally best to do that first. (It may take two people to do this.) Most seats are held by catches, some by bolts.

Before drilling, you should also check the passenger compartment to see where it will be best to run the cable. The best route is usually along the side of the car. You can tuck it under the edges of side panels (you may have to loosen their mounting screws), run it under the sill-plates at each door (they're easy to remove, usually held by just a screw or two), or insert the cable under the edges of the carpets and floor mats. In some cases, it's more practical to lift the carpets and run the cable along the lower edge of the transmission hump and through the center console.

If you are unable to remove the rear seat cushion, you could try to snake the wire straight through the trunk, or fish it through with a hook made from coathanger wire. If that fails, try raising the seat's front edge enough to get your hand under it. (You may want to slip a block beneath the seat's front edge.) If the seat doesn't lift up easily, check on how it's mounted; it may be bolted in place.

As you work, you should be using cable clamps or cable ties to keep the antenna lead out of the way. This is most important in the trunk where a loose cable could be snagged by luggage or other cargo, and when passing across the front of the car where it could tangle with the steering gear or pedals.

The antenna cable may not be exactly the right length, but that's no problem. If it's too long, you can cut the excess and use a new PL-259 connector. The solderless connector type for RG-58 A/U coaxial cable is best for this purpose.

If the cable is too short, you can buy an extension. Buy one with plugs already installed and the shortest length that will do the job.

Other Antenna Sites. Because your signal's coverage increases as you raise your antenna, and because its pattern is most symmetrical when the antenna is at the center of the car, a roof mount is a most efficient choice. Unfortunately, a roof mount can be quite difficult to install. Also, most people hesitate to drill holes in an area that is so conspicuous.

For a roof antenna, you'll have to drill a hole in the roof and snake the antenna lead from there, under the car's cloth

headliner, then down a window pillar to the dash or floor level. That may be easier if you have a dome light in the center of the car's roof—take out the light and you can usually drill directly through the roof. Just be sure there will still be room to put the light back, once the antenna is installed. If you have no center light, you'll have to take the headliner down to do the job neatly—and in most cars, that's not easy.

You can also use a magnetic-base antenna. It requires no drilling and installation (the cable could be passed through the rubber gasket around the car's door opening or through a slightly opened window). Furthermore, the antenna is easily hidden in the car when you park.

Antennas that clip temporarily to the car's roof gutter are available, too, as are permanent fender-mounted or cowl-mounted types. The latter include electric-powered antennas, which might also combine AM and FM broadcast radio.

Fine-Tuning Your Antenna. It's not enough to just install and connect your antenna. You also have to adjust it for minimum SWR—standing wave ratio. This is the ratio between the power that comes out of your transceiver and the lost power that bounces back from the antenna line instead of going out over the air. (It will similarly affect the strength of a received signal.)

To do this, you'll need a modestly priced SWR meter, if your CB transceiver doesn't have one built in. This will reduce some of the savings you made by doing your own installation, but is a worthwhile investment for making periodic checks on your antenna system.

The meter plugs in between the transceiver and the antenna cable. If you have added an extension to your antenna's cable, you can connect the meter between the cable and extension. Otherwise, you'll need a short stub of cable with plugs on both ends to connect the meter to your transceiver; some meters include this cable, but not all do.

You can't tune an antenna for the same SWR on every channel. The farther you go in frequency from the channel for which the antenna has been tuned, the higher the SWR will be. So, unless you do almost all your talking on a single channel, you should tune the antenna to the center of the band for the best average efficiency on all channels.

For 40-channel transceivers, this would be channel 20 or 21. Listen for a break between conversations before you press the mike "talk" button. You don't want to interfere with other CB users' conversations! Also, you may legally transmit a silent carrier only when making adjustments like this and then for not more than one minute out of every five.

Your meter will probably have a switch marked FWD on one side and REV or SWR on the other. Switch it to the forward position and press your mike's talk switch. The needle should move up the scale. Adjust the meter's calibration knob until the pointer reaches a red line or other index mark. Then flick the switch back to SWR or REV and read the pointer again. It should have dropped back to a reading somewhere between 1.1 and 1.5 or so. Now release your PTT mike switch so you can make antenna adjustments that will produce the lowest SWR reading.

Theoretically, an SWR of 1:1 is perfect; in practice, it will be higher, say, 1.2:1 at mid-channel and 1.5:1 to 2:1 at end channels.

To lower an antenna's SWR, you must adjust its length. This requires either lengthening or shortening the antenna. To tell which, repeat your SWR checks on a moderately low channel (around channel 10) and a fairly high one (say, channel 30). If SWR is lower on channel 10 than channel 20, you'll have to *shorten* the antenna; if it's lower on channel 30 than on 20, you'll have to *lengthen* it. (If it is much higher than 2:1 on any channel, stop transmitting on that channel at once and check cable connections at the transceiver and the antenna ends.)

Most of the better antennas have length adjustments, either an adjustable tip (on top- or center-loaded antennas or on some fiberglass "continuously loaded" types), or an adjustment on the coil housing (of base-loaded types). To lengthen or shorten such an antenna, simply loosen the adjustment setscrew with the Allen wrench supplied, make a small height adjustment, and lock it in place while you re-check your SWR with the meter.

Less expensive antennas and some older types may have to be trimmed to obtain a proper match. Either a hacksaw or bolt cutter will do the trick. Cut no more than ⅛ inch at a time.

Eventually, your SWR will get as low as it's going to be and your next adjustment will only serve to raise it a trifle. At that point, go back one step to where you got your lowest reading. Then, for a final check, measure your SWR on both channel 1 and channel 40. If they're not quite equal, readjust until they are.

Now, at last, you're ready to go on the air and ask for a radio check. ◇

Measuring and adjusting for minimum SWR is an important final step to ensure optimum antenna efficiency and avoid damaging a CB transceiver.

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BY RAY WILKINS

FOUR EASY-TO-BUILD LED PROJECTS

WITH THE prices of LED's and CMOS IC's continuing to drop, electronics experimenters should take advantage of the circumstances and build some of the many interesting projects that can be made using these devices. The four circuits described in this article are not only fun to build, they also teach the builder quite a bit about the devices and their uses.

The circuits take advantage of the fact that CMOS devices require very low power, so no power on/off switches are used. The quiescent current drawn by the CMOS chips (when the LED's are off), allows normal battery shelf life. Once the pushbutton switch on a project is operated, the circuit "does its thing," and then stops.

Blinker. As shown in Fig. 1, this circuit uses a single CMOS hex inverter to provide both timing and drive to make the two LED's blink alternately. Built with two small red LED's, the circuit makes

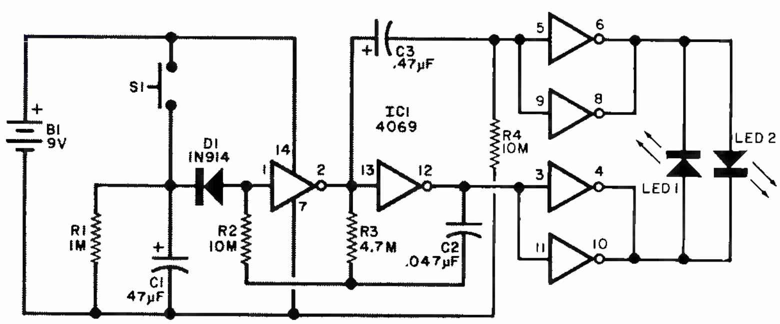


Fig. 1. Dual LED alternate blinker uses parallel gate output for more LED driving current.

BLINKER PARTS LIST

B1—9-volt battery
C1—47-µF, 10-V electrolytic
C2—0.047-µF disc capacitor
C3—0.47µF, 10-V electrolytic
D1—1N914 diode
IC1—4069 CMOS hex inverter
LED1, LED2—Light emitting diode (2 red, or 1 red/1 green)
R1—1-megohm resistor
R2, R4—10-megohm resistor
R3—4.7-megohm resistor
S1—Normally open pushbutton switch

an ideal HO-gauge model railroad crossing blinker. With LED's of two different colors (in one package), it can be used to obtain other effects.

Resistors *R2* and *R3* and capacitor *C2* determine the flash rate, while *R1* and *C1* set the total display time. The component values shown here produce a blinking rate of two per second and an on time of about 20 seconds. To change the timing, change the values of the capacitors since decreasing the value of the resistors will increase the quiescent battery current drain.

Flasher. A simple variable-rate LED flasher is shown in Fig. 2. The voltage across *C1* determines the flash rate. When the pushbutton switch is closed, capacitor *C1* charges to 9 volts and the flasher blinks rapidly. As the voltage is discharged through *R1*, the flasher slows down until the charge on *C1* reaches about 4.5 volts, at which point the oscillator stops and the LED stays off. The flash rate is set by the values of *R2*, *R3*, *R4*, *R5*, and *C2*. Capacitor *C1* and bleeder resistor *R1* create the slow-down period.

Binary Counter. A circuit that demonstrates the operation of a six-bit binary counter is shown in Fig. 3. When the

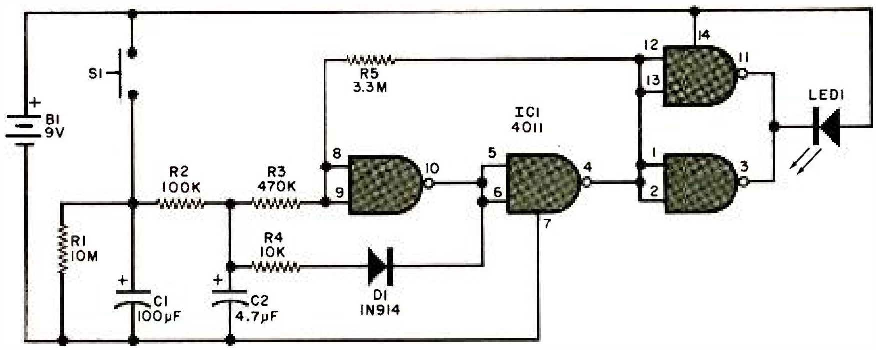


Fig. 2. Single LED flasher also uses parallel gate output for driving the LED.

FLASHER PARTS LIST

B1—9-volt battery
C1—100-µF, 10-V electrolytic
C2—4.7-µF, 10-V electrolytic
D1—1N914 diode
IC1—4011 CMOS quad 2-input NAND gate
LED1—Red light emitting diode
R1—10-megohm resistor
R2—100,000-ohm resistor
R3—470,000-ohm resistor
R4—10,000-ohm resistor
R5—3.3-megohm resistor
S1—Normally open pushbutton switch

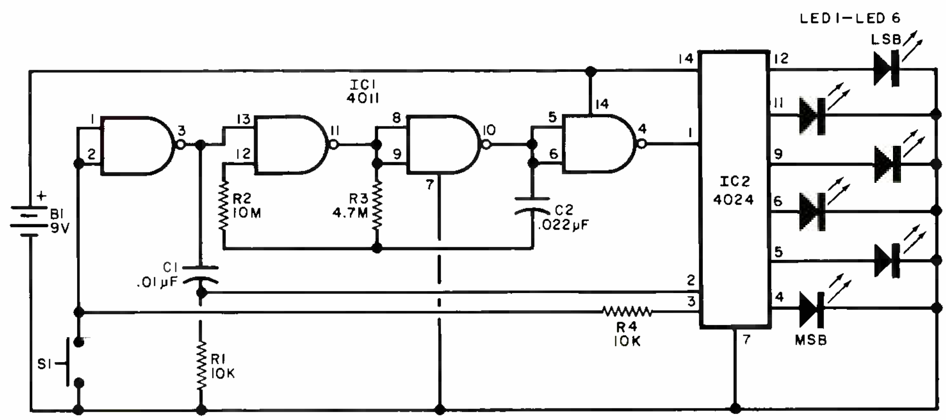


Fig. 3. Simple binary counter illustrates counting in the 1-2-4-8-16-32 mode.

BINARY COUNTER PARTS LIST

B1—9-volt battery
C1—0.01-µF disc capacitor
C2—0.022-µF disc capacitor
IC1—4011 CMOS quad 2-input NAND gate
IC2—4024 CMOS binary counter
LED1-LED6—Red light emitting diode
R1, R4—10,000-ohm resistor
R2—10-megohm resistor
R3—4.7-megohm resistor
S1—Normally open pushbutton switch

pushbutton switch is depressed, the circuit starts counting from zero (all LED's off) to 63 (all LED's lit). After reaching the full count, the circuit automatically resets to zero and shuts itself off. The six LED's come on in a binary (1, 2, 4, 8, 16, 32) sequence which is typical of digital counters.

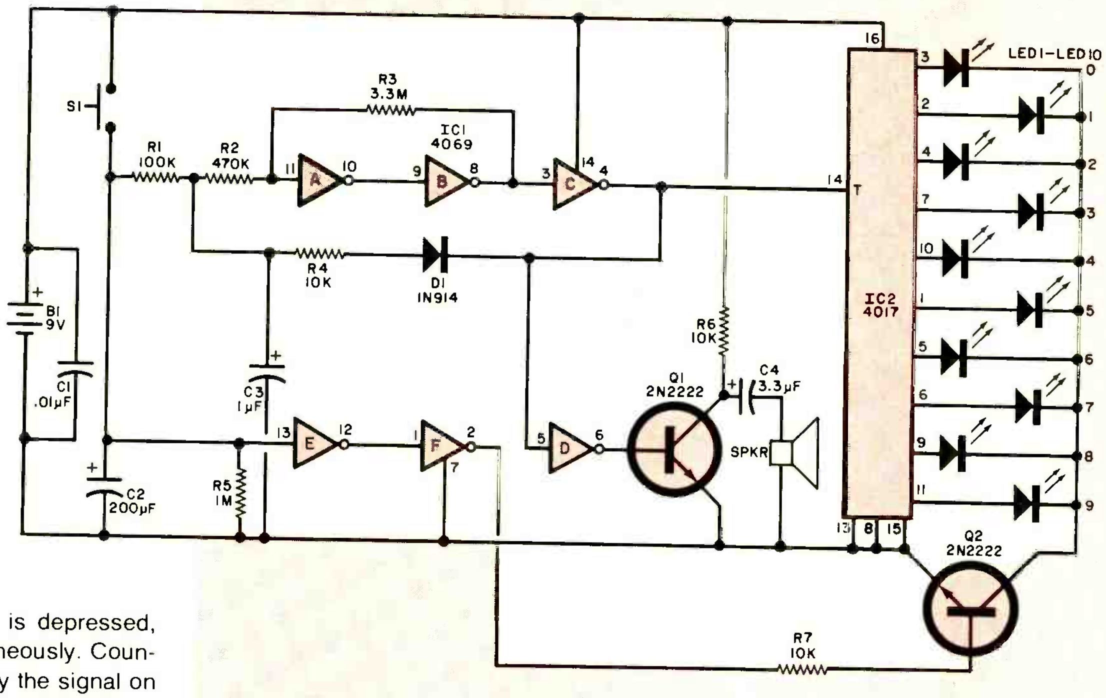


Fig. 4. "Wheel of Fortune" sequentially lights one of 10 LED's and generates audible clicks.

When the pushbutton is depressed, two things occur simultaneously. Counter *IC2* is reset to zero by the signal on pin 2, thus placing all of the *IC2* outputs at their low states (0 volts). Thus, none of the LED's can glow. The second action is an enable level signal (+9 volts) at pin 13 of *IC1*. This action allows the oscillator (the middle two gates) to start, thus producing an input signal to the counter IC through the last gate of *IC1*.

The counter then counts until it is full, illuminating the LED's in the proper sequence. One count after full count is reached, pin 3 of *IC2* goes high. This signal is inverted by the first gate of *IC1*, and its output goes low, thus disabling the oscillator. The circuit then remains in the "all LED's off" state until the pushbutton is depressed again. The value of *C2* can be changed to increase or decrease the counting speed.

Wheel of Fortune. The circuit shown in Fig. 4 is a 10-LED spinning wheel with audible 'clicks' as the wheel passes each point. The rotation starts fast, then gradually slows down to a random stop (with a click at each position). After the rotation ceases, the selected LED stays lit for about 10 seconds, then goes out. The cycle restarts by depressing the pushbutton switch.

The logic requires only two IC's. Of these, *IC1A*, *IC1B* and *IC1C* form a vari-

WHEEL OF FORTUNE PARTS LIST

B1—9-volt battery
C1—0.01-μF disc capacitor
C2—200-μF, 10-V electrolytic
C3—1-μF, 10-V electrolytic
C4—3.3-μF, 10-V electrolytic
D1—1N914 diode
IC1—4069 CMOS hex inverter
IC2-4017 CMOS decade counter decoder
LED1-LED10—Red light emitting diode
Q1, Q2—2N2222 transistor
R1—100,000-ohm resistor
R2—470,000-ohm resistor
R3—3.3-megohm resistor
R4, R6—10,000-ohm resistor
R5—1-megohm resistor
S1—Normally open pushbutton switch

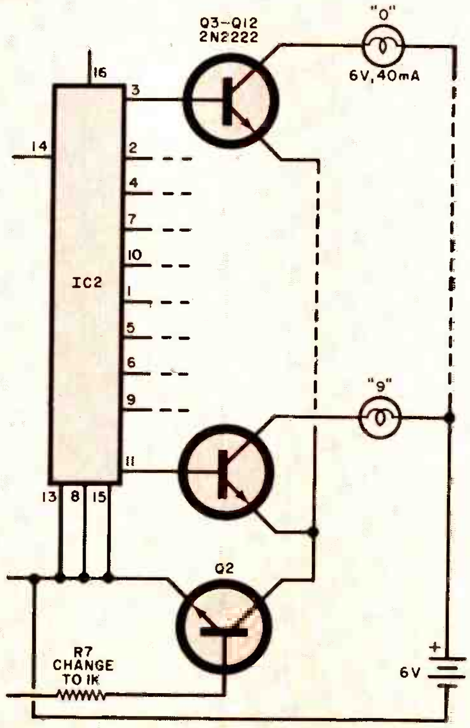


Fig. 5. Modifying the Wheel of Fortune for use with conventional 6 volt lamps.

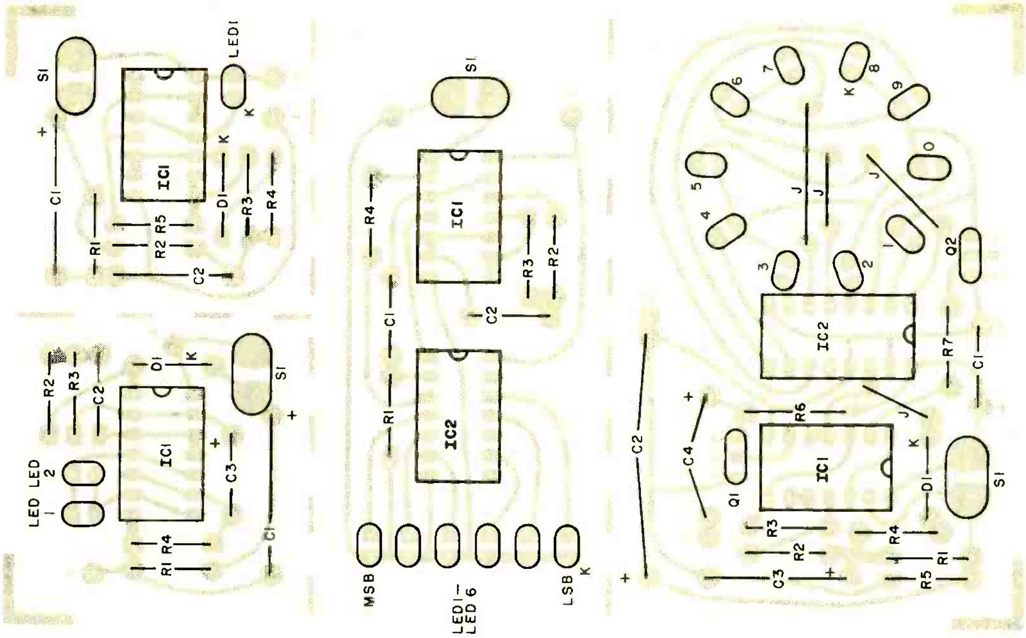
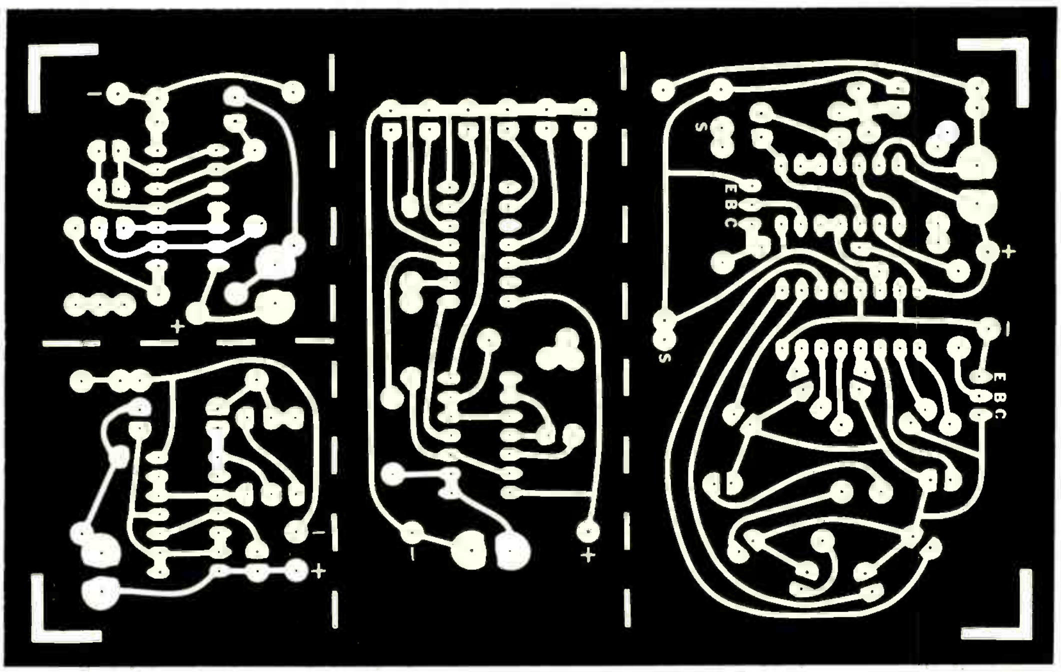


Fig. 6. Foil pattern and component installation. The four circuits are separated along the dotted lines.
Note: Pc board available from Ray Wilkins, Box 551, Hanover, NH 03755 for $4.50 ppd.



able frequency oscillator operating exactly like the oscillator in the Fig. 2 flasher circuit. Then *IC2* is a combination decade counter, decoder and driver that powers 10 LED's in sequence, with the LED's arranged in a circular display. Each pulse from the oscillator advances the count by one.

The oscillator pulses are buffered by *IC1D* and amplified by transistor *Q1* to drive a small loudspeaker. Capacitor *C3* affects the speed of rotation, while *C2* determines the total length of time that the display stays lit. The dc voltage across *C2* is also applied to a pair of buffering inverters (*IC1E* and *IC1F*) with the output used to turn on switching transistor *Q2*. When this transistor is saturated, it allows the LED's to turn on. When the voltage across *C2* drops, the output of inverter *IC1F* drops to zero, causing *Q2* to cut off, thus turning off the LED's.

It is possible to substitute conventional 6-volt, 40-mA lamps in place of the LED's by using the circuit shown in Fig. 5. To operate these optional lamps, an extra 6-volt battery is required.

Construction. Any type of construction can be used for any of the projects. If you want to use a printed circuit, you can use part or all of the foil pattern shown in Fig. 6. The four sections of the pattern can be separated at the dotted lines. Component layouts are also shown in Fig. 6. Install passive elements first, then the IC's. Be sure to observe the polarities of the electrolytic capacitors, diodes and IC's. Use a conventional 9-volt battery clip and leads for the connections. The red lead is positive, and the black lead is negative. ◇

Experimenter's Corner

By Forrest M. Mims

GETTING ACQUAINTED WITH CMOS

THOSE OF YOU who have built some of the digital circuits presented in this column over the past several months have probably noticed a problem common to all the 7400-series TTL integrated circuits. They are power hungry. The 7489 64-bit RAM, for example, typically draws 80 milliamperes. Some 7489 chips require up to 120 milliamperes. That's one-fourth of the current demand of a 6-volt lamp in a portable sealed-beam lantern!

One way around the TTL power problem is to use low-power Schottky TTL chips. These chips typically require only twenty percent of the power of conventional TTL. Low-power Schottky devices, which aren't as easy to find and cost more than conventional TTL, are designated with an "LS", such as: 74LS89, 74LS90, etc.

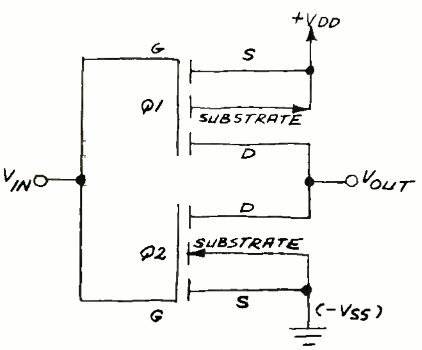


Fig. 1. Basic CMOS gate.

The best solution to the TTL power problem is to use CMOS IC's instead. In case you're not familiar with CMOS, it's a logic family which uses voltage-sensitive, metal-oxide semiconductor (MOS) field effect transistors, as opposed to current-sensitive, bipolar transistors.

CMOS has an ultra-low power requirement. The CMOS 74C89, for example, is functionally almost equivalent to the TTL 7489 64-bit RAM. The CMOS version, however, typically consumes only 0.050 microampere in operation! This power saving feature makes CMOS ideal for battery-powered devices like digital watches, pocket calculators, and spacecraft.

Why does CMOS require so little power? The answer lies in the very structure of CMOS circuitry. A basic CMOS gate (an inverter) is shown in Fig. 1. Note that a *complementary* (the "C" in CMOS) pair of enhancement-mode MOSFET's comprise the inverter. (Although other CMOS logic elements are more complex, they all use complementary MOSFET's and the following description captures the essential characteristics of the CMOS logic family.) An enhancement MOSFET is normally off, displaying a high resistance between drain and source. To turn it on, you must apply a sufficiently large voltage between the gate and source.

In this circuit, *Q1* is a p-channel MOSFET and *Q2* is an n-channel device. The two form a series circuit between V_{DD} and ground. If V_{IN} is low, the p-channel MOSFET is on and the n-channel MOSFET is off. Thus, *Q1* exhibits a relatively low resistance between drain and source and *Q2*'s channel resistance is very high. The output terminal is therefore effectively connected to + V_{DD} and isolated from ground, and V_{OUT} is high. If V_{IN} is high, there is no potential difference between the gate and source of *Q1*, so the p-channel MOSFET is off. However, V_{GS} for *Q2* is high, and the n-channel device turns on. This grounds the output terminal, making V_{OUT} low.

Note that in either case (V_{IN} high or low), one MOSFET is on and the other is off. Because the two devices are connected in series, a high-impedance path exists between + V_{DD} and ground for either input state. That's why CMOS requires so little supply current. In fact, the only time its current demand rises is during an input state transition (V_{IN} going towards + V_{DD} or ground). During such a transition, the devices will have channel resistances between the two extremes and more current will be drawn from the source.

Among the other advantages to using CMOS are the small chip area required for each gate, the very high noise immunity, the large fan out (the number of CMOS gate inputs that can be driven by one output), a wide range of permissible power supply voltages, and low output and high input impedances. There are a few drawbacks, however. A MOSFET's gate structure is very fragile, and the extremely high input impedance makes CMOS susceptible to damage from static electricity. Also, CMOS employs both p- and n-channel MOSFET's in close proximity to each other on the same chip. This makes CMOS more costly to manufacture than conventional TTL, which employs npn transistors exclusively. Finally, the structure of CMOS results in relatively large stray capacitances, which combined with high input impedances result in relatively slow logic. The typical maximum speed for CMOS logic is 1 to 5 MHz.

In many applications, high speed isn't required and CMOS is perfectly acceptable. The other major problem with CMOS, its vulnerability to static electricity, has been dealt with by diffusing protective zener diodes at the sensitive gate structures. The diodes shunt high voltages away from the gates, preventing their destruction. However, you may not know if a particular device is diode-protected, and external appearance will not tell you. Unless you know for a fact that a particular CMOS device is protected, play it safe and handle it carefully.

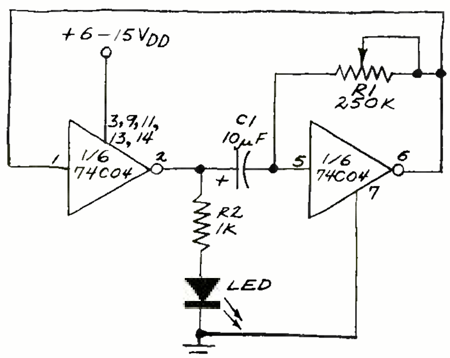


Fig. 2. Astable multivibrator.

In recent years a wide range of CMOS chips has become available at prices attractive to the experimenter from many of the advertisers in the Electronics Marketplace pages of this magazine. One common family is a pin-for-pin equivalent of the traditional TTL 7400 series. These chips even use the same num-

bers, inserting a "C" after the 74 prefix. Thus, a 74C00 is the CMOS version of the TTL 7400. Another common CMOS family is the 4000 series. Let's use a chip from each family in test circuits.

CMOS Astable Multivibrator. A good way to become better acquainted with CMOS is to build a simple astable multivibrator from a few of the inverters in a 74C04 hex inverter. One possible circuit is shown in Fig. 2. This circuit will flash its LED at ample brightness while consuming only a few milliamperes from the four series-connected 1.5-volt alkaline AA cells. Excepting current through the LED, the circuit consumes less than half a milliampere.

The circuit's repetition rate can be varied by adjusting the setting of *R1*. Naturally, current demand goes up when the pulse rate is increased.

Avoid touching the pins of the 74C04 when you build the circuit. CMOS chips that do not have diode protection are almost always sold with the pins inserted in conductive plastic foam (*not* styrofoam) or with the pins otherwise shorted together to prevent damage from static electricity. Grasp the ends of a CMOS DIP between your forefinger and thumb, and then insert it into a solderless breadboard. Use insulated connection wires,

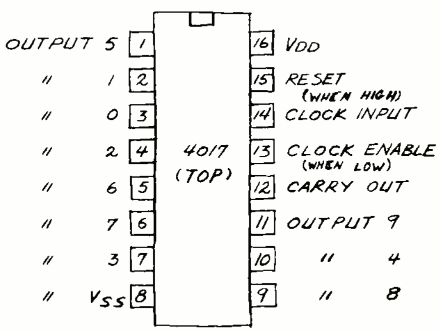


Fig. 3. Pin outline of the 4017. Each activated output goes high for one clock cycle then returns to the low state.

and avoid touching exposed conductors. (You'll want to take more elaborate precautions when handling expensive CMOS chips such as microprocessors.)

Incidentally, CMOS chips can be operated from a power supply delivering from 3 to 15 volts, so feel free to use a higher supply voltage.

CMOS Divide-by-10 Counter/ Decoder. The 4017 CMOS divide-by-10 counter/decoder is an exceptionally handy chip. It does the job of a 7490 TTL decade counter *and* a 7441 TTL 1-of-10 decoder. Figure 3 shows the pin outline for this versatile IC.

We can put the astable multivibrator we just built to work by using it as a source of clock pulses for the 4017 counter. Figure 4 shows one possible arrangement in which the 4017 successively flashes each of ten LED's. Only one LED series resistor is needed since only one LED is on at any given instant.

