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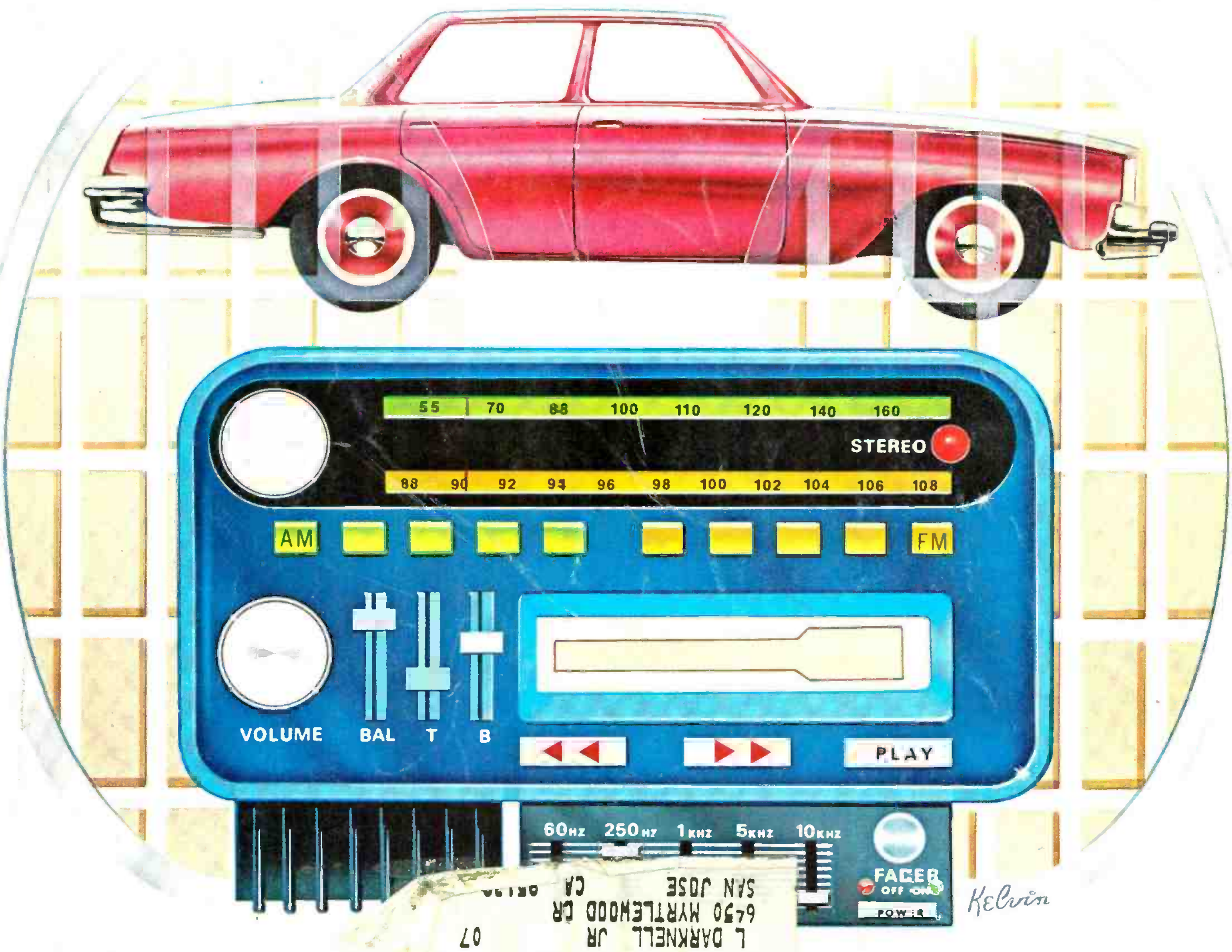

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Tes
In This
Issue

New Quartz-Lock System
Infinity Speaker—New Induction Tweeter
Hafler Preamplifier—New Equalization Circuit

COBRA RE-INVENTS THE REMOTE CB.

The first remote CBs were nothing more than a CB transceiver that you locked in your trunk and an oversized mike that could barely fit in your hand.

Such was the state of the art when the first remotes were introduced. Which was why Cobra spent till now improving the state of the art.

Introducing the result. The Cobra 62XLR. Small enough to go under the seat or on the firewall as well as in the trunk. Strong enough to take the bounces and jolts those early remotes couldn't. Powerful enough to punch through loud and clear.

The receiver has automatic gain control, switchable noise limiting, plus Dual-Gate Mosfet and Monolithic Crystal Filter to keep interference to a minimum. So the voice you hear always comes through loud and clear.

The streamlined mike puts all the controls at your fingertips. Speaker, channel selector and squelch are built right in. So there's no fiddling around while you're driving around.

And with Cobra's reputation for building them right and our nationwide network of Service Centers making sure they stay that way, you can be pretty sure that nobody's ever going to improve on the 62XLR.

Cobra may not have been the first to make a remote. But we were the first to do it right.

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fact:
the IV does more... *much more!*

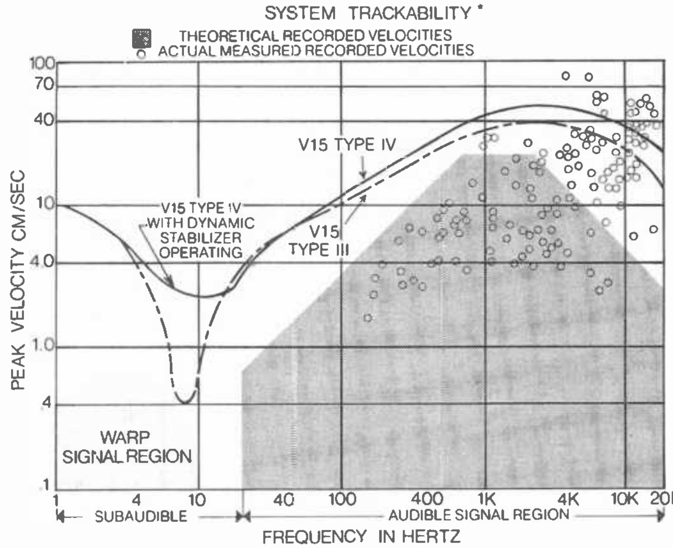
The creation of the new V15 Type IV is a tour de force in innovative engineering. The challenge was to design a cartridge that would transcend all existing cartridges in musical transparency, technical excellence, and uniformity. The unprecedented research and design disciplines that were brought to bear on this challenge over a period of several years have resulted in an altogether new pickup system that exceeds previous performance levels by a significant degree—not merely in one parameter, but in totality.

In fact, this pickup system has prevailed simultaneously over several extremely difficult music re-creation problems which, until now, have defied practical solutions. Most of all, this is an eminently musical cartridge which is a delight to the critical ear, regardless of program material or the rigorous demands of today's most technically advanced recordings.

THE V15 TYPE IV OFFERS:

- Demonstrably improved trackability across the entire audible spectrum—especially in the critical mid- and high-frequency areas.

SYSTEM TRACKABILITY*



*Cartridge-tone arm system trackability as mounted in SME 3009 tone arm at 1 gram tracking force.

- Dynamically stabilized tracking overcomes record-warp caused problems, such as fluctuating tracking force, varying tracking angle and wow.
- Electrostatic neutralization of the record surface minimizes three separate problems: static discharge; electrostatic attraction of the cartridge to the record; and attraction of dust to the record.
- An effective dust and lint removal system.
- A Hyperelliptical stylus tip configuration dramatically reduces both harmonic and intermodulation distortion.
- Ultra-flat response—individually tested to within ± 1 dB.
- Lowered effective mass of moving system results in reduced dynamic mechanical impedance for superb performance at ultra-light tracking forces.

For more information on this remarkable new cartridge, write for the V15 Type IV Product Brochure (ask for AL569), and read for yourself how far Shure research and development has advanced the state of the art.

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JULY 1978

Popular Electronics®

VOLUME 14, NUMBER 1

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

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- PERSONAL COMPUTERS FOR SMALL BUSINESSES
- BUILD A DIGITAL DARK-ROOM TIMER

TEST REPORTS:
Realistic Optimus 10 Speaker System
Pioneer of America Car Stereo FM/AM Receiver
Leader Dual-Trace Oscilloscope
Motorola CM-550 Mobile AM/SSB CB Transceiver

Cover Art by George Kelvin

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Editorial

THE ELECTRONIC CURSE!

An editor from *New York* magazine telephoned me today and said, "I'm calling you because I'm doing a feature story on laziness." Allowing me a few seconds to recover from that opening line, she asked if I know anyone locally whose home is equipped to do most anything at the push of a button or on voice command.

Have our electronic servants made us lazy, as some people seem to believe? I think not, in the true sense of the word. But others may view this differently.

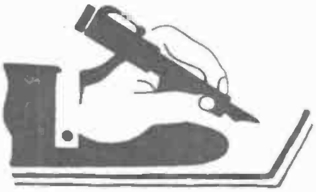
Many Japanese, for example, feel that some electronic aids can make a person sluggish, physically or mentally. That's one reason why the use of the abacus or *soroban* is so widespread in Japan (some 25 million Japanese use this device today). Interestingly, the abacus is considered to be a valuable aid for increasing one's mental alertness. Of course, the Japanese haven't forsaken electronic calculators. They've simply added a mechanical device to their ownership of an electronic product, much as many Americans use bicycles as well as automobiles.

The importance that such mental-alertness training holds for the Japanese is underscored by the abacus instruction given every year to some two million elementary school students. Furthermore, abacus instruction is mandatory for business administration students (about 300,000), and more than 300,000 Japanese are enrolled in *special* abacus schools. Every year, 1½ million Japanese take exams in the use of the abacus to get a degree in proficiency level. Sort of a "black belt" in abacus. Local abacus contests are held in Japan, with winners competing in an annual *soroban* contest.

Primitive product or not (the abacus pre-dates Christ), tests prove that experienced abacus users can match the speed of electronic calculator users for addition, subtraction, division and multiplication. More important, though, Japanese company spokesmen claim that the mental exercise garnered by using an abacus develops a cerebral agility that is beneficial in business. Abacus users are said to be able to figure out customers' change in their heads with amazing speed and accuracy, for example; at Hitachi, Ltd., computer key punch operators are chosen on the basis of abacus proficiency, etc. To see how you fare against a skilled abacus user, time yourself with an electronic calculator for answers to 30 problems at the level of 8546 × 38. (A recent 18-year-old soroban champion required only 1½ minutes on an abacus to solve 30 such calculations when he entered high school.)

I'm not suggesting that one forget about using an electronic calculator, of course. But in line with electronics being a possible curse in some respects, let's not forget the basics of creating and assembling these and other electronic devices. How you approach this makes the difference between a kit builder and an electronics experimenter. There's nothing wrong with the former, but to really learn about electronics, don't forget the latter! And in response to those people who think that electronics makes one lazy, electronics enthusiasts all know that it takes considerable work (and knowledge) to assemble or design electronic equipment so that we *can* take it easy.

Art Salsberg



Letters

"ROAOMATE" REVISITED

With reference to the "Roadmate" CB converter featured in the October 1976 issue of POPULAR ELECTRONICS, an r-f signal can leak from the antenna through *C1, R6, and LED1* to the power system of the vehicle. Moreover, r-f noise from the ignition system can enter the converter via the opposite path. Addition of a 10-mH miniature choke in series with *R6* will overcome this problem and result in a noticeably higher S/N for the converter. *—Mark W. Fleming, Watertown, MA.*

GETTING THE NAME STRAIGHT

Although the article "How to Upgrade a Basic ELF Microcomputer" (February 1978) appears to be technically sound and proficiently written, the contention that "Feelin' Groovy" was penned by *Neil* Simon looks very odd. The author of "Feelin' Groovy" is *Paul* Simon. *—Donald L. Wallace, Dayton, OH.*

UFO RESEARCHER

Having researched the UFO (unidentified flying object) controversy for the past 21 years, I read with interest "Investigating UFO's and Other Magnetic Phenomena" (May 1978). I am very pleased to see some fresh material on the subject. Author George Lawrence's UFO article was most informative. *—Hayden C. Hewes, Director, International UFO Bureau, Inc., Edmond, OK.*

GREAT TUTORIAL

Thanks for the great article on "How to Design Power Supplies" in the April 1978 issue. It was one of the best tutorial articles on electronics I have ever seen. It combined clearly presented theoretical material, good practical examples (including diagrams and pictures), and practical suggestions for determining values for a given component. *—Charles Ragland, San Francisco, CA.*

ELF USER'S GROUP

I am certain that many POPULAR ELECTRONICS readers will be interested to know that we are forming a COSMAC-1802 User's Group for hobbyists who have any of the Elf versions available, including VIP, Infinite, and other 1802-based microcomputers. We will be corresponding, exchanging software and ideas, etc. Membership is free. Interested readers, please write directly to: Patrick Kelly, Box 7162, Los Angeles, CA 90022.

A COMPONENT CHANGE

With reference to the "Real-Time ½-Octave Analyzer" that appeared in the September and October 1977 issues of POPULAR ELECTRONICS, please be advised that there has been a component substitution. An SN76502 was originally specified for *IC36*. This particular IC has been discontinued. The new part number is TL4441CN.

Also, Table I in the article had two errors in it. The filter capacitors should be labelled *C8* and *C28* (not *C9* and *C29*) and should be 0.068 µF (not 0.047-µF). *—Richard Marsh*

Out of Tune

In "Microprocessor Microcourse, Part 2" (April 1978) the Q and $\bar{Q}$ outputs of the flip-flop in Fig. 13 should be transposed.

In "Elf II ROM Monitor" (March 1978) the connection to pin 17 of a 2102 in Fig. 1 should be to a 2101.

In "How to Design and Build Power Supplies, Part I" (April 1978), on page 43 under "Filters," the second paragraph should read ". . . the higher frequency of the *full-wave* rectifier's output is easier to filter." Also the last sentence under the "Filters" heading should read 8000 µF—not 8000 pF.

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Many important articles covering a variety of interests in the broad field of electronics are published in POPULAR ELECTRONICS. Reprints of selected articles and test reports are now available in the event that you missed some you would like to have for reference or study purposes—or for projects you wish to build. Reprints are only $1 each, 75¢ for those marked with an asterisk, $1.50 for those noted. Minimum order is $3.

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40874*MXR Stereo Graphic Equalizer
40875*Nakamichi Model 500 Stereo Cassette Deck
40876 Onkyo Model TX-4500 AM/Stereo FM Receiver
40877*Ortofon MC20 Moving Coil Phono Cartridge
40878*Pickering Model XV-15/625E Stereo Phono Cartridge
40879 Pioneer Model CT-F8282 Stereo Cassette Deck
40880 Radio Shack "Realistic" Model STA-2000 AM/Stereo FM Receiver
40881 Rotel RX-7707 AM/Stereo FM Receiver
40882 Sansui Model TU-9900 AM/Stereo FM Tuner
40883*Shure Model M24H Stereo Phono Cartridge
40884*Sony Model TA-4650 V-FET Stereo Power Amplifier
40885*Spectro Acoustics Model 210 Stereo Graphic Equalizer
40886*Stanton Model 681EEE Stereo Phono Cartridge
40887 Teac Model PC-10 Portable Stereo Cassette Deck
40888*Technics Model SB-6000A Linear Phase Speaker System
40889*Thorens Model TD-126C Record Player
✓40969*Akai Model GX-270D-SS Four-Channel Tape Recorder
✓40970 Speakerlab Model S7 Speaker System Kit
✓40972*Dual Model 1245 Automatic Turntable
✓40973*Burwen Model DNF 1201A Noise Reducer System

COMMUNICATIONS

40890*Cobra Model 29XLR 40-Ch. AM CB Mobile Transceiver
40891*Drake Model SSR-1 AM/SSB Communications Receiver
40892*Kenwood Model TS-820 Amateur Radio Transceiver
40893*Kris Model XL-50 40-Ch. AM CB Mobile Transceiver
40894*President Model "Washington" 40-Ch. AM/SSB CB Base Station
40895 Yaesu Model FRG-7 AM/SSB Communications Receiver
40971*General Electric Model 3-5825 AM/SSB CB Transceiver
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New Products

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

B&K Precision Portable Oscilloscope

The B&K Precision Model 1432 portable, triggered-sweep, dual-trace oscilloscope has a rated bandwidth of 15 MHz and vertical sensitivity of 2 mV/division. Operation can be from 117 or 234 V ac or 12 V dc. Features include: channel A ±channel B, 19 calibrated sweep ranges from 0.5 μs to 1.5 s, 5x magnifier, automatic selection of chopped or alternate display modes, and automatic TV line and frame sync selection. The TTL-compatible Z axis permits intensity modulation of the 3" CRT over a 1-MHz range. Battery overcharge is prevented by an automatic charge-limiting circuit. The Model 1432 is supplied with two 10:1/direct probes, four accessory tips with carrying pouch, ac and dc power cables, and a viewing hood. Options include a rechargeable battery pack. $750.

CIRCLE NO 93 ON FREE INFORMATION CARD

Hidden Radar Detector Converter

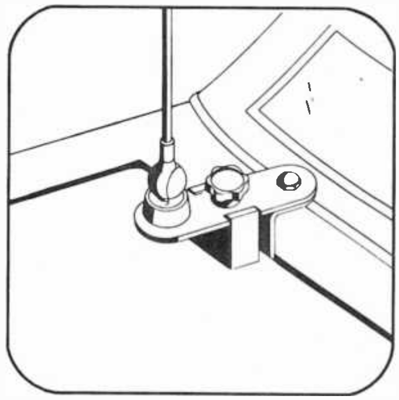
Bel Sales' "Shadow" converter allows concealment of any radar detector under car hoods, says the manufacturer. When X band or K band radar is sensed by the radar detector, the "Shadow" flashes a red

light and sounds a warning beeper. The new device is powered from the car's cigarette lighter. Wiring and a waterproofing kit are included. $49.95

CIRCLE NO. 89 ON FREE INFORMATION CARD

Hustler Quick Mount CB Antenna

The Hustler "Speedy Seizer" mobile antenna is designed for fast, semipermanent mounting on such car-panel edges as doors and trunk lids. A built-in ball joint allows its use on vertical or horizontal edges requiring only a ⅛" gap with a ⅝" minimum return behind the panel for clamping. The mount grounds directly to the vehicle body, yet can be readily removed for car washes or concealment. The 46" long antenna is a



stainless steel center-loaded whip with screwdriver-adjustable tip rod for SWR adjustments. A 17' RG-58 cable with factory-installed connectors is provided. $19.95.

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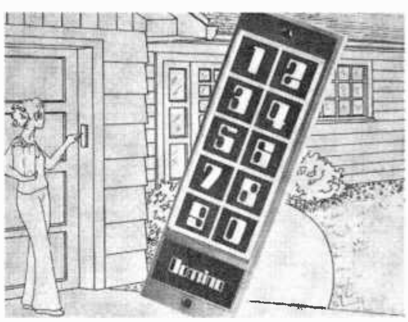
Automatic Garage Door Electronic Lock

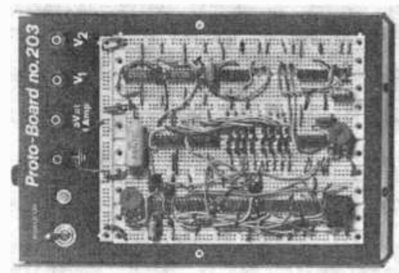
Here is an electronic combination lock to activate automatic garage-door openers without using radio control or a key. The three-digit combination has a total of 390



possible combinations; wrong digits disable the system for 30 to 60 seconds. The lock is guaranteed to operate from −50° to 150°F., and requires only two low-voltage wires and two screws for its installation. $19.95. Address: Domino Engineering Corp., Box 376, Taylorville, IL 62568.

Five-Volt Powered Breadboard

Designed primarily for TTL logic circuits, the Continental Specialties PB-203 Proto-Board includes a 1%-regulated, 5-volt dc power supply. The breadboard area includes enough tie points to support fourteen, 14-pin DIP IC's. Four binding posts



provide additional power and signal connections. The power supply is rated at 1 A, 5 ±0.25 V, with 10 mV combined ripple and noise at ½ A out, and is protected against short circuits. Dimensions are 6½ x 9¾ x 3¼ in. (16.5 x 24.8 x 8.3 cm). $80.

CIRCLE NO. 91 ON FREE INFORMATION CARD

Teac Open-Reel Tape Deck

Teac's new quarter-track, two-channel A-6600 is an open-reel tape deck with separate erase, record, playback, and reverse-playback heads. Full IC logic push-button control is provided, along with automatic reverse (with sensing foil) and automatic repeat play. A two-capstan servo-tension system moves tape at speeds of

3¾ and 7½ ips. The A-6600 also includes a 20-dB microphone attenuator pad, cue selection, auto space, large and small reel tension switch, individual microphone and line controls for each channel, a master control, independent two-position bias and

(Continued on page 10)

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equalization controls, large VU meters which can be switched to read up to ±6 VU, independent input level controls for mike/line mixing capability, and a separate output level control. Optional accessories include the RC-80 remote control. $1300.

CIRCLE NO 92 ON FREE INFORMATION CARD

Portable Radio Direction Finder

The Apelco Marine Electronics DF-10 radio direction finder receives marine and aviation radio beacons, the marine band,

and standard AM broadcasts. The DF-10 features a switchable noise limiter and a bfo. Another tuning aid provided is a sensitivity meter, which doubles as a power cell strength indicator. The solid-state radio direction finder is powered by eight "D" cells. Dimensions are 7.5"H x 11"W x 9"D (19.1 x 27.9 x 22.9 cm). Weight is 8.5 lb (3.9 kg). $249.

CIRCLE NO 86 ON FREE INFORMATION CARD

Rabco Straight-Line-Tracking Turntable

The Rabco Model ST-8 straight-line-tracking 33-1/3-45-rpm turntable was recently unveiled by Harman-Kardon. The ST-8 plays records the same way the master is recorded; the company claims zero tracking error, zero skating force, and zero sty-

lus overhang. A "Hall-effect" servo-controlled dc motor drives the 2.4-lb (1.1-kg) turntable via a belt. The platter is brought to selected speed from a dead stop in only one revolution, according to the manufacturer. Wow and flutter is said to be 0.05%; and rumble is rated at −65 dB. Turntable speed accuracy is maintained automatically but the user can also adjust it by ±5.5%. The 6-g low-mass tonearm has automatic lift-off and damped cueing. Other ST-8 highlights include a built-in bubble level with adjustable levelers and touch-sensitive resistance-type switches. Dimensions are 6.8"H x 16.5"W x 16.3"D (15.7 x 41.9 x 41.3 cm). $499.

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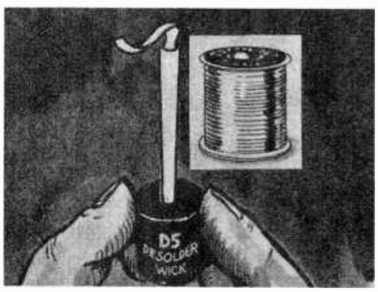
Satin Moving-Coil Cartridge

The Satin Model M-117G is claimed to be the only moving-coil stereo cartridge that offers an output great enough to drive amplifiers and receivers directly without the need for a transformer or pre-preamplifier. In addition, the Satin is also said to be the only moving-coil cartridge with user-replaceable stylus assembly. (It is held in place by magnetic force.) The key to the high 3.0-mV output of the cartridge is the use of aluminum ribbon coils and an advanced magnetic structure to concentrate a high magnetic force in a 250-micron gap. The cartridge comes with a 0.2 × 0.8 mil elliptical diamond stylus. Frequency range is rated at 20 Hz to 25,000 Hz. Compliance is rated at 12×10^{-6} cm/dyne. Recommended tracking force is 0.5 to 1.5 g. $115.

CIRCLE NO 87 ON FREE INFORMATION CARD

Chemtronics Solder/Desolder System

The Chemtronics SD5 Modular Solder/Desolder System consists of a pound or half-pound spool of MIL-spec solder and a D5 Desolder Wick Dispenser Tool



snapped into the core of the solder spool. The D5 features a 2½" heat-resistant Teflon probe which is said to allow precise application of the flux-treated wick. The probe tip also aids "webbing" of the wick, which is available in 0.06" and 0.10" gauges. The entire SD5 system is refillable and available as separate components. Solder comes in 16-, 18-, and 21-gauge sizes with 63/37, 60/40, 50/50, and 40/60 formulas.

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Space Byte Modular Business Computer

Space Byte's new Modular Business Computer is a business-oriented system that includes the Space Byte SB85-16 Terminal Mounted Mainframe with 8085-based CPU and 16K of read/write memory, a Hazeltine 1500 video display terminal, and an

iCOM 3712 dual floppy disk drive with iCOM FDOS III operating system. All hardware is mounted on an adjustable, roll-away floor stand. The BIZPAK business-application software provided is a report-generating system written in assembly language, and features interactive program modules for accounts payable and receivable, payroll, and general ledger. There is extensive operator prompting and transparent file maintenance for inexperienced computer operators. Other software available includes Disk Extended BASIC, CP/M, and Fortran-80. Hardware and software maintenance contracts are available.

CIRCLE NO 95 ON FREE INFORMATION CARD

Onkyo Digital Synthesized Tuner

Onkyo's Model T-909 FM tuner uses digital processing techniques throughout its circuitry, according to the manufacturer. The T-909 employs a quartz crystal controlled oscillator said to provide a tuning frequency accuracy of ±30 ppm. Tuning is accom-

plished in 200-kHz steps, and the T-909 displays the frequency to which it is tuned on front-panel, seven-segment LED's. Among the features of the T-909 is its seven-channel, user-programmable memory. This allows station selection at the push of a button. Other features include Dolby NR adaptor plug-in provisions and a deemphasis switch, front-end dual-gate MOSFET's, multipath detector terminals, and a "birdie"

(Continued on page 12)

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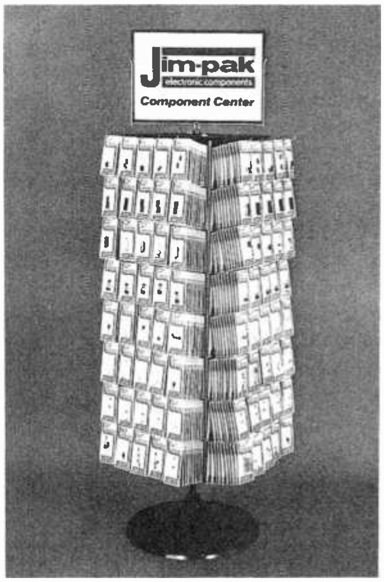
Santa Cruz — Santa Cruz Electronics
Santa Monica — Mission Control
Sunnyvale — Sunnyvale Electronics
Torrance — SE Electronics
Vallejo — Zackit
Van Nuys — Thrifty Electronics Supply
Ventura — Lombard's Electronics Inc.
Walnut Creek — Byte Shop of Walnut Creek
Westminster — JK Electronics
COLORADO
Aurora — Com Co Electronics
Steamboat Springs — Norm's TV & Electronics
CONNECTICUT
Bridgeport — Bridgeport Computer
FLORIDA
Ft. Lauderdale — Computers For You
Gainesville — Lafayette Radio
Lakeland — Lakeland Specialty Electronics
Orlando — Altair Computer Center
Tampa — AMF Electronics
Tampa — Microcomputer Systems
GEORGIA
Atlanta — Atlanta Computer Mart
HAWAII
Aiea — Delcoms Hawaii
Honolulu — Integrated Circuit Supply
IDAHO
Idaho Falls — Audiotronics
ILLINOIS
Carbondale — Lafayette Radio
Evanston — Itty Bitty Machine Co.
Evanston — Tri-State Electronic Corp.
Granite City — Computer Systems Center
Groveland — Moyer Electronics
Mount Prospect — Tri-State Electronic Corp.
Niles — Computer Land
Oak Park — Spectronics Inc.
Rockford — Imperial Computer Systems
Schaumburg — Data Domain
INDIANA
East Chicago — Acro Electronics Corp.
Hammond — Quantum Computer Works
IOWA
Clinton — Bridge Elec. Computer Center
Indianola — Electronix Limited
KANSAS
Kansas City — Electronic Surplus Sales

KANSAS (Continued)
Manhattan — Communications Specialties Ltd.
Wichita — Amateur Radio Equipment Company
KENTUCKY
Lexington — Radio-Electronic Equipment Co.
LOUISIANA
Baton Rouge — Davis Electronics Supply Co.
MARYLAND
Baltimore — Computer Workshop of Baltimore
Baltimore — Everything Electronic
La Vale — J & M Electronics
Rockville — Computer Workshop
Silver Spring — Computers Etc.
Towson — Baynesville Electronic Inc.
Towson — Computers Etc.
MASSACHUSETTS
Medford — Tufts Electronics
North Adams — Electronics Supply Center
Waltham — Computer Mart Inc.
Worcester — RM Electronics Inc.
MICHIGAN
Ann Arbor — Airway Electronic Communications
Flint — Hobby Electronic Center
Grand Rapids — Micro Computer World
Lansing — Fulton Radio Supply Co.
Mt. Clemens — The Computer Store



MINNESOTA
Duluth — Northwest Radio of Duluth
Eagan — Computer Room Inc.
MISSOURI
El Dorado Springs — Beckman Electronics
Parkville — Computer Workshop of Kansas City
MONTANA
Billings — Conley Radio Supply
NEBRASKA
Lincoln — Altair Computer Center
North Platte — Scott Radio Supply Corp.
Omaha — Omaha Computer Store
NEVADA
Las Vegas — Century 23
NEW JERSEY
Bayville — A.R.S. Communications Services
Bricktown — Radio Shack Associate Store
Cherry Hill — The Computer Emporium
Hoboken — Hoboken Computer Works
Pompton Lake — Computer Corner of New Jersey
Ramsey — Typetronic Computer Store
NEW YORK
Albany — Fort Orange Electronics
New York — Computer Mart of New York

NEW YORK (Continued)
Rensselaer — Com-Tech Electronics
Rochester — 2001 Microsystems
Troy — Trojan Electronics
White Plains — The Computer Corner
Williamsville — Hirsch Sales Co.
NORTH CAROLINA
Durham — Futureworld
Greensboro — Byte Shop
Raleigh — Byte Shop of Raleigh
OHIO
Bucyrus — Mead Electronics
Cincinnati — Digital Design
Columbus — Heathkit Electronic Center
Dayton — Altair Computer Center
Reynoldsburg — Universal Amateur Radio
OKLAHOMA
Guymon — Sound Service
Oklahoma City — Bits, Bytes & Micros
Tulsa — High Technology
OREGON
Beaverton — Altair Computer Center
Coos Bay — Herrick Electronix
Ontario — Miller Electronics
Salem — Computer Pathways
PENNSYLVANIA
Drexel Hill — Kass Electronic Distributors
Erie — Warren Radio
Hershey — Microcomputer Systems Inc.
Murraysville — Computer Workshop of Pittsburgh
Phoenixville — Stevens Electronics
Pittsburgh — Tydings Company
Wilkesbare — Hamline Electronics
RHODE ISLAND
Cranston — Jabbour Electronics City
Pawtucket — Jabbour Electronics City
SOUTH CAROLINA
North Charleston — Technical Services Inc.
TENNESSEE
Clarksville — Masstronics
Knoxville — Byte Shop
Memphis — Bluff City Electronics
Memphis — Sere-Rose & Spencer Electronics
Oak Ridge — Computer Denn
TEXAS
Amarillo — Computer Encounters Inc.
Dallas — CompuShop
Houston — Altair Computer Center
Houston — Interactive Computers
San Antonio — Sherman Electronics Supply Inc.
UTAH
Provo — Alpine Electronic Supply Co.
VIRGINIA
Alexandria — Computer Hardware Store
Alexandria — Computers Plus Inc.
Charlottesville — Lafayette Electronics
Hampton — Lafayette Radio
Richmond — Computers-To-Go
Springfield — Computer Workshop of North Virginia
Virginia Beach — Heathkit Electronic Center
WASHINGTON
Bellevue — Altair Computer Center
Longview — Progress Electronics
Pasco — Riverview Electronics
Seattle — C-Com
Seattle — Empire Electronics
Spokane — Personal Computers
WEST VIRGINIA
Morgantown — The Computer Corner
Morgantown — Electro Distributing Co.
Ripley — Thompson's Radio Shack

CANADA
Alberta — The Computer Shop
Ontario — Home Computer Centre
Quebec — Wang's Microcenter

PANAMA
Panama City — Electrotecnia S.A.
Panama City — Sonitel, S.A.

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Paris — Computer Boutique

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filter. Controls include SCAN UP, SCAN DOWN, MEMORY, and MUTING. The tuner's specifications are: usable sensitivity of 9.8 dBf (1.7 μV) mono, 17.2 dBf (4 μV) stereo; capture ratio, 1.5 dB; alternate channel attenuation, 80 dB; and a frequency response of 30-16,000 Hz +0.5, −2 dB.

CIRCLE NO 96 ON FREE INFORMATION CARD

TRS AM/SSB CB Base Station

The TRS Challenger Model 1400 is its new top-of-the-line 40-channel AM/SSB base station CB transceiver. It features LED numeric channel display and a built-in digital

clock. AM and SSB sensitivity is reported as 0.7 and 0.3 μV at 10 dB (S + N)/N, respectively. Selectivity is rated at −50 dB for ±10 kHz (AM) and ±2.5 kHz (SSB). PA audio output is 4 W. Front-panel controls and indicators include switchable anl and noise blanker, high and low tone-cut controls, panel-meter dimmer, r-f gain, squelch, and fine-tune controls, plus S/r-f and SWR meters. A front-panel headphone jack and dual speakers are also provided. The ac-powered transceiver measures 5.9"H x 15.8"W x 11.4"D (14.9 x 40.0 x 28.9 cm). $549.95.

CIRCLE NO 97 ON FREE INFORMATION CARD

Jensen Spectrum Series Loudspeakers

The Spectrum Series is a new line of home stereo speakers from Jensen Sound Laboratories, headed by the top-of-the-line 550. The 550 features a 15" woofer with polyurethane foam suspension, two 3½" direct-radiating mid-range drivers, and a 1½" Mylar dome tweeter. Frequency response is 45-20,000 Hz ±3 dB, and recommended

power input is 10-90 W continuous. The Comptrac crossover network provides uniform energy transfer between drivers with minimum phase shift. High- and mid-range frequency level controls are hidden behind the cocoa-colored, free-floating grille. Cabinetry is of hardwood. The 550 measures 31"H x 19.5"W x 15.5"D (78.7 x 49.5 x 39.4 cm). $299.95.

CIRCLE NO 98 ON FREE INFORMATION CARD

Amateur TV Converter

Science Workshop's Model ATVC-10 amateur TV converter enables one to monitor transmissions in the 420-450-MHz band on TV channels 2 through 6. It connects to the vhf terminals of a standard TV receiver. The ac-powered converter features Varactor-tuned circuits and adjustable r-f gain. Its walnut and beige aluminum cabinet measures 1.8" x 4.3" x 4.1" (4.6 x 10.9 x 10.4 cm). $49.95 factory wired; $39.95 semi-kit (critical circuits prewired and aligned). Address: Science Workshop, Box 393, Bethpage, NY 11714.

3M Instant-Record Cassettes

3M's new instant-record cassettes (IRC) eliminate the possibility of program material loss due to recording on cassette tape leaders. The new tapes feature leaders of low-noise recording tape, allowing recording over the entire length of the tape. The leaders are heavy-duty 1.5-mil tape, with 1-mil tape being used on the IRC-30 cassette. This new tape format should prove to be handy in all cassette tape applications, and especially valuable to blind students who tape notes. 3M IRC cassettes are available in C30 ($1.50), C60 ($1.80), and C90 ($2.50) versions.

CIRCLE NO 99 ON FREE INFORMATION CARD

Shakespeare Digital Depth Indicator

Shakespeare Marine Electronics' new 400-D digital depth indicator, packaged in a water-tight case, offers interesting functions. One is an audio alarm when a preset depth has been reached. Another provides a sound warning if depth varies from a user-determined range or "window," as might happen when a ship slips anchor. "Fail-safe" programming of the 400-D is said to prevent false readings from being displayed if positive bottom contact is lost. The 400-D display consists of a 3½-digit LCD readout, back-lighted for night operation. $349.95.

CIRCLE NO 100 ON FREE INFORMATION CARD

Radio Shack's personal computer system? This ad just might make you a believer.

You can't beat the 4K system at $599

TRS-80 "Breakthru"
- TRS-80 microcomputer
- 12" video display
- Professional keyboard
- Power supply
- Cassette tape recorder
- 4K RAM, Level-I BASIC
- 232-page manual
- 2 game cassettes

...or the step-up 16K system at $899

TRS-80 "Sweet 16"
- Above, except includes 16K RAM

...or the fast 4K/printer system at $1198

TRS-80 "Educator"
- Above, except includes 4K RAM and screen printer

...or the Level-II 16K/printer/disk system at $2385

TRS-80 "Professional"
- Above, except includes 16K RAM, disk drive, expansion interface, and Level-II BASIC

So how are you gonna beat the system that does this much for this little? No way!

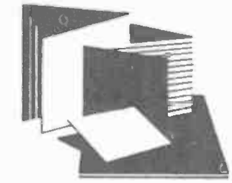
...The amazing new 32K/Level-II/2-disk/ line printer system at $3874

TRS-80 "Business"
- Above, except includes 32K RAM, line printer, and two disk drives

Get details and order now at Radio Shack stores and dealers in the USA, Canada, UK, Australia, Belgium, Holland, France, Japan. Write Radio Shack, Division of Tandy Corporation, Dept. C-053, 1400 One Tandy Center, Fort Worth, Texas 76102. Ask for Catalog TRS-80.

Radio Shack®
The biggest name in little computers

Prices May Vary at Individual Stores and Dealers



New Literature

B&K FREQUENCY COUNTER GUIDE

A six-page brochure from B&K-Precision provides application information and complete specifications on four B&K frequency counters. They include models that count up to 520 MHz, universal and autoranging counters, and portable instruments. A selection of frequency counter accessories are also described, including probes, power adaptors, carrying cases and an RF signal tap. Address: B&K Precision, Sales Dept., 6460 W. Cortland Ave., Chicago, IL 60635.

EDMUND HOBBYIST CATALOG

Hundreds of new products are listed in Edmund Scientific's 165-page spring catalog for experimenters, do-it-yourselfers, hobbyists, and students. Some of these products include the Astroscan 2001, the 6-in. f/6 and the 8-in. f/5 telescopes; a Solar Water and Beverage Heater; a manual on "How to Reduce Heating Costs Without Alternative Energy Sources;" and a Power Miser that makes use of trapped air in a/c units which is usually wasted. Other new products featured are: a low-cost TV projection lens; UFO slide sets; electronic computers ready to be built, electronic experiments for youngsters; and a dictionary of scientific and technical terms. Address: Edmund Scientific, Co., 7782 Edscorp Bldg., Barrington, NJ 08007.

SYSTRON-DONNER PRODUCT CATALOG

Systron-Donner Corp. has issued a 20-page catalog on its test instruments. Frequency counters from 10 MHz to 24 GHz; universal counter-timers; digital volt/multimeters for portable, bench, and systems applications; dc laboratory and systems power supplies; pulse/function/data signal and sweep generators; time code readers/generators/displays; spectrum analyzers; microwave components and a new instrumentation controller for IEEE bus applications are included. Address: Systron-Donner Corporation, 10 Systron Dr., Concord, CA 94518.

CONTINENTAL SPECIALTIES CATALOG

Continental Specialties Corp. has released a 12-page catalog describing its line of electronic prototyping, development and testing hardware. New products such as hand-held logic probes, and a matching digital pulser—part of CSC's test equipment family called The Logical Force—the MAX-100 compact frequency counter are introduced. Other products included are test sockets, solderless breadboards, test instruments and matching blank cases, and IC test clips. Address: Continental Specialties Corp., 70 Fulton Terrace, New Haven, CT 06509.

HEATH INSTRUMENT CATALOG

Heath/Schlumberger has announced availability of its latest Assembled Instruments Catalog. It contains 32 pages of descriptions and specifications for Heath oscilloscopes, laboratory-grade Strip and X-Y recorders, power supplies, signal and function generators, counters, multimeters (analog or digital), and a selection of accessories such as probes and interconnecting cables. A listing of self-instruction courses in ac and dc electronics, semiconductor devices, digital techniques, microprocessors and others is included. Address: Heath/Schlumberger, Dept. 57-020, Benton Harbor, MI 49022.

WIDL VIDEO CATALOG

"The Catalog of Video Supplies and Accessories," now available from WIDL, Video, Chicago, contains over 500 items such as video tape, audio cassettes, tape labels, microphones, video and audio cables, connectors and adapters, printed video forms and other video accessories. Address: WIDL Video, 5325 N. Lincoln, Chicago, IL 60625.

"A sight for sore ears"

C.W. McCall 10/4

Hard to believe there's one simple solution to the noise, range and privacy problems of conventional AM/CB. But there is.

It's Midland Power Single-Sideband CB.

TUNE OUT TROUBLE. Instead of 40 overcrowded channels, Midland SSB splits each channel into three. And you get more output power than your ordinary AM/CB.

As for features, Midland makes SSB as simple or as advanced as you please. Take our Model 79-900, shown below.

It's the top of the Midland SSB line, with all the important controls—our 2-button "Touch and Run" channel selector that runs through all 40 channels and stops where you want, SSB clarifier and volume control—on the mike, as well as on the panel.

MOST ADVANCED. Electronically, it's the most advanced SSB in Midland's 17 years of electronics experience. A result of the attention Midland pays to the needs and wants of serious CBers.

In the words of C. W. McCall, America's Number 1 CBer: "Do your ears a favor. See your Midland CB dealer now."

And while you're there, ask about the new Midland Mobile Audio AM/FM car stereo line, with Micro-Precision™ Tuning.

Midland SSB Run with Number 1.

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Learn to service Communications/CB with NRI's Complete

Learn design, installation and maintenance of commercial, amateur or CB communications equipment.

There are more than 25 million CB sets out there, millions more two-way radios, walkie-talkies, and other communications apparatus in use by business, industry, government, police and fire departments, and individuals. That means a lot of service and maintenance jobs... and NRI can train you at home to fill one of these openings. NRI's Complete Communications Course covers all types of two-way radio equipment... AM and FM transmission and reception, television broadcasting, microwave systems, radar principles, marine electronics, mobile communications, and aircraft electronics. And NRI guarantees you will pass the exam for the commercial FCC Radiotelephone License you need to perform most servicing work, or your tuition will be refunded in full. This money-back agreement is good for six months after completion of your course.

Some designed-for-learning equipment you get.

Learn on your own 2-meter, digitally synthesized VHF transceiver.

You'll learn to service all types of communications equipment as you assemble your own VHF transceiver. NRI engineers have designed it, not only as a commercial-quality, high-performance unit, but as a unique "power-on" training tool to give you actual bench experience with the principles needed to service CB, commercial, and amateur equipment.

Then we help you get your FCC Amateur License so you can go on the air.

The complete course includes 48 lessons, 9 special reference texts, and 10 training kits. Included are your own electronics Discovery Lab,™ antenna applications lab, CMOS digital frequency counter, and an optical transmission system. You'll learn at home, at your own convenience, earning your FCC license and the preparation you need for the communications field of your choice. Mail the postage-paid card today.

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CB specialist course also offered.

If you prefer, you can concentrate on the booming field of CB radio with NRI's special course in CB servicing. You get 37 lessons, 8 reference texts and plenty of hands-on training with your own 40-channel CB, AC power supply, and multi-meter. Also included are 14 coaching units to make it easy to get your commercial Radiotelephone FCC License... required for you to test and service communications equipment.

Stereo Scene

By Ralph Hodges

POWER SUPPLIES AND OTHER REVELATIONS

SUDDENLY an enormous amount of attention is being paid to power supplies in audio amplifiers. To quote from a technical manual of a major Japanese manufacturer: "It may fairly be said that the most important thing in audio amplifier designing is the power supply circuit as a source of energy, because the fundamental function required from amplifiers is to drive speakers."

The same manual goes on to describe the "ideal" characteristics of a power supply: "(1) Low output impedance; (2) Good transient response; (3) Huge power capacity and stable energy supply." This appears to make good sense.

Some time ago, I wrote in this space about a modification to the Dynaco Stereo 400 that would make it a "super" amplifier. Much of the modification involved augmenting the power supply (to the tune of several hundred thousands of microfarads) to improve the amplifier's "audible" characteristics. At that time I was enthusiastic about the difference (created by Frank Van Alstine of the company of the same name) that I heard between the modified and unmodified versions of what was basically the same amplifier. I still am. So is Dynaco, to judge by the emergence of the new 416 amplifier with its add-on option of zillions of microfarads that can be purchased in a very attractive package, plugged into the supply rails of the 416, and set on top of the amplifier to create a convenient and reasonably compact duo. And I truly believe it does.

How Does It Work? To observe the difference between an augmented and unaugmented power supply you merely connect a voltmeter across the supply rails of your amplifier and see (and perhaps hear) what happens as it's playing a record or tape. Does the voltage go up and down? Often it will, and presumably that's not good. Several amplifier manufacturers have begun using the term "dynamic crosstalk" to describe a condition (in an amplifier utilizing a single power supply) in which the demands made upon one channel will effectively modulate the output of the other channel, because the power supply feeding both is pumping up and down. You can eliminate dynamic crosstalk—if its possibility concerns you—by building separate and well-shielded power supplies for each channel, or by designing a power supply that refuses to quit under any conditions of current drain.

Separate power supplies have been cropping up in astonishing numbers recently. But anyone who has ever hefted a power transformer for a truly big audio amplifier knows that duplicating it (for the second, third, or even fourth channel) is not especially cost effective. Reverting to a single supply and adding umpteen filter capacitors can evidently help to an extent. But note that these capacitors, although they weigh very little, occupy a great deal of space. It takes a *lot* of capacitors to make any significant difference in the performance of a power supply, and this probably accounts for various manufacturers' policies of offering additional filter capacitors as add-on rather than as built-in facilities.

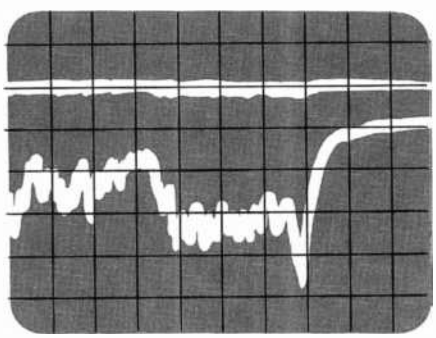


Fig. 1. Top trace is voltage variation of switching supply while playing music. Bottom is regular supply with same music.

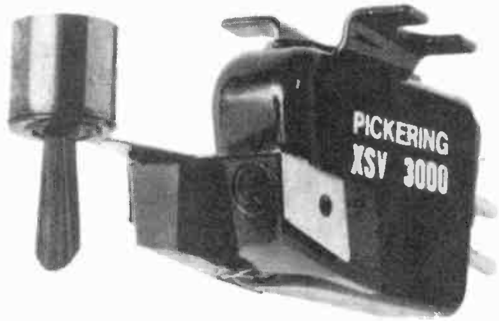
Enter the presumed great hope of the future: the *switching* power supply. This concept reportedly comes to us fresh from the world of the computer, and if it's a little surprising that it's barely reached into the realm of audio applications before now, it seems the possible deluge is finally at hand.

The switching power supply is a high-frequency device, operating typically at a frequency between 20,000 and 35,000 Hz. For such frequencies a transformer can be quite efficient *and* compact. Furthermore, it would stand to reason that the storage capacitors, being charged at such a high rate, would not need to incorporate the "extra" capacitance generally required by a high-power amplifier with a 60-Hz supply. If the above suggests the possibility of an unusually small and lightweight assembly, you're on the right track. Recently I was shown a supply for a power amplifier worth 120 watts per channel into 8 ohms (and 240 watts per channel—an honest doubling!—into 4 ohms) that a group of schoolchildren could have effortlessly played catch with. And yet this supply exhibited almost no variation under music-playback conditions that had a conventional supply's voltages pumping up and down vigorously. (Fig. 1.)

The power amplifier was the M-7070, a new product from JVC; and by the time you read this, Sony will have announced two integrated amplifiers with switching supplies to the U.S. market. Block diagrams for the two designs are shown in Figs. 2 and 3. Note that in both cases some form of feedback is used to regulate voltages and—in JVC's case—to lower output impedance.

From all indications American manufacturers are hot on the heels of the overseas companies, although they are not necessarily in agreement as to the proper goals of power-supply design. At least one is unconcerned about maintaining tightly regulated supply voltages as long as the necessary voltages are there when called for. And the speed (transient response?) of a switching supply should enable extremes of the musical waveform to be "tracked" easily as they occur. At other times the supply will "stand down" in a much more efficient mode of operation.

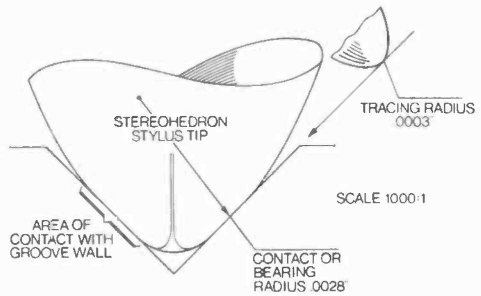
A Head That's Finally Together? The latest evolution in the Nakamichi 600 Series of two-head cassette decks has a feature that's a little breathtaking:



The XSV/3000 is the source of perfection in stereo sound!

