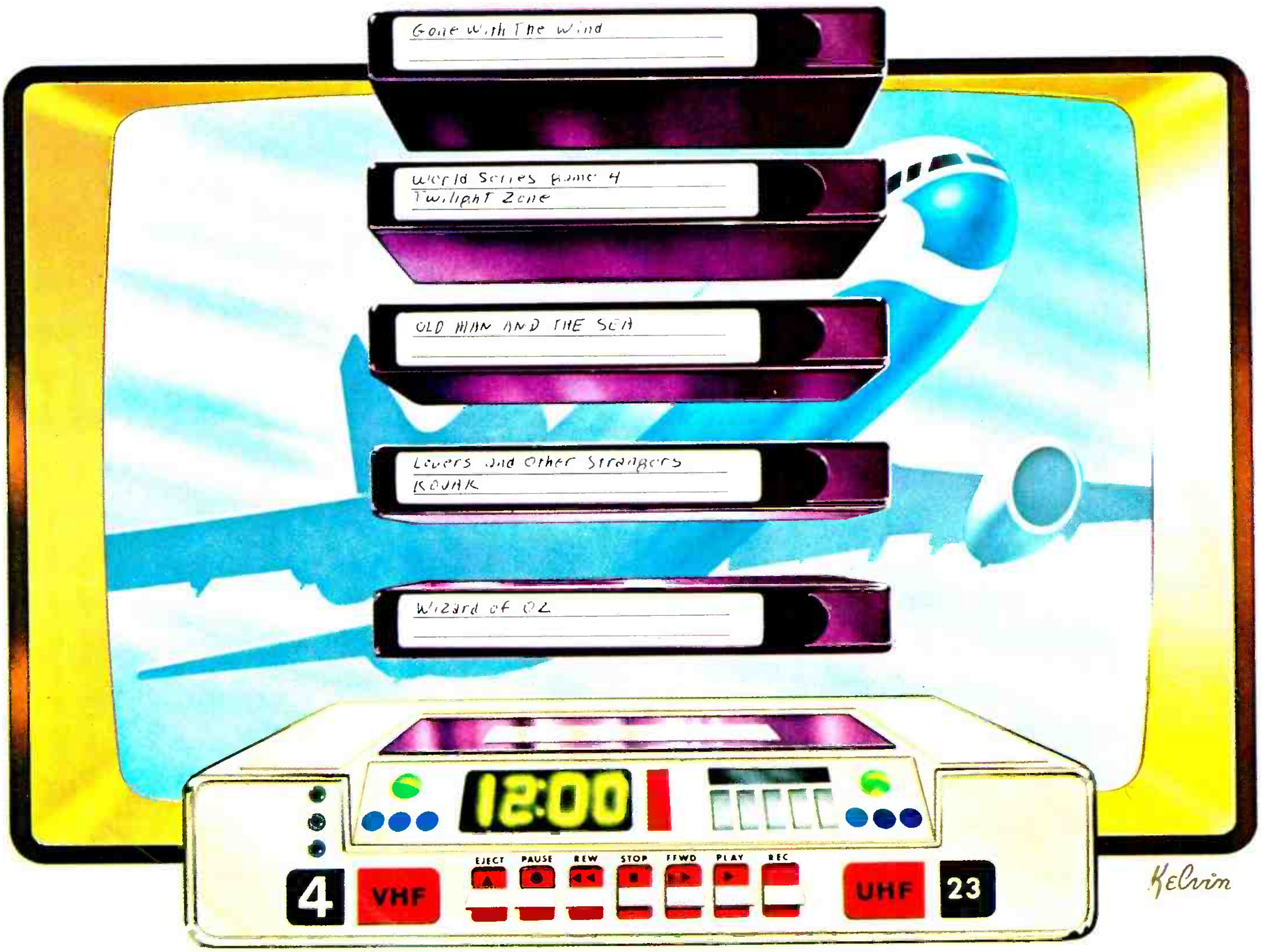
Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

AUGUST 1978/$1

Audio Alarm Backs Up Car Warning Lights
Build a Digital Darkroom Timer
Personal Computers for Small Businesses

Video Cassette Recorders
A RISING HOME-ENTERTAINMENT STAR



Tested In This Issue

- Kenwood 3-Head Cassette Deck
- Realistic Bookshelf Speakers
- Pioneer Car Stereo FM/AM Receiver
- Motorola Mobile AM/SSB CB Transceiver

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Popular Electronics

FOR THOSE OF YOU WHO ARE HAVING SECOND THOUGHTS ABOUT YOUR FIRST CB.

Move up to the all-new Cobra 29GTL. It's the third generation of the trucker-proven Cobra 29. And like the 29 and the 29XLR before it, it advances the state of the art.

Transmitter circuitry has been refined and updated to improve performance.

Receiver circuits have been redesigned to include dual FET mixers, a monolithic crystal filter and a ceramic filter to reduce interference and improve reception.

By improving the transmitter circuitry the 29GTL keeps you punching through loud and clear. By incorporating new features for better reception everything you copy comes back loud and clear.

So if you're having second thoughts about your first CB, make your next CB the Cobra 29GTL.

We back it with a guaranteed warranty and a nationwide network of Authorized Service Centers where factory-trained technicians are available to help you with installation, service and advice.

But more important than that, we sell it at a price you won't have second thoughts about.

Cobra®

Punches through loud and clear.

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DYNASCAN CORPORATION
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CIRCLE NO. 6 ON FREE INFORMATION CARD

NEW ASTRO-FANTOM™

CB ANTENNA

GOES WHERE NO CB ANTENNA HAS GONE BEFORE!

SUPERIOR PERFORMANCE FOR AUTO, TRUCK, MARINE, RV, MOTORCYCLES AND HOME USE

avanti® antennas

AVANTI RESEARCH AND DEVELOPMENT, INC.
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It Mounts On Glass Transmits and Receives THRU Glass

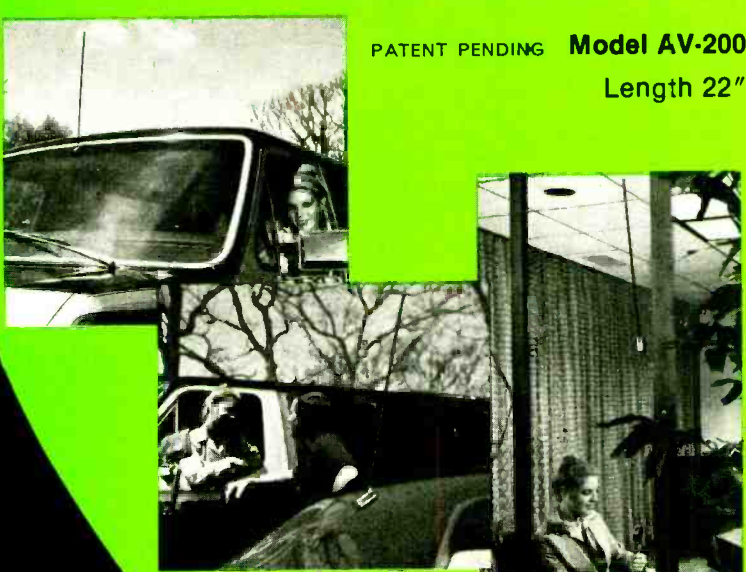
Now from the AVANTI Research Laboratories comes a sleek, 22" full 1/2 wave antenna, so unique that it mounts on glass, transmits through glass and receives through glass...yet requires no grounding to metal as do conventional 1/4 wave antennas. No holes to drill...no clamps, clips or magnets to ever mar or scratch your car's finish! No pinched cables to run in through doors, windows or trunk. The Astro-Fantom is a handsome, low profile antenna that provides the ultimate in convenience!

EASY INSTALLATION. The Astro-Fantom is so uncomplicated that installation takes only five minutes and requires no tools. It bonds securely to the glass with an all weather tested 3M press-on adhesive, yet can be quickly transferred when desired. The fiberglass whip removes instantly for storage, car wash or theft protection.

ONE MOUNT SATISFIES EVERY NEED. Astro-Fantom's unique mount attaches anywhere there's a metal framed window. Front, side, or rear of vehicle, boat and motorcycle windshields, even home installation.

CLEAREST COMMUNICATIONS. Avanti's exclusive space age co-inductive™ coupling box actually rejects static and interference as it establishes a highly tuned circuit to transmit and receive radio signals through the glass.

FULL 360° SIGNAL. Astro-Fantom's full 1/2 wave design eliminates dead spots and directional problems found in conventional CB antennas.



PATENT PENDING **Model AV-200**
Length 22"

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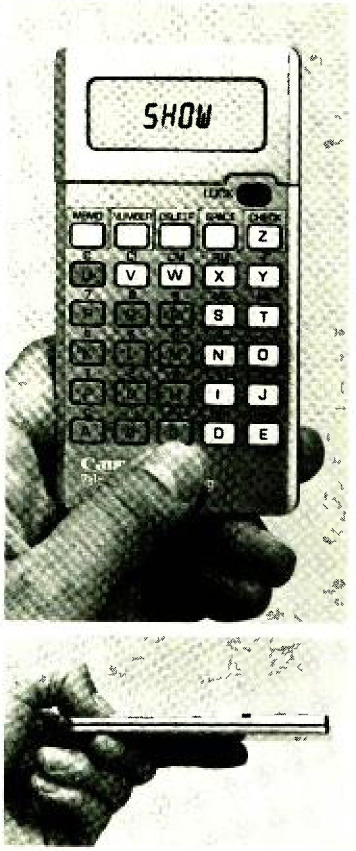

Pocket Yellow Pages

Let your fingers do the data entry with America's first computerized pocket telephone directory.

You're stuck. You're at a phone booth trying to find a phone number, and people are waiting. You feel the pressure.

To the startled eyes of those around you, you pull out your calculator, press a few buttons, and presto – the phone number appears on the display of your calculator. A dream? Absolutely not.

Space-age technology has produced the Canon Directory – a calculator that stores 20 of your most frequently called numbers in its memory and let's you recall them simply by entering the person's name or initials.

The keyboard has letters as well as numbers (like the touch-tone pad on a telephone), so it's easy to enter data and use. Want to call Jim? You enter J I M, and your display shows Jim's phone number. Even when you shut your unit off, it retains your complete directory in its large memory.

Ever forget to shut your calculator off when you slipped it in your pocket? No problem with the Canon Directory. The system was built like a liquid crystal digital watch. Its display can remain on constantly without draining the two long-lasting hearing aid batteries which you get with your unit. A low battery indicator also warns you well enough in advance when it's time to change batteries.

STORE IN CONFIDENCE

If you lost your little black book with all those confidential numbers, you might get in trouble. Not so with the Directory. Without knowing the specific initials or name, you can't access the numbers.

And then there's convenience. You carry your calculator with you anyway. Why not add the convenience of a telephone directory to a full-function calculator? When it comes to calculating, the Canon is no slouch either. There's a fully-addressable memory, square root, and an add-on discount percentage system.

EASY TO OPERATE

Just enter the name and number you want stored and press a few buttons. That's all there is to it. Changing an entry is just as easy. You can also store credit card numbers, important serial numbers, birthdays, and anniversaries. For example, enter the next birthday or important date you should remember under "DATE." This date will appear each time you enter the word "DATE." By getting in the habit of doing that each week, the Canon won't let you forget. Or have you ever been stuck at a phone booth with no pen to write your messages? With the Canon, you can enter them directly into your unit – name and number.

The Canon Directory is a new breakthrough in recent calculator technology. The large-scale integrated circuit is programmable by the user – something nearly impossible just a few short months ago.

TEST IT FOR A MONTH

Order the Directory. Quickly program it with your most frequently called numbers. (You'll be amazed at how many 20 numbers seem when you sort out your personal directory.) Then use it every day. Program those important dates, your social security number, the phone numbers of your favorite restaurants, airlines, or movie theaters. Test the batteries by leaving your unit on for a week.

See how easy it makes life. Then within 30 days, decide if you want to keep it. If not, no problem. Just slip it in its handy mailer and send it back. We won't be upset, and in fact, we'll thank you for at least giving our unique product a test.

JS&A is America's largest single souce of space-age products – a substantial company which has been in business for over a decade. Canon is the famous company that manufactures quality cameras, calculators, and other precision quality instruments.

If service is ever required, just slip your three-ounce unit in an envelope and mail it to Canon's national service-by-mail center. It's just that easy. Service should never be required since practically all components are on a single integrated circuit, but we wanted to assure you that a service program is an established part of Canon's program. The unit is 2¾"x 5½" and only one centimeter thick.

To order your own Canon Directory, send **$79.95** plus $2.50 for postage and handling to the address below (Illinois residents, please add 5% sales tax), or call our toll-free number below. By return mail you will receive your unit, a handy wallet-style carrying case, and a one-year limited warranty.

This year, let the sophistication of space-age technology and your fingers do all the walking. Order your Pocket Yellow Pages at no obligation, today.

JS&A NATIONAL SALES GROUP

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Northbrook, Ill. 60062 (312) 564-7000

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AUGUST 1978

Popular Electronics®

VOLUME 14, NUMBER 2

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

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- BUILD A DISCO MIXER
- NOW YOU CAN ENJOY HI-FI TV SOUND
- BUILD A LOW-COST A/D CONVERTER
- HOW TO DESIGN PC BOARDS FROM A SCHEMATIC

TEST REPORTS:
Sony Class-D Amplifier
Panasonic RF-2800 5-Band Portable Receiver

Cover Art by George Kelvin

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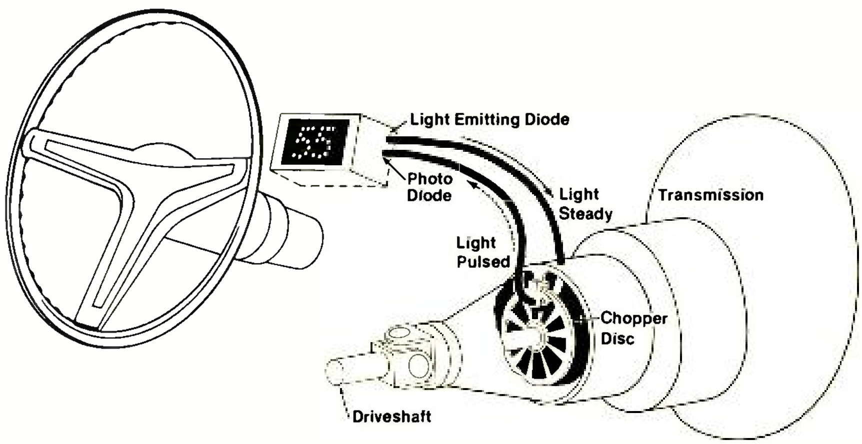
Editorial

THE LIGHT TRAVELLER

A few years ago, futurists were speculating that around the year 1990 we would enjoy a fantastic new communications technique using light travelling through glass fibers. This would provide enormous load capacity, immunity to noise and moisture, and very low cost.

On the way to the 1990's, fiber optics or "light communications" arrived—two decades early! The cost factor is still too high for many applications at this time (owing to high connector cost, I understand), but industry pundits are confident that it will be significantly cheaper than other communication links in the future. They say optical transmission of data and voice will likely bury copper cables one day.

A number of experimental lightwave systems are, in fact, up and running right now. Ma Bell has such a link in Atlanta, GA, for example, with the equivalent of 672 digitized voice channels on a single glass fiber. In another area, it's said that a typical fighter plane's 450 pounds of copper wire could be replaced by only 50 pounds of fiber cable. Fiber optics are being used in automobiles, too. DuPont, for example, has developed a photo-cybernetic system to monitor vehicle speed, eliminating less reliable mechanical linkages. Readout is by digital LED's. And just imagine what the potential clock rate of a computer would be with no impedance in interconnecting circuitry! Clearly, it's a technology whose time has come.



Japan seems to be moving appreciably faster than we are toward implementing an optical fiber information transmission system. Test operations for an interactive CATV network in Japanese households began in 1976. The goal is to provide them with two-way services that include cashless shopping, request entertainment, police and fire protection, and remote telemetering. Field trials with 300 subscribers are supposed to be in operation now.