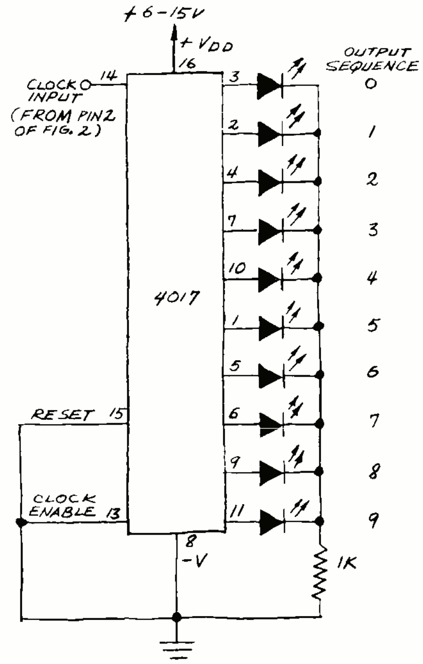


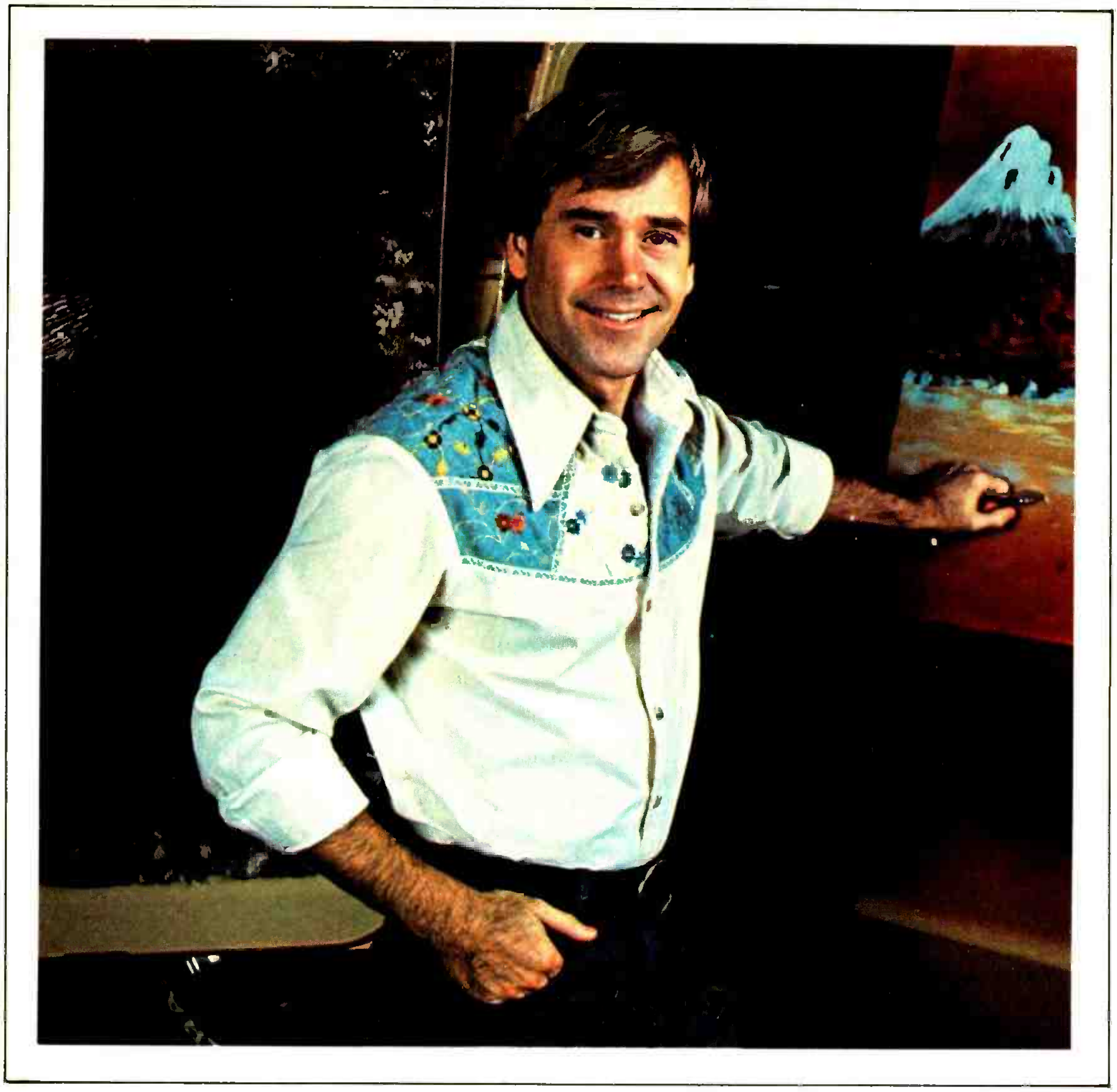
Fig. 4. Sequence generator.

Can you think of any applications for the 74C04 clock/4017 counter? If you adjust the clock so that it supplies one pulse each second, you can use the circuit as a handy darkroom timer. The circuit also makes an unusual light flasher or attention getter. Just arrange the LED's in a circle or in a random pattern and adjust for the best visual effect.

Another application for the circuit is as a sequence generator. I originally designed the circuit as a microinstruction sequencer for a homebrew digital controller made from a dozen or so TTL chips. The TTL drew so much current from my power supply that it was necessary to use CMOS for the sequencer circuitry. Since the controller was designed to operate at relatively slow operation (below 100 kHz), CMOS was the logical choice in this case.

Another excellent way to learn more about CMOS is to read Don Lancaster's *CMOS Cookbook* (Howard W. Sams & Co., Inc., 1977). This 414-page book is filled with useful tips, applications and design possibilities. ◇

You gotta shop around.



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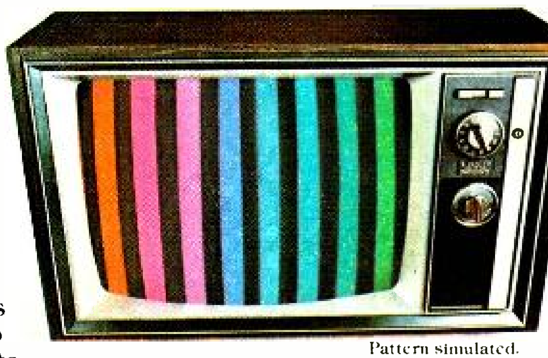

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Hobby Scene Q&A

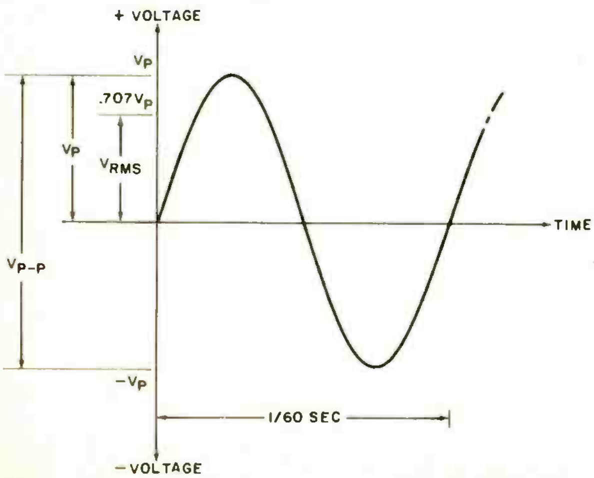
By John McVeigh

Have a problem or question on 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.

"AC VOLTAGES"

Q. ***I would like to know if commercial power is 110 volts peak or working voltage.—Paul Coelho, Mill Valley, CA.***

A. An alternating voltage (terms like "ac voltage," "ac current," "dc voltage," etc. are really misnomers) can be expressed in several ways. The wave-form delivered by commercial power companies is sinusoidal, similar to the waveform shown in the figure. Such a wave can be described by its peak voltage V_P, the highest (or lowest) voltage the waveform attains during one cycle. It can also be described by its peak-to-peak voltage V_{P-P}, which, in the case of a symmetrical waveform, is twice the peak voltage. Finally, it can be described by its "working," "effective," or root mean square (rms) voltage, which is the square root of the mean value of the square of the instantaneous voltage. Strictly speaking, it is not the average value of the voltage, which for a sine wave is zero (the positive and negative portions of the signal cancel each other out in straight averaging). In non-mathematical terms, the rms value of a signal is the voltage required to produce the same amount of energy (say, heat dissipated by a resistor) that a steady direct voltage would. For a "110-volt" sine wave from a commercial power station, the rms voltage V_{RMS} is 110 volts, the peak voltage V_P is $\sqrt{2} \times 110$ volts or 155.6 volts, and the peak-to-peak voltage V_{P-P} is 311.2 volts.



CW BANDPASS FILTER

Q. ***I need a sharp audio bandpass filter for CW reception. Do you have one that peaks around 800 Hz?—Dean Poeth, WB8TMD, Columbus, OH.***

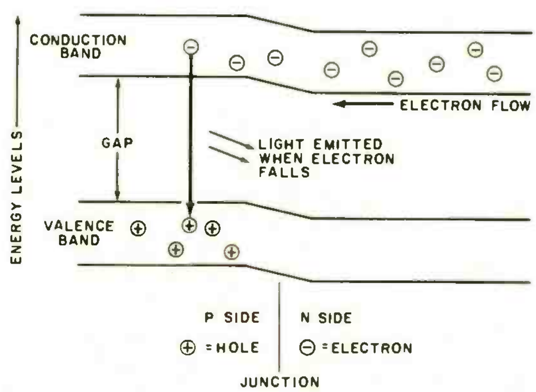
A. The best circuit I have on hand is the input stage of the Morse-A-Letter, the Morse decoder which appeared in the January 1977 issue. This circuit is not only an active bandpass filter, but has excellent agc characteristics as well. You could use a low-impedance earphone in place of the speaker at edge connector location *A8*. Of course, the digital circuitry can be omitted if you want to decode the Morse yourself!

HOW AN LED WORKS

Q. ***Why does a light emitting diode emit light, and why just one color?—Lou D'Antuono, Queens, NY.***

A. A LED is similar to a germanium or silicon diode in that it is composed of semiconductor material. On one side of the semiconductor *junction*, the material contains impurity atoms with extra electrons as compared to the majority material. These excess electrons are not bound into the crystal lattice structure, and will move with a little push. This side is called the n side. On the other or p side, impurity atoms are added that are deficient in electrons as compared to the majority atoms. Thus there are "slots" in the bounding structure called holes into which electrons can fall. The excess electrons occupy a "conduction band" and have higher average energies than the electrons in the "valence band" on the p side.

Forward biasing a pn junction pushes electrons from the n side to the p side, where they fall from the conduction band into the valence band (into holes). Any electron that falls into the valence band gives up energy in the form of heat or light. The process is shown in the figure. The wavelength of the emitted electromagnetic energy depends on the gap between the two bands. The wider the gap, the more energy is given up, and the higher the frequency (shorter wavelength) of the emitted radiation. If the gap is sufficiently wide, the radiation will be in the visible spectrum. The width of the gap depends on the material used to form the diode. That's why only one narrow group of wavelengths (color, in the case of visible light emitters) is radiated by a particular diode. Gallium Arsenide (GaAs) or Gallium Arsenide Phosphide (GaAsP) is used to form most LED's.



Product Test Reports

SUPERSCOPE AIRCOMMAND AM CB TRANSCEIVER

Features LED meter readouts, channel-9 scan and SWR indicator.

THE Superscope Aircommand 40-channel mobile AM CB transceiver departs from convention, as do a few others, by indicating relative signal strength, output power, etc., with a row of LED's instead of a meter. Another special feature is channel 9 scanning with individual squelch control and an audible alarm that sounds whenever a signal appears on channel 9.

Aside from its special features, the Aircommand has a Delta tune control with center detent; individually switched automatic noise limiter (ANL) and noise blanker (NB); detachable microphone with a headphone connection at the mike plug; bottom-facing speaker; PA mode; external-speaker jacks; auxiliary input jack for feeding output from a portable radio or tape player through the transceiver's audio section; and electronic voltage regulation. It operates from a 12-to-16-volt dc, negative- or positive-ground source.

The transceiver measures 9 1/16" D × 7 9/16" W × 2 7/16" H (23 × 19.2 × 6.2 cm). It comes with mobile-mounting hardware and rubber feet for base station installations and carries a suggested retail price of $229.95

Technical Details. Although a schematic diagram was not supplied with our test transceiver, we were able to surmise the following details. The receiver employs double conversion to i-f's of 9785 and 455 kHz. A filter at the second i-f provides the selectivity. The circuit lineup consists of the customary r-f amplifier, mixers, i-f amplifiers, detector, agc, squelch, audio ANL, and audio amplifier stages. (The last doubles as the modulator for the transmitter.)

The PLL system follows the usual pattern. It uses a 10,240-kHz crystal-controlled oscillator from which the standard reference signal is derived. This oscillator is also used for the second conversion, using the difference between its frequency and that of the first i-f. The voltage-controlled oscillator (vco) at the first mixer operates at a frequency 9785 kHz below the CB signal to minimize the possibility of high receiver radiation above 28 MHz and to insure better image rejection.

The transmitter's carrier is derived from the vco, the signal from which is routed through the r-f amplifiers and the driver and power-output amplifiers. A multielement output network matches to 50-ohm loads and minimizes spurious responses and harmonics that might otherwise cause TVI and other service interference. Amc is included in the transmitter to maintain high average modulation without excessive overmodulation that could cause adjacent-channel splatter.

The RF GAIN and audio VOLUME and the DELTA TUNE and SQL (squelch) controls on the transceiver's front panel are arranged in concentric pairs. Although the SWR CAL control appears to be a concentric pair, it is actually a single control. The other functions are handled by lever-type switches located in the lower center of the panel. The switch at the left is for selecting between PA and CB operation. The next three toggles are for switching in and out the noise blanker (NB), for Channel 9 SCAN/HOLD/OFF selection, and for switching in and out the ANL. The last switch is for setting the LED display to indicate relative SWR in its up position and relative output power (PWR) in its down position and for calibrating the system in the center (CAL).

Just right of center on the front panel is a horizontal row of eight discrete red LED's. The one on the left is a power ON indicator. The next four LED's are labelled for relative power or SWR at 1.5, 3, 5, and 10. The sixth LED is labelled CAL for SWR and is additionally used with the last two LED's to indicate modulation level. Calibration labelling below the LED's is for relative signal strength starting with S4 and ending with S9 + 20 dB. The lowest SWR that can be indicated is 1.5; if the low-end LED does not come on, it is assumed that the SWR is less than 1.5:1.

The red seven-segment numeric LED displays used for the channel indicator are located directly below the row of discrete LED's. The channel selector switch dominates the right end of the front panel.

With the channel-9 lever in the OFF position, normal channel selection is via the channel selector knob. With the switch in the SCAN position, channel 9 comes up only when a signal is being received on this channel, at which time a CH9 LED at the upper right of the panel comes on and a beeping tone sounds. By placing the switch in its HOLD position, channel 9 is kept open.

Laboratory Measurements. The sensitivity of the receiver measured a nominal 0.5 μV for 10 dB (S + N)/N with 1000 Hz at 30% modulation. The agc threshold range was 0.5 to 50 μV. The agc held the audio output to within 7 dB with a 20-dB r-f signal change at 1 to 10 μV and to 10 dB with an 80-dB change at 1 to 10,000 μV. A nominal 50-μV input signal registered an S9 reading.

Adjacent-channel rejection and desensitization was 60 dB minimum. Image and i-f rejection were 75 and 80 dB, respectively. Other unwanted-signal rejection was 60 dB except in the area of 25 MHz, where the rejection was 40 dB.

The overall audio response at the −6-dB points was 500 to 4000 Hz. The audio output was 5 watts with a 1000-Hz sine-wave signal with an 8-ohm output amplifier load. The THD at this output level was 4%. The amplifier was also capable of putting out 6 watts of power at 10% THD and could also be driven into clipping. The PA output was about 10% lower in each test.

Voltage regulation is apparently provided for the transmitter, since the carrier output power maintained a constant 3.75-watt level at any power supply potential between 12 and 16 volts. Such regulation is quite unusual. In all cases, the power gradually drifted down to 3.5 watts after a short period of operation.

With a 1000-Hz signal at microphone input levels 16 to 25 dB greater than that required for 50% modulation, the modulation held to nominally 90% at 2% THD. Under these conditions, the adjacent-channel splatter was down 45 to 50 dB. Using a 400-Hz tone, the THD was 8%. When we switched to a 2500-Hz tone, the splatter was only 38 dB down but still within the FCC regulation.

During operation with maximum voice levels, the modulation slightly exceeded 100% on occasion on the negative and positive peaks. However, the splatter was down 50 to 55 dB. The overall audio response at the −6-dB points was 300 to 3500 Hz. The transmitter's frequency held to within −193 Hz on all channels.

User Comment. The transceiver's performance was startlingly good. Particularly noteworthy was the effectiveness of the ANL and noise blanker. Both performed excellently in our bench tests and in actual on-the-road tests in a noisy vehicle. The audio quality was unusually crisp on receive and of better-than-average quality on transmit. Moreover, the modulation was highly effective. In this respect, we observed that one must take care to avoid speaking too closely into the microphone to avoid "breathy" sounds on the receiving end.

The sophisticated channel 9 emergency scanning function, boasting independent squelch, worked beautifully. It's a most welcome feature.

Although the use of LED's to indicate operating parameters, as on this transceiver, provides only approximate val-

ues, the method can be of more use to the CB'er than the often supplied miniature analog meter movements. Also, the LED's add a colorful and flashy touch to the otherwise bland-looking transceiver.

About the only minor criticism we can make is that the black-finished transceiver's panel markings (though they are white) are difficult to see at night. In addition, the concentric rotary controls are located at the top of the panel, where they protrude far enough to obscure the labelling of the switches below them. The solution to this problem, of course, is to tilt the transceiver upward as is often done in mobile installations.

All in all, we feel this transceiver ranks among the best we have tested.

CIRCLE NO 104 ON FREE INFORMATION CARD

HAZELTINE MODEL 1500 COMPUTER TERMINAL

Professional terminal in kit form.

AS ACTIVITY in the home microcomputer field has matured, several "big-name" manufacturers have introduced products for use in this new market. One such manufacturer is the Hazeltine Corporation, which is making available its well-known Model 1500 computer terminal in semikit form at a savings over the assembled version's price.

The Model 1500 terminal features an 80-character/line × 24-line format with upper- and lower-case characters. It can be interfaced with a microcomputer via either a 20-mA current loop or an RS-232 system.

The terminal measures 20.6" D × 15.5" W × 13.5" H (52.1 × 40 × 34.3 cm) and weighs 35 lb (15.9 kg). Contact your local store for price.

General Description. The Model 1500 is a classical high-quality terminal. Its character set is displayed in a 7 × 10 dot matrix. Standard and reverse video is provided for all 94 ASCII characters available. The refresh rate is 60 frames per second, noninterlaced, with the display on the built-in 12" (30.5-cm) diagonal glare-proof CRT screen. Dual intensity of any word or character is selectable, and all data is stored in an on-board 2048 × 8 bit RAM.

The terminal also has an on-board ROM that accepts a number of remote (computer-generated) commands. These include cursor address, incremental cursor, read cursor address, clear screen, clear foreground, clear to end of screen, clear to end of line, home cursor, set high/low display intensity, audible alarm, backspace, keyboard lock/unlock, insert/delete line, and remote tab function.

Interfacing with either the 20-mA cur-

CIRCLE NO 1 ON FREE INFORMATION CARD

Hazeltine's Model 1500 computer terminal comes in semikit form as shown here and is easily assembled.

rent loop or RS-232 system provides full or half-duplex operation, with compatibility with a 103A or 202 modem. Eight baud rates between 110 and 19,200 baud are individually selectable. Also provided is a choice of odd, even, or no parity and a choice of one or two stop bits. All selections are made via a set of DIP switches located under a small lift-off panel near the keyboard.

User Comment. It is difficult to consider the Model 1500 terminal as a kit since its major electronic elements come assembled, tested, and guaranteed by Hazeltine. All that must be done is to follow the assembly instructions given in the well-written manual as the various elements of the terminal are mounted. Then the individual elements are simply interconnected with a solderless wiring harness.

Exercising care in installing the elements and making neat interconnections, we assembled the kit in about four hours, counting from the time we opened the carton in which the kit was shipped. At the end of this time, our terminal was up and running with our computer. The job of assembly is very simple and straightforward; it can be accomplished by anyone who has a rudimentary knowledge of electronics and mechanics. The only hand tools required are a screwdriver and pliers.

Following assembly, the first test we made was to deposit a full screen of m's and w's to test the edge-to-edge clarity of the character display because of the wide bandwidth required to keep the characters from filling in. The full screen of characters also permits checking the linearity of both the horizontal and the vertical portions of the sweep. In our test sample, these were extremely linear and in sharp focus.

When we filled the screen with upper- and lower-case characters, the terminal's character generator, in conjunction with the wide bandwidth, produced an extremely clear display. All keys and key combinations that generate ASCII codes operate in a "typamatic" mode. That is, depressing any of these keys initially produces the selected character on-screen; and, if the key is held down for

more than three-quarters of a second, the character is repeated at a rate of 15 characters per second. In all cases, the terminal displays its characters in a very professional manner, including scrolling. The alphanumeric keyboard and the numeric cluster have finger-tip contoured keytops and a good "touch."

While we were using the terminal, we tried changing the baud rate without changing that of the computer we were using. We discovered that if terminal and computer are not set to the same baud rate, the terminal initiates an insistent "beeping" via its internal alarm and the CRT screen displays a line of PE (parity-error) symbols.

Using the simple instructions provided in the manual that accompanied the kit, we made several changes to a couple of our BASIC programs to permit us to use some of the special remote commands to the terminal (such as screen clear and two-level brightness). Also, using the lock/unlock commands, we managed to defeat the keyboard to prevent anyone's toying with it while a special program was running.

Examining the voluminous and very well-written assembly and operating manual, we discovered that the Model 1500 is more than just a computer terminal. The system is controlled by an 8080A microprocessor and a complete set of support IC's, has internal ROM and RAM, and video display section. With its built-in keyboard, I/O porting, and high-resolution CRT monitor, this excellent terminal can certainly give homebrewers some interesting thoughts on expanding the system.

The manual provided with the terminal kit is by far the most complete we have seen this side of military gear manuals. The maintenance sections are complete, with oscilloscope waveforms, voltage measurements, logic guides, flow charts, etc. There is virtually nothing that can go wrong with the terminal that is not covered by the manual.

If you are a serious computer enthusiast and have spent time and money upgrading your computer system, you should give some thought to moving up to a Hazeltine Model 1500 "professional" computer terminal, especially at its reasonably moderate price. The same goes for small businesses and educational institutions on the lookout for a commercial terminal at a savings in cost.

After working with the Model 1500 for several weeks, we were very favorably impressed with its performance.

DX Listening

By Glenn Hauser

NON-ENGLISH BROADCASTS TO NORTH AMERICA

THOSE who are not initiated into the world of DX listening often assume one must be multilingual to get anything out of short-wave broadcasts. This is emphatically not the case. Yet, nearly every country that broadcasts in English to North America also broadcasts in its native language and a few use additional languages as well. They deserve your attention, and the native music can be enjoyed with no language barrier.

All these stations send out free program schedules on request. If you don't hear an exact address announced on the air, simply use the station name, city and country. The stations get so much mail that little else is really necessary. Some are reticent about sending schedules in a certain language, unless you write to them in that language. Here's a survey of non-English broadcasts to North America (all times are GMT; frequencies are subject to change.)

Albania. R. Tirana's English broadcasts are so dogmatic and insulting that many SWL's prefer the incomprehensible Albanian. Try 9790, 7300 and 6200 kHz at 0000–0100 and 0200–0230; or 11,985 and 9500 kHz at 1030–1100.

Argentina. RAE English is in three one-hour blocks, exceeded by Spanish at 0000–0300 and 0400–0600 on 9690 kHz weekdays. On weekends, all programs are in Spanish—before 2400 on 11,710 kHz, after 0000 on 9690 kHz.

Australia. Has French for the Pacific at 0000–0100 on 15,320 and 15,160 kHz. Quebec is just a bit farther in the same direction. In our summer, try again at 0500–0600 on additional frequencies in the 16- and 19-Meter bands.

Austria. ORF has German at 2300–0100 and 0200–0330 on 6155 and 9770 kHz; French at 0100–0130; and German at 0400–0430 and 0500–0600 on 6015 kHz.

Belgium. BRT-4 precedes its 0015 English with a half hour of Dutch on the same frequency.

Bulgaria. R. Sofia's 0000 English is flanked by Bulgarian at 2330–2400 and 0100–0130 on the same frequency.

Canada. Among RCI's many French broadcasts audible in North America, these are intended for us: 0100–0127 on 5960 kHz; 0200–0227 on 9605 and 5960 kHz; 0330–0357 on 9535 and 5960 kHz. Listen for a DX show and mailbag on Sundays (GMT Mondays). Spanish: 0030–0057 on 9535 kHz; 0130–0157 on 9535, 6185, and 5960 kHz; 0230–0257 on the same channels as 0300 English.

China. R. Peking in Chinese generally uses frequencies that at other hours are in English. Cantonese is at 0100 and 0300; Standard Chinese at 0200 and 0400.

Cuba. R. Habana Cuba's extensive Spanish schedule is designated for North, Central and South America. If you can't find this, your receiver is turned off! Also, French at 0300–0330 on 11,760 kHz.

Czechoslovakia. R. Prague's "Interprogramme" at 2300–0100 on 9630 and 6055 kHz includes Czech & Slovak at 2300, German at 2330, and French at 0000. Regular broadcasts include Czech & Slovak in the half hour preceding the 0100 English on most of the same channels.

Chile. The Voice of 'Free' Chile uses the same antennas and frequencies for non-English as for English: French at 0000, 0130, and 0300 and Spanish at 0100 and 0230.

Denmark. R. Denmark is stymied by a law that forbids it to broadcast in English! Danish to North America is on 15,165 kHz; most transmissions before 1805 GMT are either for Greenland or North America in general.

Dominican Republic. R. Clarin is in Spanish whenever it isn't in English. Check for a mailbag show at 2230; Sundays after 1500 GMT, hear results of the national lottery—"90 pesos!"—being shouted several times an hour.

Ecuador. HCJB—or the evangelists buying time on it—have the curious idea that it's worthwhile to broadcast to North America in Russian at 0130–0200 in the 19- and 25-Meter bands. Last year there was even Czech. French follows Russian at 0200–0230 on the same frequencies. Spanish comes this way at 1230–1530 on 11,910 kHz; 1630–2100 on 15,160 kHz; 2230–0500 on 11,960 kHz; 0100–0500 on 6050 kHz. Japanese to Japan crosses North America on the way at 1130–1225 on 9715 kHz.

Egypt. R. Cairo follows its English program on 9475 kHz with an hour in Arabic at 0330.

Finland. R. Finland has been ordered to cut its external broadcasts 2 hours and 45 minutes per day. Will this come out of English or Finnish? The latter was scheduled in the hour preceding the 1300 English on the same frequency (exc. Swedish Wed. 1230–1255), and again at 1500–1600 (exc. Wed. 1500–1525 Swedish).

France. Does not use English for North America or any language in our evenings. But at 1200–1710 it's a powerhouse in French on 15,440 and 17,780 kHz. When France is on summer time, this shifts to 1100–1610.

Germany, East. R. Berlin International inserts 45 minutes of German between the 0100 and 0230 English on the generally inaudible 9730 kHz. On the same frequencies as the 0330 English, German follows at 0415.

Germany, West. Almost every night, Deutsche Welle jokes about its "enormous" 20-minute English program. For true enormity, try its 230-minute German program, aired twice at 2200 and 0200 on many hard-to-miss frequencies from Germany, Rwanda, Malta, Canada, Antigua and Montserrat. For this, DW publishes a day-by-day, hour-by-hour schedule similar to BBC's "London Calling." DW also provides morning news in German at 1300–1320 and 1330–1350.

Greece. On the same frequencies as English, Voice of Greece is in Greek at 0000–0015, 0045–0215, 0230–0350, 1200–1215, 1230–1250, 1500–1515, 1530–1550. And in French at 0030–0045.

Hungary. R. Budapest broadcasts more Hungarian to us than English, and on the same frequencies, at 0130–0200, 0230–0300, 0330–0400. On GMT Mondays this expands to 0130–0300 and 0330–0500.

Iran. Voice of Iran is slow to beam English our way, but there's plenty of music and Farsi after 2000 on 15,084

kHz. During the summer this is audible well into the night.

Israel. Each Israel Radio English program is accompanied by one in French on the same channels: 0515–0530, 1230–1300, 2030–2055, and 2200— 2230. Hebrew news follows English on same frequencies at 2300. The Hebrew home service is relayed our way on mostly weaker SW transmitters—at 0400–0610 on 7465 and 5882.5 kHz; 1740–2315 on 9355 and 12,077 kHz. At times, a channel above 15,500 kHz can also be heard.

Italy. English broadcast to Japan is longer than the one to North America! But Italian is something else: 2230–0100 on 11,905, 9710, 9630, 9575, and 6010 kHz. The variety of music and information on this service puts their leaden English ⅓ hour to shame. It's followed by French at 0120–0140.

Japan. R. Japan has a 15-minute Japanese newscast every hour of the day at 15 past (except for half-hours at 1030, 1430 and 2330) on same frequencies as English General Service, varying with season and time of day among 15,105, 9505, 5990 kHz. The 0130 English is preceded by Japanese at 0100, and is followed by Spanish at 0230–0300.

Korea, South. R. Korea, unlike R. Pyongyang, broadcasts more Korean than English our way. At 0230, 0430, 1600, and 2030 on 11,850 and 9640.

Libya. The People's Revolutionary Broadcasting is in Arabic only, most of the day on 15,100, 11,700, or 9500 kHz.

Netherlands. Both R. Nederland relays, in Madagascar and Bonaire, come in better here than in Holland itself. Daily Dutch from Bonaire for North America is at 0030–0120 on 6165 and 6020 kHz; 0430–0520 on 9590 and 6165 kHz. And on Sundays only at 2130–2220 from Holland on 9715 kHz; from Bonaire 2230–2320 on 15,320 and 15,180 kHz. Spanish: 0330–0420 on 9590 and 6165 kHz.

Norway. Check R. Norway's English schedule. The preceding hour on Sundays, and the entire 90 minutes on weekdays is in Norwegian, with some English music announcements.

Poland. R. Warsaw insists on not specifying what times are Polish and what are English to North America—but usually the Polish is at 0230–0300 and 0330–0400 on the same frequencies. Most of them are inaudible except at midsummer.

Portugal. Another country with more native language than English. Portuguese is at 0100–0300 and 0330–0500 on the same frequencies as English.

Romania. R. Bucharest until recently had Yiddish to North America. But now, on same channels as English, it's only Romanian at 2300–2400 and 0230–0300.

Spain. RTVE employs a different and larger frequency net for Spanish than for English. A two-hour service is aired thrice, at 2300, 0100, and 0300. Prime channels are 11,945, 11,775, 9630, 9360, and 6120 kHz. Also, for seamen in the "northwest Atlantic," from 2145.

Sweden. R. Sweden has Swedish at 2330, following English at 2300; at 0100 and 0200 on the same frequency as 0030 English; at 1430 on the same as 1400 English. French is at 0230 on a single frequency. Some of the Spanish broadcasts for "Latin America" are on the same beam as eastern North America: at 0000 and 0130, it is the same as 0030 English; and at 0300, it is the same as 0230 French. This Spanish crossing on the way to Central America holds true for many other European stations.

Switzerland. Each Swiss language gets exactly the same time as English, on the same frequencies in subsequent half hours: 0245 in German, 0315 in French, 0345 in Italian; 0500 in Italian, 0530 in German, 0600 in French; 1345 in German, 1415 in French, 1445 in Italian, and Spanish at 0215.

Taiwan. VOFC has standard Chinese at 2040–2140 on the same channels as 2140 English, and surrounding the 0100 English are standard Chinese at 0000 and Cantonese at 0200–0300, on mostly same channels.