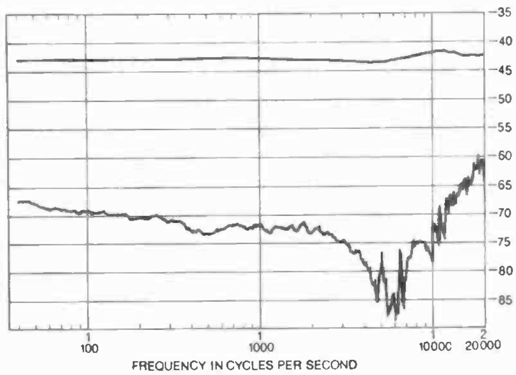
Three big features... all Pickering innovations over the past 10 years... have made it happen.

1976: Stereohedron® This patented Stylus tip assures super traceAbility™, and its larger bearing radius offers the least record wear and longest stylus life so far achievable.



1. Technical drawing of the Stereohedron shape

1975: High Energy Rare Earth Magnet Another Pickering innovation, enabling complete miniaturization of the stylus assembly and tip mass through utilization of this type of magnet.



2. Frequency response curve of the XSV/3000

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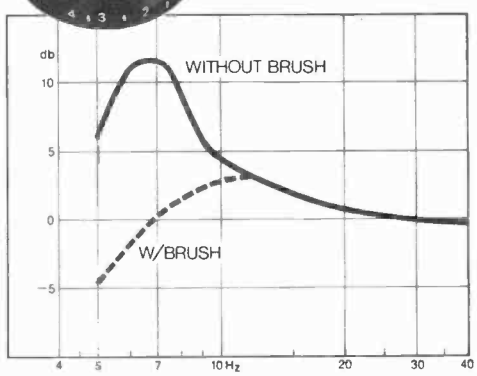

3. Damping effect on tonearm resonance

1968: Dustamatic® Brush This Pickering patented invention dynamically stabilizes the cartridge-arm system by damping low frequency resonance. It improves low frequency tracking while playing irregular or warped records. Best of all, it provides record protection by cleaning in front of the stylus.

For further information write to Pickering & Co., Inc., Dept. PE 101 Sunnyside Blvd., Plainview, N.Y. 11803

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PICKERING

"for those who can hear the difference"

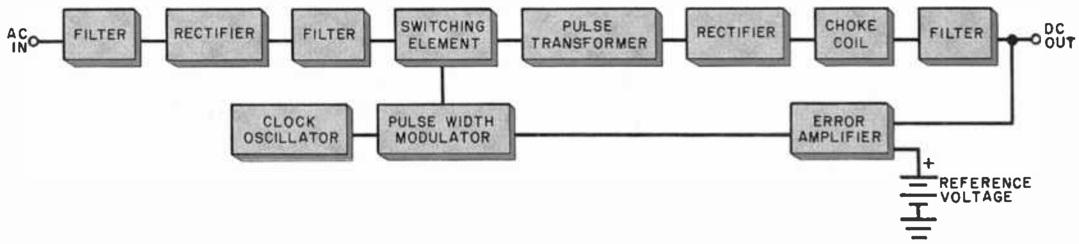


Fig. 2. JVC calls its switching supply D.P.S. or Digital Power Supply.

a record/playback head with a 0.9 *micron* gap. Now that should—and in fact does—make a lovely playback-only head for a three-head cassette deck, but the common understanding has been that you just can't use such a narrow gap for recording; flux saturation in the magnetic gap kills you almost immediately, driving distortion way up.

Well, perhaps not. According to Nakamichi, analysis of the flux pattern propagated by such a head (if it is properly designed) shows that the pattern—and particularly the so-called "critical zone" where recording actually takes place—can in fact remain well-defined and controlled, if a little distorted from its familiar shape. Experts in tape-recording theory contacted immediately after the Nakamichi announcement allowed that the whole idea was plausible, although they could not of course vouch for this particular execution of it sight unseen.

I won't exhaustively detail the specifications of the new Nakamichi machine here, except to note that its usable frequency response is claimed to extend comfortably beyond 20,000 Hz, and that performance appears to be as much tape as machine limited. The "distortion compensating" circuits of the previous Model 600 have disappeared from the present machine, but there are phase-correcting circuits.

Dialing Vertical Angle. Of late I've had very little time to spend on the phono vertical-tracking-angle issue, with which this column has dealt on several past occasions. (If you recall, the proposition is that vertical tracking angle, which can be altered by raising or lowering the tonearm or shimming the phono cartridge in the headshell, is critical to within a degree or even less for proper record-player performance. It should also logically require at least occasional alteration for different records.) Fortunately, reports continue to come in from the field; reports that are positive, negative, and just plain frustrated.

It is extremely difficult to give adequate instructions on zeroing-in on approximately correct vertical tracking angle (VTA) to someone who lives at a distance. The situation is only made worse by certain cartridge/tonearm/turntable combinations that assume somewhat improbable-looking geometries as they approach the optimum setting (although a careful analysis of the various angles involved usually reveals that they are not so improbable at all). But there may be a little help in the offing for those inclined to pursue the matter.

The story is this: many have found playing a left-minus-right signal from a stereo record to be extremely helpful in establishing at least a ballpark setting for VTA. The idea makes perfect sense, and I'm abashed that I didn't think of it myself. In listening to the L-R, all you do is try to minimize familiar old distortion and mistracking effects, which will no doubt be plentifully evident on vocal sibilants and other demanding high-frequency signals. It is recommended that several records be used, since in many cases the vocalist you're trying to focus on will almost completely disappear in the L-R mode. (In fact, if on such records he/she *does* completely disappear, that's a good sign.) What you really want is a record in which a centered vocalist acquires a distinct distant and reverberant quality. Once you've established an initial "optimum" setting for this one record, you can rest assured that optimum settings for others won't be far off.

Getting an L-R signal can be as simple or complex as you'd care to make it. The simplest way is to reverse the leads on one channel of the phono cartridge and then switch the amplifier to mono. Some fiddling with the balance control is then advisable (the outputs of a phono cartridge's two channels are rarely matched perfectly) to get as complete a drop-out of the central performers in the stereo panorama as possible. An alternate route to an L-R signal is, of course, the use of a phase inverter somewhere after the phono preamp to add the two channels in anti-phase. Whatever takes your fancy.

It's also been suggested that you use a mono recording in pristine condition—if you can find one—for the L-R test. In this case you should hear nothing *but* distortion, and the less distortion the better in terms of VTA adjustment.

Again, I'd like to emphasize that I'm not convinced this adjustment can be carried out successfully on every record player. It seems logical that a certain amount of rock-solid stability must be there to begin with before such subtleties can be heard. But I'd be glad to be proved wrong and look forward to further reports from the field. ◇

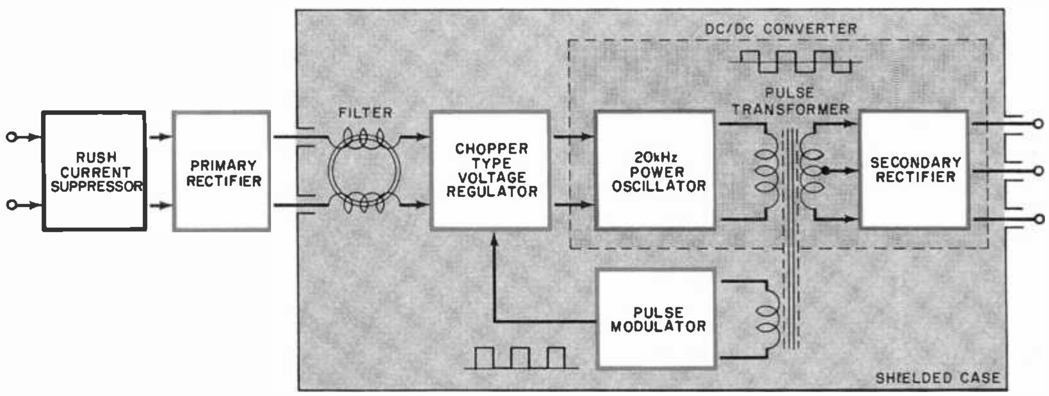


Fig. 3. Block diagram of Sony supply. Note feedback derived from primary of transformer.

Yesterday you could admire LED digital tuning in short wave.* Today you can afford it.

Introducing Panasonic's Command Series™ top-of-the-line RF-4800. Everything you want in short wave. Except the price. Like a five-digit LED frequency display. It's so accurate (within 1 kHz, to be exact), you can tune in a station, even before it's broadcasting. And with the RF-4800's eight short wave bands, you can choose any broadcast between 1.6 and 31 MHz. That's the full frequency range. That's Panasonic.

And what you see on the outside is just a small part of what Panasonic gives you inside. There's a double superheterodyne system for enhanced reception stability and selectivity as well as image rejection. An input-tuned RF amplifier with a 3-ganged variable tuning capacitor for exceptional sensitivity and frequency linearity. Ladder-type ceramic filters to reduce frequency interference. And even an antenna trimmer that changes the front-end capacitance for maximum reception from minimal broadcast signals.

To help you control all that sophisticated circuitry, Panasonic's RF-4800 gives you all these sophisticated controls. Like an all-gear-drive tuning control to prevent "backlash." Separate wide/narrow bandwidth selectors for optimum reception even in crowded conditions. Adjustable calibration for easy tuning to exact frequencies. A BFO pitch control. RF-gain control for increased selectivity in busy signal areas. An ANL switch. Even separate bass and treble controls.

And if all that short wave isn't enough. There's more. Like SSB (single sideband) amateur radio. All 40 CB channels. Ship to shore. Even Morse communications. AC/DC operation. And with Panasonic's 4" full-range speaker, the big sound of AM and FM will really sound big.

The RF-4800. If you had a short wave receiver as good. You wouldn't still be reading. You'd be listening.

*The ability to receive short wave broadcasts will vary with antenna size, time of day, operator's geographic location and other factors. You may need an optional outside antenna to receive distant short wave broadcasts.

Panasonic®
just slightly ahead of our time.

CIRCLE NO. 16 ON FREE INFORMATION CARD

Julian Hirsch Audio Report

CARTRIDGE LOADING AND PREAMPLIFIER INTERACTION

Interaction [between cartridge and preamplifier] can modify response by several decibels.

FOR MANY YEARS, it was assumed that a magnetic cartridge (of the moving-magnet or moving-iron type) would perform correctly if it were simply terminated by a 47,000-ohm resistance. (The adoption of this load value was one of the earliest instances of standardization in the hi-fi industry.) More recently, we have become aware that matters are not quite so simple. For instance, the input resistance is shunted to ground by a capacitance. Part of this is in the tonearm wiring that connects the record player to the preamplifier and part in the preamplifier circuit itself.

The reactance of the shunting capacitance decreases with increasing frequency, reducing the total load impedance presented to the cartridge. It might seem that this would reduce the cartridge's high-frequency output, but this is true only when the frequency is very high. At lower frequencies, the added shunt capacitance actually boosts the cartridge's output, and most cartridges are designed to be terminated in a specific capacitance as well as resistance for flattest overall frequency response.

To see why this is so, one must realize that the cartridge has a high-frequency *mechanical* resonance between its effective moving stylus mass (referred to the tip) and the compliance of the vinyl record material. This may occur at a frequency as low as 10,000 Hz in lower-priced cartridges, whose styli are more massive, and as high as 30,000 Hz or more in CD-4 cartridges. Most often, it falls in the 15,000-to-25,000-Hz range. The resonance takes the form of a peak in the cartridge's output, which may be more or less damped by mechanical means in the structure of the stylus system.

There is also an *electrical* resonance, between the inductance of the cartridge coil and the total shunting capacitance of the load circuit. Here, the damping is supplied by the 47,000-ohm load resistance and, to some extent, by the winding resistance of the cartridge. This resonance produces a response peak whose frequency is determined by the L and C values and whose amplitude is controlled by the "Q" of the system established by the circuit resistance. However the *mechanical* resonance and its frequency response characteristics are not affected by any electrical circuits within the cartridge or external to it.

By proper proportioning of the electrical and mechanical resonances of the cartridge, the combined response can be made very flat throughout the audio-frequency range. By placing the electrical resonance somewhat above the mechanical resonance and if both have the correct "Q" values, the mechanical-resonance peak will be attenuated and the rise in frequency will improve the overall flatness.

This is why a cartridge manufacturer will usually specify a range of load capacitance values (such as 250 to 300 pF or 400 to 500 pF) into which his cartridge will deliver its rated frequency response. These values take into account the normal wiring capacitance of the record player's tonearm and its connecting cables (typically 100 to 500 pF in modern units) and assume about 150 pF of input capacitance in the preamplifier. The actual preamplifier capacitance, however, may vary widely, from nearly zero to many hundreds of picofarads. Sometimes, as in the Hafler Model DH-101 reviewed this month, the naturally low-input capacitance of the amplifier has been padded to 250 pF, making the load broadly optimum for a wide variety of cartridges.

The effect of too little capacitance is to produce a peak in the cartridge response, often at a frequency of 12,000 to 15,000 Hz. Too much capacitance will often boost the high frequency output of the cartridge [in the 10,000-to-15,000-Hz range] but will attenuate it faster at higher frequencies. A greatly excessive capacitance will roll off the output pronouncedly above 10,000 Hz or so.

There is a second factor to consider that is entirely unrelated to the cartridge load but which also influences the overall frequency response. In some phono preamplifier stages, the feedback network that provides the RIAA playback equalization is not well isolated from the cartridge input. When the stage is driven from the resistive source impedance of a signal generator, the frequency response may appear to be an accurate RIAA curve. However, the presence of the inductance of the phono cartridge across the input terminals may modify the amplifier feedback sufficiently to alter its response at very high frequencies. In a good amplifier this effect is moderate, usually less than ±1 dB of variation up to 20,000 Hz. (This may be a boost or a cut or a combination of the two.) In a few cases, fortunately becoming rarer these days, the interaction can modify the response by several decibels, which is plainly audible and obviously undesirable. In the finest preamplifier designs, there is absolutely no interaction between the cartridge and the preamplifier equalization.

Audio Test Reports/

HIRSCH/HOUCK LABORATORIES

HAFLER MODEL DH-101 STEREO PREAMPLIFIER

"Plain Jane" preamp produces exceptionally fine performance.

HIRSCH-HOUCK LABS REPORT

The Hafler Model DH-101 stereo preamplifier is almost starkly simple, but its performance is literally "state of the art." Its distortion is virtually unmeasurable, and every effort appears to have been made to eliminate the various flaws, both major and minor, that plague many preamplifier designs.

The preamplifier is available in both factory-wired and kit forms. The kit assembly process is principally one of mechanical assembly and the soldering of wires from the circuit boards to the switches and controls. The circuit board assemblies themselves come completely wired and tested. The Model DH-101 measures 13¾"W × 8½"D × 3¼"H (34.9 × 21.6 × 8.3 cm) and weighs 8 lb (3.6 kg). Suggested selling price about $300 factory-wired, $200 kit.

General Description. The front-panel controls of the preamplifier consist of three knobs and 10 pushbutton switches. The faces of the rectangular pushbutton switches appear in black when the switches are not engaged (out positions). Pressing in any of these switches causes the face color to change to white (yellow in the case of the TAPE monitor buttons), clearly indicating the status of the controls without requiring LED indicators or extra electrical switching.

In addition to the various signal input and output jacks, the rear apron contains two pairs of phono jacks labeled EXT PATCH, which are normally connected together by heavy jumpers. They are in the signal path, after the input selector but ahead of any of the preamplifier's active circuitry, except for the phono preamplifier stages. They make it possible to connect an equalizer or other signal processor into the system without sacrificing any of the tape-recorder versatility of the preamplifier.

All the amplifier circuits are on a single circuit board, onto which the lugs of the control potentiometers are soldered. When they are installed on the front panel, the potentiometers are the sole mounting support for the circuit board, but they appear to be perfectly adequate for that purpose. A smaller board contains the power supply circuits (with IC regulators for the ± 18-volt supplies) and another board carries the pushbutton switches. There is a large empty space in the preamplifier that can accommodate a moving-coil phono cartridge preamplifier (to be made available at a later date) that will connect to one of the phono inputs.

The performance specifications of the Model DH-101 can be summed up quite simply, although they are extensive. All noise levels are inaudible and, with "A" weighting, are very difficult to measure. All frequency-response characteristics are within 0.5 dB of flat or the specified equalization response. All distortions are less than the residual levels of any standard laboratory instruments, up to the rated output of 3 volts. There is no

PERFORMANCE SPECIFICATIONS

Specification	Rating	Measured
Rated output	3 volts, 10-100,000 Hz	As rated
Maximum output	7 volts, 20-20,000 Hz	12 volts at 1000 Hz
THD	Less than 0.001% at rated output	Less than 0.0025% (instrument residual)
IM distortion	Below instrument residual	Less than 0.002% (instrument residual)
Rise time	2 µs	3 µs
Slew rate	12 V/µs	7 to 12 V/µs, depending on measurement method.
Frequency response	20-20,000 Hz, +0/-0.25 dB	20-20,000 Hz, +0/0.5 dB
Hum & noise	−90 dBV ("A" weighted) (high level)	Less than −80 dBV (measurement limit)
	−86 dBV ("A" weighted; phono)	−68 dBV (unweighted)
Phono Frequency response	Within ±0.5 dB of RIAA, 40-15,000 Hz.	As rated
Phono overload (1000 Hz)	180 mV	180 mV
Phono cartridge interaction at 20,000 Hz	Unmeasurable	Unmeasurable
Phono gain (1000 Hz)	34 dB	35.4 dB
High level gain (1000 Hz)	20 dB ± 1 dB	20.0 dB
Bass tone control range (50 Hz)	± 12 dB	+14.5, −16 dB
Treble tone control range (20,000 Hz)	±10 dB	+11.5, −17 dB

detectable interaction between the phono preamplifier response and the inductance of a phone cartridge.

User Comment. The basic appearance of the Model DH-101 is so plain and devoid of gadgetry and styling features that it is difficult to credit it with being quite possibly the most highly refined preamplifier one can buy (in terms of sheer performance). Our measurements convinced us of the accuracy of the claims for this preamplifier, and we looked to our use tests to either confirm or amend the conclusions of our measurements.

Connecting the preamp to a hi-fi system revealed what is probably its only weak point. The phono connectors on the rear apron, at least on our early sample, seemed to be slightly oversize in their outer diameter, requiring considerable force to insert some of the mating plugs. This would not have been so bad, but the rear apron itself is a thin, flexible metal surface, liberally covered with holes and cutouts. It bent inward, sometimes to an alarming degree, when the necessary pressure was applied to the phono plugs as they were inserted. This did not result in any permanent deformation of the metalwork, but it did detract from the overall image of quality which is conveyed by every other aspect of the performance and operation of the preamp itself. *(Continued on page 30)*

Product Focus

The Hafler Model DH-101 is the first preamplifier we've tested whose phono equalization has been designed to conform to the IEC characteristic, expected to be adopted by the RIAA at some future time. The major effect of the change is to incorporate a very effective infrasonic (rumble) filter in the phono equalization. Instead of the preamplifier gain continuing at a nearly constant value to some indeterminate frequency below 50 Hz (as in the present RIAA characteristic), the response is rolled off at low frequencies. The difference between the two curves is 3 dB at 20 Hz (and only 0.6 dB at 50 Hz). Hence, audible differences can be expected to be negligible. However, the IEC response curve is down by about 18 dB at 2 Hz, compared to the extended RIAA curve. Hafler has tailored the equalization of the Model DH-101 to be a compromise between the two, falling within 0.3 dB of the existing RIAA curve down to 30 Hz, yet matching the IEC curve within 1 to 2 dB throughout. A second difference in the IEC curve is merely one of definition; its high-frequency roll-off, at 6 dB/octave, is extended to 20,000 Hz instead of stopping at 15,000 Hz as before.

Both the phono preamplifier and the tone control (output) sections of the Model DH-101 employ differential amplifiers with complementary-symmetry output stages. All the preamplifier circuits use discrete components, the only IC's being the power supply regulators. The phono preamplifier has a very high output voltage capability (actually equal to that of the main tone control amplifier). Its very low output impedance enables it to drive an adequate signal into the low impedance of the equalizing network in the feedback loop, even at very high frequencies, without distortion.

In the main amplifier section, the tone controls are located at the output of the amplifier and supply a feedback signal to the side of the differential input that is not driven by the program signal. In their configuration, the active circuits of the Model DH-101 resemble a typical power amplifier output stage (except for their power ratings). Hafler credits this circuit design for much of the exceptional performance of the preamplifier, including its extremely low distortion, excellent pulse handling and transient characteristics, and (especially in the case of the phono input) a constant input impedance at all frequencies of interest, regardless of the reactive nature of the phono cartridge or other source connected to the input.

(Continued from page 26)

There were no switching transients when any of the pushbuttons were operated. Although there is no obvious source of a time delay in the power supply circuits, there was no sign of a "thump" when the preamplifier was switched on, even when connected to an already energized power amplifier. The controls operated smoothly and with a quality "feel." We were unable to measure the preamplifier's noise level, which was below the minimum range of our test instruments. However, even with the volume set near maximum, which produced ear-splitting levels from records, lifting the pickup left a deafening silence, the hiss being barely audible with one's ear against the speaker. Through the high-level inputs, there was absolutely no audible hiss or hum, at any setting of the volume control.

The preamp was designed to terminate most phono cartridges correctly and to be free of interaction with them. To this end, each phono input has a 220-pF capacitor wired across it to ground. With the normal amplifier input capacitance of about 30 pF and typical phono-cable and tonearm wiring capacitance of about 150 pF, this loads the cartridge with about 400 pF (in parallel with 47,000 ohms). This is an optimum condition for many cartridges, including those from Ortofon and many Shure models, among others. If the cartridge is meant to be terminated in a lower capacitance, such as 250 pF, or the connecting cables have a higher than usual capacitance, the manufacturer suggests that the 200-pF capacitors be removed or replaced with other capacitors of a lower value. This is not critical in most cases, but anyone who is convinced that he can hear the difference may wish to trim the amplifier input capacitance to an optimum value for his cartridge.

Although we tested a factory-wired Model DH-101, we have been informed by those who have built the kit that it is very simple, and that even a neophyte should be capable of assembling a properly performing preamplifier in a few hours or so.

CIRCLE NO. 101 ON FREE INFORMATION CARD

TECHNICS MODEL SL-1500MK2 DIRECT-DRIVE TURNTABLE SYSTEM

Quartz-control speed system also operates at each pitch control stop.

HIRSCH-HOUCK LABS REPORT

The Technics Model SL-1500-MK2 is a complete direct-drive system for playing records. It consists of a turntable that is directly driven at either 33 1/3 or 45 rpm by a dc motor whose speed (including pitch adjustment) is precisely controlled by a quartz oscillator; a precision tonearm with damped cueing, automatic muting and automatic return; and an acoustically isolated base. A see-through plastic dust cover is hinged to the rear of the base.

The player measures approximately 17 11/16" W × 15 1/8" D × 5 11/16" H

PERFORMANCE SPECIFICATIONS

Specification	Rating	Measured
Wow and Flutter	0.025% wrms (JIS)	0.05% rms (IRE)
Rumble	−50 dB (DIN 45539A) −73 dB (DIN 45539B)	34 dB unweighted (NAB) −58 dB (ARLL weighted)
Build-up characteristic	90° or ¼ rotation at 33-1/3 rpm	Less than 1 second to full speed or stop
Tracking error angle	+3° (outer groove of 12" disc); +1° (inner groove)	As specified (less than 0.4°/in. throughout)
Effective tonearm mass	22 g with 6.5-g cartridge at 1.25-g stylus pressure	19 g net, less cartridge but with shell; measured with 6-g cartridge at l-g force
Tonearm/cable capacitance	Not specified.	100 pF to ground; 6.5 pF between channels
Antiskating calibration	Not specified.	Requires approximately l-g greater setting than tracking force
Arm cueing	Not specified.	Very slow; no drift
Base isolation	Not specified.	Much better than average for direct-drive turntables; exceptionally resistant to jarring.

(14.5 × 45.3 × 38.4 cm) and weighs 26 lb (11.8 kg). The manufacturer's suggested price, less cartridge, is $369.95.

Technical Description. As exemplified in the Model SL-1500MK2, the direct-drive turntable motors used by Technics are dc motors with "heteropolar" construction. According to Technics, dc motors are more efficient than are ac motors in turntable applications, requiring less power and generating less heat. The heteropolar motor used in the company's latest series of quartz-controlled turntables has a 12-pole stator, around which revolves a 16-pole permanent-magnet rotor that is a part of the platter itself. This 3:4 pole ratio is claimed to be optimum for a high-torque, high-efficiency direct-drive motor.

Mounted concentrically with the direct-drive rotor and stator is a frequency generator (tachometer) that supplies a feedback signal to the control circuits that drive the motor. The generator consists of two 91-tooth gears that are smaller than the motor itself. One gear is on the platter and the other is fixed and has a magnetic coil structure built into it. The gear teeth do not touch. As the teeth move past each other, a voltage is induced in the coils of the fixed gear. This supplies 91 pulses per revolution of the platter to the control system.

Current is supplied to the windings of the motor with precise timing from a bidirectional drive circuit. The drive circuit is effectively a three-phase, full-wave system that produces smaller torque pulsations and, consequently, less wow and flutter than the half-wave systems used to drive some other turntable motors. The timing of the signals sent to the stator windings is controlled by three sets of fixed-position sensing windings and a separate position detector rotor that turns with the motor. These elements perform the commutation function that is necessary for the operation of a dc motor. Since all commutation is accomplished by means of magnetic induction, there are no brushes to wear out or become noisy.

The speed of the turntable is locked to the frequency of a crystal-controlled oscillator and is maintained to an accuracy of ±0.002%. Similar accuracy has been achieved in a number of other quartz-locked turntables in recent months, but only at the 33 1/3- and 45-rpm nominal operating speeds. For vernier speed control, the quartz locks of these turntables are disabled and their speed references are then adjustable dc voltages, as they are in conventional direct-drive turntables.

In the Technics turntable, however, the full accuracy and stability of a quartz-lock system are maintained, while the speeds can be adjusted over a ±9.9% range in discrete 0.1% steps. The exact deviation is decimally displayed by a digitally driven numeric readout, as are the basic 33 1/3- and 45-rpm operating speeds. The synthesized quartz frequency generator that makes this display possible would not have been practical before the development of large-scale integrated (LSI) circuits.

At the heart of the system is the synthesizer/counter chip. In it, the frequency of an external voltage-controlled oscillator (vco) is divided by 1000 and compared with the frequency of a crystal oscillator, which is also divided by 1000. The filtered output of the phase comparator is fed back to the vco, locking the latter in frequency and phase to the crystal reference signal. The divided frequency from the vco is also counted by circuits within the IC and converted into digital display drive signals. A scanning counter, controlled by + and − pushbuttons on the control panel of the turntable, can be used to change the frequency division ratio of the vco from 901 to 1099 in integral steps. This changes the frequency in 0.1% steps from −9.9% to +9.9%, while maintaining phase lock with the crystal reference.

A starting signal is applied to the turntable's coils when the system is first turned on. As the turntable speeds up, the frequency fed back from the frequency generator's gears is converted to a dc voltage in a frequency-to-voltage (F/V) converter whose output drives the motor's torque-control circuit. Simultaneously, the frequency feedback signal is compared with the vco signal, which is already locked to the divided crystal-oscillator frequency, in a phase comparator whose output is summed with the F/V converter's output. When the correct speed is attained, control is automatically transferred to the output of the phase comparator. The strobe markings under the turntable platter are illuminated by LED's and can be seen from above by a mirror system. The

(Continued on page 34)

SHAKESPEARE HAS

Talk power. Some CBers have it. Some don't.

If you don't have talk power, the odds are twenty to one the fault's in the antenna. You're not getting out. You're not coming through.

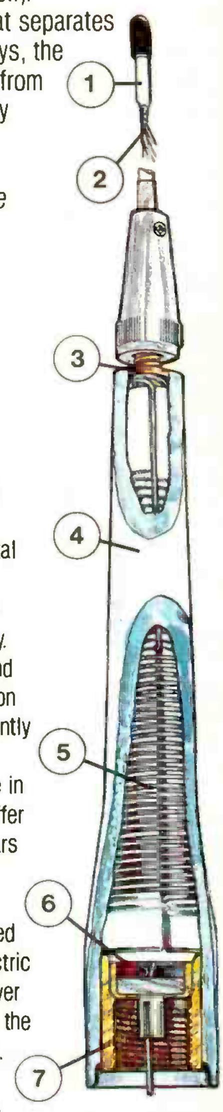
'Tis far better to transmit than to receive

Frankly, you can receive a signal with almost any antenna. A wire coat hanger might do.

But the name of the game in CB antennas is transmission (unless you like talking to yourself).

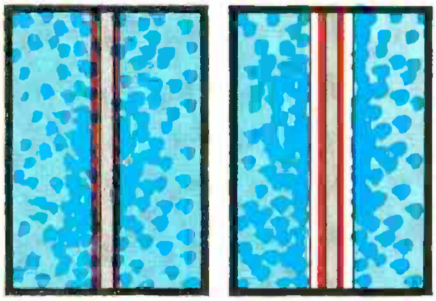
Talk power is what separates the men from the boys, the Knights of the Road from the weaklings. Your nearby Shakespeare antenna dealer will show you how *Shakespeare has everyone talking...loud and clear!*

Now you're talking!



(1) A protective sheath of high grade resin fiberglass totally encompassing the metal radiator. (2) Silver plated copper radiator lowers resistance and increases efficiency.
(3) Solid brass insert, hand soldered at the coil termination (not just crimped) to permanently seal out moisture.
(4) Strength and elegance in this polycarbonate housing offer immediate protection and years of aesthetic beauty.
(5) Helical wound tin plated copper coil on a tapered low-loss polycarbonate dielectric core. (6) Molten dipped silver mica matching capacitor (not the typical varnished pasteboard).
(7) Solid brass threaded fitting for positive coupling to antenna mount.

EVERYONE TALKING!

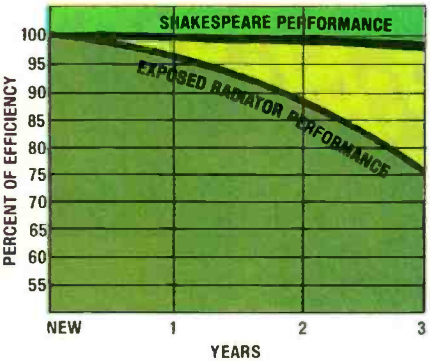


METAL ANTENNA (TYPICAL) — SHAKESPEARE FIBERGLASS ANTENNA

The principle of "skin effect": A transmitted signal, in the form of energy, travels on the surface of the metal radiator of an antenna. This occurs regardless of the length, density, or thickness of the metal radiator. Picture an antenna surface after it has been bombarded by millions of tiny particles as it travels through our air day after day. Dust, dirt, pollutants, salt, chemicals...all of them impinging on the surface to create obstacles that offer resistance to your transmitted signal.

The principle of "skin effect". Within six months exposure, surface resistance on an exposed antenna can rob you of up to 20% of your power.

DETERIORATION, SEVERE ENVIRONMENT



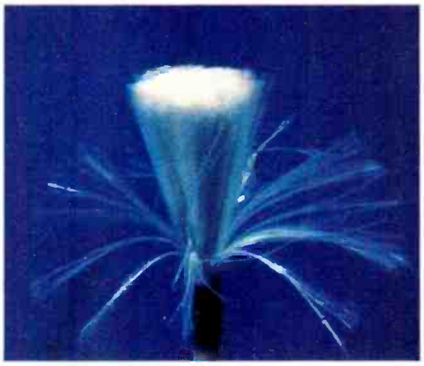
A speck of dust? It's hell in your eye... even worse on your antenna!

Like we said, it's the surface of a metal antenna that radiates the signal. Or is meant to.

Metal corrodes. Fiberglass does not corrode. And the fiberglass surface is far less susceptible to pollution and contaminants in the environment.

With a Shakespeare fiberglass antenna, surface deterioration does not mar performance because *the surface is not the radiator.* Instead, the radiator is sealed inside the fiberglass sheath, which is transparent to electronic radiation and lets the signal through without interference or distortion.

Thousands of glass filaments, running parallel the entire length of the antenna, are molded and cured under extreme heat and pressure to provide a structure amazingly strong, durable, and corrosion resistant.



Fiberglass... the way we do it.

Shakespeare has created "The Big Three" in antenna design: The Black Knight. The White Knight. The Silver Knight. Each of these great base loaded antennas is engineered to be the *best of its kind.* Each is pre-tuned at the factory.

The Black Knight™ antenna is Shakespeare's triumph in a new space age material, graphite. Providing unheard of strength and rigidity to keep your Black Knight antenna erect at highway speeds.

The White Knight™ antenna is Shakespeare's fiberglass beauty. The metal radiator that transmits the signal is sheathed in enduring fiberglass; safeguarded for life against moisture, salt, dirt, dust, pollution, and corrosion.

The Silver Knight™ antenna is Shakespeare's metal antenna, just to prove we're able to take on our competition at its own game. If it's a metal antenna you want, we've got the best metal anntenna you can buy.

RELAX...the world's largest Fiberglass antenna plant just made your next antenna.

200,000 square feet devoted entirely to CB and marine antennas and related fiberglass products, complete with advanced testing facilities and laboratories for research and development.

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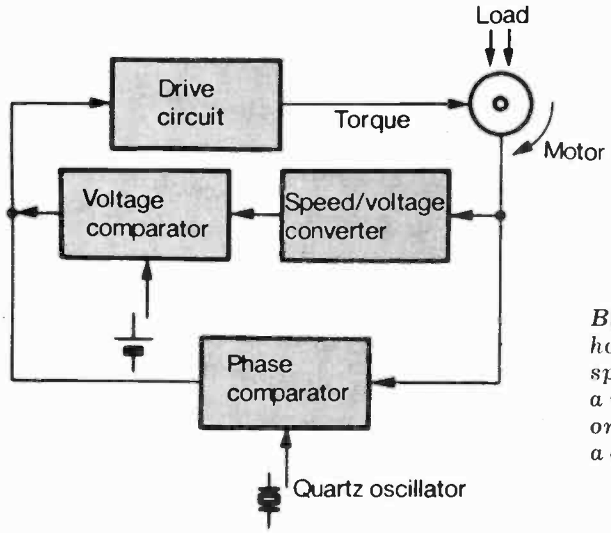
The Shakespeare Company/Manufacturers of Fishing Tackle, Communication Equipment, Industrial Fiberglass, Wonderthread and Specialized Monofilaments, Golf Equipment, Automotive Products, Saddlery and Equestrian Accessories, and Marine Taxidermy.

CIRCLE NO. 43 ON FREE INFORMATION CARD



Block diagram shows how motor rotational speed is "locked" to a reference frequency originating in a quartz oscillator.

(Continued from page 31)

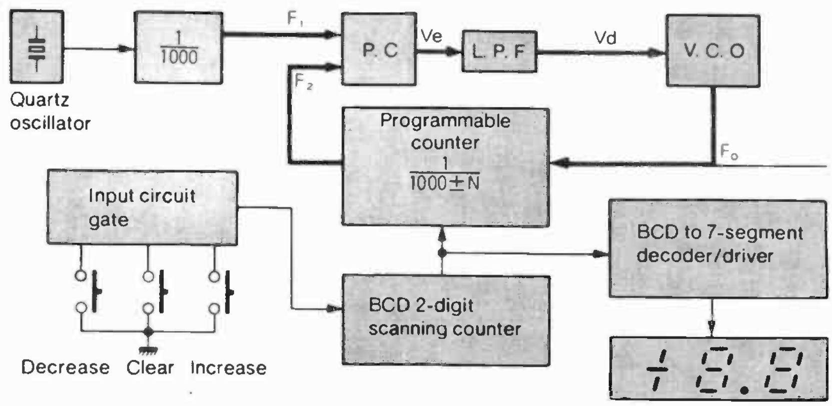
markings remain stationary, no matter what speed the platter is set for, as long as the phase-lock system is in control.

The motor drive is inherently bidirectional, allowing the speed of the platter to stabilize rapidly after it has been changed in either direction. A useful by-product of this system is the rapid braking that accompanies the shutdown of the motor.

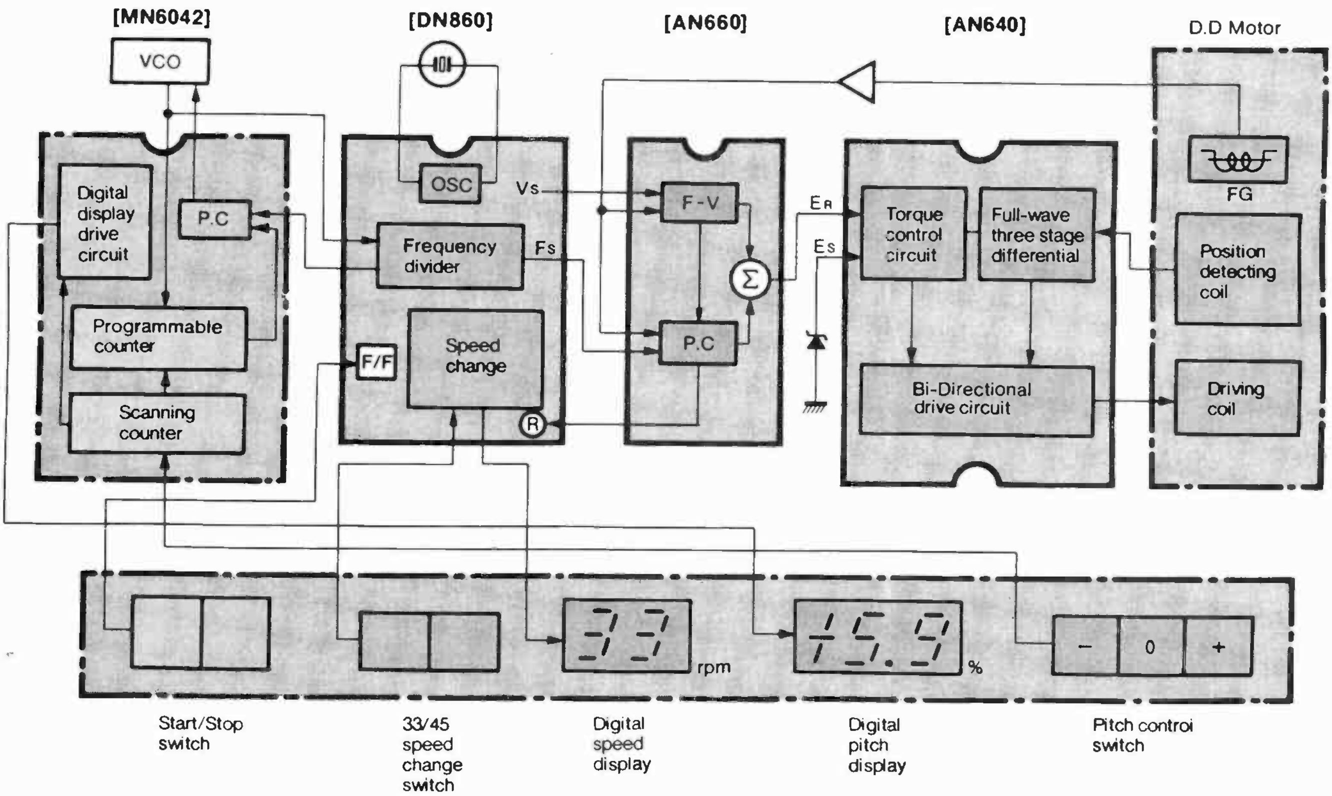
The tonearm furnished as part of the player is a mildly S-shaped aluminum tube with a lightweight diecast head shell. It is fitted with the four-pin bayonet locked plug that is now used almost universally with Japanese tonearms. The precision ball-bearing pivots are claimed to have less than 7 mg of friction in the horizontal or vertical planes.

(Continued on page 40)

The quartz synthesizer pitch control permits pitch variation by ±9.9% in steps of 0.1% by dividing the oscillator frequency by 1000.



The principal circuit components of the phase control system are incorporated in four IC's. Shown here also are the direct-drive motor and control/display circuits.



THE NEW Stereo Review SRT14 STEREO TEST RECORD

The editors and technical staff of Stereo Review present the most comprehensive, accurate and easy-to-use test record ever developed.

Here, at last, is a record that contains everything you need to get the fullest, most realistic reproduction from your stereo equipment.

Whether you've spent thousands on your stereo system or have a more modest setup, the SRT14 is an indispensable tool for helping you realize the full potential of your equipment.

Best of all, you don't have to be an electronics engineer to use it. You can actually perform a complete stereo-system checkup *by ear alone*.

A test lab in a record jacket

Employing the most advanced recording, mastering, and pressing techniques, the Stereo Review SRT14 is produced to strict laboratory standards. Engraved in its grooves are a series of precisely recorded test tones, frequency sweeps, and random-noise signals that enable you to accurately analyze and check your stereo system for:

- Frequency response.
- Stereo separation.
- Cartridge tracking.
- Channel balance.
- Hum and noise, including turntable rumble
- Wow and flutter
- Optimum speaker placement, and more . . . much more.

And you can do it all without any instruments . . . by ear alone.

Step-by-step instructions

Included with the SRT14 is a detailed instruction manual complete with charts, tables, and diagrams. This takes you step by step through the testing process. It explains the significance of each test. It tells you what to listen for. It clearly describes any abberations in system response. And it details corrective procedures.

For professionals too

The usefulness of the SRT14 is not confined to the nontechnical listener. Included on the record are a series of tests that call for the use of sophisticated measuring instruments, such as oscilloscopes, chart recorders, and distortion analyzers. These tests permit the advanced audiophile and professional to make precise measurements of transient response, recorded signal velocity, anti-skating compensation, IM distortion, and a host of other performance characteristics.

SRT14 record contents

FREQUENCY-RESPONSE TEST, LEFT AND RIGHT CHANNELS. Consists of half-octave warble tones that permit testing and adjustment of frequency response of a sound system over the full audio range.

STEREO SEPARATION. Indicates the amount of signal leakage from one channel into another using warble tones from 400 to 12,800 Hz.

PHONO-CARTRIDGE TRACKING, HIGH FREQUENCY. Consists of a two-tone test signal (16,000 and 16,300 Hz) that repeatedly swoops to a high level and returns to a fixed low level. The level and quality of an audible "difference tone" indicates mistracking.

PHONO-CARTRIDGE TRACKING, LOW FREQUENCY. A single 300-Hz tone recorded with similar swoops indicates mistracking as an increase in harmonic distortion.

CHANNEL BALANCE. Separate random-phase noise sources for the two channels permit balancing not only of overall channel levels, but also of the individual tweeters and mid-range drivers in the speaker systems.

PHASE TEST, SPEAKERS AND PHONO-CARTRIDGE. A low-frequency warble tone is recorded alternately in and out of phase several times to establish correct interchannel phasing.

NOISE TEST. A very low-level recording of a piano provides a reference playback level by which the low-frequency noise of a sound system playing an unmodulated groove can be judged.

RECORD-PLAYER FLUTTER TEST. A passage of piano music is recorded three times with increasing amounts of flutter. The degree to which the record-player's flutter "masks" the recorded flutter indicates its relative severity.

FREQUENCY-RESPONSE SWEEP, 10,000 TO 40,000 HZ. The frequency response and channel separation of a phono cartridge at ultrasonic frequencies can be measured with a voltmeter or other appropriate instrument to give an indication of the cartridge's suitability for CD-4 reproduction.

FREQUENCY-RESPONSE SWEEP, 500 TO 20,000 HZ. Similarly, the cartridge's response and separation over the range of important audible frequencies can be measured.

SQUARE-WAVE TEST. The high-frequency response, phase shift, and resonant characteristics of a phono cartridge can be evaluated quickly by viewing the reproduced waveform of an RIAA-equalized 500-Hz square wave on an oscilloscope.

TONE-BURST TEST. Tone bursts sweeping from 500 to 20,000 Hz give an indication of a phono cartridge's transient response when the reproduced signal is viewed on the oscilloscope.

INTERMODULATION-DISTORTION TEST. A phono cartridge's intermodulation distortion can be measured directly using a standard IM meter designed to analyze an SMPTE signal.

ANTISKATING TEST. A specially designed test signal permits adjustment of skating compensation for best reproduction of critical high-level recorded passages.

1,000-HZ REFERENCE TONES. Four tones whose recorded velocities increase by 3-dB steps can be used to determine (by the comparison method) the recorded signal velocity on a disc recording.

FLUTTER AND SPEED TEST. A 3,150-Hz tone recorded with great speed—accuracy and stability provides a signal for use with a flutter meter or frequency counter.

STEREO-SPREAD TEST. A series of recorded gun shots provide a guide to optimum speaker placement for the most subjective satisfying stereo image.

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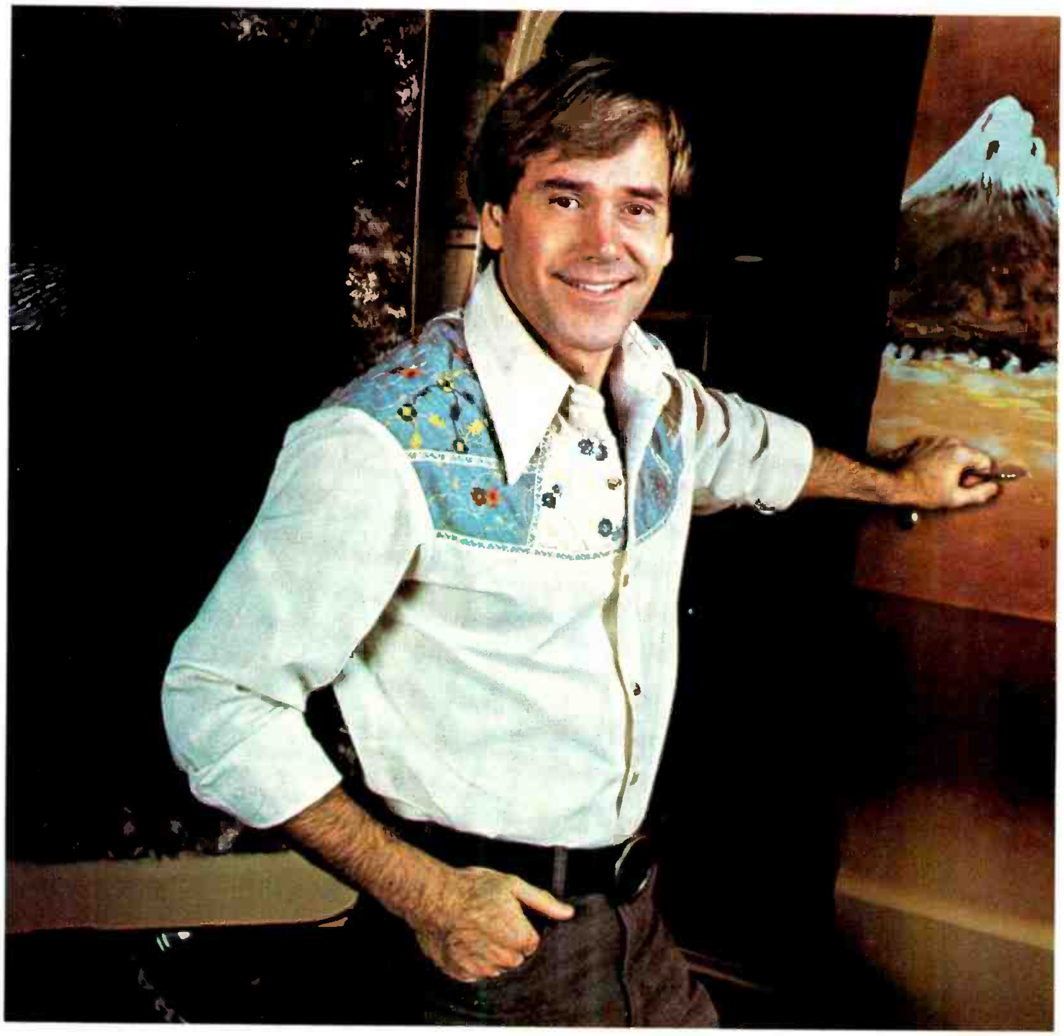
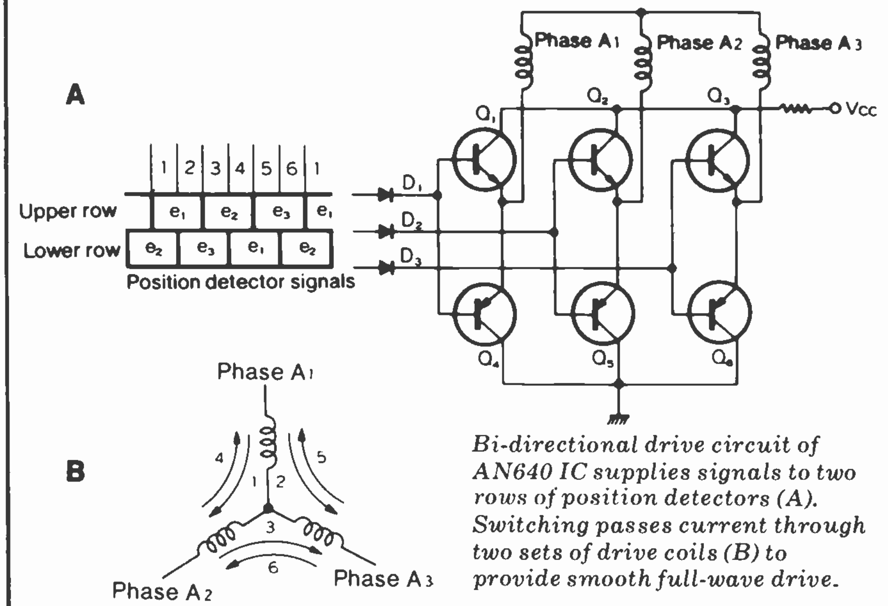


When you do, you'll probably pick CIE. You can't afford to settle for less when it comes to something like electronics training that could affect your whole life.