Light communications are not as esoteric as you might suspect from the above. Edmund Scientific Co., Barrington, NJ, for instance, sells fiber-optic kits and assembled units right now. Check Lou Garner's "Solid State" column this issue, too, to see what's happening out there in the light-communication field. It's the beginning of a new, exciting electronics field that will have an enormous impact on our lives in the not-too-distant future.

Part of the electronics action is always in the future. That's why it is so invigorating! And PE will continue to prepare you for what's coming up next.

Art Salsberg

Totally Integrated, Entirely Self-Contained

THE PET™

PERSONAL COMPUTER

With technology so advanced,
Concept so remarkable,
Operation so utterly simple,
Cost so incredibly low.
The PET has given rise to a brand new era...
The Age of the Personal Computer

HIGH SPEED PRINTER ACCESSORY

Immediate Delivery

FEATURING AN IEEE-488 BUS

THE PET has become the standard for the personal computer industry. Consumer and business publications have lauded its discovery. POPULAR SCIENCE and PLAYBOY have given special tribute to the "mind-boggling" PET.

IN A LEAGUE WITH IBM, HP AND WANG MINICOMPUTERS

THE PET is a minicomputer and should not be confused with game products that hook up to household T.V.'s. **What sets it apart from other computers is price. While others cost from $11,000 to $20,000 and more, THE PET, with similar power, costs only $795.00.**

Features an IEEE-488 Bus -- like HP's mini and full size computers. This standard data and control channel permits direct connection to many peripherals. Over 120 pieces of compatible equipment such as counters, timers, spectrum analyzers, digital voltmeters and printer plotters, from HP, Phillips, Fluke, and Textronix, etc., are currently available.

ROM Magazine, January 1978, writes, "THE PET comes out of the box, plugs into the wall, and is ready to use." It is equipped with a CRT video display with reverse and blink features, an alpha-numeric keyboard with complete graphics and a built-in standard cassette tape deck.

THE PET has 8K bytes of RAM [user memory]. Optional equipment permits expansion to 32K. And, it has 14K bytes of ROM [program memory].

THE PET COMMUNICATES IN BASIC. THE EASIEST COMPUTER LANGUAGE

If THE PET wants you to press a key, it will flash, "Press such and such", on the display. You speak back to it through its full size 73-key keyboard.

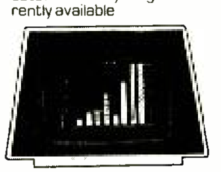
EXTENSIVE CHARACTER ORIENTED GRAPHICS

The unit features a 9-inch, high resolution, 1000 character CRT. Characters are arranged 40 columns by 25 lines on an 8 x 8 matrix for superb graphics.

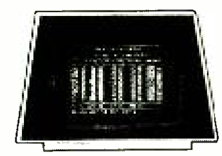
WHAT IS THE PET REALLY FOR?

It is the single most important teaching device for any computer related subject. It will entertain the most sophisticated data application, or the simplest inquiry/response assignment. **IN THE LAB** it handles instrumentation, process monitoring, and more. A number of Fortune 500 companies have already made it an integral part of their lab and general office system.

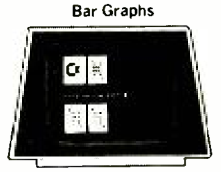
As a **BUSINESS TOOL** it will. Maintain ledgers. Keep payroll records. Create P & L's. Control inventory. Store and analyze sales data. Draw bar graphs. Issue invoices. Hook up to on-line computer system. **AT-HOME** it will. Compute state and federal tax returns. Make heat and insulation analyses. Keep Christmas lists. Keep checkbook and finances up to date. A variety of games, from Blackjack to Galaxy, is currently available.



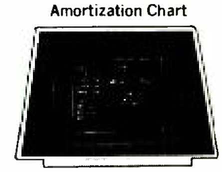
Bar Graphs



Amortization Chart



Black Jack



Teaching Trigonometry

HIGH SPEED PET PRINTER

This powerful word processor prints hardcopies, invoices, computer correspondence. Faster than an IBM Selectric. THE PET Printer delivers 60 characters per second at a sustained rate -- with upper and lower case capability. Characters are one-eighth inch tall and are printed in a 7 x 8 dot matrix. The printer uses a standard 8½" wide paper roll. And, it is only $599.95.

PERIPHERAL SECOND CASSETTE

This optional component expands storage and increases flexibility. Only $99.95.

MILES OF SOFTWARE

Many programs are available now, including, "BASIC BASIC" which shows how to write a program. You can develop your own programs to meet personal requirements.

GAME PROGRAMS ARE $9.95 EACH:

☐ Black Jack ☐ Draw Poker ☐ Galaxy Games
☐ Space Flight ☐ Target Bong, Off-The-Wall
☐ Lunar Lander, Wumpus, Rotate, Tic-Tac-Toe
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PROGRAMS AT $14.95 EACH:

☐ **Mortgage Analysis**
Diet Planner and Biorhythm
☐ **Basic Basic**-by Lodewyck and James

PROGRAMS AT $24.95 EACH:

☐ **Basic Investment Analysis**-loans, annuities, return on regular and irregular sequences of payments, calendar calculations
☐ **Stock Portfolio Recordkeeping and Analysis**-keeps track of buys, sells, and dividends. Calculates current value, rates of return
☐ **Checkbook Recordkeeping and Analysis**-keeps track of checks and deposits. Analyzes expenses by date and type

PROGRAMS AT $29.95 EACH:

☐ **Basic Math Package**-matrix addition, multiplication, determinants and inverses to 16 x 16, solution of simultaneous linear equations, vector and plane geometry calculations, integration by trapezoidal, Simpson's rule or Gaussian quadrature, differentiation
☐ **Basic Statistics Package**-mean, median, variance, standard deviation, skewness, kurtosis, frequency distribution, linear regression, T-tests, correlation analyses

FREE ORIENTATION PACKAGE

Your PET comes complete with two programs and an easy-to-follow instruction manual. By working through the routines you will quickly discover how easy it is to gain command of your personal computer.

SERVICE WORLDWIDE

Because your PET is self-contained and compact, professional factory service is never far away. If major service is required, the unit can simply be returned by UPS to an authorized Commodore PET clinic.

To order your PET send check or money order for $795.00 plus $20.00 for shipping and insurance. To order the PET Printer, add $599.95 plus $12.00 for shipping and insurance. The Second Cassette is $99.95. No shipping and insurance charges are required when ordering a second cassette or programs with your PET. Credit card orders are invited to call our toll free number below. Orders will be accepted on our TELEX, No. 25-5268.

Use THE PET for 30 days with no obligation. If, for any reason, you are not satisfied, return it for a prompt and courteous refund.

TECHNICAL SPECIFICATIONS

MEMORY
Random Access Memory (user memory): 8K internal, expandable to 32K bytes
Read Only Memory (operating system resident in the computer): 14K bytes
8K-BASIC interpreter program, 4K-Operating system,
1K-Diagnostic routine
1K-Machine language monitor

VIDEO DISPLAY UNIT
9" enclosed, black & white, high resolution CRT
1000 character display, arranged 40 columns by 25 lines
8 x 8 dot matrix for characters and continuous graphics
Automatic scrolling from bottom of screen
Winking cursor with full motion control
Reverse field on all characters
64 standard ASCII characters; 64 graphic characters

KEYBOARD
9½" wide x 3" deep; 73 keys
All 64 ASCII characters available without shift.
Calculator style numeric key pad
All 64 graphic and reverse field characters accessible from keyboard (with shift)
Screen Control: Clear and erase
Editing: Character insertion and deletion

CASSETTE STORAGE
Fast Commodore designed redundant-recording scheme, assuring reliable data recovery
Cassette drive modified by Commodore for much higher reliability of recording and record retention
High noise immunity, error detection, and correction
Uses standard audio cassette tapes
Tape files, named

OPERATING SYSTEM
Supports multiple languages (BASIC resident)
Machine language accessibility
File management in operating system
Cursor control, reverse field, and graphics under simple BASIC control
Cassette file management from BASIC
True random number generation or pseudo random sequence

INPUT/OUTPUT
All other I/O supported through IEEE-488 instrument interface for peripherals
I/O automatically managed by operating system software
Single character I/O with GET command
Easy screen line-edit capability
Flexible I/O structure for BASIC expansion with peripherals

BASIC INTERPRETER
8K BASIC; 20% faster than most other 8K BASICS
Upward expansion from BASIC language
Strings, integers, multiple dimension arrays
10 significant digits; floating point
Direct memory access: PEEK and POKE commands

DIMENSIONS
16" wide; 18½" deep; 14" high. Weight: 44 lbs.

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CIRCLE NO 8 ON FREE INFORMATION CARD

Letters

ABOUT THAT ADAPTIVE SWEEP.

You chaps are a bit backward in your article "The Spectrum Analyzer in Hi-Fi Measurements" (January 1978), in which you cover "an intriguing and unique feature of the Hewlett-Packard 3580A Spectrum Analyzer"—its "adaptive sweep." I took out a British Patent in 1952 that covers a similar feature inasmuch as the relatively rapid frequency timebase is slowed down when a signal above a certain minimum level is present as a Y display. There is the obvious choice of simply switching between two preset scan rates or making the scan rate somewhat inversely proportional to the Y level, or perhaps rate of change of the Y level. I have never found it necessary to "back up" in frequency, because if the scan rate in the passband is adequately slow, the peak response is accurate. Although there may be some distortion in the build-up to this value, this is not usually of interest. In our spectrum analyzers, which were research tools mainly for r-f, I also had a bandwidth for the crystal filters that could be varied in steps in a very simple manner using a single quartz crystal. *F.G. Clifford, Wynberg, S. Africa.*

GOOD ITEMS FOR LIMITED READING TIME

I have just read with interest "Choosing a Mobile CB Antenna," by John J. McVeigh, and "How to Install Mobile CB Transceivers and Mobile CB Antennas," by Ivan Berger, in your April 1978 issue. They are outstanding both in detailed content and comprehensive accuracy. With limited reading time available, I have to select those publications providing the most usable information. POPULAR ELECTRONICS is such a publication, for which I thank you. *—R. R. Knierim, Lima, OH.*

MULTIMETER REPLACEMENT IC'S

I'm delighted with my Sabtronics 2000 Digital Multimeter kit, which you reviewed in your December 1977 issue—as I'm sure are other readers. However, here is some useful information if they run into troubles resulting from such things as using the wrong scale and "zapping" the meter. The A/D converter IC (marked 20-786) is the Motorola 14433P; the IC segment driver (marked 20-788) is Motorola MC14511B; and the Digit Drive is a 75492. The op amp in the ac converter (Z3) can be switched to a 741 if necessary. If the kit doesn't auto-zero in the 10V ac mode, it is because of the multiplex decimal point noise from the selector switches. Sabtronics sells a small "add-on" Low Noise Decimal Point Drive kit for about $3.00, and it definitely works. *—R.B. Stillwater, Winnipeg, Manitoba, Canada.*

A SIMPLER VERSION

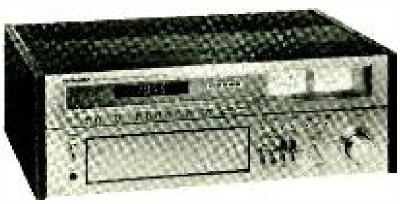
I've found a simpler version of the pseudo-random data generator described in the January 1978 Experimenter's Corner. It eliminates the need for a second decade counter and timer and performs similar operation. Referring to Fig. 4 in the December 1977 Experimenter's Corner, you will find that connecting the DATA IN pins of the 7489 to the output pins of the 7490 decade counter in the same sequence (A to A, B to B, etc.) and switching WRITE ENABLE switch on for 10 clock pulses will result in the memory slots of the RAM's being loaded with the binary address. This provides an automatic form of obtaining a 0-to-9 binary at the DATA LED's, which is basically what the pseudo-random data generator does. *—Allan P. Saadus, Sunnyvale, CA.*

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.

Toshiba Frequency Synthesized Receiver

Toshiba's SA-7150 AM/stereo FM receiver features a power-output rating of 150 W rms/channel into 8 ohms over 20-20,000 Hz with 0.05% maximum total harmonic distortion. Its tuner section incorporates

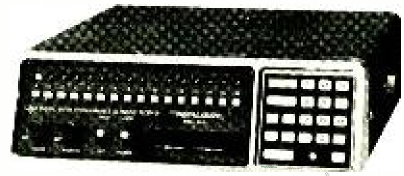


PLL frequency synthesis and also has six memory channels for instant selection of one of six AM or FM stations. The frequency tuned is displayed on green seven-segment LED's. The entire AM or FM broadcast bands can be scanned by using UP and DOWN buttons, with the process automatically reversing at the band ends. FM usable sensitivity is rated as 9.8 dBf. Other features are separate transformers for the class A and class B amplifier sections, five LED signal level indicators, built-in FM Dolby circuit, narrow and wide i-f band selection, peak-reading power meters, high and low filters, −10-dB and −20-dB audio muting, dual-direction tape duplication capability, multipath monitor, and phono impedance selector. $995.

CIRCLE NO 89 ON FREE INFORMATION CARD

Realistic Programmable Scanner

Radio Shack's new Realistic PRO-2001 programmable scanner offers coverage of 30-50, 144-174, and 430-512 MHz without the use of crystals. This microprocessor-controlled unit can scan 16 programmed channels or an entire band segment by entering its frequency limits. Frequency selection is accomplished with a front-panel keyboard, and each of the 16 channels has selectable lockout. A LED indicator lights



when a channel is being programmed, scanned, or monitored. Out-of-band or improper frequency selection is indicated by an error message. Other PRO-2001 features include switchable scan delay, a built-in 9-V battery that saves memory, and choice of manual or automatic scan with a high-speed scan rate of 15 channels/second. Variable squelch, built-in speaker, and jacks for headphones, tape recorders, external speakers, and uhf and vhf antennas round out the PRO-2001's provisions. Operation is from 120-V ac or 12-V dc. Dimensions are 3.4" x 10.2" x 10.9" (8.6 x 25.9 x 27.6 cm). Includes mobile mounting bracket and power cables. $399.95.

CIRCLE NO 91 ON FREE INFORMATION CARD

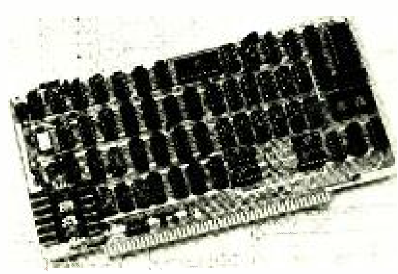
K40 Mobile CB Antenna

American Antenna's K40 is a base-loaded whip antenna with 56" radiating element of 17-7PH stainless steel. Its coil construction combines metal and plastic, and an isolation chamber is said to dampen static. The whip is adjustable over 2" with no cutting. A quarter-turn quick-release permits removing the antenna from its 30° rotating base. The K40 is supplied fully assembled with 18' of coaxial cable complete with connectors and trunk-lip mount. An optional universal mount permits mobile mounting in any location.

CIRCLE NO 92 ON FREE INFORMATION CARD

Vector Graphic Video Display Board

FLASHWRITER is Vector Graphic's latest computer peripheral. This video display board generates 16 lines of 64 characters using a 7 x 9 dot matrix and is designed to operate with a 4-MHz clock frequency. Other capabilities are character-by-character generation, reverse video, reduced intensity, and block and line graph-



ics. It has its own screen-refresh memory and latched eight-bit parallel port, is S-100 compatible, and video output is available as composite video or separate video and sync. $195 kit, $235 assembled.

CIRCLE NO 93 ON FREE INFORMATION CARD

Marantz Quartz-Lock Turntable

The new Marantz Model 6350Q direct-drive turntable uses a PLL servo system with quartz crystal timing reference for automatic speed control. Wow and flutter is rated below ±0.025% wrms, and speed deviation is said to be less than ±0.003%. In-

dependent speed control for 45 and 33⅓ rpm modes allows ±3% adjustment. The statically balanced tonearm features automatic lift and shut off, antiskating, and viscous damped cue control. The turntable comes with a hinged dust cover and antiskid platter mat.

CIRCLE NO 94 ON FREE INFORMATION CARD

Record Care Work Pad

Ball Corporation's Sound Guard Record Care Work Pad is a lint-free, non-slip, washable surface for use in LP record care. The pad is nonabsorptive and its high coefficient of friction prevents record slippage during inspection, cleaning, or coating of a record with a cleaner or preservative. A receptacle area holds excess fluids. $7.99.