Thailand. Has perpetually inaudible North American service in English at 0415–0515 around 11,905 kHz, and caps this with French to North America at 0520–0550.

USSR. R. Moscow's North American service in English is only the tip of the iceberg. There are several different Russian services. SW relays of the "Mayak" second-program home service can be heard throughout the day and evening. R. Rodina (Homeland) at 2330–0030 and 0200–0300. A distinct Golos Rodiny at 0130–0200. "Atlantika," for seamen in the Atlantic, at 1300–1400; Pacific Ocean Radio Station at 0700–0800 and 1930–2030. R. Kiev has Ukrainian at 2200–2300 and 0330–0400. R. Vilnius is in Lithuanian at 0100–0130. Most of Yerevan's nondaily transmission at 0300–0330 is in Armenian.

Vatican. Radio follows 0100 English with French at 0115–0130, conflicting in time with Rome's other shortwave station.

If you'd just like to hear broadcasts in a certain language, the Voice of America may be the answer. Reception is best in the central states. ◇

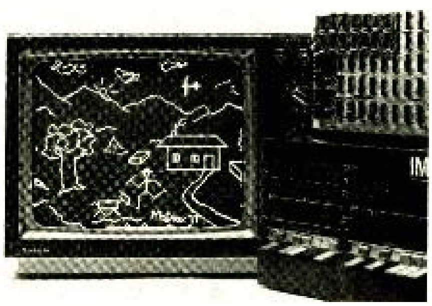
Computer Bits

by Leslie Solomon

HIGH-RESOLUTION GRAPHICS

NO MATTER how many alphanumeric characters your terminal can put on the screen, there are times when those characters are no substitute for graphics. However, when you examine the field, you will find that many low-cost "graphics" displays are simply nonalphanumeric characters resident within the character generator used, or they are limited to simple bar graphs. There are boards and systems that have some graphics capability, but the graphics are generally small "blocks" rather than discrete dots, so their overall effect is somewhat coarse.

Recently we had an opportunity to try out a new graphics board, the ALT-256*2 Graphic Display Interface ($395 assembled and tested) from Matrox Electronic Systems, POB 56, Ahuntsic Stn., Montreal, Canada H3L 3N5 (Tel: 514-481-6838), and available through most computer stores. This S-100 bus board can display 256 lines with 256 individually addressed dots on each line, thus allowing for excellent resolution. Each dot can be made black, white, or, if three boards are used, any color. The system can work with as many as eight boards but in this case, direct manipulation of the color byte is required as explained in the manual. Access time is 3.4-μs per dot, and the entire screen can be erased with a single instruction. The board can use external sync, and can be strapped for USA or European TV standards for noninterlaced display.



Graphics using the Matrox interface, shown at upper right.

The ALT-256*2 board contains 65k × 1 of RAM, and individual 8-bit registers for the X and Y coordinates and the data for each dot. Thus, it is easy to specify an individual dot anywhere on the screen, and determine whether that particular dot should be black or white (or color if you use extra boards). The screen can be erased black or white depending on the data sent to the input.

The software provided with the ALT-256*2 consists of a very detailed manual, and a pair of paper tapes. One tape contains the MTX GRAPH software that is configured as a series of callable subroutines while the second tape contains a demonstration program that uses the MTX GRAPH to create a continuous action graphics display. Total memory required is about 1k.

Six of the seven subroutines in the MTX GRAPH package are: INITG (initializes the system to standard defaults); PAGE (erases the entire screen); CURSOR (allows positioning the cursor at point X, Y); DOT (sets the point defined by the cursor); LINE (creates a line of dots between the current cursor position and the point X, Y); and CHAR (displays an ASCII character at the current cursor position). In the latter routine, the cursor is left at the next character position. Certain control characters are then used to select color, fixed or proportional character spacing, and dot size. The last routine is called ANIMAT, which produces a pause until the start of the next vertical blanking period, and is used in animation routines.

After plugging the ALT-256*2 into our S-100 computer, we loaded both tapes, and following the manual, started the demonstration program. Because we had only one board, and a monochrome monitor, we had no experience with color operation.

Comments on Use. The demonstration is impressive. It starts with a set of large characters on screen, followed by an interesting "lace curtain" effect that

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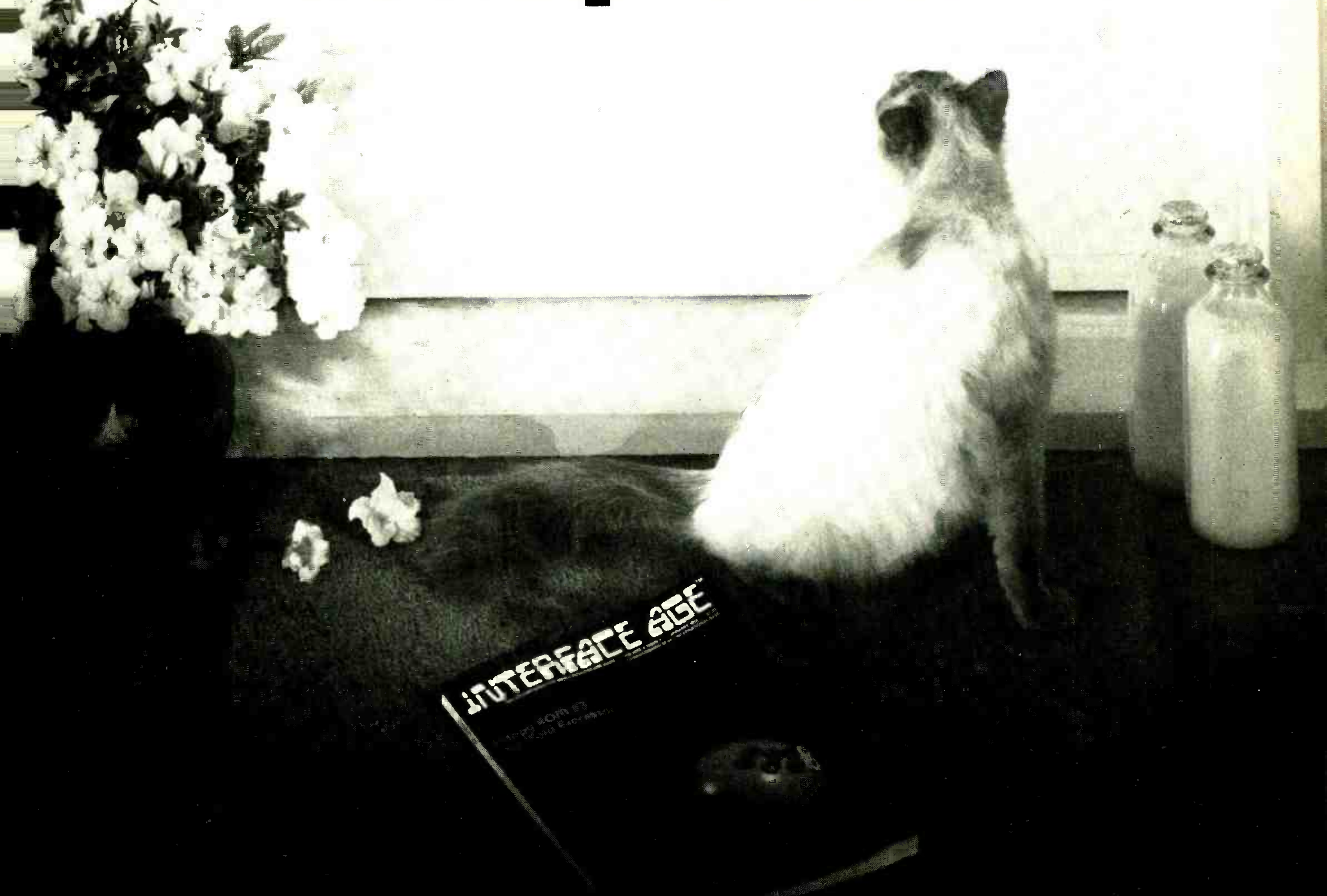

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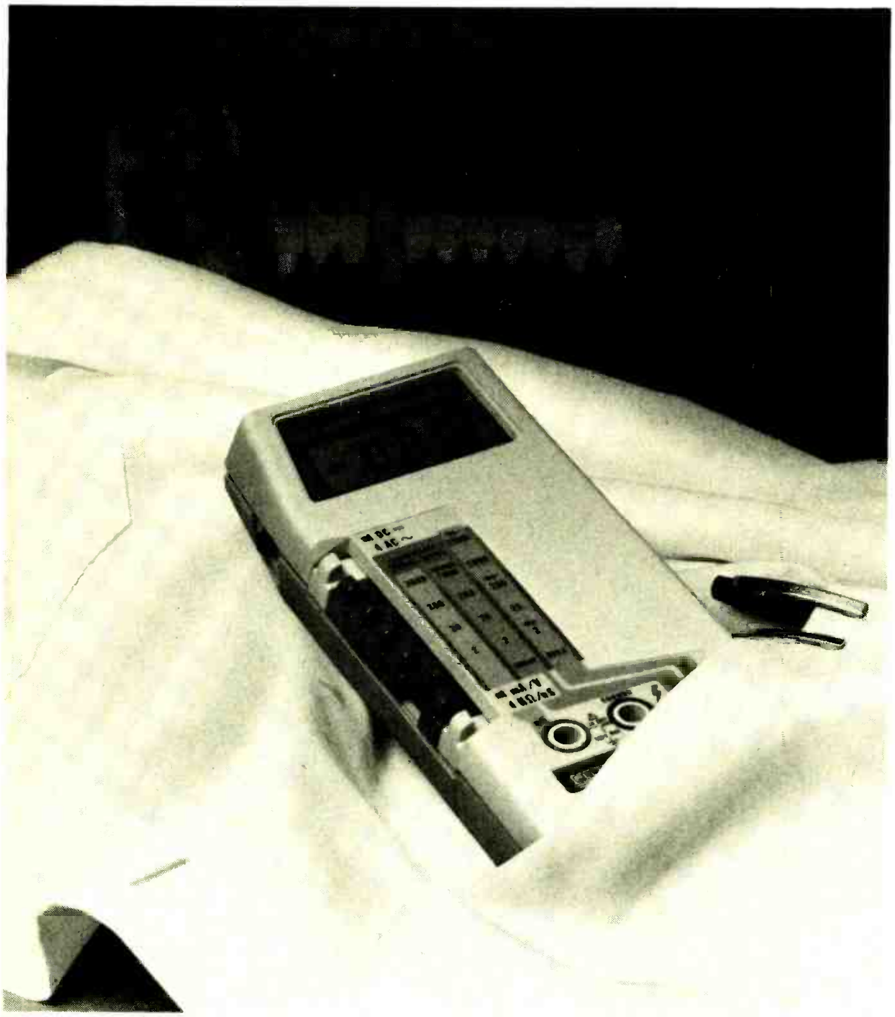


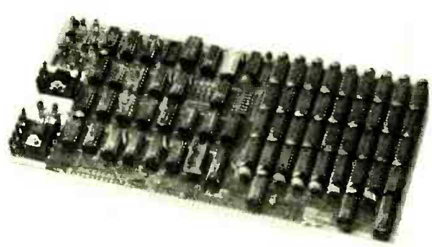
creeps across the screen. Suitable pauses are built-into the program so that you can study the various patterns on screen. Then follows a series of fan-like displays that illustrate line-calling routines, and some small (but very clear) alphanumerics. After a few more demonstrations of the various calling routines, a little man is made to "walk" across the screen, with swinging arms, to demonstrate the animation portion.

The manual contains a considerable amount of information and includes a complete listing of both the demonstration program and the MTX GRAPH package.

We have been playing with some 8080 machine language programs to "call" the various graphics subroutines and learn how best to use the high-resolution graphics. The results have been surprisingly good. We are also writing some BASIC programs using FILL and CALL commands to access the graphics software, also with successful results. One future project is a joystick interface for some really adventurous picture creations.

If high-resolution graphics appeals to you, drop into your local computer store and take a look at this new system from Matrox.

Z80 Things. North Star Computers, Inc., 2465 Fourth St., Berkeley, CA 94710 (Tel: 415-549-0858) has introduced a couple of Z80 goodies. The first is a 4-MHz Z80 board compatible with an S-100 bus, called the ZPB. It is available for $199 in kit form or $259 fully assembled. Features include auto-jump startup, vectored interrupts, operation with or without front panel, and space for 1k of 2708 EPROM. The EPROM option is $49 for the kit and $69 assembled.

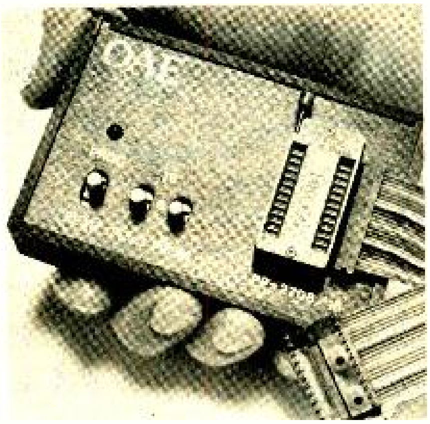


The North Star 16k RAM board for use with 8080 or Z80.

The other Z80 device is a 16k RAM board (S-100) for use with either 8080 or Z80 and will operate at full speed (no wait states) at 4 MHz. The RAM's are 200 ns, and on-board refresh is provided. Bank switching capability is provided

and board addressing is switch-selectable in two 8k sections. An important feature is the availability of a parity check option. The 16k board is $399 in kit form, and $459 fully assembled. The parity option is $39 kit and $59 assembled.

PROMing. Oliver Audio Engineering, Inc., 676 West Wilson Ave., Glendale, CA 91203 (Tel: 213-240-0080), which brought us the first low-cost paper-tape reader, now introduces its PP-2708/16 PROM programmer ($249 as a kit, $295 assembled and tested). The new programmer plugs directly into any 2708 or TMS-2716 socket, and the PROM to be programmed is mounted in its zero-insertion-force socket. The data is dumped over the eight lower address lines using the OAE interface. No additional power supplies are required and all timing and control sequences are automatically handled by the programmer. Because of this simplicity, only a short software routine is required. A five-foot flat ribbon cable interconnects the programmer with the PROM socket.



The OAE PP-2708/16 PROM programmer plugs into any 2708 or TMS-2716 socket.

Bus Stop. If you have an Altair/S-100 bus system, or are planning to get one, there are a couple of new motherboards of which you should be aware. The first is from Vector Electronic Co., Inc., 12460 Gladstone Ave., Sylmar, CA 91342 (Tel: 213-365-9661). Their Model 8803 costing $29.95 accommodates 11 plug-in boards, and can have passive or active bus termination. One slot position may be used to interface the motherboard for system expansion. Twelve tantalum capacitors are included to suppress transients on the various power supply lines. Ground and +5-volt traces are rated at 10 amperes while the ±12-volt busses are rated at 7 amperes.

The second S-100 bus motherboard is from Thinker-Toys, 1201 10th St., Berkeley, CA 94710 (Tel: 415-527-7548) and costs $76. Called the Wunderbuss, this new motherboard features full shielding of the signal paths, and active termination of all data lines. Signal isolation is achieved by a cross-coupled system of ground lines interlaced between signal lines. The motherboard with 10 edge connectors is available for $120, and with 20 edge connectors the price is $154.

PROM/RAM Board. Now available from Vector Graphic, Inc., 790 Hampshire Road, Westlake Village, CA 91361 (Tel: 805-497-6853) is a new S-100 board that occupies two independently addressable 8k blocks, has 1k of RAM on board, and a capacity of up to 12k of 2708 EPROM's. Complete addressing flexibility is provided, and video or disk-operating system boards can be nested in the 3k of unused space. MWRITE logic and jump-on-reset allow operation without a front panel. A 24-command

PROM monitor is available to interface with most I/O boards. Price is $135 in kit form, $175 assembled.

Print an Apple. If you have an Apple II computer, then you should be aware that Microproducts, 1024 17th St, Hermosa Beach, CA 90265 (Tel: 213-374-1673), has introduced its PCB that interfaces the Apple II with the SWTP PR-40 Printer. The board, at $49.95 assembled, plugs into the Apple II and comes with an interconnecting cable. A cassette with operating software is also provided. The printer prints one line at a time when the return key is depressed. The printer subroutine can also be called in a BASIC program for usual printing.

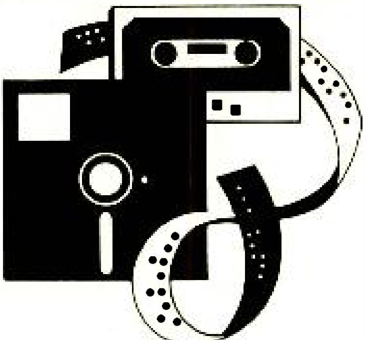
New I/O Port. Since getting stuff into and out of a computer is somewhat of a necessity, and since most hobbyists now use more than one I/O device, multi-porting is becoming very important. Dajen Electronics, 7214 Springleaf Ct., Citrus Heights, CA 95610 (Tel: 916-723-1050) has one answer in their System Central Interface (SCI) board selling for $285 in kit form and $345 assembled and tested. This S-100 bus board provides a serial port with RS-232 and 20/60-mA current loops; baud rates from 45 to 9600; three independent 8-bit parallel ports that can be programmed bitwise for input and latched output; bi-phase (Tarbell) cassette port; onboard relays for control of two recorders; and three status lines to control an automatic tape deck. Also included are 256 bytes of RAM for stack and buffer storage; a 2708 programmer; space for three 2708's; and 2k system monitor program, having 18 commands. All IC's are socketed, and the board will work with 4-MHz Z80 systems. All output connectors, cable and plugs for recorder are provided.

A Microproducts board interfaces an Apple II with an SWTP PR-40.

1802 Items. Netronics, 333 Litchfield Rd., New Milford, CT 06776 (Tel: 203-354-9375), the source for the Elf-II, has announced a 4k RAM board for the Elf-II bus at $89.95 plus $3 postage/handling. Using 2102's and requiring 500-mA from the 5-volt line, the memory is buffered and decoded with page selection in 4k blocks anywhere in memory. There is an on-board regulator and three-state outputs. The board will preserve the 256 bytes of the original.

This same firm also has an Elf-II prototype board ($17 plus $1 postage/handling) that has room for 32 IC's in a mix of 14, 16, 20, 22, 24, or 40 pins. Wire-wrap or solder pencil connections can be used. Like the memory board, this board has gold-plated Elf-II bus connector fingers, and has provisions for a 5-volt regulator.

The third item announced by Netronics is an outboard Elf-II power supply that provides ±8 volts at 5 amperes, unregulated, and ±16 volts at 1 ampere, also unregulated. Price is $34.95 plus $3 for postage and handling. ◇



Software Sources

Basic Data Base Management System. People's Data Base System is a BASIC program for use in a variety of applications including word-processing, accounting, software development, mailing-list files and label-printing, schedules and lists, among others. The System will run on any BASIC with statements for DATA, DIM, GOSUB, GOTO, INPUT, LET, PRINT, READ, REM and string variable with MID$; this includes most 8k and some 5k BASICS. The system is available in book form, with complete source listing and applications printout, for $14.95. Write: Microware Div., Physical Biological Sciences Ltd., Box 47, Blacksburg, VA 24060.

8080 Software Contest. College and university students and faculty are eligible to enter a software contest announced by Intel's Insite program library. Entries must be written in Intel assembly language or PL/M and must include a source listing and test program to assure program validity, and a source paper tape or diskette. More than $28,000 worth of microcomputer development equipment, plus numerous $100 memberships in the Intel User's Library, will be awarded to colleges and universities submitting the best programs by June 30, 1978. Monthly winners will receive Intel PROMPT 48 or PROMPT 80/85 microcomputer design aid systems. The grand prize will be an Intellec 888 Microcomputer Development Center, including 64k RAM, dual-drive one-megabyte diskette system, CRT console, and software. Programs will be judged for their originality, documentation, creativity and applicability to microprocessors. Both individuals and teams may enter. For entry forms and details, write: Insite Library Contest, Intel Corp., Microcomputer Div., 3065 Bowers Ave., Santa Clara, CA 95051.

8080/Z80 Cassette Operating System. The ZAPS Cassette Operating System includes a Z80 assembler, text editor, in-memory file system, labelled cassette tape storage system and other utilities. Runs in 14k of memory, including buffers and 1k for symbol table, on most 8080 and Z80 systems. The assembler processes the Zilog mnemon-

ics, with a wide variety of pseudo-operands available. The system can accept numerical values in hex, octal, decimal or binary. A 90-page user manual includes I/O modification instructions. On Tarbell, Digital Group or TDL cassette, $60 from computer stores or write to Algorithmics, Box 56, Newton Upper Falls, MA 02164.

High-Level Language for 6502. FCL65E, a high-level language similar to DEC's FOCAL, is available for 6502-based microcomputer systems. The 6.5k program offers 8-to-9-digit accuracy, 8-level priority interrupt handling, string variables and functions. Commands include Ask, Comment, Continue, Do, Erase, For, Go, If, Modify, On, Quit, Return, Set, Type and Write, plus several commands called by symbols. The interpreter permits editing, corrections of current line, debugging and error detection, plus functions for absolute value, integer, integer rounding, random number, I/O device functions, ASCII/decimal and decimal/ASCII conversions, terminal echo suppression, memory examine and deposit, user subroutines, string comparisons, and others. FCL65E is available for TIM- and KIM-based systems. All system-specific I/O calls are located in a zero page block for easy modification to other 6502 systems. A complete listing is $35, a mini-manual is $6 and a 104-page user's manual is $12. Hex or binary paper tape or hex dump is available for $17. The program is also available on KIM cassettes in Hypertape (6X speed) format at $19. At regular speed, KIM cassettes are $23.50, and 3X-speed cassettes are $20.25. Write: The 6502 Program Exchange, 2910 Moana Ln., Reno, NV 89509.

6800 Text Editing & Processing Systems. The editing system is line- and content-oriented for easier assembly-language program development and document preparation. Edit directives include Append, Change, Copy, Move, Delete, Insert, Overlay, Print, and Replace—plus pointer-addressing and string searches. Other commands display output-format and up to 20 tab-stop settings, and display or suppress line numbers. Renumbering is also available, as are paper-tape or cassette save, write, read and gap (null string) commands. The Text Processing System, a companion program, is used to format edited files for printing or display. Options include paging, titling, page numbering, paragraphing, spacing and right-margin justification. The 6800 Text Editing System is $23.50; the Text Processing System (which can also be used independently) is $32, with both in complete manual form with source listing. KC-standard cassettes are $6.95 each, for either program. Write: Technical System Consultants, Inc., Box 2574, W. Lafayette, IN 47906.

PDP-8 Simulator for 8080. The Simul8tor permits 8080 computers to run PDP-8 programs, which are widely and inexpensively available. (However, speed limitations may preclude the use of such programs as PDP-8 BASIC and FOCAL, and the availability of DP-8 software on paper tape rather than cassette may be intolerable to some users.) Simul8tor is available on Intel-format paper tape or Tarbell cassette for $20. Write: The Amide Corp., Box 600, Sag Harbor, NY 11963.

6800 Disassembler. Available in punched paper tape (MIKBUG format) with assembly listing, object code and instructions, this program will print an assembly listing of the object code of any program stored in memory. It operates in less than 1.8k bytes, beginning at 0800 hex (2k decimal). $12.95. Write: Software Exchange, 2681 Peterboro, W. Bloomfield, MI 48033.

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18. ADC Accutrac 4000 Record Player
19.*Empire Model 698 Manual Turntable
20. Kenwood Model 600 Integrated Stereo Amplifier
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22.*Nakamichi Model 500 Stereo Cassette Deck
23. Onkyo Model TX-4500 AM/Stereo FM Receiver
24.*Ortofon MC20 Moving Coil Phono Cartridge
25.*Pickering Model XV-15/625E Stereo Phono Cartridge
26. Pioneer Model CT-F8282 Stereo Cassette Deck
27. Radio Shack "Realistic" Model STA-2000 AM/Stereo FM Receiver
28. Rotel RX-7707 AM/Stereo FM Receiver
29. Sansui Model TU-9900 AM/Stereo FM Tuner
30.*Shure Model M24H Stereo Phono Cartridge
31.*Sony Model TA-4650 V-FET Stereo Power Amplifier
32.*Spectro Acoustics Model 210 Stereo Graphic Equalizer
33.*Stanton Model 681EEE Stereo Phono Cartridge
34. Teac Model PC-10 Portable Stereo Cassette Deck
35.*Technics Model SB-6000A Linear Phase Speaker System
36.*Thorens Model TD-126C Record Player

COMMUNICATIONS

37.*Cobra Model 29XLR 40-Ch. AM CB Mobile Transceiver
38.*Drake Model SSR-1 AM/SSB Communications Receiver
39.*Kenwood Model TS-820 Amateur Radio Transceiver
40.*Kris Model XL-50 40-Ch. AM CB Mobile Transceiver
41.*President Model "Washington" 40-Ch. AM/SSB CB Base Station
42. Yaesu Model FRG-7 AM/SSB Communications Receiver

TEST INSTRUMENTS

43.*B&K-Precision Model 280 Digital Multimeter
44.*B&K-Precision Model 1471B Dual-Trace Scope
45.*Ballantine Model 1010A Dual-Trace Scope
46.*Fluke Model 8020A Digital Multimeter
47.*Hewlett-Packard Model 280 Digital Multimeter
48.*Sencore Model DVM-32 Digital Multimeter
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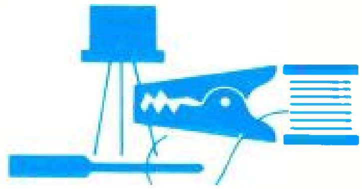
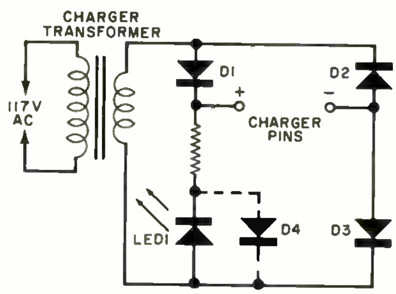


Tips & Techniques

CHARGE INDICATOR

A LED indicator can be added to the charging stand for your rechargeable soldering iron to indicate whether or not the charging current is actually flowing. The circuit shown here will cause a negligible change in the normal charging current if your charger is a simple half-wave rectifier (as most are). This is especially important if you have a "quick charge" iron.



The LED will glow only when the iron is in the stand and making contact with the charger's output pins. Diodes *D1* through *D3* must be able to handle the maximum charging current. My "quick charge" iron draws about 440 mA maximum, so 1N4002's are suitable. A standard TIL-32 or similar LED can be used. Resistor *R1* is selected to limit LED current to a safe value. My charger has a 3-volt secondary, so I used a 330-ohm, ½-watt resistor.

When the iron is in its stand, diodes *D1* and *D3* allow full current to flow through the iron's batteries for one half of the ac cycle. During the other half cycle, only the low LED current flows through *LED1*, *R1*, the iron and *D2*.

Most chargers have enough room inside to accommodate the diodes and resistor. The LED should be mounted in a hole drilled in the charger housing so as to be plainly visible when the unit is operating. Also, take care to observe polarities when connecting the new components. Diode *D4* (same type as *D1* through *D3*) is needed only if the transformer's output voltage exceeds the reverse voltage rating of the LED.—*K.L. Kingston, Lafayette, IN.*

REMOVING ROSIN

While desoldering some DIP IC's, I discovered that removing the rosin from between the pins was very tedious. I tried cotton swabs, but the cotton came off the stick and left me with a bigger mess than I had started with. Happily, I discovered a solution. I took the discarded swab sticks and cut them at a 45° angle at one end. The point can be easily maneuvered between DIP pins, and the flat edge can be used for cleaning larger areas. As the end gets mangled, simply cut it off and start again. Toluene, available in most hardware stores, makes a good rosin solvent.—*Rebecca S. Peutz, Olympia, WA.*

RECONDITIONING NUT DRIVERS

The hex socket of an inexpensive, hand held nut driver can become worn with age, allowing slippage. But most are made with deep enough sockets to allow resurfacing. Grind down the socket past the rounded edges, but be careful not to remove so much metal that the socket becomes too shallow to accommodate the average hex nut.—*Joseph Smolski*

PANEL MOUNTING LED'S

Mounting LED's on a panel can be a problem. Although they can always be wedged into grommets, this tends to block off much of the light output. But there's another approach you can take when using the larger "dome" LED's with a shoulder molded around their bases (MV-5000 series and similar). Drop the leads through a pair of adjacent holes in a scrap of 0.1" (2.54-mm) perforated board. (Enlarge one hole slightly if necessary.) Drill out a hole on either side for mounting hardware. Then drill a hole in the panel to pass the dome but not the shoulder, and two holes for mounting hardware. Insert the LED and perf board from the rear and secure with No. 2 machine hardware. A fancier mount can be made from a discarded nylon banana jack. Remove the innards and cut off most of the bushing, leaving just enough thread to hold the nut firmly. Cement the LED in the top of the jack with leads passing through the body. If the leads are flexible, wedge a bit of cork or rubber into the bottom of the assembly to keep the leads from shorting. Don't forget to identify polarity *first!* Then mount the assembly onto the panel.—*Parke S. Barnard*

Electronics Library

IC OP-AMP COOKBOOK

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Basic op amp theory is covered in this work, as well as practical circuit applications. Over 250 circuits are presented. The book is organized into three parts: an introduction to the IC op amp with discussion of general considerations; practical circuit applications; and two appendices of manufacturers' reference material. Circuits such as audio preamps, power amps, active filters, log amplifiers, function generators, and current-differencing amplifiers for general- (709, 741, and 101) and special-purpose IC's are included.
Published by Howard W. Sams & Co., 4300 W. 62nd St., Indianapolis, IN 46206. 592 pages. $12.95, soft cover.

TALK-BACK TV

by Richard Keith

In the not-too-distant future, viewers will be able to "talk back" to their TV receivers and get results. In fact, there are already a number of locations around the U.S. where cable TV is offering a host of talk-back services that range from electronic mail to meter reading. In anticipating the time when talk-back TV will be an everyday reality, this book discusses the history of the medium and details the possibilities it has to offer to the user. It reveals how talk-back TV is already providing a variety of services to the modern family and includes detailed descriptions of a number of currently operating systems. It also discusses the potential the new medium will have for intrusion on privacy.
Published by Tab Books, Blue Ridge Summit, PA 17214. 238 pages. $9.95 hard cover; $5.95 soft cover.

HANDBOOK OF OSCILLOSCOPE WAVEFORM ANALYSIS AND APPLICATIONS

by Miles Ritter-Sanders, Jr.

This new book introduces the reader to waveform development and the interpretation of waveform distortion. Linear and nonlinear circuit action are covered first, followed by solid-state circuit analysis and troubleshooting techniques. Later chapters discuss audio amplifier malfunctions and waveform analysis, stereo multiplex circuit tests, industrial electronics circuit action and waveforms, and basic magnetic-amplifier waveforms. Distinctions between ideal and real waveforms are illustrated, and the basic waveform-number relationships are explained without the use of higher mathematics.
Published by Reston Publishing Co., Inc., P.O. Box 547, Reston, VA 22090. Hard cover. 200 pages. $15.95

MICROPROCESSORS: FUNDAMENTALS & APPLICATIONS

Edited by Wen C. Lin

The purpose of this book is to aid readers who are weak in computer fundamentals to gain an understanding of how microprocessors work and how they are being applied in system design and instrumentation. The 42 reprinted papers that make up the contents of this book are arranged in four parts by subject category. The first part contains introductory papers on general microprocessor information. The second part covers architecture, software, interfacing, system development aids, and testing. Part three describes some of the myriad applications of microprocessors, while part four is concerned with microprogramming techniques as a bridge between hardware and software engineering. A glossary of computer terms is included.
Published by John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016. 335 pages. $17.95 hard cover; $9.95 soft cover.