Bi-directional drive circuit of AN640 IC supplies signals to two rows of position detectors (A). Switching passes current through two sets of drive coils (B) to provide smooth full-wave drive.

(Continued from page 34)

The head shell has a calibrated scale and index marker that can be used to set the correct stylus overhang for any cartridge whose stylus-to-center spacing is known. The damped cueing system has a built-in muting switch that silences the audio outputs as soon as the tonearm is lifted and does not unmute until after the pickup had reached the surface of the record. Another useful feature of the tonearm is its adjustable height. By loosening a screw on the side of the tonearm's pivot support, the entire arm can be moved vertically over a 6-mm range with 1-mm calibrated accuracy. This makes it easy to set any cartridge parallel with the surface of a record for correct vertical tracking angle and to avoid mechanical interference between the body of the cartridge and the record.

The turntable's mounting base serves more than just a cosmetic function. The entire record player is supported on felt-damped feet, and the combined turntable/tonearm system is floated from the base on separate resilient mounts. The goal here was to isolate the turntable from external vibration and minimize acoustic feedback, often a problem with direct-drive record players.

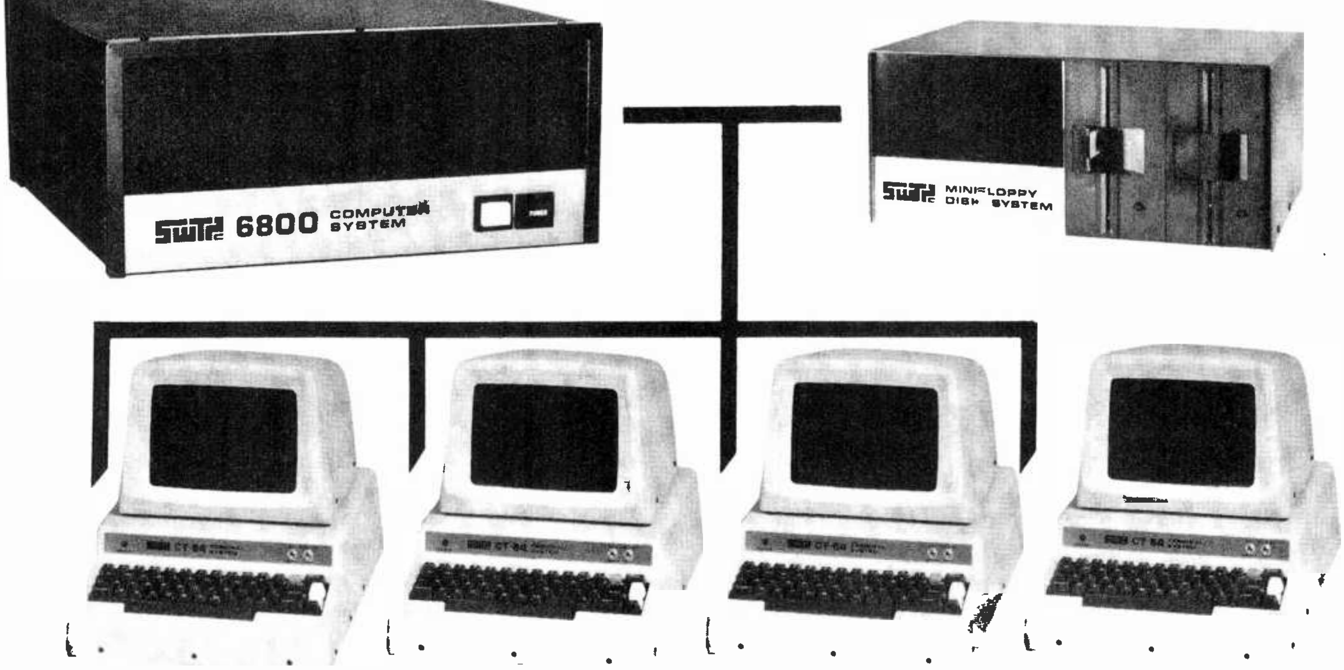
User Comment. We tested the record player with an AKG Model P8ES phono cartridge installed in its tonearm and performed our listening tests with an Ortofon Model M20FL Super cartridge installed. Cartridge installation and setup were simple and straightforward.

The record player conveys a sense of precision in both appearance and "feel" that is also evident in its performance. Having the operating controls out front and accessible even with the cover closed is a real advantage. The one slip-up in this respect is that the cueing control is not accessible until the dust cover is lifted. We also found the dust cover itself awkward to lift with one hand. Its front surface slopes to the rear and is difficult to grasp and lift except by its side or with two hands.

The turntable cannot be faulted. It came swiftly up to speed and changed speed so rapidly and in such small increments that we could hardly believe that anything was really changing. When we played the 1000-Hz band of a test record and displayed the output on a frequency counter, each touch of a vernier button changed the displayed frequency by exactly 1 Hz. The almost instantaneous stopping of the platter when the STOP button was touched was a nicety we appreciated.

The cueing/muting system is ingenious, but was too slow for our taste. Some 10 seconds are required to unmute after the cueing lever is lowered, though the descent time of the tonearm can be adjusted over wide limits, depending on the height to which the lift is set. If the descent is too fast, a portion of the record will not be heard before the muting is disabled. If the descent is too slow, the unmuting will occur before it should and the thump of the stylus contacting the record will be heard. Optimally, the descent should be timed, by appropriate setting of the lift height, for

MULTI-USER SYSTEM



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about nine seconds. This may tax the user's patience, but will result in ideally quiet cueing action.

The strobe pattern was always rock steady during our tests, except for brief transients as we were making large speed changes. The only way to make the pattern move was to place so much drag on the turntable that it dropped out of synchronism with the quartz oscillator. Needless to say, under a condition like this, we did not have to look at the strobe pattern to know that the turntable was running slow.

The Model SL-1500MK2 is certainly one of the nicest looking pieces of record playing machinery we have seen. It offers a combination of mechanical and electronic sophistication that is nothing less than remarkable for a record-playing system of its modest price.

INFINITY MODEL Qb SPEAKER SYSTEM

Three-way system features electromagnetic induction tweeter.

HIRSCH-HOUCK LABS REPORT

The three-way Infinity Model Qb speaker system features a new tweeter of unconventional design, called an EMIT (electromagnetic induction tweeter). This is backed up by a 10" (25.4-cm) woofer whose cone mass is progressively decoupled with increasing frequency to improve its performance in the upper-bass range. The 600-to-4000-Hz midrange is handled by a 4" (10.2-cm) cone driver. The system's impedance is rated at 4 ohms, and recommended driving power is 15 to 150 watts/channel.

The fully sealed enclosure is finished in birch-grain vinyl. It measures 25" H × 14½ W × 12"D (63.5 × 36.8 × 30.5 cm) and weighs nearly 40 lb (18.2 kg). Although it is no larger than many so-called "bookshelf" speaker systems, the Model Qb is meant to be placed on the floor, preferably on an optional steel pedestal available from Infinity. The pedestal raises the speaker about 12" from the floor and tilts it slightly backward, preferably no closer than a couple of feet from any room wall.

Two small knobs set into the rear of the cabinet are provided for varying the outputs of the midrange and treble drivers over a limited range. The frequency response of the speaker system is rated at 42 to 32,000 Hz ±3 dB, under unspecified test conditions. The horizontal dispersion is rated at ±60° at 20,000 Hz for an output-level decrease of 2 dB.

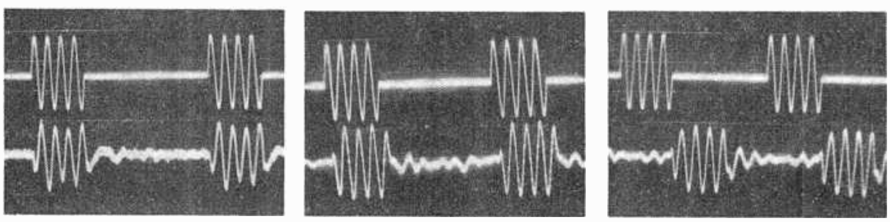
The nationally advertised value of the Model Qb is $192 and the optional steel stands are $40 per pair.

Laboratory Measurements. The averaged frequency response of the speaker system, measured in the reverberant field of our test room, was exceptionally flat from several hundred hertz to the 15,000-Hz upper limit of our microphone's calibration. The overall variation of ±2 dB from 450 to 15,000 Hz places the Model Qb in a very select group of speaker systems. (Our measurements are made at normal listening distance in a normally furnished room, rather than in the unnatural environment of an anechoic chamber.) The polar dispersion was good, although in our test room, there was about a 5-dB difference in high-frequency output measured on-axis and 30° off-axis.

Locating the microphone close to the woofer, the output of the latter exhibited a downward-sloping characteristic at frequencies beyond 65 Hz. It amounted to about an 8-dB decrease at 600 Hz, where the steeper attenuation of the crossover network began. Below 45 Hz, the output fell at the 12 dB/octave rate that would be expected from a sealed speaker system.

Splicing the woofer and midrange/high-frequency curves together was not as unambiguous as we would have liked, but our best approximation of a combined curve revealed a considerable low-frequency rise below 200 Hz. This did not coincide with what we heard from the speaker system. It is probable that by installing the speaker on its tilt stand and locating it well away from any wall, the bass response would tend to be minimized, which is in all likelihood why Infinity recommends the use of the stand. In any event, it was clear that the woofer's output down to below 35 Hz, was at or above the midrange and high-frequency levels.

The midrange and tweeter level controls had very limited adjustment ranges, making it impossible to seriously degrade the performance of the speaker



Tone-burst responses at 100, 500, and 5000 Hz.

Product Focus

The most unique feature of the Infinity Model Qb, visually and audibly, is its EMIT (Electromagnetic induction tweeter) speaker. The EMIT is used singly in the Model Qb (and its lower priced two-way version, the Qa) and in arrays in the company's higher-priced speaker systems. It is meant to provide the essential advantages of electrostatic speakers, such as extremely smooth and extended high-frequency response and excellent transient response. Unlike the electrostatic speaker, it is rugged, efficient, can handle considerable power input, and has superior dispersion.

From the front, the EMIT does not look at all like a conventional speaker. It is a flat plate with four narrow slits, behind which there appears to be a plastic diaphragm. This diaphragm is a thin, low-mass plastic, resembling that of an electrostatic tweeter. Deposited on it is an etched conductor "winding" that consists of a number of turns in the shape of a highly elongated rectangle. The long sides of the winding are behind the slots in the front plate, and the conductors are in the field of two powerful samarium-cobalt magnets.

The signal current passing through the conductors on the tweeter diaphragm produces a deflection of the thin plastic. The diaphragm is driven uniformly over its effective radiating surface, like that of an electrostatic speaker. But the efficiency and ruggedness of the EMIT give it a considerable advantage over the electrostatic type. In addition, the EMIT does not require a power source for a polarizing voltage. The vertical orientation of the slots in the front plate gives the driver excellent horizontal dispersion.

system by careless setting of the controls. The tweeter level could be varied over about a ±1-dB range at frequencies beyond 3500 Hz, and the midrange control had a range of about ±1 dB from 600 to 3500 Hz.

The impedance of the system attained its minimum of 4 ohms at 20 Hz. A second minimum impedance of 4 to 5 ohms occurred at 120 Hz. Over most of the audio range, the impedance measured between 5 and 15 ohms. At the 54-Hz bass resonance point, the impedance was almost 20 ohms.

For a fully sealed speaker system, the Model Qb is moderately efficient. When driven with 2.8 volts of random noise in the 1000-Hz octave (2 watts into the rated 4-ohm impedance), it produced an 89-dB sound-pressure level (SPL) at a distance of 1 meter. The bass distortion at a 1-watt level (2 volts) was less than 1% down to 65 Hz. It rose slowly to 4% at 40 Hz and to 7% at 30 Hz. With a 10-watt input, the distortion rose more rapidly. It reached 5% at 56 Hz and 10% at 40 Hz. The tone-burst response was good at all frequencies.

User Comment. The absence of peaks or dips in the response of the Model Qb is immediately apparent from its sound. The speaker system sounds smooth and uncolored. The EMIT tweeter has a crystalline clarity, with no trace of stridency. In general, we listened to the speaker system with its level controls set to their centers of rotation, which gave us the flattest response in our lab measurements. In our opinion, however, these controls could have been omitted altogether, since their effect on the sound is so subtle.

The bass performance of the system is not as easy to evaluate as that of the EMIT, since the bass is influenced to a greater degree by the listening room. Following Infinity's instructions for setup, we felt that the balance between lows, middles, and highs was just right. The bass was deep and solid when required, and there was little tendency to exaggerate the upper bass, which is a common fault with many speaker systems. On powerful organ-pedal notes, the woofer on one system tended to "flutter" at its extreme excursion. Investigating this, we felt an air leak around the tweeter when the woofer was driven hard. This was obviously a manufacturing defect because it did not occur with the other speaker system in our stereo setup.

The brown grille cloth is attached to a wooden frame that snaps onto the speaker enclosure with two plastic fasteners, one of which is located at the center of the top edge and the other at the center of the bottom edge of the frame. These fasteners support the grille about ⅛" (3.2 mm) from the front of the enclosure. When the systems were driven hard, the grille assemblies rocked from side to side. This did not produce any audible buzzing or resonance effects in our tests, however.

The Infinity Model Qb is competitively priced with a number of other fine speaker systems. It is highly listenable, with a smooth, uncolored sound and no detectable audible weaknesses in its performance. Also, playing the speaker system for an extended period of time, we concluded that we would be happy to "live" with it.

CIRCLE NO. 103 ON FREE INFORMATION CARD

HOW TO GET HI-FI SOUND IN ANY AUTO!

The latest mobile sound components and how to match them to an automobile environment.

BY PETER SUTHEIM

A BOUNTIFUL crop of high-quality audio components for mobile use has been introduced this year. Consequently, it's now easier to obtain "hi-fi" sound in an automobile. Here is an in-depth look at some of the new car speakers, power boosters, equalizers, tape decks and FM receivers and the special challenges you will face if you are to take full advantage of the better sound they offer.

Speakers. The primary problem involved in an audio system for a car concerns the speakers and their placement. As you know, there is little space available for normal-size speaker enclosures in an automobile. Thus, you must use tiny enclosures or mount "raw" loudspeakers in already available cavities. With stereo and quadraphonic sound, the problem is compounded.

If you have the space, excellent speaker performance can be had from several makes and models of small integral speaker systems. The ADS Models 2002 and 2001, which include biamplification systems, are prime examples of this type. The enclosures themselves are about the size of squat milk cartons. They are made of cast aluminum, and each contains a 4″ (10.2-cm) woofer and a 1″ (2.54-cm) dome tweeter. The individual speakers in each enclosure are driven by separate amplifiers, with frequency division for crossover occurring before the amplifiers.

ADS produces virtually the same speaker system without the amplifier as the Model 200. It is a 4-ohm system specifically designed for a car stereo setup. The Model 200's thrive on hefty amounts of power, so they will *not* sound their best with the typical 3-watts/channel EIA-rated output of most low-cost in-dash car stereo units.

Similar to the ADS Model 200 are the Visonik "Little David" 50, the Braun "Output C," the ACR system, Tamon's Model LB-1030, and the Roadstar Mod-

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el RS-6040. The foregoing are merely the *smallest* high-quality speaker systems. The ADS Model 300, for example, is akin to them but it has a 6" (15.2-cm) woofer and offers correspondingly better bass and higher power-handling ability. Advent's Model 400 is a larger design.

If integral speaker systems, with their properly designed enclosures, appear to be impractical (for space or safety reasons) or unattractive, you will have to mount raw speakers into the body of your car. Unfortunately, the most popular speaker-mounting locations are not truly ideal acoustically. These include in the doors, under the seat, in the shelf under the rear window, etc. Such locations might excite low- and middle-frequency resonances in the car's interior air space or mechanical resonances in the body structure. Such problems, however, are usually minimized by ambient noise and other factors. Also, upper frequencies produced by speakers in such locations do not get a straight shot at the listener. However, these locations are the most likely available ones in a car, and do serve rather well in this strange acoustic environment.

Installing Raw Speakers. If you can accomplish it mechanically, the best place for a couple of small midrange drivers is either directly in front of you in the dashboard or just under the dash. Here, one driver would be placed at each end of the dash and aimed slightly upward. However, because space is limited and because the open-bottom dash makes a poor woofer baffle, they should be supplemented by a woofer system located elsewhere. A passive crossover or an active arrangement with two sets of amplifiers should be used in this case.

The speakers should be rigidly mounted as nearly flush with the outer surface as possible. (Shallow cavities created by rear mounting tend to color the sound.) Some protection, in the form of a suitably cut slab of soft open-cell foam (available from electronics and car-stereo stores), is required for the speakers. If you wish, back up the foam with aluminum window screening or lightweight hardware cloth for protection.

With some midrange drivers, especially smaller ones, you may not need tweeters. If you do—and you will if you use 5" (13-cm) drivers—use only one per channel. Locate the tweeters as close as possible to the midrange drivers, preferably right next to them. The tweeters can use their own special amplifier or the same amplifier as the midrange drivers. In either case, a dividing network is required to protect the tweeters from potentially damaging low-frequency energy. Use a minimum value of 4 μF (nonelectrolytic) capacitance in series with the tweeter and amplifier for an 8-ohm tweeter or 8 μF for a 4-ohm tweeter. This provides a 6-dB/octave rolloff below about 5000 Hz. You can improve on this by adding a low-resistance, 0.25-mH air-core inductor in series with an 8-ohm midrange driver or a 0.12-mH choke in series with a 4-ohm driver. Connections are shown in Fig. 1.

Door Mounting. If you cannot find a suitable location for the speaker drivers up front, you will have to put them in the doors or somewhere to the rear. Doors are not the very best choice for mechanical and acoustic reasons. For example, some speakers are too deep to fit into such shallow locations. Moreover, without adequate damping material, the outer sheet metal tends to reflect shorter-wavelength energy back through the cone. But given limited auto interior space, doors are deservedly popular speaker-mounting locations.

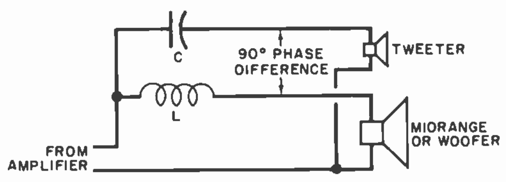
There are some precautions to observe when installing speakers in doors. For example, damping material is difficult to install unless you can prevent it from interfering with the window and latch mechanisms. For the same reason, it is risky to cut into the interior door panel just below the window, which is the best acoustical location. Door-mounted speakers are, therefore, usually installed far down, where some of the upper frequencies are radiated into upholstery and carpet.

The proper way to install a speaker in a door is to remove the entire interior trim panel, which means removing at least the window crank as well. Then examine the exposed mechanical setup to determine if there is clearance for a small 3" to 5" (7.6 to 12.7 cm) driver as high and as far forward as possible. Once this has been determined, cement as large a square of ½"-thick felt or sound-deadening board as possible to the inside surface of the outer sheet-metal panel at that location; use roofing cement or silicone-rubber adhesive. Crank the window up and down to be sure the damping material does not interfere with any mechanism. Do not cut any holes in the interior panel until you have determined what you plan to do.

Rear-shelf Mounting. Another possible location for mounting raw, unenclosed speakers is the shelf under the rear window. Though there are several drawbacks to this location, too, most can be overcome. The most serious drawback is that the speaker backs "look" into a trunk that's a large, rather reflective resonant cavity common to both speakers. This will tend to reduce stereo separation and promote boomy bass. In small cars that are nearly airtight, you may even run the risk of rupturing the trunk-speaker cones if you slam the door with all windows rolled up. Some manufacturers such as Acoustic Fiber Sound have made a bid to solve these problems with enclosed speaker systems.

If the speakers face upward, sound will be reflected and dispersed by the rear window of the car. This is an effective way of throwing the sound into the car, but it further reduces stereo separation and stereo imaging, which is already somewhat peculiar because the speakers are behind the listeners.

Finally, the sun tends to roast anything on the rear shelf. Therefore you *must* protect the speakers with a foam grille. The grille itself will likely have to be replaced after a year or so when it crumbles. For mobile stereophiles who like robust sound with lots of bass and "hot" highs, the rear shelf is the place to put multiple-driver assemblies with 6" × 9" woofers and separate tweeters (and even separate midrange drivers in some



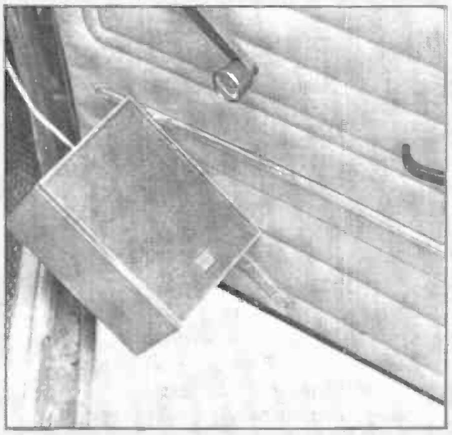
SPKR IMPED	C	L	TURNS
4Ω	8μF	0.12mH	75
8Ω	4μF	0.25mH	105

NO. 18 ENAMELED MAGNET WIRE ON 1" DOWEL, 1" LONG

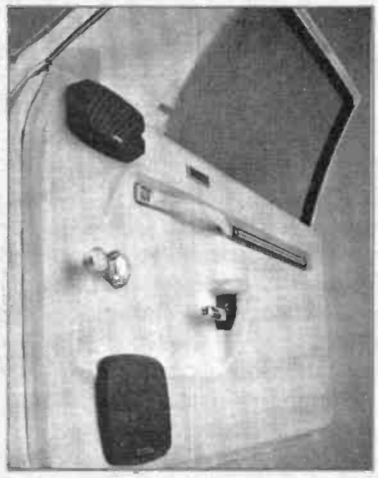
Fig. 1. Simple passive crossover for use with separate woofer and tweeter rolls off 6 dB/octave below 5000 Hz.

AUTO SPEAKER SYSTEM SAMPLER

Advent EQ-1 self-amplified 6" × 9" speaker is equalized for rear-deck mounting.



Unorthodox door mounting of Radio Shack "Minimus 0.5" aims sound at listener's ears, but could use separate woofer for deeper bass.



Jensen Triaxial® for front door panels has low-mounted 5¼" woofer, and surface-mounting mid-high module.

Bi-amplified ADS 2002 speakers are designed to operate with Nakamichi's high-quality Model 250 cassette player.

models). Since the midrange drivers and tweeters in such systems often have closed backs, channel-to-channel coupling via the trunk at middle frequencies is less of a problem. At low frequencies, most of the material on commercial pop recordings is essentially monophonic anyway, so there is no loss.

Advent has announced its Model EQ-1 twin 6" × 9" (15.2 × 22.9 cm) powered speaker system that is equalized especially for rear-deck mounting. Also worth noting is the Polk Mini-Monitor, which may be too large for most cars, but not for some vans.

Coaxial speakers or preassembled systems with a woofer and a tweeter make sense if you keep in mind the general principles stated here. Jensen Sound Laboratories and KLH, among others, even have 3-way coaxial types.

Your vehicle may offer unique mounting possibilities. Some van owners, for example, have been happy with speakers mounted into the seats themselves or into the roof. A few general hints may help. First, low frequencies are essentially nondirectional, and the ear is easily fooled into placing the origin of the bass frequencies at the source from which the middle frequencies are emanating. Therefore, you are free to work with small drivers, leaving the bass from as high as 200 Hz and down to be reproduced by other speakers located under a seat or on the rear shelf. Also, small drivers are far easier to install in near-optimum locations.

The second hint is to aim the midrange drivers and accompanying tweeters, if any, so they have a clear path to your ears. The larger the cone, the lower the frequency at which uneven dispersion begins: for a 3" driver, it is at about 4000 Hz; for a 4" driver, at about 3000 Hz; and for a 5" driver, at about 2500 Hz. This means that for any place you sit, off-axis output from the driver will be erratic and not easily predictable beyond those frequencies. In a high-quality system, this is the chief reason for crossing over to a tweeter at those frequencies.

The third hint is to mount the midrange driver, where possible, in a rigid airtight box filled (but not packed tightly) with fiberglass or other insulation. An internal volume of 180 cu in. (9" × 5" × 4"), for example, will allow smooth response down to about 120 Hz with a suitable 3" or 4" high-compliance driver. The box need not be rectangular; in fact, an irregular shape will reduce cavity-resonance problems.

Finally, protect all drivers with an acoustically transparent foam or screen grille.

Speaker Connections. Phasing multiple drivers can be a challenge. With loudspeakers close together and wired in series or parallel, they are either in- or out-of-phase. In-phase hookups are preferred, for better bass response and clearer stereo imaging. Therefore, with identical parallel-connected speakers, wire "like" terminals together (one terminal is usually identified with a spot of paint or a "+"); with identical speakers in series, wire opposite terminals together as shown in Fig. 2.

If you mix dissimilar speakers, you must first establish the correct phasing. You can do this with a single flashlight cell by temporarily connecting it across the speaker's terminals and observing the direction of cone travel. If the cone moves outward, mark the speaker terminal to which the positive terminal of the battery is connected with nail polish. If the cone moves inward, mark the speaker terminal to which the battery's negative terminal is connected. Do this with every driver you plan to use, whether or not they are already marked.

It's not as easy when crossover capacitors and inductors are involved. With a simple 6-dB/octave circuit like that shown in Fig. 1, there is a 90° phase difference between the low (midrange) output and the high (tweeter) output. The usual practice is to connect the tweeter in a way that would be out-of-phase if there were no crossover network. Try making connections both ways. If you hear a difference, connect it the way that sounds best to you. With a properly phased set of drivers, the sound is more coherent than with improperly phased speakers.

A separate woofer system calls for a more sophisticated crossover. Because of the low frequencies involved, this is best handled with a separate amplifier and an active crossover network. Alternatively, you could use a passive network, of course. However, inductive values become large and the coils are therefore costlier. Additionally, there is some loss of power. If you want a passive woofer network, however, the circuit in Fig. 3 works well. It requires two 12-mH iron-core chokes of less than 1-ohm resistance (available from TSR Engineering, 5146 W. Imperial Hwy., Los Angeles, CA 90045 for $7.50 each).

An active-filter circuit for one channel is illustrated in Fig. 4. The "low" output is intended to feed a separate power booster. More economically, a single crossover can be used for both channels, feeding a common bass amplifier/speaker channel as shown. This requires only one bass amplifier (Setton makes a single-channel one), and one woofer. The main speakers then each receive a full-range signal.

A cluster of four 5" or 6" woofers makes sense at low frequencies if you can find the space for them. Use two 8-ohm units in parallel across each power booster output. Unlike typical power amplifiers, boosters generally "like" 4-ohm loads. Be sure to check the manufacturer's instructions on this, though.

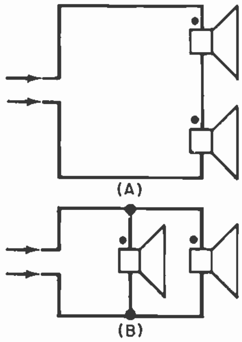


Fig. 2. For correct phasing in multiple-speaker installations, wire "unlike" terminals in series as at (A), "like" ones in parallel as at (B).

If you listen mostly to classical music, you can "fake it," if it is more convenient, by taking the bass from only one channel with a below-100-Hz dividing network (Fig. 3).

Finally, you may wish to consider a neat trick to give a sense of expanded space without expensive reverberation or delay devices. Simply connect two small (3" is fine), inexpensive drivers, wired in series and out-of-phase, from the "hot" side of one channel to the "hot" side of the other channel. (See Fig. 5.) Locate the drivers someplace to the rear of the car, on either side of the rear window, for example. The type of enclosure used is unimportant.

A 25-ohm speaker level control potentiometer wired in series with the drivers will allow you to experiment with the level of the rear ambience until it satisfies you. Also, a nonpolarized 8- or 10-μF capacitor connected across the speaker pair attenuates the upper couple of octaves to make the "recovered ambience" sound more like actual reflected sound. The effect of this hookup is very similar to some matrix quadraphonic schemes at nowhere near the expense. (For true 4-channel sound, an eight-track tape deck would be required.) It also does wonders for stereo; rear-seat passengers will enjoy it, too.

Amplifiers. A single transformerless class-B output stage working with a 12-volt supply (actually about 13.8 volts) cannot produce more than about 2 watts of continuous power into an 8-ohm load or 4 watts into a 4-ohm load without being overdriven. Since this is what most low-cost car stereos use, you can see that the output power claims for some of them are wildly optimistic. Hence the market for power boosters.

There are several ways to obtain more power from a 12-volt source. The most common and least expensive is limited to a theoretical maximum of four times the "simple" power output. How this is done is shown in Fig. 6. Two identical amplifiers are fed the same input, both out-of-phase. The speaker load is connected between the "hot" outputs, neither side of which can be grounded. One amplifier "pushes" as the other "pulls." The net effect is to double the supply voltage, which produces four times the power in the same resistive load. This works out to about 8 watts into 8 ohms and 16 watts into 4 ohms.

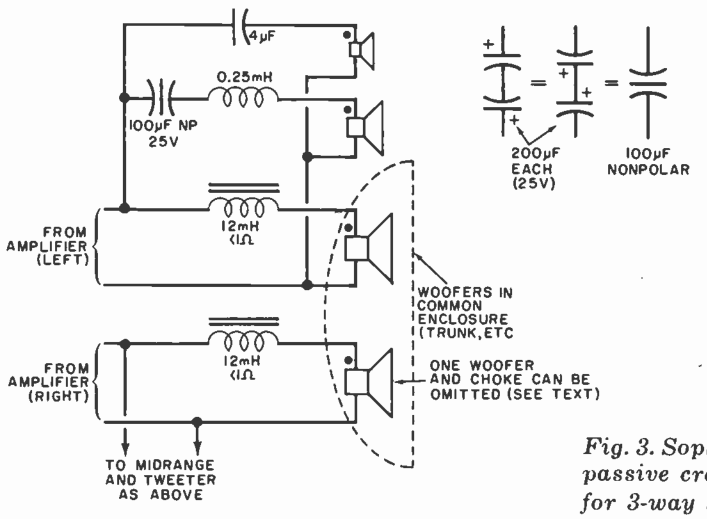
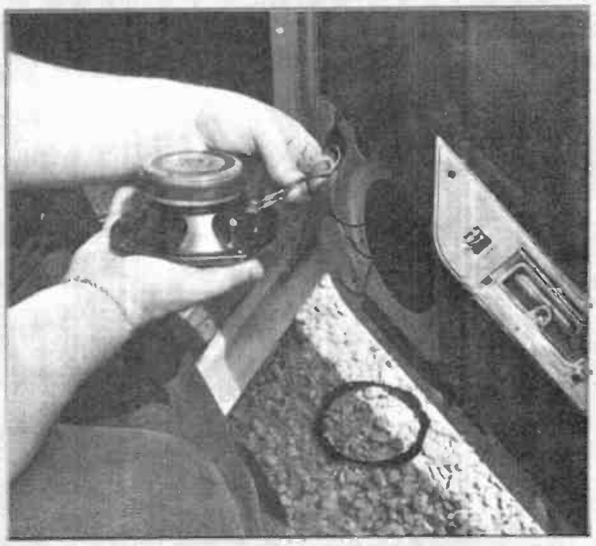


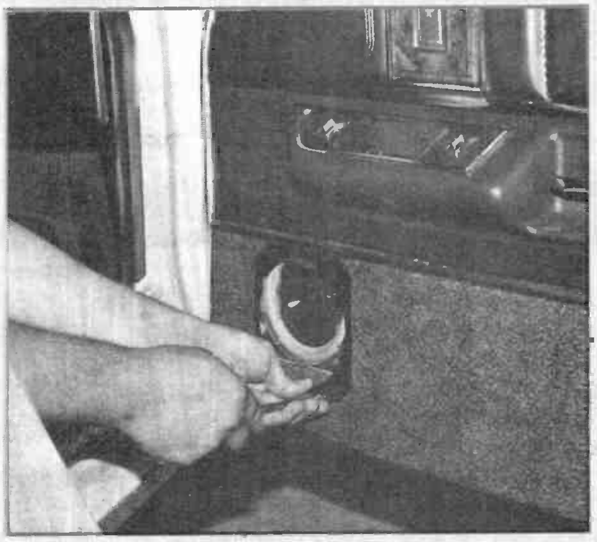
Fig. 3. Sophisticated passive crossover for 3-way systems.

TECHNIQUES FOR AUTO SPEAKER INSTALLATION

Unscrewing carpet-retaining plate provides handy channel for wires feeding signals to amplifiers or to the rear speakers.

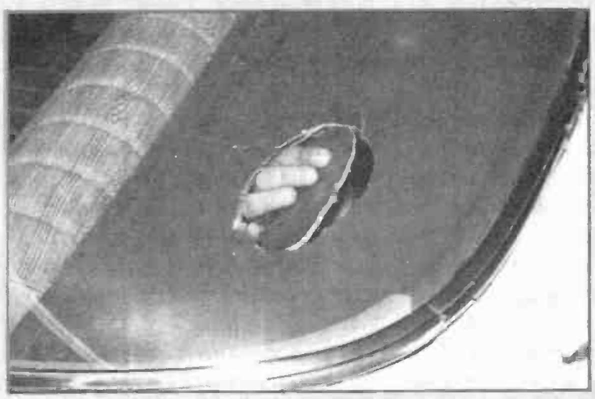


Removing front door panel shows where this "Kriket" speaker can mount. (Here, there's a pre-cut hole.) Attach wires before securing speaker.



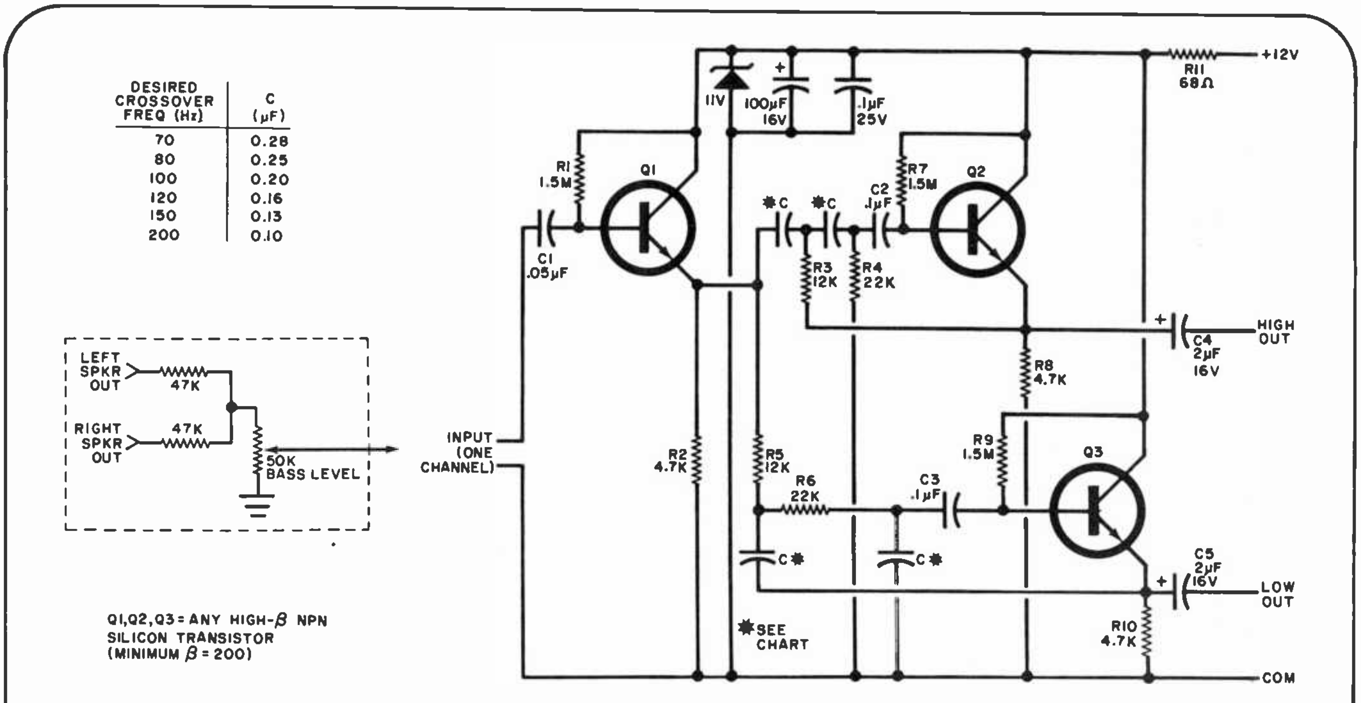
Reinstalling the door panel, a snap-in grille mounting plate is secured. With some makes, a grille snaps onto the speaker or is held by speaker-mount screws.

Sound-deadening board, secured with roofing cement, suppresses rattles and resonances which may occur with sheet-metal door panels.



Cut speaker hole in rear deck with a sharp blade or sabre saw. Many trunks have oval stampings under the deck that can be used as guides when cutting 6" x 9" holes.

Add speaker grilles to protect cones and to enhance appearance. Use bolts, not screws, to fasten grille. One of two speakers on back deck is shown.



DESIRED CROSSOVER FREQ (Hz)	C (μF)
70	0.28
80	0.25
100	0.20
120	0.16
150	0.13
200	0.10

Fig. 4. Electronic crossover feeds highs and lows to separate amplifiers. Crossover frequency depends on value of capacitor. Summing network (dashed box) lets you use one crossover and one bass amplifier to feed a common woofer. Otherwise, 2 crossovers and 4 amplifiers are required.

A variation of this technique uses an autotransformer to step up the voltage to the speaker. Since almost unlimited current is available from the car's electrical system, it is possible to use high-current output transistors to swing as much as 3 or 4 amperes into a transformer winding. In effect, the speaker's impedance is stepped down to 2 ohms or less by the transformer. Since output power is inversely proportional to load impedance, it goes up accordingly.

A third way is to use a dc-to-dc converter to raise the supply voltage. The output power available with this technique is limited only by the current that can be drawn from the car's electrical system without taxing other functions it must also serve. This approach makes it possible to adapt the power-amplifier circuits from home audio components to mobile service. All that is necessary is to design a switching-type dc converter with sufficient voltage, current, and regulation to feed the desired amplifier.

A fourth method you can use is biamplification. By dividing the audio spectrum into two or more parts, with corresponding numbers of amplifiers in each channel, each feeding a suitable speaker, you effectively parallel the amplifiers across the 12-volt supply. The combined output from this scheme is several times greater than you would expect, thanks to the uneven distribution of energy in music. (This is the technique employed in the ADS Model 2001 and 2002 systems and some Sanyo stereos.)

Unless a specification sheet explicitly mentions "FTC ratings," car-amplifier output power figures should be taken with a large grain of salt. Copy writers can come up with amazing power figures by ignoring clipping, assuming a 14- or 15-volt supply and a 4-ohm or less impedance, using "peak" power, etc. Read before you buy, and be prepared to pay reasonably high prices for good amplifiers. The $20 power boosters are likely to be disappointing.

Most boosters are designed to operate from the speaker outputs of a complete in-dash or under-dash radio receiver and/or tape player. Since the outputs of such a unit generally include a large series dc-blocking electrolytic capacitor, the boosters usually have a low-value resistor (10 to 100 ohms) across their inputs. This reduces the ill effects of dc leakage through the capacitor. Unfortunately, the low input shunt resistance also makes it impossible to drive the boosters like normal power amplifiers, directly from the volume control of the main unit. It is usually possible to snip one lead of this input shunt to remove it. Bear in mind, however, that by opening the booster's case you will in all likelihood void its warranty if tinkering is noticeable.

Once you remove the shunt, you have a two-channel power amplifier that can be used directly from the volume or tone controls of your main unit or with the active crossover described in this article.

Some power boosters have a transformer input and no shunt resistor. These can definitely *not* be used from high-impedance internal feeds.

One manufacturer hopes to standardize the industry on a 1000-ohm source impedance and 10,000-ohm input, with typically 250-mV input levels. But until that occurs, you are on your own. Impedance matching is not the issue here. However, a 50,000-ohm volume control will not take kindly to a load of 100 ohms from its wiper to ground. The output level will be severely reduced, and there may be distortion at the top end of the volume control. If you mate components from different manufacturers, you will have to obtain schematic diagrams from each manufacturer and examine them to determine if the units you plan to use are compatible. However, most units are compatible, with minor modifications.

You can solve some mating problems by using a pair of emitter-follower circuits, as shown in Fig. 7. (The maximum source impedance at a volume-control wiper is one-fourth the value of the control if the control is fed from a low impedance. It occurs at the setting where the output level is 6 dB down from maximum.) Assuming a 50,000-ohm control, the highest source impedance will typically be between 10,000 and 15,000 ohms, depending on what precedes the control. It is unwise to drive more than 10′ to 15′ (3 to 4.6 m) of shielded cable at this impedance. If you do, high-frequency losses may become audible. However, you may need greater length than this in a large car if the power amplifier is located in the trunk. This is where an emitter-follower circuit can prove useful!

The outputs of mobile booster amplifiers usually float with respect to ground. Hence, use separate conductor pairs for connections to all speakers. If either side of a speaker output is grounded or a common lead between outputs is used, the booster amplifier can be damaged. Use nothing smaller than No. 18 wire for dc supply leads and speaker wiring. In fact, No. 16 is better, especially with 4-ohm speakers and speakers wired in parallel.

Booster amplifiers can usually be located anywhere. Some have power switches, but you can avoid the need for accessing them by using the circuit in Fig. 8. This allows all accessories to be turned on and off from the switch on the main dashboard receiver or player. If the dash receiver you choose has a connection for a power-driven antenna, you can use that to operate a relay like the one in Fig. 8. The contacts of the relay can then switch the boosters and other devices. Be sure, however, that the relay can handle at least half of the maximum current drawn by the booster amplifier at full output.

Avoid mounting boosters (or any electronics, for that matter) near heater outlets or where they will be exposed to direct sunlight or engine heat. Some boosters are quite heavy, which necessitates the need for secure mounting. The heavier ones are best laid flat on a sturdy surface and then bolted down with No. 8 or No. 10 machine screws, lockwashers, and nuts.

You are on your own when it comes to connectors. Only a small number of mobile electronics gear uses the familiar phono jack and plug. With the manufacturer's instructions and a schematic diagram, which is often but not always supplied, you will usually be able to identify the various leads and attach suitable connectors if needed. Do not expect one manufacturer's booster amplifier to interface with another's dashboard unit without connector modification.

Tape Units. Most serious audiophiles have a strong preference for cassettes over the eight-track tape format. Cassette tapes are small and improving constantly. Furthermore, there is a greater variety of home-recording cassette hardware enabling one to use the same tapes in an auto cassette machine. Also, tape winding and rewinding are much faster, and Dolby noise reduction is available. Moreover, some manufacturers produce mobile cassette machines with recording provisions. At least two of them (Sanyo and Blaupunkt) make in-dash systems with AM and stereo FM receivers and cassette decks that allow *recording* of cassettes in stereo from the receiver or in mono via a microphone. But if you want eight-track cartridge capability, several manufacturers will oblige you with in-dash and under-dash models.

The top-of-the-line cassette tape units at this writing are from Nakamichi and Uher, both of which are quite expensive but can also be used as self-powered portables. The Nakamichi Model 250 is a player only, while the 350 also records. Both have built-in Dolby NR circuits. The Uher Model 210 is a recorder/player sans Dolby. Some better-than-average players have begun to appear in in-dash combination systems with stereo receivers. Examples of these include the Concord Models HP-100 and HP-350, Motorola TC876AX, Sanyo Model FT1490A with Dolby, Kraco KID-588 with auto reverse, and Pioneer Model KPH-9000, among others. Dynascan Corp.'s Cobra 50XLR in-dash combo also incorporates a CB transceiver.

When you are out shopping, read the specifications carefully and check out missing entries. And don't always believe that a low price indicates a bargain. Some run-of-the-mill cassette machines exhibit inordinately high flutter, especially with thinner C-90 and C-120 tapes. A special nuisance is "warble" on a bumpy road, caused by a poorly designed or adjusted tape transport.

FM Receivers. Until recently, the best mobile FM tuners were poor performers. Then Pioneer spearheaded a change in this image a while back with its "Supertuner" line. More recently, Sanyo with its "Audio Spec" line, Concord, and others have joined the ranks.

If you want absolutely everything in your car stereo, now you can almost get it. The latest in car-stereo units incorporate stereo cassette with auto-reverse, plus AM/FM-stereo radios with digital tuning and readouts (that double as clocks) plus three tuning modes: auto-scan, preselect, and manual.

The first three of what promises to be a new wave of high-end, do-all stereo units are the Fujitsu Ten ETX-41B ($275), the J.I.L. 634E ($350), and the

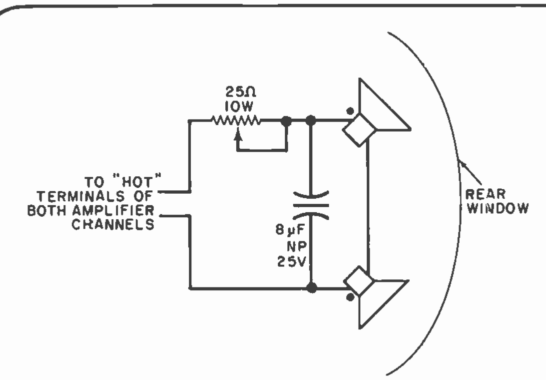


Fig. 5. Stereo expansion circuit gives added reverb and a "rear-channel" effect by playing signal components that are out of phase in front channels.

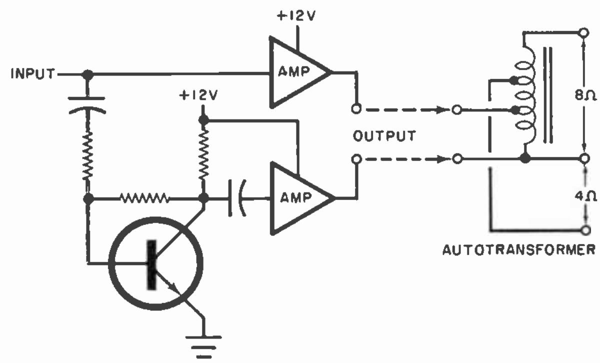


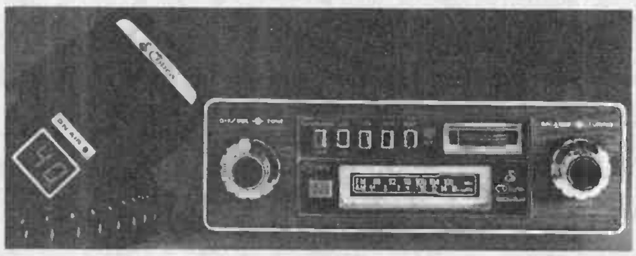
Fig. 6 Push-pull connection uses 2 amplifiers to quadruple power. Optional autotransformer further increases available power.

MOBILE RECEIVERS AND TAPE EQUIPMENT SAMPLER

The Pioneer "Supertuner" underdash TP-900 has easy-to-read circular FM dial, 8-track tape.

Separate components—cassette deck, tuner and amplifier—make up this Panasonic stereo system.

Sanyo underdash cassette player comes with slide-in/out bracket.



Cassette, CB and AM/stereo FM are combined in this 5"-deep Cobra 50 XLR.

Panasonic Q8520 ($399.95). Their tuning facilities differ somewhat: the J.I.L. has only 4 station-select buttons (which bring in 8 stations—4 AM and 4 FM), but auto-scans in two modes, either stopping at the first station found, or pausing there unless instructed to stop. The Fujitsu unit can preselect 5+5 stations (with a rotary switch instead of pushbuttons), and only has the stop-until-restarted auto-tuning mode. The Panasonic has similar auto-tuning, but preselects 6+6 stations and has an unconventional "manual" tuning mode: a pair of buttons which scan the dial up or down until released.

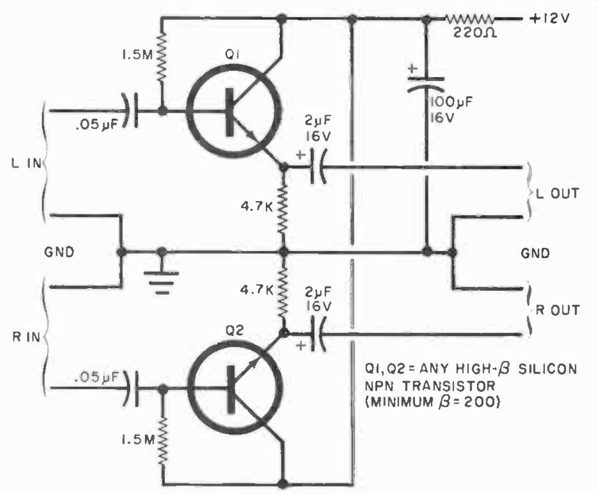
As to tape features, the Panasonic offers Repeatrack, which automatically restarts the tape after rewinding, the Fujitsu has Dolby, and the J.I.L. is also available in an 8-track version, the Model 874E.