CIRCLE NO 95 ON FREE INFORMATION CARD

Remote Coded Alarm Lock

A 12-key pad for remote "combination-lock" alarm operation has been announced by Mountain West Alarm Supply Co. The Model D14 features a field-replaceable, preprogrammed code key. The keypad operates on 6 to 24 volts ac or dc, and draws less than 2 mA standby current, including its red and green LED status lights. The beige, high-impact ABS case measures 4⅞ x 3½ x 1⅛ in. (12.1 x

8.9 x 2.86 cm), and is designed for surface mounting. $53.00. Address: Mountain West Alarm Supply Co., Box 10780, Phoenix, AZ 85064.

Digital S Meter

Digi-Comm's "Signal Hunter" is an S meter with three-digit numeric display of received signal strength to one-tenth of an S unit, with signals over S9 displayed directly in dB. The Signal Hunter also displays rel-

ative r-f power output when the attached transceiver is operated in the transmit mode and features a calibration control for matching it accurately to a CB transceiver. It requires a 12-V dc power source. Dimensions are 1.8"H x 4.3"W x 1.5"D (4.6 x 10.8 x 3.8 cm). A magnetic mount is included. Address: Digi-Comm, Ste. 110, 720 Ste-Catherine St. West, Montreal, Canada H3B 1B9.

Nortronics Cassette Bulk Eraser

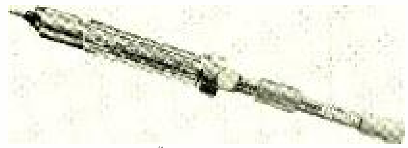
The QM-230 is a self-powered, hand-held bulk eraser for standard compact cassettes. Erasure is accomplished by ceram-

ic magnets within the bulk eraser, through whose field the cassette passes. Thus, no battery or ac power sources are required. The eraser is built into a contoured, Cycolac case with a wood-grain finish. $24.00.

CIRCLE NO 96 ON FREE INFORMATION CARD

Anti-Static Desoldering Tool

Edsyn's Silverstat "Soldapullt" desoldering tool incorporates a conductive plastic tip and barrel housing which, when used in a static-controlled work station, allow static charges to drain off to ground through the user's hand. This feature is said to protect

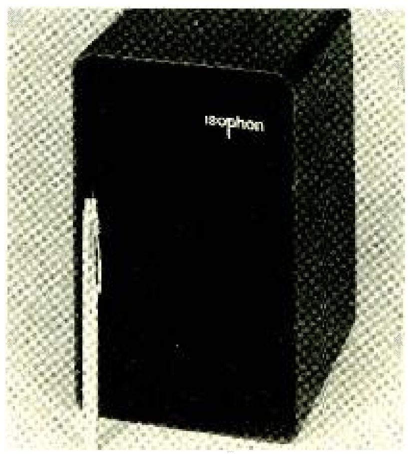


sensitive FET and MOSFET semiconductor devices from damage due to static electricity discharge. The device has a fully enclosed loading shaft, high-low vacuum adjustment, and bayonet-type disassembly.

CIRCLE NO 97 ON FREE INFORMATION CARD

Isophon Miniature Speaker System

Walter Odemer Co.'s Isophon DIA-2000 miniature speaker system measures 5" x 6" x 7.5" (12.7 x 15.2 x 19.1 cm). The two-way speaker has a nominal impedance of 4 ohms. Peak power rating is 70 W while



power handling capability is 50 W. Crossover frequency is 2000 Hz at 12 dB/octave. The DIA-2000 is finished in a black metallic case with a two-section, snap-in foam grille.

CIRCLE NO 98 ON FREE INFORMATION CARD

Superex Base Station Microphone

The new Superex M-611 omnidirectional base station microphone features an electret element, FET preamplifier, and transistor output amplifier stage. Output gain is controlled with a slide potentiometer, and the extra large PTT paddle is lockable.

Power for the M-611 is provided by a self-contained "C" cell. The interchangeable microphone stem allows use of lapel microphone and acoustic tube microphone headset plug-in modules. Frequency response of the new Superex microphone is claimed to be 250-8000 Hz; sensitivity is rated at −45 dB. Comes with a 6′ (1.8 m) unterminated six-conductor cable. $44.95.

CIRCLE NO 99 ON FREE INFORMATION CARD

Heath Metal Locator

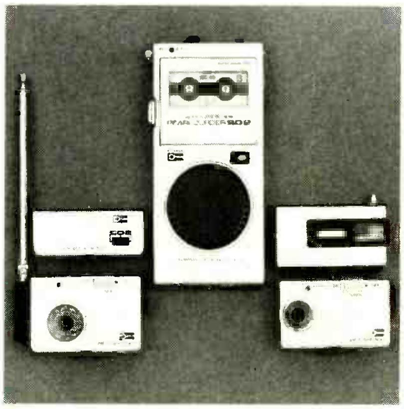
A new metal locator kit, the GD-1190

"Cointracker," has been introduced by Heath Company. It features adjustable discrimination, pushbutton tuning, waterproof search coil, and the length of its collapsible shaft is adjustable. Metal detection is signaled to the user via a built-in meter and through an adjustable-volume headphone output. A battery recharging jack is also provided. Weight is 3.5 lb (1.6 kg). $149.95.

CIRCLE NO 90 ON FREE INFORMATION CARD

120-Minute Portable Microcassette

The Olympus Pearlcorder SD2 is a two-speed (15/16 and 15/32 ips), capstan drive, modular, pocket-size cassette system providing 120-minute recording/playback capability with a Microcassette. Side-mounted controls include record, stop, pause, and four-way cue, review, rewind, and fast-forward. Features include automatic off, cassette eject, built-in electronic condenser microphone, and LED



battery-strength indicator. It comes with a Voice Actuator Module allowing VOX control of recording with three sensitivity positions. Optional plug-in modules offer reception of AM and FM broadcasts, as well as direct air-to-tape recording capability. Accessories include tie-clip mike, external speaker with built-in amp, and various adapters. Weight is only 12 oz. $275.95.

CIRCLE NO 100 ON FREE INFORMATION CARD

New Literature

ROYCE CB GUIDE

The "1978 Royce CB Buyer's Guide" covers the company's complete line of CB transceivers, antennas, and accessories. A highlight of the guide is a glossary section describing over 50 CB features such as large-scale integrated circuitry, phase-locked loops, channel 9 scan and TV interference suppression. Address: Royce Electronics, 1746 Levee Rd., North Kansas City, MO 64116.

NATCAM CATALOG

A new, 64-page catalog of tools, technical supplies and test instruments is now available from National Camera. With 13 categories of items, the catalog is useful to engineers, hobbyists, photographic and electronic specialists, do-it-yourselfers, and repair technicians. Address: National Camera, 2000 W. Union Ave., Dept. QRR, Englewood, CO 80110.

GE 2-WAY RADIO FM SERVICE HANDBOOK

The "Test and Troubleshooting Handbook," for 2-way radio FM service technicians is available from General Electric for $2.50. Applicable to mobile, base station, and personal/portable equipment, the 30-page publication stresses systematic approaches on how to run and interpret standard tests, and compare results with characteristics in the published specifications of equipment serviced. Address: General Electric Mobile Radio Dept., Box 4197, Lynchburg, VA 24502.

ARGOS PACKAGED SOUND SYSTEMS BROCHURE

Argos Sound has released a four-page brochure on its line of packaged sound systems. Included are the Sound Pak II, a system for large groups; the Voice Director II, an outdoor cordless system; the Speech Director II, a compact lectern sound system; and the Executive, a sound system said to be as portable as a briefcase. Optional accessories are included in the brochure. Address: Argos Sound, 600 S. Sycamore St., Genoa, IL 60135.

E-Z HOOK ELECTRONIC TEST ACCESSORY CATALOG

Now available from E-Z Hook is a 92-page guide describing its line of test hooks, probes, connectors, jumpers, test lead and coaxial cable assemblies, adaptors, breadboarding and harness board components. Address: E-Z Hook, Box 450, Arcadia, CA 91006.

"Direct" to you from Radio Shack

"I'm very impressed with the way Radio Shack has translated latest technology into good looks and precision record playing in the 400."

Peter Nero
Composer/
Pianist

Realistic®
Direct-Drive Automatic . . .
Finest Turntable We've Ever Offered

Two motors, damped cue/pause, S-shape tonearm, speed controls, $39.95-value Realistic/Shure cartridge

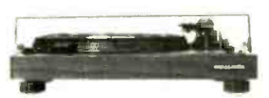
The LAB-400 makes studio performance both affordable and convenient. Its massive die-cast platter rests directly atop a 16-pole brushless DC servomotor. The platter and motor rotate at the same speed, either 33⅓ or 45 RPM — no idler wheels, reduction gears or belts to alter the music that's stored in your record's grooves. The result: wow and flutter is less than 0.03% WRMS and rumble is better than −63 dB (DIN B). The fully automatic tonearm has an effective length of 8¹¹⁄₁₆", for flawless tracking down to ½ gram. Handsome walnut vinyl veneer base with ultra-modern, slim design. Elliptical-stylus magnetic cartridge and detachable hinged dust cover — significant "extras" that aren't extra. All for $199.95.*

Fully Automatic Tonearm Operation

You need never touch the tonearm — just select record size and push start switch. An independent motor does the rest, cueing the arm, gently lowering it onto the record, and removing it at disc's end. With repeat mode, cue/pause, anti-skate and tracking force controls.

Two speeds with controls for ±4% pitch adjustment.

Neon light with strobe disc for checking speed.



Low-profile styling with precision shock-mounts to stop acoustic feedback.

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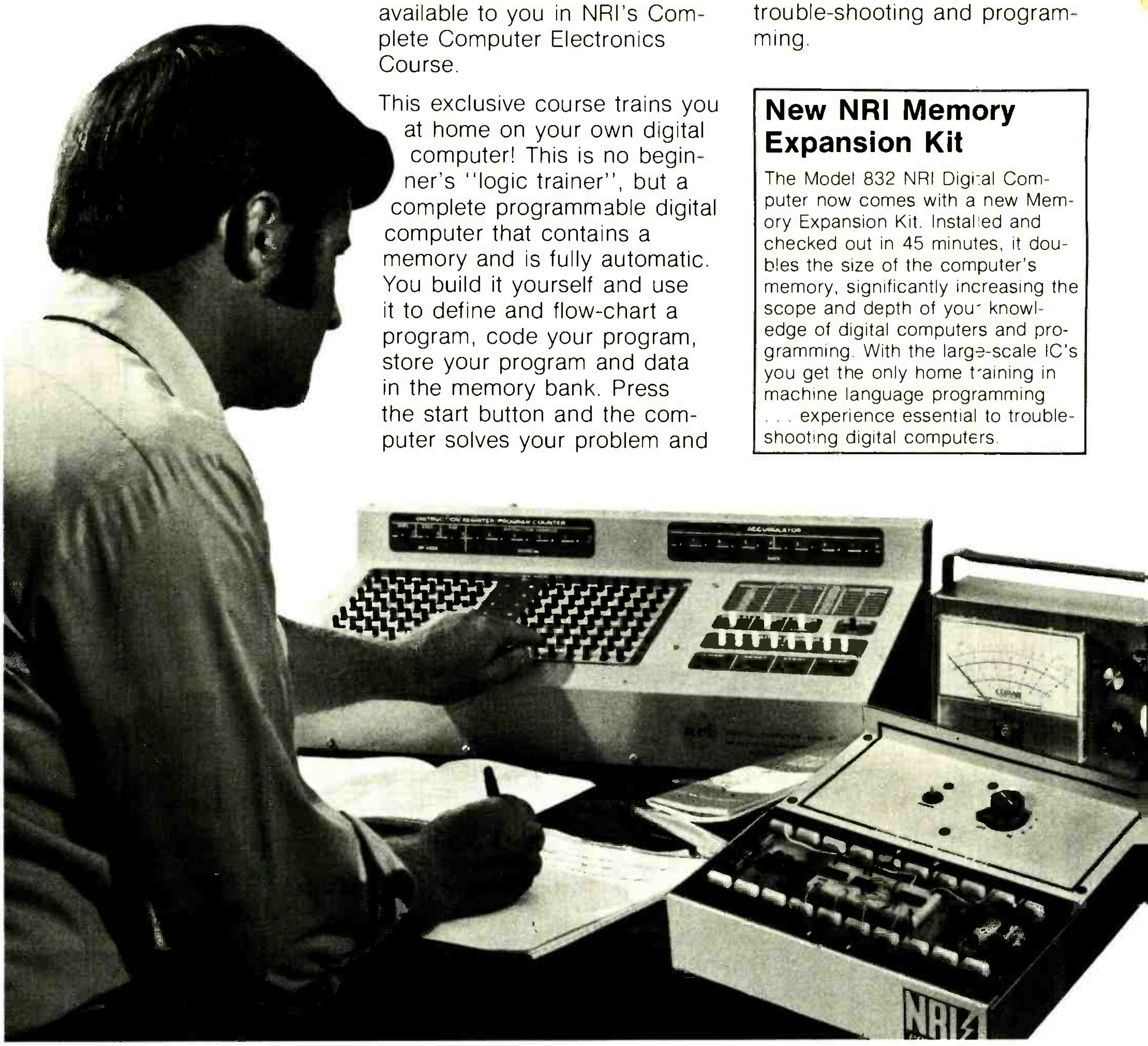
New NRI Memory Expansion Kit

The Model 832 NRI Digital Computer now comes with a new Memory Expansion Kit. Installed and checked out in 45 minutes, it doubles the size of the computer's memory, significantly increasing the scope and depth of your knowledge of digital computers and programming. With the large-scale IC's you get the only home training in machine language programming . . . experience essential to trouble-shooting digital computers.



Stereo Scene

By Ralph Hodges

RFI AND OTHER MATTERS

IN MID-APRIL, RFI was the subject of a strongly worded memorandum from the Institute of High Fidelity to its members (principally equipment manufacturers). The IHF wanted particularly to warn against pending legislation in the Congress that would in one way or another require manufacturers of RFI-prone equipment—TV, hi-fi, and all the rest—to render their products interference-proof. Almost simultaneously, word came out of Canada that the agency that erects and oversees that country's system of standards was considering much the same thing. As it happens, Canada and the U.S. have a history of strong independence on such matters. To have the two governments attacking the RFI situation almost in unison may mean something significant.

How to Love RFI. It's a certainty that many readers of this magazine are unwitting or at least involuntary producers of RFI since they generate signals that other people, trying to listen to or view other things, encounter as interference. However, I suspect that many of these RFI creators are or have been RFI sufferers as well, and hence are willing to lend an ear to the other side of the story. The other side is this.

There is no question that organized amateur radio and other groups have been most generous with time, trouble, and advice in an effort to solve the RFI problem wherever they've found it, and we of the audiophile persuasion are grateful. At the same time we are concerned that these efforts may have oversimplified the problem in the governmental if not the public eye. The nation at large seems ready to believe that RFI will go away tomorrow if the "irresponsible" manufacturers of hi-fi equipment and other consumer electronics equipment take the proper design steps; but the evidence doesn't show it.

A skilled amateur radio operator would probably have little difficulty isolating interference points-of-entry in a neighbor's hi-fi system, and possibly even less difficulty in stopping them, with items from his parts bin. But what else has he stopped in the process? Without intending to demean the expertise of hams and other skilled amateurs in the slightest, I think it's fair to say that many pieces of high-fidelity equipment can react a bit unpredictably when "modified" to effect an RFI cure. By now it's generally known and understood that excessive capacitive loading of a typical phono cartridge plays havoc with frequency response, among other things, even though it's often a quick and successful treatment for RFI. What's less well-known and little understood is the effect of a capacitor hung on the output of a modern power amplifier, particularly when the parallel load presented by the loudspeaker system is not defined. Under the best of circumstances the capacitor will nearly take away any r-f being picked up by the speaker cables. Under the worst, it will shut down the amplifier in a burst of spontaneous oscillation.