SOLID STATE DESIGN FOR THE RADIO AMATEUR

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Published by the American Radio Relay League, 225 Main Street, Newington, CT 06111. 256 pages (10¾" × 8¼"). $7.00, soft cover, in the USA and Possessions, $8.00 elsewhere.

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Operation Assist

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)

Webster Chicago Model 80 wire recorder. Schematics and parts list, owners manual. Mike Carey, Box 361, Highway 20, Madison, AL 35758.

Jackson Condenser tester Model 650A. Operation manual and schematic. Nicholas Markovic, 2236 E. Euclid Ave., Milwaukee, WI 53207.

Gonset GSB 100. Manual and schematic. Kevin Grammes, 836 Boichot Rd., Lansing, MI 48906.

Acoustech I amplifier. Schematic. Edward Heyman, 300 Center Hill Rd., Centerville, DE 19807.

Superior Instruments Co., tube tester, Model TV-11. Operating instructions and schematic diagram. P.J. Hughes, 1337 Weber Dr., Clearwater, FL 33516.

Eico Model 460 oscilloscope. Schematic and parts source. Ron Aitken, 10840 Aintree Cres., Richmond, B.C. Canada V7A 3V1.

Rutherford Model B14 pulse generator. Operation manual and schematic. **Marconi** Instruments Ltd., Universal Bridge, operation manual and schematic. **Tektronix** type L plug-in unit. Operation manual and schematic diagram. D. Tovar, 4700 Rockmoor Ln., Fort Worth, TX 76116.

Knight amplifier Model T-175. Owner's manual and schematic. Bill Cross, 3561 Millburn Avenue, Baldwin, NY 11510.

Supreme Instruments Audolyzer Model 562. Schematic, operating manual. Richard Roggeveen, 5569 Dunsburry Ct., San Jose, CA 95123.

Motorola car radio Model 421, serial #11787-9W. Schematic. Anthony Bochichio, 45 Andrews St., Staten Island, NY 10305.

Fisher Model KX100 stereo master control amplifier. Schematic, parts list, service manual. William G. Agard, 881st Maint. Company, APO, NY 09165.

Bogen RPF60 FM stereo receiver. Instruction manual and schematic. Jesse Aronson, 755 Rugby Rd., Brooklyn, NY 11230.

Hallicrafters SX28 Super Skyraider. Schematic, operation manual, and related literature. William E. Pamplin, Box 527, Clarkston, GA 30021.

Heath GD-1999 Universal Color TV Game. Schematic and construction manual. John Francis, 3508 E. 22nd, Spokane, WA 99203.

Hammarlund Model HQ-180A receiver. Need schematic and service manual. Thomas G. Campbell, 246 E. Lincoln Ave., Altoona, PA 16601.

Hallicrafters SX110 receiver. R.T.T.A. signal generator Model K. Schematics and instruction manual. Walt Studer, 418 Walton Dr., Buffalo, NY 14225.

Jackson Model CRO-2 oscilloscope. Schematic and manual. R. Stanley, 129 N.W. 30th Street #7, Oklahoma City, OK 73118.

Texas Instruments Model SR-11 calculator. Schematic and pc layout. D. DiGiacomo, 713, George Ln., Glendora, NJ 08029.

Heathkit Vacuum Tube Voltmeter, Model V-4A. Schematic, operation manual, parts list. Howard E. Colbert, 810 South 21st St., St. Joseph, MO 64501.

Tektronix oscilloscope Model 315R. Schematic and alignment data. Lynn Russell, 4851 Aliana Plaza, Yorba Linda, CA 92686.

Truetone Model D711 radio receiver. Schematic. Maury Zivitz, 5136 Murphy Drive, Metairie, LA 70002.

Aiwa reel-to-reel tape recorder, model TP-710. Parts and schematic diagram. A.T. Most, 4 Lannigan Drive, Lawrenceville, NJ 08648.

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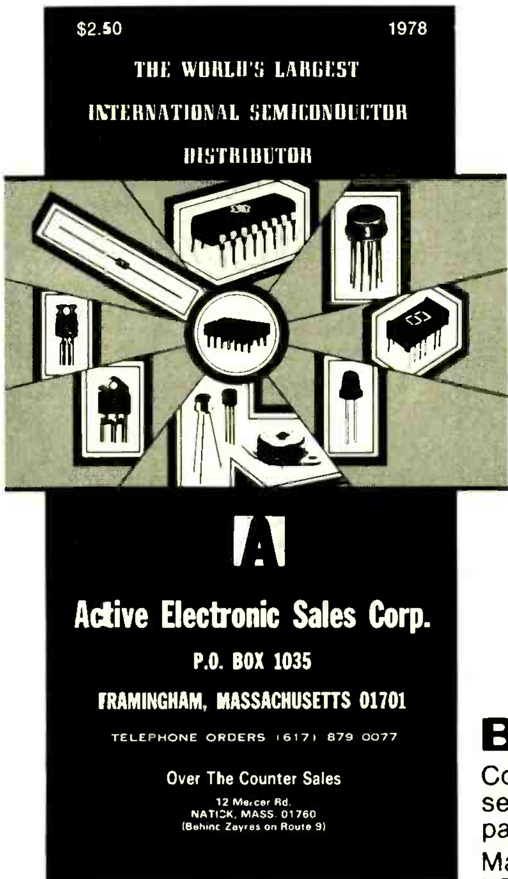

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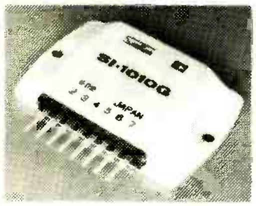

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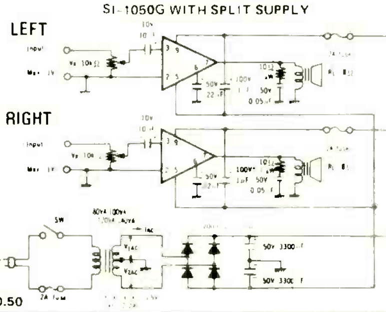

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22	220	2.2K	22K	220K	2.2M
24	240	2.4K	24K	240K	2.4M
27	270	2.7K	27K	270K	2.7M
30	300	3.0K	30K	300K	3.0M
33	330	3.3K	33K	330K	3.3M
36	360	3.6K	36K	360K	3.6M
39	390	3.9K	39K	390K	3.9M
43	430	4.3K	43K	430K	4.3M
47	470	4.7K	47K	470K	4.7M
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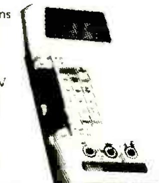

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47	6/$1.00	5/$1.00	4/$1.00	4/$1.00	3/$1.00
100	5/$1.00	5/$1.00	4/$1.00	4/$1.25	3/$1.00
220	4/$1.00	4/$1.00	3/$1.00	3/$1.25	2/$1.00
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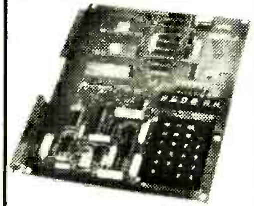
KIM-1 MICROCOMPUTOR



KIM-1—Computor Module from MOS Technology. 1K RAM, 2K ROM continuing system executive, complete audio cassett interface, 15 bidirectional I/O lines, a 24 key keyboard and a six-digit LED display.

Documentation—KIM-1 Users Manual 6500 Hardware Manual, and 6500 Programming Manual.

Fully Assembled Fully Tested Only $245.00

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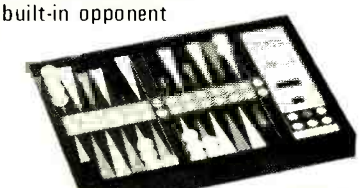

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YM-S	Metalized Polyester Film	.0047mfd to 2.2mfd 250vdc	15	$9.95
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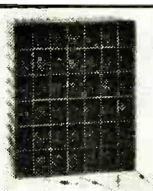

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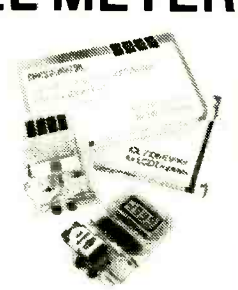

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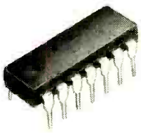
Made by National Semiconductor and Motorola



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7400	276-1801	35¢
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7441	276-1804	99¢
7447	276-1805	99¢
7448	276-1816	99¢
7451	276-1825	39¢
7473	276-1803	49¢
7474	276-1818	49¢
7475	276-1806	79¢
7476	276-1813	59¢
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7486	276-1827	49¢
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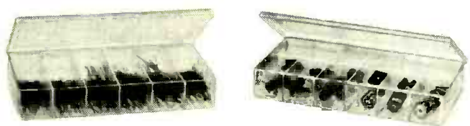
74150	276-1829	1.39
74154	276-1834	1.29
74192	276-1831	1.19
74193	276-1820	1.19
74194	276-1832	1.19
74196	276-1833	1.29

Resistor and Capacitor Packs



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272-1405	0.68	39¢	272-1411	10.0	49¢
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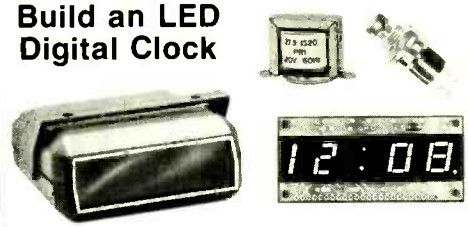
Build an LED Digital Clock



12-HR LED Clock Module. Just add a transformer and switches for a complete clock with 0.5" LED display. **277-1001** **14.95**
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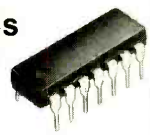

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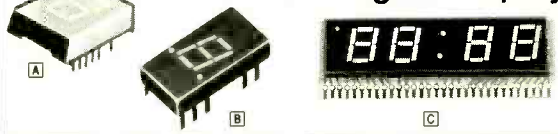
74C74	276-2310	89¢
74C76	276-2312	89¢
74C90	276-2315	1.49
74C192	276-2321	1.69
74C193	276-2322	1.69
4001	276-2401	49¢
4011	276-2411	49¢
4013	276-2413	89¢
4017	276-2417	1.49
4020	276-2420	1.49
4027	276-2427	89¢
4049	276-2449	69¢
4050	276-2450	69¢
4511	276-2447	1.69
4518	276-2490	1.49

LED Digital Displays



Digits	Size	Drive	Cat. No	ONLY
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A 1	0.6"	Cath.	276-066	2.99
B 1	0.3"	Anod.	276-053	1.99
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Digits	Size	Drive	Cat. No.	ONLY
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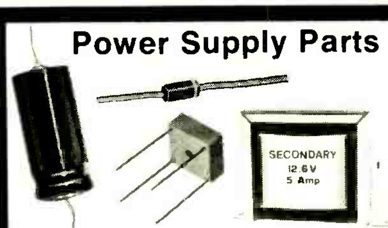
C 4	0.5"	Anod.	276-1201	6.95
C 4	0.5"	Cath.	276-1202	6.95

Power Supply Parts



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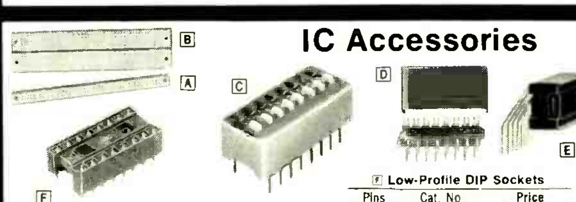
273-1514	18 CT	4A	4x2x$2\frac{1}{2}$"	8.95

IC Accessories



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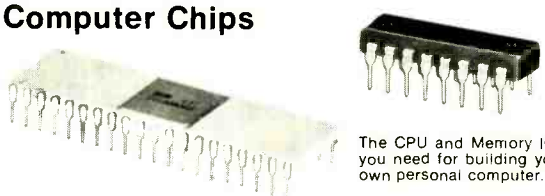
75492	276-1702	99¢
7805	276-1770	1.29
7812	276-1771	1.29
7815	276-1772	1.29

Computer Chips



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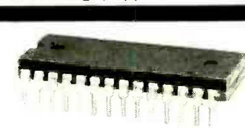

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4060 1.58
4066 .79
4071 .23
4072 .23
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4082 .23
4502 .79
4510 1.14
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UA78L05ACZ .40
UA78L06ACZ .40
UA78L08ACZ .40
UA78L10ACZ .40
UA78L12ACZ .40
UA78L15ACZ .40
UA78L18ACZ .40
UA78L24ACZ .40
UA7905CU 1.70
UA7906CU 1.70
UA7908CU 1.70
UA7909CU 1.70
UA7912CU 1.70
UA7915CU 1.70
UA7918CU 1.70
UA7924CU 1.70

MISC IC

MM5314N 3.75

MICROPROCESSORS

8080A	8-BIT CPU, 2 USEC CYCLE	$ 9.95
8212	8-BIT I/O PORT	$ 3.25
8216	BI-DIRECTIONAL BUS DRIVER	$ 3.25
8224	CLOCK GENERATOR	$ 3.25
8228	SYSTEM CONTROLLER	$ 6.00
8251	COMMUNICATIONS INTERFACE	$10.50
8255	PERIPHERAL INTERFACE	$10.50
1702A	2K EPROM 1 USEC	$ 5.75
2708	8K EPROM 450 NSEC	$15.75
2102AN-4L	1K LOW POWER 450 NSEC RAM	$ 1.69
SC/MP	5 VOLT SC/MP CPU	$ 9.95
2650	MICROPROCESSOR 1.25 MH-2 CLOCK 40 DIL	$24.95

I.C. SOCKETS

8 PIN SOLDER	.17	1.60/10	14.50/C
14 PIN SOLDER	.20	1.90/10	17.00/C
16 PIN SOLDER	.22	2.10/10	18.75/C
18 PIN SOLDER	.29	2.75/10	24.50/C
20 PIN SOLDER	.30	2.85/10	25.25/C
22 PIN SOLDER	.33	3.15/10	27.75/C
24 PIN SOLDER	.38	3.60/10	32.25/C
28 PIN SOLDER	.45	4.25/10	38.25/C
40 PIN SOLDER	.63	6.00/10	53.50/C
8 PIN W-W	.24	2.30/10	20.50/C
14 PIN W-W	.26	2.50/10	22.00/C
16 PIN W-W	.27	2.85/10	25.50/C
18 PIN W-W	.60	5.70/10	51.00/C
20 PIN W-W	.70	6.65/10	59.50/C
22 PIN W-W	.84	8.00/10	71.50/C
24 PIN W-W	.96	9.10/10	81.50/C
28 PIN W-W	1.12	10.60/10	95.20/C
40 PIN W-W	1.36	12.50/10	115.00/C

8080A CHIP SET
ONE EACH 8080A, 8212, 8224 and 8228 PLUS SIXTEEN 2102AN-4L ALL FOR — **$44.95**

MOLEX I.C. SOCKET PINS

.85/C 8.20/M 38.20/5M 275.00/50M

PLESSEY SAMPLER

AN ASSORTMENT OF METALIZED POLYESTER CAPACITORS
300 CAPS 18 VALUES $26.00

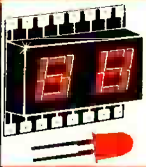
MINIBOX METALIZED POLYESTER CAPACITORS

.001	.14	1.15/10	9.00/C	.033	.15	1.25/10	10.00/C
.0022	.14	1.15/10	9.00/C	.047	.15	1.25/10	10.00/C
.0033	.14	1.15/10	9.00/C	.068	.15	1.25/10	10.00/C
.0047	.14	1.15/10	9.00/C	.1	.17	1.35/10	11.00/C
.0068	.14	1.15/10	9.00/C	.22	.23	1.85/10	15.00/C
.01	.14	1.15/10	9.00/C	.33	.30	2.50/10	20.00/C
.022	.15	1.25/10	10.00/C	.47	.36	3.00/10	24.00/C

ELECTROLYTIC CAPACITORS

VALUE	RADIAL LEADS			AXIAL LEADS		
.47/50V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
1/50V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
2.2/50V	.08	.65/10	5.41/C	.12	.90/10	7.82/C
3.3/50V	.08	.65/10	5.41/C	.12	1.00/10	8.31/C
4.7/35V	.08	.65/10	5.41/C	.12	.95/10	7.91/C
4.7/50V	.08	.68/10	5.75/C	.12	1.00/10	8.31/C
10/16V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
10/25V	.08	.65/10	5.66/C	.12	1.00/10	8.31/C
10/35V	.09	.70/10	6.12/C	.12	1.00/10	8.94/C
10/50V	.10	.75/10	6.58/C	.14	1.15/10	9.56/C
22/16V	.08	.67/10	5.66/C	.12	1.00/10	8.31/C
22/25V	.09	.70/10	6.09/C	.13	1.05/10	8.74/C
22/35V	.11	.85/10	7.29/C	.15	1.19/10	9.98/C
22/50V	.12	1.00/10	8.48/C	.17	1.32/10	11.22/C
33/16V	.09	.75/10	6.90/C	.12	1.00/10	8.48/C
33/25V	.10	.81/10	7.50/C	.14	1.15/10	9.56/C
33/35V	.13	1.05/10	9.65/C	.17	1.34/10	11.23/C
33/50V	.14	1.13/10	10.41/C	.19	1.52/10	12.89/C
47/10V	.09	.71/10	6.52/C	.13	1.04/10	9.50/C
47/16V	.10	.81/10	7.47/C	.14	1.15/10	9.56/C
47/25V	.13	1.05/10	9.65/C	.17	1.30/10	11.22/C
47/35V	.14	1.13/10	10.41/C	.19	1.51/10	12.89/C
47/50V	.15	1.21/10	11.16/C	.21	1.71/10	14.55/C
100/10V	.10	.77/10	6.58/C	.14	1.13/10	9.56/C
100/16V	.11	.85/10	7.28/C	.17	1.30/10	11.22/C
100/25V	.13	1.10/10	9.15/C	.20	1.55/10	13.30/C
100/35V	.17	1.41/10	11.85/C	.25	1.93/10	16.50/C
100/50V	.21	1.71/10	14.55/C	.29	2.30/10	19.70/C
220/10V	.13	1.08/10	9.15/C	.18	1.42/10	12.05/C
220/16V	.15	1.16/10	9.86/C	.20	1.55/10	13.30/C
220/25V	.21	1.71/10	14.55/C	.29	2.35/10	19.96/C
220/35V	.25	2.03/10	17.26/C	.35	2.79/10	23.70/C
220/50V	.29	2.35/10	19.96/C	.40	3.23/10	27.44/C
330/6V	.14	1.12/10	9.50/C	.19	1.48/10	13.71/C
330/10V	.15	1.16/10	9.83/C	.21	1.64/10	15.13/C
330/16V	.21	1.66/10	14.14/C	.31	2.45/10	22.70/C
330/25V	.23	1.86/10	15.79/C	.38	3.07/10	28.38/C
330/35V	.33	2.66/10	24.59/C	.43	3.43/10	31.68/C
330/50V	.54	4.30/10	39.73/C	.60	4.81/10	44.45/C
470/6V	.15	1.21/10	11.16/C	.20	1.64/10	15.13/C
470/10V	.21	1.71/10	14.55/C	.31	2.45/10	22.70/C
470/16V	.23	1.81/10	15.39/C	.33	2.66/10	24.59/C
470/25V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
470/35V	.41	3.27/10	30.26/C	.47	3.78/10	34.99/C
470/50V	.54	4.30/10	39.73/C	.75	6.03/10	55.80/C
1000/6V	.22	1.90/10	16.50/C	.35	2.76/10	25.54/C
1000/10V	.24	1.96/10	16.62/C	.38	3.07/10	28.38/C
1000/16V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
1000/25V	.42	3.33/10	28.27/C	.68	5.42/10	50.13/C
1000/35V	.60	4.81/10	44.45/C	.75	6.03/10	55.81/C
2200/6V	.36	2.86/10	26.48/C	.43	3.43/10	31.68/C
2200/10V	.42	3.33/10	28.27/C	.60	4.81/10	44.45/C
2200/16V	.54	4.30/10	36.58/C	.68	5.42/10	50.13/C

LED DIGITS AND LAMPS



FND357	.375" Single Digit, CC, Red	$1.35
FND500	.5" Single Digit, CC, Red	1.35
FND507	.5" Single Digit, CA, Red	1.35
FND800	.8" Single Digit, CC, Red	2.50
FND807	.8" Single Digit, CA, Red	2.50
NSN373	.3" Dual Digits, CC, Red	2.20
NSN374	.3" Dual Digits, CA, Red	2.20
NSN583	.5" Dual Digits, CC, Red	2.60
NSN584	.5" Dual Digits, CA, Red	2.60
NSN783	.7" Dual Digits, CC, Red	3.00
NSN784	.7" Dual Digits, CA, Red	3.00

NSL5053 Dif. Red T-1¾ Lamp w/Mtg. Hdwe $1.80/10 $16.00/100
NSL5056 Dif. Narrow Angle Red T-1¾ Lamp w/Mtg. Hdwe $1.80/10 $16.00/100

5% CARBON FILM RESISTORS

¼ WATT RESISTOR ASSORTMENTS

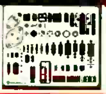
Catalog Number	Description	PRICE
RS125	Set of 5 each of the 73 standard 5% ¼ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 meghom (365 total pcs.)	$9.90
RS225	Set of 5 each of the 72 standard 5% ¼ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pcs.)	$9.90

½ WATT RESISTOR ASSORTMENTS

Catalog Number	Description	PRICE
RS150	Set of 5 each of the 73 standard 5% ½ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 meghohm (365 total pcs.)	$9.90
RS250	Set of 5 each of the 72 standard 5% ½ watt carbon film resistors in the series 1.1, 1.2, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pcs.)	$9.90

Bishop Graphics 5"x6"

The Digi-Key Catalog features many more quality Bishop Graphics products.



3365-Nd **12.50**

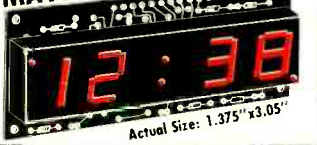
CLOCK MODULES

The MA1002 and MA1010 series clock modules by National Semiconductor are fully assembled and tested clocks using a 4 digit LED display and an MOS integrated circuit on the same board. Simply connect switches and our special transformer and you have a fully functioning clock.

The MA1003 clock module is a fully assembled and tested 12 hour clock using a high brilliance green flourescent display and crystal time base making it perfect for car, boat or other portable use. It operates directly from 12 volts DC so no transformer is needed. Our price includes three push button switches for setting the time.

MA1002A	.5" LED 12 Hour AM-PM Clock Module	$10.50
MA1002A SET	Module with Transformer & Switches	$13.95
MA1002C	.5" LED 24 Hour Clock Module	$10.50
MA1002C SET	Module w/Transformer & Switches	$13.95
MA1003	12 Volt Car Clock with Switches	$17.50
MA1010A	.84" LED 12 Hour AM-PM Clock Module	$13.00
MA1010A SET	Module w/Transformer & Switches	$16.45
MA1010C	.84" LED 24 Hour Clock Module	$13.00
MA1010C SET	Module w/Transformer & Switches	$16.45

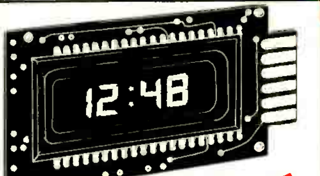
MA1002 0.5" High Digits



Actual Size: 1.375"x3.05"

MA1010 0.84" High Digits

Actual size: 1.75"x3.75"



MA1003 $17.50 NEW!

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TTL DATA BOOK, 592 P, NAT. SEMI.	9010B	$4.00
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CMOS DATA BK, 77 EDIT, 555 P, NAT. SEMI.	9012B	$3.00
POWER TRANSISTORS, 151 P, NAT. SEMI.	9013B	$3.00
MEMORY DATA BK, 592 P, NAT. SEMI.	9014B	$3.00
MOS/LSI DATA BK 713 P, NAT. SEMI.	9015B	$4.00
INTERFACE DATA BK, 464 P, NAT.	9016B	$4.00
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LIN. APPLIC. BK, VOL. 2, 246 P, NAT. SEMI.	9019B	$4.00
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8080A MICRO. SYS. DESIGN MAN, NAT. SEMI.	9021B	$5.00
SC/MP MICRO. APP. HANDBK, NAT. SEMI.	9022B	$5.00
SPECIAL FUNCTION DATA BK, NAT. SEMI.	9023B	$3.00
CMOS I.C.'S, 278 P, SOLID STATE SCIENT.	9030B	$3.00
SIGNETICS ANALOG MANUAL, 637 P	9031B	$5.95

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Digi-Key Means Quality, Service & Savings

½ WATT ZENER DIODES

.15 1.30/10 11.00/C

1N5226B	3.3V	1N5242B	12V
1N5227B	3.6V	1N5243B	13V
1N5228B	3.9V	1N5244B	14V
1N5229B	4.3V	1N5245B	15V
1N5230B	4.7V	1N5246B	16V
1N5231B	5.1V	1N5247B	17V
1N5232B	5.6V	1N5248B	18V
1N5233B	6.0V	1N5249B	19V
1N5234B	6.2V	1N5250B	20V
1N5235B	6.8V	1N5251B	22V
1N5236B	7.5V	1N5252B	24V
1N5237B	8.2V	1N5253B	25V
1N5238B	8.7V	1N5254B	27V
1N5239B	9.1V	1N5255B	28V
1N5240B	10V	1N5256B	30V
1N5241B	11V	1N5257B	33V

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2-56 1/4 SCREW	.99/C
2-56 1/2 SCREW	.99/C
4-40 1/4 SCREW	.65/C
4-40 1/2 SCREW	.60/C
6-32 1/4 SCREW	.65/C
6-32 1/2 SCREW	.75/C
8-32 3/8 SCREW	.90/C
8-32 5/8 SCREW	.99/C
2-56 HEX NUT	.55/C
4-40 HEX NUT	.55/C
6-32 HEX NUT	.60/C
8-32 HEX NUT	.60/C
NO 2 LOCKWASHER	.85/C
NO 4 LOCKWASHER	.45/C
NO 6 LOCKWASHER	.45/C
NO 8 LOCKWASHER	.45/C

FREE CATALOG

SILICON TRANSISTORS

MPS918	.16	1.55/10	13.60/C	130.00/M
MPS930	.16	1.55/10	13.60/C	130.00/M
MPS2222A	.16	1.55/10	13.60/C	130.00/M
MPS2369A	.16	1.55/10	13.60/C	130.00/M
MPS2907A	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3394	.16	1.55/10	13.60/C	130.00/M
MPS3395	.16	1.55/10	13.60/C	130.00/M
MPS3563	.16	1.55/10	13.60/C	130.00/M
MPS3565	.16	1.55/10	13.60/C	130.00/M
MPS3638A	.16	1.55/10	13.60/C	130.00/M
MPS3640	.16	1.55/10	13.60/C	130.00/M
MPS3641	.16	1.55/10	13.60/C	130.00/M
MPS3643	.16	1.55/10	13.60/C	130.00/M
2N3904	.16	1.55/10	13.60/C	130.00/M
2N3906	.16	1.55/10	13.60/C	130.00/M
2N4124	.16	1.55/10	13.60/C	130.00/M
2N4126	.16	1.55/10	13.60/C	130.00/M
2N4401	.16	1.55/10	13.60/C	130.00/M
2N4403	.16	1.55/10	13.60/C	130.00/M
2N4410	.16	1.55/10	13.60/C	130.00/M
2N5087	.16	1.55/10	13.60/C	130.00/M
2N5089	.16	1.55/10	13.60/C	130.00/M
2N5210	.16	1.55/10	13.60/C	130.00/M
2N3055	.99	9.20/10	85.00/C	800.00/M
MPF102	.36	3.35/10	30.60/C	300.00/M
2N5457	.48	4.50/10	41.00/C	400.00/M
MPSA13	.28	2.60/10	24.00/C	230.00/M
MJ2955	.99	9.20/10	85.00/C	800.00/M

NEW! 74C SUPER QUALITY SUPER PRICES

74C00

74C00N	.25	74C154N	2.90
74C02N	.25	74C157N	1.90
74C04N	.27	74C160N	1.18
74C08N	.25	74C161N	1.18
74C10N	.25	74C162N	1.18
74C14N	.90	74C163N	1.18
74C20N	.25	74C164N	1.10
74C30N	.25	74C165N	1.10
74C32N	.25	74C173N	1.30
74C42N	.98	74C174N	1.16
74C48N	1.28	74C175N	1.16
74C73N	.72	74C192N	1.38
74C74N	.48	74C193N	1.38
74C76N	.72	74C195N	1.10
74C83N	1.38	74C221N	1.90
74C85N	1.38	80C95N	.48
74C86N	.40	80C96N	.48
74C90N	.98	80C97N	.48
74C93N	.98	80C98N	.48
74C95N	1.10	74C901N	.48
74C107N	.70	74C902N	.48
74C150N	2.90	74C909N	1.78
74C151N	1.90	74C926N	7.80

STRANDED HOOK UP WIRE

20 ga PVC	2.50/100'	10.00/500'
22 ga PVC	2.80/100'	11.25/500'
24 ga PVC	2.10/100'	8.50/500'
26 ga PVC	2.10/100'	8.50/500'

Digi-Key Stocks the Entire AP Line

SILICON DIODES

1N4001	.64/10	5.50/C
1N4002*	.66/10	5.60/C
1N4003	.68/10	5.80/C
1N4004	.70/10	5.95/C
1N4005	.82/10	7.05/C
1N4006	.90/10	7.75/C
1N4007	.99/10	8.60/C
1N4148	.40/10	3.50/C

FREE CATALOG

SLIDE SWITCHES

SPST	.15	1.25/10	10.00/C
SPDT	.19	1.70/10	13.00/C
DPDT	.23	2.00/10	19.00/C

50 VOLT DISCS

100 PF	.40/10	3.50/C
220 PF	.40/10	3.50/C
470 PF	.40/10	3.50/C
.001 UF	.40/10	3.50/C
.0022 UF	.40/10	3.50/C
.0047 UF	.40/10	3.50/C
.01 UF	.45/10	3.65/C
.022 UF	.50/10	4.00/C
.047 UF	.70/10	5.60/C
.1 UF	1.35/10	11.50/C

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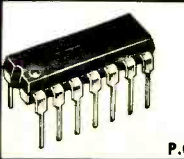

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7400 TTL

7400	.18	7442	1.08	74107	.49
7401	.21	7448	1.15	74121	.55
7402	.21	7450	.26	74122	.49
7404	.21	7451	.27	74123	1.05
7405	.24	7453	.27	74125	.60
7407	.45	7454	.41	74126	.81
7408	.25	7460	.22	74132	3.00
7409	.25	7472	.39	74141	1.15
7410	.20	7473	.45	74150	1.10
7411	.30	7474	.45	74151	1.25
7413	.85	7475	.80	74153	1.35
7416	.43	7482	1.75	74154	1.54
7417	.43	7483	1.15	74157	1.30
7420	.21	7485	1.12	74161	1.45
7422	1.50	7486	.45	74164	1.65
7425	.43	7489	2.49	74165	1.65
7427	.37	7490	.69	74166	1.70
7428	.35	7491	1.20	74174	1.95
7430	.26	7492	.82	74175	1.95
7432	.31	7493	.82	74180	1.05
7437	.47	7494	.91	74181	3.55
7438	.40	7495	.91	74191	1.50
7440	.21	7496	.91	74195	1.00
7441	1.10	74100	1.25	74197	1.00

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74L30	.33	74LS20	.39	74LS174	2.50
74L42	1.50	74LS51	.39	74LS386	5.50
74L86	.69	74LS74	.65	74S153	2.25
74LS00	.39	74LS112	.65	74S387	1.95

74H00 TTL

74H00	.33	74H11	.33	74H53	.39
74H01	.33	74H20	.33	74H55	.39
74H04	.33	74H21	.33	74H73	.59
74H05	.35	74H30	.33	74H74	.59
74H10	.33	74H40	.33	74H76	.65

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MC666P	1.60	MC1469R	2.50
MC670P	1.60	MC1489	4.60
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MC844	1.25	MC1810P	1.25
MC853P	2.25	MC3004L	2.25
MC876P	2.25	MC3007P	2.25
MC1004L	1.25	MC3021L	2.15
MC1010L	1.25	MC3060L	2.65
MC1305	1.95	MC3062L	3.00
MC1352P	1.55	MC4024P	2.20
MC1357	1.70	MC4044P	4.80
MC1371	1.85	MC14507CP	1.25
MC1439	2.65	MC14511CP	2.76
MC1458P	.50	MC14512CP	1.70

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4001AE	.29	4023AE	.29
4002AE	.29	4024AE	1.50
4007AE	.29	4025AE	.35
4010AE	.58	4028AE	1.60
4011AE	.29	4029AE	2.90
4012AE	.29	4030AE	.65
4015AE	1.25	4037AE	4.50
4016AE	.65	4040AE	2.40
4018AE	1.10	4044AE	1.50
4019AE	.65	4049AE	.75
4020AE	1.75	4050AE	.75
4021AE	1.50		

LINEAR

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75451BP	.39	LM307H	.35	LM747	.90
75452BP	.39	LM309K	1.25	LM748H	.45
75453BP	.39	LM311H	.90	LM1458N	.80
75454BP	.39	LM318N	1.50	N5556V	1.50
75491BP	.79	LM339N	1.85	NE5558	1.00
75492BP	.85	LM351AN	.65	NE555V	.60
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CA3006	3.50	LM380N	1.45	UA702	.80
CA3018	1.10	LM566	2.25	UA703CH	.45
CA3018A	1.60	LM711CH	.60	UA709CH	.30
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10MF25	Axial Leads	.15	100MF16	Radial Leads	.19
10MF50	Axial Leads	.16	100MF25	Radial Leads	.24
10MF150	Axial Leads	.20	500MF50	Axial Leads	.60
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5" Taunt-Band Meter · One milliampere full scale, 3½", scale length. Coil resistance 465 ohms. Made by Modutec for Bose. Meter scale in VUs (-20 to + 30). Meter is designed to be mounted coil up. Complete with "smoke" plastic cover. Over-all 5 1/8"x4". Meter face mounts in a 5 1/8"x2 3/8" cutout: A beautiful meter. **NT539 $4.89**

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BOSE SPEAKERS

Bose has discontinued their original 301 System. New-Tone purchased the speakers remaining in inventory when the 301 was discontinued, and is offering them at prices that seem impossible. The speakers have been tested with the Bose "Tone Standard" as a reference and have been subjected to the Bose power-handling test which includes both fixed and sweep-frequency testing. **8-Inch Woofer** (Bose Part No. 102606) has a free-air resonant frequency of 25-35 Hz., and has a 1.5", 8.5-ounce magnet. The upper tested-frequency is 4000 Hz. **3-Inch Tweeter** (Bose Part No. 107376) has a free-air resonant frequency of 1200-1500 Hz., and has an upper tested-frequency of 16.5 kHz. **Supplies are limited.** We urge you to take advantage of these prices and stock up for your future needs.