On the presumption that you'll use amplifiers or boosters with them, all three have low power—about 15 watts per channel at 10% distortion for the J.I.L. and Panasonic, and zero watts for the Fujitsu (it has no power amplifier stage at all).

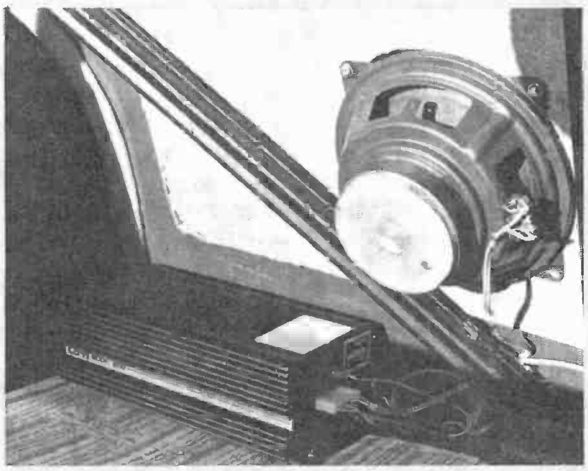
If the other features don't impress you that much, but the digital tuning does, less feature-laden digital stereo/clock units are available from Audiovox, Boman, Craig and Sanyo.

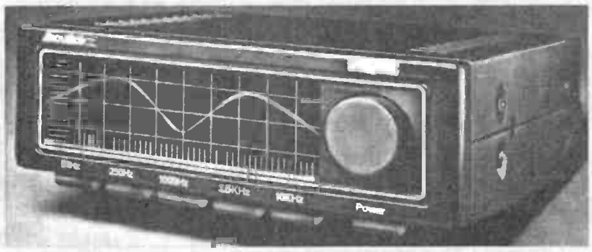
Though still not on a par with fine home component FM tuners, the new breed of high-quality car radios packs a lot of performance capability into a small package. When you are shopping around, read the manufacturers' specifications for their receivers very carefully. The published specifications for the better receivers are quite comprehensive.

Fig. 7. Pair of emitter-follower circuits permits using lengthy speaker lines without high-frequency loss.



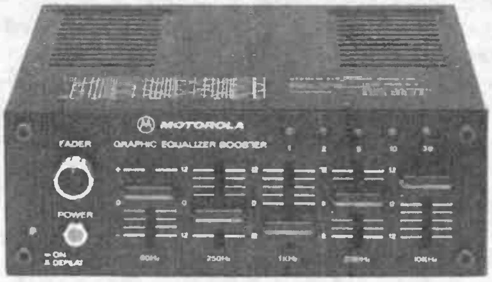
POWER BOOSTER AND EQUALIZER SAMPLER



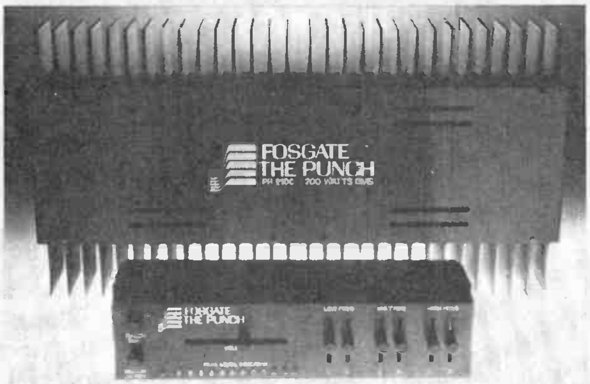


SparkOmatic GE-500 40-W rms equalizer/booster displays illuminated response curve, features front-rear fader control.

Trunk-mounted 7-inch Isophon woofer "speaks" into rear-seat back below 120 Hz. Driven by one channel of Jandy booster.



Motorola equalizer/booster has 30-W rms power output, LED power indicators.



Fosgate 200-W amp has preamp with source selector, power LED's, 3-way equalization.

Fujitsu Ten preamp has 5 inputs, including mike mixing.

They give figures for sensitivity in stereo as well as mono, capture ratio, alternate-channel selectivity, etc. Always look for a complete statement for a specification. For example, a "2-μV" sensitivity rating is meaningless if the background noise suppression is not stated. It might take 50 μV or more to give you a listenable signal in stereo.

FM reception in a moving vehicle is difficult at best, of course. An unaided vertical whip antenna does not capture much signal, especially from stations that transmit only a horizontally polarized signal. (More and more FM stations are going to circular polarization, however, which includes a vertical field component that maintains its strength near the ground.) The single omnidirectional whip antenna is also vulnerable to multipath interference (delayed reflections combining with the direct signal), which severely distorts the signal and causes dropouts and noise bursts in the sound.

Horizontally oriented windshield strip antennas eliminate the polarization problem, but tend to favor the fore and aft directions. The best antenna at present is still a single front-fender-mounted 31" (78.7-cm) stainless-steel whip, connected by a short length of coaxial cable directly to the antenna input of the receiver. The coax shield should be well

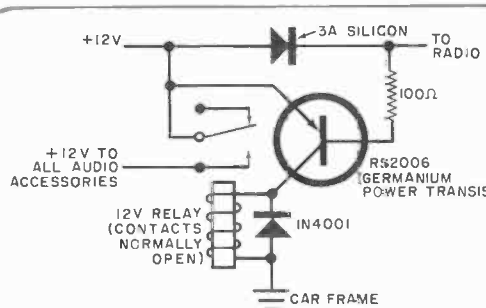


Fig. 8. Relay circuit for remote control of booster amplifier.

Amplifiers, Boosters, Equalizers—Who Makes What?

If you're searching for an amplifier or booster for your car stereo, it helps to know who has products in your desired power range. Here's a quick run-down of the power ranges available from each company, in watts per channel for 4 ohms, at less than 1% distortion. Power figures with higher or unspecified distortion levels are marked with asterisks. Figures marked "E" are for booster/equalizers.

Company	**Watts/Channel**
ADS	25
Audiomobile	20-75, E20
Audiovox	E16*
Boman Astrosonix	25*
Clarion	E10-20, 12.5
Concord	18
Craig	12-25, E36
Fosgate	20-50
Fujitsu Ten	20
Jandy Car-Fi	30-80, E20-30
Kraco	20*, E25-30*
Kustom Kreations	37.5*
Laser Acoustics	65-175, E65-175
Linear Power (Shmegg)	15-125
Mega	25
Motorola	12-20
MetroSound	20-35, E20
Muntz	15-20*
Panasonic	10
Pioneer	12-20
Prime	E10
Pyramid	20-40, E22
Royal Sound	10-30*, E25
Sanyo	15-25
Sanyo biamp	23+5W @ 3%
Setton	40
Sonic Boom	12.5-45
SparkOmatic	15*, E20*

grounded to the vehicle's chassis at the antenna end. Telescoping designs that can be extended to several feet may be somewhat better for AM reception. But they may be a source of noisy or erratic reception as they age and contact between the sections deteriorates. They are also more easily broken.

FM boosters are of questionable usefulness. With a low-grade FM receiver in a weak-signal area, they can be helpful. But in urban areas where signals are strong and multipath reception is a problem, such a preamplifier can make things worse by increasing crossmodulation distortion. The best mobile tuners are the least likely to benefit from an auxiliary preamp, and their performance may actually be degraded by one unless its noise figure, almost never published for these devices, is better than that of the r-f stage in the receiver itself.

Accessories. A variation of the power booster amplifier that includes tone controls or a "graphic" equalizer is a growing and popular addition to a mobile sound system. It can be very useful, but bear in mind that even a relatively small audible boost in some parts of the frequency spectrum can demand significantly more power from your amplifiers. Also, don't apply excessive boost at very low frequencies since small speakers may reach the limits of their cone excursions, resulting in distortion and possible damage.

Though a graphic equalizer may help even out a vehicle's peculiar acoustics, the typical five-band unit will not provide enough compensation to wholly flatten out the overall system response. But it may alter the sound's tonal balance to reduce some of the masking caused by noises in a moving vehicle. There is at least one seven-band car equalizer, from Jandy Car-Fi. Moreover, there are nongraphic equalizers available from Laser Acoustics. These have provisions for screwdriver-adjustable frequency settings which can't be misadjusted by curious passengers.

At this writing, the power amplifiers built into most graphic-equalizer accessories are not particularly distinguished, some being rated at as much as 10% distortion. This picture will undoubtedly change. Again, remember to read and interpret all published specifications.

Finishing Up. Ignition noise is not the problem it once was. Most recent cars are equipped by the factory with interference-reducing ignition wiring. Older cars and cars ordered without factory-installed radio receivers may have to be fitted with resistor-type spark plugs or add-on resistors or be rewired with resistive ignition cable.

Alternators are not usually prime causes of FM interference. If yours is, you can get suppression kits from, say, Radio Shack, Lafayette Radio and other sources to eliminate the interference. Too, if your car has the older type of dc generator, you might have to install a suppressor. The kit should include coaxial capacitors rather than the more common axial- or radial-lead capacitors.

Coaxial capacitors can also aid in reducing noise from fan and wiper motors and electric fuel pumps. A single 0.25-μF coaxial capacitor connected very near the offending device, and solidly grounded nearby through its mounting lug, will often render the interference inaudible. Sometimes you will have to add inductance in series with the supply lead to the motor. A value of 1 mH or thereabouts should do nicely. Be sure that the inductor and coaxial capacitor are rated to handle the current drawn by the motor when it is operating at maximum speed.

If you run into persistent electrical interference in your car, the *Mobile Manual for Radio Amateurs* contains much information that is useful for combatting the problem. It is published by the American Radio Relay League (ARRL) and is available from most electronics parts and equipment stores.

In Conclusion. With careful selection of mobile audio components, installation, and interfacing, you can easily obtain good high-fidelity sound in your car, van, or RV. The hints presented here should help you tailor your system to the peculiar acoustical and electrical environment of your vehicle. Then you and your passengers can enjoy more realistic music reproduction. ◇

BY L. STEVEN CHEAIRS

Build an ELECTRONIC VOLTAGE REGULATOR FOR YOUR CAR

Solid-state system uses new IC to achieve high reliability at low cost.

UNTIL recently, all automotive voltage regulators have been electromechanical devices. As a result, they exhibit all the disadvantages associated with relays and breaker points—wear, chatter, changes in spacing, and pitted contacts due to arcing. The latest model solid-state regulators are inherently more reliable. Now, with the introduction of a new IC from Motorola, it's possible to build one at low cost to replace mechanical or costly discrete component solid-state regulators.

In addition to the new IC, the full-feature, solid-state voltage regulator presented here employs only a handful of discrete components. It is easy to construct and install, and offers selectable temperature coefficient, overvoltage protection, as well as automatic shutdown in case of loss of battery voltage.

About the Circuit. A typical automotive charging system is shown in Fig. 1. The alternator differs from a generator with a fixed field in that the magnetic field is derived from dc flowing in the rotating field winding. Field current, usually about 3 amperes, is supplied via the voltage regulator. The alternator stator windings are usually connected in a three-phase wye (Y) configuration producing an ac output. Six silicon diodes form a three-phase, full-wave rectifier which converts the ac to dc.

The output of the alternator is a function of both shaft speed and magnetic field strength. Variations in load resistance and shaft speed can be compensated for by changing the amplitude of the field winding current and hence the strength of the magnetic field. That's exactly what the voltage regulator does.

An electromechanical regulator accomplishes this task by "chopping" the field current or inserting into and removing a fixed resistor from the field current loop. The contacts of such a regulator can be opening and closing more than 200 times each second. Solid-state voltage regulators, including this project, govern the amplitude of field current electronically. A voltage-dependent current source is used to drive a power transistor whose output current excites the field winding. Stock regulators typically employ a zener diode, several fixed resistors, a thermistor which sets the regulator's temperature coefficient, a driver transistor and a power output transistor.

The internal structure of the Motorola MC3325 monolithic silicon IC, upon which this project is based, is shown in Fig. 2. The integrated circuit can be viewed as composed of four separate sections—a temperature coefficient circuit, a battery-voltage loss detector, an overvoltage detector and an output drive amplifier. Each of these sections can be biased independently by the addition of a few passive components. The IC is designed to drive an npn Darlington transistor which in turn controls current through the field winding.

Shown in Fig. 3 are the three basic alternator types commonly used in automobiles. The regulator presented in this article can be used with the floating field (A) and pulled-up field (B) alternators. However, the regulator cannot be used with a grounded field alternator (C) unless the output stage of the regulator is modified. Alternatively, the alternator can be modified to make it a floating field type. The project has not been tested with this type of alternator, but provisions for the required regulator modifications have been included on the pc-board foil pattern.

Some automobiles employ alternators with integral voltage regulators. That is, the voltage regulator is enclosed in the alternator housing. The project can be used with such an alternator if the housing is removed, the voltage regulator by-

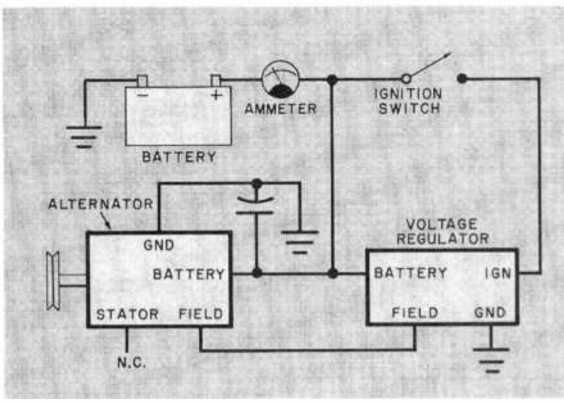


Fig. 1 Block diagram of a typical automotive charging system.

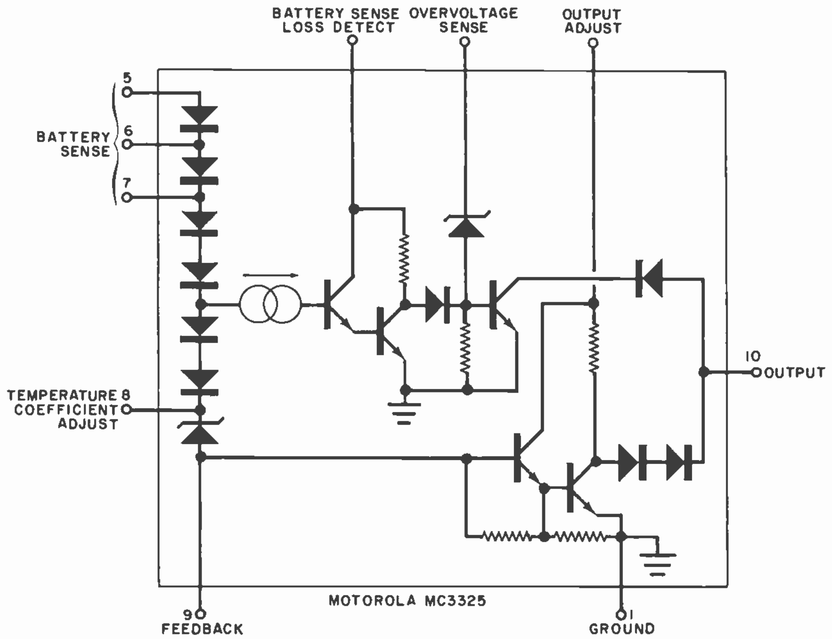
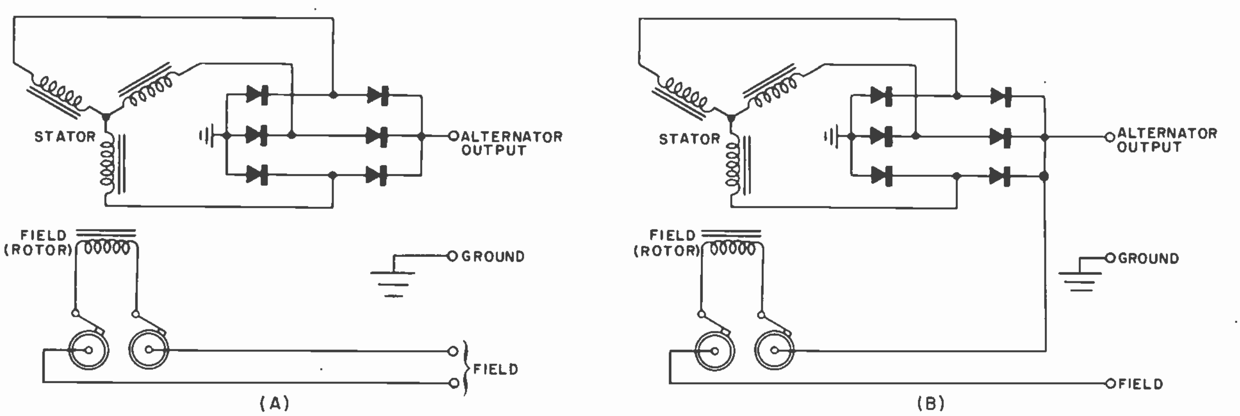


Fig. 2. Schematic of the internal structure of the Motorola MC3325 automotive voltage regulator IC.

PARTS LIST

C1, C2—0.01-µF disc ceramic
D1—1N4003 rectifier
IC1—MC3325 automotive voltage regulator (Motorola)
Q1—2N6059 npn Darlington transistor
The following are ¼-watt, 5% carbon-composition resistors:
R1—13,000 ohms
R2—1000 ohms
R3—1600 ohms
R4—2200 ohms
R5—2000 ohms
R6—1500 ohms
R7—3000 ohms
Misc.—Printed circuit board, suitable metallic enclosure, heat sink, power transistor socket, silicone thermal compound, terminal strip, IC socket or Molex Soldercons, pc board standoff, machine hardware, etc.
Note: The following are available from Questar Engineering Co., 50 South McDonald Street, Mesa, Arizona 85202: Etched and drilled glass-epoxy printed circuit board for \$5.25; 2N6059 npn Darlington transistor for \$5.85; MC3325 IC for \$1.75. Arizona residents add sales tax.



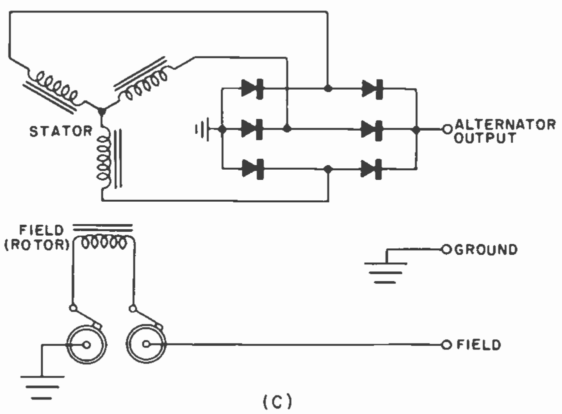


Fig. 3. Three types of alternators found in automobiles: floating field (A); pulled-up field (B); grounded field (C).

passed, and the alternator rewired so that the field winding and rectifier output are connected to the external terminal block. The exact modifications required vary with each charging system.

The schematic diagram of the IC voltage regulator is shown in Fig. 4. Very few external components are needed. Darlington transistor *Q1* drives the alternator field coil. The fixed resistors are used to bias the various sections of *IC1*. Resistor *R3* functions as a current limiting resistor in case an overvoltage condition occurs at the output diodes of the alternator. The magnitude of the regulated voltage is determined by *R5*. Resistor *R1* establishes the current in the IC's diode string. The magnitude of this current determines the regulator's temperature coefficient. The maximum overvoltage of the charging system is limited by *R6*.

Construction. Printed circuit construction techniques are recommended for the assembly of the voltage regulator. Etching and drilling and parts placement guides for a suitable board are shown in Fig. 5. All components except *Q1* are mounted on the printed circuit board. Use a minimum amount of heat consistent with the formation of good solder joints and pay close attention to polarities and pin basing of semiconductors. An IC socket or Molex Soldercons will facilitate the installation of *IC1*.

The Darlington transistor should be mounted on a heat sink attached to the metallic project enclosure. A power transistor socket, a mica insulating washer, silicone thermal compound, machine hardware and shoulder washers should be employed. A suitable terminal (pre-

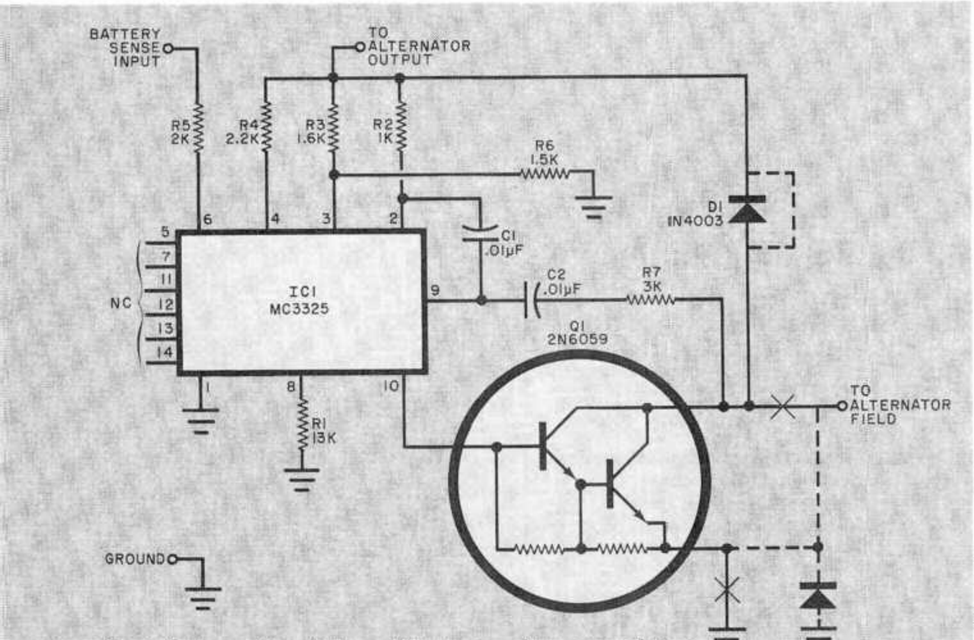


Fig. 4. Schematic of the solid-state voltage regulator. For use with grounded-field alternator, use dashed lines.

ferably of the barrier block type) should be mounted on the enclosure to provide convenient points for the ground, battery sense, field and alternator output connections. Interconnect the pc board, transistor socket and terminal strip using No. 16 or heavier insulated, stranded copper wire. Mount the pc board in the enclosure using metallic standoffs and machine hardware.

Adjustments. The key circuit parameters can be optimized for use in a particular charging system by changing the values of certain fixed resistors, namely, *R3*, *R5*, and *R6*. Before changing any of the values specified in the parts list, consult your automobile's specifications. Then use the following information to determine the resistor values.

Resistor *R3* limits current through the zener diode internally connected to pin 3 of *IC1*. In operation, the voltage between pin 3 and ground (the sum of the zener voltage and the voltage drop across the transistor's base-emitter diode) will be about +7.5 volts. The value of *R3* should be chosen so that the current flowing through the resistor, internal zener, and base-emitter diode at maximum overvoltage is between 2.0 and 6.0 milliamperes.

The following equation is used to compute the value of *R3*: $R3 = (V_{overmax} - V_z)/I_3$, where V_z is the zener voltage, +7.5 volts, I_3 is the current flowing into pin 3, between 2.0 and 6.0 mA, and $V_{overmax}$ is the maximum output voltage of the alternator. The specified value of *R3* is 1600 ohms. If the alternator output varies between 13.0 and 16.0 volts, I_3 varies between 3.4 and 5.3 mA. Thus, over the full range of voltages anticipated, the zener current is less than 6.0 and greater than 2.0 mA.

The magnitude of the regulated voltage is determined by the value of *R5*, which is defined by the following equation: $V_{reg} = (1 + R5/R1)(8.4) + (n + R5/5000)(0.7)$, where n is 3 for the circuit shown in Figs. 4 and 5 and *R1* is chosen so that the current in the battery sensing diode string is between 0.5 and 1.0 mA. This current in part establishes the regulator's temperature coefficient, which can be varied from approximately −9.0 mV/°C to −13.0 mV/°C by changing the number of diodes in the string.

The approximate temperature coefficient of the zener diode is +3.0 mV/°C, and that of the string diodes and transistor base-emitter diodes is −2.0 mV/°C each. Starting at pin 1 (refer back to Fig. 2), and counting upward, we add −2.0 mV/°C for the first base-emitter diode, −2.0 mV/°C for the second, +3.0 mV/°C for the zener, and −10 mV/°C for the five diodes between pins 8 and 6. This results in a total temperature coefficient of −11 mV/°C.

The voltage between pin 8 and ground should range from +7.9 volts minimum to 8.8 volts maximum. The resistance of *R1* should be greater than 7800 ohms and less than 16,600 ohms, where $R_{max} = V_{max} / I_{min}$ and $R_{min} = V_{min} / I_{max}$. If a typical voltage of 8.35 volts and a current through the diode string of 0.64 mA are assumed, the resistance of *R1* should be 13,000 ohms. This results

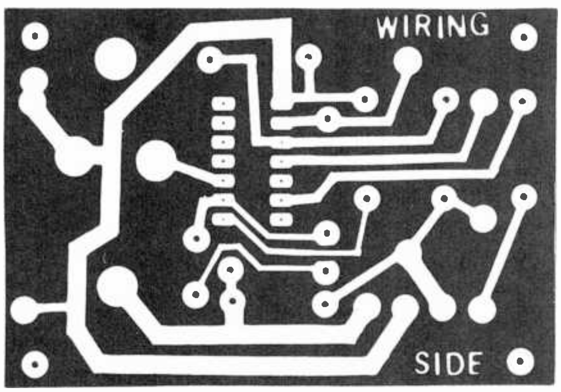
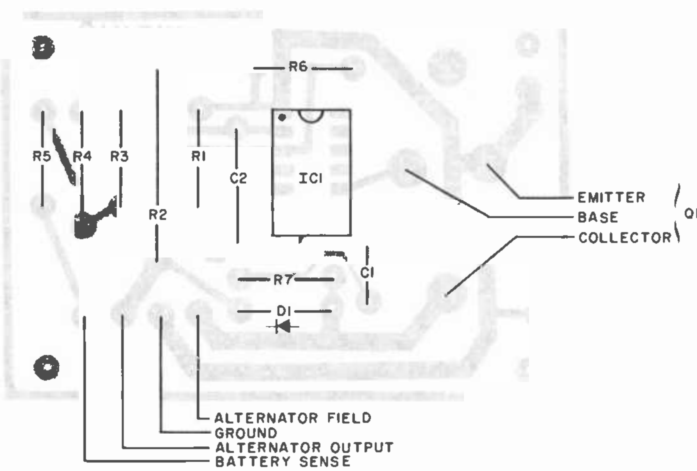


Fig. 5. Etching and drilling guide for pc board is at left, with parts placement guide shown below.



in a minimum current of 0.61 mA and a maximum of 0.68 mA for the specified range of voltages between pin 8 and ground. In most charging systems, the normal charging voltage will be between 13.3 and 15.3 volts. Accordingly, 14.0 volts is a good choice for V_{reg}. Solving the equation previously given for a V_{reg} of 14.0 volts results in an *R5* resistance of 2333.3 ohms. A 2000-ohm resistor will cause V_{reg} to be 14.3 volts.

The value of *R6* is more easily determined. This resistor limits the maximum overvoltage, which can be expressed as: $V_{overmax} = [(R3+R6)/R6](7.5)$. We have previously calculated the resistance of *R3* to be 1600 ohms, so we can simplify the equation: $V_{overmax} = [(1600 + R6)/R6\,](7.5)$. If the maximum overvoltage is chosen to be 16.0 volts, then *R6* should have a resistance of 1411.8 ohms. The closest "standard" value, 1500 ohms, will limit $V_{overmax}$ to 15.5 volts. Because this 88.2–ohm change in resistance varies the maximum overvoltage by 0.5 volt, a 5% (or closer) tolerance component should be used for *R6*. In fact, it's a good idea to use resistors with such tolerances for all three biasing resistors (*R3*, *R5*, and *R6*).

If a Darlington transistor other than the type specified in the schematic and Parts List is used as *Q1*, it might be necessary to change the value of *R2*. Check the data sheet of the Darlington transistor for the beta of the device. Then select a value of *R2* that will provide enough drive when the alternator output voltage is at its minimum level. An expression you can use to determine the required resistance is: $I_{drive} = (V_{min} - 2.8)/(R2 + 50)$.

Installation. The project should be mounted at or near the location of the voltage regulator that is being replaced—except if the existing regulator is an integral one. In any event, the regulator should be positioned near the battery for good thermal tracking. All interconnections between the regulator and the rest of the charging system should be made with flame-retardant, oil-resistant insulated stranded wire. Use No. 14 wire for the battery, ground, and field connections and No. 10 wire for the connection to the alternator output terminal. Most, if not all, of the wires needed should be already present. If not, add a required length of suitable wire, keeping the gauge requirements just mentioned in mind. Finally, be sure the regulator is firmly secured in place to prevent possible damage caused by vibration. ◇

BY DOUGLAS KOHL

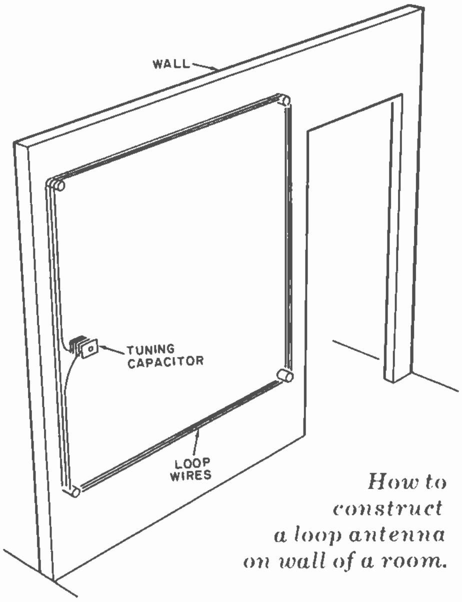
Low-cost LOOP ANTENNA EXTENDS AM RADIO RECEPTION

Easy-to-build air-core loop helps pull in distant stations on inexpensive radios.

EVEN IF you're vacationing too far from home for normal AM reception, you can still pick up home-town broadcasts with an ordinary AM radio. Alternatively, if you're staying at home, you can receive out-of-town sports broadcasts to keep tabs on your favorite team. Using an inexpensive external loop antenna will do the trick. Here's why it works and how to build one.

Because portable and desk-top AM receivers employ relatively small, internally mounted ferrite-core loop antennas, they can deliver only enough signal for good reception of local stations. However, if an external loop with a larger effective cross-sectional area is substituted for the internal one, or used in tandem with it by mutual coupling, the working sensitivity of the receiver is increased in direct proportion to the ratio of the loop areas.

If the loops are used in tandem, no connections or modifications to the receiver are necessary. Signals will be coupled to the small internal loop inductively when the two loops are placed in proximity to each other. If your home is of wood-frame construction and the walls do not have metal lath, you can mount the large loop on a wall or even conceal the loop behind it. The loop can then be a source of fun as a mystery spot where your neighbor's $5 transistor radio will work better than ever before!



How to construct a loop antenna on wall of a room.

Constructing a Loop. A typical large loop antenna is shown in the figure. It is made simply by winding a series of turns of wire on some supporting structure. The loop is tuned by a variable capacitor connected across it. The antenna can be supported by wooden pegs inserted into the wall or by a free-standing wooden cross frame. Insulated copper wire, No. 20 or larger, should be used. Bell wire or even No. 14 house wire will yield excellent results. Such a loop can be concealed if other members of the family consider it unsightly.

Plan to make your loop square, or at most, slightly rectangular. This makes it easy to compute the area inside the loop. Construct your loop so that it is as large as possible. A 7-ft × 9-ft (2.1- × 2.7-m) loop, for example, is suitable if you have 8-ft (2.4-m) walls. If possible, mount the loop on a wall which is in line with the distant radio stations you want to receive. The antenna is most sensitive to signals parallel to the plane of the loop, and least sensitive to signals propagating in directions perpendicular to it (striking the antenna broadsides).

To calculate how many turns of wire are needed, compute the area of the proposed loop and use the following formula: $N = 242.3/\sqrt{A}$ where N is the number of turns and A is the area in square inches (1 square inch = 6.45 cm^2). For example, suppose the planned loop will measure 6′ 9″ (2.1 m) on each side. Its area will be 6,561 square inches (4.2 m^2 or 42,330 cm^2) and the number of turns required will be three. For your convenience, here are the loop sizes corresponding to an integral number of turns:

N	Length of each side
3	80-11/16″ (2.05 m)
4	60-5/8″ (1.60 m)
5	48½″ (1.23 m)
6	40-3/8″ (1.03 m)
7	34-5/8″ (88 cm)
8	30-5/16″ (77 cm)
9	26-7/8″ (68.3 cm)
10	24-3/16″ (61.4 cm)

Incidentally, you can make a small, portable loop on a wooden frame to take along on picnics, or on a boat. A loop two feet square (0.3716 m^2 or 3716 cm^2) will provide good results with a "pocket portable" receiver.

Connect the loop ends to each side of an ordinary air dielectric variable tuning capacitor (one loop end to the rotor plates and the other to the stator plates). The capacitor, which can be removed from a junked AM receiver or purchased new (or surplus), should have a maximum capacitance of at least 360 pF. Multisection capacitors can be wired in parallel to extend the loop's tuning range. Be sure to solder all connections using rosin core solder.

Using the Loop. A loop antenna will provide some improvement in reception of all stations, not just the one at the frequency to which it is tuned. However, for best results the loop should be resonated. Tune the receiver to the desired station's frequency and place it in the vicinity of the large loop. Orient the receiver so that its internal ferrite bar is perpendicular to the plane of the loop. Then rotate the shaft of the antenna's tuning capacitor until the signal peaks.

Enhanced reception will be experienced when the receiver is placed up to approximately one side dimension of the loop in front of, or behind the wall on which the loop is mounted. Experiment with the placement of the receiver to determine the location that gives best results. The closer the receiver is to the loop, the more signal coupled to the internal ferrite antenna. For casual listening, as opposed to chasing weak DX signals, the degree of coupling between the loop and the receiver will not be critical, thanks to the large measure of improvement the loop provides. ◇

Shortwave DX "CATCHES" FROM AFRICA

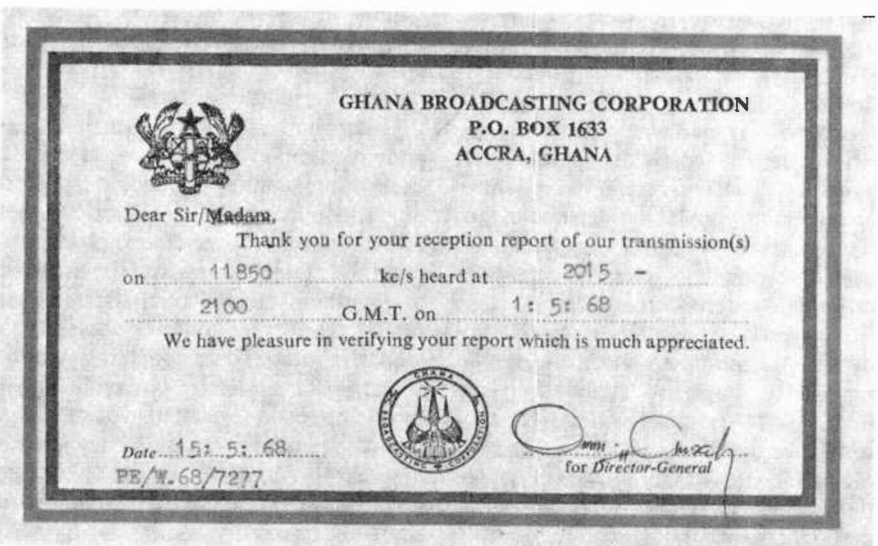
BY HARRY L. HELMS, JR.

Broadcasts from a changing continent can be informative and interesting.

SOME people tune the shortwave bands to keep closer tabs on what's happening in the rest of the world. Others seek distant, rarely heard DX stations. It's not often that one section of the world can offer exceptional opportunities for both categories of SWL's, but Africa certainly can. There are numerous stations to challenge your skills as a dial-spinner, while at the same time offering the politically-aware news-oriented SWL some of the most potentially explosive listening excitement to be found anywhere.

Major DX'ing fireworks are provided by the rapidly escalating radio war between the white minority regimes in South Africa and Rhodesia, and the black nations that surround them in southern Africa. More interesting listening comes from the numerous former colonies struggling to achieve stable nationhood, undergoing various internal upheavals in the process. Such instability makes extracting a QSL from many African outlets an even greater challenge than hearing the station! Yet such situations can provide supreme DX satisfaction when overcome, resulting in the arrival of a highly prized verification.

QSL card sent by the Ghana Broadcasting Corporation verifying reception.


GHANA BROADCASTING CORPORATION
P.O. BOX 1633
ACCRA, GHANA

Dear Sir/Madam,
Thank you for your reception report of our transmission(s)
on 11850 ke/s heard at 2015 -
2100 G.M.T. on 1: 5: 68
We have pleasure in verifying your report which is much appreciated.

Date 15: 5: 68
PE/W.68/7277
for Director-General

South Africa's Big Voice. There's no question as to which nation has the biggest signal in Africa: The Republic of South Africa puts a thumping signal into all parts of the world with its external service, *Radio RSA*. In addition, it has an extensive network of domestic shortwave services which can be easily heard throughout North America.

Radio RSA currently broadcasts in English to North America at 2230-2320 GMT on 9585, 11800, and 11900 kHz. Programming is typical of most government-operated broadcasters: news, editorials, features, music, and mailbag programs. For the SWL interested in African affairs and politics, *Radio RSA* can provide insights into South African foreign policy that cannot be obtained through conventional American news media.

The governmental body responsible for domestic broadcasting services is the *South African Broadcasting Corporation* (SABC), which provides programming in English, the Dutch dialect Afrikaans, and various tribal vernaculars. SABC's English service is widely heard on 4875 kHz from 0300 GMT sign-on until fade out at sunrise in South Africa. Programming is pop music and a generally subdued announcing style. Sometimes telephone call-in shows are featured, and these are among the most fascinating programs you're likely to find on shortwave.

Private broadcasting stations are not allowed in South Africa, but SABC provides its own commercial service known as *Springbok Radio*. This service operates all through the South African night and offers the same pop music and mellow style of SABC's noncommercial service. You will recognize many of the brands mentioned in the commercials, since many American firms market their goods in South Africa, while some brands, such as "Jungle Oats" cereal, are clearly unique to South Africa!

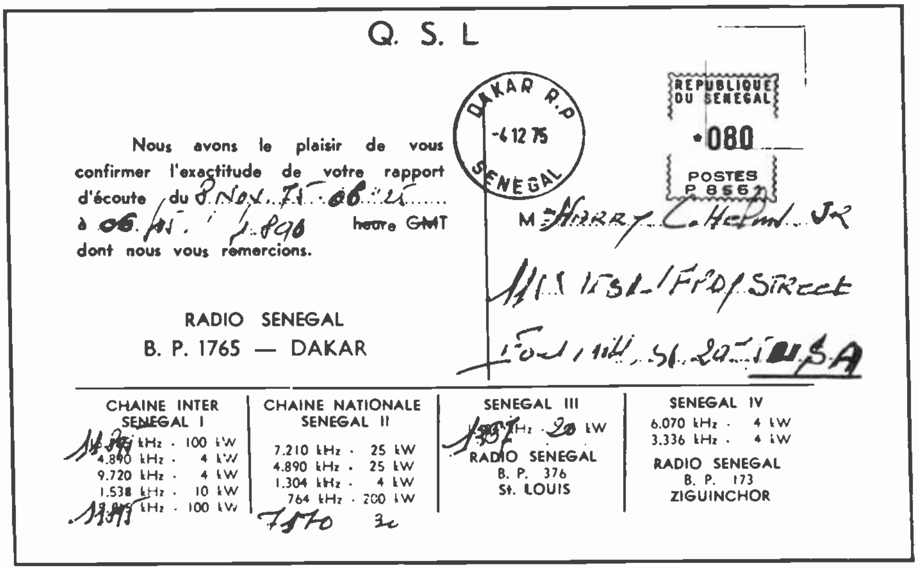
In the summer of 1977 SABC opened yet another domestic service, this time featuring rock and roll music in a style similar to that of American "Top Forty" stations, although with fewer suggestive lyrics and songs than heard on American radio. This service is known simply as *Radio Five* and best reception is on 3388 kHz from 0300 GMT onward.

The *Rhodesia Broadcasting Corporation* can be heard on 3396 kHz from 0355 GMT sign-on in English. Programming is mainly news, pop music, and advertising, delivered in a sedate style that seems oblivious to the explosive situation facing the nation. But SWL's have heard items warning Rhodesians to prepare for the "war sacrifices" that might lie ahead. If the guerrilla campaign against the Ian Smith regime isn't settled in some peaceful manner, Rhodesia might provide some of the most dramatic listening available to the SWL. This station is a good verifier, by the way, and the wise SWL should secure a QSL now before any future political changes.

Voices of Opposition. None of the black-ruled nations of southern Africa opposed to the regimes in South Africa and Rhodesia have the commanding shortwave signals possessed by South Africa. This makes them better DX, yet none are extraordinarily difficult. Most are audible, at varying levels, throughout North America on average receiving equipment.

Perhaps the most virulent opposition voice belongs to *Radio Tanzania*, which can be heard in English from 1730 to 1915 GMT on 15435 kHz. A regular program at 1800 GMT is "Liberation for South Africa and Liberia," consisting of stinging, barbed commentary directed against those two nations. Also occasionally heard at 1830 GMT is the "Voice of Namibia" program, calling for the liberation of the territory of South West Africa, which is controlled by South Africa. *Radio Tanzania's* newscasts are similarly peppery. *Radio Tanzania* allows the American SWL to directly hear the views and opinions of the more militant nationalist groups. Moreover, the American news media often fail to capture the impassioned nature of the nationalist movements which comes across so clearly over *Radio Tanzania*.

Zambia is a nation which is also steadfastly opposed to the regimes of South Africa and Rhodesia, yet it maintains a more moderate radio voice. *Radio Zambia* transmits its general service, consisting of English and local vernacular languages, on 3346 kHz from 0350 to 0530 GMT and on 7250 kHz from 0630 GMT until fade-out due to sunrise in Zambia. Reception of either frequency cannot be termed easy, but *Radio Zambia* does manage to put a readable signal into the United States most days. Newscasts feature extensive coverage of African nationalist activities but without the stridency of *Radio Tanzania*. Much African music is played, making it a listening treat even for those uninterested in politics. One distinctive characteristic of *Radio Zambia* is the practice of referring to areas under white rule by their nationalist or native names. For example, Rhodesia is always called "Zimbabwe" by *Radio Zambia*. Zambia can also often be heard sending greetings to listeners in white-ruled areas.


Q. S. L

DAKAR R.P. -4 12 75 SENEGAL

REPUBLIQUE DU SENEGAL •080 POSTES

Nous avons le plaisir de vous confirmer l'exactitude de votre rapport d'écoute du 8 NOV. 75 06.25 à 06.45 1.896 heure GMT dont nous vous remercions.

M. Harry C. Helms Jr

RADIO SENEGAL
B. P. 1765 — DAKAR

CHAINE INTER SENEGAL I	CHAINE NATIONALE SENEGAL II	SENEGAL III	SENEGAL IV
kHz · 100 kW	7.210 kHz · 25 kW	kHz · 20 kW	6.070 kHz · 4 kW
4.890 kHz · 4 kW	4.890 kHz · 25 kW	RADIO SENEGAL	3.336 kHz · 4 kW
9.720 kHz · 4 kW	1.304 kHz · 4 kW	B. P. 376	RADIO SENEGAL
1.538 kHz · 10 kW	764 kHz · 200 kW	St. LOUIS	B. P. 173
kHz · 100 kW			ZIGUINCHOR

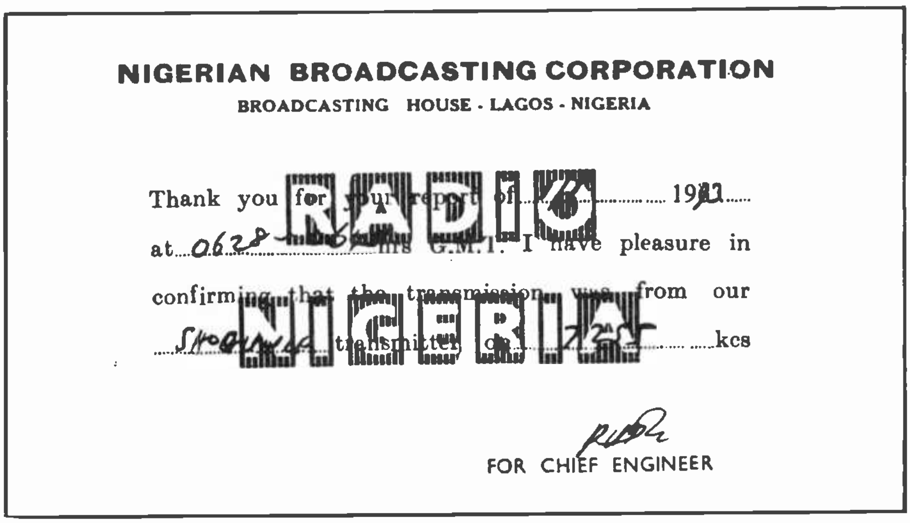
Radio Senegal's QSL card gives the station's frequencies and power outputs. Note that it is in French.

Amin Speaks to the World. Few leaders in world history can compare in notoriety and controversy with Idi "Big Daddy" Amin of Uganda. Listeners who wish to keep up with his latest escapades can do so by tuning in to the external services of the *Uganda Broadcasting Corporation*. It is on the air in English from 1880-1830 GMT on 15325 kHz (although with interference from *Radio Canada International*) and from 2030-2100 GMT on 9730 kHz. Transmissions are to Africa, but Uganda's powerful 250-kilowatt transmitters often deliver strong signals to North America.

Uganda's broadcasts are not as exciting as one might expect, given Amin's pyrotechnics. Programming is a varied hodge-podge, seemingly spontaneous, with musical selections running the gamut from traditional African music to Judy Garland and American country and western. Yet interspersed are various features and commentaries, giving first-hand glimpses into Uganda and its policies. Uganda's newscasts are often the means by which Amin springs his surprises on the world. The first news of Amin's "post-operative coma" came from UBC's external services, for example. Thus, Uganda always has the potential for exciting and dramatic listening as long as Amin remains in power.

Other English Voices. Not all African broadcasters are as heavily politicized in their English programs as the

Verification card from the Nigerian Broadcasting Corporation.


NIGERIAN BROADCASTING CORPORATION
BROADCASTING HOUSE - LAGOS - NIGERIA

RADIO NIGERIA

Thank you for your report of .... 19.....
at 0628 hrs G.M.T. I have pleasure in confirming that the transmission was from our .... transmitter on .... kcs

FOR CHIEF ENGINEER

stations we have discussed so far. Some offer relatively balanced news coverage and much interesting African music. For those seeking a more moderate perspective on African affairs, the *Voice of Nigeria* is a listening must. Best North American reception is on 7275 kHz at 0600 GMT sign-on and on 11770 kHz from 1800-1930 GMT. These are external services intended for foreign audiences. Also easily heard is the domestic service, *Radio Nigeria*, on 4990 kHz. Listeners in the East will find this frequency audible from fade-in around 2130 GMT until sign-off at 2305 GMT. Listeners throughout North America can try for their sign-on at 0430 GMT. Programming consists of authentic African music, news, and interviews. Both the *Voice of Nigeria* and *Radio Nigeria* are very friendly verifiers.

Ghana is an African nation which has of late curtailed much of its international broadcasting activity. Once a station which rivaled *Radio RSA* as Africa's leading radio voice, *Radio Ghana* is now restricted to one frequency, 6130 kHz, where it is heard until its 2300 GMT sign-off in English. It now uses the slogan, "The Voice of the Revolution," and bears watching as this nation attempts to stabilize its internal situation. SWL's in the West will find Ghana easier to catch via their domestic shortwave service, the *Ghana Broadcasting Corporation*, which signs on at 0600 GMT on 4915 kHz. Plenty of African music and commentaries are featured. If you send a reception report to either station, don't be surprised to receive letters from Ghanaians wanting to be your pen-pal—numerous SWL's have received them for several years. Apparently many letters from the United States are opened in Ghana by local postal employees!

A station completely different from the norm in African broadcasting is the *Sierra Leone Broadcasting Service*, operating from a nation established by the British for much the same purpose as Liberia: as a home for former slaves. Listeners in the East can hear it on 3316 kHz at 2335 GMT sign-off, usually with religious programming, while listeners further west can listen for their 0600 GMT sign on. Programming then is rock and pop music, commercials, and a DJ—all sounding rather like the radio voice of another former British colony, *Radio Belize* in Central America! Yet even this relatively tame station had many interesting news items during a coup attempt in early 1977.

Those who seek a true challenge should try to hear *and verify* the English service of *Radiodiffusion Television Ivoirienne* broadcasting from Ivory Coast. English is scheduled around 2000 GMT on 11920 kHz, and programming features American soul and African pop music. You're likely to hear a variety of station identifications used, but the two most common are *Radio Abidjan* (after the name of the national capital) and *Radio Ivory Coast International*. Signals are often good throughout North America, and the real challenge starts after you've heard the station. Their QSL policy is sporadic and totally unpredictable. Some listeners receive a verification with their first report. Others cannot get a reply despite numerous reports. Your author falls into the latter category, having sent several reports since 1969 with nothing to show for the effort!