At this point it's necessary to get a bit defensive. In an ideal world, audio equipment would behave predictably when confronted with an external filter to eliminate RFI; in fact, in an ideal world it wouldn't pick up RFI at all. But real-world hi-fi systems, engineered for "reasonable" conditions that are suddenly becoming extreme (a few years ago, who would have believed we would have to cope with several dozen radio transmitters driving past the front door every hour), are understandably caught short. This is embarrassing and exasperating, particularly for those responsible manufacturers who thought they were doing their best by the consumer.

Is congressional legislation the answer? For audio and video equipment of indifferent quality and poor shielding, it might be. But for true high-fidelity equipment in good working order it is probably a mistake. The true RFI weakness of the good gear is that it is typically strung together with mechanical connectors of dubious efficacy, plus long lengths of cable that may be virtually naked to many types of interference-producing signals. Substitution of some of the excellent (if costly) interconnection and grounding schemes now available can bring about an astonishing immunity to RFI without involving equipment manufacturers in questionable modifications (and increased costs) to meet a situation that is still helter-skelter out in the field.

Many serious audiophiles would prefer to learn to love RFI rather than to have the equipment designs they believe in altered by governmental fiat. Surely they are entitled to this consideration. As the RFI situation heats up again (as it probably will), let's hope that all parties will try to educate rather than legislate the problem away.

How to Love TV. Few audiophiles have felt so neglected as those seeking advice on how to route TV sound through their hi-fi systems. Audio writers, myself included, are usually reluctant to offer any quidance on tapping a signal from a TV circuit point because of the appalling electroshock hazard should there be some misinterpretation of the instructions or irregularity in the design of the TV chassis. A separate audio-only TV tuner has long seemed the best idea for this potential market. But where have these tuners been hiding? I recall RCA's offering one some time ago, and a company called Rhodes features a TV-sound "adapter" in the classified pages of electronics magazines. But that's been it.

According to U.S. Pioneer, these potentially attractive products have been hiding from the spectre of the notoriously low fidelity of TV sound broadcasts. Reports from the television industry have spoken of indifferent miking, slipshod mixing, crude equalization to suit the frequency responses of the definitely non-hi-fi loudspeaker in the typical TV console, and the grotesque distortions introduced by the cables and other transmission used to relay the audio portions of the broadcasts to various transmission sites. Few have been able

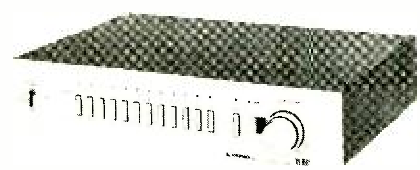
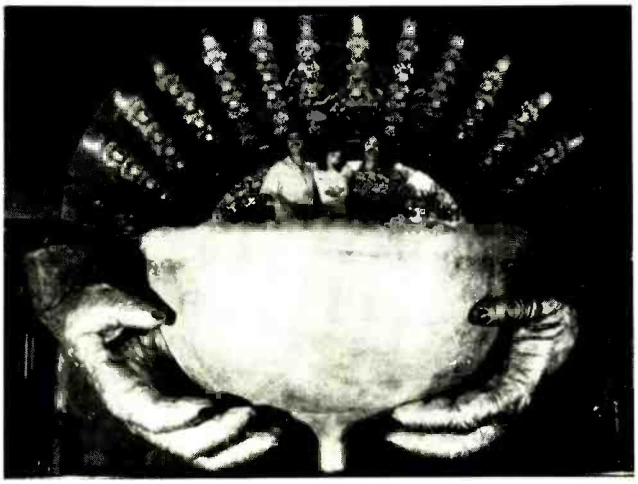


Fig. 1. Pioneer TVX-9500 tuner for TV sound reception.

PROFESSIONAL

On location: Stanton is there where TGIF (Thank God, It's Friday) is filmed.



Go to the Club called *Osko's* in the Los Angeles Area. Revel in the sound around you, supplied to Osko's by Sound Unlimited Systems, Inc., a prime packager of Disco systems. They have supplied 90 systems to Stationary facilities and 60 to Mobile operations.

Sound Unlimited swears by Stanton's 500AL because they have used it for many years until Stanton came out with the 680 EL. Now they use this model exclusively in all of their installations, and endorse it without reservation.

Whether your usage includes recording, broadcasting, archives, Disco or home entertainment, your choice should be the overwhelming choice of the Professionals in every field . . . Stanton Cartridges.

P.S. "Thank God It's Friday" has turned out to be a dynamite film starring Disco Star, Donna Summer.

For further information write to: Stanton Magnetics, Terminal Drive, Plainview, N. Y. 11803

STANTON!

CIRCLE NO 46 ON FREE INFORMATION CARD

to confirm or deny these reports because the equipment necessary to attempt a high-fidelity pick-up of TV audio has not been readily available.

Now Pioneer has stepped in with the TVX-9500 (Fig. 1), an attractive TV tuner that would seem to meet all the requirements for high-fidelity reception. According to Pioneer, the motivation for introducing this product was AT&T's recent increase of the bandwidth of audio long lines and microwave links from a dismal figure of about 5000 Hz to an FM-radio-quality of 15,000 Hz. And the motivation of AT&T's generous bandwidth extension was the need for relay facilities that could handle the requirements of the high-speed data transmission that computers thrive on.

The Audiophile's Light Show. It's not exactly an established fact that what the music listener desperately needs is a visual level indicator. But if he *does* truly need one, the alternatives are constantly getting better and cheaper.

Some years ago peak-reading level indicators, often employing illuminated displays of one sort or another, began appearing on professional recording consoles. Almost at once some of the more astute recordists began hailing them as an important assist to the recording arts. The professional standby, the venerable VU meter, was as useful as ever in communications work. However, it exhibited too many weaknesses for high-dynamic-range music recording, where its leisurely attack time (0.3 second to indicate full value) could not keep up with the abrupt transients of close-miked music; recordings were thus suffering.

Simultaneously the audiophile was getting his fair share of peak-level indicators, usually in the form of one or two LED's on the front panels of tape recorders that winked at the approximate point of tape overload. Very recently we've had entire metering systems made of such LED's on a few audiophile products (not to overlook some of the

Fig. 2. Nakamichi T-100 Audio Analyzer has plasma readout.

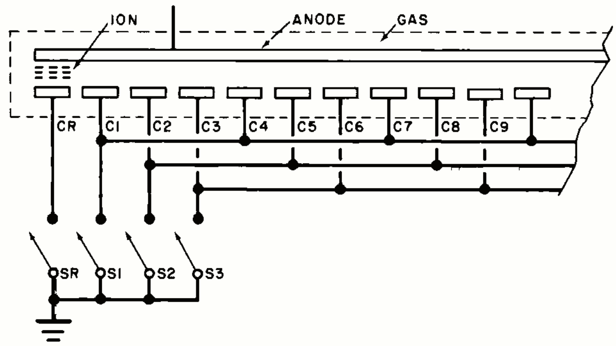


Fig. 3. Diagram of cathode-switching scheme for the Nakamichi T-100.

conventional meters driven by peak-indicating electronics, or Sony's unique light-beam galvanometer with similar electronic assistance). Such LED displays are complex to wire, however, each having its own separate leads to be contended with; and, of course, the associated circuitry must provide an individual electronic switch for each. Consequently, metering systems involving more than eight to ten LED's per channel are rare.

Now equipment manufacturers—several of them at this time—think they have some answers: the "fluorescent" and "plasma" indication systems. These innovations have recently turned up on Pioneer, Sony and Technics cassette decks, a JVC level indicator (not quite available as this is being written), and a Nakamichi "Audio Analyzer" (Fig. 2). The last is an interesting little item also containing the facilities for making total-harmonic-distortion and speed/wow-and-flutter measurements.

The plasma indicator renders an inert gas incandescent by means of an electrical discharge through it. Construction evidently involves a gas-filled glass tube with electrodes spaced along its length. In the displays seen so far, the user beholds little vertical bars of light working their way up and down a calibrated horizontal scale, often of considerable length. The JVC indicator (Model DS-7070), for example, can show up to thirty such bars for each channel, which provides good resolution over a fairly extensive dynamic range.

The operation of the Nakamichi device, Model T-100, gives an indication of the attractive economies that can be realized with the "plasma" technique. In this manufacturer's scheme, at least, it seems that *adjacent* electrodes must be charged in order to achieve any incandescence. Alternately spaced electrodes can remain on all day without producing anything visible. By wiring up appropriately alternating electrodes to three basic control busses (Fig. 3), it is possible to simplify the switching required of the associated control IC's considerably. This is because the only condition of interest is when two adjacent electrodes receive power. Alternately spaced electrodes can receive power with no consequences.

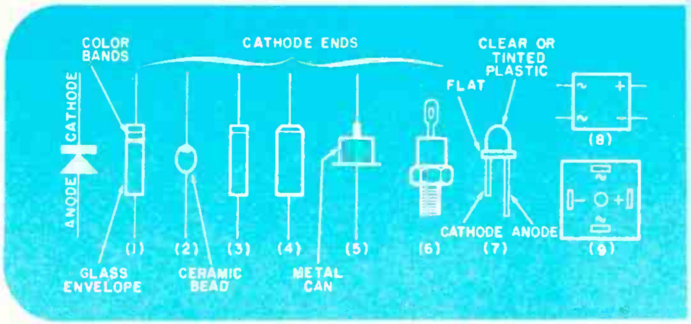
Other advantages claimed for the plasma system include virtually instantaneous response of the indicators (0.02 millisecond is specified for the JVC unit), no parallax, and a wide variety of indicator shapes possible merely by changing the shape of the electrode. Furthermore, the number of electrodes can be increased without incurring ruinous costs. Naturally, the drive circuitry can incorporate any of the features available with other metering systems. These include a choice of peak, VU, or "average" level indication, "peak hold" (by which the highest level achieved by the monitored signal is stored for later reference), and the choice of various weighting systems. For a recent evaluation of direct-to-disc recordings in which I was a participant, the JVC DS-7070 was used extensively to determine relative dynamic ranges. There were great sighs of relief from all concerned because of the ease and repeatability of the measurements.

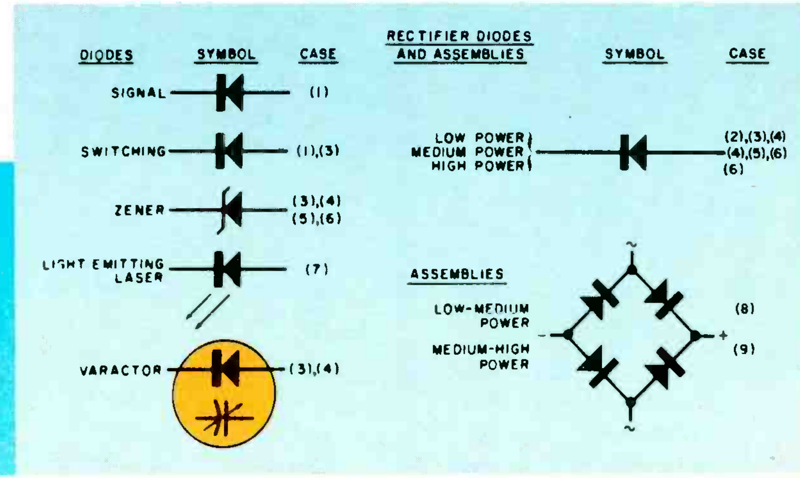
As for the fluorescent system, the concept is similar, but in this case the tube is evacuated. Internally there are a cathode, grid, and anode, plus phosphors on the interior wall that glow when bombarded with electrons—a rather familiar concept. I've not yet seen any specific claims made for the speed of this system, but it is probably adequate to its task.

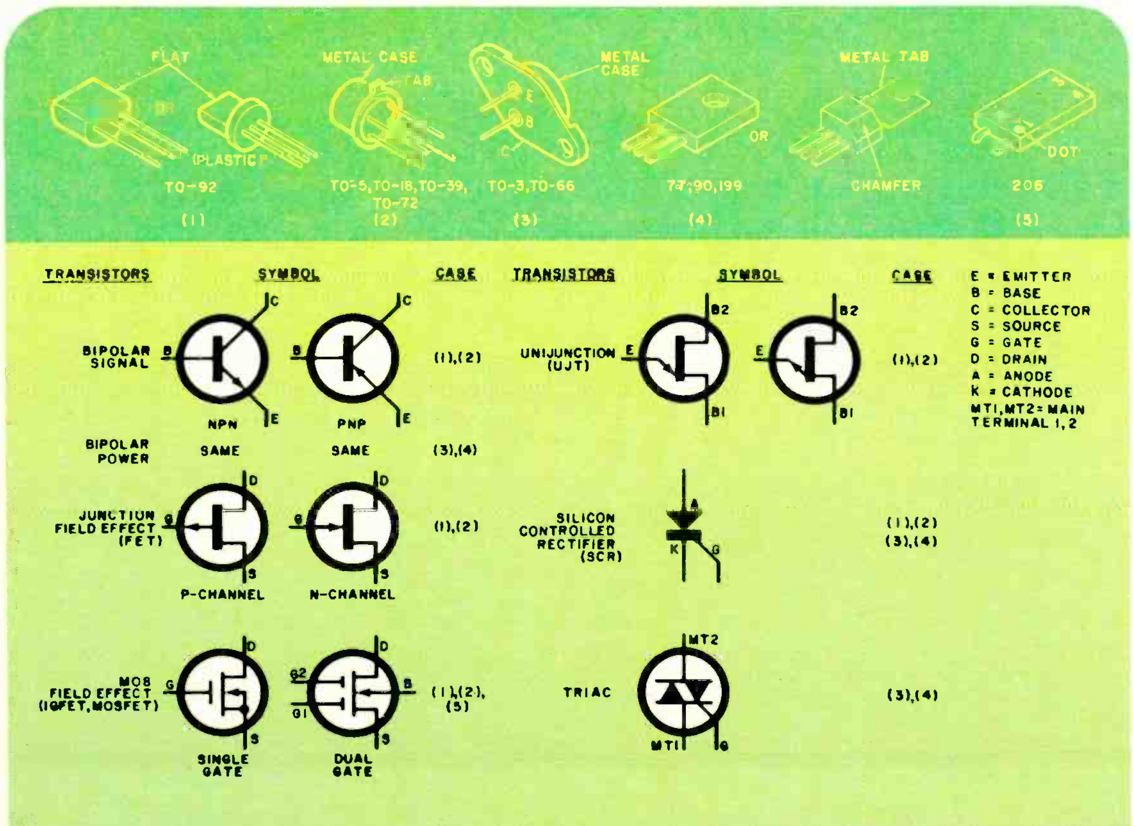
All in all, a clear potential seems to be here for the best metering system to date, and without great agonies imposed on the pocketbook. To my knowledge this innovation is *not* yet to be found on the consoles and tape machines used by professionals. It may be interesting to see how they react. ◇

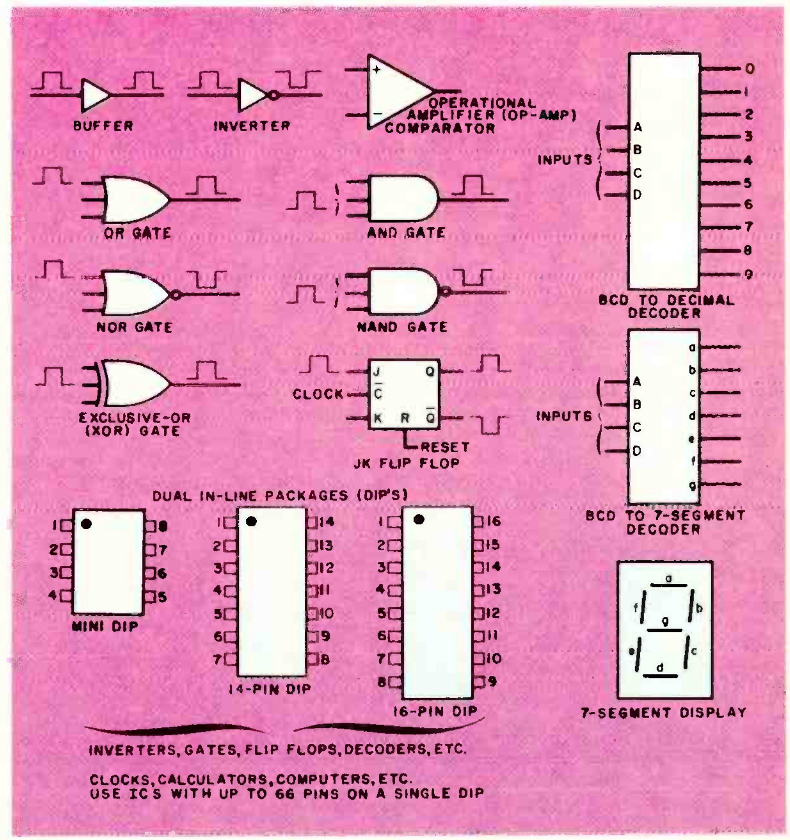
SOLID STATE
COMPONENTS CHART

Illustrated are typical case configurations and schematic symbols for various solid-state components. Those at right are for diodes and rectifiers; directly below, for transistors and solid-state control devices; and below right, for integrated circuits and seven-segment, light-emitting diode displays.