Sorry, we have no information about the Bose enclosures or the crossover networks, nor do we have more specs. Bose says these data are proprietary information.

8" Woofer NT541 $10.95

3" Tweeter NT542 $ 3.95

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1N4006	1.10	10.00
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2N2646	.45	MU4893	.50
2N2647	.55	MU4894	.50
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2N4852	.75	2N6028	.70
2N4870	.50	D5E37	.35
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1N60	.25	2N1544	.80	2N2894	.40	2N3414	.17	2N3866	1.25	2N4403	.20
1N270	25	2N1554	1.25	2N2903	3.30	2N3415	.18	2N3903	.16	2N4409	.20
1N914	10	2N1560	2.80	2N2904	.25	2N3416	19	2N3904	.16	2N4410	.16
1N4148	.25	2N1605	1.75	2N2904A	30	2N3417	.20	2N3905	.16	2N4416	.75
1S1555	.35	2N1613	.50	2N2905	.25	2N3442	1.85	2N3906	.16	2N4441	1.00
		2N1711	.50	2N2905A	30	2N3553	1.50	2N3954A	3.75	2N4442	1.15
2N173	1.75	2N1907	4.10	2N2906	.25	2N3563	.20	2N3955	2.45	2N4443	1.35
2N338A	1.05	2N2102	.70	2N2906A	.30	2N3565	.20	2N3957	1.25	2N4852	.55
2N404	.75	2N2160	.70	2N2907	.25	2N3638	.20	2N3958	1.20	2N5061	.30
2N443	2.50	2N2218	.25	2N2907A	.30	2N3642	.20	2N4037	60	2N5064	.50
2N508A	.45	2N2218A	30	2N2913	.75	2N3643	.20	2N4093	.85	2N5130	.20
2N706	25	2N2219	.25	2N2914	1.20	2N3645	.20	2N4124	.16	2N5133	.15
2N718	.25	2N2219A	30	2N3019	1.00	2N3646	.14	2N4126	.16	2N5138	.15
2N718A	30	2N2221	25	2N3053	.30	2N3731	3.75	2N4141	.20	2N5294	.50
2N918	60	2N2221A	.30	2N3054	.70	2N3740	1.00	2N4142	.20	2N5296	.50
2N930	25	2N2222	.25	2N3055	.75	2N3771	1.75	2N4143	.20	2N5306	.20
2N956	30	2N2222A	.30	2N3227	1.00	2N3772	1.90	2N4220A	.45	2N5400	.40
2N1302	1.25	2N2270	.40	2N3247	3.40	2N3773	3.00	2N4234	.95	2N5401	.50
2N1305	.75	2N2369	.25	2N3250	.50	2N3819	.40	2N4400	.16	2N5457	.35
2N1420	.20	2N2484	.32	2N3393	.20	2N3823	.70	2N4401	.16	2N5458	.30

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TV-1 VIDEO INTERFACE

You will want to know about the TV-1 Video to Televisior Interface Kit.
No need to buy a separate Video Monitor if you already own a TV set. Just connect the TV-1 between your system video output and the TV set antenna terminals - that's all there is to it - to convert your TV set to a Video Monitor, and at a much lower cost! PRICE $8.95

REAL TIME CLOCK FOR S-100 BUS

BARE BOARD $30.00 KIT $124.95

SOROC IQ 120 TERMINAL

A CAPABLE LOW COST. APPROACH TO REMOTE VIDEO DISPLAY TERMINALS

* Cursor Control Keys Standard
* Numeric Key Pad Standard
* Line and Page Erase Standard
* Addressable Cursor Standard
* Switch Selectable Transmission from 75 to 19,200 bps Standard
* Communication Mode. HDX/FDX Block
* Interfaces: Printer Interface RS232 Extension
* RS232C Interface
* Non-Glare Read Out Screen
* Protect Mode Standard
* Tab Standard

$975.00 Assembled

Price Includes

* Block Mode
* Lower Case
* 24 Line Option
* and shipping charge is on us.

JADE

Computer Products

5351 WEST 144th STREET
LAWNDALE, CALIFORNIA 90260
(213) 679-3313

RETAIL STORE HOURS M-F 9-7 SAT. 9-5

Discounts available at OEM quantities. Add $1.25 for shipping. California residents add 6% sales tax.

COMPU/TIME CT 100

COMPU/TIME offers A Real Darn Clever Enhancement to users of IMSAI/ALTAIR Microprocessors

S100 BUS COMPATIBLE

TIME & CALENDAR

COMPU/TIME	CT100	$199 Kit	$245 Assembled
COMPU only	C101	$149 Kit	$189 Assembled
TIME only	T102	$165 Kit	$205 Assembled
COMPU/TIME PC Board only			$ 80

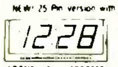
MM16 EPROM

- Utilizing up to 16 2708 EPROMS
- S-100 Bus Computer Systems
- Memory capacity of 8K or 16K bytes by DIP
- 8K boundary addressing by DIP Switch
- 0 to 4 wait cycles by DIP Switch
- Data output address input lines fully buffered
- Hi-grade glass-epoxy with plated-thru holes
- Epoxy solder masked

$99.00

FCS 8000A — 3½ Digit .8" Display

NEW! 25 Pin version with colon & am pm indicator



FRONT VIEW FSC8000

SPECIAL $3.75 ea.

- Connects almost one for one with 3817, 3817A or D (3817 available at $5.00 each)
- Typical segment current 8mA except colon 10 hrs b & c and 10 min a & d which are 16 mA
- Forward voltage drop 1.5 volts
- MAXIMUM FORWARD CURRENT 25 mA

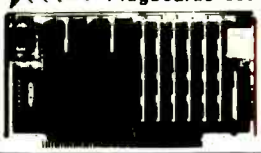
Vector

SLIT-N-WRAP WIRE WRAP TOOL

- Slits and opens insulation exposing bare wire
- No pre-cutting or pre-stripping
- Comes complete with two 100 ft spools #28 AWG wire

Model P180 $24.50

Vector Plugboards 8800V



Universal Microcomputer/Processor plugboard use with S-100 bus complete with heat sink & hardware 5.3 x 10 x 1/16

$19.95

CHANNEL F

Fairchild video entertainment system

$129.95

- Freeze Action
- Speed Option
- Automatic time and scorekeeping
- Battery-free AC operation
- Dual controls with 8-way action
- Built-in Pro Hockey and Tennis games
- Easy hook-up on any B/W or Color TV
- Factory warranty

Channel F — additional cartridges — $17.95 ea.

0811 — Tic-Tac-Toe/Shooting Gallery Quadra-doodle/Doodle
0812 — Desert Fox Shooting Gallery
0813 — Blackjack (1 or 2 players)
0814 — Spitfire (1 or 2 players)
0815 — Spacewar (2 players)
0818 — Magic Numbers (computer logic)
0819 — Drag strip (1 or 2 players)
0820 — Maze (2 players)
0822 — Baseball (2 players)

D—SUB CONNECTORS

NO. PINS	PART NO.	PRICE	COVER PRICE
9	DE-9P	1.49	1.25
9	DE-9S	2.15	
15	DA-15P	2.11	1.50
15	DA-15S	3.10	
25	DB-25P	3.00	1.50
25	DB-25S	4.00	
37	DE-37P	4.14	2.00
37	DE-37S	6.00	
50	DD-50P	5.40	2.25
50	DD-50S	8.00	

EDGE CONNECTORS

NO.	PINS		TYPE	
20	DUAL	10 PIN	GOLD	$ .50
30	DUAL	15 PIN	GOLD	.75
44	DUAL	22 PIN	GOLD	1.95
44	DUAL	22 PIN	GOLD	2.50
80	DUAL	40 PIN	GOLD	4.95
86	DUAL	43 PIN	GOLD(6800)	5.00
100	DUAL	50 PIN	GOLD(IMSAI/ALTAIR)	4.25
100	DUAL	50 PIN	GOLD(IMSAI/ALTAIR)	4.95
100	DUAL	50 PIN	GOLD(NO EARS-IMSAI	3.50
100	DUAL	50 PIN	TIN (.1" SPACING)	3.25

ALTAIR/IMSAI CARD GUIDES .25¢ EACH

CLOCK CHIPS

[illegible]	6 Digit BCD Outputs, Reset PIN	$9.95
MM5311	6 Digit BCD Outputs, 12 or 24 Hour	4.95
MM5312	4 Digit BCD Outputs 1 PPS Output	4.95
MM5314	6 Digit 12 or 24 Hour 50 or 60 Hz	4.95
MM5316	4 Digit Alarm 1 PPS Output	6.95
MM5318	Video Clock Chip, For Use With (MM5841 $9.95)	9.95
CT7001	6 Digit, Calendar, Alarm, 12 or 24 Hour	5.95

Wire Wrap

	1-24	25-99	100-999	1K
10	39	36	32	26
14	34	33	31	29
16	36	34	32	30
18	70	[illegible]	54	40
20	[illegible]	75	67	55
22	95	[illegible]	72	59
24	[illegible]	[illegible]	72	59
28	[illegible]	[illegible]	80	71
36	1.40	1.25	1.00	83
40	1.56	1.40	1.20	[illegible]

I C SOCKETS

Lo Profile-Solder Tin

	1-24	25-99	100-999	1K & Up
(8)	15	14	13	12
(14)	25	20	16	14
(16)	25	20	18	16
(18)	28	27	26	20
(20)	34	33	30	239
(22)	36	35	34	28
(24)	36	35	34	289
(28)	44	43	42	367
(40)	60	58	57	493

7400 TTL Series

7400	.18	7443	1.20	74100	1.75	74162	1.90
7401	.20	7445	1.05	74107	.40	74163	1.40
7402	.20	7446	1.05	74109	.45	74164	1.50
7403	.20	7447	.85	74110	.80	74165	1.40
7404	.20	7448	.95	74116	2.00	74166	1.50
7405	.25	7450	.20	74120	1.25	74167	3.00
7406	.35	7451	.20	74121	.55	74170	2.00
7407	.35	7453	.20	74122	.45	74172	9.75
7408	.25	7454	.20	74123	.95	74173	1.50
7409	.25	7460	.20	74125	.55	74174	1.10
7410	.20	7470	.40	74126	.80	74175	1.20
7411	.25	7472	.35	74128	.65	74176	1.50
7412	.40	7473	.40	74132	1.50	74177	.90
7413	.75	7474	.40	74136	1.80	74180	1.00
7414	.70	7475	.70	74141	1.15	74181	2.00
7416	.35	7476	.40	74142	4.00	74182	.90
7417	.40	7479	2.00	74144	4.00	74184	2.00
7420	.20	7480	.69	74145	1.10	74185	2.00
7422	.75	7482	1.50	74147	2.50	74186	12.00
7425	.35	7483	.85	74148	1.75	74190	1.40
7426	.30	7485	1.10	74150	1.00	74191	1.25
7427	.35	7486	.40	74151	1.10	74192	1.10
7428	.40	7489	2.25	74153	1.10	74193	1.10
7429	.40	7490	.55	74154	1.10	74194	1.20
7430	.25	7491	1.10	74155	1.10	74195	1.00
7432	.30	7492	.60	74156	1.10	74196	1.10
7433	.40	7493	.60	74157	1.20	74197	1.30
7437	.30	7494	.85	74158	1.75	74198	1.50
7438	.35	7495	.90	74159	3.60	74199	1.75
7439	.36	7496	.80	74160	1.30		
7440	.20	7497	4.00	74161	1.30		
7441	.75						
7442	.50						

CMOS

34001	.40	4050	.61	4517	8.50	MM74C173N	1.39
4000	.25	4051	1.10	4518	1.65	MM74C174N	1.39
4001	.25	4052	1.10	4519	.90	MM74C175N	1.39
4002	.25	4053	1.10	4520	1.65	MM74C192N	1.71
4004	3.50	4060	3.25	4521	3.25	MM74C193N	1.71
4006	1.40	4061	7.00	4522	1.75	MM74C195N	1.61
4007	.25	4063	2.50	4527	3.00	MM74C200N	10.45
4008	1.25	4066	.85	4528	1.75	MM74C221N	[illegible]
4009	.48	4067	6.00	4583	1.45	MM74C901N	.84
4010	.48	4068	.35	4584	.75	MM74C902N	.84
4011	.25	4069	.35	MM74C00N	.38	MM74C903N	.84
4012	.25	4070	.85	MM74C02N	.38	MM74C905N	11.20
4013	.60	4071	.35	MM74C04N	.38	MM74C906N	.84
4014	1.25	4072	.35	MM74C08N	.38	MM74C907N	.84
4015	1.25	4073	.35	MM74C10N	.38	MM74C908N	3.80
4016	.59	4075	.35	MM74C14N	2.18	MM74C909N	2.52
4017	1.25	4076	1.85	MM74C20N	.38	MM74C910N	10.45
4018	1.25	4077	.42	MM74C30N	.38	MM74C914N	7.18
4019	.70	4078	.35	MM74C32N	.38	MM74C915N	1.71
4020	1.25	4081	.35	MM74C42N	1.42	MM74C918N	4.19
4021	1.25	4082	.35	MM74C48N	2.13	MM74C922N	5.65
4022	1.25	4085	1.35	MM74C73N	.84	MM74C923N	5.75
4023	.35	4086	1.45	MM74C74N	.87	MM74C925N	12.00
4024	1.00	4089	3.00	MM74C76N	.84	MM74C926N	12.00
4025	.35	4093	1.75	MM74C83N	2.00	MM74C927N	12.00
4026	2.25	4098	2.50	MM74C85N	2.00	MM74C928N	12.00
4027	.60	4160	1.75	MM74C86N	.99	MM80C97N	.84
4028	1.25	4161	1.75	MM74C89N	6.75	MM80C98N	.84
4029	1.50	4162	1.75	MM74C90N	1.32		
4030	.60	4163	1.75	MM74C93N	1.32		
4032	1.60	4174	1.75	MM74C95N	1.61		
4033	2.00	4175	1.60	MM74C107N	1.89		
4034	3.50	4194	1.80	MM74C150N	5.67		
4035	1.60	4501	.38	MM74C151N	3.80		
4038	1.60	4502	1.75	MM74C154N	5.67		
4040	1.50	4503	1.15	MM74C157N	3.40		
4041	1.45	4506	.70	MM74C160N	1.71		
4042	1.25	4507	1.00	MM74C161N	1.71		
4043	1.20	4508	4.00	MM74C162N	2.57		
4044	1.25	4510	1.75	MM74C163N	1.71		
4045	2.50	4511	2.00	MM74C164N	1.61		
4046	1.95	4512	1.50	MM74C165N	1.61		
4047	2.50	4514	4.75				
4048	1.00	4515	4.75				
4049	.61	4516	1.75				

74LS00

74LS00	.29	74LS60	.29	74LS151	1.25	74LS196	1.87
74LS01	.29	74LS73	.49	74LS153	1.25	74LS197	1.87
74LS02	.29	74LS74	.49	74LS154	3.65	74LS221	2.00
74LS03	.29	74LS75	.69	74LS155	1.25	74LS240	3.00
74LS04	.29	74LS76	.49	74LS156	1.85	74LS241	3.00
74LS05	.35	74LS78	.65	74LS157	1.50	74LS242	3.00
74LS08	.29	74LS83AN	1.75	74LS158	1.55	74LS243	2.60
74LS09	.50	74LS85	2.25	74LS160	1.95	74LS244	2.60
74LS10	.29	74LS86	.69	74LS161	1.95	74LS247	1.68
74LS11	.40	74LS90	.89	74LS162	1.95	74LS248	1.35
74LS12	.50	74LS92	.89	74LS163	1.95	74LS251	1.91
74LS13	.69	74LS93	.89	74LS164	1.95	74LS253	1.75
74LS14	1.70	74LS95	1.50	74LS165	2.00	74LS257	1.75
74LS15	.40	74LS96	1.89	74LS166	2.00	74LS258	1.95
74LS20	.29	74LS107	.55	74LS168	2.00	74LS259	4.75
74LS21	.40	74LS109	.59	74LS169	2.00	74LS260	.50
74LS22	.40	74LS112	.59	74LS170	4.00	74LS266	.68
74LS26	.39	74LS113	.60	74LS173	2.00	74LS273	2.50
74LS27	.39	74LS114	.60	74LS174	1.87	74LS279	.79
74LS28	.39	74LS122	.60	74LS175	1.95	74LS283	1.85
74LS30	.29	74LS123	1.25	74LS181	3.69	74LS284	6.16
74LS32	.39	74LS124	1.80	74LS189	6.16	74LS290	1.56
74LS37	.48	74LS125	.87	74LS190	2.49	74LS293	1.56
74LS38	.48	74LS126	1.07	74LS191	2.49	74LS295	2.00
74LS40	.39	74LS132	1.25	74LS192	2.25	74LS298	2.00
74LS42	1.20	74LS136	.59	74LS193	2.25	74LS352	1.65
74LS47	1.25	74LS138	1.25	74LS194	1.89	74LS353	1.85
74LS48	1.68	74LS139	1.25	74LS195	1.87	74LS365	.87
74LS51	.29					74LS366	.85
74LS52	.29					74LS367	.87
74LS54	.29					74LS368	.87
74LS55	.29					74LS386	.68
						74LS390	3.00
						74LS395	2.25
						74LS670	3.95

LINEAR

LM300H	1.70	LM702H	.79	LM2111N	1.35
LM301AH	.35	LM703LN	.45	LM2900N	.90
LM301AN	.35	LM703CH	.45	LM2901N	2.95
LM302H	.75	LM709CH	.40	LM2902N	3.00
LM306H	2.50	LM710CH	.60	LM2903N	1.60
LM307H	.55	LM710N	.75	LM2904N	1.60
LM307N	.35	LM711CH	.39	LM2917N	2.00
LM308AH	3.75	LM711CN	.39	LM3046N	1.25
LM308AN	3.00	LM723CH	.55	LM3053N	1.50
LM308H	1.00	LM723CN	.55	LM3064N	1.25
LM308N	1.00	LM725CH	2.50	LM3065N	1.00
LM310H	1.15	LM725CN	3.00	LM3067N	2.60
LM310N	2.00	LM733CH	1.00	LM3075N	1.75
LM311D	2.00	LM733CN	1.00	LM3089N	3.00
LM311H	.90	LM739N	1.19	LM3146N	2.00
LM311N	.80	LM741CH	.35	LM3302N	2.00
LM311N	.80	LM741CN	.35	LM3401N	.80
LM312H	2.70	LM741CJ	.39	LM3900N	.49
LM318H	1.50	LM741CN	.39	LM3905N	.89
LM318N	1.50	LM747CH	.79	LM3909N	.90
LM319N	1.25	LM747CN	.79	LM3911N	1.25
LM321H	3.00	LM748CH	.39	LM4024N	2.75
LM322N	3.00	LM748CN	.39	LM4044N	3.00
LM324N	1.65	LM7600N	3.00	LM4250CH	2.00
LM339AN	3.00	LM1303N	.90	LM4250CN	2.00
LM339N	.99	LM1304N	1.19	LM4558N	.75
LM348N	1.85	LM1305N	1.40	LM5556N	1.75
LM350N	1.00	LM1307N	.85	LM5558N	1.00
LM358N	1.00	LM1310N	2.25		
LM370H	1.15	LM1358N	1.00		
LM370N	2.75	LM1414N	1.75		
LM373N	2.95	LM1458H	1.30		
LM375N	3.00	LM1458N	.59		
LM377N	2.00	LM1468N	2.90		
LM380N	1.05	LM1488N	1.95		
LM380N	1.05	LM1489N	1.95		
LM380N	1.05	LM1496H	.95		
LM381N	1.75	LM1496N	.95		
LM382N	1.75	LM1556N	1.75		
LM386H	.85	LM1596J	2.25		
LM387AN	.75	LM1800N	1.90		
LM387N	.95	LM1808N	2.00		
LM388N	1.25	LM1810N	2.00		
LM389N	1.25	LM1812N	4.00		
NE531T/V	2.00	LM1820N	1.25		
NE550A	1.30	LM1830N	2.00		
NE555V	.39	LM1845N	1.75		
NE556B	1.25				
NE560B	5.00				
NE562B	5.00				
NE565B	1.50				
NE566B	2.00				
NE566T/V	1.75				
NE567V	1.59				

RCA LINEAR SERIES

CA3013	2.15
CA3023	2.56
CA3035	2.48
CA3039	1.35
CA3046	1.30
CA3059	3.25
CA3060	3.25
CA3080	.85
CA3081	2.00
CA3082	2.00
CA3083	1.60
CA3086	.85
CA3089	3.75
CA3130	1.39
CA3140	1.25
CA3401	.49
CA3600	3.50

MICROPROCESSOR CRYSTALS

FREQUENCY	price
1.0 MHz	5.95
1.8432 MHz	9.80
2.0 MHz	5.95
2.097152 MHz	8.50
2.4576 MHz	8.50
2.667 MHz	8.50
3.00 MHz	8.50
3.20 MHz	8.50
3.2768 MHz	8.50
3.579545 MHz	1.25
4.0 MHz	4.95
4.0 MHz	4.95
4.194304 MHz	4.95
4.91520 MHz	4.95

FREQUENCY	price
5.0 MHz	4.95
5.0688 MHz	4.95
5.185 MHz	4.95
5.7143 MHz	4.95
6.00 MHz	4.95
6.144 MHz	4.95
6.40 MHz	4.95
6.5536 MHz	4.95
8.0 MHz	4.95
10.0 MHz	4.95
18.00 MHz	4.95
18.432 MHz	4.95
20.0 MHz	4.95
22.1184 MHz	4.95
27.0 MHz	4.95
36.0 MHz	4.95
48.0 MHz	4.95

FOR PROCESSOR TECH 14.318 $4.95

DIP SWITCHES

4 POSITION	$1.50	7 POSITION	1.80
5 POSITION	1.60	8 POSITION	2.00
6 POSITION	1.70	9 POSITION	2.25
		10 POSITION	2.50

WIRE WRAP CENTER

HOBBY-WRAP TOOL-BW-630

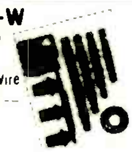
- Battery Operated (Size C)
- Weighs ONLY 11 Ounces
- Wraps 30 AWG Wire onto Standard DIP Sockets (.025 inch)
- Complete with built-in bit and sleeve

$34.95 batteries not included

WIRE-WRAP KIT — WK-2-W

WRAP • STRIP • UNWRAP

- Tool for 30 AWG Wire
- Roll of 50 Ft White or Blue 30 AWG Wire
- 50 pcs each 1 2 3 & 4 lengths — pre-stripped wire



$11.95

WIRE WRAP TOOL WSU-30

WRAP • STRIP • UNWRAP - $5.95

WIRE WRAP WIRE — 30 AWG

50 ft $1.95 1000 ft $15.00

SPECIFY COLOR — White · Yellow · Red · Green · Blue · Black

WIRE DISPENSER — WD-30

- 50 ft roll 30 AWG KYNAR wire wrap wire **$3.45 ea.**
- Cuts wire to desired length
- Strips 1" of insulation **Specify** — Blue-Yellow-White-Red

LIQUID CRYSTAL DIGITAL CLOCK-CALENDAR

For Auto Home Office
Small in size (2x2½x½)
Push button for seconds release for date
Clocks mount anywhere with either 3M double sided tape or VELCRO included
2 MODELS AVAILABLE
LCD 101 portable model runs on self contained batteries for better than a year
LCD 102 runs on 12 volt system and is back lighted

LCD-101 or LCD-102 your choice ..... **$33.95 ea**

Clear desk stand for **$2.00**

MA1003, 12V DC CLOCK MODULE

Built in X'TAL controlled time base. Protected against automotive volt transients. Automatic brightness control with 0.3" green color display. Display turnoff with ignition "OFF"

$17.95

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Computer Products

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LAWNDALE, CALIFORNIA 90260
(213) 679-3313

RETAIL STORE HOURS M-F 9-7 SAT 9-5

Discounts available at OEM quantities. Add $1.25 for shipping. California residents add 6% sales tax

1978 CATALOG NOW AVAILABLE

CIRCLE NO. 36 ON FREE INFORMATION CARD

EDMUND SCIENTIFIC

ENVIRONMENTS

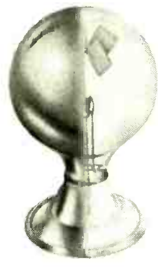
• Strange, beautiful records that can help you think

Scientifically designed to help you study, read, meditate, romance or eliminate unwanted noise, these long-playing $33^1/_3$ rpm reacords provide a unique tranquil experience. Each provides one hour of naturally occuring sounds that range from soothing surf to thunderstorm.

A) **Seashore/Aviary**—surf on one side, melodic birds on other. **No. 72,156 AV**

B) **Thunderstorm/Rain in Forest**—beautifully realistic rainfall. **No. 72,157AV**

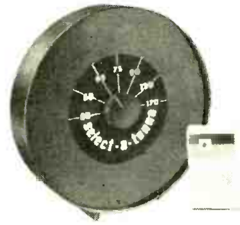
$7.25 ea. Ppd.



CROOKE'S RADIOMETER powered by sunlight

Fascinating solar rotor spins at 3,000 RPM. First-surface silvering on 1/2 dome makes hemispherical mirror. 5x3".

No. 60,529AV **$5.75** Ppd.



SUPER POWER FOR ANY AM RADIO

Antenna assist has pulled in station 1,000 miles off! No wires, clips, grounding. Solid state. No batteries, tubes, plugs.

No. 72,095AV **$19.95** Ppd.

ULTRA SELECT-A-TENNA No. 72,147AV **$24.95** Ppd.

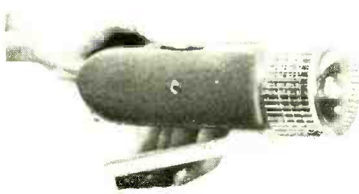
Free Catalog

KNOW YOUR ALPHA FROM THETA!

For greater relaxation & concentration, monitor your Alpha/Theta brain-waves with audio or visual signals on Bio-sone II. Features of $200-up units. 3 feed-back modes! 4-lb.

No. 1668AV ($9^1/_2$x$5^5/_8$x$4^1/_4$") **$149.95** Ppd.

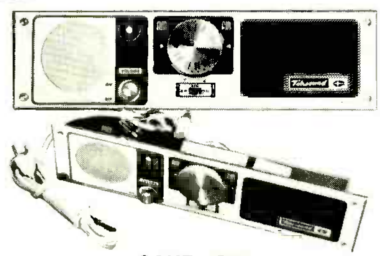
No. 71,809AV (FOR BEGINNERS) **$59.95** Ppd.



FLYWHEEL GENERATOR FLASHLIGHT

Never needs batteries, uses a flywheel generator to keep light bright. Each squeeze of handle gives 2 sec. flash of light. Continuous squeezing keeps light shining. Only 6-oz.

No. 61,086AV **$14.95** Ppd.



SAVE 40% — DELUXE AM/FM WALL RADIO

Great surplus buy saves you 40% on brand new AM/FM Deluxe Wall Radio w/ handsome silver/black control panel. Mount anywhere den, kitchen, bedroom, office, workshop. Self-cont. Philco-Ford radio chassis ($14^1/_4$x$3^{13}/_{16}$x$3^1/_2$") w/11 transistors, vol. control, AM/FM hi-sensitivity tuner, AFC, $2^3/_4$" dia. speaker, $7^1/_2$' 110V AC cord. Orig. cost $30 ea. in 3000 quant. for nat'l motel chain. Buy several now.

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☐ Please send me the following items I have indicated below:

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30 DAY GUARANTEE
You must be completely satisfied with any Edmund item or return it within 30 days for a full refund.

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Address______________________
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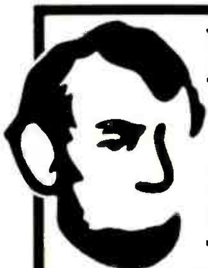
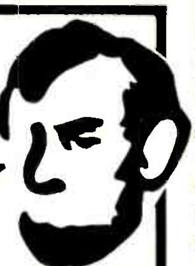
THIS SPECIAL ONE CENT SALE IS FOR MAGAZINE ADS ONLY



POLY PAKS IS THE NEW WORLD'S 'CENT-ER' FOR DOUBLING YOUR MONEY



THIS NEW LIST OF "ONE-CENTERS" HELPS FIGHT INFLATION!

LEDS!

YOUR CHOICE 5 for $1.00
1¢ SALE 10 for $1.01

Order by Cat. No.