Thank you for your report on the reception of our Domestic English Service/Afrikaans Service/ Commercial Service (Springbok Radio) from the

H.F. Verwoerd Shortwave Station

DATE: 19 October 1975

TIME: 0350 **GMT**

FREQUENCY: 3980 **kHz**

SOUTH AFRICAN BROADCASTING CORPORATION

SUID-AFRIKAANSE UITSAAIKORPORASIE

P.O. Box 4559, Johannesburg, South Africa

Supreme

MR. H. . HELMS JR

[illegible]

[illegible]

U.S.A.

P. V.D.M. MARTINS
for: DIRECTOR: TECHNICAL SERV.

South African Broadcasting Corporation QSL card verifying reception on 3980 kHz.

Non-English Stations. For those more interested in QSL's than program content, or for linguists, don't ignore non-English broadcasts, as follows.

Since many African nations were formerly French colonies, it is hardly surprising that French is a very common language over the African airwaves. Thus, you'll have to resurrect your high school or college French to follow the news programs and commentaries on these stations. But if you don't know French, you'll find that you can follow the programming well enough to prepare a reception report, and these stations will usually verify a reception report written in English.

Benin is a new name for the former nation of Dahomey, and its *La Voix de la Revolution Beninaise* is a most unusual experience for North American listeners. Programming is in French, with local music, frequent excited political speeches and slogans, and repeated mentions of Cuban troops in Africa. It operates on 4870 kHz, and is scheduled to sign on at 0415 GMT although at the time of this writing it is sometimes operating all night. English has been reported in the past around 2030 GMT by European SWL's.

Another all-night operation is *Radiodiffusion Nationale* in Guinea, operating on 7125 and 4910 kHz. Although it identifies as *La Voix de la Revolution* on occasion, its programming has toned down over the years. French is used along with local vernacular languages, and much African music is featured.

The Congo is well-heard in North America via *Radiodiffusion Television Congolaise* on 4765 kHz at 0400 GMT sign on. Tribal rhythms and drumming are often featured, and are a delight if you haven't heard them before. Listeners in the East might want to try for their

English programs scheduled for 2130 GMT, although these are presented on a somewhat irregular basis.

Chad is heard well throughout North America on 4905 kHz via the programs of *Radiodiffusion Nationale Tchadienne*. Sign-on is at 0430 GMT in French with pop and rock music mixed with more traditional native flute and drum music. If you are proficient in French you will also find the numerous political commentaries to be of interest.

ENGLISH BROADCASTS FROM AFRICA

Times in GMT

Frequency	Station
3250	**South Africa,** *Springbok Radio,* Johannesburg. Approximately 2215-0300 sign-off. Pop music and commercials.
3316	**Sierra Leone,** Freetown. 0600 sign-on with pops and rock music, advertisements.
3346	**Zambia,** Lusaka. *General service*. Sign on at 0350-0530 in English and local languages African music and news.
3388	**South Africa,** *Radio Five*, Johannesburg. Audible 0300 until sunrise fade-out. Rock music.
3396	**Rhodesia,** Salisbury. Sign on 0355 in English. Pop music and ads. Low-key generally but increasingly reminding listeners to prepare for possible wars with neighboring states.
4875	**South Africa**, *SABC*, Johannesburg. Sign-on 0300 with pop music. Identifies as *Radio South Africa*.
4915	**Ghana**, Accra. *Domestic service*. Sign-on 0600. News, commentary, African music.
4990	**Nigeria,** Lagos. Fade approximately 2130 until 2305 sign-off, also at 0430 sign-on. Authentic African music, news and features.
6130	**Ghana**, Accra. *International service*, until 2300 sign-off.
7250	**Zambia**, Lusaka. *General service*. Sign-on 0630. Similar programming as 3346 kHz outlet.
7275	**Nigeria**, Lagos. *Voice of Nigeria* international service. News, commentaries, and music from 0600 sign-on.
9585	**South Africa,** *Radio RSA,* Johannesburg. International service beamed to North America 2230-2320.
9730	**Uganda,** Kampala. *External service*. Varied programming and unpredictable news 2030-2100.
11770	**Nigeria,** Lagos. *Voice of Nigeria*, similar to 7275 kHz, 1800-1930.
11800	**South Africa,** *Radio RSA*, Johannesburg. Same schedule as 9585.
11900	**South Africa,** *Radio RSA*, Johannesburg. Same schedule as 9585.
11920	**Ivory Coast,** Abidjan. African and U.S. soul music around 2000.
15325	**Uganda,** Kampala. *External service*, 1800-1830.
15435	**Tanzania**, Dar es Salaam. Anti-Rhodesian and South African programming 1730 to 1915 sign-off. Often stinging in its criticism of white minority regimes.
3210	**Mozambique,** Maputo. Portugese talks and music from 0315.
4765	**Congo, Peoples Republic** of, Brazzaville. Sign-on 0400. French with much native music. Also before 0000 sign off along East Coast.
4820	**Angola**, Luanda. All night. Best after Latin American stations clear the frequency after 0500. Portugese talk and local and pop music.
4870	**Benin,** Cotonou. French language revolutionary speeches and slogans. Many mentions of Cuba and local music. 0415 sign on, occasionally all night.
4890	**Senegal**, Dakar. 0600 sign-on French and native languages with much exotic local music.
4895	**Mozambique,** Maputo. 0400 sign-on. Portugese with talks and instrumental music, some English identifications.
4905	**Chad**, N'djamena. 0430 sign-on. French with African music. Also audible in East at 2200 sign-off.
5038	**Central African Empire**, Bangui. French talks with native and pop music until 2300 sign-off, also at 0430 sign-on.
5047	**Togo**, Lome. French talk and music like Bangui-5038—be careful not to confuse the two! In East until 2300 sign-off. Also at 0530 sign-on.
7125	**Guinea**, Conakry. French and vernacular languages with African music all night.
9535	**Angola**, Luanda. Sign-on 0500. Portugese with chanting, African and pop music, and talks.

Senegal's *Radiodiffusion du Senegal* puts good signals into North America on 4890 kHz at its 0600 GMT sign on. They sign on with a melody played on a native instrument known as the "khora" and feature its distinctive sound on many of their musical selections. Much exotic chanting can be heard as well, along with some native languages. French announcements are likely to be the only things familiar to most listeners.

Two stations often confused by new SWLs are *Radiodiffusion du Togo* on 5047 kHz and *La Voix de L'Empire Centrafricane* (from the former Central African Republic, now called Empire) on 5038 kHz. Both stations program in French with African and pop music. Both sign off at 2300 GMT and put powerful signals into the East Coast at that time. *Togo* signs on at 0530 GMT, however, while the *Central African Empire* starts operations at 0430 GMT.

Portugal's Former Colonies. The shortwave stations of Angola and Mozambique were exciting listening a few years ago as they gained independence from Portugal and were racked by internal conflicts. SWL's could tune in live political rallies with excited speakers and crowd shouts. Programming slants varied as different factions gained control of the broadcasting stations.

The situation is more stable now. *Angola's Radio Nacional* can be heard at 0500 GMT sign-on in Portugese with African and pop music, certainly a change from their former all-night political harangues.

Mozambique is also heard in Portugese with much guitar music on 4895 kHz at 0400 GMT sign-on. Fortunately for SWL's, *Radio Mozambique* also has some English station identifications. DXers seeking a challenge can shoot for *Radio Mozambique's* 3210 kHz outlet, which is sometimes heard past 0315 GMT with similar programming. Both Angola and Mozambique are quiet now, but alert SWL's should keep abreast of African events which could offer excellent listening possibilities.

The above advice could be applied equally well to any station in Africa. Not only does shortwave allow you to hear news direct from the source, but it also sometimes permits you to hear news in progress. There have been cases where SWL's have heard live *gunfire* in the background of African shortwave broadcasts! And given the highly explosive nature of certain sections of the continent, that sound might be heard again.

BY BRIAN DANCE

Listen to a NEW WORLD OF SOUNDS WITH ULTRASONIC DETECTOR

Inexpensive detector converts ultrasonic sounds from insects, compressed gas leaks, etc., to an audio output.

EXPLORING the world of ultrasonic sound—which lies above approximately 20 kHz—can be exciting and educational. Here is a frequency spectrum beyond human hearing where many insects and rodents communicate with each other, where sounds from leaks in pressurized gas lines occur, etc.

The inexpensive circuits presented here convert these ultrasonic sounds to audio frequencies, enabling anyone to hear them. Also included is a simple ultrasonic transmitter circuit that will enhance your ability to probe this interesting electronics area.

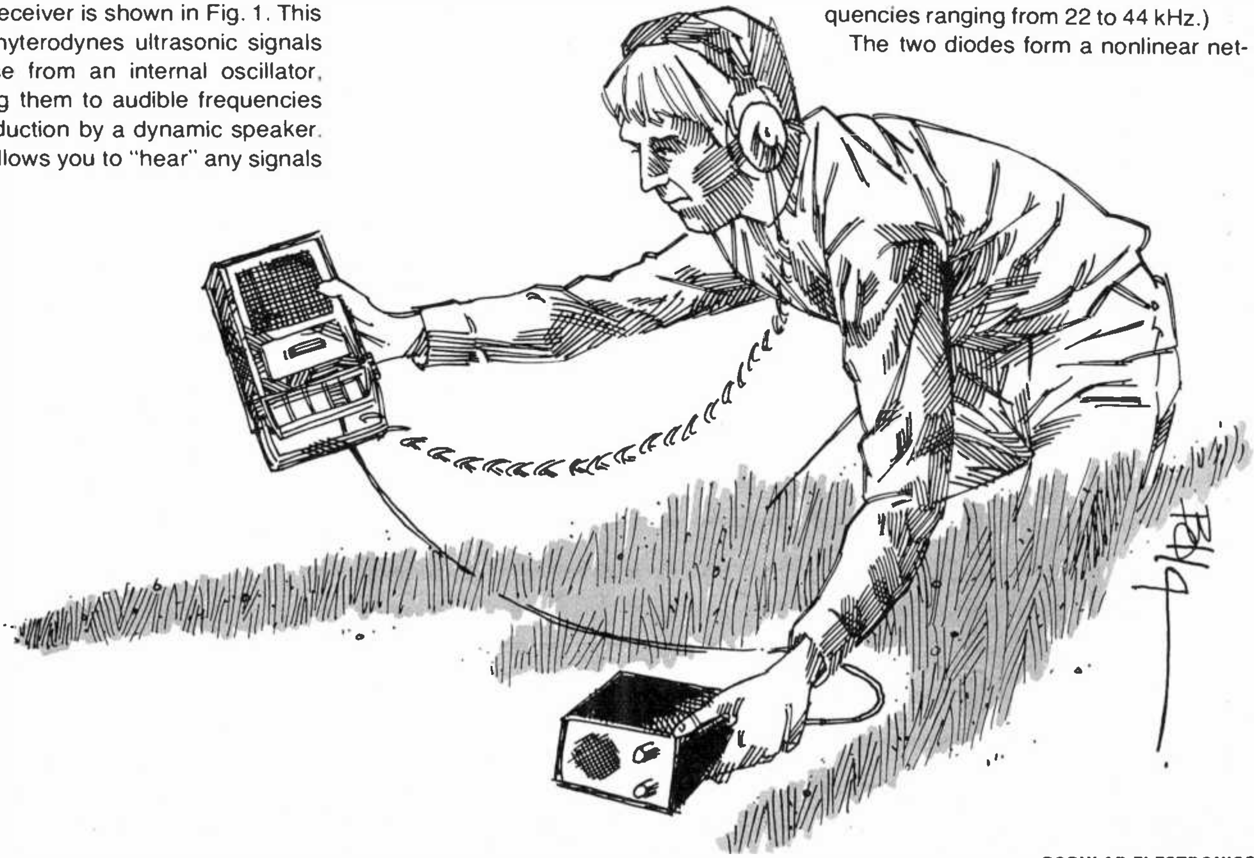
An Ultrasonic Receiver. The schematic diagram of a heterodyne-type ultrasonic receiver is shown in Fig. 1. This receiver hyterodynes ultrasonic signals with those from an internal oscillator, converting them to audible frequencies for reproduction by a dynamic speaker. Thus, it allows you to "hear" any signals it detects.

Piezoelectric transducer *TR1* converts ultrasonic waves impinging upon it into ac waveforms which are applied to the noninverting input of operational amplifier *IC1A*. Because a single-ended power supply is used, resistors *R1* and *R2* bias the noninverting input to one-half the supply voltage. Resistor *R3*, effectively connected across *TR1* by electrolytic capacitor *C1*, damps the transducer's resonant response and broadens its bandwidth. At dc, *R5* provides 100% negative feedback to stabilize the operating point. At signal frequencies of interest, the gain of *IC1A* is 60 dB for the values given in Fig. 1.

The output of *IC1A* is directly coupled to op amp *IC1B*, a similar amplifier stage. The voltage gain of *IC1B*, about 43.5 dB with the component values specified, is somewhat lower than that of the preceding stage. Signals at the output of *IC1B* are capacitively coupled by *C5* to diodes *D1* and *D2*.

Also applied to the diodes is the output of an ultrasonic oscillator comprising *IC3* and its related components. The frequency of this oscillator is determined by the setting of potentiometer *R12* and the capacitance of *C9*, which is chosen so that the oscillator output corresponds to the resonant frequency of the transducer. (Transducers are readily available from surplus dealers with resonant frequencies ranging from 22 to 44 kHz.)

The two diodes form a nonlinear net-



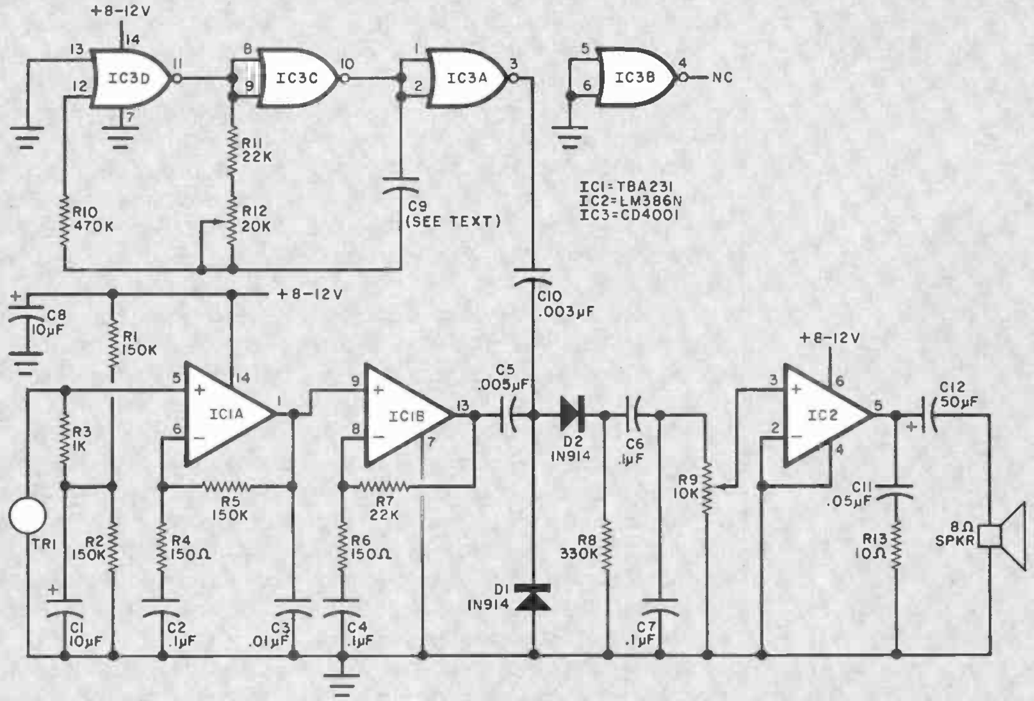


Fig. 1. An ultrasonic receiver, where incoming signals heterodyne with those from the local oscillator to produce an audible output.

PARTS LIST FOR FIG. 1

C1,C8—10-μF, 25-V tantalum
C2,C4,C6,C7—0.1-μF disc ceramic
C3—0.01-μF disc ceramic
C5—0.005-μF disc ceramic
C9—180-pF (or 330-pF) disc ceramic, polystyrene, glass or silver-mica (see text)
C10—0.003-μF disc ceramic
C11—0.05-μF disc ceramic
C12—50-μF, 25-V electrolytic
D1,D2—1N914 signal diode
IC1—TBA231 dual op amp (see note)
IC2—LM386 audio amplifier
IC3—CD4001 quad 2-input NOR gate
The following fixed resistors are ¼-W, 10% carbon composition:
R1,R2,R5—150,000 ohms
R3—1000 ohms
R4,R6—150 ohms
R7,R11—22,000 ohms
R8—330,000 ohms
R10—470,000 ohms
R13—10 ohms
R9—10,000-ohm linear-taper potentiometer
R12—20,000-ohm linear-taper potentiometer
SPKR—8-ohm dynamic speaker
TR1—Piezoelectric ultrasonic transducer
Misc.—Printed circuit or perforated board: suitable enclosure: hook-up wire: dc power source: machine hardware: etc.
Note—The TBA231 dual op amp is imported from the U.K. by SG-ATES Semiconductor Corp., 435 Newtonville, MA 02160 (Tel: 617-969-1610).

work. Hence, when signals from the oscillator and the op amp are applied, they heterodyne with each other. If *IC3* oscillates at a frequency fairly close to that of an ultrasonic wave detected by *TR1*, an audible beat signal will appear at the cathode of *D2* at a frequency equal to the difference between the two ultrasonic frequencies. The process is similar to that performed in a conventional superheterodyne r-f receiver. The beat note, which can be tuned by adjusting *R12*, is amplified by *IC2*, an audio IC, to a level sufficient to drive the dynamic speaker. Potentiometer *R9* serves as an audio gain control.

An Ultrasonic Transmitter will help you explore the ultrasonic region more fully. A suitable design is shown schematically in Fig. 2. The circuit is similar to the local oscillator stage in the receiver, but the previously unused fourth gate in the 4001 is employed to provide push-pull drive for transducer *TR2*. The output frequency is variable by means of *R3*. The capacitance of *C1* should be chosen so that the nominal oscillating frequency corresponds to the resonance of the transducer. As was the case with *C9* in the receiver, *C1* should be 180 pF if 44-kHz transducers are used, or it should be 330 pF for use with 22-kHz transducers.

Construction. Either printed circuit or perforated board can be used to duplicate the transmitter and receiver circuits. Parts placement is not especially critical. The use of sockets or Molex Soldercons is recommended when mounting the IC's on the boards. Be sure to observe normal precautions when handling the CMOS devices. Install polarized capacitors and semiconductors with due regard for polarity and pin basing. Batteries are well suited to power the transmitter and receiver circuits. Note that, when transmitter switch *S1* is in the OFF position, the output states of *IC1*'s gates are frozen. The quiescent current drain of the circuit is so small that no power switch is necessary. If a battery supply is used with the receiver, however, an spst power switch should be used to disconnect the circuit from the supply when it is not being operated.

Use. Receiver potentiometer *R12* tunes the circuit across a limited portion of the ultrasonic frequency range. Apply power and adjust audio gain control *R9* until some noise is heard through the speaker. Then rub the palms of your hands in front of *TR1*. The receiver will detect the ultrasonic energy from the rubbing.

You will notice that *TR1* has a very directional response. This is due to the fact that ultrasonics have very short wavelengths (compared to those at audio frequencies) and are thus subject to less diffraction at the edges of large objects. Also, ultrasonic waves behave like light waves in that they tend to travel in straight lines.

It's interesting to note that if coupling capacitor *C10* in the receiver is disconnected from the diode mixer, the receiver will still detect ultrasonic signals if more than one frequency is present. The frequencies present at the input will beat against each other to produce an audible output. This can be verified by repeating the palm-rubbing experiment described earlier after the coupling capacitor has been disconnected. The speaker will still generate an audio output even though no local oscillator signal is being injected into the diode mixer.

If an ultrasonic wave generated by transmitter transducer *TR2* now impinges upon *TR1*, the random noise reproduced by the speaker will drop to a low level. No tone will be heard because only one frequency is applied to the mixer. Stray coupling that allows a portion of the local oscillator output to reach the mixer will create an audible beat.

When the receiver and transmitter are operating in the same room, a signal will be heard as *R12* tunes the receiver across its range. The two transducers do not *have* to be directly facing each other if enough hard surfaces in the room reflect the ultrasonic waves, and the room is not so large that it introduces excessive signal attenuation.

The circuits presented have been successfully used with ultrasonic transducers from many different sources, including those used in television receiver remote control accessories. Of course, if you want to tune in several ultrasonic "bands," you can use a multiple-pole rotary switch to select the appropriate transducer and its corresponding oscillator capacitance. Experimentation indicates that the receiver can "hear" the transmitter at distances up to 125 feet if the transducers are aimed at each other. The use of a suitable parabolic reflector in tandem with *TR1* and/or multiple driven transmitter transducers should result in even greater useful range.

Other Suggestions. We have already mentioned the possibility of using these circuits for signalling purposes. Many other practical applications exist. For example, leaks in the rubber sealing of car doors and windows or in the sealing of a freezer door. The transmitter is placed in the car or freezer and fills the interior with ultrasonic waves. The walls of the interior reflect the waves to create a wide dispersion of ultrasonic energy. If the receiver's transducer is moved over the exterior, a tone will be heard whenever it passes any leaks. ◇

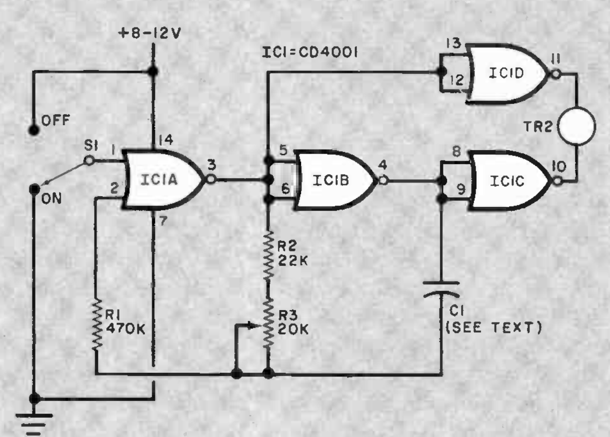


Fig. 2. This ultrasonic transmitter employs four NOR gates.

PARTS LIST FOR FIG. 2

C1—180-pF (or 330-pF) disc ceramic, polystyrene, glass or silver mica capacitor
IC1—CD4001 quad dual-input NOR gate
R1—470,000-ohm 10%, ¼-W resistor
R2—22,000-ohm 10%, ¼-W resistor
R3—20,000-ohm linear-taper potentiometer
S1—Spdt switch
TR2—Piezoelectric ultrasonic transducer
Misc.—Printed circuit or perforated board; suitable enclosure; hook-up wire; dc power source; machine hardware, etc.

Micro-PROCESSOR MICROCOURSE

BY FORREST M. MIMS

PART 5: THE CONTROL SECTION OF PIP-2.

THUS FAR in this series, we have covered the basics of number systems, digital logic and microprocessor organization. We have also introduced PIP-2, a simple 4-bit educational microprocessor, and learned how it's organized and programmed.

Now let's take a detailed look at the control section of PIP-2. We will see how instructions are fetched from the program memory, decoded and executed. We will also learn how to revise PIP-2's instruction set by modifying the microinstructions stored in control's ROM.

PIP-2's Control Section. The most important and complex section of a microprocessor is its control circuitry. This is the element that fetches instructions from the microprocessor's memory in the proper sequence, then decodes and executes the instructions.

The overall operation of the control section is a perfectly synchronized sequence of individual operations that fetch instructions, transfer data, advance counters and perform arithmetic operations.

The control section responds to a load instruction, for example, by simultaneously connecting the memory address containing the data word to be loaded (the *source*) and the input of the appropriate register (the *destination*) to the microprocessor's bidirectional bus. The control then sends a clock pulse to the register to complete the load operation and proceeds to fetch the next instruction.

While all this might seem extremely complicated to the unititiated, it's really quite simple since the program instruction is merely a binary bit pattern that can be interpreted by the control section to perform a specific task. In simplest terms, the control section is no more complicated (at least in principle) than the decoder circuit that lights up the proper segments of a seven-segment display in response to a binary-coded decimal (BCD) input nibble.

The heart of the control section of some microprocessors is a complex combinational network of gates that decodes program instructions and activates the appropriate control inputs of the various sections of the processor. More advanced microprocessors employ a special ROM that contains the sequences of microinstructions necessary to accomplish each program instruction. These so-called *microprogrammable* microprocessors are much more versatile since their instruction sets can be extensively revised by simply modifying the microinstructions stored in the ROM.

PIP-2, the educational microprocessor we've been studying, is microprogrammable and the block diagram shown in Fig. 1 illustrates the general organization of PIP-2's control section. You might want to refer back to Part 4 of this series to see how control interfaces with the remainder of PIP-2.

A detailed breakdown of PIP-2's control, including the organization of the microprogrammable ROM containing the microinstructions, the microinstruction decoders and the clock, is shown in Fig. 2. We will now discuss each part of the control section.

Clock. The clock is a relatively simple but vital part of CONTROL since it provides the synchronized train of pulses that cycle PIP-2 through a program. The clock's output is said to be *two-phase* since it supplies two streams of pulses having identical frequency but different phases from outputs $\phi 1$ and $\phi 2$. Fig-

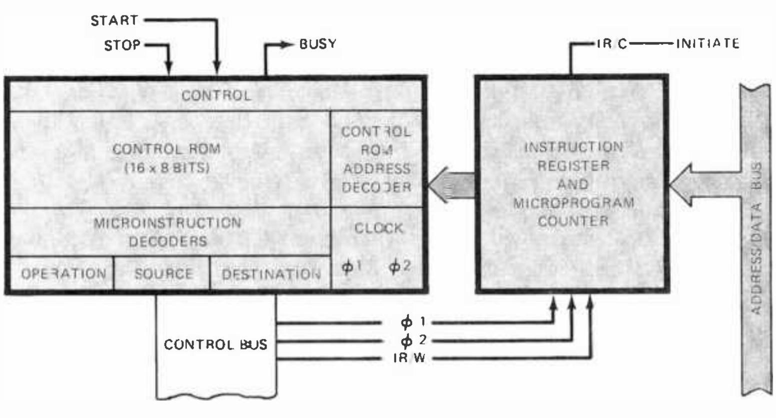


Fig. 1. Organization of the PIP-2 control section.

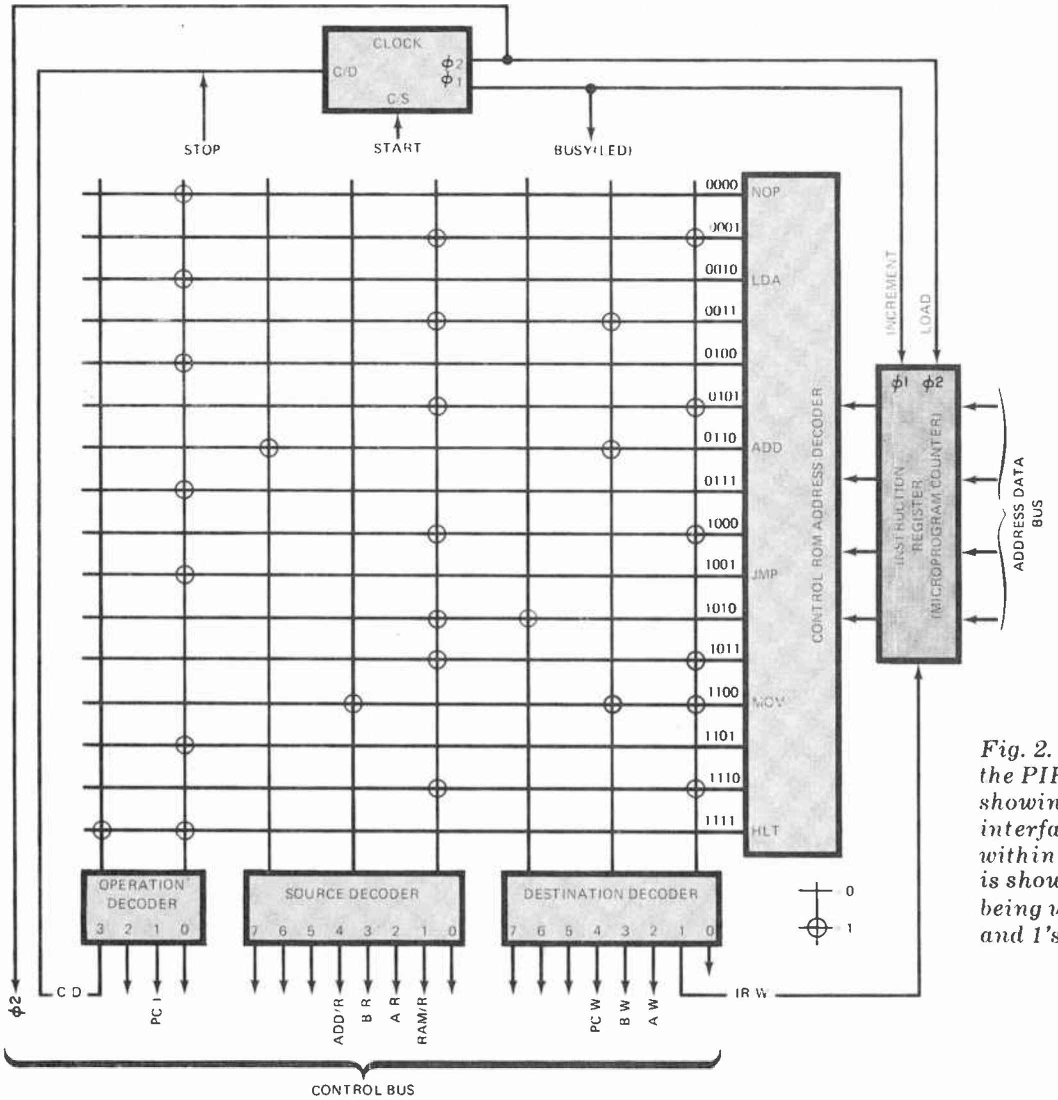


Fig. 2. Internal details of the PIP-2 control section showing how the three decoders interface with the microprogram within the ROM. Here, the ROM is shown as a matrix with 0's being unconnected junctions and 1's having a connection.

ure 3 shows the timing diagram for these two clock signals.

The clock has two control inputs. A low at C/S applied by pressing the START switch *starts* the clock. A low at C/D applied by pressing STOP, or by a signal from the microinstruction decoder (activated by a HLT instruction in the program), *disables* the clock.

Instruction Register and Microprogram Counter. This is a 4-bit counter that doubles as a 4-bit register. It receives the op-codes from the program memory, which are actually control ROM addresses, and feeds them into the control ROM address decoder.

Signals from clock phase $\phi 1$ increment the instruction register and cause it to step through a sequence of addresses in the control ROM, much like PIP-2's program counter steps through addresses in the program memory when executing a program. That's why the instruction register can also be called a microprogram counter.

The instruction register has a couple of other control inputs. When IR/W is low, a $\phi 2$ pulse from the clock *writes* the instruction on PIP-2's address/data bus into the instruction register. When IR/C is low, the instruction register is *cleared* to 0000.

Control ROM Address Decoder. This is simply a 1-of-16 decoder that activates appropriate addresses in the control ROM in response to the data in the instruction register. When the nibble 0000, for example, is in the instruction register, the first address in the control ROM is selected.

Control ROM. This is a 128-bit ROM organized as sixteen 8-bit bytes. Each byte is assigned a unique address (0000 to 1111) and comprises a single microinstruction. As shown in Fig. 2, the control ROM is loaded with microroutines (sequences of microinstructions) for six separate program instructions. As we'll soon see, these microroutines can be easily changed by simply reprogramming the ROM.

Microinstruction Decoders. Control has a pair of 1-of-8 decoders (Source and Destination), and a single 1-of-4 decoder (Operation). The selected output of each decoder goes *low* while the remaining outputs stay *high*.

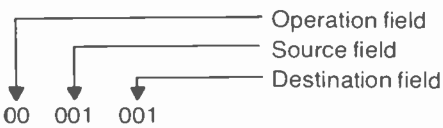
These decoders convert the microinstructions encoded in the selected ROM address into the appropriate operations necessary to execute the microinstruction. As you can see in Fig. 2, the control ROM is divided into sixteen 8-bit bytes. The first two bits of each byte are fed into the operation decoder. The next three bits go to the source decoder and the final three bits go to the destination decoder.

The outputs from the three decoders and from the clock form PIP-2's control bus. The outputs of the *source* decoder go to the read (R) control inputs of the various sections of PIP-2. The outputs of the *destination* decoder go to the write

(W) control inputs of the various sections. And the outputs of the *operation* decoder go to the special operation control inputs, clock disable (C/D) and program counter increment (PC/I).

Note that several outputs of the *source* and *destination* decoders and two outputs from the *operation* decoder are not used. This means that additional circuits (maybe a C register, perhaps an arithmetic-logic unit) can be connected to PIP-2's address data bus. These lines may also be used to control external devices. In both cases, of course, new microinstructions would have to be added to the control ROM to activate the new circuits.

Note also how the bit pattern stored in the ROM activates the decoders. Address 0001, for example, contains the microinstruction 00001001. Let's divide this byte into each of the three bit fields applied to the decoders and see what happens:



The operation field (00) does nothing since it activates the unconnected 0 output of the *operation* decoder.

The source field (001) activates the 1 output of the *source* decoder. This applies a low to RAM/R.

The destination field (001) activates the 1 output of the *destination* decoder. This applies a low to IR/W.

The result? The output of the program memory (RAM) and the input of the instruction register (IR) are simultaneously connected to the address/data bus, and the arrival of the next ϕ 2 pulse from the clock loads the instruction register with the selected instruction op-code in the program memory.

Now that we know something about each of the sections of PIP-2's control and how an individual microinstruction is executed, let's see how control fetches and executes an instruction from the program memory.

Fetching and Executing. Understanding how control fetches (retrieves) an instruction from the program memory and then executes it will take you a long way toward understanding how real microprocessors work. You might find it handy to have Part 4 of the Microcourse available since we'll be referring to PIP-2's instruction set mnemonics and op-codes.

Let's assume the first instruction in the program memory (address 0000) is LDA. This is a memory reference instruction that is followed by a 4-bit data nibble in the next program memory address. When executed, LDA will load the A register with the data nibble in program memory address 0001.

After the program containing the LDA instruction is loaded into the program memory, the INITIATE switch is pressed to return the program counter to program memory address 0000. The instruction register doubles as a microprogram counter and pressing INITIATE clears it to 0000 also.

The two microinstructions that comprise NOP occupy the first two bytes of the control ROM. When START is pressed, the first clock pulse advances the combination instruction register/microprogram counter to the second NOP microinstruction (control ROM address 0001).

What's the byte stored in this address? Figure 2 shows that this microinstruction is 00001001—which activates the RAM/R and IR/W control inputs discussed earlier. When the ϕ 2 clock pulse arrives, the instruction register advanced to the next address in the program memory (which contains the data nibble to be loaded into the A register). Signal ϕ 2 is a do-nothing clock pulse since there is no data located on the address/data bus.

The third ϕ 1 clock pulse advances the instruction register to the second microinstruction in the LDA microroutine (control ROM address 0011). This microinstruction (00001010) applies lows to RAM/R and A/W. When clock pulse ϕ 2 arrives, the A register copies the contents of the data nibble following the LDA op-code in the program memory.

Now that the A register has been loaded with the specified data nibble, the most important part of the LDA instruction has been accomplished. The remaining two microinstructions fetch the next step from the program memory.

The fourth ϕ 1 clock pulse advances the instruction register to LDA microinstruction 01000000. This increments the program counter to the next address in the program memory (0011). The next ϕ 2 clock pulse is another do-nothing pulse. The fifth ϕ 1 clock pulse advances the instruction register to the final LDA microinstruction, 00001001.

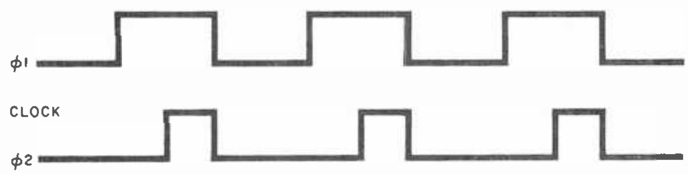


Fig. 3. Timing diagram of the PIP-2 two-phase clock.

copies the op-code of the instruction in program memory address 0000. The op-code for LDA is 0001, so in this case the instruction register doesn't change states. (What would happen if the op-code was 1011 or 0101?)

Thus far, all of control's operations have been preprogrammed and completely automatic with the specific goal of fetching the first instruction from the program memory. What happens next?

Recall that the op-code for each instruction is a binary number that is 0001 less than the starting address of the microroutine in the control ROM that executes the instruction. When the next ϕ 1 clock pulse arrives, the instruction register advances to the first microinstruction in the LDA microroutine and things start to happen. Let's follow the various steps in the execution of the LDA microroutine to see how.

The first LDA microinstruction (Fig. 2) is 01000000. Only the PC/I control input is activated; the program counter is This loads the op-code of the next instruction in the program memory into the instruction register.

All the steps necessary to execute LDA appear rather complicated at first. But if you'll browse back through the preceeding paragraphs again you'll see that LDA, like all of PIP-2's instructions, is merely a collection of very simple operations neatly strung together by the ϕ 1 and ϕ 2 pulses from the clock. Figure 4 is a sequence of diagrams that shows exactly what happens.

Summing Up Control. Now that you've seen how PIP-2 fetches, decodes and executes an instruction, you can better appreciate the sophistication of control. You can even think of control as a simple microprocessor inside PIP-2. The control ROM contains the program, the instruction register serves as the program counter and the microinstruction decoders implement the various instructions.

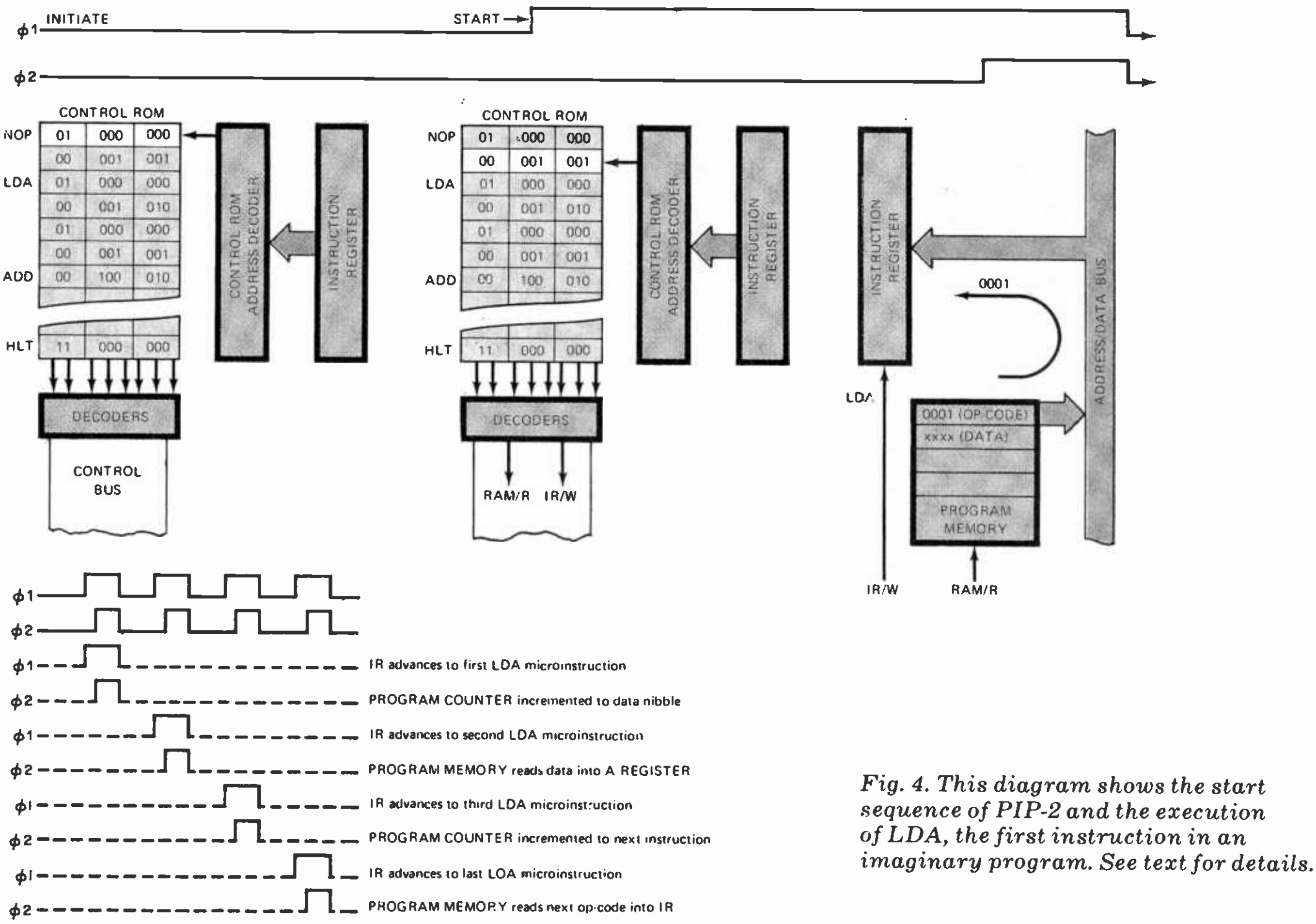


Fig. 4. This diagram shows the start sequence of PIP-2 and the execution of LDA, the first instruction in an imaginary program. See text for details.

The Table summarizes the microroutines necessary to execute each PIP-2 instruction. In addition to the mnemonics and their op-codes, the table contains the entire truth table of the control ROM. It also shows the operations that take place for each microinstruction.

Microprogramming PIP-2. Look back at the table of microroutines for a moment. Notice how often the fetch operations PC/I and RAM/R→IR/W occur? Remove these microinstructions from the table and we're left with only five additional microinstructions.

Obviously there are more possible microinstructions than just these seven. All that's necessary to arrive at a new microinstruction is to place one source and one or more destinations on the address data bus. Here are some possibilities:

A/R→IR/W
A/R→PC/W
B/R→IR/W
B/R→PC/W
B/R→A/W
RAM/R→B/W
ADD/R→B/W
ADD/R→PC/W
ADD/R→IR/W

Of course these are only some of the additional microinstructions that are possible. All sorts of possibilities open up if we activate *more* than one destination device. For example, RAM/R→A/W;B/W;PC/W.

If we assume that you have assembled a working version of PIP-2, it's quite possible the original instruction set will not fill your requirements. If that's the case, you can substitute new microinstructions to devise your own special instruction set.

Suppose you want to replace LDA with LDB (load the B register). All you have to do is find the LDA microroutine in the control ROM and reprogram the byte that loads the A register (address 0011) so that the B register is loaded instead. The original byte is 00001010. The new byte is 00001011. The remaining bytes are unchanged. The op-code for LDA becomes the op-code for LDB since we haven't changed the location of the microroutine in the control ROM.

You can use this same procedure to microprogram other new instructions into PIP-2. Just remember these points:

1. Be sure to assign the correct op-code to each new instruction. Remember, the op-code is a binary number that is 0001 *less* than the first address of the microroutine in the control ROM.

2. If necessary, be sure to include the appropriate fetch microinstructions in each new microroutine so the next instruction in the program memory will be retrieved.

3. Be sure the microinstruction at the 0001 address in the control ROM is always 00001001. This is necessary since this microinstruction plays a key role in fetching the first instruction from the program memory during PIP-2's automatic start sequence.

4. Plan ahead! Are you eliminating an existing instruction(s) you might need later? Does the control ROM have room for the new instruction(s)? Are there any possible programming shortcuts you can use to implement instructions *not* in the control ROM?

5. Document your work so you'll know what you've done.

Don't let these simple precautions stop you from having a go at microprogramming PIP-2! Some of the possibilities are very interesting.

For example, an instruction that loads the program counter with the contents of

PIP-2'S MICROROUTINES

Program Memory Mnemonic	Program Memory OP-Code	Control ROM Address	Microroutine OP	Microroutine S	Microroutine D	Operation
NOP	1111	0000	01	000	000	PC/I
		0001	00	001	001	RAM/R→IR/W
LDA	0001	0010	01	000	000	PC/I
		0011	00	001	010	RAM/R→A/W
		0100	01	000	000	PC/I
		0101	00	001	001	RAM/R→IR/W
ADD	0101	0110	00	100	010	ADD/R→A/W
		0111	01	000	000	PC/I
		1000	00	001	001	RAM/R→IR/W
JMP	1000	1001	01	000	000	PC/I
		1010	00	001	100	RAM/R→PC/W
		1011	00	001	001	RAM/R→IR/W
MOV	1011	1100	00	010	011	A/R→B/W
		1101	01	000	000	PC/I
		1110	00	001	001	RAM/R→IR/W
HLT	1110	1111	11	000	000	C/D

the A register permits the program to branch to an address specified by the result of an addition. This procedure is called *indirect addressing*. It gives a microprocessor the ability to branch to one of several possible addresses in its program memory depending upon the results of an earlier operation.

Here's one possible microroutine that performs the indirect addressing operation we've been discussing:

Microinstruction OP	S	D*	Operation
00	100	100	ADD/R→PC/W
00	001	001	RAM/R→IR/W

** OP = operation; S = source; D = destination decoders.*

Since the second microinstruction of this microroutine is the same as the second microinstruction of NOP in PIP-2's original instruction set, we can easily substitute it for NOP. We just reprogram the first address in the control ROM with 00100100 and assign NOP's op-code to the new instruction.

For convenience, it's nice to assign a mnemonic to the new instruction. Since the instruction is an indirect jump, one possibility is JMI. You might want to be more specific since other indirect jump instructions are possible. Since this is a "JUMP INDIRECT TO ADDRESS IN A," a better mnemonic might be JIA.

Now that you know how PIP-2 is microprogrammed, how about adding a new instruction or two on your own? With a little care you just might come up with an instruction set that's better.

Summing Up. If you've stayed with the course, you should have a fairly respectable knowledge of some of the fundamental basics of microprocessors. To be sure, *real* microprocessors are far more sophisticated than PIP-2. But PIP-2 has prepared you to move up to real microprocessors. ◇

Solid State

By Lou Garner

CROSSING THE BRIDGE

MODERN solid-state equipment designs are often an interesting blend of the very old with the very new. To achieve their goals, engineers frequently employ state-of-the-art semiconductor devices in networks which have been in use for many decades. Back in 1847, well over a century ago, Sir Charles Wheatstone adapted a basic circuit developed by S. H. Christie (in 1833) for use in making precision resistance measurements. His adaptation of the Christie design has been known ever since as the *Wheatstone Bridge*, and is still used today in its original or modified form in equipment and instrument designs.

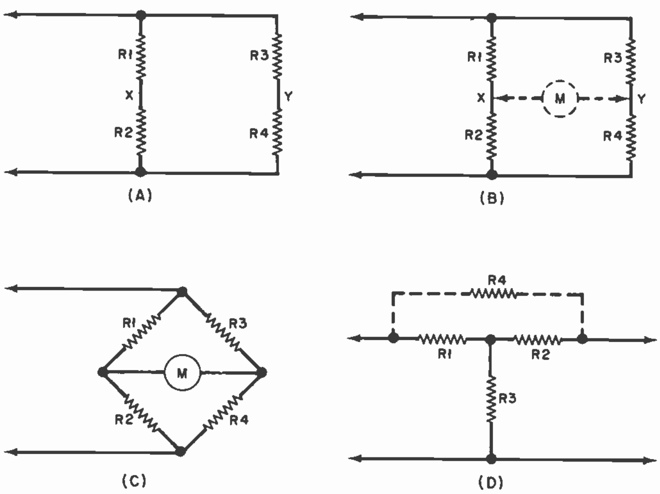


Fig. 1. Developing the bridge circuit: (A) Basic series-parallel network; (B) Meter between common point; (C) Wheatstone bridge; (D) Bridged -T network.

Let's examine the evolution of the bridge circuit. Consider the simple network shown in Fig. 1A: just two parallel branches, each consisting of two resistors in series. Resistors *R1* and *R2* make up one branch, *R3* and *R4* the parallel branch. Neither a spectacular nor unusual arrangement, but consider the potentials at points "X" and "Y" if a voltage is applied across the two branches. If *R1* and *R2* have the same resistance *ratio* as *R3* and *R4*, the relative potentials at "X" and "Y" will be the same, *regardless of the actual resistance values*. As an example, if *R1* is a 1000-ohm unit, *R2* is 9000 ohms, then the voltage at point "X" will equal that at point "Y" if *R3* is, say, 10,000 ohms and *R4* is 90,000 ohms, for both branches have *the same ratio* of 1:9. In practice, this can be demonstrated quite easily by connecting a high-impedance voltmeter or sensitive galvanometer between the two points, as illustrated in Fig. 1B.

This simple fact provided the scientist and engineer with an extremely powerful tool for measuring the value of unknown resistances, for if an accurately known standard resistance were used for *R3* and means were provided for determining the ratio of *R1*: *R2*, then *R4*'s value could be calculated easily and accurately once the voltage at "X" equalled (or *balanced*) that at "Y," and the balance could be established by adjusting the *R1*:*R2* ratio.