Julian Hirsch Audio Report

Cassette Recorder Tape Compatibility

As regular readers of our product test reports know, there is a potentially serious compatibility problem between a cassette recorder and the tape used in it (the same problem exists with open-reel recorders, but is very much less critical). This is why it is so important that the recorder manufacturer specify the tapes for which his machine has been adjusted, and why—in the absence of such information—we have to measure the record/playback frequency reponse with a considerable number of tapes to discover which are most suitable for that machine, and which, if any, should not be used with it.

A few cassette recorders, such as the Kenwood KX-1030 tested this month, have a convenient front-panel adjustment of recording bias. This is intended to match the tape's requirements more precisely than is possible with a simple two or three position BIAS switch (although that switch is still required). A somewhat similar feature is found on the Aiwa AD-6800 recorder, and no doubt will appear on others.

We have seen a few cassette decks whose bias adjustments, though not on the front panel, were at least accessible for screwdriver adjustment from the outside of the machine. Since such an adjustment requires external test equipment, it is of little value to the average consumer. The most practical way for a user to adjust the bias of a recorder is to monitor the playback from the tape as it is being recorded—in other words, a three-head recorder is imperative! The Kenwood KX-1030 has that feature, while the Aiwa AD-6800 has a third head dedicated solely to that purpose (in normal use, it is a conventional two-head machine).

". . . to adjust bias of a recorder . . . a three-head recorder is imperative!"

In both units, the adjustment technique consists of recording two equal-amplitude audio tones at middle and high frequencies. The Kenwood records each tone on both channels at the same time, alternating them in bursts of about one-second duration, while the Aiwa records them continuously and simultaneously with one tone on each channel. The adjustment is based on a small change of bias, about a nominally correct value, having little effect on output at low and middle frequencies (400 Hz is used in both machines), but with considerable effect on playback response at high frequencies. In the Aiwa, the upper frequency is 8000 Hz, and in the Kenwood it is 10,000 Hz. When the adjustment is made on the Aiwa recorder, the playback signals are displayed on its level meters, and the bias is varied until both meters read the same. The adjustment is common to both channels. Kenwood provides separate adjustments for each channel, and the two output signals are displayed alternately on the meters so that the bias can be set for minimum pointer movement as the tones are automatically switched.

A different approach to the compatibility problem is taken by JVC. They hold that, because of the effect of bias changes on the output level and distortion, this is not a desirable method of optimizing a two-head recorder (although they concede that it has some merit with a three-head machine). The changes in output level can affect the performance of the machine's noise-reducing circuits (Dolby or ANRS), for example. JVC maintains that the best way to match a machine to a tape is through an adjustment of the high-frequency recording equalization (EQ), and that this is the only satisfactory method to use with a two-head machine. This may be a largely academic consideration, since the other machines we have seen all use a three-head configuration, if only for purposes of adjustment.

Nevertheless, there can be no doubt that *both* recording bias and EQ have a profound effect on the ultimate performance of any tape recorder, and most especially a cassette deck. To see why this is so, we will use as an example the manufacturers' published data for two competitive ferric oxide tapes of good quality. Both have been plotted in

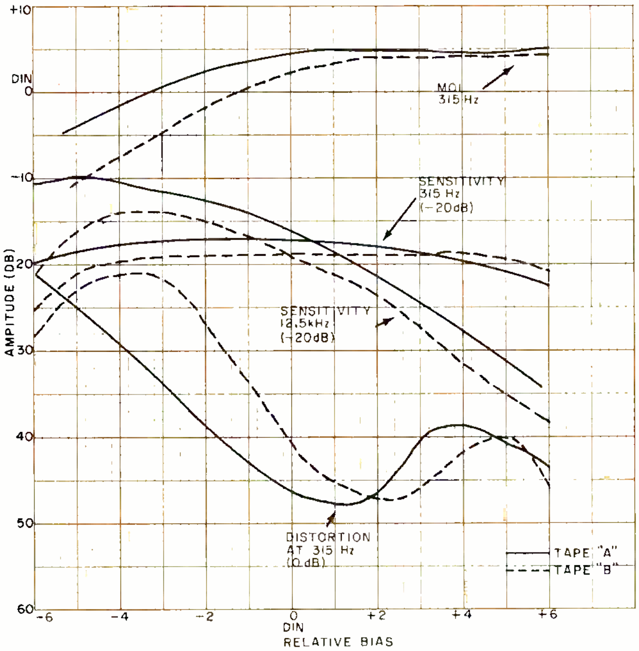


Fig. 1. Tape performance comparison is plotted here for two different tapes (A and B) to demonstrate effect of bias.

Fig. 1 on the same coordinates, with the solid lines representing tape "A" and the dashed lines tape "B". The horizontal axis represents relative bias current, in decibels, with the 0-dB level corresponding to the recommended bias for the standard DIN tape that is the basis for tape specifications throughout the world. On the vertical axis, we note the various output conditions for the tapes.

The uppermost curves are the MOL, or *maximum output level*, which is the output corresponding to a playback distortion of 3% at a frequency of 315 Hz. As the curves show, when these tapes are biased to DIN level or slightly higher, they have achieved their maximum output level at low and middle frequencies, with tape "A" having perhaps one or two decibels more output than tape "B". One might think that any bias above, say, +2 dB, would result in optimum performance from either tape; but look at the distortion curves at the bottom of the graph! Both tapes achieve a minimum distortion of −48 dB (0.4%), though at different bias currents. Tape "B" requires about 1.5 dB more bias than tape "A" for its minimum distortion conditions. When so biased, its 315-Hz output is also at maximum and, perhaps, 1 dB less than the output from tape "A".

Based on this partial information, we might conclude that tape "B" should be operated at a bias 1.5 dB higher than tape "A". This is probably true, but it is not the whole story. At about the −20-dB level, look at the sensitivity curves at 315 Hz for both tapes. They show the playback output at that frequency from a −20-dB recording level; it can be seen that this is nearly independent of bias, with tape "A" having about 2 dB more output than tape "B" at bias levels of 0 dB or less, and slightly less output than tape "B" at high bias levels. Intersecting the 315-Hz sensitivity curves are the downward sloping 12.5-kHz sensitivity curves. These show clearly the large effect of bias on the 12.5 kHz playback level from a −20-dB constant recording level. Let us assume that the recorder has been set up with tape "A" at a bias level of +1 dB. With an ideal recording head, it would still be necessary to boost the recording signal at 12.5 kHz by about 1.5 dB to give a "flat" response (which we will define here as an equal output at 315 Hz and 12.5 kHz). If the machine had been set up for tape "B" at a +2.5-dB bias, the recording equalization boost at 12.5 kHz would have to be about 6 dB for the same "flat" response. Due to head losses, the actual boost would be greater in each case, but that need not concern us here.

Now, if that machine, set up for tape "A", were to be rebiased for "flat" response with tape "B", without changing the recording EQ, the bias would have to be reduced to about +0.5 dB. At this point, the 1.5-dB recording EQ would give the desired frequency response. If, on the other hand, the machine originally adjusted for tape "B" were to be re-biased for tape "A", the bias would now be +3 dB (so that the 6 dB of high-frequency recording EQ would give a "flat" response). As a result, the distortion would be increased by 6 dB!

Evidently, one cannot truly optimize a cassette recorder by a bias adjustment alone. How about JVC's method of adjusting recording EQ for flattest frequency response at a fixed bias level? In theory, this would appear to be no better than the bias adjustment technique. If it actually works better, this could only be because most tapes within a given performance category are designed to operate with very nearly the same bias. To the extent that this is so, the EQ adjustment should be fine. If it is *not* so, then we still have the possibility—even probability—that a tape will not be operating at its lowest distortion point even though it is delivering its "flat-test" frequency response.

In the case of the JVC method, which has been used on its KD-75 and other cassette decks, one must depend solely on hearing judgment to establish the correct recording equalization. If built-

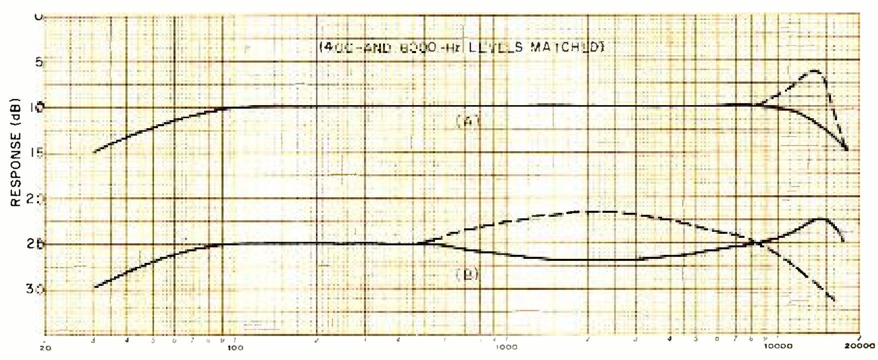


Fig. 2. Possible response variations between two tapes. Close match is obtained in (A), but variation can be as great as shown in (B).

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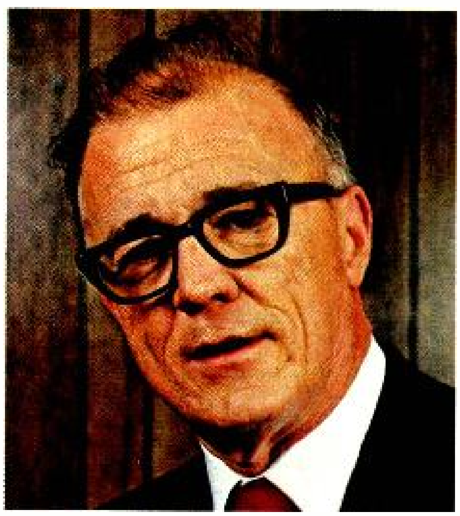

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in oscillators and metering were provided, with a third head for playback, this adjustment could be made as it is in the Aiwa and Kenwood machines. However, the JVC deck has two heads. We can say, based on our experience with all three machines, that although the metering systems of the Kenwood and Aiwa machines work very well, it is at least as easy to make the adjustment by listening to the playback of a recording of interstation FM tuner hiss, in an A-B comparison against the incoming signal, as the bias (or EQ) is varied. In the case of the JVC recorder, this requires that the noise be recorded with several settings of the EQ switch, and comparison made on playback.

There is still another pitfall in any of these tape optimization methods. The Kenwood and Aiwa approach is based on obtaining equal response at only two frequencies, one low and one high. This does not assure that the response will be the same at all intermediate frequencies, or above the high frequency. Figure 2A shows a response curve from a machine which has a slightly drooping high-end response. Also, its 8000-Hz and 400-Hz levels have been matched. The dashed line shows another condition, with exactly the same matching at 400 and 8000 Hz, but with a slight peak at higher frequencies. (Such a peak might result from using a "hotter" tape.) The two would certainly sound very different, of course. The higher the frequency used for the upper end of the adjustment, the less likely this is to happen, but it is equally possible to have the conditions shown in Fig. 2B. No matter how it is done, the fact that two tapes give the same output at two frequencies does not mean that they will sound alike. This is an advantage of making the adjustment by ear, for the best *subjective* frequency response.

Probably the best approach to solving the compatibility problem (which we have not yet seen on the market) would be to use both bias and EQ adjustments, with several high-frequency signals available, and a third head-plus-meter read-out system. The bias could then be set for a maximum (or other specified) value of output at 400 Hz, and the EQ could be trimmed for equal output at two or three high-test frequencies. This, after all, is what the factory technician does when he sets up the machine in the first place. If the user could do the same, without recourse to external equipment, he could *really* enjoy optimum performance from his recorder, with any tape.

Audio Test Reports

HIRSCH HOUCK LABORATORIES

Kenwood Model KX-1030 Cassette Deck

Deck features a vernier bias adjustment, two test oscillators, and bias and equilization switches which allow a precise match to any tape formula.

Kenwood's Model KX-1030 is a front loading cassette deck, with a single electronically controlled dc motor for its capstan and hub drives. It is a three-head machine, on which the program can be monitored directly from the tape as it is being recorded. A vernier bias adjustment on the front panel operates with two built-in test oscillators to allow the recording bias to be optimized for tape formulation.

A genuine off-the-tape monitoring system requires separate Dolby circuits for recording and playback functions so that both can be used simultaneously; the KX-1030 has this "Double Dolby" feature. It also has a "memory rewind" that stops the tape automatically in rewind when the index counter returns to a previously set "000" reading, and a full mechanical disengagement and "autostop" at the end of the tape, in any operating mode. Separate front-panel switching is provided for three basic tape formulations: chrome, ferric, and ferrichrome. The bias and equalization are separately switchable (in addition to the vernier bias adjustment).

The Kenwood deck's control panel has a pale gold finish, with matching metal knobs, to match the appearance of other Kenwood components. The recorder's dimensions are about 17"W x 6½"H x 12¾"D (43 x 16.7 x 32.5 cm), and it weighs 16.5 lb (7.5 kg). The suggested retail price is $400.

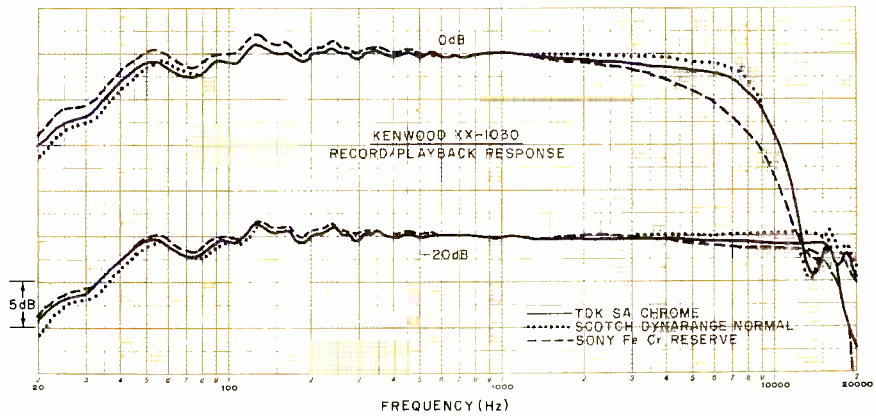
General Description. The tape transport is located at the left side of the recorder, and the bottom-hinged cassette door has guide slots into which the cassette is loaded. The door can be removed easily for access to the heads. Most of the cassette is visible through a large window in the door. It has the usual array of mechanical "piano key" operating levers, located in a row below the cassette compartment. Unlike many cassette decks, the KX-1030 cassette door is not opened by pressing the STOP key or any other control. Instead, pressing in the upper portion of the cassette door and releasing it allows the door to spring open (the word PUSH appears at its upper left corner). This is similar to the "touch latch" found on some cabinet doors, which use no external hardware. In the KX-1030, the door cannot be opened unless the tape is at a stop.

A lever switch to the left of the door turns on the POWER to the recorder; below it is a stereo PHONE jack. Two large meters occupy the center of the panel with a red PEAK LED between them. Above the meters is the index counter and the MEMORY REWIND button, as well as a red RECORD light and a green DOLBY light. The recording level controls are below the meters. They consist of two concentric pairs of large knobs, one for the microphone inputs and the other for the line inputs. Slip-clutch couplings in each pair allow separate adjustment of recording levels in the two channels. To their right are lever switches for DOLBY and tape MONITOR functions (the latter connects the LINE outputs, in the rear of the recorder, to the SOURCE input signal or to the output of the TAPE playback amplifier). There is also a concentric pair of playback OUTPUT level controls and a pair of MIC jacks for medium impedance dynamic microphones.