- ☐ #4E2135 JUMBO RED LEDS
- ☐ #4E2137 MICRO RED LEDS
- ☐ #4E2790 JUMBO RED CLEAR LEDS
- ☐ #4E2792 JUMBO TAPERED AMBER
- ☐ #4E2140 MICRO GREEN LEDS

1.5 AMP BULLET RECTIFIERS!

Order by Cat. No. 4E60B84 and voltage

☐ 50V	10 for $.59	20 for $.60
☐ 100V	10 for .69	20 for .70
☐ 200V	10 for .79	20 for .80
☐ 400V	10 for .89	20 for .90
☐ 600V	10 for 1.09	20 for 1.10
☐ 800V	10 for 1.19	20 for 1.20

OP AMP 1¢ GIVEAWAYS

Order by Type Number

Type	Sale	1¢SALE
☐ LM308V	2 for $1.00	4 for $1.01
☐ LM311V	2 for 1.00	4 for 1.01
☐ LM558V	3 for 1.19	6 for 1.20
☐ LM709H	10 for 1.19	20 for 1.20
☐ LM741V	5 for 1.19	10 for 1.20
☐ LM1800N	1 for .99	2 for 1.00
☐ LM3900N	2 for 1.00	4 for 1.01

MICRO MINI TOGGLE SWITCHES!

3 Amps, 125 VAC contacts, with chrome handles, complete with mounting hardware.

Cat. No	Type	Sale	2 for
☐ 4E3936	SPDT	$1.29	$1.30
☐ 4E5085	SPDT*	1.39	1.40
☐ 4E4037	DPDT	1.45	1.46
☐ 4E5087	4PDT*	1.95	1.96

BUY 1 AT OUR SALE PRICE

GET 2 FOR 1¢ MORE

4 DIGIT FLUORESCENT CLOCK BASIC KIT

12 or 24 hours! .57" bright blue digits! Easy to breadboard uses MM5316 clock chip and minimum of external components! AM—PM indicator, includes options for alarm, clock radio, snooze, and more! Basic kits include readouts, IC's, sockets, transistors & all necessary components! (case, PC board, transformer, line chord not included). Requires 12VCT transformer.

- ☐ #4E3791 Fluorescent Basic Kit $9.95, 2 kits $9.96
- ☐ #4E3792 Components for optional alarm $2.95 (No 1¢ sale)
- ☐ #4E3686 12VCT "pluggable" transformer 1.95 (No 1¢ sale)

Quan.	Description (Order by Cat. No. in parenthesis)	Sale	1¢SALE
☐ 10	CALCULATOR KEYBOARDS, 20 keys and more (4E3524)	$2.00	20 for $2.01
☐ 15	SLIDE VOLUME CONTROLS, asstd values (4E3057)	2.00	30 for 2.01
☐ 10	CRYSTALS, may include CB, Ham & more (4E3250)	2.00	20 for 2.01
☐ 150	MOLEX IC SOCKETS, on a strip, cut to length (4E3144)	2.00	300 for 2.01
☐ 100	TERMINAL STRIPS, from 2 lugs up (4E3136)	2.00	200 for 2.01
☐ 30	NE-2NEON LAMPS, all 100% good (4E2613)	2.00	60 for 2.01
☐ 40	SHIELDED CABLE, 1 cond, mikes, phonos (4E3577)	2.00	80 for 2.01
☐ 50	TRANSISTOR ELECTROS, asstd values, styles (4E2747)	2.00	100 for 2.01
☐ 3	SOUND TRIGGERS, sound triggers scr w/amp (4E3625)	2.00	6 for 2.01
☐ 15	6V TEST INDICATORS, leads, grain-o-wheat (4E3526)	2.00	30 for 2.01
☐ 100	CAPACITOR SPECIAL, discs, mylar, lytics, more (4E2738)	2.00	200 for 2.10
☐ 30	MINI TRIMPOTS, to 1 meg, 1 turn, ¼W (4E3345)	2.00	60 for 2.01
☐ 10	VOLTAGE REGULATORS, hobby LM320, 340, TO-3 (4E3330)	2.00	20 for 2.01
☐ 30	PANEL SWITCHES, slides, rotaries, mod, etc (4E3268)	2.00	60 for 2.01
☐ 200	RESISTOR SPECIAL, ¼ to 1W, carbon, metal (4E3054)	2.00	400 for 2.01
☐ 200	HALF WATTERS, resistors, carbon, metal (4E3046)	2.00	400 for 2.01
☐ 100	NATIONAL IC BONANZA, linears, 7400s ROMS (4E2860)	2.00	200 for 2.01
☐ 40	HOBBY LEDS, asstd types, mostly useable (4E2859)	2.00	80 for 2.01
☐ 15	LM340T VOLTAGE REGULATAORS, 5 to 24V, TO-220 (4E2635)	2.00	30 for 2.01
☐ 100	TWO WATTERS, resistors, carbon-metal marked (4E2735)	2.00	200 for 2.01
☐ 100	POLYSTYRENE CAPS, asstd values, voltage, hi-Q (4E2729)	2.00	200 for 2.01
☐ 50	THERMISTORS, resistors that change with temp (4E4089)	2.00	100 for 2.01
☐ 20	BRIDGES, untested, 2, 4, 6, 10, amp, full wave (4E4022)	2.00	40 for 2.01
☐ 25	LAMP'N'SOCKET SETS, micro, 1.5V, T2 (4E3957)	2.00	50 for 2.01
☐ 15	MIXED READOUTS, hobby, untested, .127, .3, .5, etc. (4E3619)	2.00	30 for 2.01
☐ 150	QUARTER WATTERS, resistors, metal film, marked (4E3413)	2.00	300 for 2.01
☐ 100	PLASTIC TRANSISTORS, untested, RO-92 (4E2604)	2.00	200 for 2.01
☐ 200	PREFORMED RESISTORS, ¼, ½, 1W, marked, asstd (4E2608)	2.00	400 for 2.01
☐ 200	PRECISION RESISTORS, ¼, ½, 1W, 1%, 2% marked (4E2428)	2.00	400 for 2.01
☐ 60	DIPPED MYLARS, shiny finish, asst values (4E2597)	2.00	120 for 2.01
☐ 30	VOLUME CONTROLS, audio, linear, asstd values (4E2421)	2.00	60 for 2.01
☐ 5	7.5 VOLT ZENER DIODES, 1 watt (4E5187)	1.00	10 for 1.01
☐ 5	9.1 VOLT ZENER DIODES, 1 watt (4E5188)	1.00	10 for 1.01
☐ 30-FT.	WIRE WRAP WIRE, 30 gauge (4E3803)	1.19	60-ft for 1.20
☐ 5	TANTALUM CAPS, 2.2uF, 25V (4E5189)	1.00	10 for 1.01
☐ 1	TV GAME SWITCH, choose TV or game, 75 pr 300 ohms (4E3970)	1.50	2 for 1.51
☐ 1	ALARM CLOCK CHIP, MM5316, 4-digits (4E1759)	2.95	2 for 2.96
☐ 5	PANCAKE PHOTOCELLS, 600 to 15K ohms (4E2939)	1.00	10 for 1.01
☐ 1	100KHZ MARKER CRYSTALS, approx for marker gen. (4E3896)	1.95	2 for 1.96
☐ 1	MOTHERBOARD EDGE CONNECTOR, 106 pins, .125" (4E3987)	3.50	2 for 3.51
☐ 1	48-PIN EDGE CONNECTOR, .156" spacing (4E3963)	1.95	2 for 1.96
☐ 1	JOYSTICK, two 10K pots, for computers, TV games (4E5037)	2.95	2 for 2.96
☐ 1	CHARACTER GENERATOR, 5 × 7 Mostek MK 2002P (4E3898)	4.95	2 for 4.96

READOUTS!

		ONE CENT SALE
☐ 3½ DIGIT LCD WRISTWATCH DISPLAY, (#4E3960)	3 for $1.19	6 for $1.20
☐ GE FLUORESCENT NIXIES, 7-seg, blue (#4E3684)	1 for 1.00	2 for 1.01
☐ SPERRY FLAT NIXIES, orange dual digit (#4E5014)	2 for 1.19	4 for 1.20
☐ SPERRY FLAT NIXIES, orange, .3", 1½-dig (#4E5015)	2 for 1.19	4 for 1.20
☐ MAN-3 BUBBLE READOUT, .19" red, com cath. (#4E3338)	6 for 1.00	12 for 1.01
☐ MAN-4 READOUT, bubble, red, com anode (#4E1503)	2 for 1.00	4 for 1.01
☐ FND-10 BLOCK READOUT, .122" com cathode (#4E2082)	2 for 1.19	4 for 1.20
☐ 8-DIGIT READOUT, led, com cathod, red (#4E5190)	1 for 1.95	2 for 1.96

SPEAKERS!

	Each	2 for
☐ 6" TWIN CONE SPEAKER, hi-fi, for car'n'home (#4E5059)	$4.50	$4.51
☐ 2¼ × 5" OVAL SPEAKER, 8 ohms (#4E2553)	1.49	1.50
☐ 2 × 6" OVAL SPEAKER, 8 ohms (#4E3454)	1.49	1.50

MICROPHONES!

	Each	2 for
☐ CONDENSOR MIKES, sensitive, 500 ohms, 1½V (#4E3178)	$4.95	$4.96
☐ COMMUNICATIONS MIKE, 500 ohms, CB-HAM (#4E4074)	4.50	4.51
☐ NOISE CANCELLING MIKE, Ham-CB, 500 ohms (#4E3902)	6.95	6.96

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	Each	2 for
☐ SPDT 12V BLOCK RELAY, 5A contacts (#4E4032)	$1.98	$1.99
☐ SPDT 12V REED RELAY, 1A contacts (#4E4094)	1.49	1.50
☐ SPOT 12V SENSITIVE, 2000 ohm coil (#4E3044A)	1.95	1.96

AMPLIFIERS!

	Each	2 for
☐ 8 WATTS ON A BOARD, with built-in preamp (#4E5040)	$5.95	$5.96
☐ 9 WATTS ON A CHIP, Toshiba TA7205 (#4E5057)	4.95	4.96
☐ 3 WATTS ON A CHIP, G-E PA 263 (#4E1522)	1.50	1.51

TRANSFORMERS!

	Each	2 for
☐ 12V TRANSFORMER, 300ma, pc leads, 110pri. (#4E3412)	$1.49	$1.51
☐ 12V TRANSFORMER, 1A, 110/220pri, open frame (#4E4040)	2.95	2.96
☐ 24VCT TRANSFORMER, 300ma, open frame, 110pri. (#4E3323)	1.95	1.96

POLY PAKS® BIGGEST 1¢ GIVEAWAY SALE!

IT MAKES "CENTS" TO GIVE OUR CUSTOMERS THE BEST BARGAINS!

TTL'S, BUY ONE AT SALE PRICE, GET 2ND FOR ONLY 1¢ MORE

Honest Abe Penny Sale!

Order By Cat. No. 4E1981 & Type No.

Type	Each	2 for
☐ SN7400	$.19	$.20
☐ SN7401	.19	.20
☐ SN7403	.19	.20
☐ SN7404	.25	.26
☐ SN7405	.19	.20
☐ SN7406	.19	.20
☐ SN7408	.21	.22
☐ SN7410	.19	.20
☐ SN7413	.39	.40
☐ SN7414	.65	.66
☐ SN7416	.29	.30
☐ SN7420	.19	.20
☐ SN7423	.29	.30
☐ SN7426	.25	.26
☐ SN7427	.25	.26
☐ SN7430	.29	.30
☐ SN7432	.25	.26
☐ SN7437	.25	.26
☐ SN7438	.29	.30
☐ SN7440	.19	.20
☐ SN7442	.69	.70
☐ SN7443	.69	.70
☐ SN7444	.65	.66
☐ SN7445	.99	1.00
☐ SN7446	1.35	1.36
☐ SN7447	1.25	1.26
☐ SN7448	1.35	1.36
☐ SN7450	.19	.20
☐ SN7451	.19	.20
☐ SN7453	.19	.20
☐ SN7454	.19	.20
☐ SN7455	.19	.20
☐ SN7460	.19	.20
☐ SN7462	.19	.20
☐ SN7464	.19	.20
☐ SN7465	.19	.20
☐ SN7470	.25	.26
☐ SN7471	.25	.26
☐ SN7472	.25	.26
☐ SN7473	.55	.56
☐ SN7474	.29	.30
☐ SN7475	.79	.80
☐ SN7476	.59	.60
☐ SN7478	.59	.60
☐ SN7480	.29	.30
☐ SN7482	.39	.40
☐ SN7483	.99	1.00
☐ SN7485	1.49	1.50
☐ SN7486	.39	.40
☐ SN7488	1.95	1.96
☐ SN7490	.69	.70
☐ SN7491	.79	.80
☐ SN7492	.45	.46
☐ SN7493	.49	.50
☐ SN7494	.69	.70
☐ SN7495	.69	.70
☐ SN7496	.69	.70
☐ SN7498	.69	.70
☐ SN74100	1.49	1.50
☐ SN74107	.39	.40
☐ SN74112	.25	.26
☐ SN74113	.19	.20
☐ SN74114	.25	.26
☐ SN74121	.49	.50
☐ SN74123	.69	.70
☐ SN74125	.59	.60
☐ SN74126	.39	.40
☐ SN74132	1.25	1.26
☐ SN74140	.99	1.00
☐ SN74141	1.49	1.50
☐ SN74145	1.25	1.26
☐ SN74148	1.75	1.76
☐ SN74150	.99	1.00
☐ SN74151	.99	1.00
☐ SN74153	.99	1.00
☐ SN74154	1.75	1.76
☐ SN74155	.79	.80
☐ SN74156	.69	.70
☐ SN74157	.99	1.00
☐ SN74158	.99	1.00
☐ SN74160	1.25	1.26
☐ SN74161	1.25	1.26
☐ SN74163	1.19	1.20
☐ SN74164	.99	1.00
☐ SN74165	1.25	1.26
☐ SN74166	1.25	1.26
☐ SN74173	1.25	1.26
☐ SN74174	1.49	1.50
☐ SN74175	.99	1.00
☐ SN74177	.79	.80
☐ SN74179	1.49	1.50
☐ SN74180	.49	.50
☐ SN74182	.69	.70
☐ SN74190	1.49	1.50
☐ SN74191	1.75	1.76
☐ SN74192	.85	.86
☐ SN74193	.85	.86
☐ SN74194	1.25	1.26
☐ SN74195	.49	.50
☐ SN74197	.75	.76
☐ SN74199	1.75	1.76
☐ SN74200	5.50	5.51
☐ SN74251	1.75	1.76
☐ SN74284	4.50	4.51
☐ SN74285	4.25	4.26

DIP SWITCHES!

	Each	2 for
☐ 2 SWITCHES ON A DIP (#4E3668)	$ .77	$ .78
☐ 3 SWITCHES ON A DIP (#4E3669)	.88	.89
☐ 6 SWITCHES ON A DIP (#4E3671)	1.29	1.30

IC SOCKETS!

☐ 8-PIN MINI-DIP (#4E2123)	4 for $1.19	8 for $1.20
☐ 14-PIN DIP (#4E1308)	3 for 1.19	6 for 1.20
☐ 16-PIN DIP (#4E1309)	3 for 1.19	6 for 1.20
☐ 18-PIN DIP (#4E3378)	6 for 1.19	12 for 1.20
☐ 24-PIN MSI/DIP (#4E3886)	2 for 1.19	4 for 1.20
☐ 28-PIN MSI/DIP (#4E3887)	2 for 1.19	4 for 1.20
☐ 8-PIN TO-5 (#4E1307)	4 for 1.19	8 for 1.20

FULL WAVE 10 AMP BRIDGE RECTIFIERS!

Order by Cat. No. 4E2447 & voltage

PRV	Sale	2 for
☐ 50	$1.29	$1.30
☐ 100	1.49	1.50
☐ 200	1.69	1.70
☐ 400	1.99	2.00
☐ 600	2.25	2.26
☐ 800	2.50	2.51

RIBBON CABLE!

Order by Cat. No. 4E3939 and Conductors

Cond.	Sale	1¢ Sale
☐ 20	7-ft. $1.98	14-ft. $1.99
☐ 26	4-ft. 1.98	8-ft. 1.99
☐ 34	3-ft. 1.98	6-ft. 1.99
☐ 40	3-ft. 1.98	6-ft. 1.99

2-Amp Epoxy BRIDGE RECTIFIERS!

PENNY SALE! BUY ONE AT SALE PRICE, GET 2ND FOR ONLY 1¢ MORE

- Full Wave! • TO-5 case!

Order by Cat. No.4E1346 and PIV

PIV	Sale Each	2 for
☐ 50	$.59	$.60
☐ 100	.69	.70
☐ 200	.79	.80
☐ 400	.89	.90
☐ 600	.99	1.00
☐ 800	1.19	1.20
☐ 1000	1.29	1.30

POP-AMPS AT "CENT-CIBLE" PRICES

Buy ONE At Sale Price, Get 2ND For Only 1¢ More - Order By Type No.

Type	Each	2 for
☐ LM300H	$.49	$.50
☐ LM301H-V	.45	.46
☐ LM308V-H	.79	.80
☐ LM309K	1.29	1.30
☐ LM311H-V	.79	.80
☐ LM318V	1.29	1.30
☐ LM320H-5, 12, 15	1.29	1.30
☐ LM320K-15	1.29	1.30
☐ LM320T-6, 5	1.29	1.30
☐ LM322N	1.19	1.20
☐ LM324N	1.75	1.76
☐ LM339N	1.09	1.10
☐ LM340K-5, 6, 8, 12, 15, 18,	1.29	1.30
☐ LM340T-5, 6, 8, 12, 15, 18, 24	1.29	1.30
☐ LM350N	.59	.60
☐ LM370N-H	1.29	1.30
☐ LM374H	1.79	1.80
☐ LM376V	.29	.30
☐ LM377N	2.25	2.26
☐ LM381N	1.69	1.70
☐ LM531H	1.49	1.50
☐ LM532H-N	.29	.30
☐ LM555V	.75	.76
☐ LM558V	.79	.80
☐ LM561N	1.00	1.01
☐ LM565N	.99	1.00
☐ LM703H	.49	.50
☐ LM704H	.29	.30
☐ LM709N-H	.25	.26
☐ LM710N	.39	.40
☐ LM733N	.79	.80
☐ LM739N	.89	.90
☐ LM741V-H	.30	.29
☐ LM1304	.80	.79
☐ LM1310	1.00	.99
☐ LM1312	2.00	1.99
☐ LM1414V	.80	.79
☐ LM1458V	.70	.69
☐ LM1800N	1.00	.99
☐ LM3028H	.66	.65
☐ LM3900N	.50	.49
☐ LM3909V	1.76	1.75
☐ LM4195	1.96	1.95
☐ LM4250	1.20	1.19
☐ LM75451	.40	.39
☐ LM75453	.40	.39
☐ LM75491	.80	.79
☐ LM75492	.80	.79
☐ LM75494	.60	.59
☐ PA263	1.50	1.51

10 AMP - POWER TABS! SCRS! TRIACS! QUADRACS!

Order by Cat. No. and voltage!
#4E1448 - TRIACS #4E730 - SCRS
#4E1590 - QUADRACS

PRV	Sale	2 for
☐ 50	$ .55	$ .56
☐ 100	.69	.70
☐ 200	.88	.89
☐ 300	1.19	1.20
☐ 600	1.59	1.60

SPECTROL "SKINNY-TRIMS"

3/8" square, screwdriver shaft, 2% tol, 1/4 watt, Cermet, PC leads. Order by Cat. No. and value.

Your Choice 2 for $1

Ohms

- ☐ 10** ☐ 50** ☐ 100** ☐ 200** ☐ 500* ☐ 1K* ☐ 2K**
- ☐ 5K* ☐ 10K* ☐ 20K** ☐ 50K** ☐ 100K**

- ☐ No. 4E3863 25 turn upright, type 64
- ☐ No. 4E3866 single turn, flat, type 63

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WE RESERVE THE RIGHT TO LIMIT QUANTITIES!!!!!!

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P.O. BOX 942E
LYNNFIELD, MA.

C.O.D.'s MAY BE PHONED

CIRCLE NO. 49 ON FREE INFORMATION CARD

7400N TTL

SN7400N	.16	SN7472N	.39	SN74160N	1.25
SN7401N	.18	SN7473N	.39	SN74161N	.99
SN7402N	.20	SN7474N	.35	SN74162N	1.95
SN7403N	.20	SN7475N	.50	SN74163N	.99
SN7404N	.20	SN7476N	.35	SN74164N	.99
SN7405N	.20	SN7479N	5.00	SN74165N	.99
SN7406N	.35	SN7480N	.50	SN74166N	1.25
SN7407N	.35	SN7482N	.99	SN74167N	3.25
SN7408N	.25	SN7483N	.70	SN74170N	2.10
SN7409N	.25	SN7485N	.89	SN74172N	6.00
SN7410N	.20	SN7486N	.39	SN74173N	1.50
SN7411N	.30	SN7488N	3.50	SN74174N	1.25
SN7412N	.35	SN7489N	2.49	SN74175N	.99
SN7413N	.69	SN7490N	.45	SN74176N	.79
SN7414N	.70	SN7491N	.75	SN74177N	.79
SN7416N	.35	SN7492N	.49	SN74179N	2.49
SN7417N	.35	SN7493N	.49	SN74180N	.99
SN7420N	.20	SN7494N	.79	SN74181N	2.49
SN7421N	.39	SN7495N	.79	SN74182N	.95
SN7422N	.49	SN7496N	.79	SN74184N	1.95
SN7423N	.37	SN7497N	3.00	SN74185N	1.95
SN7425N	.29	SN74100N	1.25	SN74186N	15.00
SN7426N	.29	SN74107N	.39	SN74187N	6.00
SN7427N	.37	SN74109N	.95	SN74188N	3.95
SN7429N	.42	SN74116N	1.95	SN74190N	1.79
SN7430N	.25	SN74121N	.39	SN74191N	1.25
SN7432N	.25	SN74122N	.39	SN74192N	.89
SN7437N	.35	SN74123N	.50	SN74193N	.89
SN7438N	.35	SN74125N	.60	SN74194N	1.25
SN7439N	.25	SN74126N	.60	SN74195N	.75
SN7440N	.21	SN74132N	1.25	SN74196N	1.00
SN7441N	.89	SN74136N	.95	SN74197N	1.00
SN7442N	.69	SN74141N	1.15	SN74198N	1.75
SN7443N	.75	SN74142N	2.95	SN74199N	1.75
SN7444N	.75	SN74143N	3.25	SN74200N	5.59
SN7445N	.75	SN74144N	3.00	SN74251N	1.79
SN7446N	.89	SN74145N	1.15	SN74279N	.90
SN7447N	.69	SN74147N	2.35	SN74283N	2.25
SN7448N	.89	SN74148N	2.00	SN74284N	6.00
SN7450N	.25	SN74150N	1.25	SN74285N	6.00
SN7451N	.25	SN74151N	.79	SN74365N	.75
SN7453N	.25	SN74153N	.89	SN74366N	.75
SN7454N	.25	SN74154N	1.25	SN74367N	.75
SN7459A	.25	SN74155N	.89	SN74368N	.75
SN7460N	.25	SN74156N	.89	SN74390N	2.25
SN7470N	.45	SN74157N	.89	SN74393N	2.25

20% Discount for 100 Combined 7400's

CMOS

CD4000	.23	CD4044	.89	CD4520	1.29
CD4001	.23	CD4046	1.79	MC14562	14.50
CD4002	.23	CD4047	2.50	CD4566	2.25
CD4006	1.19	CD4048	1.35	MC14583	3.50
CD4007	.25	CD4049	.49	74C00 Series	
CD4009	.49	CD4050	.49	74C00	.39
CD4010	.49	CD4051	1.19	74C02	.55
CD4011	.23	CD4053	1.19	74C04	.75
CD4012	.25	CD4056	1.49	74C10	.65
CD4013	.39	CD4059	9.95	74C14	3.00
CD4014	1.39	CD4060	1.49	74C20	.65
CD4015	1.19	CD4066	.79	74C30	.65
CD4016	.49	CD4068	.39	74C42	2.15
CD4017	1.19	CD4069	.45	74C73	1.50
CD4018	.99	CD4070	.55	74C74	1.15
CD4019	.49	CD4071	.23	74C89	4.00
CD4020	1.19	CD4072	.49	74C90	3.00
CD4021	1.39	CD4076	1.39	74C93	2.00
CD4022	1.19	CD4081	.23	74C95	2.00
CD4023	.23	CD4082	.23	74C107	1.25
CD4024	.79	CD4098	2.49	74C151	2.90
CD4025	.23	MC14409	14.95	74C154	3.00
CD4026	2.25	MC14410	14.95	74C157	2.15
CD4027	.69	MC14411	14.95	74C160	3.25
CD4028	.89	MC14419	4.95	74C161	3.25
CD4029	1.19	MC14506	.75	74C163	3.00
CD4030	.49	MC14507	.99	74C164	3.25
CD4035	.99	CD4508	3.95	74C173	2.60
CD4040	1.19	CD4510	1.39	74C193	2.75
CD4041	1.25	CD4511	1.29	74C195	2.75
CD4042	.99	CD4515	2.95	80C95	1.50
		CD4518	1.29	80C97	1.50

LINEAR

LM300H	.80	LM340T-8	1.25	LM739N	1.19
LM301H	.35	LM340T-12	1.25	LM741CH	.35
LM301CN	.35	LM340T-15	1.25	LM741CN	.35
LM302H	.75	LM340T-18	1.25	LM741-14N	.39
LM304H	1.00	LM340T-24	1.25	LM747H	.79
LM305H	.60	LM350N	1.00	LM747N	.79
LM307CN	.35	LM351CN	.65	LM748H	.39
LM308H	1.00	78MG	1.75	LM748N	.39
LM308CN	1.00	LM370N	1.15	LM1303N	.90
LM309H	1.10	LM373N	3.25	LM1304N	1.19
LM309K	1.25	LM377N	4.00	LM1305N	1.40
LM310CN	1.15	LM380N	1.25	LM1307N	.85
LM311H	.90	LM380CN	.99	LM1310N	2.95
LM311N	.90	LM381N	1.79	LM1351N	1.65
LM317K	6.50	LM382N	1.79	LM1414N	1.75
LM318CN	1.50	NE501K	8.00	LM1458CN	.59
LM319N	1.30	NE510A	6.00	LM1496N	.95
LM320K-5	1.35	NE529A	4.95	LM1556V	1.75
LM320K-5.2	1.35	NE531H	3.00	LM2111N	1.95
LM320K-12	1.35	NE536T	6.00	LM2901N	2.95
LM320K-15	1.35	NE540L	6.00	LM3053	1.50
LM320T-5	1.25	NE550N	1.30	LM3065N	.69
LM320T-5.2	1.25	NE555V	.39	LM3900N(3401)	.49
LM320T-8	1.25	NE560B	5.00	LM3905N	.89
LM320T-12	1.25	NE561B	5.00	LM3909	1.25
LM320T-15	1.25	NE562B	5.00	LM5556N	1.85
LM320T-18	1.25	NE565H	1.75	MC5558V	1.00
LM320T-24	1.25	NE565N	1.25	LM7525N	.90
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LM324N	1.80	NE567H	1.95	8038B	4.95
LM339N	.99	NE567V	1.49	LM75450	.49
LM340K-5	1.35	LM703CN	.45	75451CN	.39
LM340K-6	1.35	LM709H	.29	75452CN	.39
LM340K-8	1.35	LM709N	.29	75453CN	.39
LM340K-12	1.35	LM710N	.79	75454CN	.39
LM340K-15	1.35	LM711N	.39	75491CN	.79
LM340K-18	1.35	LM723H	.55	75492CN	.89
LM340K-24	1.35	LM723N	.55	75494CN	.89
LM340T-5	1.25	LM733N	1.00	RC4151	5.95
LM340T-6	1.25			RC4194	5.95
				RC4195	3.25

74LS00 TTL

74LS00	.29	74LS76	.49	74LS155	1.25
74LS02	.29	74LS83	1.75	74LS157	1.50
74LS03	.29	74LS85	2.49	74LS160	1.95
74LS04	.35	74LS86	.49	74LS161	1.95
74LS05	.35	74LS90	.89	74LS162	1.95
74LS08	.29	74LS92	.89	74LS163	1.95
74LS10	.29	74LS93	.89	74LS164	1.95
74LS13	.69	74LS95	1.50	74LS175	1.95
74LS14	1.75	74LS96	1.89	74LS181	3.69
74LS20	.29	74LS107	.59	74LS190	2.49
74LS26	.39	74LS109	.59	74LS191	2.49
74LS27	.39	74LS112	.59	74LS192	2.49
74LS28	.39	74LS123	1.25	74LS193	2.49
74LS30	.29	74LS132	1.25	74LS194	1.89
74LS32	.39	74LS136	.59	74LS195	1.89
74LS40	.39	74LS138	1.25	74LS253	1.75
74LS42	1.25	74LS139	1.25	74LS257	1.75
74LS47	1.25	74LS151	1.25	74LS260	.55
74LS51	.29			74LS279	.79
74LS55	.29			74LS367	.99
74LS73	.49			74LS368	.99
74LS74	.49			74LS670	3.95

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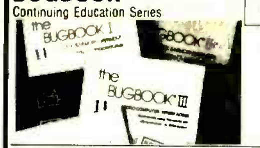

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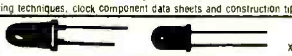
DISCRETE LEDS



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XC209	Green	4/$1	XC111	Green	4/$1
XC209	Orange	4/$1	XC111	Yellow	4/$1
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XC22	Yellow	4/$1	XC526	Green	4/$1	XC556	Green	4/$1			
XC22	Orange	4/$1	XC526	Yellow	4/$1	XC556	Yellow	4/$1			
SSL-22	RT	4/$1	XC526	Clear	4/$1	XC556	Orange	4/$1			
						XC556	Clear	7/$1			

INFRA-RED LED
¼ x ¼ x 1/16
Flat 5/$1.00

SALE DISPLAY LEDS SALE

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6680	Common Cathode-orange	.560	.79
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6710	Common Anode-red-D.D	.560	.79
MAN 3	Common Cathode-red	.125	4/$1	MAN 6730	Common Anode-red ±1	.560	.79
MAN 4	Common Cathode-red	.187	1.95	MAN 6740	Common Cathode-red-D.D	.560	.79
MAN 52	Common Anode-green	.300	1.00	MAN 6750	Common Cathode-red ±1	.560	.79
MAN 71	Common Anode-red	.300	1.25	MAN 6760	Common Anode-red	.560	.79
MAN 72	Common Anode-red	.300	.79	MAN 6780	Common Cathode-red	.560	.79
MAN 74	Common Cathode-red	.300	1.50	DL701	Common Anode-red ±1	.300	1.00
MAN 81	Common Anode-yellow	.300	.79	DL702	Common Cathode-red	.300	1.25
MAN 82	Common Anode-yellow	.300	.79	DL704	Common Cathode-red	.300	.99
MAN 84	Common Cathode-yellow	.300	.79	DL707	Common Anode-red	.300	.99
MAN 3620	Common Anode-orange	.300	.79	DL741	Common Anode-red	.600	1.49
MAN 3630	Common Anode-orange ±1	.300	1.35	DL746	Common Anode-red ±1	.630	1.95
MAN 3640	Common Cathode-orange	.300	.79	DL747	Common Anode-red	.600	1.49
MAN 4610	Common Anode-orange	.300	.79	DL749	Common Cathode-red ±1	.630	1.95
MAN 4640	Common Cathode-orange	.400	.79	DL750	Common Cathode-red	.600	1.49
MAN 4710	Common Anode-red ±1	.400	.79	DL338	Common Cathode-red	.110	3/1.00
MAN 4730	Common Anode-red	.400	1.00	FND70	Common Cathode (FND359)	.250	.69
MAN 4740	Common Cathode-red	.400	.79	FND503	Common Cathode (FND500)	.500	.99
MAN 4810	Common Anode-yellow	.400	1.00	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.79	5082-7300	4 x 7 Sgl. Digit-RHDP	.600	19.95
MAN 6630	Common Anode-orange	.560	.79	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6640	Common Cathode-orange-D.D.	.560	.79	5082-7304	Overrange character (±1)	.600	15.00
MAN 6650	Common Cathode-orange ±1	.560	.79	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50
MAN 6660	Common Anode-orange	.560	.79				

RCA LINEAR

CA3013	2.15	CA3082	2.00
CA3023	2.56	CA3083	1.60
CA3035	2.48	CA3086	.85
CA3039	1.35	CA3089	3.75
CA3046	1.30	CA3091	3.50
CA3053	1.50	CA3102	2.95
CA3059	3.25	CA3123	2.15
CA3060	3.25	CA3130	1.39
CA3080	.85	CA3140	1.25
CA3081	2.00	CA3401	.49
		CA3600	1.75

EXAR

XR-2206KB Kit $19.95 | XR-2206KA Kit $14.95

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XR-1800P	3.20
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XR-2208	5.20

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XR-556CP	1.85
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XR-2240CP	4.80

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XR-215	6.60
XR-567CP	1.95
XR-567CT	1.70

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

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

SOLDERTAIL STANDARD (TIN)

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

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.30	.27	.24	24 pin	$.70	.63	.57
14 pin	.35	.32	.29	28 pin	1.10	1.00	.90
16 pin	.38	.35	.32	36 pin	1.75	1.40	1.26
18 pin	.52	.47	.43	40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.40	.38	.35	22 pin	.95	.85	.75
10 pin	.45	.41	.37	24 pin	$1.05	.95	.85
14 pin	.39	.38	.37	28 pin	1.40	1.25	1.10
16 pin	.43	.42	.41	36 pin	1.59	1.45	1.30
18 pin	.75	.68	.62	40 pin	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 ea	10 OHM, 27 OHM	12 OHM, 33 OHM	15 OHM, 39 OHM	18 OHM, 47 OHM	22 OHM, 56 OHM	1/4 WATT 5%	50 PCS.
ASST. 2	5 ea.	68 OHM, 180 OHM	82 OHM, 220 OHM	100 OHM, 270 OHM	120 OHM, 330 OHM	150 OHM, 390 OHM	1/4 WATT 5%	50 PCS.
ASST. 3	5 ea.	470 OHM, 1.2K	560 OHM, 1.5K	680 OHM, 1.8K	820 OHM, 2.2K	1K, 2.7K	1/4 WATT 5%	50 PCS.
ASST. 4	5 ea.	3.3K, 8.2K	3.9K, 10K	4.7K, 12K	5.6K, 15K	6.8K, 18K	1/4 WATT 5%	50 PCS.
ASST. 5	5 ea.	22K, 56K	27K, 68K	33K, 82K	39K, 100K	47K, 120K	1/4 WATT 5%	50 PCS.
ASST. 6	5 ea.	150K, 390K	180K, 470K	220K, 560K	270K, 680K	330K, 820K	1/4 WATT 5%	50 PCS.
ASST. 7	5 ea.	1M, 2.7M	1.2M, 3.3M	1.5M, 3.9M	1.8M, 4.7M	2.2M, 5.6M	1/4 WATT 5%	50 PCS.