So far, so good... but what, you may wonder, does all of this have to do with bridges? Simple—the meter (M) has "bridged" corresponding points in two parts of the network, and if the basic circuit is redrawn as in Fig. 1C, you'll recognize the standard form of the Wheatstone bridge. The basic design may be used for other than resistance measurements if an ac rather than a dc voltage source is used, and if reactive elements (inductances and capacitances) are used in the arms of the bridge, with a sensitive ac detector substituted for the meter. If a series RC network is used in place of *R3* and a parallel RC network for *R4*, the arrangement becomes a *Wien bridge* that will "null" (zero voltage between points "X" and "Y") at a specific frequency dependent upon the relative RC values. The Wien bridge can be used for measuring capacitances and in other applications.

Going a step further, a "bridge" circuit need not always be a measurement device. It can be another network element, as in the *bridged-T* arrangement shown in Fig. 1D. Here, *R4* is the bridging element. Used in attenuators and for impedance matching, bridged-T networks also can serve as special-purpose low- and high-frequency filters if reactive components (inductors and/or capacitors) are used in the arms.

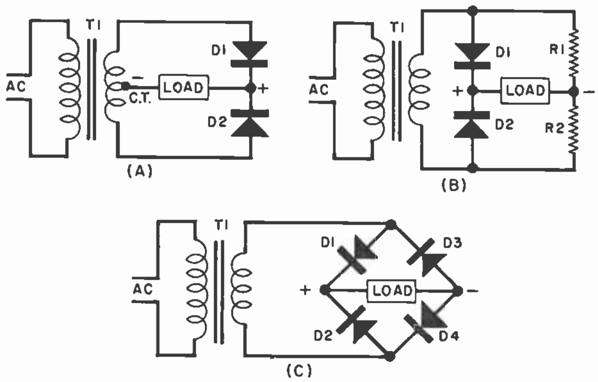
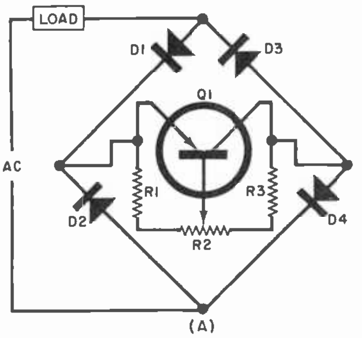


Fig. 2. Rectifier circuits: (A) Full-wave; (B) Modified full-wave; (C) Full-wave bridge.

In a broad sense, the conventional full-wave rectifier is a type of "bridge" circuit, for the dc load serves as a bridge between the transformer center tap (CT) and the corresponding junction between two rectifiers (*D1* and *D2*), as illustrated in



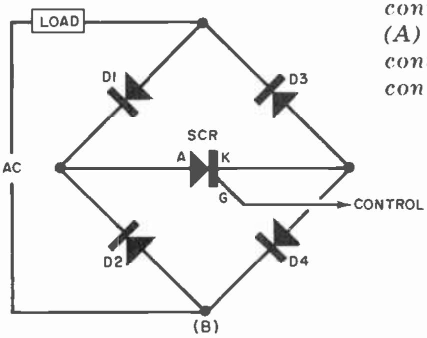


Fig. 3. Using a bridge rectifier to control an ac load: (A) Transistor control; (B) SCR control.

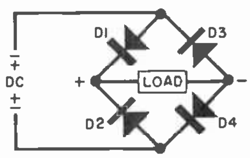


Fig. 4. Using a bridge rectifier as an automatic polarity switch.

Fig. 2A. If the transformer secondary has no center tap, an artificial center may be set up by using two resistors of equal value (*R1* and *R2*) as in Fig. 2B. Unfortunately, while this arrangement will provide full-wave rectification, it is rather inefficient. Resistors *R1* and *R2* place a constant drain on the transformer, whether or not current is required by the load and, in addition, extra power is dissipated in the resistors as load current increases. These disadvantages may be offset by replacing *R1* and *R2* with additional rectifier diodes *D3* and *D4*, as shown in Fig 2C, and, of course, we now have the widely used *bridge rectifier*. Note the configuration's overall similarity to the original Wheatstone bridge.

Although the bridge rectifier's primary application is as an ac-to-dc converter, it can be used in other ways. The amount of ac drawn from the source, whether a transformer secondary or the power line, is directly proportional to the dc load; the greater the load current, the greater the ac, and vice-versa. This characteristic can be utilized to control the current through an *ac load*, such as a motor, solenoid, or incandescent lamp. Simply connect the ac load in series with a suitable bridge rectifier and provide a variable dc load, such as a power transistor or SCR, as illustrated in Fig. 3A and 3B, respectively. Both are useful techniques to remember if you don't have a Triac handy.

Another interesting application for the bridge rectifier is given in Fig. 4. Here, the bridge rectifier is connected between a *dc source* and a dc load (such as a CB transceiver, battery operated amplifier, or similar unit), insuring that the correct polarity will be applied to the equipment *regardless of the original source connections*. This is an inexpensive precaution for equipment which may be installed incorrectly.

A useful and versatile arrangement, the bridge rectifier is by no means the only application for the bridge concept in modern solid-state circuit designs. Another useful application is shown in Fig. 5. Here, the inputs of a conventional op amp are connected across the two branches of an RC Wien bridge,

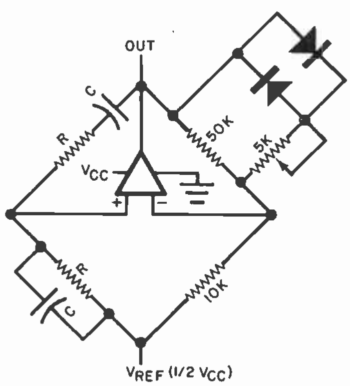


Fig. 5. In this circuit, the inputs of an op amp are connected across the branches of an RC Wein bridge with the output furnishing ac drive.

with the output furnishing ac drive to the network. The result is a simple and reliable audio oscillator. The circuit's frequency of operation is established by the component values in the series and parallel RC arms according to the equation f= 1/(2π RC). For operation at, say, 1 kHz, the two "R" resistors might have values of 16,000 ohms each, while the two "C" capacitors could be 0.01- µF units. Other RC combinations could be used for the same frequency of operation, of course, as long as the basic equation is satisfied, but, as a general rule, it is best to stick with standard off-the-shelf values. The Wien bridge oscillator can be duplicated quite easily and inexpensively in the home laboratory. It can be assembled as a stand-alone circuit for experimental tests or, if preferred, incorporated as a circuit element in more complex designs, such as musical instruments or test equipment. The two diodes are general-purpose types while the specified op amp is one section of a type LM148. A quad device, the LM148 is essentially four standard type 741 op amps in a single 14-pin DIP and, if desired, a single type 741 unit can be used in the circuit without changing component values. Except for the 5,000-ohm adjustment potentiometer, the resistors may be either ¼-or ½-watt types, while the tuning capacitors should be high quality, low-voltage ceramic or plastic film types. The dc source voltage (V_{CC}) may range from 4.5 to as high as 16.0 volts, but the input reference voltage (V_{ref}) should be set at *one-half* the source voltage for optimum performance.

Another type of bridge circuit suitable for experimenter and hobbyist solid-state projects is illustrated in Fig. 6. Here, a

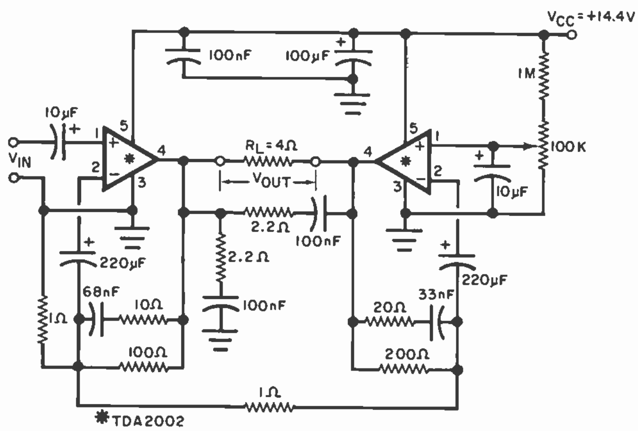


Fig. 6. Power amplifier bridge configuration.

loudspeaker load (*RL*) is "bridged" between the outputs of two integrated circuit power amplifiers to achieve a power output nearly twice that available from a simple amplifier. The input signal is coupled simultaneously to the noninverting (+) input terminal (pin 1) of one amplifier through a 10-μF dc blocking capacitor and to the inverting (−) input terminal (pin 2) of the second amplifier through a 1-ohm series isolation resistor and a 220-μF dc blocking capacitor. Used alone in a single-ended arrangement, each amplifier is capable of delivering approximately 8 watts to a low-impedance load when operated on a 14.4-volt dc power source. In the bridge configuration, the pair of amplifiers can deliver 15 watts to a comparable load when operated on a similar dc source.

With neither layout nor lead dress overly critical, the bridge audio amplifier circuit can be assembled using chassis construction or either perf or pc board assembly techniques, as preferred. Good audio wiring practice should be followed, of course, with the signal-carrying leads kept short and direct and ample spacing between the input and output leads. Except for the 100,000-ohm balance control, all resistors are half-watt types. Capacitors marked with polarity symbols are electrolytics, others are low-voltage ceramic or plastic film types. The semiconductor amplifiers should be attached to an adequate common ground heat sink by their metal tabs.

Assembled in small plastic packages with extended metal mounting tab/heat sinks, the (Motorola) TDA2002 devices are 8-watt monolithic silicon class-B power amplifiers designed primarily for automotive and general purpose applications. Each device features internal thermal overload and supply over-voltage protection as well as short-circuit current limiting. The TDA2002 may be used on dc supply voltages from 8 to 18 volts and deliver intermittent peak currents of up to 4.5A. As a general rule, the higher the supply voltage in a given circuit, the larger the maximum output power up to the device maximum ratings.

Reader's Circuit. Guy Isabel (1725, Henri-Bourassa East Blvd., Apt. 25 Montreal, Quebec, H2C 1J5, Canada) uses the simple burglar alarm circuit shown in Fig. 7 in his own home. It includes a lantern battery, a spst power lock switch, an alarm device such as a heavy-duty bell, a medium-current silicon controlled rectifier, a capacitor and a group of normally open (NO) spst magnetic switches, *S1* through *SN*. The required capacitor value will vary somewhat with the gate sensitivity of the SCR used but, generally, will range from 0.05 μF to about 0.5 μF although a small electrolytic of 1 to 5 μF may be needed in some installations. In practice, the magnetic switches are mounted to protect doors, windows and other access openings, arranged to close when the door or window is opened, and wired in parallel.

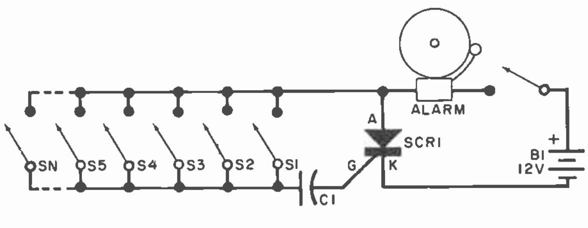


Fig. 7. Burglar alarm uses sensors in parallel.

The circuit draws virtually no current from the battery when in a "stand-by" condition with the on/off switch closed. If any door or window is opened, closing the corresponding reed switch, however, *C1* will charge and this current surge will fire *SCR1*, sounding the alarm. Once *SCR1* switches to a conducting state, the control switches have no effect and the alarm will continue to sound until the battery runs down or until the system is reset by opening the power/reset switch.

Guy's design, while simple, fairly reliable, and offering the user a virtually zero stand-by current drain, does suffer from two disadvantages. First, the control switches are wired in parallel, requiring two wires to be run to every switch. Second, the circuit is not "fail safe." That is, if an accidental (or deliberate) break should occur in the wiring to the control switches, the system will offer reduced or zero protection. Most commercial burglar alarm systems employ a "supervised" alarm line . . . i.e., one in which a small current flows at all times, so that any break (as by a burglar cutting wires) will result in an alarm.

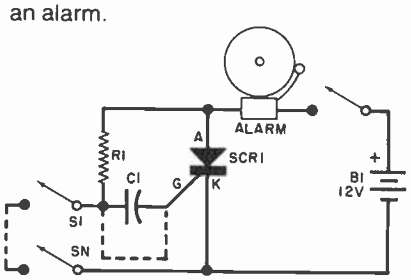


Fig. 8. Burglar alarm with supervised line for "fail safe" operation.

A "fail safe" design using virtually the same number of components is illustrated in Fig. 8. Here, normally closed magnetic switches are used to protect the access openings and these (*S1* to *SN*) are wired *in series*, requiring a single lead alarm line. A current-limiting resistor (*R1*) is needed, but, generally, *C1* is no longer required and may be eliminated (as shown by the dotted line connection). A half-watt resistor, *R1*'s value will depend on the gate sensitivity of *SCR1*. If the device requires, say, only 1 mA to fire, a 10,000-ohm resistor may by used, assuming a 12-volt battery. The stand-by current drain can be determined by dividing the battery voltage by *R1*'s value.

In operation, a small current flows through *R1* and the control line circuit whenever the system is switched on but the control line effectively shorts out the SCR's gate voltage and this device remains in a nonconducting state. If there is a break in the line, however, whether caused by an open switch or someone cutting the line, gate current is applied to the SCR through *R1*, firing this device and sounding the alarm. As before, once the SCR has fired, the alarm will continue to sound until the battery is exhausted or until the system is reset by opening the on/off switch.

With either circuit, care must be taken when choosing the alarm device, whether a bell, buzzer, siren or gong. If this is an "interrupter" type electromechanical unit, it may be possible for an intruder to silence the alarm, once activated, simply by restoring the control line circuit to its normal standby condition (i.e., either opening or closing the appropriate switch, depending on which circuit is used). This problem may be avoided by shunting the alarm device with a small resistor of adequate value to maintain the SCR's sustaining current even when the alarm device interrupts the normal current flow.

Another DVM. The ink was barely dry on our March column describing digital meter circuits when the National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, CA 95051) announced a new 3½-digit, *0.5 inch high* LED display designed especially for instrumentation applications, including power supply readouts, multimeters and digital panel meters. Designated type NSB5388, the new common-cathode multiplexed GaAsP display is compatible with National's own ADD3501 DVM chip as well as with comparable chips offered by other manufacturers, and can be connected easily by PCB type terminals on the edge of the device. Featuring separate access to its plus/minus sign and decimal points, the display offers a digit light intensity rated, typically, at 1.6 mcd at 10 mA per segment peak current.

Device/Product News. Motorola Semiconductor Products, Inc. (Box 20912, Phoenix, AZ 85036) has announced its entry into the "BIFET" operational amplifier market with a line of twelve devices, all based on the generic LF155A type. The LF155/255/355 series offer low supply current requirements; the LF156/256/356 group, a 5-MHz gain-bandwidth at a higher current; and the decompensated LF157/257/357, a 20-MHz gain-bandwidth.

The Intel Corporation (3065 Bowers Ave., Santa Clara, CA 95051) has introduced a new family of HMOS 4096x1-bit fully-static random-access memories. Identified as the 2141 series, the family includes seven types providing four speed versions and three low-power selections. Requiring only a fraction of the power of conventional MOS static RAM's, the new devices offer maximum access times ranging from 120 to 250 ns, with minimum cycle times equalling the maximum access times. Assembled in 18-pin DIP's, all seven units use a single +5 V, −10% dc power source and are directly compatible with TTL on all inputs and outputs.

Raytheon's Semiconductor Division (350 Ellis Street, Mountain View, CA 94040) has announced a new high-performance dual operational amplifier. Designated type 4559, the new unit is specified for use in audio systems, data modems, telecommunications equipment, function generators, and similar equipment. Guaranteed to be unity gain stable, the 4559 has a minimum unity gain bandwidth of 3.0 MHz, a slew rate of 1.5 V/μs equalization, a noise voltage of only 2.0 μV rms maximum and a full power bandwidth of 25 kHz.

Fairchild's Semiconductor Products Group (464 Ellis Street, Mountain View, CA 94042) is now offering a new series of inexpensive 3-terminal, half-amp voltage regulators. Identified as the μA78C family, the devices are offered in the special packages with heat sink tabs which may be used as direct replacements for units assembled in standard TO-202 packages. Nine voltage options of the regulator are available as stock items: 8, 10, 12, 15, 17, 18, 20, 22 and 24 volts.

RCA's Solid State Division (Box 3200, Somerville, NJ 08876) is now producing the first multiple-technology dual-voltage comparators available from the semiconductor industry. The CA3290 series of BiMOS dual comparators feature two independent single- or dual-supply voltage comparators on a monolithic chip and a high common-mode input voltage range, making then well suited for applications in long-time-delay circuits, square-wave generators, A/D converters, and high-source-impedance voltage comparators. Gate-protected MOS/FET transistors in the input circuit provide very high input impedances (1.7 terohm typical), extremely low input currents (3.5 pA typical at +5 V), and high-speed performance. With a dc supply voltage range of from 4 to 36 V, the devices are compatible with TTL, DTL, ECL, MOS, and CMOS logic systems. Different versions of the CA3290 family are available in TO-5 cans, 14-lead DIP's and 8-lead MiniDIP's. ◇

Hobby Scene Q&A

By John McVeigh

DERIVING 60 Hz

Q. ***How do clock chip manufacturers obtain an accurate 60-Hz timing signal from a 3.579545-MHz crystal? The nearest frequency that permits the use of a decent dividing network seems to be 3.6000 MHz. —George Rogers, Waynesboro, VA.***

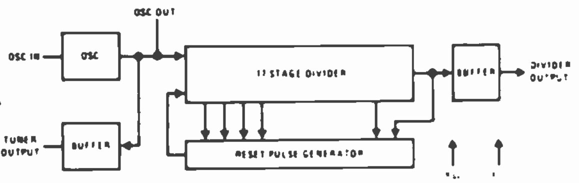
A. The key word in your question is "decent." I assume you mean that the nearest frequency which can be divided by a nice round number is 3.6 MHz. You are correct—applying a signal at that frequency to four successive decade counters and one ÷6 counter (or a ÷3 stage and a simple flip-flop which divides by two) will result in an output at exactly 60 Hz. However, semiconductor manufacturers have chosen a different route.

Shown in Fig. A is the block diagram of National Semiconductor's MM5369 oscillator/17-stage programmable divider IC. The programmable modulus of the counter can vary from 10,000 to 98,000. If a 3.579545-MHz quartz crystal is connected to the IC and tuned (via a small trimmer capacitor) to oscillate at exactly that frequency, the MM5369 will produce a 60.0000838-Hz output—according to my calculator—when the counter's modulus is 59,659. The output waveform for this combination of oscillator frequency and counter modulus is shown in Fig. B.

Now, why use a 3.579545-MHz crystal and a modulus of 59,659? I suspect that the reason is that high-quality crystals at that frequency have been mass-produced for years. Every color television contains one because that is the frequency of the chroma subcarrier. The chroma oscillator is locked to that at the transmitter by PLL techniques.

The use of feedback via gates permits a designer to obtain nonstandard moduli such as 3, 5, 7, 9, etc. The 7490 bi-quinary counter with a ÷5 stage as well as a ÷2 flip-flop is a good example of this. Combining such feedback with presettable counters via LSI technology enables manufacturers to produce such sophisticated counters as the MM5369 at reasonable cost. Apparently, producing such counters and combining them with mass-produced color TV crystals was found to be more economical than using IC counters having standard moduli teamed up with quartz crystals that oscillate at "nice, round" frequencies but that were not being mass-produced.

A



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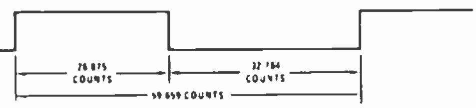
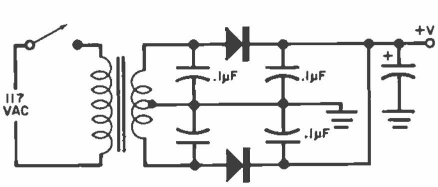


BUZZING DIODES

Q. ***My stereo system includes a separate tuner and amplifier. I am experiencing heavy interference when the tuner is in the AM mode. There's an awful buzz clear across the band which only the strongest signals can overcome. Investigating the problem with a small transistor radio, I discovered that the amplifier is the source of the noise. Also, the noise signal is very strong near the tuner's ferrite rod antenna—whether the tuner is plugged into the ac outlet or not. Both components' chassis are grounded to a ground rod. What causes this, and what can be done to eliminate it? —David Shoulders, Eugene, OR.***

A. I suspect that the interference is being caused by transients in the amplifier's power supply. When an ac voltage is applied to a silicon diode, the diode does not conduct exactly for one half-cycle and then shut off for the other half-cycle. Rather, a silicon diode will not begin to conduct until the barrier potential at the diode junction (about 0.6 volt) is overcome. Also, the diode is a very nonlinear device, especially at the knee (the region in which it starts to conduct) of its characteristic curve.



As a result, turn-on and turn-off transients are generated near the 0° and 180° points in the sinusoidal cycle. These transients are rich in interference-causing harmonics of the line frequency. I suspect that they are being radiated by wiring in the amplifier and perhaps by the line cord. The reason the signals are stronger near your tuner's ferrite rod AM antenna is transformer action. Mutual coupling between the two ferrite antennas causes signals picked up by the tuner's coil to be passed to that in the transistor radio.

The diode transients can be dealt with by installing 0.1-µF disc ceramic capacitors on both sides of each diode as shown in the figure. Here, a full-wave center-tapped power supply is shown. If a dual polarity supply is used, repeat the procedure for the negative supply. If a full-wave bridge rectifier is employed, install bypass capacitors at each corner of the bridge. The capacitive reactance of these components is too high to interfere with the rectifying action of the power supply.

All chassis in the system should be well grounded to a good earth ground. You mentioned that both components are grounded. That's good—but beware of hum-producing ground loops. If separate grounding wires are attached from each chassis to earth ground, no conductors should run from one chassis to the next. The shields of signal cables, if connected to a chassis at each end of the cable, will cause a loop to occur between the already grounded chassis. Such a ground loop can cause hum problems, but not the "buzz" you have described. Look to the amplifier's power supply for the source of that signal.

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.

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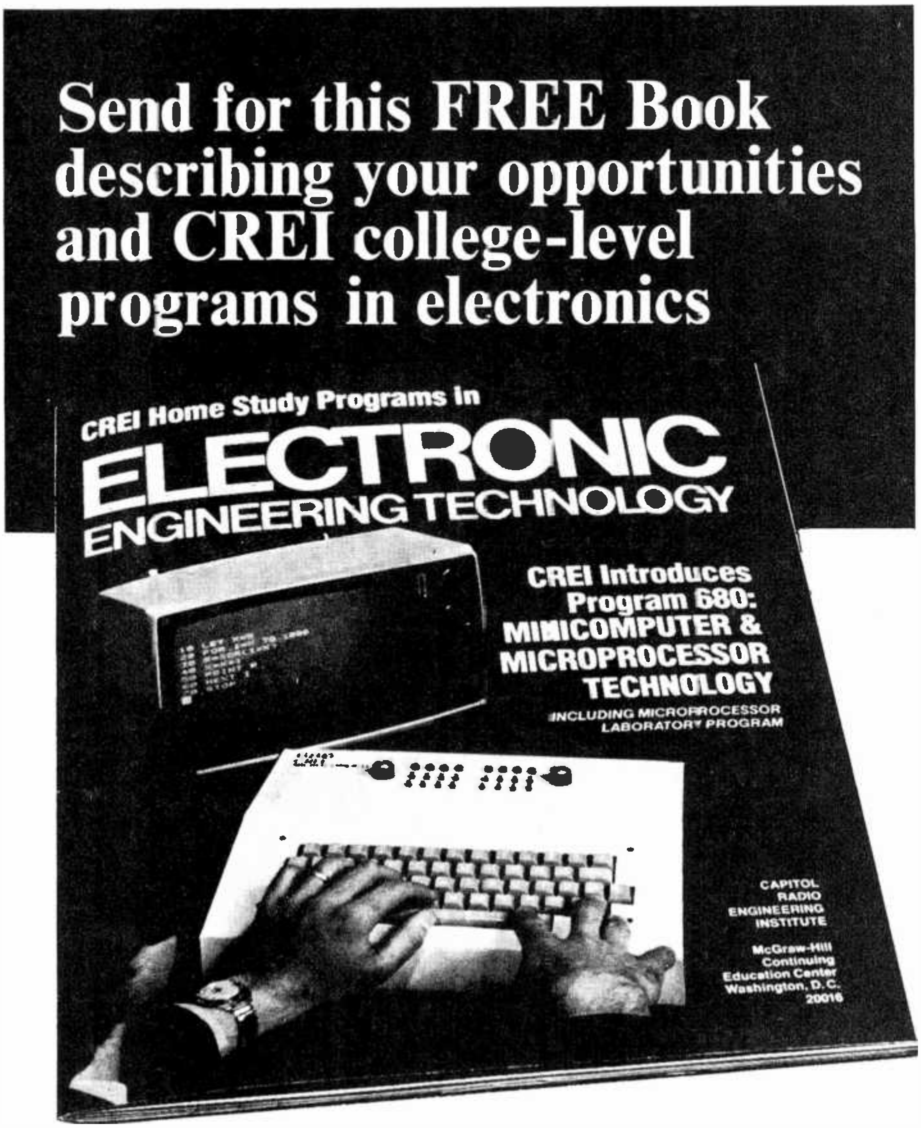

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Experimenter's Corner

By Forrest M. Mims

DIGITAL TO ANALOG CONVERTERS, PART 1

ALMOST any electronic circuit can be classified as either analog or digital. Analog circuits are those in which the signal voltages present may be at any level between low and high extremes determined by the power supply. Many analog circuits are known as linear circuits since they produce an output directly proportional to an input signal over a limited range of amplitude and frequency. Digital circuits are, on the other hand, those in which signals can assume only one of two distinct levels. Typically, one is at or near ground potential and the other near the power-supply voltage. In TTL digital integrated circuits, the two voltage levels are a low of a few tenths of a volt and a high of about 3.3 to 5.0 volts.

Although an amazing variety of circuit functions can be performed using only analog or digital techniques, some applications can only be accomplished by combining the two methods. Some examples of combining analog and digital techniques are the digital voltmeter, speech recognition circuitry, sophisticated motor-speed controllers, digital data transmission and many kinds of computer output circuits for controlling electromechanical devices like solenoids.

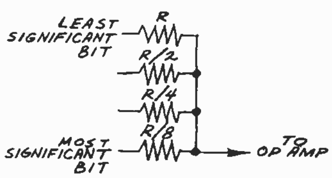


Fig. 2. Simple 4-bit D/A converter using resistor ladder.

D/A Conversion. Let's suppose that you've built a simple digital controller circuit that will turn individual lamps in an array on and off in any pattern you specify. The brain of the controller is a semiconductor memory that you can program with the desired information. How would you use your controller to adjust the *brightness* of a single lamp without modifying the controller circuitry?

The solution to this problem is a digital-to-analog (D/A) converter. The D/A converter is connected directly to the controller's output and adjusted to produce an output voltage proportional to the controller's binary output. Figure 1 shows how the controller is connected to the D/A converter.

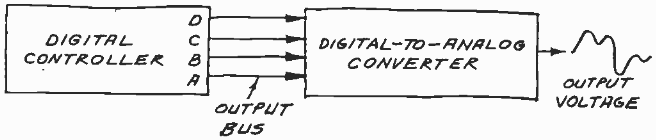


Fig. 1. Connecting digital controller to D/A converter.

There are several ways to design a D/A converter circuit, but the most common uses a resistor network followed by one or more operational amplifiers. Figure 2 shows a simple, 4-bit D/A converter that uses a ladder-like network of parallel input resistors. The values of the resistors are determined by their binary weighting factors. A 4-bit input has binary weighting factors of 2^3 (8_{10}), 2^2 (4_{10}), 2^1 (2_{10}) and 2^0 (1_{10}). If the lowest order (2^0) resistance is R, then the values are R, R/2, R/4 and R/8.

Though the circuit shown in Fig. 2 is very simple, it has two major drawbacks. First, it's difficult (at the hobbyist level) to find resistors having the precise resistances that are required. Second, the resistance values become spread over a very wide range for a relatively small number of input bits. Thus, for a 10-bit D/A converter, the input resistors must range from R to R/1024. The digital circuit connected to the D/A converter, often a chain of flip-flops or gates, must be able to supply a wide range of currents (high currents for low resistances and low currents for high resistances).

The problems of the D/A converter in Fig. 2 can be solved by increasing the number of resistors in the ladder network. The result is the *R-2R* ladder network shown in Fig. 3. As you can see, the ladder resistors have values of *R* and *2R*. This means only two readily available resistance values are required. It's possible to use a single value if you're willing to connect two *R* resistors in series to obtain the *2R* values.

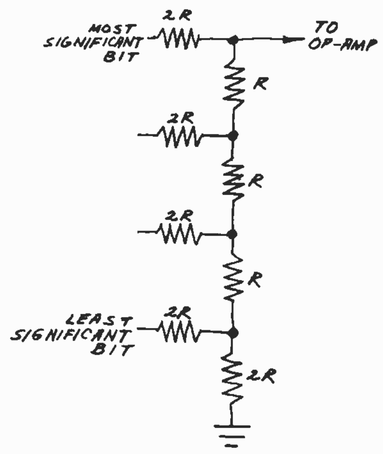


Fig. 3. R-2R resistor ladder network for D/A converter.

D/A Conversion Demonstrator. If you're serious about electronics experimentation and want to stay abreast of the latest developments, you should assemble a D/A demonstration circuit like the one shown in Fig. 4. This circuit is the basis for the practical D/A converter we'll discuss later.

The demonstrator circuit uses four spdt switches to achieve a 4-bit input. There's nothing improper about a mechanically switched binary output. Many real-world circuits use them. Most D/A converters, however, are connected directly to a digital circuit that provides a binary output.

You can test the operation of the D/A converter by connecting a voltmeter across its output while switching in various binary outputs. Since we're using a 9-volt battery as a reference voltage and since there are sixteen possible input combinations, the output voltage should range from 0 volts to slightly under 9 volts in increments of 9/16 volt.

Here are the actual voltages measured with the demonstrator circuit:

Binary In	Voltage Out
0000	.00
0001	.57
0010	1.12
0011	1.69
0100	2.19
0101	2.76
0110	3.32
0111	3.89
1000	4.50
1001	5.06
1010	5.60
1011	6.15
1100	6.69
1101	7.78
1110	7.82
1111	8.40

The output of the circuit is plotted on a graph in Fig. 5. As you can see, the response of the circuit is reasonably linear, even though I used 10% tolerance resistors. Commercial D/A converters are made with resistors having tolerances of 1% or better. When very close tolerances are necessary for super-accurate D/A converters, a pulsed laser is used to vaporize minute portions of the carbon or metal-film resistive elements until the exact values required are obtained.

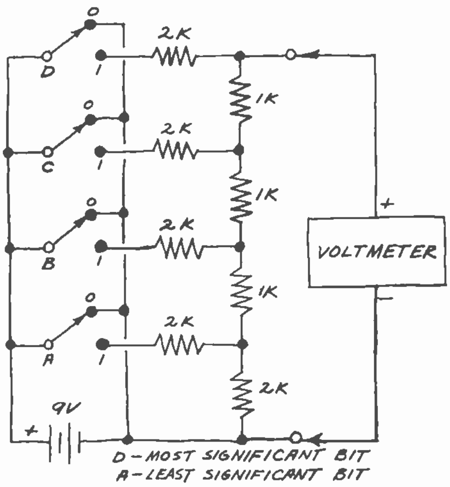


Fig. 4. D/A demonstrator circuit.

It's handy to be able to predict in advance the analog voltage output for a specific input bit pattern. The weighting factors for our 4-bit network are:

Most Significant Bit—
$2^3 = 1/2$ Reference Voltage
$2^2 = 1/4$ " "
$2^1 = 1/8$ " "

Least Significant Bit—
$2^0 = 1/16$ Reference Voltage

To calculate the analog output, simply multiply the reference voltage by the weighting factor for each bit portion with a 1 and sum the products. Thus 1100 is:

1—1/2 × 9 = 4.50
1—1/4 × 9 = 2.25
0— 0 0
0— 0 0
6.75 volts

The calculated analog output, 6.75 volts, is only 0.06 volt higher than the value measured with the prototype circuit. That's an error of less than 1%! ◇

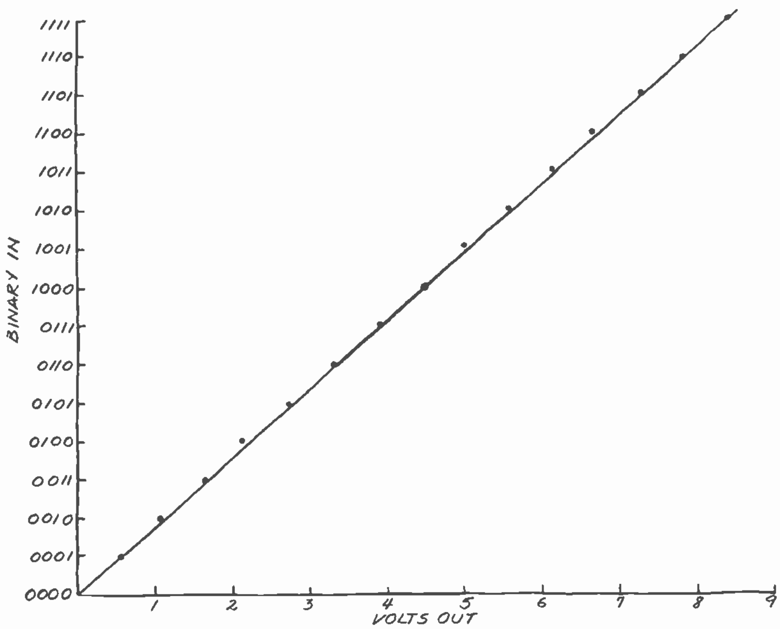
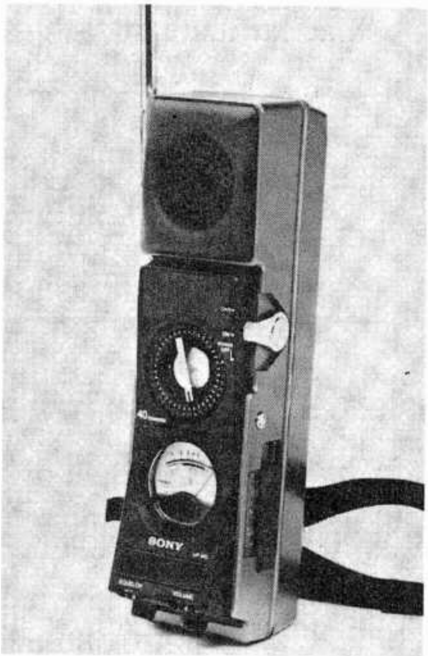


Fig. 5. Voltage output vs. binary input for Fig. 4.

Product Test Report

SONY MODEL ICB-1020 PORTABLE CB TRANSCEIVER

Hand-held AM, 40-channel transceiver has 1-W r-f power and hot front end.



The hand-held Model ICB-1020 AM transceiver from Sony uses the latest in phase-locked-loop (PLL) synthesizers to provide coverage on all 40 CB channels. It is powered by eight AA cells that fit within its housing and has provisions for obtaining power from a 12-volt mobile electrical system and, with an adapter, standard 117-volt ac line power. Whichever power source is used, the rated r-f output power from the transmitter is 1 watt.

The transceiver provides: VOLUME and SQUELCH controls; separate POWER switch with power ON and CH-9 positions (the latter bypasses all channels for instantaneous access of channel 9); earphone, external MIC, and accessory power jacks; and a large S/r-f/battery condition meter.

The walkie-talkie type transceiver measures 10⅝"L × 4½"W × 3⅝"D (27 × 11.4 × 9.2 cm) and weighs 2.75 lb (1.25 kg). Its suggested retail price is $174.95.

General Description. We did not receive a schematic diagram for the transceiver, nor were we able to determine much of the circuitry by visual observation. From what we could observe, however, the receiver employs double-conversion to i-f's at 10,695 and 455 kHz, with selectivity obtained at the latter.

The PLL system is more or less standard. It engages a 10,240-kHz crystal signal from which the standard reference is derived and which also is used for the second-conversion oscillator. The technique used is to have the voltage-controlled oscillator (vco) used for the first conversion on the low side of the CB signal instead of the upper side. This ensures better image rejection and a reduced chance of adverse receiver-to-antenna or case radiation on vhf.

The transmitter carrier is derived from the PLL system. It is amplified and raised to a high-level output by a power amplifier, where a multisection network matches the output to the telescoping antenna built into the transceiver. As usual, the driver and power-amplifier stages are collector modulated.

The case of the transceiver is designed along the lines of a handset. The speaker is at the top end and is equipped with a cushioned pad for comfortable listening. Even so, sufficient audio level is available to seldom require ear-contact listening.

At the center of the case is a small hinged panel that can be depressed to activate the transmitter. Slightly recessed in the center of this panel is the channel selector with an easy-to-grip operating bar. The channel numerals around the periphery of the selector are small but easy to read.

The power switch is a three-position lever located on the right side of the transceiver's case. Pushing the lever one position forward powers the transceiver. Pushing the lever to its third position immediately switches the system to channel 9, at which time, a tiny LED comes on at the channel-9 position of the selector switch. Pulling the lever back one position cuts out channel 9 and reinstates operation on the channel to which the channel selector is set. This is a convenience for occasional monitoring of channel 9 without disturbing normal operation and for quickly accessing the channel in an emergency.

The large round-faced meter, calibrated from S1 to S9 for receiving, is exceptionally readable. Colored portions of the meter scale indicate battery condition and the proper modulating levels.

A "lip" type microphone is built into the bottom of the transceiver's case. This is backed up by an external-microphone jack that can be more conveniently used in fixed and base-station locations with an accessory mike.

At the bottom of the case are located the VOLUME and SQUELCH controls. The jacks for external facilities are on the right side of the case and are protected by a rubberized cover. The two halves of the case are also sealed with a weatherproof Neoprene gasket.

The antenna is on the left side of the case. It is a swivel telescoping whip that can lock in any orientation between vertical and horizontal. When not in use, the antenna stows along the side of the case, where a retaining clip holds it.

The batteries that power the transceiver install in a plastic holder that inserts and locks into a cavity at the lower end of the case. This arrangement eliminates the need to open the case to change batteries.

Laboratory Measurements. The transmitter developed a nominal 1-watt output on our test bench. It is presumed that to conform with FCC type-acceptance requirements, some form of automatic modulation control (amc) is used. However, we discovered that overmodulation at greater than 100% of the negative-modulation peaks occurred when speaking into the microphone at very close range. Even so, adjacent-channel splatter with voice was a minimum of 55 dB down.

The 6-dB down audio response on transmit was a nominal 300 to 2200 Hz. In on-the-air tests, the signal sounded exceptionally clean and crisp. The r-f output frequency's tolerance held to within ±5 Hz on all channels, centered at +270 Hz.

Measurements on the receiver were quite difficult to perform because the telescoping antenna is permanently attached to the transceiver, allowing interference from CB signals almost continuously. We did, however, manage to squeeze in most tests, but our results must be viewed as nominal values.

The receiver's sensitivity was 0.5 μV for 10 dB (S + N)/N at 30% modulation and 1000 Hz. Listening tests indicated that this figure would have been even better under ideal laboratory test conditions. The maximum squelch threshold sensitivity measured 0.5 microvolts, while the meter registered S9 with a 300-microvolt input.

Image and i-f rejection were an excellent 80 dB, while other unwanted-signal rejection (mostly due to overloading) was 55 to 60 dB. Adjacent-channel rejection and desensitization was 55 to 60 dB. Translated into signal strength, desensitization occured with a nominal 1000-μV signal, which is also the level required to produce overload responses.

The 6-dB down audio response was 225 to 2300 Hz, and the audio output power with a 1000-Hz tone into a 4-ohm speaker was 250 mW with a sine wave at 3.5% THD and 340 mW at 10% THD with slight clipping.

We were unable to obtain an accurate determination of the agc characteristic because the permanently attached antenna picked up case or lead radiation from our signal generators. However, listening tests indicated about a 10-dB audio output variation over a 60-dB input range at 10 to 10,000 μV.

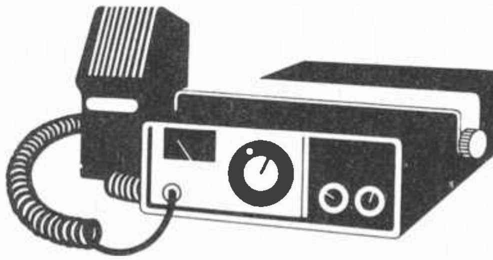
The receiver drew about 70 milliamperes with no input signal. On transmit and without modulation, the drain was 250 milliamperes.

User Comment. This transceiver has a really high-quality professional look and feel about it. Its workmanship reminds one of a fine camera's.

We noted that the transceiver does not employ a noise-limiting system. However, the service for which the transceiver was designed does not generally require one.

To summarize, this is one of the finest transceivers we have ever used, both in appearance and in performance. It has a really "hot" receiving section and signal delivery that comes up to all our expectations for a 1-watt transmitter working into a limited antenna system. Reliable communication coverage can be maintained over a 1-to-5-mile range, depending on terrain and location.

CIRCLE NO 104 ON FREE INFORMATION CARD



CB Scene

By PE Editorial Staff

INSIDE A SIDEBAND CLUB

THE WHISPERS started as soon as I entered a meeting room where some 75 CB single sidebanders were gathered for a weekly meeting in an Eastern-US town: "Is he from the FCC?" Finally confronted openly, I assured attendees that I wasn't, displaying my PE business card and a copy of the latest issue to prove it.

Suspicions allayed, members candidly discussed their club and "hobby" with me. According to "call sign" numbers assigned, I was told, there are about 2700 sidebanders who belong to this club, one of many such organizations around the country. Attempting to ferret out club officers, I learned that there were none: no president, vice president, treasurer or what-have-you. The only title (unofficial) was the Master Holder of the Log (club member #386)—a listing of club on-the-air numbers that started with #1 and is said to now be past #2700. If a member retires, his or her number is not issued again. In addition to the numbers, the log contains the members' first names and the towns in which they reside. Perhaps 150 members are considered to be very active.

In response to my question about the purpose of the club, members told me that the reasons are outlined in the club's bylaws. They added that there are no copies of the bylaws available because they are not written down, simply passed from one member to another by word-of-mouth. Essentially they cover how to break properly, use of Q codes (which are employed extensively), and channels "reserved" for their local use (16 LSB, 18 USB, and 36 to 40 upper and lower sidebands). Moreover, there are no club fees.

Listening to these club members modulating prior to attending a meeting, it's clear that they are polite—no profane language whatsoever, a wait of about three or four seconds before keying a mike in the event a breaker wants to announce himself, and so on. It's equally clear that FCC call signs are not used and that the five-minute talk limit prohibition is not followed.

"Does anyone here use a linear?" I innocently asked. After a spate of "What's a linear?" responses, I learned that everyone used either a linear or an overpowered basic rig. Power is the name of the game. But DX'ing is not! In fact, club members are so unhappy about purposeful incoming long-distance transmissions, that they expressed a wish that there were some channels set aside by the FCC just for this use so that those who like this form of CB communications would stay away from the local channels. Most skip in this eastern locale comes from Texas and Oklahoma, they told me.

Every area has its equipment favorites. In this club, it was certain Cobra, Courier and President CB models. "They use the same Signetics PLL chip and a fine pc board . . . we've got it down pat on how to adjust the rigs for higher power." No one, it seems, uses stock models here. Interestingly, many club members use amateur radio gear.

Virtually all of the club members said they own both a mobile and a base station. In many cases, the base was originally the first SSB mobile purchased, with addition of a power supply. Also, it was claimed that more than 95 percent of the club members had 40-channel rigs, even if they "rolled their own" in one way or another.

Many of the members own beam antennas so that they can really reach out. The most popular ones cited were: Avanti's "Moonraker IV" and "PDL-II," and Wilson's "Y Quad." Antenna Specialists' "Super Scanner" was very popular, too, though more for its omni-switched position than for its beam application. Shakespeare's "Big Stick" was a special favorite among omni's at the club. The K-40 mobile was held in high regard here.

One member (#2584) is a long-time ham, claiming a General license. To prove it, he whipped out his amateur license, which drew some gasps from fellow members because it listed his surname, which is information rarely issued to even club members. He participates in training club members for their amateur radio license, mostly the Novice, he said. "About 70 percent of the sidebanders are trying to become hams."

The club members don't use call signs on the air because most of them operate contrary to some of the FCC rules and regulations. Only first names (no handles) and club numbers are employed. Also, when using AM they find it necessary to key the mike and get in quickly. If legal call signs were used, it would be impossible to "break" in the area, they say. The majority of members operate

above channel 40 when the assigned channels are too noisey. "Sliders" are *de rigueur*.

There are national CB clubs that specialize in long-distance communications, it was pointed out. The Whiskey Club was cited as an example. The illegal call sign for this club starts with the number that represents the order in which the state that the CB'er resides in joined the Union, followed by a W, followed by an assigned number. Another illegal DX club is the Echo club from Germany. Both clubs are said to form networks directly above Channel 40's frequency.

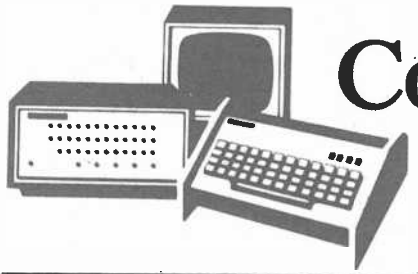
Typical CB communication range with the rigs used in this group is said to be: mobile-to-mobile, 10 miles; mobile-to-base, 15 miles; base-to-base with omnidirectional antennas, 20 to 25 miles; with beams, 25 to 50 miles. All club members agreed that during traffic rush hour, it's impossible to communicate more than a mile or so from a mobile.

Asked how much cooperation they get from AM'ers on the channels they carved out for themselves, they said that most AM'ers cooperate. The few that don't are "wiped out" by using transmit sliders to put out signals on top of them.

"The people are really nice," was the most common reason given for working CB sideband. They come from all walks of life, are mostly adults (30 to 50 years of age, it seemed to me), and among the sidebanders present were two physicians, one school teacher, a hospital administrator, and an auto-service station manager. The members all said, too, that their hobby has motivated them to learn a lot about electronics. It was estimated that a typical sidebander spends from $2000 to $3000 on CB/amateur radio gear until the desired mobile and base systems are owned.

What do they want from the FCC? "Just for them to let us alone because we've got the best of all worlds right now for our hobby," was one response that drew agreement from everyone. If there was a change, they'd like channels assigned strictly for SSB use, where AM'ers couldn't use them unless a rig was doctored. SSB'ers and AM'ers are incompatible, they noted. Further, they would like some of their practices legalized, especially higher r-f power than presently permitted. Members added that they don't know of any problems caused by running higher power, stressing that they don't use illegally high power between 7 p.m. and midnight, the most popular TV viewing hours.

Shades of Prohibition days! ◇



Computer Bits

By Hal Chamberlin

COMPUTER ARITHMETIC

ASK A LAYMAN what a computer does best and he will probably say that it is best at computing complicated mathematical formulas. However, ask the same question of a hobbyist who has obtained a computer for the purpose of mathematical computation and he will probably say that his machine handles text much better than numbers. The truth is that microcomputers have very little "number crunching" ability built-in. All that is normally available is addition and subtraction of 8-bit numbers and some can't even subtract directly! Automatic handling of decimal numbers is frequently provided also, but proper use of decimal arithmetic is far more complex than the normal binary arithmetic. As a result of this limited arithmetic capability, all other mathematical operations must be broken down into addition and subtraction of 8-bit numbers.

Arithmetic with integer numbers larger than the capacity of a computer word is termed "multiple precision arithmetic" with "double precision" used to signify the special case of two-word numbers. The words (bytes in an 8-bit processor) forming the number are simply strung end-to-end. A 24-bit number for example would consist of 3 bytes. The leftmost byte is called the "most significant" or "high" byte, and the rightmost is called the least significant or "low" byte. The bytes in the middle, if any, have no special name.

The most important multiple precision operations for general computation are addition, subtraction, multiplication, division, comparison, negation, incrementing, decrementing, and left and right rotates including the carry flag. Usually the software necessary to do these operations is organized into a subroutine package. It is a common practice in such software packages to define "registers" for multiple precision numbers in *main memory*. At least two registers are typically needed; the *left* operand, and the *right* operand, quite analogous to the equivalent operation done on paper. The package may be written for a specific number length such as 32 bits (4 bytes) or the length may be variable and passed to the subroutines as arguments. Besides the actual arithmetic subroutines, a "number move" routine is needed to conveniently move the multibyte data into and out of the pseudo registers. With a variable length arithmetic package, it becomes easy to do calculations to dozens or even hundreds of "decimal places" of accuracy in assembly language, which is much better than any BASIC language system.

Increment and Decrement. Incrementing and decrementing multiple precision numbers is probably the simplest of this type of operation. Assume for the moment that a 16-bit number, which is stored as two bytes in memory, is to be incremented by one. Although some machines may have an instruction to do this to a pair of registers, let's try to do it directly in memory using a 6502 microprocessor. For incrementing, the first step is to increment the least significant byte directly in memory using the INC instruction of the 6502. Next it is necessary to determine if an "overflow" of that byte occurred. This could normally be determined by looking at the carry flag but on the 6502, INC does not change the carry. Close examination of the overflow situation, which only occurs if the byte was equal to FF_{16} before incrementing, will reveal that after the overflow the byte will *always* be zero! Therefore, the Z-flag can be tested instead. If an overflow did indeed occur, then the most significant byte should be incremented; otherwise the job is done. This procedure can be extended to numbers of any length by continuing to move left, byte-by-byte, incrementing as long as the previous byte overflowed.