At the upper right of the panel are the two TAPE SELECTOR switches, providing separate BIAS and EQUALIZATION settings marked CHROME, NORMAL, and RESERVE (for ferrichrome tape). To the left of the BIAS switch are two small concentric knobs that vary recording bias separately for the two channels around the nominal values selected by the BIAS switch. Below them is a pushbutton switch marked OSC.

To optimize recording bias for a specific tape, the machine is placed in a recording condition with the output set to maximum. The OSC button is engaged, and the MONITOR switch is set to TAPE. The recorder's internal oscillators record tones of 400 Hz and 10,000 Hz, alternately, in bursts of about one-second duration. The red REC light glows when the 10,000-Hz tone is on, and is off when the 400-Hz tone is being recorded. The meters display, alternately, the playback output from these signals. If bias is set correctly, they will play back at the same amplitude, and the meter readings will not change as the tones are switched. The quality of the tape (presence of dropouts, etc) may cause the higher frequency reading to fluctuate somewhat, but its average level should be the same as the 400-Hz tone. If not, the BIAS vernier knobs are adjusted separately for each channel until the meter reading does not change as the tones are switched. If the 10,000-Hz reading is higher than the 400-Hz reading, the bias control is turned clockwise to increase the bias and reduce the high-frequency response; if it is lower, the knob is turned counter-clockwise to reduce the bias.

The "three head" configuration used in the Kenwood KX-1030 has a combination record/playback head in which two electrically distinct heads, with separate and parallel gaps, are housed in a single case small enough to fit through the access hole in the edge of the cassette housing.



Frequency response at two recording levels using three tape formulations.

Product Focus

Two interesting features of the Kenwood KX-1030 contribute greatly to its usefulness as well as its performance, although neither is really exclusive to this machine. A combination record/playback head, with separate gaps in a common housing, has been used in a number of cassette recorders. It is a reasonable and economical alternative to a true three-head construction. The latter requires a miniaturized playback head to fit through an opening in the cassette that was never meant to receive a head, and is further complicated by the need to adjust the record head azimuth to match that of the playback head for every cassette used. This process is simplified by built-in oscillators and indicators in the few recorders using this system, but it is undeniably a more expensive route.

In the combination head, two separate heads are packaged in the same shielding enclosure. Their gaps are spaced as closely as possible to avoid the alignment errors due to tape skewing (a problem with the true three-head machines), although the need to provide a reasonable degree of signal isolation between them sets a limit to this. More important, the two head gaps must be precisely parallel, since any deviation from parallelism will severely limit the high-frequency response of the machine. The combination head, however, does share the most basic and important advantage of a three-head machine (other than its monitoring function), which is the ability to optimize the two gap widths for recording and playback functions. In theory, at least, this should give any *properly designed three-head recorder a wider frequency response, more headroom, and generally superior performance to a recorder with a single gap combination record and playback head.*

The second feature of the KX-1030 is its bias adjustment system that makes it possible to match the recorder to any tape, using its built-in test and adjustment facilities. Although both *bias and equalization should be adjusted for truly optimum performance, this is difficult and undesirable for a product aimed at a broad and mostly nontechnical market. Fortunately, one can achieve a first approximation of correct operation by a bias adjustment alone, given a suitable setting of the recording equalization response. Kenwood has taken the logical step of supplying two different recording signals, at middle and high frequencies, from built-in test oscillators. On the assumption that the recording equalization is correct, it is reasonable to expect that biasing a tape for equal response at both frequencies will tend to give it the flattest overall frequency response. To aid in doing that, what could be more logical than to use the recorder's own meters (since it can play back while recording) to confirm that this equality exists? Although the merits and limitations of this approach have been argued extensively, the results speak eloquently for themselves in the KX-1030. Unlike some of the purists among us, we would agree with Kenwood (for surely they are well aware of the limitations of their technique) that a partial cure for a problem is better than none at all.*

Performance Specifications

Specification	Rating	Measured
Tape Speed Error	NA	+1.0%
Fast Winding Time (C−60)	80s	72s
Frequency Response (+3 dB)		
Normal	35-15,000 Hz	36-16,500 Hz
CrO_2	35-18,000 Hz	35-17,000 Hz
FeCr	35-17,000 Hz	35-16,000 Hz
Signal-to-Noise Ratio (Mfr. figures above 5 kHz)		
Normal	55 dB (Dolby off)	61 dB (A-wtd)
	65 dB (Dolby on)	67 dB (CCIR-wtd)
CrO_2	57 dB (Dolby off)	61 dB (A-wtd)
	67 (Dolby on)	67 dB (CCIR-wtd)
FeCr	NA	60.5 dB (A-wtd)
		67 dB (CCIR-wtd)
Harmonic Distortion	Less than 1.3% at 0 VU (Normal)	0.5% Normal
		0.7% CrO_2
	(NA-CrO_2 and FeCr)	1.1 % FeCr
Wow & Flutter	0.06% Wrms	0.07% Wrms
		±0.10% Wtd. Peak (DIN)
Input Sensitivity (for 0 VU)	77.5 mV Line	88 mV
	0.19 mV Mic	0.19 mV
Output Level (0 VU)	775 mV	760-840 mV (depending on tape)

Laboratory Measurements. The specifications of the Kenwood KX-1030 name the specific tape formulations used to establish its ratings. They are TDK SD (NORMAL), TDK SA (CHROME), and Sony Ferrichrome (RESERVE). We used these tapes to verify the machine's ratings except that, TDK SD having been discontinued, was replaced with a somewhat similar ferric tape, Scotch Dynarange.

Because of the ease of adjusting the KX-1030 for any tape, we actually measured the record/playback frequency response with some 15 different tapes. The differences between them were minor and confirmed that the machine can be adjusted to give perfectly satisfactory results with almost any tape sold today.

The playback frequency response (NORMAL, 120-µs) was measured with a TDK AC-337 test tape. It was within +1, −2 dB over the 40-to-12,500-Hz range of the tape. The 70-µs response, measured with the Teac 116SP tape, was within +1.5, −2 dB over the 40-to-10,000-Hz range of the tape. The record/playback frequency response, at a −20-dB recording level, was virtually identical for TDK SA and Scotch Dynarange tape. The recorder had a rather unusual configuration of low-frequency head contour response ripples, extending up to 400 Hz, but above that frequency, the response was extremely flat, varying by less than 1 dB overall up to 15,000 Hz and beyond. At a 0-dB recording level, the usual high-frequency tape saturation effect caused the response to drop off, so that it intersected the −20-dB curve at about 12,500 Hz.

To our surprise, the Sony Ferrichrome tape's response had a slight downward slope with increasing frequency above 4000 Hz, and its 0-dB response curve showed noticeably greater saturation than the other tapes. Its overall numerical tolerances over the audio range were much the same as the others.

The Dolby-circuit tracking was outstanding. It exhibited less than 1 dB of difference between the frequency response curves made with and without the Dolby system at levels from −20 to −40 dB, up to 14,000 or 15,000 Hz. Crosstalk between channels, measured with a TDK AC-352 tape, was −43 dB at 1000 Hz.

For a 0-dB recording input, the required input was 88 mV (LINE) and 0.19 mV (MIC). The microphone input overloaded at a rather low 15 mV. The resulting maximum playback output was in the range of 0.76 to 0.84 volts, depending on the tape used. Distortion (third harmonic) was from 0.5% to 1.1%. (Dynarange gave the lowest distortion and Ferrichrome the highest.) The headroom above 0 dB for a 3% playback distortion level was between 5 and 7 dB. Noise levels are given in the table of performance data, and were consistent with the performance of today's better cassette decks. The noise increased by 4.5 dB through the microphone input, at maximum gain.

The meters read about 85% of their steady-state readings when driven with 0.3-second tone bursts (this is somewhat slower than the VU standard, which requires a 99 to 100% reading under these conditions). The PEAK light began to glow at +5 dB, so that it is an effective indicator of the maximum safe recording level with any tape. Headphone volume was quite good, even with 200-ohm phones, which cannot be driven to useful listening levels by the headphone outputs of many recorders.

The tape transport operated about 1% fast (a normal tolerance for a cassette deck). The flutter was 0.07% in a weighted rms measurement, and ±0.1% in a DIN (weighted peak) measurement. The transport moved a C-60 cassette from end to end in 72 seconds.

User Comment. The Kenwood KX-1030 offers a combination of features and performance not commonly encountered in its price class. Although the three-head configuration, per se, makes little difference in the actual performance of the machine as compared to one with first-class combination record/playback heads, it does make it possible to optimize the recorder for any tape (within the limits of a bias-only adjustment). Lacking this feature, the user of a cassette recorder *must* use the specific tape for which his machine was set at the factory if he is to obtain the rated performance. This information is simply not available from many manufacturers, and is always subject to change without notice (or to obsolescence as new, improved tapes are developed).

When we recorded interstation FM tuner hiss at a level of about −15 dB and compared the playback to the input we could usually hear a trace of dulling at the highest frequencies. The effect was slight, to be sure, and could only be detected by a critical comparison to the original signal. We then trimmed the BIAS controls to minimize the audible difference, and found that an improvement was usually possible. In fact, this proved to be a more sensitive technique for setting the bias than using the recorder's own meters and test oscillators because we did not have to interpret the meter's fluctuating readings. That fluctuation, in itself, however, is a clue to one of the major advantages of the Kenwood bias adjustment system. It is an ideal way to evaluate the homogeneity of a tape. All else being equal (or even somewhat unequal in respect to frequency response, etc), a tape with a steadier 10,000-Hz output in this adjustment has fewer dropouts and is likely to make a better-sounding recording than a "flatter" tape with a more irregular output.

Of course, most people who use the KX-1030 will select a suitable tape and set up the machine for it in the beginning. There will be no need for regular use of the bias adjustment feature, and the recorder can be used just like any ordinary machine (with the "plus" that one will always be able to hear the recording as it is made). In its overall listening quality, the KX-1030 is at least the equal of any other machine we've tested in its price class, as well as some at considerably higher prices. Its modest price for the performance it offers is made possible by the omission of a few refinements, we'd judge. For example, the transport control keys are stiff, requiring appreciable operating pressure. The single-motor transport, though adequate to move the tape smoothly at 1⅞ ips, cannot match the fast speeds provided by some 2- or 3-motor transports. But these shortcomings are more than made up for, we believe, by the useful and novel features of this machine. We especially like the ability to adjust bias optimally according to the tape used.

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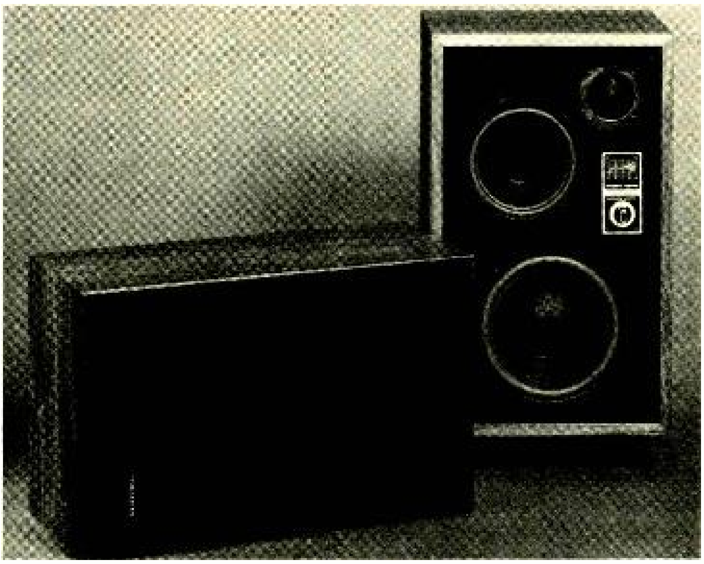
Realistic Optimus-10 Speaker System



Two-way vented bookshelf system employs a passive radiator for more efficient bass reproduction.

HIRSCH-HOUCK LABS REPORT

Radio Shack's Realistic Optimus-10 "bookshelf" size speaker system features a two-way design in an efficient vented enclosure. Its 8" (20.3-cm) woofer operates with a 10" (25.4-cm) passive radiator to deliver an extended low-bass response claimed to be comparable to the response obtainable from an acoustic-suspension design but at significantly higher efficiency.

The Optimus-10 measures 25" × 15⅜" × 10⅝"D (63.5 × 39.1 × 27 cm) and weighs 45 lb (20.5 kg). The system is priced at $139.95.

General Description. The effective crossover between active and passive cones in the system occurs at 60 Hz. Therefore, the passive radiator operates principally at frequencies between 45 and 60 Hz. A small cone tweeter takes over at frequencies beyond 2500 Hz. No physical crossover network is used, since the natural rolloff characteristics of the drivers provide the necessary crossover action.

The system's nominal impedance is rated at 8 ohms and its power-handling capacity is rated at 75 watts. Although the tweeter's natural low-frequency rolloff supplies the crossover action, the driver is protected against damage from high-magnitude low-frequency signals by a series capacitor. A variable series resistor serves as a BRILLIANCE control that can be used to adjust the output of the tweeter over a ±3-dB range. The cone tweeter is driven by a 1" (25.4-mm) voice coil formed of aluminum wire.

The 8" woofer has a four-layer aluminum voice coil whose inductance helps to roll off its response beyond 2500 Hz. The woofer's vent is a 10" passive cone (instead of the usual hole or ducted port in the speaker board) whose mass and compliance have been selected to cross over its response above 60 Hz to the driven cone. The passive cone resembles a conventional 10" loudspeaker without a magnet or voice coil. As used in this speaker system, it is equivalent to a 9" (22.9-cm) diameter port at the end of a 4½' (1.37-m) duct. Since such a large duct system would obviously be impractical in a compact speaker system, the passive radiator is a much more practical means of obtaining the same acoustical effect.

A major advantage of this type of low-frequency radiator design is the high

Performance Specifications

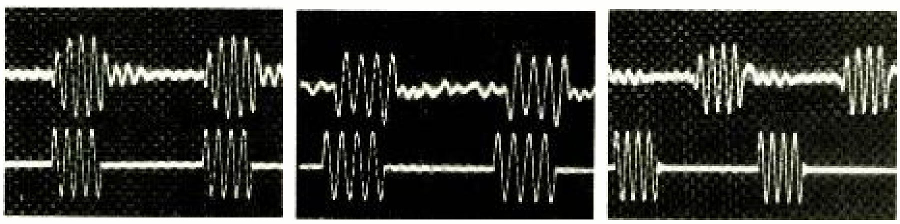
Specification	Rated*
Frequency response (1 meter on axis; anechoic)	42-20,000 Hz ±3 dB
Dispersion at −6-dB points	1 kHz, 125° 10 kHz, 70°
System sensitivity	1 watt input of white noise produces 90 dB SPL at 1 meter
Power capacity	
Acoustic	60 Hz
Electrical	2.5 kHz
Nominal impedance	8 ohms
Minimum impedance	6.4 ohms

*Manufacturer's specifications are given. Because of differences in test conditions, only impedance could be verified.

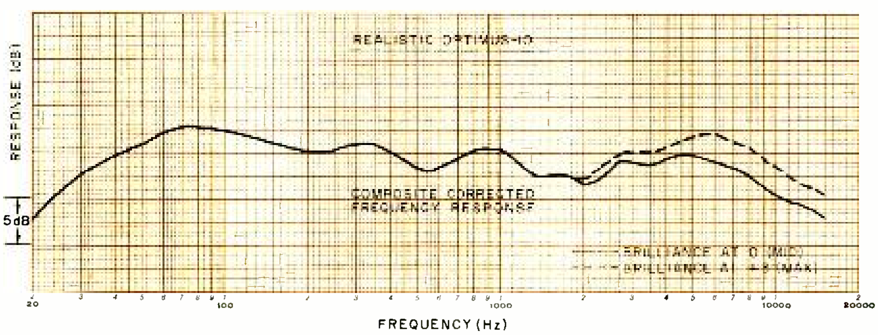
efficiency it makes possible, as compared to conventional sealed acoustic-suspension schemes. Although the driver is rated to handle up to 75 watts of program material, the manufacturer suggests that a 15- or 25-watt amplifier will adequately drive the system to produce good listening volume in a typical room, and amplifiers rated up to 100 watts can be used safely.