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- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped wire.

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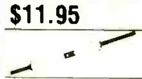

WIRE WRAP TOOL WSU-30

WRAP • STRIP • UNWRAP - $5.95

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25 ft. min. $1.25 50 ft. $1.95 100 ft. $2.95 1000 ft. $15.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

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- Cuts wire to desired length
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Specify blue, yellow, white or red **$1.98/spool**

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SW7416	2.20	19.00	180.00	SW7486	2.20	19.00	180.00
SW7417	2.20	19.00	180.00	SW7491	3.50	31.00	300.00
SW7420	1.30	11.00	100.00	SW7494	3.50	31.00	300.00
SW7423	2.20	19.00	180.00	SW7495	3.50	31.00	300.00
SW7425	1.70	14.00	130.00	SW7496	3.50	31.00	300.00
SW7427	1.50	12.00	110.00	SW74100	6.90	66.00	650.00
SW7430	1.50	12.00	110.00	SW74104	2.20	19.00	180.00
SW7432	1.50	12.00	110.00	SW74105	2.20	19.00	180.00
SW7437	1.50	12.00	110.00	SW74107	2.20	19.00	180.00
SW7438	1.50	12.00	110.00	SW74121	2.20	19.00	180.00
SW7440	1.20	9.00	80.00	SW74123	2.50	22.00	200.00
SW7443	3.50	31.00	300.00	SW74145	5.50	51.00	500.00
SW7444	3.50	31.00	300.00	SW74150	6.90	66.00	650.00
SW7445	3.50	31.00	300.00	SW74151	3.50	31.00	300.00
SW7446	4.00	36.00	350.00	SW74153	4.00	36.00	350.00
SW7450	1.20	9.00	80.00	SW74156	4.00	36.00	350.00
SW7453	1.20	9.00	80.00	SW74180	4.50	41.00	400.00
SW7454	1.20	9.00	80.00	SW74181	9.90	96.00	950.00
SW7460	1.20	9.00	80.00	SW74182	4.50	41.00	400.00
SW7472	2.20	19.00	180.00	SW9601	2.50	22.00	200.00
SW7475	3.50	31.00	300.00	SW9602	4.90	44.00	430.00
SW7480	2.90	26.00	250.00				

Pre-tubed • No mixing or combining prices

TV GAME CHIP SET — $7.95

Includes AY-3-8500-1 Chip and 2.010 mhz crystal
(2.010 crystal — $.99 ea/AY-3-8500-1 Chip — $7.50 ea.)

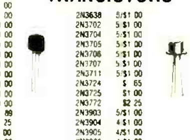
ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	8/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25m	20/1.00
1N5232	5.6	500m	.28	1N4734	5.6	1w	.28
1N5234	6.2	500m	.28	1N4735	6.2	1w	.28
1N5235	6.8	500m	.28	1N4736	6.8	1w	.28
1N5236	7.5	500m	.28	1N4738	8.2	1w	.28
1N456	25	40m	6/1.00	1N4742	12	1w	.28
1N458	150	7m	6/1.00	1N4744	15	1w	.28
1N485A	180	10m	6/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.50
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR	$1.95
C38M	35A @ 200V	SCR	1.95
2N2328	1.6A @ 200V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC	1.95

TRANSISTORS



MPS A05	.30			PN4250	4/$1.00
MPS A06	5/$1.00			2N4400	4/$1.00
2N918	4/$1.00			2N4401	4/$1.00
2N2219A	3/$1.00	2N3638	5/$1.00	2N4402	4/$1.00
2N2221	4/$1.00	2N3702	5/$1.00	2N4403	4/$1.00
2N2222A	5/$1.00	2N3704	5/$1.00	2N4409	5/$1.00
2N2369	5/$1.00	2N3705	5/$1.00	2N5086	4/$1.00
2N2369A	4/$1.00	2N3706	5/$1.00	2N5087	4/$1.00
2N2484	4/$1.00	2N3707	5/$1.00	2N5088	4/$1.00
2N2906A	4/$1.00	2N3711	5/$1.00	2N5089	4/$1.00
2N2907A	5/$1.00	2N3724	$.65	2N5129	5/$1.00
2N2925	5/$1.00	2N3725	$1.00	2N5138	5/$1.00
2N3035	2/$1.00	2N3772	$2.25	2N5139	5/$1.00
2N3055	$.89	2N3903	5/$1.00	2N5209	5/$1.00
MJE2955	$1.25	2N3904	4/$1.00	2N5210	5/$1.00
MJE3055	$1.00	2N3905	4/$1.00	2N5432	$2.00
2N3392	5/$1.00	2N3906	4/$1.00	2N5449	3/$1.00
2N3398	5/$1.00	2N4013	3/$1.00	2N5951	5/$1.00
PN3567	3/$1.00	2N4014	3/$1.00	C106B1SCR	2/$1.00
PN3568	4/$1.00	2N4123	6/$1.00	40409	$1.75
PN3569	4/$1.00	PN4249	4/$1.00	40410	$1.75

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.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	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.13	.10	1.0/16V	.15	.13	.10
4.7/25V	.16	.14	.12	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

SOCKET JUMPERS

Mates with two rows of .025" sq. or dia. posts on patterns of .100" centers and shielded receptacles. Probe access holes in back. Choice of 6" or 18" length.

Part No.	No. of Contacts	Length	Price
924003-18R	26	18"	$ 5.38 ea.
924003-06R	26	6"	4.78 ea.
924005-18R	40	18"	8.27 ea.
924005-06R	40	6"	7.33 ea.
924006-18R	50	18"	10.31 ea.
924006-06R	50	6"	9.15 ea.

JUMPER HEADERS

Solder to PC boards for instant plug-in access via socket-connector jumpers. .025" sq. posts. Choice of straight or right angle.

Part No.	No. of Posts	Angle	Price
923863-R	26	straight	$1.28 ea.
923873-R	26	right angle	1.52 ea.
923865-R	40	straight	1.94 ea.
923875-R	40	right angle	2.30 ea.
923866-R	50	straight	2.36 ea.
923876-R	50	right angle	2.82 ea.

INTRA-CONNECTOR

Provides both straight and right angle functions. Mates with standard .10" x .10" dual row connectors (i.e. 3m, Ainsley, etc.) Permits quick testing of inaccessible lines.

Part No.: 922576-26 **No. of contacts:** 26 **Price** $6.90 ea.

INTRA-SWITCH

Permits instant line-by-line switching for diagnostic or QA testing. Switches actuated with pencil or probe tip. Mates with standard .10" x .10" dual-row connectors. Low profile design. Switch buttons recessed to eliminate accidental switching

Part No.: IS-26 **No. of contacts:** 26 **Price** $13.80 ea.

CRYSTALS

THESE FREQUENCIES ONLY

Part #	Frequency	Case/Style	Price
CY1A	1.000 MHz	HC33/U	$5.95
CY2A	2.000 MHz	HC33/U	$5.95
CY2.01	2.010 MHz	HC33/U	$.99
CY3A	4.000 MHz	HC18/U	$4.95
CY7A	5.000 MHz	HC18/U	$4.95
CY12A	10.000 MHz	HC18/U	$4.95
CY14A	14.31818 MHz	HC18U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

CONNECTORS

PRINTED CIRCUIT EDGE-CARD

156 Spacing-Tin-Double Read-Out

Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)	$1.95
18/36	PINS (Solder Eyelet)	$2.49
22/44	PINS (Solder Eyelet)	$2.95
50/100A (.100 Spacing)	PINS (Wire Wrap)	$6.95

25 PIN-D SUBMINATURE (RS232)

DB25P	PLUG	$3.25
DB25S	SOCKET	$4.95
DB51226-1	COVER FOR 25S/25P	$1.75

LOTS OF POTS

Untested 3/8" square Spectrol Trimpots
Single-turn Printed Circuit Potentiometers

GB134	3 ea. of:	10-20-25-50 100-200-250-500 ohm	= 24 pcs.	$2.95
GB135	3 ea. of:	1K-2K-2.5K-5K 10K-20K-25K-50K	= 24 pcs.	$2.95
GB136	3 ea. of:	100K-200K-250K-500K 1Meg-2Meg-2.5Meg-5Meg	= 24 pcs.	$2.95

(Values subject to substitution within each group.)

EXTRA SAVINGS Buy all 3 (GB134, 135 & 136) for only $7.49

SWITCHES

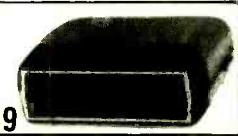
1/4" mounting holes

				1-9	10+
TOGGLE (sub-miniature)	JMT121	SPDT	on-off-on	$1.95	$1.43
	JMT123	SPDT	on-none-on	1.65	1.21
	JM1221	DPDT	on-off-on	2.55	1.87
	JM1223	DPDT	on-none-on	2.15	1.58
TOGGLE (Printed Circuit)	MPC121	SPDT	on-off-on	$2.05	$1.53
	MPC123	SPDT	on-none-on	1.75	1.31
	MPC221	DPDT	on-off-on	2.65	1.97
	MPC223	DPDT	on-none-on	2.25	1.68
PUSH BUTTON	PB123	SPDT	maintained	1.95	1.47
	PB126	SPDT	momentary	1.95	1.47
PUSH BUTTON Miniature	MS102	DPST	momentary open	.35	.30
	MS103	SPST	momentary closed	.35	.30
DIPSWITCH SPST	206-4	8 pin dip	4 switch	1.75	1.65
	206-7	14 pin dip	7 switch	1.95	1.85
	206-8	16 pin dip	8 switch	2.25	2.15

1/16 VECTOR BOARD

	0.1" Hole Spacing Part No	P-Pattern L	W	Price 1-9	10 up
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 062XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44 062WE	4.50	6.50	2.07	1.86
	84P44 062WE	4.50	8.50	2.56	2.31
	169P44 062WE	4.50	17.00	5.04	4.53
	169P84 062WE	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062WEC1	4.50	17.00	6.80	6.12

INSTRUMENT/ CLOCK CASE



Injection molded unit. Complete with red bezel 4½" x 4" x 1-9/16".

$3.49

MICROPROCESSOR COMPONENTS

8080A	CPU	$10.95	CDP1802	CPU	$19.95
8212	8 Bit Input/Output	4.95	MC6800	8 Bit MPU	19.95
8214	Priority Interrupt Control	7.95	MC6820	Periph. Interface Adapter	7.95
8216	Bi-Directional Bus Driver	4.95	MC6810AP1	128 x 8 Static RAM	5.95
8224	Clock Generator/Driver	5.95	MC6830L8	1024 x 8 Bit ROM	15.00
8228	System Controller Bus Driver	5.95	Z80	CPU	24.95

CPU'S

8080A	Super 8008	$10.95
2650	8 Bit MPU	26.50
P8085	CPU	29.95

SR'S

2504	1024 Dynamic	$ 3.95
2518	Hex 32 BIT	7.00
2519	Hex 40 BIT	4.00
2522	Dual 132 Bit SSR	2.95
2524	512 Dynamic	.99
2525	1024 Dynamic	3.00
2527	Dual 256 BIT	3.95
2529	Dual 512 BIT	4.00
2532	Quad 80 BIT	3.95
2533	1024 Static	5.95
3341	Fifo	6.95
74LS670	16 x 4 Reg	3.95

UART'S

AY-5-1013	30K Baud	$ 5.95

ROM'S

2513(2140)	Char. Gen.-upper case	$ 9.95
2513(3021)	Char. Gen.-lower case	9.95
2516	Char. Gen.	10.95
MM5230	2048 BIT (512 x 4 on 256 x 8)	1.95

MM5262	2K x 1	Dynamic RAM	3 for 1.00

RAM'S

1101	256 x 1	Static	$ 1.49
2101	256 x 4	Static	5.95
2102	1024 x 1	Static	1.75
2107/5280	4096 x 1	Dynamic	4.95
2111	256 x 4	Static	6.95
TMS4044-45NL	4K	Static	14.95
7489	16 x 4	Static	2.49
8101	256 x 4	Static	5.95
8111	256 x 4	Static	6.95
8599	16 x 4	Static	3.49
21L02/91L02	1024 x 1	Static	2.25
74200	256 x 1	Static	6.95
93421	256 x 1	Static	2.95
UPD414(2104)	4K	Dynamic 16 Pin	5.95
UPD416	16K	Dynamic	49.95

PROMS

1702A	2048	Famos	$ 5.95
5203	2048	Famos	14.95
82S23	32 x 8	Open C	5.00
82S123	32 x 8	Tristate	5.00
74S287	1024	Static	7.95
3601	256 x 4	Fast	3.95
2708	8K	Eprom	10.95
2716	16K	Eprom	29.95
6301-1	1024	Tri-State Bipolar	3.49
6330-1	256	Open Collector Bipolar	2.95

SPECIAL REQUESTED ITEMS

FCM3817	$5.00	11C90	19.95	7205	19.95	9368	3.95
AY-3-8500-1	7.50	4N33	3.95	ICM7045	24.95	LO110/111	25.00/set
AY-5-9100	17.50	8T20	7.50	ICM7207	7.50	95H90	11.95
AY-5-9200	14.95	8T97	2.00	ICM7208	22.00	MC3061P	3.50
AY-5-9500	4.95	HD0165	7.95	ICM7209	7.50	MC4016 (74416)	7.50
AY-5-2376	14.95	MCM6571	13.50	MK50240	17.50	MC1408L7	8.95
9374	1.95	MCM6574	13.50	DS0026CH	3.75	MC1408L8	9.95
82S115	25.00	MCM6575	13.50	TIL308	10.50	74C922	9.95

CLOCK CHIPS

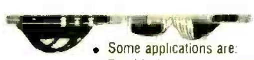
MM5309	$9.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5841	9.95
CT7001	5.95

PARATRONICS

Featured on February's Front Cover of Popular Electronics

Logic Analyzer Kit Model 100A

$229.00/kit



- Analyzes any type of digital system
- Checks data rates in excess of 8 million words per second
- Trouble shoot TTL, CMOS, DTL, RTL, Schottky and MOS families
- Displays 16 logic states up to 8 digits wide
- See ones and zeros displayed on your CRT, octal or hexadecimal format
- Tests circuits under actual operating conditions
- Easy to assemble — comes with step-by-step construction manual which includes 80 pages on logic analyzer operation.

(Model 100A Manual - $4.95)

- Some applications are:
  - Troubleshooting microprocessor address, instruction, and data flow
  - Examine contents of ROMS
  - Tracing operation of control logic
  - Checking counter and shift register operation
  - Monitoring I/O sequences
  - Verifying proper system operations during testing

PARATRONICS TRIGGER EXPANDER - Model 10

Adds 16 additional bits. Provides digital delay and qualification of input clock and 24-bit trigger word. — Connects direct to Model 100A for Integrated unit).

Model 10 Kit - $229.00
Baseplate — $9.95
Model 10 Manual — $4.95

B&K PRECISION 3½-Digit Portable DMM

- Overload Protected
- .3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv 1Va 0.1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage 0-1000V/ AC Voltage 0-1000V
Freq. Response 50-400 HZ
DC/AC Current 0-100mA
Resistance 0-10 meg ohm
Size 6.4" x 4.4" x 2"

Model 2800 $99.95

Comes with test leads, operating manual and spare fuse

Accessories:

AC Adapter BC-28	$9.00
Rechargeable Batteries BP-26	20.00
Carrying Case LC-28	7.50

CSC 100 MHz 8-Digit Counter

- 20 Hz-100 MHz Range
- .6" LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1.75" x 7.38" x 5.63"
- Four power souces, i.e. batteries, 110 or 220V with charger, 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95

ACCESSORIES FOR MAX 100:

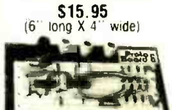
Mobile Charger Eliminator — use power from car battery — Model 100 — CLA $3.95

Charger/Eliminator — use 110 V AC — Model 100 — CAI $9.95

CONTINENTAL SPECIALTIES

PROTO BOARD 6

$15.95 (6" long X 4" wide)



Other CS Proto Boards

PB100 - 4.5" x 6"	$ 19.95
PB101 - 5.8" x 4.5"	29.95
PB102 - 7" x 4.5"	39.95
PB103 - 9" x 6"	59.95
PB104 - 9.5" x 8"	79.95
PB203 - 9.75 x 6½ x 2¾	80.00
PB203A - 9.75 x 6½ x 2¾	129.95

(includes power supply)

PROTO CLIPS

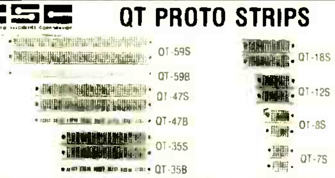
14 PIN	$4.50
16 PIN	4.75
24 PIN	8.50
40 PIN	13.75

DESIGN MATES

DM1 - Circuit Designer $69.95
DM2 - Function Generator $74.95
DM3 - RC Bridge $74.95

LOGIC MONITOR for DTL, HTL, TTL or CMOS Devices **$84.95**

CSC QT PROTO STRIPS



QT type	# holes	price
QT-59S	590	12.50
QT-59B	bus strip	2.50
QT-47S	470	10.00
QT-47B	bus strip	2.25
QT-35S	350	8.50
QT-35B	bus strip	2.00
QT-18S	180	4.75
QT-12S	120	3.75
QT-8S	80	3.25
QT-7S	70	3.00

Experimentor 300	$ 9.95
Experimentor 600	$10.95

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets - 25¢ — Send 35¢ Stamp for 1978 Catalog
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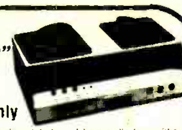
Advertised Prices Good Thru April

The Incredible "Pennywhistle 103"



$129.95 Kit Only

The **Pennywhistle 103** is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications for the deaf. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable)
Maximum Data Rate	300 Baud
Data Format	Asynchronous Serial (return to mark level required between each character)
Receive Channel Frequencies	2025 Hz for space 2225 Hz for mark
Transmit Channel Frequencies	Switch selectable Low (normal) 1070 space, 1270 mark High 2025 space, 2225 mark
Receive Sensitivity	-46 dbm accoustically coupled.
Transmit Level	-15 dbm nominal Adjustable from -6 dbm to -20 dbm
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar)
Power Requirements	120 VAC, single phase, 10 Watts
Physical	All components mount on a single 5" by 9" printed circuit board. All components included

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

The Original the 3rd Hand

$9.95 each

- Leaves two hands free for working
- Clamps on edge of bench, table or work bench
- Position board on angle or flat position for soldering or clipping
- Sturdy, aluminum construction for hobbyist, manufacturer or school rooms

DIGITAL STOPWATCH

- Bright 6 Digit LED Display
- Times to 59 minutes 59.59 seconds
- Crystal Controlled Time Base
- Three Stopwatches in One Times Single Event — Split & Taylor
- Size 4.5" x 2.15" x .90" (4½ ounces)
- Uses 3 Penlite Cells

Kit —	**$39.95**
Assembled —	**$49.95**
Heavy Duty Carry Case	**$5.95**
Stop Watch Chip Only (7205)	**$19.95**

IMC 3½ DIGIT DPM KIT

- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

Model KB500 DPM Kit	**$49.00**
Model 311D-5C-5V Power Kit	**$17.50**

JE700 CLOCK

The JE700 is a low cost digital clock, but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6" x 2½" x 1". It utilizes a MAN72 high brightness readout, and the MM5314 clock chip.

12 or 24 Hour

115 VAC

KIT ONLY **$16.95**

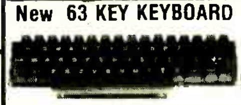
HEXADECIMAL ENCODER 19-KEY PAD

- 1 - 0
- ABCDEF
- Shift Key
- 2 Optional Keys

$10.95 each

New 63 KEY KEYBOARD

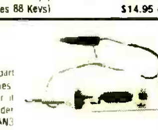
$29.95 IN STOCK



This keyboard features 63 unencoded SPST keys unattached to any kind of P.C.B. A very solid molded plastic 13" x 4" base suits most applications.

HD0165	Encoder Chip (encodes 16 Keys)	$7.95 ea.
AY-5-2376	Encoder Chip (encodes 88 Keys)	$14.95 ea.

JE803 PROBE

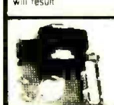


The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test, drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols (HI) 1 (LOW) 0 (PULSE) P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.

$9.95 Per Kit

printed circuit board

T²L 5V 1A Supply



This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware, for only **$9.95 Per Kit**

CIRCLE NO. 37 ON FREE INFORMATION CARD

S.D. COMPUTER PRODUCTS AN EMPIRE IND CO

P.O. BOX 28810D DALLAS, TEXAS 75228

64K FOR $995.00

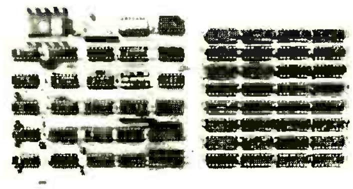
At last! The popular Expandoram is available in a 16k multiple version. Similar to our 32k Expandoram, the new Super Expandoram is offered in 16k, 32k; 48k and 64k. Low power devices mean the very lowest power consumption. Allow 3-4 weeks for delivery.

16K — $281.00 48K — $757.00
32K — $519.00 64K — $995.00

32K FOR $475 EXPANDORAM KIT 24K FOR $367.00

MEMORY CAPACITY
MEMORY ADDRESSING
MEMORY WRITE PROTECTION

8K, 16K, 24K, 32K using Mostek MK4115 with 8K boundaries and protection Utilizes DIP switches. PC board comes with sockets for 32K operation. Orders now being accepted. Allow 6 to 8 weeks for delivery.



INTERFACE CAPABILITY
Control, data and address inputs utilizes low power Schottky devices.

POWER REQUIREMENTS
+ 8VDC 400MA DC
+ 18VDC 400MA DC
— 18VDC 30MA DC

on board regulation is provided. On board (invisible) refresh is provided with no wait states or cycle stealing required.

MEMORY ACCESS TIME IS 375ns.
Memory Cycle Time is 500ns.

Buy an S100 compatible 8K Ram Board and upgrade the same board to a maximum of 32K in steps of 8K at your option by merely purchasing more ram chips from S.D. Sales! At a guaranteed price — Look at the features we have built into the board.

16K FOR $259.00 8K FOR $151.00

Z-80 CPU BOARD KIT — $139.

CHECK THE ADVANCED FEATURES OF OUR Z—80 CPU BOARD. Expanded set of 158 instructions, 8080A software capability, operation from a single 5VDC power supply, always stops on an M1 state, true sync generated on card (a real plus feature!), dynamic refresh and NMI available, either 2MHZ or 4MHZ operation, quality double sided plated through PC board, parts plus sockets priced for all IC's. *Add $10 extra for Z—80A chip which allows 4MHZ operation.

Z—80 chip with Manual — 29.95

S.D. SALES NEW EXPANDABLE EPROM BOARD

16K or 32K EPROM **$49.95 w/out EPROM**

Allows you to use either 2708's for 16K of Eprom or 2716's for 32K of Eprom.

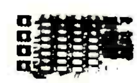
KIT FEATURES:

1. All address lines & data lines buffered.
2. Quality plated through P.C. Board, including solder mask and silk screen.
3. Selectable wait states.
4. On board regulation provided.
5. All sockets provided w/board.

WE CAN SUPPLY 450ns 2708's AT $11.95 WHEN PURCHASED WITH BOARD.

4K LOW POWER RAM KIT

Fully Buffered — on board regulated — reduced power consumption utilizing low power 21L02 — 1 500ns RAMS — Sockets provided for all IC's. Quality plated through PC board. *Add $10 for 250ns RAM operation



The Whole Works - $79.95

8K LOW POWER RAM — $159.95

Fully assembled and tested. Not a kit. Imsai — Altair — S-100 Buss compatible, uses low power static 21L02-500ns fully buffered on board regulated, quality plated through PC board, including solder mask, 8 pos. dip switches for address select.

250 ns Operation $189.95

6 DIGIT ALARM CLOCK KIT

Features: Litronix dual 1/2'' displays, Mostek 50250 super clock chip, single I.C. segment driver, SCR digit drivers. Kit includes all necessary parts (except case). Xfmr optional. Eliminate the hassle.

AC XFMR — **$1.50 Case $3.50** **$12.95**

Bowmar 4 Digit LED Readout Array
Full ½'' Litronix Jumbo Dual Digit LED Displays

4 JUMBO .50'' DIGITS ON ONE STICK!
WITH COLONS & AM/PM INDICATOR
$3.95

DL 722 - C.C.	DL 728 - C.C.
DL 721 8 C.A.	DL 727 - C.A.
99c	$1.29

NEW FROM S.D.

"VERSAFLOPPY"™ KIT

THE VERSATILE FLOPPY DISK CONTROLLER

ONLY $149.00

Features: IBM 3740 Soft Sectored Compatible. S-100 BNS Compatible for Z-80 or 8080. Controls up to 4 Drives (single or double sided). Directly controls the following drives:

1. Shugart SA400/450 Mini Floppy.
2. Shugart SA800/850 Standard Floppy.
3. PERSCI 70 and 277.
4. MFE 700/750.
5. CDC 9404/9406.

34 Pin Connector for Mini Floppy. 50 Pin Connector for Standard Floppy. Operates with modified CP/M operating system and C-Basic Compiler.

The new "Versafloppy" from S.D. Computer Products provides complete control for many of the available Floppy Disk Drives, Both Mini and Full Size. At the heart of "Versafloppy" is the powerful Western Digital FD1771B-1 Single Density Controller Chip. This allows a great flexibility via Control Software. Listings for Control Software are ncluded in the price.

FD 1771B-1 CHIP ALONE $39.95

Low Cost Cassette Interface Kit

Features: Play and record K.C. Standard 2400/1200 Hz tapes. 300 Baud. TTL I/O Compatible. Phase Lock Loop. Both 22 Pin Connector and 8 Pin Molex Connector. Comes partially assembled. Oscillator and phase lock loop pre-tuned to K.C. Standard. Selector switch sends cassette data or auxiliary Input data to microprocessor. LED Indicates logic 1 level.

$19.95

Jumbo LED Car Clock Kit

FEATURES:

A. Bowmar Jumbo .5 inch LED array
B. MOSTEK — 50250 — Super clock chip.
C. On board precision crystal time base
D. 12 or 24 hour Real Time format.
E. Perfect for cars, boats, vans, etc.
F. PC board and all parts (less case) inc.

Alarm option — $1.50
AC XFMR — $1.50

$16.95

RAMS

21L02 500NS	8 11.50
21L02 250NS	8 15.95
2114 — 4K	14.95
1101A — 256	8/$4.00
1103 — 1K	.35
MK 4115 8K	15.45
74S 200 256	3.95

CPU's

Z—80 includes manual	29.95
Z—80A includes manual	34.95
8080A CPU 8 BIT	11.95
8008 CPU 8 BIT	6.95

PROMS

1702A - 1K - 1.5us	3.95 or 10/35.
2708 - 8K - 450ns	14.95
5204 - 4K	7.95
82S129 — 1K	2.50
2708U 8K signetics 650ns	9.95

COUNTER CHIPS

MK50397 6 Digit elapsed timer	8.95
MK50250 Alarm clock	4.99
MK50380 Alarm chip	2.95
MK50395 6 digit up/dn. count.	12.95
MK5002 4 digit counter	8.95
MK5021-Cal. chip sq. root	2.50

★ ★ ★ ★SUPER FLOPPY SPECIAL★ ★ ★ ★

S. D. SALES,' VERSAFLOPPY S-100 CONTROLLER BOARD PLUS SHUGART SA 400 FLOPPY DISK DRIVE INCLUDING CABLE FOR ONLY

$479.00

MICRO-DIP $1.95

New — Series 2300
The World's Smallest
Coded BCD Dual-In-Line
Switch! PC Mount
2300 02G BCD 1-2-4-8
2300 12G BCD 1-2-4-8
Compliment

★ ★ JOY STICKS★ ★

FOUR 100 K-OHMS POTS

Ideal for electronic games

$3.95

Z-80 Programming Manual

IN DEPTH DETAIL OF THE Z-80 CPU MICRO-COMPUTER
S. D. SALES SPECIAL
$9.95

Thermistors 1.5K ohm	5/$1.00
Tantalum Caps 1 mfd. 20VOC P.C. Leads	15/$1.00
Flat Pack IC Assort.	20/$1.00
Electrical Coil 13T Type C - 10T Type C	12/$1.00
2 Transistor Audio	8/$1.00
Trimmer Pots 10K, 20K, 25K, Mini	10/$1.00
Disc Caps For Bypass .01 mfg - 100 WUDC PC Leads	40/$1.00
New Cambion Jacks Part #450-4352 Gold Plated	50/$1.00

Silicon Rectifier Special 1N4007. 1 amp 1000 PN.	10/$1.00
Photocell Assortment	12/$1.00
Plastic Readout Filters Amber	6/$1.00
Disc Cap Assortment	60/$1.00
P.C. Lead Diodes 1N4148 1N 914	100/$2.00
1N4002-1A-100 PN	40/$1.00
MICA Trimmer PC402 Miniature 1.5-20 P.C. P.C. Mount	4/$1.00
Resistor Special 22 ohm Carbon Comp.	25/$1.00
Resistor Assortment 1/4 W 5% & 10% PC leads	200/$1.50

CHOOSE $1. FREE MERCHANDISE FROM ASTERISK ITEMS ON EACH $15 ORDER

MICROPROCESSOR CHIPS

8212 - I/O port	3.50
8214 — P.I.C.	12.95
8216 — Non Invert Bus	4.95
8224 — Clock Gen.	4.95
8226 — Invert Bus	3.95
PIO for Z—80	14.95
CTC for Z—80	14.95
8228 Sys. Controller	8.20
8251 Prog. comm. interfact	10.95
8255 prog. prep. interface	13.50
8820 Dual Line Recr	1.75
8830 Dual Line Dr.	1.75
2513 Char. Gen.	7.50
8838 Quad Bus. Recvr.	2.00
74LS138N — 1/8 decoder	.99
8T97-Hex Tri-State Buffer	1.25
1488/1489 RS232	1.50
TR 1602B Uart	3.95
TR 1863 Uart	8.50
FD 1771B-1	39.95

CMOS

4001	19	4029	99
4002	19	4042	69
4011	19	4047	1.50
4013	32	4049	35
4016	32	4069	23
4017	95	4071	19
4020	97	4076	97
4022	97	14518	1.10
4024	75	14528	85
4027	39	14529	85

CALL IN YOUR BANKAMERICARD (VISA) OR MASTER CHARGE ORDER IN ON OUR CONTINENTAL TOLL FREE WATTS LINE:

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DEALER INQUIRIES INVITED!