Multiple precision decrement is nearly as easy. First the low byte is examined to determine if it is zero. If it is not, it is decremented and the job is finished. If it is zero, a decrement will cause it to underflow. In that case, we decrement it anyway and then move left to the next byte and repeat the sequence. When the most significant byte is reached because of underflow of all previous bytes, it is simply decremented without any testing for zero. Note that these algorithms work equally well for *signed* two's complement multiple precision numbers.

Add and Subtract. Multiple precision addition and subtraction are more interesting. These operations require the left and right operand pseudo registers. The usual convention is to put the answer into the left operand register, much like arithmetic instructions themselves. The first step in double-precision addition is to clear the C flag and then, using the ADC instruction, add the low byte of the left operand to the low byte of the right operand and store the result back into the low byte of the left operand. Now, being careful not to disturb the carry flag, the ADC instruction is used to add the *high* bytes of the two operands together and store the result in the high byte of the left operand which completes the operation. For multiple precision one continues left adding pairs of bytes together with the ADC instruction until the most significant bytes are added.

Quadruple precision addition operation is shown below. The C-flag is used

Addition of two 4-byte numbers.

```
  02791256          02   79     12   56
+0FE534B3          0F   E5     34   B3
---------
  125E4709           1    0      1    0 <- C=0
           C=0 <- 012  15E    047  109
```

to transfer carry information from lesser significant bytes to more significant ones. One can actually think of it as adding multiple digit numbers together where each "digit" is a byte between 0 and 255. The carries are transferred from digit to digit just like decimal addition on paper. If care is taken on the return sequence from the add subroutine, except for Z, the status flags will correctly indicate the result of the operation just performed.

For subtraction, one could write a similar subroutine using the SBC instruction on each byte in the numbers. Before starting, however, it is necessary to *set* the C-flag for proper operation. Another way to do subtraction is to *complement* the right operand and then *add* it to the left operand using the add subroutine just described. Usually a complement routine is needed anyway, so this scheme can also save some memory.

A two's-complement operation consists of merely inverting the bits of the number and then incrementing the result. Thus a multiple-precision complement routine would invert the bits of each byte of the right operand and then call the multiple precision increment routine described earlier. An exclusive-OR of a byte with all ones, using an "EOR #$FF" instruction, is all that is necessary to invert it.

Comparison. Not all needed multiple-precision functions are involved with computing answers, some comparison operations are necessary also. Probably the most important of these is a comparison with zero since the Z-flag is not meaningful after a multiple-precision add or subtract. Such a subroutine could be used to logic-OR all of the bytes in the number together using the accumulator. If the result of the OR'ing is zero, then each byte in the number must have been zero.

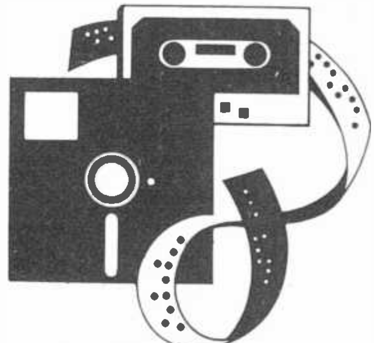
One way to do a signed comparison between two signed numbers is to subtract them and then see if the result is negative (right operand is larger), zero, or positive (left operand is bigger). Besides destroying one of the numbers being compared, this method suffers from a subtle pitfall. If the left operand is a large positive number and the right operand is a large negative number, the subtraction can overflow and the comparison result will be invalid. The converse case, right operand positive and left operand negative, creates the same problem. There is never any possibility of overflow when the numbers are of like sign however.

A dedicated comparison subroutine overcomes both problems. Unlike previous routines where the operation started at the right, comparison should start with the most significant bytes. The first step is to look at the sign bits. If they differ, the comparison result is clear already and any overflow problems are avoided. If the sign bits are the same, then the most significant bytes are subtracted but the result is not stored. If the result of the subtraction is nonzero, then the outcome of the comparison is known (negative means right operand larger, positive means left operand larger) and a return can be taken. If the result is zero, then lesser significant bytes must be subtracted until either a nonzero result is obtained or the entire number has been processed. In the latter case, equality between the two is the conclusion.

Rotation. Multiple precision rotation is much like addition in that the C-flag is used to transfer bits from one byte to the next. Although a more comprehensive set is easily written, subroutines to rotate left and right including C are usually sufficient. The rotate is effectively changed to a shift if the calling program clears C before calling multiple rotate. Rotates by several bit positions are accomplished by repeated calls to a single bit position rotate routine.

For a multiple rotate left, start at the rightmost byte. The byte is rotated left with carry by use of the ROL instruction which puts the old C-flag into bit-zero, shifts the whole byte left by one, and puts bit-7 into the C-flag. Following this, the next byte to the left is rotated in a similar manner. The C-flag serves to transfer bit-7 of the low byte into bit-zero of the next higher byte. This process is repeated until the entire number has been done. Note that in the 6502, all of the manipulation can be performed directly in the pseudo register.

Rotate right is the exact opposite of rotate left. Start with the leftmost byte and use the ROR instruction on each lower byte in sequence. Unfortunately, some early production 6502's were manufactured without the ROR instruction. For these, an ROR can be simulated by doing 8 ROL's in a row instead. ◇



Software Sources

8080 Word Processing for iCOM Floppy. This new text-formatting program for 8080 microcomputers using iCOM floppy disks has four ways of indicating the end of a page. It can mark the end of the page on roll paper, pause to wait for a new sheet to be inserted, and issue a form-feed at the bottom of the page; or it can exit back to the iCOM FDOS II or FDOS III operating system. Other features include: page-top and page-bottom titling, automatic page numbering, print of selected pages only, text filling, justification, line centering, line and word underlining, and selectable line spacing. The program comes on an iCOM-formatted diskette, in hex ASCII object format. Input to the program is created with the text editor, and contains formatting commands and text. Source code for a driver for the AJ-841 Selectronics terminal is also available. Price of the diskette and manual is $235 (FOB North Hollywood); enhancements will be available periodically at a nominal fee. Ortronics, 4753 Irvine Ave., North Hollywood, CA 91602.

6800 Game of Life. The Game of Life, in which the computer creates new patterns of "cell" growth around patterns keyed in by the user, is now available for 6800 computer systems. Memory required is less than 2K, and the program is designed for the SWTPC 6800 computer. Price for complete source listing and Motorola-format paper tape is $7.50 with postage and handling, $8.50 for listing and KC-standard cassette. Write: Applied Microcomputer Systems, Box 68, Silver Lake, NH 03875.

TRS-80 and PET Games. Thirteen games are available on cassette for $2 per cassette plus the cost of the games themselves. Each cassette holds up to 16K, in any combination of 8K and 4K programs. Games requiring 4K of memory include: Guess the Number and Reverse ($1 each); Acey-Ducey, Hurkle and Mastermind ($2 each); Craps, Golf, Hammurabi, Lunar Lander (with 2 degrees of freedom) and Wumpus ($3 each). In addition, Life Expectancy, requiring 4K or 8K, is $4, and 8K Football and Star Trek are $5 each. Apparat, Inc., Box 10324, Denver, CO 82010.

H8 Cook's Helper Program. "Cook's Helper," written in Extended B.H. BASIC, includes two programs: *Menu* produces menus within stated calorie limits based on lists of preferred foods. *Shopper* rearranges your shopping list in order of the shelf arrangement of your favorite grocery store. Tape No. 103.1 with listing and instructions, $10. Ed-Pro, Inc., 6580 Buckhurst Trail, Atlanta, GA 30349.

KIM-1 Extended I/O Monitor. XIM (Extended I/O Monitor) adds 17 commands (4 are user-defined) to the KIM TTY Monitor. The new commands can move, compare, and fill memory blocks, and dump them in hex or ASCII; enter hex data or ASCII characters into RAM from a terminal; calculate relative branch distances; search for a block of data; execute programs from a given address; or jump back to the KIM monitor. There is also a breakpoint service routine which prints the processor status register in binary for easier troubleshooting. XIM requires less than 1K of memory starting at 2000 hex, and is relocatable. Cassette or paper-tape versions with 45-page manual, $12 and $10 respectively. Pyramid Data Systems, 6 Terrace Ave., New Egypt, NJ 08533.

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

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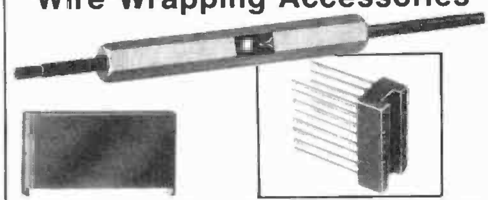

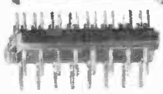

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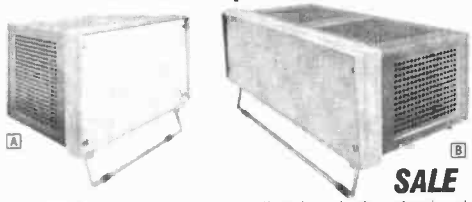

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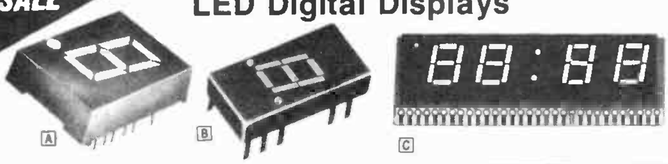

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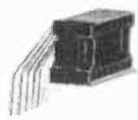

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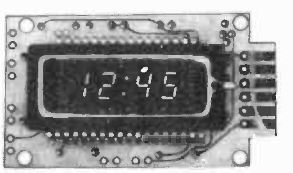

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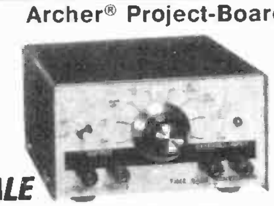

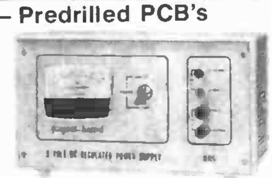

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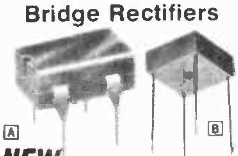

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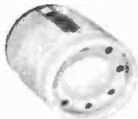

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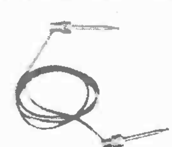

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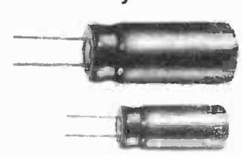

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74LS08	.23	74LS86	.35	74LS163	.89
74LS10	.23	74LS90	.49	74LS164	.89
74LS13	.49	74LS92	.59	74LS175	.79
74LS14	.99	74LS93	.59	74LS181	2.49
74LS20	.23	74LS95	.79	74LS190	.89
74LS26	.29	74LS96	.89	74LS191	.89
74LS27	.29	74LS107	.35	74LS192	.89
74LS28	.29	74LS109	.35	74LS193	.89
74LS30	.23	74LS112	.35	74LS194	.89
74LS32	.29	74LS123	.99	74LS195	.89
74LS40	.29	74LS132	.79	74LS253	.79
74LS42	.69	74LS136	.39	74LS257	.69
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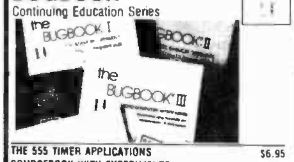

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BUGBOOKS I and II by Peter R. Rony, David G. Larsen, WB4HYJ — $17.00 per set
Sold as a set these two books outline over 90 experiments designed to teach the reader all he will need to know about TTL logic chips to use them in conjunction with microprocessor systems. You'll learn about the basic concepts of digital electronics including gates, flip-flops, latches, buses, decoders, multiplexers, demultiplexers, LED displays, RAM's, ROM's, and much, much more.

BUGBOOK IIa by Peter R. Rony, David G. Larsen, WB4HYJ — $5.00
This volume will introduce you to the fabulous UART chip — that all important interface between data terminals, etc., and your microcomputer. It also covers current loops, and the RS 232C interface standard. Particularly recommended for any RTTY enthusiast.

BUGBOOK III by Peter R. Rony, David G. Larsen, WB4HYJ, Jonathan A. Titus — $15.00
Here is the book that puts it all together. Besides having much valuable text there are a series of experiments in which the reader completely explores the 8080 chip pin by pin and introduces you to the Mark 80 microcomputer, a unique easily interfaced system. It is recommended that you have the background on the BUGBOOKS I & II before proceeding with BUGBOOK III.

BUGBOOK V and VI by David G. Larsen, Peter R. Rony, Jonathan A. Titus — $19.00 per set
Experiments in digital electronics, 8080A microcomputer programming and 8080A microcomputer interfacing. An integrated approach to self-instructed basic digital electronics, breadboarding and 8080A interfacing/programming. Bugbook VI integrates the digital concepts of Bugbook V into a treatment of 8080A microcomputer programming and interfacing. Detail & laboratory experiments included with each book.

CMOS-M — DESIGNERS PRIMER AND HANDBOOK New expanded version — $8.50
Starts at basic structure of CMOS devices through integration into MSI.

COMPLETE MANUAL FOR DIGITAL CLOCKS by John Weiss and John Brooks — $3.95
Familiarizes technician or hobbyist with basic theories behind digital clocks. Includes trouble shooting guides, basic characteristics of clocks, soldering techniques, clock component data sheets and construction tips.

DISCRETE LEDS

	.125" dia.			.190" dia.	
XC209	Red	5/$1	XC111	Red	5/$1
XC209	Green	4/$1	XC111	Green	4/$1
XC209	Orange	4/$1	XC111	Yellow	4/$1
XC209	Yellow	4/$1	XC111	Orange	4/$1

.200" dia.			.185" dia.			.200" dia.			.085" dia.		
XC22	Red	5/$1	XC526	Red	5/$1	XC556	Red	5/$1	MV50	Red	6/$1
XC22	Green	4/$1	XC526	Red	100/$8	XC556	Red	100/$8	.170" dia.		
XC22	Yellow	4/$1	XC526	Green	4/$1	XC556	Green	4/$1	MV10	Red	4/$1
XC22	Orange	4/$1	XC526	Yellow	4/$1	XC556	Yellow	4/$1	INFRA-RED LED		
SSL-22	RT	4/$1	XC526	Clear	4/$1	XC556	Orange	4/$1	1/4" x 1/4" x 1/16"		
						XC556	Clear	7/$1	Flat		5/$1.00

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6680	Common Cathode-orange	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6710	Common Anode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6730	Common Anode-red ±1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 52	Common Anode-green	.300	1.25	MAN 6750	Common Cathode-red ±1	.560	.99
MAN 71	Common Anode-red	.300	1.25	MAN 6760	Common Anode-red	.560	.99
MAN 72	Common Anode-red	.300	.99	MAN 6780	Common Cathode-red	.560	.99
MAN 74	Common Cathode-red	.300	1.25	DL701	Common Anode-red ±1	.300	.99
MAN 81	Common Anode-yellow	.300	.99	DL702	Common Cathode-red	.300	1.25
MAN 82	Common Anode-yellow	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 84	Common Cathode-yellow	.300	.99	DL707	Common Anode-red	.300	.99
MAN 3620	Common Anode-orange	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3630	Common Anode-orange ±1	.300	.99	DL746	Common Anode-red ±1	.630	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 4610	Common Anode-orange	.300	.99	DL749	Common Cathode-red ±1	.630	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL750	Common Cathode-red	.600	1.49
MAN 4710	Common Anode-red ±1	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4730	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Anode	.350	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode (FND500)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6630	Common Anode-orange	.560	.99	5082-7300	4 x 7 Sgl. Digit-RHDP	.600	19.95
MAN 6640	Common Cathode-orange-D.D.	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6650	Common Cathode-orange ±1	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6660	Common Anode-orange	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

CA3013	2.15	CA3082	2.00
CA2023	2.56	CA3083	1.60
CA3035	2.48	CA3086	.85
CA3039	1.35	CA3089	3.75
CA3046	1.30	CA3130	1.39
CA3059	3.25	CA3140	1.25
CA3060	3.25	CA3160	1.25
CA3080	.85	CA3401	.49
CA3081	2.00	CA3600	3.50

CALCULATOR CHIPS AND DRIVER

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MM5736	1.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
5030	7.95

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
7001	5.95

9374 - 7-segment LED driver common anode LEDs $ .99

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

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

SOLDERTAIL STANDARD (TIN)

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

SOLDERTAIL STANDARD (GOLD)

8 pin SG	$ .30	.27	.24	24 pin SG	$ .70	.63	.57
14 pin SG	.35	.32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.75	1.40	1.26
18 pin SG	.52	.47	.43	40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

8 pin WW	$.40	.38	.35	22 pin WW	.95	.85	.75
10 pin WW	.45	.41	.37	24 pin WW	1.05	.95	.85
14 pin WW	.39	.38	.37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	.42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	.68	.62	40 pin WW	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.
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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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XR2206KA $14.95 Function Generator Kit (includes chip, P.C. Board and instructions)

XR2206KB $19.95 Function Generator Kit (includes all components, P.C. Board and instructions)

XR-L555 $1.50
Micro-Power version of the popular 555 Timer and directly interchangeable. Dissipates 1/15th the power and operates down to 2.7 volts. Perfect for battery operation and CMOS circuits.

XR2242CP $1.50
Precision timing circuit for generating timing pulses in **minutes, hours** and days or up to 1 year by using two. Reduces cost of time delay circuits. Basic 555 Timer with built-in 8-bit Counter.

XR205	$ 8.40	XR1489	1.39	XR2556	$ 3.20
XR210	4.40	XR1800	3.20	XR2567	2.99
XR215	4.40	XR2206	4.40	XR3403	1.25
XR320	1.55	XR2207	3.85	XR4136	1.25
XR555	.39	XR2208	5.20	XR4151	2.85
XR556	.99	XR2209	1.75	XR4194	1.45
XR567CP	.99	XR2211	5.25	XR4202	3.60
XR567CT	1.25	XR2212	4.35	XR4212	2.05
XR1310P	1.30	XR2240	3.45	XR4558	.75
XR1468CN	3.85	XR2264	4.25	XR4739	1.15
XR1488	1.39			XR4741	1.47

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	4/1.00	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	5/1.00	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	1.70
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(2N1849)	$1.95
C38M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
TIS133	5/1.00	PN3567	3/1.00	PN4249	4/1.00
TIS135	5/1.00	PN3568	4/1.00	PN4250	4/1.00
40409	1.75	PN3569	4/1.00	2N4400	4/1.00
40410	1.75	MPS3638A	5/1.00	2N4401	4/1.00
40673	1.75	MPS3702	5/1.00	2N4402	4/1.00
2N918	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2219A	3/1.00	MPS3704	5/1.00	2N4409	5/1.00
2N2221A	4/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2222A	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2369A	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
MPS2369	5/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2484	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2906	4/1.00	2N3724A	.65	PN5138	5/1.00
2N2907	5/1.00	2N3725A	1.00	2N5139	5/1.00
2N2925	5/1.00	2N3772	2.25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	4/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100+		1-9	10-99	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	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	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.

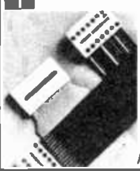
Part No.	No. of Contacts	Length	Price
924003-18R	26	18"	$ 5.38 ea.
924003-06R	26	6"	4.78 ea.
924005-18R	40	18"	8.27 ea.
924005-06R	40	6"	7.33 ea.
924006-18R	50	18"	10.31 ea.
924006-06R	50	6"	9.15 ea.

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.

DIP JUMPERS



Mates with standard IC sockets
24" length • Fully Assembled & Tested

# CONTS	DESCRIPTION	PART NO.	PRICE
14	sgl. end	924-102-24	$ 1.92
14	dbl. end	924106-24	3.02
16	sgl end	924112-24	2.13
16	dbl. end	924116-24	3.34
24	sgl. end	924122-24	3.30
24	dbl. end	924126-24	5.20
40	sgl. end	924132-24	5.53

Also Available in 12" and 36" lengths

CRYSTALS

THESE FREQUENCIES ONLY

PART NO.	FREQUENCY	CASE	PRICE
CY1A	1.000MHz	HC33	5.95
CY1.84	1.8432MHz	HC33	5 95
CY2A	2 000MHz	HC33	5 95
CY2.01	2.010MHz	HC33	1.95
CY2.50	2.500MHz	HC33	4.95
CY3.27	3.2768MHz	HC33	4.95
CY3 57	3.579545MHz	HC33	4.95
CY3A	4.000MHz	HC18	4.95
CY4.91	4 916MHz	HC18	4 95
CY7A	5.000MHz	HC18	4.95
CY5.18	5 185MHz	HC18	4 95
CY6.14	6 144MHz	HC18	4.95
CY6.40	6.400MHz	HC18	4 95
CY6.55	6.5536MHz	HC18	4 95
CY12A	10.000MHz	HC18	4.95
CY14A	14 31818MHz	HC18	4.95
CY19A	18.000MHz	HC18	4.95
CY18 43	18.432MHz	HC18	4.95
CY22A	20.000MHz	HC18	4.95
CY30A	32.000MHz	HC18	4 95

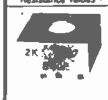
TRIMMERS

10MM size trimmers -.394" Dia.

Part No.	1-9	10-24	25-49	100+
TR-11(valve)	.35	.30	.25	20

Resistance values - 100, 500, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 1 meg

TRIMPOTS



Single-Turn - 1/2 Watt
Square - Top Adjust - 3/8" Size

Part No.	1-9	10-24	25-49	50-99
63P(value)	.99	.89	80	.70

Resistance Values - 50, 100, 500, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K, 1 meg

15-Turn - 3/4 Watt

Rectangular Side Adjust 3/4" x 1/4" Size

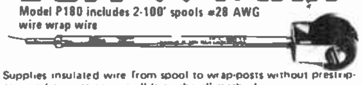
Part No.	1-9	10-24	25-49	50-99
43P(value)	1.35	1.25	1.20	1.15

Resistance Values - 50, 100, 500, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K, 1 meg

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	64P44 062WE	4 50	6 50	2 07	1 86
GLASS	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 062WECI	4 50	17 00	6 80	6 12

Model P180 includes 2-100' spools #28 AWG wire wrap wire



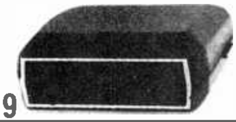
Supplies insulated wire from spool to wrap-posts without prestripping and precutting using "daisy chain" method.

Model P180 $24.50

REPLACEMENT WRAP BIT for P180 Slit N Wrap No. P180A $12.95 each

Replacement wire-wrap wire for P180 #28 AWG (pkg of 3) $2.75 each
W28-2-A green W28-2-B red
W28-2-C clear W28-2-D blue

INSTRUMENT/ CLOCK CASE



Injection molded unit. Complete with red bezel. 4½" x 4" x 1-9/16".

$3.49

MICROPROCESSOR COMPONENTS

P8085	CPU	$29.95	CDP 1802	CPU	$19.95
8080A	CPU	10.95	Z80	CPU	24.95
8212	8-Bit Input/Output	4.95	2650	MPU	26.50
8214	Priority Interrupt Control	7 95	MC6800	MPU	19 95
8216	Bi-Directional Bus Driver	4.95	MC6810AP1	128 x 8 Static Ram	5.95
8224	Clock Generator/Driver	5.95	MC6820	Periph. Interface Adapter	7 95
8228	System Controller/Bus Driver	5.95	MC6821	Periph Interface Adapter	11.50
8251	Prog. Comm. Interface	9 95	MC6830L8	1024 x 8 Bit ROM	14.95
8255	Prog. Periph. Interface	10.95	MC6850	Asychronous Comm Adapter	14.95

RAM'S

1101	256 x 1	Static	$ 1 49
1103	1024 x 1	Dynamic	99
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
2112	256 x 4	Static	5 95
2114	4K x 1	Static 450ns	9 95
2114L	4K x 1	Static 450ns Low Power	10 95
2114-3	4K x 1	Static 300ns	10 95
2114L-3	4K x 1	Static 300ns Low Power	11 95
7489	16 x 4	Static	1 75
8101	256 x 4	Static	5 95
8111	256 x 4	Static	6 95
8599	16 x 4	Static	3 49
21L02	1024 x 1	Static	1 95
74200	256 x 1	Static	6 95
93421	256 x 1	Static	2 95
MM5262	2K x 1	Dynamic	3/1 00
MK4027 (UPD414)	4K	DYNAMIC 16 PIN	5 95
MK4116 (UPD416)	16K	DYNAMIC 16 PIN	29 95
TMS4044-45NL	4K	STATIC	14 95

ROM'S

2513(2140)	Character Generator (upper case)	$ 9 95
2513(3021)	Character Generator (lower case)	9 95
2516	Character Generator	10 95
MM5230N	2048 Bit Read Only Memory	1 95

USER MANUALS

1802M	CDP1802 Manual	$ 7 50
Z80M	Z80 Manual	7 50
2650M	2650 Manual	5 00

PROMS

1702A	2048 x 1	Famous	$ 5 95
5203	2048 x 1	Famous	14 95
82S23	32 x 8	Open C	5 00
82S115	4096 x 1	Bipolar	19 95
82S123	32 x 8	Tristate	5 00
74S287	1024 x 1	Static	7 95
2708	8K	EPROM	10 95
2716 T I	16K	EPROM	29 95
2716 Intel	16K	EPROM	59 95
6301-1	1024 x 1	Tri State Bipolar	3 49
6330-1	256 x 1	Open C Bipolar	2 95
74186	512 x 1	TTL Open Collector	9 95
74188	256 x 1	TTL Open Collector	3 95

SHIFT REGISTERS

MM5013N	1024 BitAccumulator Dynamic	2 95
MM5016H	500/512 Bit Dynamic	89
MM5017N	Dual 500/512 Bit Dynamic	2 95
2504T	1024 Dynamic	3 95
2518	Hex 32 Bit Static	4 95
2519	Hex 40 Bit Static	4 00
2522	Dual 132 Bit Static	2 95
2524	512 Dynamic	99
2525	1024 Dynamic	2 95
2527	Dual 256 Bit Static	2 95
2528	Dual 250 Static	4 00
2529	Dual 240 Bit Static	4 00
2532	Quad 80 Bit Static	2 95
2533	1024 Static	2 95
3341	Fifo	6 95
74LS670	4 X 4 Register	1 95

UART'S

AY-5-1013	30K BAUD	$ 5 95

SPECIAL REQUESTED ITEMS

TELEPHONE KEYBOARD CHIPS

AY-5-9100	$14 95
AY-5-9200	14 95
AY-5-9500	4 95
AY-5-2376	14 95
HD0165	7 95
74C922	9 95

ICM CHIPS

ICM7045	$24 95
ICM7205	19 95
ICM7207	7 50
ICM7208	19 95
ICM7209	6 95

NMOS READ ONLY MEMORIES

MCM6571	$13 50
MCM6574	13 50
MCM6575	13 50

TV GAME CHIP SET
AY-3-8500-1 Chip and 2 010 MHz Crystal $7.95

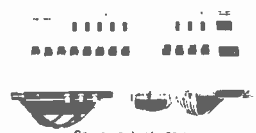
MISCELLANEOUS

11C90	$19 95	MK40240	$17 50
MC3061P	11 95	DS0026CH	3 75
MC1408L7	4 95	TIL306	10 20
MC1408L8	5 75	95H90	11 95
LD110/111	$25 00/set		
MC4016(74416)	7 50		
4N33	3 95		

PARATRONICS

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)

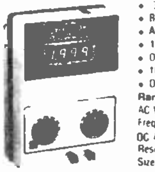
- Some applications are
- — Troubleshooting microprocessor address, instruction, and data flow
- — Examine contents of ROMS
- — Tracing operation of control logic
- — Checking counter and shift register operation
- — Monitoring I/O sequences
- — Verifying proper system operations during testing

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
- Overrange 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

KEYBOARDS

63-Key Unencoded

This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most applications. IN STOCK **$29.95/each**

Hexadecimal Encoder

19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. **$10.95/each**

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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 025 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

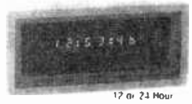
Kit —	$39.95
Assembled —	$49.95
Heavy Duty Carry Case	$5.95
Stop Watch Chip Only (7205)	$19.95

iMK 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 KB503 5V Power Kit	$17.50

JE700 CLOCK



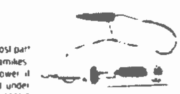
12 or 24 Hour
115 VAC

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 MMS314 clock chip

KIT ONLY **$16.95**

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 **JE225 $9.95 Per Kit**

CSC PROTO BOARDS

PROTO BOARD 6 $15.95 (6" long X 4" wide)

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 (includes power supply)	129.95

PROTO CLIPS

14 PIN	$4 50
16 PIN	4.75
24 PIN	8.50
40 PIN	13.75

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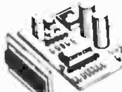
Jumbo LED Car Clock Kit



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

MUSICAL HORN

One tune supplied with each kit. Additional tunes — $6.95 each. Special tunes available. Standard tunes now available: — Dixie — Eyes of Texas -- On Wisconsin — Yankee Doodle Dandy — Notre Dame — Pink Panther — Aggie War Song — Anchors Away — Never on Sunday — Yellow Rose of Texas — Deep in the Heart of Texas — Boomer Sooner — Bridge over River Kwai.

CAR & BOAT KIT 34.95 | HOME KIT 29.95 | Special Design Case $3.50 | Assembled & Tested Add $10.00

TELEPHONE RELAY

Assembled & Tested $29.95

Automatically Starts & Stops Tape Recorders

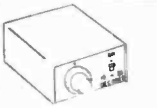
Surreptitious Interception of telephone conversation is a violation of Federal Law and this device is not intended for such use.

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**

NEW IMPROVED UNSCRAMBLER!



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Punched and Printed Case

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

12V 1 AMP POWER SUPPLY

INPUT VOLTAGE 25V MAX. OUTPUT CURRENT 1 AMP. MAX. LOAD REGULATION 50mV. OUTPUT VOLTAGE 12V. LINE REGULATION 0.01%. KIT CONTAINS ALL PARTS EXCEPT FOR LINE CORD AND TRANSFORMER.

ONLY **$4.50**

7400 TTL DIGITAL CIRCUITS

7400	11	7442	47	7490	65	74156	89
7401	13	7443	59	7491	61	74157	55
7402	13	7444	.59	7492	43	74160	55
7403	13	7447	68	7493	43	74161	65
7404	15	7448	71	7494	67	74163	65
74L04	29	7450	13	7495	.67	74164	85
74S04	44	7451	13	7496	67	74165	.89
7406	16	7453	13	74100	30	74174	.85
7408	19	7460	19	74104	49	74175	85
7410	13	7470	27	74107	28	74180	67
7411	18	7472	25	74109	31	74181	1.93
7412	.26	7473	29	74121	29	74182	68
7416	15	7474	29	74123	48	74191	98
7420	13	7475	47	74132	99	74192	79
7423	25	7476	31	74136	.99	74193	81
7425	29	7480	31	745138	1 95	74194	81
7426	23	7481	55	74141	75	74195	69
7437	23	7482	.57	74151	61	9316	.85
7438	23	7483	.67	74153	61	9601	3/$1
7440	13	7485	89	74154	98	9L04	35
7441	76	7489	1.25	74155	.89		

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

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		
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

SOCKETS

- 8 Pin Low Profile 20
- 14 Pin Low Profile 22
- 16 Pin Low Profile 25
- 18 Pin Low Profile 30
- 28 Pin Low Profile 69
- 40 Pin Low profile 89

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709	Operational Amplifier	.25
710	Differential Comparators	.40
711	Dual Differential Comp.	.35
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LM 301	Operational Amplifier	.30
LM 307	Operational Amplifier	.30
LM 308	Operational Amplifier	95
LM 309K	5V Lamp Regulator	1.49
LM 710	Voltage Comparator	.25
LM 311	Voltage Comparator	85
LM 318	Operational Amplifier	1 15
LM 723	Voltage Comparator	69.
LM 324	Quad Operational Amplifier	1.20
LM 377	Dual 2W Amplifier	1.65
LM 3900	Quad Op-Amplifier	40
LM 741	Operational Amplifier	.25
LM 748	Operational Amplifier	.25
NE 553	Quad Timer	1 95
NE 555	Timer	40
NE 556	Dual Timer	95
NE 567	Tone Decoder	1.25
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75491	Quad Segment Driver	.35
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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

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

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The most popular digital IC's ever Produced. Very hard to find!

UL914	DUAL 2 INPUT NOR	.99
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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. interface	10.95
8255 Prog. perp. 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
TR1602B Uart	3.95
TR1863 Uart	8.50

PROMS

1702A - 1K - 1.5us	3.95 or 10/35.
2708 - 8K Intel - 450ns	14.95
5204 - 4K	7.95
82S129 — 1K	2.50
2708S - 8K signetics 650ns	9.95

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IN 4002 1 Amp 100 PIV	40/$1
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IN 270	10/$1

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IN 752 5.6V 400M	4/$1
IN 1958 8.2V 400M	4/$1
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IN 5271 100V 500M	10/$1
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4.7V 500 MW	10/$1
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10V 1 Watt	8/$1
15V 500 MW	10/$1
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IN 4148/IN914 Long Leads	20/$1
IN 4148/IN914 Cut Leads	40/$1
IN 4148/IN914 PC Leads	100/$2

CLOCK & COUNTER CHIPS

MK50252	Clock Chip	$4 99
MK50250	Alarm Clock	3.75
MK50380	Alarm Chip	2.95
FCM7010	Direct Drive Clock Chip	4.95
MK5005	4 Digit Counter w/Latch	8.50
MK5002	4 Digit Counter	8.95
MK50395	6 Digit UP/Down Counter	12.95
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CT5005	Calculator Chip w/Specs	1.25
MK5021	Cal. Chip w/sq rt.	2.50

SOCKET SPECIAL! 28 PIN IC SOCKET 3 FOR $1 WHEN PURCHASED W/CLOCK IC

HOUSE # TTL IC's

7400	10/1 00	7437	6/1.00
7404	10/1 00	7438	6/1.00
7408	10/1 00	74141	3/1.00
7420	10/1.00	74153	3/1.00

Please specify that you are ordering House Number TTL.

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300 KHz	$1.50
3 57945	1 25

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2 Per Pack 2/$1

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2N 3904 NPN	6/$1
2N 3906 PNP	6/$1
2N 3392 Pre-Amp	25/$1
2N 4400 NPN	10/$1
2N 4402 PNP	10/$1
EN 2222 NPN	8/$1
EN 2907 PNP	8/$1

POWER TRAN.

115 W 200V	NPN	95
TIP 29 (EP967)	NPN	4/$1
TIP 30 (EP929)	PNP	4/$1
TIP 31 P C Leads	NPN	5/$1
MJE 2370		3/$1
2N 3055		75
TN 2021 By RCA		95
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7805 Pos.	5V 1 Amp	.99	7818 Pos.	18V 1 Amp	.99
7806 Pos.	6V 1 Amp	.99	7824 Pos.	24V 1 Amp	.99
7808 Pos.	8V 1 Amp	.99	7905 Neg.	5V 1 Amp	1.10
7812 Pos.	12V 1 Amp	.99	7912 Neg.	12V 1 Amp	1.10
7815 Pos.	15V 1 Amp	.99	7915 Neg.	15V 1 Amp	1.10

723 VOLTAGE REGULATORS

Output voltages variable from 2 volts to 37 volts. A very versatile and popular device. —14 PIN DIP

69c

MOTOROLA VOLTAGE REGULATOR

MC1469R. TO-66. 9 lead package for 3 to 30V outputs. Provides 600 MA direct output or more by using an external power transistor. Regular catalog price — $4 00 each! With specs **$1.95 each**

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TO -5 HEATSINKS

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DL 721 8 C.A.	DL 727 - C.A.
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1,900MFD 35WVDC (Mini)	3/$2
8,000MFD 15WVDC	95 cents each
33,000MFD 40WVDC	$4.00 Each

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33MFD 10WVDC	6/$1
22PF 10	10/$1

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68PF 50V	.001MFD 50V
100PF 100V	.002FMD 200V
150PF 50V	.01MFD 200V
220PF 50V	0.2MFD 200V
330PF 50V	3.3PF 500V
.001MFD 500V	100PF 500V

PC Leads 25/89 cents No Mix

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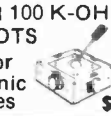
FOUR 100 K-OHMS POTS



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10 Amp	50V	1 25
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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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74L10	.33	74LS10	.39	74LS138	1.89
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	.85	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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MC725P	1.50	MC1510G	8.00
MC789P	1.50	MC1514L	4.50
MC790P	1.50	MC1595L	6.25
MC817P	1.30	MC1723CL	3.60
MC836P	1.35	MC1741CG	1.20
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

C MOS

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

75450BP	.49	LM301H	.35	LM741CH	.45
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
CA3005	1.60	LM370N	1.25	NE556	1.50
CA3006	3.50	LM380N	1.45	UA702	.80
CA3018	1.10	LM566	2.25	UA703CH	.45
CA3018A	1.60	LM711CH	.60	UA709CH	.30
CA3026	1.50	LM723H	.75	UA749CH	.45
CA3046	.35	LM741CN	.45		

IC's ON THE MOVE

BBD BUCKET BRIGADE DEVICE
MM3001 19.50 MN3002 11.70
MM3003 9.45
HALL IC: DN834 1.25 DN837 1.50
DN835 1.35 DN838(NEW)

ZENER DIODES

½ Watt, ± 10% .... $.30 each to 33 V
1 Watt, ± 10% .... $.40 each to 33 V
Voltages to 200V, and ± 5% Available

1 Megohm Potentiometer - Made by Clarostat. 7/8" diam., split, knurled shaft ½" long.
NT544 $.39 Three for $1.00

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5400	1.00	5475	1.50
5404	1.25	5486	1.90
5410	1.00	5493	2.00
5426	1.25	54100	1.80
5473	1.50	54LS04	1.00

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LM340K-5	1.70
LM340K-6	1.70
LM340K-8	1.70
LM340K-15	1.70
LM340K-18	1.70
LM340K-24	1.70
LM340T-5	1.50
LM340T-6	1.50
LM340T-8	1.50
LM340T-12	1.50
LM340T-15	1.50
LM340T-18	1.50
LM340T-24	1.50

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¼ Watt ± 5% Packed 5 of any one value .... $.25
½ Watt ± 5% Packed 5 of any one value .... $.30
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MINIMUM ORDER $5.00
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Canada $2.00
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2.2MF25	Axial Leads	.15	30MF25	Axial Leads	.18
3.3MF10	Axial Leads	.15	47MF25	Radial Leads	.19
3.3MF10	No Polarity	.15	47MF50	Radial Leads	.24
10MF25	Axial Leads	.15	100MF16	Radial Leads	.19
10MF50	Axial Leads	.16	100MF25	Radial Leads	.24
10MF150	Axial Leads	.20	500MF50	Axial Leads	.60
25MF35	Axial Leads	.18	1000MF35	Axial Leads	.65

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C1702A	9.95	2708	34.95	8008	19.95
2101	5.75	C5101-3	4.50	8080A	19.95
2102	1.75	MM5013	3.25	8224	10.45

Contact us for all your microprocessor needs.

NEW FROM *NEW-TONE*

Tiny Meter - Small enough to add to almost any equipment, this 300 uA S-meter has a removeable scale. Use it as is or in a voltmeter, as a tuning indicator, battery tester, etc. Meter face is ½" x ¾". Body over-all is a ¾" cube. Mounting centers 1⅛". **NT579 $2.29 3 for $6.00**

12-Volt DC Relay - Rugged 12-volt SPDT relay, with a 5 amp contact rating. housed in a tough white nylon case. **NT 565 $1.79**

Pioneer 6" Speaker - 7½-watt, 3.2-ohm speaker made the way speakers should be made. Has heavy-duty treated paper cone, protected magnet housing, and a ceramic terminal strip marked with polarity. A beautiful speaker at half the price you'd expect. **NT526 $2.39 Three for $6.00**

PC Boards — MIL grade, 1/16" glass-epoxy boards with 2-ounce copper on one side.
NT521 6"x3" $.50, NT522 6"x6" $.90' NT523 6"x8" $1.20

Regulated Power Supply Components Kit - Contains the components needed to build a fixed-voltage regulated supply including: 117/17V-1 ampere Transformer, Bridge Rectifier, 2000 uF Capacitor, and a 1 ampere LM340 3-terminal IC Regulator. Makes a fine "on board" supply or use it for breadboarding. Components only. Specify 5, 6, 8, 12 or 15 volts **NT525 $4.99**

Dry Transfer Patterns for PC Boards - Includes 0.1" spaced IC pads, donuts, angles, and 3-and 4-connector pads. Over 225 patterns on a 2"x7¼" sheet **NT520 $1.49**

5" Taut-Band Meter - One milliampere full scale, 3½", scale length. Coil resistance 465 ohms. Made by Modutec for Bose. Meter scale in VUs (-20 to +3). Meter is designed to be mounted coil up. Complete with "smoke" plastic cover. Over-all 5⅛"x4". Meter face mounts in a 5⅛"x2⅜" cutout: A beautiful meter. **NT539 $4.89**

NEW FROM *NEW-TONE*

HIGH FIDELITY SPEAKERS

8-INCH COAXIAL

Combines a high quality 8" woofer and a tweeter into a pre-phased sound reproducer. Built-in cross-over network. Excellent choice for a low cost Hi-Fi system for autos. vans. or in your home. Frequency response is a smooth 80-15000 Hz. 8-ohm VC. 10 oz. ceramic ring magnet. 25 W rating. NT577 $13.99
plus 40 cents postage

10-INCH WOOFER

The speaker for your "big sound" system. Frequency response is 20-4000 Hz: 8-ohm aluminum VC: powerful 20 oz. ceramic ring magnet and a rubberized accordion-edge suspension for excellent compliance. Handles 50 W max. Use with the NT576 for a super system. NT578 $17.99
plus 40 cents postage

50 W DOME TWEETER

Here is the super tweeter. A rugged 10 cm (4") dome tweeter which handles 50 W max. Frequency response is 4000-20000 Hz. 8-ohm VC. 8 oz. ceramic magnet. Your system can have a brilliance you never imagined. NT576 $6.99

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	10 For	100 For
1N4001	.60	5.00
1N4002	.70	6.00
1N4003	.80	7.00
1N4004	.90	8.00
1N4005	1.00	9.00
1N4006	1.10	10.00
1N4007	1.20	11.00

UNIJUNCTIONS

2N2160	.65	MU4892	.50
2N2646	.45	MU4893	.50
2N2647	.55	MU4894	.50
2N4851	.75	2N6027	.55
2N4852	.75	2N6028	.70
2N4870	.50	D5E37	.35
2N4871	.50	MU10	.35
MU4891	.50	MU20	.40

HARDWARE - SOCKETS

Nylon Screws, Nuts and Rivets - 50 piece assortment $1.99
MK 20 TO-3 Mounting Kit 5 for $.99
NT-505 Mica and bushing. Specify TO-3, TO-66 or TO-220 10 sets for $.99

IC Socket	14-Pin DIL	$.25 each
IC Socket	16-Pin DIL	$.27 each
Wire Wrap	16-Pin DIL	$.32 each

POPULAR JEDEC TYPES

1N34	.25	2N1540	.90	2N2712	.18	2N3394	.17	2N3856	.20	2N4402	.16
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	.25	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	1.70	2N2906A	.30	2N3565	.20	2N3957	1.25	2N4852	.55
2N404	.75	2N2160	.65	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	1.00	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	.35

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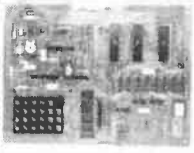
KIM-1 MICROCOMPUTER



KIM-1 Computer module from MOS Technology – 1K RAM–2K ROM–Continuing system executive–Complete audio cassette 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 and Tested $245.00

KIM-4 MOTHERBOARD– The KIM-4 Motherboard is designed to interface a single KIM-1 microcomputer with up to six system expansion modules. The motherboard also contains circuitry for buffering all appropriate system address, data, and control lines. A +5v regulator is included to provide power for the KIM-1 module from the system 8-10v DC unregulated power bus. A +12v regulator is provided for powering the KIM-1 audio cassette interface from user-supplied +15v $119.00

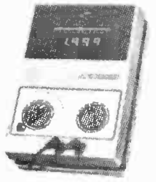
KIM-3B	8K RAM BOARD	289.00
KIM-5	ROM RESIDENT ASSEMBLER	195.00
KIM-6	WIREWRAP BOARD	39.00

XR-2242 LONG RANGE TIMER

Applications–Long delay generation – sequential timing – precision timing – ultra low frequency oscillator. Use two of these cascaded to generate time delays or timing intervals up to one year.

XR-2242 CP	1.24	25 up	100 up
	1.50	1.10	.90

B&K-PRECISION'S NEW 3½ DIGIT DMM



B&K-PRECISION's new Model 2800 portable DMM features 3-1/2 digit display, auto-zeroing and 100% overrange reading for only $99.95. Basic DC accuracy is 1%. Twenty-two ranges read up to 1000 volts DC or AC, 1000mA and 10 megohms.

All ranges are well protected against overloads. Even if you should accidentally apply +1000VDC to the 2800 while switched to an ohms range, no instrument damage will result. All DC and AC voltage ranges are protected up to ±1000 volts DC or AC. The current ranges receive the double protection of diodes and a series fuse.

Model 2800 .... $99.95

DIP SWITCHES – SPST SLIDE TYPE

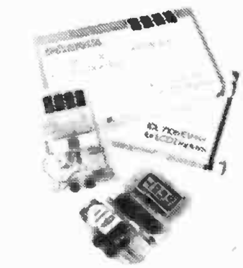
P/N	NO SWITCHES	PRICE	P/N	NO SWITCHES	PRICE
JS8722-01	1	1.00	JS8722-06	6	1.80
JS8722-02	2	1.08	JS8722-07	7	1.85
JS8722-03	3	1.40	JS8722-08	8	1.95
JS8722-04	4	1.70	JS8722-09	9	2.00
JS8722-05	5	1.75	JS8722-10	10	2.20

2N Numbers

2N508A	$ .80	2N3706	$ .25	2N4427	$1.00	2N5450	$ .20
2N697	.16	2N3707	.18	2N4858	1.00	2N5451	.25
2N699	.80	2N3708	.20	2N4895	3.60	2N5457	.60
2N706	.35	2N3709	.20	2N4896	4.40	2N5458	.45
2N711	.45	2N3710	.20	2N4897	5.40	2N5484	.60
2N718	.40	2N3711	.20	2N4898	1.10	2N5490	.70
2N718A	.40	2N3713	1.48	2N4918	.60	2N5671	12.00
2N918	.40	2N3714	1.60	2N4919	.60	2N5672	14.00
2N929	.26	2N3715	1.64	2N4920	.80	2N5777	.60
2N930	.28	2N3716	1.68	2N4921	.70	2N5778	.55
2N1132	.15	2N3721	.20	2N4922	.75	2N5811	.40
2N1613	.32	2N3724	.50	2N4923	.70	2N5817	.40
2N1711	.34	2N3725	.52	2N4983	1.10	2N5818	.40
2N1893	.36	2N3731	3.60	2N4984	1.50	2N5819	.45
2N2102	.40	2N3740	1.20	2N4987	.75	2N5822	.58
2N2160	1.50	2N3741	1.50	2N4988	1.20	2N5824	.25
2N2218	.28	2N3771	2.40	2N4989	1.60	2N5825	.26
2N2218A	.30	2N3772	2.50	2N4991	.75	2N5826	.30
2N2219	.28	2N3773	3.90	2N4993	1.80	2N5827	.30
2N2219A	.40	2N3789	2.00	2N4994	.30	2N5828	.34
2N2221	.22	2N3790	1.80	2N5038	5.60	2N5828A	.40
2N2221A	.25	2N3791	1.85	2N5039	4.80	2N6000	.50
2N2222	.22	2N3792	1.90	2N5086	.30	2N6001	.52
2N2222A	.25	2N3819	.40	2N5087	.30	2N6002	.54
2N2368	.30	2N3823	.70	2N5088	.30	2N6014	.66
2N2369	.24	2N3859	.22	2N5089	.40	2N6015	.68
2N2369A	.26	2N3860	.20	2N5109	1.90	2N6027	.50
2N2475	.60	2N3866	1.10	2N5131	.20	2N6028	.60
2N2484	.30	2N3887	2.00	2N5133	.18	2N6032	26.00
2N2605	.50	2N3868	2.10	2N5134	.20	2N6033	30.00
2N2608	2.00	2N3877A	.25	2N5172	.20	2N6034	.92
2N2646	.70	2N3903	.20	2N5179	.50	2N6035	1.00
2N2647	.95	2N3904	.22	2N5190	.80	2N6036	1.05
2N2713	.30	2N3905	.20	2N5191	.80	2N6037	.92
2N2904	.35	2N3906	.22	2N5194	.80	2N6038	1.00
2N2904A	.36	2N3955	2.70	2N5195	.90	2N6039	1.05
2N2905	.34	2N3957	1.50	2N5210	.15	2N6050	2.60
2N2905A	.36	2N3958	1.60	2N5219	.20	2N6051	2.80
2N2906	.20	2N3962	.35	2N5220	.20	2N6052	3.20
2N2906A	.21	2N3970	1.20	2N5221	.20	2N6053	2.00
2N2907	.24	2N4032	.60	2N5223	.20	2N6054	2.40
2N2907A	.28	2N4036	.50	2N5225	.18	2N6055	2.00
2N2924	.30	2N4037	.66	2N5227	.24	2N6056	2.40
2N2925	.22	2N4058	.25	2N5232	.32	2N6057	2.60
2N2926	.15	2N4060	.20	2N5232A	.25	2N6058	2.80
2N3019	.60	2N4061	.25	2N5249	.40	2N6059	3.20
2N3053	.39	2N4093	1.10	2N5294	.70	2N6076	.20
2N3054	.90	2N4123	.20	2N5296	.70	2N6099	.90
2N3055	1.00	2N4124	.20	2N5298	.70	2N6101	1.06
2N3375	6.30	2N4125	.20	2N5306	.34	2N6103	1.10
2N3391A	.25	2N4126	.24	2N5308	.40	2N6121	.66
2N3392	.28	2N4142	.18	2N5309	.52	2N6122	.68
2N3393	.22	2N4143	.18	2N5321	.60	2N6123	.88
2N3414	.20	2N4220A	1.00	2N5322	.70	2N6124	.80
2N3416	.22	2N4224	1.25	2N5323	.70	2N6125	.68
2N3417	.22	2N4228	.40	2N5336	3.70	2N6126	.88
2N3440	1.00	2N4235	1.80	2N5337	3.90	2N6218	.64
2N3442	1.80	2N4236	1.80	2N5338	4.20	2N6219	.60
2N3553	1.80	2N4237	1.20	2N5339	4.50	2N6220	.58
2N3563	.30	2N4238	1.30	2N5354	.34	2N6222	.30
2N3564	.16	2N4239	1.80	2N5355	.38	2N6223	.30
2N3565	.18	2N4248	.22	2N5366	.50	2N6224	.32
2N3567	.19	2N4249	.18	2N5367	.50	2N6225	.34
2N3568	.30	2N4250	.24	2N5368	.25	2N6288	.80
2N3569	.18	2N4256	.20	2N5369	.26	2N6290	.80
2N3638	.20	2N4258	.32	2N5370	.28	2N6292	.84
2N3638A	.22	2N4347	2.00	2N5373	.28	2N6303	5.60
2N3642	.20	2N4348	2.10	2N5375	.28	2N6354	6.30
2N3643	.20	2N4395	1.30	2N5383	.58	2N6386	1.30
2N3645	.20	2N4400	.25	2N5397	2.50	2N6387	1.40
2N3646	.14	2N4401	.25	2N5418	.30	2N6388	1.50
2N3694	.22	2N4402	.30	2N5419	.35	3N83	1.98
2N3702	.18	2N4403	.40	2N5420	.40	3N84	3.56
2N3704	.18	2N4409	.30	2N5447	.30	3N85	3.56
2N3705	.18	2N4416	.90	2N5448	.30	3N153	1.00
		2N4425	.44	2N5449	.25	4N26	2.04

Intersil 3½ DIGIT PANEL METER

LCD or LED KITS

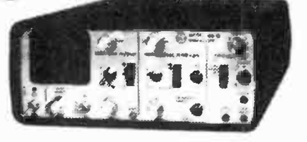


BUILD A WORKING DPM IN 1/2 HOUR WITH THESE COMPLETE EVALUATION KITS

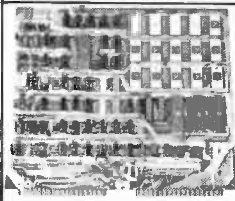
Test these new parts for yourself with Intersil's low cost prototyping kits, complete with A/D converter and LCD display (for the 7106) or LED display (for the 7107). Kits provide all materials, including PC board, for a functioning panel meter.