The BRILLIANCE control, together with a graphic display of its effect on the system's response, is located behind the grille, where it is concealed from sight in normal use. The center of its range is indicated as the "flat" setting. The enclosure's black grille cloth is on a wooden frame and is held in place by plastic snap fasteners.

Connectors are located on the rear of the enclosure. They consist of a pair of screw terminals and a phono jack for easy connection to amplifiers and receivers fitted with phono-jack speaker outputs. The inside of the enclosure has a single sheet of ½"-thick padding on its rear wall, in contrast to the typically heavier use of sound absorbent material found in most speakers.



Tone-burst response (from left to right) 60, 500, and 5000 Hz.



Composite frequency response for two brilliance control settings.

Laboratory Measurements. With the BRILLIANCE control set to its center position, frequency response of the speaker system measured in the reverberant field of the room was smooth and generally flat, with a gradual slope beyond 7000 or 8000 Hz. The output varied by about ±2 dB from 150 to 9000 Hz, and was down another 5 dB or so at 15,000 Hz. The high-frequency response, measured both on-axis with the speaker and about 30° off-axis, was virtually the same in both cases, confirming the excellent dispersion characteristic of the tweeter.

The woofer's response was measured separately for the driven and passive cones, using close microphone spacing. After correcting for relative areas of both drivers, we combined their curves to form a single bass-response curve, which is equivalent to an anechoic measurement. We then joined this curve with the curve we obtained from our middle/high-frequency response measurements. The resulting curve revealed a broad, smooth frequency response void of significant peaks and dips. The curve varied less than ±3 dB from 30 to 8000 Hz before dropping off to −7 dB at 15,000 Hz.

The BRILLIANCE control's maximum setting boosted output in the upper registers by as much as 3 dB and cut it by about 2 dB. Although the manual that came with the speaker system states that the BRILLIANCE control's effect is principally in the 10,000-to-20,000-Hz range, it actually controlled the output levels at frequencies starting at about 2000 Hz, as would be expected from the system's crossover frequency. With the control set at maximum, the system's overall response was ±3 dB from 30 to 13,000 Hz.

The system's impedance reached its minimum of about 8 ohms in the range between 100 and 300 Hz. It rose to 40 to 45 ohms at the two bass resonances of 26 and 66 Hz. Bass distortion, measured at a 1-watt nominal input level, was less than 1% from 100 down to 40 Hz. It rose to 5% at 34 Hz and to 10% at 31 Hz. With a 10-watt input, the distortion increased markedly, which is not unnatural, measuring 2% to 3.5% down to 40 Hz and 10% at 35 Hz.

The tone-burst response was good at

all frequencies, and system efficiency was very high. We measured a 93-dB SPL at a distance of 1 meter from the grille with the speaker system driven by one octave of random noise centered at 1000 Hz. This is about 3 dB better than the system's rated sensitivity. The difference is explainable by the fact that our measurement was made in a live room, while the rated sensitivity is based on the system's anechoic response.

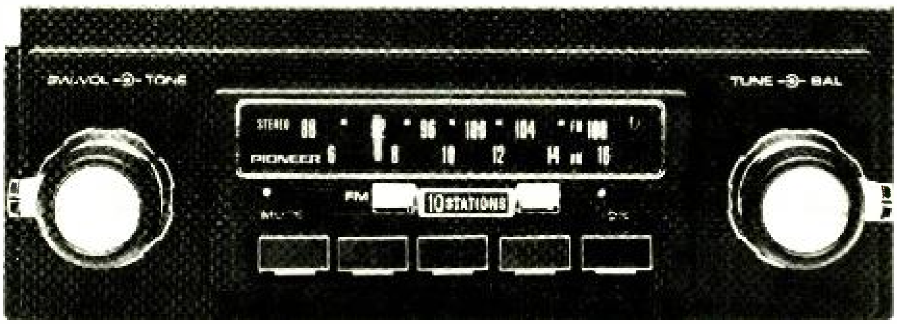
User Comment. The speaker system sounded just as its frequency response curve suggests. Its sound is smooth and clean, although it lacks some of the "sizzle" that some speaker systems exhibit at the highest frequencies. We generally preferred to use it with the BRILLIANCE control fully advanced in our fairly absorbent listening room. In spite of the apparent loss of extreme high-end output, the speaker system certainly did not sound deficient in highs. Its overall sound was nicely balanced, and there was little or no midbass booming or heaviness, in spite of its very good deep-bass response.

We generally drove the speaker system(s) from medium-powered 50-to-80-watt receivers, but we also operated it with a 200-watt amplifier with no problems. There is little danger of blowing out the system, since it produces a *very* high sound level with power inputs far below its safe limits. Hence, one's ears would balk at the sound level before the power level reached the danger point for the system.

The Optimus-10 should probably be compared to other speaker systems that carry higher "list" prices, since it is not usually discounted the way most other systems are. Accordingly, it can hold its own nicely in the $150 to $200 speaker system market. The Optimus-10 is, at the least, a very listenable system that's well worth auditioning.

CIRCLE NO. 102 ON FREE INFORMATION CARD

Pioneer Model GX-5050 Car Stereo FM/AM Receiver



Pioneer's in-dash automotive receiver provides high sensitivity, low distortion and excellent stereo separation.

THE Model GX-5050 AM/stereo FM car receiver, to which Pioneer Electronics refers as a "Supertuner," has an FM performance claimed to be the equal of a good home component tuner. In spite of its very compact size, the receiver has pushbutton tuning for five each AM and FM stations. Other features include switchable interstation FM noise muting, nonswitchable afc (automatic frequency control), automatic mono/stereo switching, and a high/low sensitivity switch for received signal conditions.

The audio amplifier section of the receiver is EIA rated at 8 watts output into 4 ohms. The tone control is concentric with the combination volume control and power on/off switch. It gives flattest response at its clockwise limit. The left-to-right stereo balance control is concentric with the tuning knob.

The receiver is supplied with a front-panel bezel that permits in-dash installation in a number of Ford and GM cars. The receiver measures 7⅛"D × 5¼"W × 2"H (18 × 13 × 5 cm) and weighs 3.1 lb (1.4 kg). Its nationally advertised value is $149.95.

General Description. As might be expected of such a compact receiver, the Model GX-5050 takes advantage of the space-saving qualities of IC's. The discrete FM front end has a FET r-f amplifier and bipolar oscillator and mixer. All AM and FM tuning is accomplished by varying inductances, where ferrite cores slide into the coil forms. There are no variable capacitors in the tuning system. The FM afc is applied through a Varactor diode.

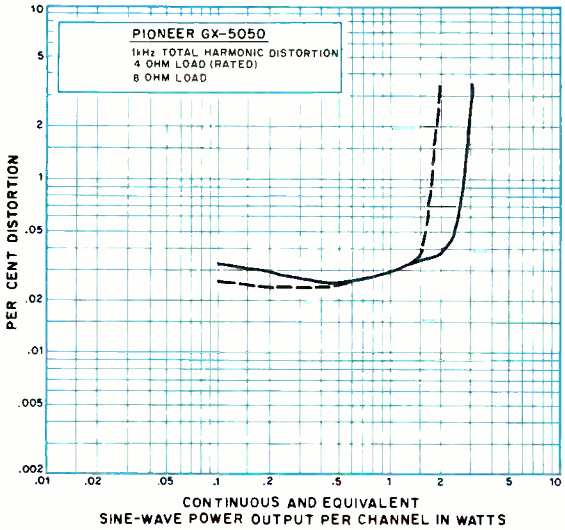
The balance of the basic FM tuner and audio amplifier functions are performed by IC's. One IC is used for i-f gain, another for limiting and quadrature detection, two more for multiplex demodulation, and a final two for separate audio channel amplification.

Separate transistors are used for interstation noise muting and voltage regulation. (Although the receiver operates from a nominal 13.8-volt dc supply, its allowable range is 11 to 16 volts, and all its circuits are designed to operate at a potential of roughly 9 volts. This potential can be obtained in a stable, regulated form with any rated input voltage.)

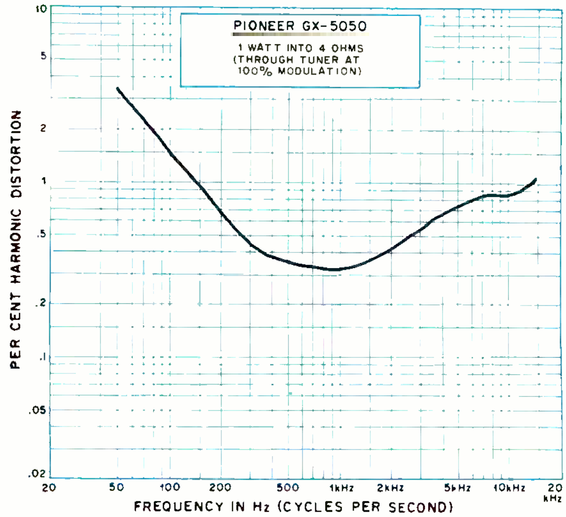
Surprisingly, the AM tuner section does not use the single IC "tuner on a chip" found in many home receivers. Instead, it employs four transistors and a number of passive components.

The AM/FM selection switch transfers the power supply bus to the selected tuner section and the diode switches that transfer the audio amplifier's inputs to the output of either tuner. It also transfers the mechanical pushbutton linkage to the coils of one tuner or the other. In spite of its very small size, the tuning assembly moves six cores as it is driven from the tuning knob.

The published specifications for the FM tuner include a 12-dBf usable sensitivity and a 50-dB quieting sensitivity of 14.3 dBf (1.1 and 1.4 μV, respectively, into the 75-ohm antenna input). The 63-dB S/N specification is not quite what one would expect from a good home FM tuner, but it is more than adequate for the usually noisy environment of a vehicle. Other ratings include a 1.7-dB capture ratio, 74-dB alternate-channel selectivity (very good), 32-dB stereo chan-



THD into 4 and 8 ohms.



Harmonic distortion at 4 ohms.

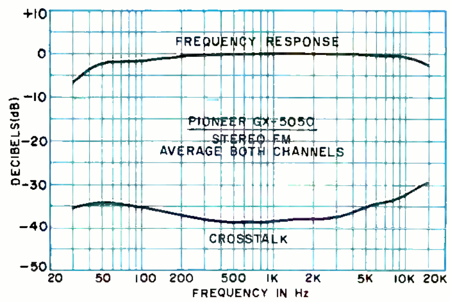
nel separation, and 0.8% and 0.95% distortion in mono and stereo. The frequency response is rated at 50 to 12,000 Hz at the 3-dB down points.

Laboratory Measurements. Although we attempted to test the receiver as we would test a home receiver, some differences were unavoidable. This was particularly true in the audio section because it could be tested only through the FM tuner section and because it is rated by EIA rather than the usual IHF standards used for home hi-fi equipment.

We do not know the EIA standards for car radios offhand. The EIA standards for home-entertainment amplifiers allow power to be rated at 5% distortion at 1000 Hz and on a music power basis in which the supply voltages are maintained at their no-signal levels. This should give some indication of the fundamentally different approaches taken by the EIA and IHF.

Since we performed our measurements using IHF standards, we had no expectation of duplicating the published ratings for the receiver. Needless to say, there were many discrepancies in our test results when compared to the published specifications. We also used a fully charged 12-volt automotive battery as our power source instead of the nominal 13.8-volts normally found in a car's electrical system, which could account for a discrepancy of about 25% in output power measurements obtained versus the published rating.

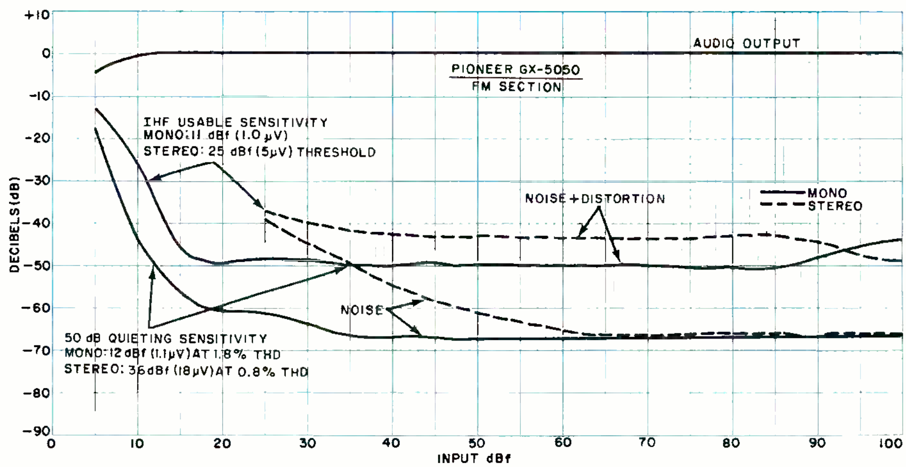
With both channels driving 4 ohms and a mono signal applied via the antenna terminals, the output clipping power of the receiver measured 1.63 watts/



Frequency response and crosstalk.

channel. (Into 8 ohms, the clipping power was 1.02 watts/channel.) At low frequencies, the distortion rose appreciably, which caused us to elect to measure the distortion-versus-frequency characteristic at a 1-watt output level into 4 ohms. (Through any reasonably efficient speaker, as would likely be used in a car, this power can produce a very considerable listening level.) From a maximum of 3.6% at 50 Hz, the distortion diminished to just slightly greater than 0.3% in the midrange and rose to 1% at 15,000 Hz. The 1000-Hz distortion was 0.3% or less up to about 1 watt. It reached 1% at 1.8 watts into 8 ohms and 2.8% into 4 ohms. The audio frequency response could not be measured separately, because of the inaccessibility of the audio amplifier's inputs. Hence, it was included in our FM tuner response measurements.

The FM tuner section lived up to its "Supertuner" name, at least in those characteristics that are important in mobile service. The mono IHF usable sensitivity was 11 dBf, or 1.1 µV. In stereo, it was set by the automatic switching threshold at 25 dBf (5 µV). The 50-dB quieting sensitivity was 12 dBf (1.1 µV) in mono and 36 dBf (18 µV) in stereo. The respective distortion levels were 1.8% and 0.8%. The LOCAL/DX switch reduced the sensitivity by 20 dB, which might be desirable when driving by a powerful FM station, to avoid overloading the tuner's front end. The FM tuner distortion (including audio distortion, but



Noise and sensitivity curve for the Model GX-5050.

at a fraction of a watt) with a 65-dBf (500-μV) input was 0.32% in mono and 0.68% in stereo. The S/N at a 65-dBf input was about 67 dB in both modes.

The FM capture ratio was 1.37 dB. AM rejection was 63 dB at 45-dBf (50 μV) input and 57 dB at 65 dBf. Image rejection was about 50 dB. This was the only specification in which the tuner fell appreciably short of meeting its ratings; it is rated for 61 dB of image rejection. However, the alternate-channel selectivity was a very good 72.6 dB, and adjacent channel selectivity was 6.4 dB. The muting threshold was 9.7 dBf (0.8 μV), which was sufficient to suppress noise between stations without interfering with the reception of any station capable of giving satisfactory quality. The 19-kHz pilot carrier leakage of −42 dB would be considered poor in a home receiver, where it could interfere with the operation of a Dolby circuit in a tuner or tape deck, but neither of these considerations apply in mobile service.

The FM frequency response, again including the audio amplifier section, with the tone control set to "flat," was down 2.5 dB at 45 and 15,000 Hz. The stereo channel separation was excellent and very uniform. It was between 34 and 38 dB from 30 to 6000 Hz and still 29 dB at 15,000 Hz. The AM frequency response was down 6 dB at 40 and 2200 Hz. The audio tone control rolled off above 500 Hz at a 6 dB/octave rate.

User Comment. We operated the receiver on our bench from the storage battery, using a 30" (76.2-cm) clip-lead antenna and a pair of highly efficient, high-quality speakers. Although this could hardly be considered an ideal receiving situation, we were pleasantly surprised to find that we could receive 48 fully listenable stations, most in stereo, with excellent audio quality. We have no doubt that the receiver would perform admirably in a car installation. It is easy to tune, with just enough afc to make up for the lack of a tuning indicator but not enough to interfere with separating closely spaced signals.