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NO COD's. TEXAS RESIDENTS ADD 5% SALES TAX. ADD 5% OF ORDER FOR POSTAGE & HANDLING. ORDERS UNDER $10. ADD 75c HANDLING. FOREIGN ORDERS — U. S. FUNDS ONLY!

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RADIO HUT

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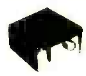
Use Our Toll Free Watts Line
For Master Charge and BankAmericard Orders

VISA

master charge

VARIABLE POWER SUPPLY KIT NO. 1 ONLY $10.95

- Continuously variable from 5V to 20V
- Excellent regulation up to ½ Amp
- Kit includes all components
- Drilled fiberglass P.C. Board
- Case included
- 4400 Mfd of filtering
- One hour assembly



VARIABLE POWER SUPPLY KIT NO. 2

Same as above but with a 1 Amp output, also with case
ONLY $13.95

This model will power a 5 watt transistorized CB Radio

LOOK AT THIS SPECIAL FROM RADIO HUT

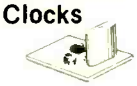
- Power Supply Kit 5V1 amp reg
- Line regulation .005%
- Load regulation 50mV

Kit includes components, PC board, transformer, fuse and pilot light. Line cord not included.

Only $6.50

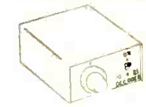
60 Hz. Crystal Time Base for Digital Clocks

$4.50
Buy 2 for $8.



A 60 Hz output with accuracy comparable to a digital watch
B Directly interfaces with all MOS clock chips
C Super low power consumption (1 5 ma type.)
D Uses latest MOS 17 stage divider IC
E Eliminates forever the problem of AC line glitches
F Perfect for cars, boats, campers, or even for portable clocks at ham field days
G Small size, can be used in existing enclosures.
KIT INCLUDES CRYSTAL, DIVIDER IC, P C BOARD PLUS ALL NECESSARY PARTS & SPECS

UNSCRAMBLER



$19.95

Plugs into earphone or external speaker of any Scanner or Monitor. Guaranteed to unscramble any 1085 call.

- Easily tuned
- Full instruction included
- Drilled fiberglass P.C. Board
- One Hour Assembly
- Punched Case

7400 TTL DIGITAL CIRCUITS

7400	11	7430	13	7480	31	74153	61
7401	13	7432	23	7481	.55	74154	98
7402	13	7433	.26	7482	.57	74155	89
7403	13	7437	23	7483	67	74156	89
7404	15	7438	23	7485	89	74157	55
74L04	29	7440	13	7489	1 25	74160	55
74S04	44	7441	76	7490	65	74161	65
7405	13	7442	47	7491	61	74163	65
7406	16	7443	59	7492	43	74164	85
7407	16	7444	59	7493	43	74165	89
7408	19	7446	68	7494	67	74174	85
7409	19	7447	68	7495	67	74175	85
7410	13	7448	71	7496	67	74180	67
7411	18	7450	13	74100	30	74181	1 93
7412	26	7451	13	74104	49	74182	68
7413	37	7453	13	74107	.28	74191	98
7416	15	7454	13	74109	31	74192	79
7420	13	7460	19	74121	29	74193	81
7421	13	7470	27	74123	48	74194	81
7423	25	7472	25	74132	99	74195	69
7425	29	7473	29	74136	99	9316	85
7426	.24	7474	29	745138	1.95	9601	3/$1
7427	19	7475	47	74141	75	9L04	.35
7428	.26	7476	31	74151	61		

74LS00 LOW POWER SCHOTTKY

74LS00	.21	74LS47	.73	74LS136	.37	74LS258	.71
74LS02	21	74LS51	.26	74LS138	71	74LS260	.26
74LS03	21	74LS54	26	74LS139	71	74LS266	26
74LS04	28	74LS55	26	74LS145	1.00	74LS279	.55
74LS05	28	74LS73	35	74LS151	.70	74LS290	.75
74LS08	21	74LS74	35	74LS153	70	74LS293	61
74LS09	.28	74LS76	49	74LS155	69	74LS295	95
74LS10	.21	74LS83	.73	74LS156	70	74LS298	95
74LS11	21	74LS85	1.35	74LS157	75	74LS365	55
74LS13	45	74LS86	36	74LS158	71	74LS366	55
74LS14	99	74LS90	55	74LS160	85	74LS367	.55
74LS15	.26	74LS92	55	74LS161	85	74LS368	55
74LS20	24	74LS93	55	74LS162	85	74LS390	1 75
74LS21	28	74LS109	38	74LS163	85	74LS393	1.45
74LS22	28	74LS112	38	74LS164	1 49	74LS670	2.30
74LS26	.32	74LS113	38	74LS168	85	74LS192	.95
74LS27	32	74LS114	38	74LS169	85	74LS193	95
74LS30	26	74LS122	49	74LS170	1.69	74LS194	95
74LS32	32	74LS124	99	74LS173	1 10	74LS195	85
74LS37	32	74LS125	.47	74LS174	1 00	74LS196	85
74LS38	32	74LS126	47	74LS175	81	74LS197	85
74LS40	26	74LS132	79	74LS190	95	74LS251	85
74LS42	65	74LS133	.35	74LS191	95	74LS253	81
						74LS257	71

74H SERIES TTL

74H00	.18	74H21	.29	74H53	29	74H73	39
74H05	.29	74H40	29	74H61	25	74H74	.39
74H20	.29	74H50	.20	74H72	45		

CMOS

CD400	.19	CD4017	95	CD4040	1.00	CD4071	19
CD4001	.19	CD4018	95	CD4041	.69	CD4081	19
CD4002	19	CD4019	19	CD4042	.69	CD4507	35
CD4006	1 20	CD4020	97	CD4043	60	CD4508	2 80
CD4007	.19	CD4021	97	CD4044	60	CD4510	1 00
CD4009	.47	CD4022	97	CD4046	1.39	CD4512	1 10
CD4010	.39	CD4023	.19	CD4047	1 50	CD4516	79
CD4011	19	CD4024	75	CD4049	35	CD4518	1 10
CD4012	29	CD4025	19	CD4050	.39	CD4520	69
CD4013	.32	CD4027	.39	CD4051	1 19	CD4528	85
CD4014	.78	CD4028	85	CD4053	1.19	74C02	45
CD4015	78	CD4029	99	CD4056	1.15	74C04	32
CD4016	32	CD4030	35	CD4066	78	74C107	79

TTL SPECIAL!

9002/7400	10/1 00
9003/7410	10/1 00
9004/7420	10/1 00
9006/7460	6/1 00
9007/7430	10/1 00
9009/7440	10/1 00
9016/7404	8/1 00
9024/74109	3/1 00
9300/74195	3/1 00

9000 series parts prime from ITT Pin for Pin compatible with 7400 series

DTL

932	Dual 4 Input Buffer	8/$1
934	Dual 5 Input NAND Gate	10/$1
941	One Shot Multivibrator	5/$1
945	JK F/F	8/$1
946	Quad 11 Input Gate NAND/NOR	8/$1
948	JK F/F	8/$1
950	F/F	10/$1
951	One Shot Multivibrator	5/$1
1800	(see 934 above)	10/$1
1806	Quad 2 Input NAND Gate	10/$1
9093	Dual JK F/F	8/$1
9094	Dual JK F/F	8/$1
9097	Dual JK F/F	8/$1
9099	Dual JK F/F	8/$1
9109	Hex Inverter	7/$1
9110	Hex Inverter	7/$1
9112	Hex Inverter	7/$1
9601	One Shot	3/$1
9930	Dual 4 Input Ext NAND	8/$1
9932	Quad 2 Input NAND Buffer	8/$1
9945	RS F/F	8/$1
9946	Quad 2 Input NAND	8/$1
9949	Quad 2 Input NAND	8/$1
9951	Monostable Multivibrator	8/$1
9962	Triple 3 Input NAND	8/$1

ITT HIGH LEVEL LOGIC

301	Dual 5 Input NAND Gate	15
302	Quad 2 Input Buffer open collector	18
303	Quad 2 Input NAND Buffer	15
311	Master Slave F/F	18
312	Dual JK Flip Flop	18
321	Quad 2 Input NAND Gate	18
322	Dual 5 Input NAND Gate	15
323	Quad 2 Input NAND Gate	18
324	Quad 2 Input NAND Gate	18
325	Dual 2 Dual 3 Input NAND Gate	13
326	Dual 2 Dual 3 Input NAND Gate	13
331	Dual 5 Input Expander	13
332	Hex Inverter	18
333	Hex Inverter	18
334	Hex Inverter	18
335	Hex Inverter	18
342	Dual One Shot Multivibrator	25
343	Dual 4 Bit Comparator	22
370	Quad D Flip Flop	22
371	Decode Counter	30
372	Quad Ripple Counter	39
380	BCE to Decimal Decoder	39
381	BCD to Decimal Decoder	39

ITT LED DRIVERS

ITT 501 Quad Seg Dr	35
ITT 502 Hex Digit Dr.	49
ITT 503 Quad Seg. Dr.	49
ITT 506 Hex Digit Dr	49
ITT 508 8 Digit Dr	49
ITT 509 8 Seg Dr.	.49
ITT 511 Quad Seg Dr	55
ITT 514 8 Digit Dr	59

We have 100's of thousands of listed parts
These parts are 100% prime

DIODES

IN 4002 1 Amp 100 PIV	40/$1
IN 4004 1 Amp 400V	15/$1
IN 4007 1 Amp 1000V	10/$1

GERMANIUM DIODES

IN 54A	$8/$1
IN 270	10/$1

ZENER DIODES

IN 746 3.3V 400M	4/$1
IN 752 5.6V 400M	4/$1
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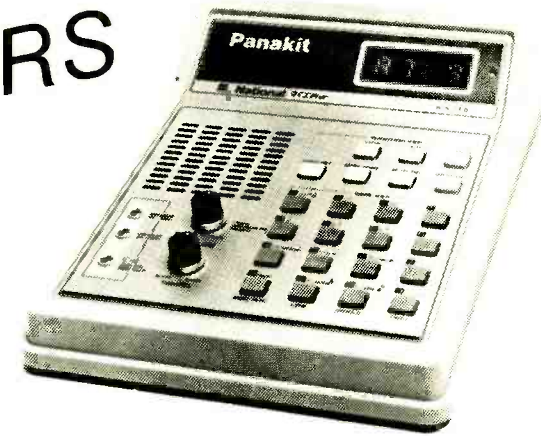

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OPERATION ASSIST

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Dumont oscilloscope, type 767. Service manual and horizontal time-base plug in. Larry Watson, Rt. 1, Box 180, Gadsden, AL 35901.

Telrad Frequency Standard Model 18A. Manufactured by **Fred E. Garner Co.**, Chicago. Circuitry needed. A.H. Ellis, 19 McClure Avenue, Brentford, Ontario, Can. N3R 4L7.

RCA TV model 8-PT-7030. Schematic and service data. P.J. Hughes, 1337 Weber Dr., Clearwater, FL 33516.

Standard Kollsman uhf converter model B, serial #59277. Schematic. Lynnie Gregory, Rt. 11, Box 211, Statesville, NC 28677.

Hickok model 610A TV-FM alignment generator. Tracy LaVere, Box 589 Garden Grove, CA 92642.

Hallicrafters model S-53A shortwave receiver. Schematic. R.C. Hartman, 2208 Bayberry St., Virginia Beach, VA 23451.

Conar Model 220 tube tester. Tube chart needed. Bob Swanberg, Box 96, Chelsea, MI 48118.

Tektronix model 511-AD oscilloscope. Manual and schematic. J.O. Dickinson, 1408 Monmouth Court West, Richmond, VA 23233.

Technics model RS-1030 US reel-to-reel tape deck. Service manual or schematic. Wallace Bonham, Box 94 Cape Girardeau, MO 63701.

Ross Electronics Corp cassette tape recorder, model #8282, serial #11404. Parts and schematic diagrams. A.T. Most, 4 Lanningan Drive, Lawrenceville, NJ 08648.

Webster WT-2 walkie-talkie. Need PTT switch or source of supply. Lamar Schwalke, P.O. Box 799, Florissant, MO 63033.

Hallicrafters Model S-36A. Operation manual or any available information. Chris Colson, 60 Deerhaven Place, Pleasant Hill, CA 94523.

Westinghouse model WR 226 3-band receiver. Schematic or service manual. Arthur Crough, RD 2, Bloody Pond Road, Lake George, NY 12845.

Hallicrafters model S-20-R "Sky Champion" receiver. All available information. J. Creasy, 824 Perry Highway, Apt. 15, Pittsburgh, PA 15229.

Roberts model 770X tape recorder. Service manual and/or schematic. Robert Fisher, 6536-14th St., Rio Linda, CA 95673.

Bell & Howell (DeVries Institute) Model 34 oscilloscope. Schematic and transformer voltage outputs or cross reference for replacement. Glenn T. Ozalan, 2220 NW Aspen, Portland, OR 97210.

Western Electric 25C amplifier. Specifications, schematic and parts list. W.Q. Cochran, 910 Townshipline, Chalfont, PA 18914.

Burroughs model C3100 electronic calculator. Schematic and repair information needed. C. Kline, 16 Old Farm Road, Barrington, IL 60010.

Allied Radio, Knight Star Roamer. Schematic and alignment procedure. M.F. Mattern, 1111 Warburton, Santa Clara, CA 95050.

Meisner phono disk recorder model #9-1065. **The Langevin Company** phono disk recorder, type 14A. Owners/operation manual and schematic for both units. D. Testa, Box 9064, Newark, NJ 07104.

Graymark model 506B two-band receiver. Schematic and manual. Henry M. Cantor, 21 Friendly Court, Babylon, NY 11702.

Hazeltine Neutrodyne receiver. Schematic or any available information. LeRoy Sampson, RR1, Radcliffe, IA 50230.

Superior Instruments tube tester model TV-11. Operating instructions. James Lewis, Box 6211, Tulsa, OK 74106.

Symphonic model TPS-5050, mini-TV. Need source of 3-inch picture tubes. Nicolas Dominquez, Ave. Pte., Tecamachalco No. 16, Mexico City, Mexico ZPIO.

Sears Model 9169 television receiver. Technical manual needed. W.A. Greenwood, 48 Third St., Leominster, MA 01453.

De Jur Model TK820 tape recorder. Mechanical, electrical

troubleshooting information, parts list. Walter Mesko, Box 210, Lake George, NY 12845.

Hallicrafters model S-38B shortwave receiver. Schematic and any available information. Ray Genest, 3175 Boul. Neilson, App. 3 Ste-Foy, Quebec 10, Can. G1W 2V7.

Morse color TV Model 7000. Service manual and parts list. J.C. Morall, 1000 Cottage Pl., Baldwin, NY 11510.

Webster-Chicago Model 80 wire recorder. Schematics and parts list, owner's manual. Mike Carey, Box 361, Highway 20, Madison, AL 35758.

Philco radio model 37-116, **Graybar** radio model 320, need chassis for both. **Philco** radio model #95, need cabinet. John Yeprad, Box 1457, Studio City, CA 91504.

Benson-Lehner Corp. digitizer "Pigmi" model. Need guide books and schmatics. W.E. Kelsey, Otter Pond Rd., New London, NH 03257.

Zenith Radio, model 770, chassis #1002204. Schematic and parts list. Ervin Thorson, RR5, Box 84 B, Marshville, IN 46151.

Edin Co., Inc. Electrocardiograph model 8023 serial #4526. Schematic or any source of information. Russell H. Miller, Jr., 3609A N. Front St., Harrisburg, PA 17110.

Patterson model PR-15 communications receiver. Schematics and service manual. E.W. Clede, 6811 Spring Forest, San Antonio, TX 78249.

Grundig TK 46 tape recorder. Owner's manual and schematic. A. Haddad, 125 Jameson Ave., #508, Toronto, Ontario, M6K 2X3 Can.

National HRO-60 General Coverage Communications Receiver. Operation manual. R. Dennis Gibbs, 9214 Venetian Way, Richmond, VA 23229.

RCA regulated power supply model WP-33P. Schematic and service information. Roger A. Leone, 136 Delta Circle, Valle Jo, CA 94590.

Satellite S20B Schematic and operation manual. Michael Unger, 183 S. Detroit St., Los Angeles, CA 90036.

Calbest Electronics, stereoplex model 6040 stereo receiver. Schematic and owner's manual. R.S. Dabe, 13400 Elsworth St., #39, Edgemont, CA 92508.

US Army R-5 receiver SN 20. Any information. George W. Anderson, 5317 Valonia St., Fair Oaks, CA 95628.

RCA model 6Q33 superheterodyne AM and shortwave receiver. Schematic or any available information. James Bias, Rt. 3, Box 175, Ridgeland, SC 29936.

Precision apparatus model #612 tube tester. Up-to-date roll. Ron Stanford, 8428 San Antonio Ave., South Gate, CA 90280.

Allied Radio Knight kit capacitor checker, kit #680. **Superior Instrument Company** multimeter model #670-A. **Jackson Dynamic** tube tester model 715. Manuals and schematics. W.L. Simpson, 370 Beagle Lane, Redding, CA 96001.

Hickok model 610A Universal Television FM alignment signal generator. Operation manual and schematic. Thomas E. Phillips, 404 E. Main St., West Newton, PA 15089.

RCA test oscillator WR-67A. Manual, schematic. W. Beale, Rt 1, Box 262A, Mechanicsville, MD 20659.

Omnitec model 701 acoustic coupler. Schematic. Ivan Berger, 215 W. 78th St., New York, NY 10024.

Precision Apparatus signal generator model E-200-C. Operating manual and schematics. Dan Williams, RD1, Stuyvesant, NY 12173.

Mitchell Industries, vhf navigator aircraft radio. Manuals, schematic. Dick Mayrand, 7 Maplewood, Rochester, NH 03867.

Weston vhf sweep generator model 984. Operating manual and schematic. Ron Patton, Country Ests. Pk-9B, Pratt, KS 67124.

Webcor 2712-1 tape recorder. Schematic and service data. Alfred E. Jordan, 897 E. Vine St., Salt Lake City, UT 84107.

Cathode-Ray oscillograph. Parts list and manual. Arthur Thompson, 26441 204 SE, Kent, WA 98031.

Triadex Muse electronic music computer. Schematic and service manual. Robert Stek, 19 Mayfield Rd., Regina, Saskatchewan, Can.

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General Radio, super MC-9, CB radio. Owner's manual, schematic or any available information. Nolly O. Byrd, 802 Spanish Ave., Pasagoula, MS 39567.

Flexowriter Model 2201-A. Schematics, any other information such as programming and interfacing. Jim Cooper, 651 Forest Ave., Paramus, NJ 07652.

National NC-120 manual or schematic. Adrian Hands, 7000 Whetstone, Alexandria, VA 22306.

Wurlitzer Juke Box model 1700 F. Service manual. Cliff Nadiger, 8073 Wonderlund Blvd., Redding, CA 96001.

Omnitec Model 800, portable terminal. Schematic. Stephen Karon, 601 Light St., Baltimore, MD 21230.

Kydo Electronics, Mypet 405 FM transceiver. Operation manual and schematics. Bill Cross, 3561 Milburn Ave., Baldwin, NY 11510.

RCA Model WO-33A oscilloscope. Operator's manual and schematic needed. Franklin B. Kovarik, 526 California Ave., E. Alton, IL 62024.

Hickok Model PS-503 power supply. Need owner's manual and/or schematic. S. Anderson 2020 N. 32 St. #112, Phoenix, AZ 85008.

RCA AR-88 receiver. Power transformer needed. Harold Donaldson, 8850 Phoenix Ave., Fair Oaks, CA.

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(Continued from page 115)

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Published by Electronic Music Laboratories, Box H, Vernon, CT 06066. 168 pages (8½" × 11"). $6.95 ($5.50 each for three or more) soft cover.

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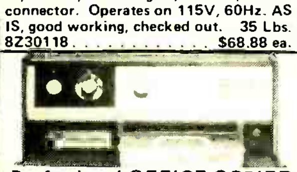

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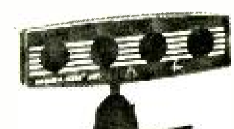

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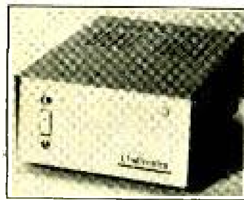

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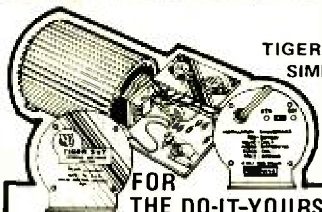

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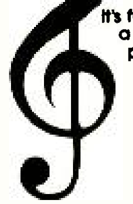

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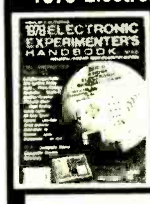

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ELECTRONICS WORLD® News Highlights in Brief

Creating Signature Profiles

The use of a person's signature as a means of identification may be furthered by the development at Sandia Laboratories of a special pen and tablet which sense three supposedly unique characteristics of a person's signature. In the pen are two piezoelectric bimorph bender elements, bonded along adjacent quadrants of a slightly flexible aluminum shaft. As a signature is written, one of these transducers generates a horizontal acceleration signal while the other detects vertical acceleration. A third set of signals is generated by pressure-sensitive transducers in the writing tablet. The three output signals, which have peak amplitudes on the order of one volt on each axis and require no biasing current or external power supply, can be processed by a computer and compared with a file record retrieved from the computer's memory. The signature verification system is expected to be useful in banks, department stores, and other institutions where personnel identification is required.

Ham Radio and Storm Spotting

The National Weather Service, which already has more than 200 weather stations and 51 storm detection radars linked by an extensive radio network, has also turned to Amateur Radio Service operators to fill some of the gaps in the reporting nets. Hams are already functioning efficiently as severe storm spotters and communicators for the NWS in the Tulsa, Okla., and Dallas-Fort Worth and Waco, Texas areas. Cooperation with hams in other tornado-prone areas of the U.S. is being developed. Interested amateurs in a particular area are contacted by the local Weather Service official and the spotting and communications needs are explained. Frequencies to be used (usually in the 2-meter band) are determined, and the system activation procedure is established. Persons interested in cooperating should request copies of the publication "Amateur Radio and the National Weather Service" to: Headquarters, Southern Region, National Weather Service, Rm. 10E09, Federal Office Bldg., Fort Worth, TX 76102.

FCC CB Slide Show

The Federal Communications Commission has produced a 10-minute cartoon slide-and-sound show about Citizens Band rules. The title is "10-4 Uncle Charlie," and it was developed to explain, in an entertaining format, the importance of the rules to the thousands of new operators who go on the air every month. The program includes 72 slides, a 10-minute audio tape cassette, a script and a question-and-answer sheet. Clubs, schools, and others interested in CB can purchase the show package for $15 (checks payable to the National Archives Trust Fund) from: National Audiovisual, Center General Services Administration, Order Section, Washington, DC 20409.

Record Awards for Good Sound

Record awards are based primarily on musical content—only secondarily on sound. The new Audio Excellence Record Awards, sponsered by Audio-Technica, are based primarily on sound. Winner in the rock/pop division was Stevie Wonder's "Songs in the Key of Life" (Tamla 13-340C2). In the classical division, the winner was "Caruso—A Legendary Performer" (RCA CRM1-1749). What garnered this sound-oriented award for a record based on masters more than 50 years old was a computer process that eliminated much of the original discs' surface noise and the resonances of the recording horns, giving Caruso's voice a more modern recorded quality. Among the factors for which the records were cited were: cleanliness of sound, instrumental and vocal balance, emphasis, dynamic range, frequency response, low noise, and stereo separation as well as dispersion.

Electronic Blackboard Transmits Data

The Bell System has developed a new blackboard, which, with the proper electronic equipment, can be used to transmit handwriting over phone lines for display on video monitors at distant locations. Used with a portable conference telephone equipped with microphones and a loudspeaker, the electronic blackboard can bring an instructor's entire presentation across the campus. The board consists of a rigid back layer and a front layer that is a thin sheet of black Mylar stretched tightly over the frame. The inner surfaces of both layers are electrically conductive and act as X-Y lines. Pressing the board with a piece of chalk registers a point at the intersection of the two axes. When the chalk is moved, a memory unit retains the dots so they blend together to form a line on the remote monitor. To erase, a device, normally resting on the control unit, is lifted so that the dot-by-dot process is reversed and the image is erased wherever pressure is applied.

Electronics in the Postal Service

If the U.S. Postal Service is to serve the public adequately and be competitive with other communications systems in the country, it is going to have to start using more electronic techniques. Such was the advice of a recent study by a Commission on Postal Service in its report to the Congress and the President. For example, the commission noted that it is now technologically possible, though not yet economically feasible, to transmit more than 50 percent of the entire volume of mail by electronic means. This is partially due to the fact that about 80 percent of first-class mail today is business-related—invoices, bills, payments, etc. The Electronic Funds Transfer systems are expected to handle 1.9 billion pieces of mail by 1980 and 6.56 billion by 1985, according to a study made by Arthur D. Little, Inc. Similarly, the Treasury Department is expanding its system of direct deposit of payments in many categories.

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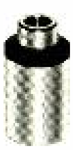

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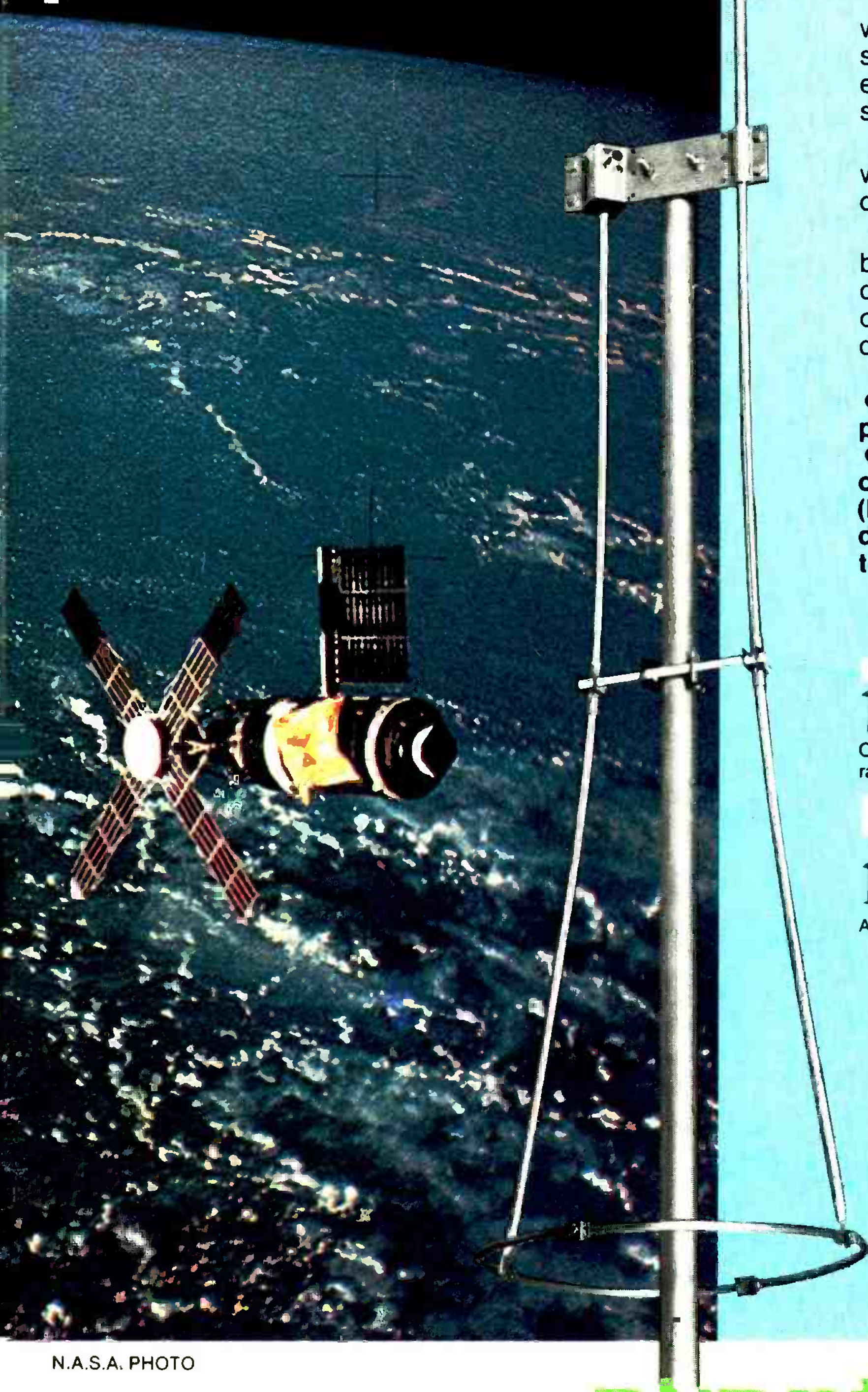

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CO·INDUCTIVE design of this patented antenna gives long range, noise free performance.

The result of years of research & development, the ASTRO PLANE has top radiation which means that your signal gets out from the highest part of your antenna. Your signal radiates about 15 feet higher than with other antennas which radiate near the bottom.

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The ASTRO PLANE has 4.46 db gain over isotropic which gives you a stronger signal and better, clearer reception.

You'll get long lasting, trouble free performance because it is compact in design — without long drooping radials, without coils to burn or short out, and with direct ground construction to help dissipate static charges and lightning.

• Stainless steel radials concentrate signal power on top • Rigid heavy-duty aluminum tubing • No long drooping radials to ice up or break off • So unique it's backed by a U.S. patent (Patent #3587109) • No coils to burn out or detune • Easy assembly • Lightweight — easy to install on simple pipe mast

Ordinary collinear or ground plane antenna signals are blocked...they radiate from the bottom.

ASTRO PLANE gets its signal over obstacles...it radiates from the top.

SPECIFICATIONS

Total Length — 12 feet	Vertical Polarity
Weight — 4 lbs.	Aircraft Quality Aluminum
Power Gain — 4.46 db	SWR — Pre-tuned — Less than 1.2:1
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