ICL7106EV (LCD) $29.95 ICL7107 (LED) $24.95

PORTABLE 15 MHz OSCILLOSCOPE



MS-15	MINISCOPE	$289.00
41-140	CARRYING CASE	30.00
41-141	10 TO 1 PROBE	24.50



AMI 6800 EVALUATION KITS

EVK99	$133.00
EVK100	269.95
EVK200	449.95
EVK300 (pictured)	699.00

50 VOLT CERAMIC DISC CAPACITORS

$1.00 Per Package

5pf	9/pkg	220pf	8/pkg	.001mfd	9/pkg	.015mfd	8/pkg
15pf	9/pkg	270pf	7/pkg	.0015mfd	9/pkg	.02mfd	8/pkg
25pf	9/pkg	300pf	7/pkg	.0022mfd	9/pkg	.022mfd	8/pkg
27pf	9/pkg	330pf	7/pkg	.003mfd	9/pkg	.03mfd	8/pkg
47pf	8/pkg	390pf	7/pkg	.0047mfd	9/pkg	.039mfd	7/pkg
68pf	8/pkg	470pf	7/pkg	.005mfd	9/pkg	.047mfd	7/pkg
100pf	8/pkg	560pf	7/pkg	.01mfd	9/pkg	.1mfd	6/pkg
150pf	8/pkg	680pf	7/pkg				

PLESSEY POLYESTER MINI-BOX CAPACITORS

$1.25 Per Package

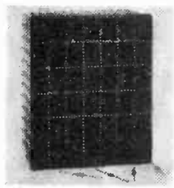
MFD	QTY	MFD	QTY	MFD	QTY	MFD	QTY
.001	8/pkg	.0068	8/pkg	.039	7/pkg	.22	5/pkg
.0012	8/pkg	.0082	8/pkg	.047	7/pkg	.27	4/pkg
.0015	8/pkg	.01	8/pkg	.056	7/pkg	.33	4/pkg
.0018	8/pkg	.012	8/pkg	.068	7/pkg	.39	3/pkg
.0022	8/pkg	.015	7/pkg	.082	7/pkg	.47	3/pkg
.0027	8/pkg	.018	7/pkg	.1	7/pkg	.56	3/pkg
.0033	8/pkg	.022	7/pkg	.12	6/pkg	.68	2/pkg
.0039	8/pkg	.027	7/pkg	.15	6/pkg	.82	2/pkg
.0047	8/pkg	.033	7/pkg	.18	5/pkg	1.0	2/pkg
.0056	8/pkg						

ALUMINUM ELECTROLYTIC (RADIAL LEAD)

Quantity per Package/ Price

MFD	10 volt	16 volt	25 volt	35 volt	50 volt
1	8/$1.00	7/$1.00	7/$1.00	7/$1.00	6/$1.00
4.7	7/$1.00	7/$1.00	6/$1.00	5/$1.00	4/$1.00
10	7/$1.00	7/$1.00	6/$1.00	5/$1.00	4/$1.00
22	7/$1.00	6/$1.00	5/$1.00	4/$1.00	4/$1.00
33	6/$1.00	6/$1.00	4/$1.00	4/$1.00	4/$1.00
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
330	3/$1.00	3/$1.00	3/$1.25	2/$1.00	2/$1.00
470	3/$1.00	3/$1.25	2/$1.00	2/$1.25	$ .80
1000	--	--	2/$1.25	$ .80	$1.20
2200	--	--	$1.30	$1.60	$2.50

HIGH QUALITY CARBON FILM RESISTOR KIT



COMPLETE WITH STORAGE BIN

Each KIT Contains 20 Each of 42 Different ¼ WATT 5% CARBON FILM RESISTORS from 68 ohm to 4.7 megohm **$24.90**

CARBON FILM RESISTORS (5%)

Only in Multiples of 100 pcs per value (ohms)

¼W . . . $1.69 per 100

½W . . . $1.79 per 100

10	100	1.0K	10K	100K	1.0M
11	110	1.1K	11K	110K	1.1M
12	120	1.2K	12K	120K	1.2M
13	130	1.3K	13K	130K	1.3M
15	150	1.5K	15K	150K	1.5M
16	160	1.6K	16K	160K	1.6M
18	180	1.8K	18K	180K	1.8M
20	200	2.0K	20K	200K	2.0M
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
51	510	5.1K	51K	510K	5.1M
56	560	5.6K	56K	560K	5.6M
62	620	6.2K	62K	620K	6.2M
68	680	6.8K	68K	680K	6.8M
75	750	7.5K	75K	750K	7.5M
82	820	8.2K	82K	820K	8.2M
91	910	9.1K	91K	910K	10.0M

EUROPEAN TRANSISTORS

BC107A	$ .44	BC460	$ .96	BD441	$ .88
BC107B	.44	BC461	1.32	BD442	.88
BC108A	.44	BC477	.52	BD533	.78
BC108B	.44	BC478	.48	BD534	.78
BC108C	.48	BC479	.52	BD535	.80
BC393	.48	BD437	.80	BD536	.80
BC394	.48	BD438	.80	BD537	.82
BC440	.88	BD439	.84	BD538	.82
BC441	1.12	BD440	.84	BD675A	.90
				BD676A	.90

TIP SERIES TRANSISTORS

TIP31	$ .70	TIP32A	$ .72	TIP122	$1.24
TIP31A	.72	TIP32B	.74	TIP125	1.12
TIP31B	.74	TIP120	1.12	TIP126	1.18
TIP32	.70	TIP121	1.18	TIP127	1.24

JAPANESE REPLACEMENT TRANSISTORS

2SB405	$ .85	2SC933	$1.00	2SC2034	$3.40
2SC536	.60	2SC1226A	1.25	2SD72	1.00
2SC828	.75	2SC1359	.90	2SD313	1.10
2SC829	.70	2SC1973	1.30	2SD325	1.25
2SC929	.70	2SC1974	3.00	3SK49	2.75
2SC930	.65	2SC1975	3.10		

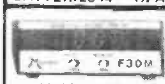
PORTABLE FREQUENCY COUNTER

- Compact (3.25" w x 1.75" h x 4.00" d)
- Total Portability (4 AA cells)
- Low Current L.S.I. Circuitry
- Fet Input
- 2 Ranges for 1Hz resolution to 1 MHz
- Accepts sine, square or ramp input waveforms
- Sensitivity 35 mV rms or 100 mV p-p
- Maximum Input – 200V rms
- Weight – 6 oz. (with batteries) (not included)
- Display – 4 digits; .3 inch
- Impedance – 1 meg shunted with 30 pf
- Includes input cable and owners manual

F1M $89.95

BATTERIES (4 – 1½ AA cells)... $3.20

TRANSMISSION FREQUENCY MONITOR



- Ideal for amateur radio CB, etc.
- Installs in series with transmission line
- Count transmitter frequencies up to 30 MHz
- Low current L.S.I. circuitry
- 4 digit .6 in L.E.D. display
- Max input power – 200 watts
- Size – 5.0" w x 2.0" h x 2.75" d
- Power requirements – 10-16 VDC @ .45A Max (not included with unit)

F30M. . . $89.95

Soft–Touch TONE DIAL

- Convert standard rotary phones into Touch-Tone.
- Improved microphone for better audio.
- Solid State reliability.
- Convenient operation.
- Utilize for tone signalling also.
- Five second installation:

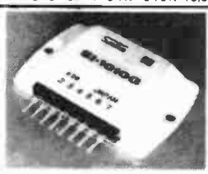
  Unscrew the mouthpiece on your telephone and drop out the carbon microphone disk. Screw on the Soft-Touch unit and you are ready to use it.
- Comes in Six colors–Black, Tan, Red, Green, White and Yellow. Order yours today.

Order Part Number 2006-Color $34.95

NEW from FLUKE MODEL 8020A

THE DMM FOR THE PROFESSIONAL

- 200-Hr. Battery Life
- 26 Ranges for 7 Functions
- 2000 Count Resolution
- High Low Power Ohms
- Autozero and Auto polarity
- MOV protected to 6000V against hidden transients and overload protection to 300V AC
- Diode Test Function
- Conductance Function checks leakage resistance to 10,000 meg ohms
- Size HWL (7.1 X 3.4 X 1.8 IN.) (18.0 X 8.6 X 4.5 cm)
- Weight: 13 oz. ONLY $169.00



Buy 2 for stereo and take 10% discount

Sanken HYBRID AUDIO POWER AMPLIFIERS

SI-1010G	(10W output)	$ 6.90
SI-1020G	(20W output)	$13.95
A-SI-8	(Socket for above)	.95
SI-1030G	(30W output)	$19.00
SI-1050G	(50W output)	$27.80
A-SI-10	(Socket for above)	.95
Data with Application Notes		.50

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Send Check or Money Order to: P.O. Box 2208P, Culver City, Calif. 90230. Calif. residents add 6% sales tax. Minimum Order $10.00. ADD $1.00 to cover postage and handling. Master Charge and Bankamericard welcomed (include your card number and exp. date). TELEPHONE ORDERS: California customers (213) 641-4064 Out of State Toll Free 800-421-6813

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OREGON ANCRONA 1125 N E 82nd Ave Portland, OR 97220 (503) 254-5541	GEORGIA ANCRONA 3330 Piedmont Rd. NE Atlanta, GA 30305 (404) 261-7100	TEXAS ANCRONA 2649 Richmond Houston, TX 77098 (713) 529-3489

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ELECTRONIC SYSTEMS

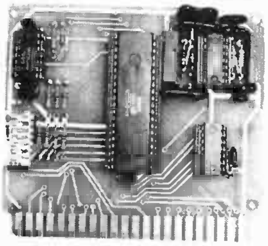
P.O. Box 9641 San Jose, CA 95157 (408) 374-5984

FOR CATALOG INCLUDING PARTS LISTS AND SCHEMATICS, SEND A SELF ADDRESSED ENVELOPE WITH 24¢ POSTAGE.

RS-232/TTY* INTERFACE

NEW

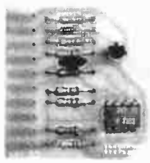
Part no. 600
- Converts RS-232 to 20mA current loop, and 20mA current loop to RS-232
- Two separate circuits
- Requires +12 and -12 volts
- Board only $4.50, with parts $7.00



UART & BAUD RATE GENERATOR*

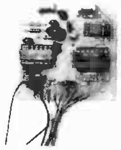
Part no. 101
- Converts serial to parallel and parallel to serial
- Low cost on board baud rate generator
- Baud rates: 110, 150, 300, 600, 1200, and 2400
- Low power drain +5 volts and -12 volts required
- TTL compatible
- All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity.
- All connections go to a 44 pin gold plated edge connector
- Board only $12.00; with parts $35.00

RS-232/TTL INTERFACE*



Part no. 232
- Converts TTL to RS-232, and converts RS-232 to TTL
- Two separate circuits
- Requires -12 and +12 volts
- All connections go to a 10 pin gold plated edge connector
- Board only $4.50; with parts $7.00

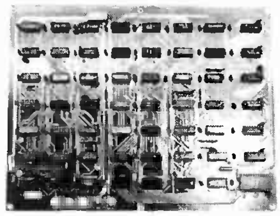
Part no. 111



TAPE INTERFACE*

- Play and record Kansas City Standard tapes
- Converts a low cost tape recorder to a digital recorder
- Works up to 1200 baud
- Digital in and out are TTL-serial
- Output of board connects to mic. in of recorder
- Earphone of recorder connects to input on board
- Requires +5 volts, low power drain
- Board $7.60; with parts $27.50
- No coils

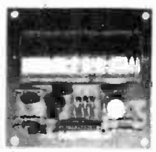
TELEVISION TYPEWRITER



Part no. 106
- Stand alone TVT
- 32 char/line, 16 lines, modifications for 64 char/line included
- Parallel ASCII (TTL) input
- Video output
- 1K on board memory
- Output for computer controlled curser
- Auto scroll
- Non-destructive curser
- Curser inputs: up, down, left, right, home, EOL, EOS
- Scroll up, down
- Requires +5 volts at 1.5 amps, and -12 volts at 30 mA
- All 7400, TTL chips
- Char. gen. 2513
- Upper case only
- Board only $39.00; with parts $145.00

DC POWER SUPPLY*

Part no. 6085
- Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp.
- Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps.
- Board only $12.50; with parts $42.50 excluding transformers

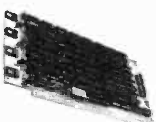


Part no. 107

RF MODULATOR*

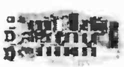
- Converts video to AM modulated RF, Channels 2 or 3
- Power required is 12 volts AC C.T., or +5 volts DC
- Board $7.60; with parts $13.50

8K STATIC RAM



Part no. 300
- 8K Altair bus memory
- Uses 2102 Static memory chips
- Memory protect
- Gold contacts
- Wait states
- On board regulator
- S-100 bus compatible
- Vector input option
- TRI state buffered
- Board only $22.50; with parts $160.00

TIDMA*



Part no. 112
- Tape Interface Direct Memory Access
- Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate.
- S-100 bus compatible
- Board only $35.00; with parts $110.00

Apple II Serial I/O Interface*

Part No. 2
- Baud rates up to 30,000
- Plugs into Apple Peripheral connector
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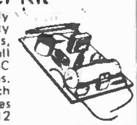

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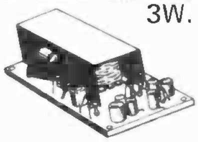

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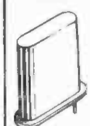

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Order By Cat. No. 7E1981 & Type No.

Type	Each	2 For	Type No.	Each	2 for	Type No.	Each	2 for
☐ SN7400	$ .19	$ .20	☐ SN7455	.19	.20	☐ SN74132	1.35	1.36
☐ SN7401	.19	.20	☐ SN7460	.19	.20	☐ SN74136	.49	.50
☐ SN7403	.25	.26	☐ SN7462	.19	.20	☐ SN74140	.49	.50
☐ SN7405	.19	.20	☐ SN7464	.19	.20	☐ SN74141	1.79	1.80
☐ SN7406	.19	.20	☐ SN7465	.19	.20	☐ SN74145	.69	.70
☐ SN7407	.39	.40	☐ SN7470	.19	.20	☐ SN74151	1.29	1.30
☐ SN7409	.39	.40	☐ SN7471	.19	.20	☐ SN74153	1.29	1.30
☐ SN7410	.25	.26	☐ SN7472	.19	.20	☐ SN74154	1.75	1.76
☐ SN7411	.59	.60	☐ SN7473	.59	.60	☐ SN74115	.79	.80
☐ SN7413	.69	.70	☐ SN7474	.29	.30	☐ SN74156	.39	.40
☐ SN7414	.99	1.00	☐ SN7475	.69	.70	☐ SN74157	.99	1.00
☐ SN7416	.35	.36	☐ SN7476	.79	.80	☐ SN74158	.99	1.00
☐ SN7417	.35	.36	☐ SN7480	.19	.20	☐ SN74161	1.25	1.26
☐ SN7420	.32	.33	☐ SN7482	.29	.30	☐ SN74164	.79	.80
☐ SN7421	.49	.50	☐ SN7483	.99	1.00	☐ SN74165	.99	1.00
☐ SN7423	.29	.30	☐ SN7486	.49	.50	☐ SN74166	1.99	2.00
☐ SN7426	.19	.20	☐ SN7488	.79	.80	☐ SN74173	.99	1.00
☐ SN7430	.29	.30	☐ SN7489	3.49	3.50	☐ SN74174	1.49	1.50
☐ SN7432	.32	.33	☐ SN7490	.99	1.00	☐ SN74175	.99	1.00
☐ SN7437	.19	.20	☐ SN7491	1.29	1.30	☐ SN74177	.79	.80
☐ SN7438	.25	.26	☐ SN7492	.69	.70	☐ SN74179	1.49	1.50
☐ SN7440	.19	.20	☐ SN7493	.69	.70	☐ SN74180	.49	.50
☐ SN7442	.69	.70	☐ SN7494	.79	.80	☐ SN74182	.49	.50
☐ SN7443	.59	.60	☐ SN7495	.59	.60	☐ SN74190	1.99	2.00
☐ SN7444	.39	.40	☐ SN7496	.29	.30	☐ SN74191	1.75	1.76
☐ SN7445	.99	1.00	☐ SN7498	.79	.80	☐ SN74192	.85	.86
☐ SN7446	1.25	1.26	☐ SN74100	1.99	2.00	☐ SN74193	.99	1.00
☐ SN7447	1.25	1.26	☐ SN74107	.29	.30	☐ SN74194	1.25	1.26
☐ SN7448	1.35	1.36	☐ SN74112	.39	.40	☐ SN74195	.29	.30
☐ SN7450	.19	.20	☐ SN74113	.39	.40	☐ SN74197	.75	.76
☐ SN7451	.19	.20	☐ SN74114	.25	.26	☐ SN74199	1.50	1.51
☐ SN7453	.19	.20	☐ SN74121	.49	.50	☐ SN74200	3.50	3.51
☐ SN7454	.29	.30	☐ SN74123	.69	.70	☐ SN74251	.79	.80
			☐ SN74125	.99	1.00	☐ SN74284	6.00	6.01
			☐ SN74126	.99	1.00	☐ SN74298	3.75	3.76

POP-AMPS AT "CENT-CIBLE" PRICES

Case code: T=TO-220 Power Tab: V=Mini dip; K=TO-3; H=TO-5; N=DIP.

Type No.	Each	2 for	Type No.	Each	2 for	Type No.	Each	2 for
☐ LM300H	$ .79	$ .80	☐ LM340T-5	1.49	1.50	☐ LM567	2.39	2.40
☐ LM300N	.49	.50	☐ LM340T-6	1.49	1.50	☐ LM703N	.59	.60
☐ LM301V	.45	.46	☐ LM340T-8	1.49	1.50	☐ LM704H	.19	.20
☐ LM301H	.45	.46	☐ LM340T-12	1.49	1.50	☐ LM709H	.19	.20
☐ LM307V	.45	.46	☐ LM340T-15	1.49	1.50	☐ LM709N	.49	.50
☐ LM308V	.69	.70	☐ LM340T-18	1.49	1.50	☐ LM710N	.39	.40
☐ LM308H	.69	.70	☐ LM340T-24	1.49	1.50	☐ LM733N	.79	.80
☐ LM309K	1.49	1.50	☐ LM350N	.49	.50	☐ LM741V	.25	.26
☐ LM311V	.79	.80	☐ LM370N	1.99	2.00	☐ LM741H	.30	.31
☐ LM311H	1.49	1.50	☐ LM376V	.29	.30	☐ LM747H	.59	.60
☐ LM318V	.99	1.00	☐ LM377N	2.25	2.26	☐ LM1304	1.49	1.50
☐ LM320H-5	.99	1.00	☐ LM380N	1.39	1.40	☐ LM1310	1.79	1.80
☐ LM320H-12	.99	1.00	☐ LM381N	1.99	2.00	☐ LM1312	2.49	2.50
☐ LM320H-15	.99	1.00	☐ LM386N	1.49	1.50	☐ LM1414V	.19	.20
☐ LM320T-5	1.49	1.50	☐ LM531H	1.49	1.50	☐ LM1458V	.39	.40
☐ LM320T-6	1.49	1.50	☐ LM532N	.25	.26	☐ LM1800N	.79	.80
☐ LM322N	1.19	1.20	☐ LM532H	.25	.26	☐ LM3028H	.65	.66
☐ LM324N	1.79	1.80	☐ NE540H	5.95	5.96	☐ LM3900N	.49	.50
☐ LM339N	1.79	1.80	☐ LM555V	.75	.76	☐ LM3909V	1.75	1.76
☐ LM340K-5	1.49	1.50	☐ LM556N	1.79	1.80	☐ LM4250	1.20	1.21
☐ LM340K-6	1.49	1.50	☐ LM558V	.39	.40	☐ LM75451	.69	.70
☐ LM340K-8	1.49	1.50	☐ LM558H	.39	.40	☐ LM75453	.69	.70
☐ LM340K-12	1.49	1.50	☐ LM561N	1.00	1.01	☐ LM75491	.80	.81
☐ LM340K-15	1.49	1.50	☐ LM565N	1.00	1.01	☐ LM75492	.80	.81
☐ LM340K-18	1.49	1.50	☐ LM565H	1.00	1.01	☐ LM75494	.60	.61
☐ LM340K-24	1.49	1.50	☐ LM566	2.49	2.50	☐ PA263	1.50	1.51
						☐ DM8864N	1.29	1.30

RIBBON CABLE!

Order by Cat. 7E3939-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

25 AMP BRIDGE RECTIFIERS

Order by Cat. No. 7E2273 & voltage

V	Each	1¢	SALE
☐ 50	$1.95	2 for	$1.96
☐ 100	1.49	2 for	1.50
☐ 200	1.69	2 for	1.70
☐ 400	1.99	2 for	2.00
☐ 600	2.25	2 for	2.26
☐ 800	2.50	2 for	2.51

25 AMP POWER STUD SCRS, TRIACS

Cat. No. 7E-14A147 (SCRs)
Cat. No. 7E-60B86A (Triacs)

V.	Each	1¢	SALE
☐ 50	$ .95	2 for	$ .96
☐ 100	1.25	2 for	1.26
☐ 200	1.95	2 for	1.96

1N4000 Epoxy Rectifiers

• Miniature! • 1.5 Amp! Order by Cat. No. and Type No.

Cat. No.	Type No.	PIV	Price	1¢ MORE!
☐ 7E2377	1N4001	50	10 for $.65	20 for .66
☐ 7E2378	1N4002	100	10 for .75	20 for .76
☐ 7E2379	1N4003	200	10 for .85	20 for .86
☐ 7E2380	1N4004	400	10 for .99	20 for 1.00
☐ 7E2381	1N4005	600	10 for 1.29	20 for 1.30
☐ 7E2382	1N4006	800	10 for 1.39	20 for 1.40
☐ 7E2383	IN4007	1000	10 for 1.49	20 for 1.50

10 AMP - POWER TABS!

#7E1448 - TRIACS
7E1730 - SCR
#4R1590 - QUADRACS

PRV	Sale	2 for
☐ 50	$ .55	$ .56
☐ 100	.69	.70
☐ 200	.88	.89
☐ 400	1.19	1.20

1.5 AMP BULLET RECTIFIERS!

Order by Cat. No. 7E60B84 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

MICRO MINI TOGGLE SWITCHES!

3 Amps, 125 VAC contacts, with chrome handles, complete with mounting hardware.

Cat. No	Type	Sale	2 for
☐ 7E3936	SPST	$1.19	$1.20
☐ 7E5085	SPDT*	1.39	1.40
☐ 7E4037	DPDT	1.45	1.46

* CENTER-OFF

BUY 1 AT OUR SALE PRICE
GET 2nd FOR 1¢ MORE

LYTIC KLINIC Electrolytic capacitors

Order by Cat. No. 7E3269 and value

UF	V	Style	Sale	1¢ SALE
☐ 10	15	P.C.	10 for $1.00	20 for $1.01
☐ 50	15	P.C.	8 for 1.00	16 for 1.01
☐ 15	25	P.C.	8 for 1.00	16 for 1.01
☐ 50	25	P.C.	6 for 1.00	12 for 1.01
☐ 20	15	Axial	10 for 1.00	20 for 1.01
☐ 20	15	P.C.	10 for 1.00	20 for 1.01

6 AMP CARTWHEEL RECTIFIERS

Cat, 7E3584 • AXIAL LEADS

V.	Each	1¢	SALE
☐ 50	$ .36	2 for	$ .37
☐ 100	.45	2 for	.46
☐ 200	.61	2 for	.62
☐ 400	.79	2 for	.80
☐ 600	.90	2 for	.91
☐ 800	1.19	2 for	1.20
☐ 1000	1.39	2 for	1.40

LEDS!

YOUR CHOICE 5 for $1.00
1¢ SALE 10 for $1.01

Order by Cat. No.
☐ #7E2135 JUMBO RED LEDS
☐ #7E2137 MICRO RED LEDS
☐ #7E2790 JUMBO RED CLEAR LEDS

ZENERS!

Order by Cat. No. 7E5210 & voltage & wattage

1 Watt	Sale	1¢ SALE
☐ 7.5V	5 for $1.	10 for $1.01
☐ 8.2V	5 for 1.	10 for 1.01
☐ 9.1V	5 for 1.	10 for 1.01
☐ 11.V	5 for 1.	10 for 1.01
☐ 12.V	5 for 1.	10 for 1.01
☐ 15.V	5 for 1.	10 for 1.01

Order by Cat. No. 7E5210B

5 WATTS	Sale	1¢ SALE
☐ 3.3V	3 for $1.	6 for $1.01
☐ 6. V	3 for 1.	6 for 1.01
☐ 6.2V	3 for 1.	6 for 1.01
☐ 8.2V	3 for 1.	6 for 1.01
☐ 9.1V	3 for 1.	6 for 1.01
☐ 12. V	3 for 1.	6 for 1.01
☐ 15. V	3 for 1.	6 for 1.01
☐ 18. V	3 for 1.	6 for 1.01
☐ 24. V	3 for 1.	6 for 1.01
☐ 30. V	3 for 1.	6 for 1.01

1¢ SALE

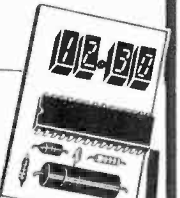
BUY ONE AT SALE PRICE, GET 2ND FOR ONLY 1¢ MORE.

4 DIGIT FLUORESCENT - LED CLOCK BASICS

Easy to build. Both units are 12 or 24 hours. Easy to bread-board, uses MM5316 clock chip and a minimum of external components. AM/PM indicator, includes options for alarm, clock radio, snooze, and more. Basic kits include IC's, sockets, transistors, readouts and all other necessary components (case, PC board, transformer, and line cord not included). Fluorescent basic includes .57" BRIGHT BLUE "NIXIE" TUBES. LED basic includes .35" RED LED READOUTS.

Wt. 1 lb.

Your Choice $9.95
2 for $9.96



☐ Cat. No. #7E3791 Fluorescent Basic Clock Kit	$9.95	2 for $9.96
☐ Cat. No. #7E4093 LED Basic Clock Kit	9.95	2 for 9.96
☐ Cat. No. #7E3812 12V 300 ma Transformer	1.49	2 for 1.50
☐ Cat. No. #7E3792 Components for Optional Alarm	2.95	(no 1¢ sale)

Parts & Semi One Centers

Quan.	Description (Order by Cat. No. in parenthesis)	Sale	1¢SALE
☐ 5	PANCAKE PHOTOCELLS, 600 to 15K ohms (7E2939)	1.00	10 for 1.01
☐ 1	100KHZ MARKER CRYSTALS, approx for marker gen. (7E3896)	1.95	2 for 1.96
☐ 1	MOTHERBOARD EDGE CONNECTOR, 106 pins, .125" (7E3987)	3.50	2 for 3.51
☐ 1	48-PIN EDGE CONNECTOR, .156" spacing (7E3963)	1.95	2 for 1.96
☐ 2	LCD THERMAL INDICATORS, 88-108°F, 7x1", flexible (#7E5195)	1.00	4 for 1.01
☐ 1	JOYSTICK, four 100K pots, with knob (#7E3808A)	4.95	2 for 4.96
☐ 1	EECO THUMBWHEEL SWITCH, BCD, 0-7 (#7E2870A)	1.49	2 for 1.50
☐ 1	8-TRACK TAPE TRANSPORT, with preamp (#7E3010)	9.95	2 for 9.96
☐ 1	PLESSEY TV SIDEBAND FILTER, for chan. 3 or 4 (#7E3975)	1.95	2 for 1.96
☐ 30-ft.	WIRE WRAP WIRE, 30 gage, for ICs, terminals (#7E3803)	1.00	60-ft for 1.01
☐ 1	METER, 50uA, 1½" square, 0-20db (#7E3705)	1.19	2 for 1.20
☐ 1	SPST RELAY, norm. open 12-24 VDC, 1250 ohms, dip style (#7E5175)	1.00	2 for 1.01
☐ 1	VEEDER ROOT COUNTER, 000-999, resettable, panel mt. (#7E5081)	1.49	2 for 1.50
☐ 2	DUAL GATE MOSFET, sim. to 3N200, 3N187, for RF & Mixer (#7E5101)	1.00	4 for 1.01
☐ 1	8-TRACK TAPE HEAD, with plug' n' cord (#7E3468)	2.50	2 for 2.51
☐ 10	CALCULATOR KEYBOARDS, 20 keys and more (7E3524)	$2.00	20 for $2.01
☐ 10	CRYSTALS, may include CB, Ham & more (7E3250)	2.00	20 for 2.01
☐ 150	MOLEX IC SOCKETS, on a strip, cut to length (7E3144)	2.00	300 for 2.01
☐ 100	TERMINAL STRIPS, from 2 lugs up (7E3136)	2.00	200 for 2.01
☐ 30	NE-2NEON LAMPS, all 100% good (7E2613)	2.00	60 for 2.01
☐ 40-ft.	SHIELDED CABLE, 1 cond, mikes, phonos, (#7E3577)	2.00	80 ft. for 2.01
☐ 50	TRANSISTOR ELECTROS, asstd values, styles (7E2747)	2.00	100 for 2.01
☐ 3	SOUND TRIGGERS, sound triggers scr w/amp (7E3625)	2.00	6 for 2.01
☐ 10	CB CRYSTALS, for phase lock loop, HAM, HC/18 (#7E5050)	2.00	20 for 2.01
☐ 100	DISC CAPACITORS, long leads, marked, asst'd (#7E2598)	2.00	200 for 2.01
☐ 100	CAPACITOR SPECIAL, discs, mylar, lytics, more (7E2738)	2.00	200 for 2.01
☐ 10	VOLTAGE REGULATORS, hobby LM320, 340, TO-3 (7E3330)	2.00	20 for 2.01
☐ 30	PANEL SWITCHES, slides, rotaries, mod, etc (7E3268)	2.00	60 for 2.01
☐ 200	RESISTOR SPECIAL, ¼ to 1W, carbon, metal (7E3054)	2.00	400 for 2.01
☐ 200	HALF WATTERS, resistors, carbon, metal (7E3046)	2.00	400 for 2.01
☐ 100	NATIONAL IC BONANZA, linears, 7400s ROMS (7E2860)	2.00	200 for 2.01
☐ 15	LM340T VOLTAGE REGULATORS, 5 to 24V, TO-220 (7E2635)	2.00	30 for 2.01
☐ 100	TWO WATTERS, resistors, carbon-metal marked (7E2735)	2.00	200 for 2.01
☐ 100	POLYSTYRENE CAPS, asstd values, voltage, hi-Q (7E2729)	2.00	200 for 2.01
☐ 50	THERMISTORS, resistors that change with temp (7E4089)	2.00	100 for 2.01
☐ 20	BRIDGES, untested, 2, 4, 6, 10, amp full wave (7E4022)	2.00	40 for 2.01
☐ 25	LAMP'N'SOCKET SETS, micro, 1.5V, T2 (7E3957)	2.00	50 for 2.01
☐ 15	MIXED READOUTS, hobby, untested, .127, .3, .5, etc. (7E3619)	2.00	30 for 2.01
☐ 150	QUARTER WATTERS, resistors, metal film, marked (7E3413)	2.00	300 for 2.01
☐ 100	PLASTIC TRANSISTORS, untested, TO-92 (7E2604)	2.00	200 for 2.01
☐ 200	PREFORMED RESISTORS, ¼, ½, 1W, marked, asstd (7E2608)	2.00	400 for 2.01
☐ 200	PRECISION RESISTORS, ¼, ½, 1W, 1%, 2% marked (7E2428)	2.00	400 for 2.01
☐ 60	DIPPED MYLARS, shiny finish, asst values (7E2597)	2.00	120 for 2.01
☐ 30	VOLUME CONTROLS, audio, linear, asstd values (7E2421)	2.00	60 for 2.01
☐ 150	PREFORMED DISC CAPACITORS, marked values, asst'd (#7E2605)	2.00	300 for 2.01
☐ 150	TRIMMER CAPACITORS, mica compression, piston, asst'd. (#7E3714)	2.00	120 for 2.01
☐ 60	YELLOW JACKET MYLAR CAPACITORS, marked, pop values (#7E3476)	2.00	150 for 2.01
☐ 150	GLASS ZENERS, 400 MW, untested, better than 50% yield (#7E2740)	2.00	300 for 2.01
☐ 75	CARBOFILM RESISTORS, ¼, ½ watt, 5 & 10%, marked, asst's (#7E3534)	2.00	150 for 2.01
☐ 250	UNMARKED CAPACITORS, polystyrene, molded, pop values (#7E3805)	2.00	500 for 2.01
☐ 300	SILICON SIGNAL DIODES, micro, glass, zeners too! 50% yield (#7E2628)	2.00	600 for 2.01
☐ 8	IC SOCKETS, 14, 18 pin, solder tail. (#7E3621)	2.00	16 for 2.01
☐ 100	1N4148/914 SWITCHING DIODES, 50% + yield. Untested! (#7E2418)	2.00	200 for 2.01
☐ 30	PC TRIM POTENTIOMETERS, thumbwheel, screwdriver ass't. (#7E3345)	2.00	60 for 2.01
☐ 15	SLIDE VOLUME CONTROLS, asst'd values, duals, singles (#7E3057)	2.00	30 for 2.01
☐ 71	4" CABLE TIES, plastic, like "Ty-wrap" (#7E5218)	2.00	150 for 2.01
☐ 1	JOYSTICK, two 10K pots, for computers, TV games (7E5037)	2.95	2 for 2.96
☐ 1	CHARACTER GENERATOR, 5 × 7 Mostek MK 2002P (7E3898)	4.95	2 for 4.96
☐	NOISE CANCELLING MIKE, Ham-CB, 500 ohms (#7E3902)	6.95	2 for 6.96

7-SEGMENT READOUTS

		ONE CENT SALE
☐ 3½ DIGIT LCD WRISTWATCH DISPLAY, (#7E3960)	3 for $1.19	6 for $1.20
☐ 2 — SPERRY FLAT NIXIES, orange, .3" dual digit (#7E5014)	2 for 1.19	4 for 1.20
☐ SPERRY FLAT NIXIES, orange, .3", 1½-dig (#7E5015)	2 for 1.19	4 for 1.20
☐ MAN-3 BUBBLE READOUT, .19" red, com cath. (#7E3338)	6 for 1.00	12 for 1.01
☐ 2 — MAN-4 READOUTS, bubble, red, com. anode, .19" (#7E1503)	2 for 1.00	4 for 1.01
☐ FND-10 BLOCK READOUT, .122" com cathode (#7E2082)	2 for 1.19	4 for 1.20
☐ 8-DIGIT READOUT, led, com cathod, red (#7E5190)	1 for 1.95	2 for 1.96
☐ FND-503, .5" red, com cathode, 7-seg. (#7E2949)	1.50	2 for 1.51

RELAYS!

	Each	2 for
☐ SPDT 12V BLOCK RELAY, 5A contacts (#7E4032)	$1.98	$1.99
☐ SPDT 12V REED RELAY, 1A contacts (#7E4094)	1.49	1.50
☐ SPDT 12V SENSITIVE, 2000 ohm coil (#7E3044A)	1.95	1.96
☐ 1 — SPST 24V REED RELAY, norm open, dip style, 1250 ohms (#7E5175)	1.49	1.50

AMPLIFIERS!

	Each	2 for
☐ 9 WATTS ON A CHIP, Toshiba TA7205 (#7E5057)	4.95	4.96
☐ 3 WATTS ON A CHIP, G-E PA 263 (#7E1522)	1.50	1.51

TRANSFORMERS!

	Each	2 for
☐ 12V TRANSFORMER, 300ma, pc leads, 110pri. (#7E3412)	$1.49	$1.50
☐ 2.9V NI-CAD CHARGER PAK, plug-in, 125ma, 125 VAC pri (#7E4098)	1.49	1.50

DIP SWITCHES!

	Each	2 for
☐ 2 SWITCHES ON A DIP (#7E3668)	$ .77	$ .78
☐ 3 SWITCHES ON A DIP (#7E3669)	.88	.89
☐ 6 SWITCHES ON A DIP (#7E3671)	1.29	1.30

IC SOCKETS!

☐ 8-PIN MINI-DIP (#7E2123)	4 for $1.19	8 for $1.20
☐ 14-PIN DIP (#7E1308)	3 for 1.19	6 for 1.20
☐ 16-PIN DIP (#7E1309)	3 for 1.19	6 for 1.20
☐ 18-PIN DIP (#7E3378)	6 for 1.19	12 for 1.20
☐ 24-PIN MSI/DIP (#7E3886)	2 for 1.19	4 for 1.20
☐ 28-PIN MSI/DIP (#7E3887)	2 for 1.19	4 for 1.20

FULL WAVE 10 AMP BRIDGE RECTIFIERS!

Order by Cat. No. 7E2447 & 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

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Magnavox model IKO-884-RUN-2 reel-to-reel tape deck. Schematic, servicing information. H.C. Hackman, 50 Township Rd., Baltimore, MD 21222.

Super Electric Products Corp. antenna tuning unit #BC-306-A S/N 58. Any available information. Allen Rodgers, 3012 Bert, Apt. 402, Ft. Worth, TX 76117.

RCA senior voltohmyst, model WV-98C. Schematic diagram and information on replacement meter or movement. Scott McCall, 1407 Donas Dr., Jacksonville, FL 32211.

Radio Manufacturing Engineers RME-84 shortwave receiver. Schematic and owner's manual. Erich Noll, 7507, East 52nd St., Kansas City, MO 64129.

Hewlett-Packard oscilloscope model 130A. Schematic. John Johansen, 37 Longmeadow Dr., Concord, NH 03301.

Triumph Mfg. Company oscillograph model 841. Any available information. Tom Bohon, 2215-A Walker Dr., Omaha, NE 68123.

Clough Brengle model CRA. Instruction manual, schematic or any available information. John Ridley, RR#2 249, South Haven, MI 49090.

Hallicrafters S20 R receiver. Schematic, dial cord information. Harry A. Barclay, Box 222, Darrow, LA 70725.

Crown A-314 tape deck. Parts and parts list. **B. M. Harrison Electrosonics** multimeter #AN/USM-34B. Schematic and parts list. Bruce M. Michaud, Box 1055, 331 Main St., Lake Placid, NY 12946.

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Jackson 5 CRO-2 oscilloscope. Schematic and operation manual. John C. Standish, 560 West Tarpon Blvd, Port Charlotte, FL 33952.

Hallicrafters model 8R40 shortwave receiver. Schematic and owner's manual. Wes Kinkaid, 1023 8th Ave., North, Great Falls, MT 59401.

Precision model E-450 color generator. Schematic and service manual. McKay Bradley, 2324 N. Powhatan St., Arlington, VA 22205.

Panasonic model RE-767 AM/FM stereo. Source for 16-ohm speakers. John Rasmussen, 1019 Amsterdam Dr., Ballwin, MO 63011.

Audio Research Corp. D-150 foil patterns, component layout and pc board layout. **Audio Research Corp.** SP3A-1 foil patterns. Joseph Tumbarello, 369 72nd St., Brooklyn, NY 11209.

Specialties Inc. radio control rig. Model Bonner Digimite 6RS. Schematic. J.L. Williamson, 408 W. Magnolia St., Siloam Springs, AK 72761.

RCA automatic tube tester model WR 110 A. Need master punch card stock #215426. Unpunched cards (WG-325A). Roscoe Edgett, 14 Walnut Dr., Whitesboro, NY 13492.

E.H. Scott SLR-12B. Service manual. William DeFelice, 143 Wheeler Rd., Monroe, CT 06468.

McMurdo Silver model #900. Schematic and operating manual. P.L. Miller, 2811 West Drexel Rd., Tucson, AZ 85706.

Panoramic oscilloscope model PCA-2, type T-200. Schematic and operating manual. Mr. Allan Vontorcik, 17301 Maple Boro Rd., Maple Heights, OH 44137.

Precision Apparatus Co., Inc., series ES-500A oscillograph. Schematic, especially power transformer section. Larry Greenstein, 1331 SW 93 Court, Miami, FL.

RCA model BT-42 superheterodyne radio. Schematic, parts list, and/or voltage requirement. John E. Jones, 1030 Wood Eden Dr., Kingsport, TN 37660.

Harvey Wells TBS-50D transmitter. Manual and/or schematic. Doug Jorgensen, 204½ N. 9th St., Oskaloosa, IA 52577.

Hycon color bar dot generator model 616. Operation manual and schematic. Robert Vigil, 2760 Corabel LN #57, Sacramento, CA 95821.

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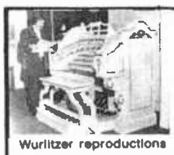

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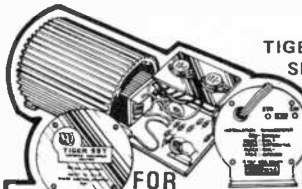

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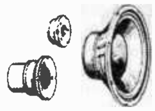

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ELECTRONICS WORLD® News Highlights in Brief

Double-Duty Digital

With cars getting smaller, finding space on the time-honored dashboard gets harder every year. Ford's solution for its 1978 Pinto and Bobcat cars is a digital clock that doubles as the AM radio's tuning display. The clock's display turns off when the ignition is off, preventing battery drain; to check the time when the engine's not running, you simply press a button. As with all digital displays, this one will make it easier to see at a glance exactly what the time is or exactly to what frequency the radio is tuned. One other advantage Ford doesn't mention: digital clocks, in our experience, seem to stand up better to the jolting and temperature extremes that have given older mechanical and electrical clocks the reputation of keeping time only until the payments stop.

REACT Keeps Reacting

REACT International, Inc., an organization of volunteer emergency CB radio owners was 15 years old last year. Though the oldest (and largest) group of its kind, it happily responds to ideas originating in the field. For example, one innovation planned for this year is a full computerization of individual team and membership records, which will simplify direct mailings to individual members. (numbering about 100,000) rather than bulk mailing to REACT team leaders. That should get information into team members' hands sooner, and save the local teams a fair amount in remailing and clerical expenses. There will also be a bi-monthly publication on team management for team leaders. For youth members, there will be a junior REACT program, too. Obviously, REACT listens to its members—not just to channel 9. To join a REACT team, contact them at 111 E. Wacker Drive, Chicago, IL 60601. Dues are $5.

Databanks on Home TV

"Pages" of special "magazines" as well as computer-stored information will be popping up on some British TV screens shortly. The "magazine" pages come from a service called "Teletext," developed jointly by the British Post Office (which is in charge of telecommunications in the U.K.), the British TV-set industry, and the semiconductor and information industries. Teletext sends its information in the intervals between frames of the broadcast TV signal. Teletext-compatible TV receivers should be available in Britain about now. By the middle of this year, a limited number of sets should appear with facilities for reception of still another TV-based information system. The new system, Viewdata, will provide viewers with thousands of pages of information, transmitted over regular telephone lines. Dial Viewdata, and the TV screen fills with a "menu" page explaining the general subject areas available. Using the phone dial as a "computer terminal," the viewer works his way quickly through more and more detailed "menus" until he finds the exact topic he wants. More than 6000 "pages" (each about equal to a double-spaced, typewritten page) of information are now available, with up to 60,000 planned for the systems' mid-year trial introduction.

"Smart" Pinball Machines

Now they're even building computers into pinball machines. The immediate advantage of replacing time-honored relay logic by microprocessors is the new features this allows: commercial pinball machines can now include such things as a memory to allow a player to compete against the high score of the week, the month or the year. (An alphanumeric display lets the year's high scorer see his name in lights—until some new player broke his record.) Bally's "Fireball" home machine (available from both Sears and JS&A Sales, and in kit form from Heath) stores up to four players' scores, can be programmed for different degrees of player skill, and has a built-in synthesizer that plays seven different tunes when extra scores or bonuses are won. The main advantage may eventually prove to be lower cost. That could lead to more home pinball machines.

Recording Studio Equipment Study

In a recent survey, US recording studios were polled to see what audio equipment was most popularly used. Interestingly, the 569 questionnaires returned to *Billboard* magazine, conductor of the survey, revealed that quite a few familiar, home-equipment brand names were in use in recording studio applications. The most favored monitor amplifiers were Crown and McIntosh, for example, and the tape-recorder (with fewer than 16 tracks) popularity list was headed by Ampex, Scully, Teac, and Sony. Nearly all brand names in the portable mixer category are well-known, too. Similarly, microphones in use, except for front-runner Neumann, could be found in any tape enthusiast's home: Electro-Voice, Shure, AKG, Sony, and Sennheiser. Preferred headphones included such familiar names as Koss, Sennheiser, and AKG. Shure, Stanton, and Pickering are the most widely used phono cartridges, and the overwhelming choices in audio tape are Ampex and Scotch. The speaker-system field was dominated by JBL and Altec, with Electro-Voice also being popular.

Hand-Held, No-Battery Calculator

Tired of replacing calculator batteries? Then Photon, a new $39.95 hand-held calculator developed by TEAL Industries, Inc., may be for you. Photon is powered by a 5.6 mm by 1.6 mm bank of solar cells which operate in all wavelengths of visible light, indoors or out. Among the more mundane features of Photon are an eight-digit liquid crystal display, computation in both mixed and chain modes, four-key memory, and live percent, square-root, and sign-change keys. But don't look for an on/off switch—there isn't one!

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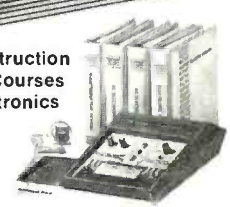

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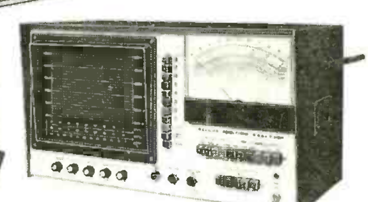

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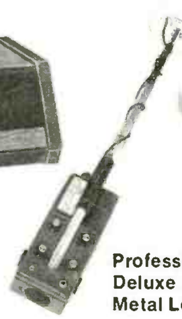

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