Although the FM dial scale is calibrated at only 4-MHz intervals and is about 3" (7.6 cm) long, it is usually possible to identify the major stations. The high sensitivity of the tuner complicates matters a little, since the dial is filled with signals.

The receiver is a most impressive example of how much performance can be built into a very small and moderately priced package.

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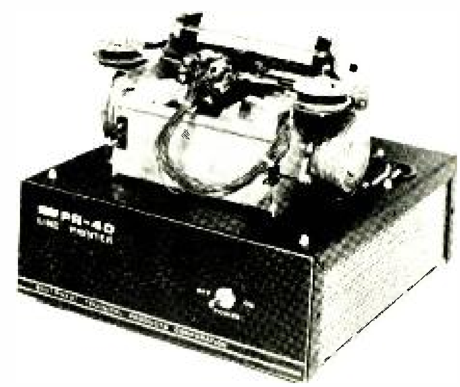

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CIRCLE NO 45 ON FREE INFORMATION CARD

BY WALTER H. BUCHSBAUM

Popular Electronics
AUGUST 1978

Video Cassette Recorders

A RISING VIDEO HOME-ENTERTAINMENT STAR!

A detailed look at home VCR's—types and brands available, how they work, distinguishing features.

THE COMING of the home video tape recorder is being announced again, for at least the third time in 10 years. However, there is a difference this time. Consumers are actually buying the new machines. (About 200,000 recorders were said to have been sold in the U.S. during 1977, and more than twice that many are expected to be sold here this year.) What has made the difference now is that the prices for the new video cassette recorders (VCR's)—which now have full color capability—are in the reasonable price range of $1000. The new machines are simple to load, thanks to drop-in tape cassettes.

Another difference between today's

successful systems and some of their unsuccessful predecessors is that the current crop of machines have built-in TV tuners. This eliminates the need for modifying existing TV receivers to feed programs to them. It also allows the system to tape one program while a different program is viewed. Timers, either built in or available as accessories, allow programs to be taped without human assistance. Classic movies, sporting events, and other forms of entertainment are now becoming available on prerecorded video cassettes, too.

You can also make your own "home movies" by plugging in a video camera. However, color cameras cost as much as, or more than, the recorders themselves, though camera prices are beginning to fall. And the cameras must be tied by cables to the recorders, so you lack the portability of a movie camera.

There are Differences. All the new VCR's have built-in r-f converters that feed signals to your TV receiver, usually on TV channel 3 or channel 4, whichever is unused in your area. (Channel 5-6 converters are available on special order for some models.) The cassettes all hold ½" (12.7-mm) magnetic tape, which can be played only in one direction. You do not, as with audio cassettes, flip the tape over to play the other side. But the similarity stops there.

There are three basic VCR systems on the market, all incompatible with each other. The tapes are available in three different types of cassettes. And they run at different speeds in the three VCR families (see Table opposite).

The first new-generation VCR to enter the U.S. market was the Betamax, developed by Sony and available or coming soon from Aiwa, Pioneer, Sanyo, Sears, Teac, Toshiba, and Zenith. Tapes for these VCR's are also available from Scotch and Ampex, and will be available from TDK next year. The Betamax tapes run at 4 cm/s (1.57 ips) for one hour in the standard-play mode. Newer two-speed Betamax decks can play tapes for two hours at 2 cm/s (0.79 ips), with slightly narrower tracks. (Betamax decks operating only at the slower speed are also available now.) This means that the two-speed machines can play tapes made on the earlier, single-speed models, but not vice-versa. Most Beta-format machines have names like "Betacord" and "Betavision," which makes them easy to identify.

The VHS system, developed and introduced by JVC, will also be marketed by Akai, GE, Hitachi, Magnavox, Curtis Mathes, MGA (Mitsubishi), Panasonic, Quasar, RCA, Sharp, and Sylvania. Tapes for these machines will be available from Fuji, 3M, and TDK. The cassette housing for the VHS tape is 30% larger than that for the Betamax. It runs for two hours at its higher 3.34-cm/s (1.3-ips) speed or for four hours at half speed.

The third competing VCR system is Quasar's Model VR-1000 "Great Time Machine" (not to be confused with Quasar's Model VH-5000, which is a VHS machine). The Model VR-1000 runs at 5.2 cm/s (2.05 ips) and has several technical differences that set it apart from the Betamax and VHS machines.

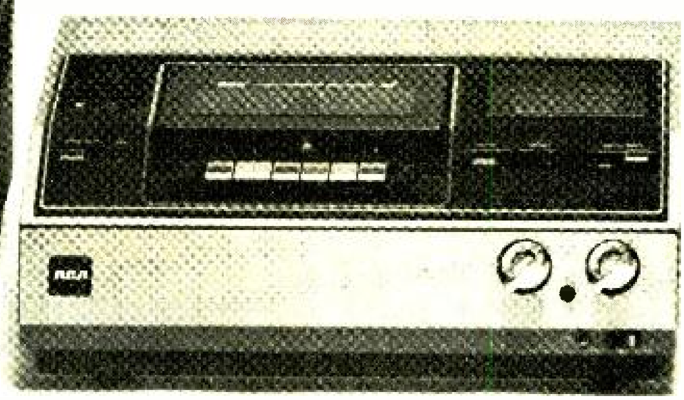
Naturally, the differences between the three basic home VCR tape formats as embodied in the Betamax, VHS, and the Great Time Machine recorders do not permit a single, common playback mechanism.

Recording Techniques. As in high-fidelity audio recording, the object in video recording is to get several octaves of frequencies onto a slow-moving tape. In video, however, the frequencies are much higher and the bandwidth is much wider than in audio (4 MHz vs. 20,000 Hz, which is 17 vs. 10 octaves). Therefore, problems in video recording are more complex than in audio recording.

Achieving sufficient bandwidth for video is a challenge because the output of conventional playback heads is not linear. It rises at a rate of 6 dB/octave as the frequency increases, dropping suddenly when the recorded wavelengths become too short for the tape-head gap. Whereas a 60-dB difference between a head's maximum and minimum output within the audio range can be compensated for by fairly simple equalization, the 102-dB requirement for video bandwidth is not so easy to compensate for in this manner.

To solve the bandwidth problem, most VCR manufacturers select a carrier at about 3.4 MHz and frequency-modulate it with the video (luminance) signal. The color subcarrier is usually converted from 3.58 MHz to somewhere around 600 kHz and is recorded on the same track as the luminance signal. The resulting spectrum resembles that shown in Fig. 1. This approach narrows the fre-

Quasar VR-1000 "Great Time Machine."



RCA SelectaVision VBT200 (VHS).

HOW VIDEO RECORDING SYSTEMS COMPARE

Recorder types	Tape width	Tape speed		Tape consumption per hour		Relative tape-to-head speed		Video track width	Audio track width	Drum diameter	Drum speed	Luminance frequency	Chroma frequency	Cassette dimensions	Cassette volume	Notes
	in.	ips	cm/s	ft²	m²	ft/s	m/s	µm	mm	mm	rpm	MHz	kHz	mm	cm³	
Consumer VCR format:																
Betamax standard-play	½	1.5	4.0	19.7	1.83	22.6	6.9	58.5	1.05	74.5	1800	3.5-4.8	688	156x96x25	374	Note 1
Betamax long-play	½	0.8	2.0	9.8	0.9	22.6	6.9	29.2	1.05	74.5	1800	--- ---	--	156x96x25	374	Note 2
VHS standard-play	½	1.3	3.3	16.4	1.52	19.0	5.8	58	1.0	62	1800	3.4-4.4	629	188x104x25	489	Note 3
VHS long-play	½	0.7	1.67	8.2	0.8	19.0	5.8	35	1.0	62	1800	3.4-4.4	629	188x104x25	489	Note 4
VR-1000 (VX-2000)	½	2.1	5.2	25.6	2.4	29.8	9.1	48	0.4	48	3600	3.1-4.6	688	213x146x44	1368	Note 5
Institutional & industrial:																
V-Cord II	½	2.9	7.4	36.4	3.4	25.4	7.7	60	1.0	81.3	----	3.1-4.3	688	156x108x25	421	
V-Cord (skip-frame mode)	—	1.5	3.7	18.2	1.7	----	---	---	1.0	81.3	----	--- ---	---	156x108x25	421	
U-Matic	¾	3.75	9.5	70.3	6.5	33.7	10.4	85	0.8	110	1800	3.8-5.4	688	222x140x32	995	
EIAJ open reel	½	7.5	19.1	93.6	8.7	36.4	11.1	110	1.0	115.8	----	3.1-4.5	767	--- ---	---	
Audio recorder formats:																
Compact cassette	1/7	1.88	4.8	3.5	0.33	1.88	4.8	none	0.5	none	none	none	none	100x64x12	77	
8-track cartridge	¼	3.75	9.5	5.9	0.54	3.75	9.5	none	0.5	none	none	--- ---	---	140x100x19	266	
Elcaset	¼	3.75	9.5	11.7	1.1	3.75	9.5	none	1.0	none	none	--- ---	---	--- ---	---	
7½ ips reel	¼	7.5	19.0	23.4	2.2	7.50	19.1	none	1.0	none	none	--- ---	---	--- ---	---	

Note 1: Video S/N: 43 dB; Resolution (lines): 250 B&W, 240 color; audio response: 50-10,000 Hz, S/N 40 dB, 3% HD; Play time: 30, 60
Note 2: Video S/N: 45 dB; audio response: 50-8000 kHz; Play time: 60, 120
Note 3: Video S/N: 45 dB; Resolution (lines): 300 B&W, 240 color; audio response: 40-10, 000 Hz, S/N 43 dB; Play time: 60, 120
Note 4: Play time: 60, 120 minutes
Note 5: Play time: 60, 120 minutes

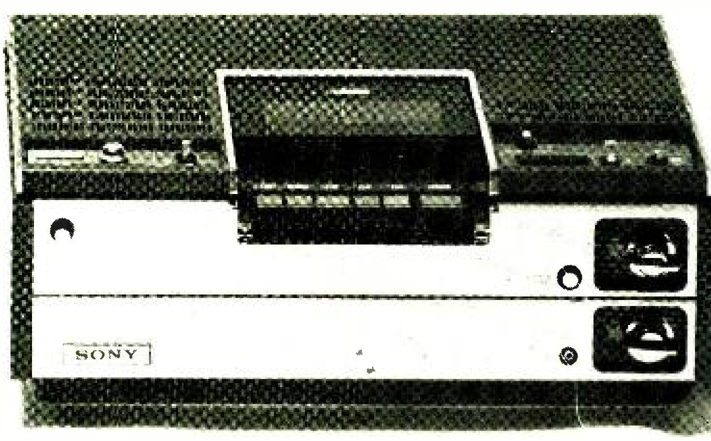
quency range down to only about 2.5 or 3 octaves.

Frequency-modulating the luminance signal makes it relatively insensitive to noise and dropouts since the constant-amplitude signal fully saturates the tape. At the same time, the high-frequency luminance signal serves as an ac bias for recording the chroma signal. This still leaves the problem of recording frequencies far higher than any in the audio range. The culprit is the short wavelengths resulting from the high frequencies, as shown in Fig. 2. The tape's motion past the heads can be speeded up to lengthen any frequency's recorded wavelength to make recording easier. But as tape speed is increased, so also is tape consumption. Narrowing the head gaps (to about 0.02 mil), applying equalization, and employing other techniques certainly help, but higher head-to-tape speeds must still be used to solve the problem.

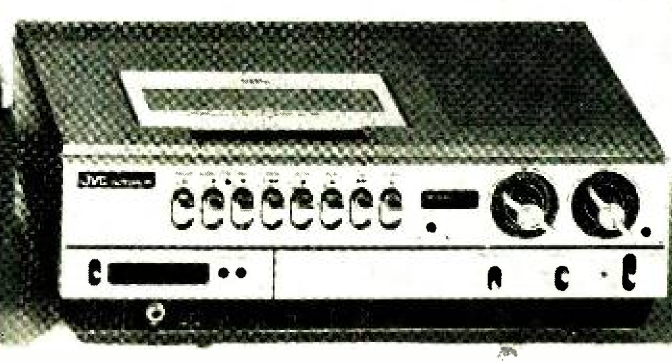
It takes a bit of trickery to increase the tape-to-head speed while maintaining an economical reel-to-reel tape consumption. This is accomplished by having the tape heads move, too. This is done with a rotating head drum around which the tape is wrapped during record and playback, as shown in Fig. 3. This allows tape-to-head "writing" speeds of 114 to 358 ips, using tape speeds of only 0.7 to 2.1 ips!

Video is transmitted in discrete "fields". (Two fields, one with odd and the other with even lines, interlace on the screen of the picture tube to form each complete "frame" of video information.) Since there is a natural break after every field, home video recorders usually record each field as a separate track that runs diagonally across the tape, as in Fig. 4. The drum is, therefore, angled slightly to the tape path to make the diagonal tracks. Each track is a portion of a helix; hence, this track arrangement is called "helical scan." Two other tracks are recorded by stationary heads along each edge of the tape—an audio track along the upper edge and a control track along the lower edge, which synchronizes the drum in playback so that each video head will "read" its proper track.

Audio track widths are 1.0 and 1.05 mm in the VHS and Beta formats, respectively. These tracks could probably be split in two for stereo or bi-lingual use, as is now done with the 0.8-mm au-



Sony Betamax SL-8200.



JVC Vidstar (VHS).

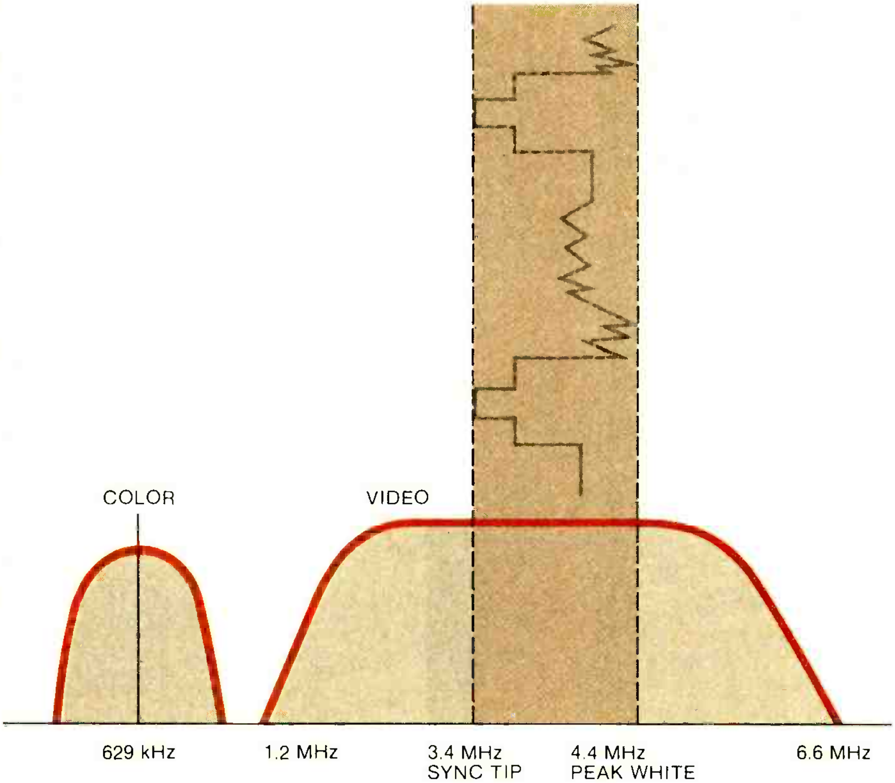


Fig. 1. Video signal spectrum of typical VCR. Luminance signal is recorded as constant-amplitude AM.

dio track of the U-Matic system. The 0.4-mm track of the VR-1000, however, would allow less successful double tracking. (For comparison, stereo sound cassettes have 0.53-mm tracks.) Both Betamax and VHS specify audio frequency ranges of 50-10,000 Hz at their higher speeds (about equivalent to audio cassette speed), with signal-to-noise ratios of 40 and 43 dB, respectively. This may prove inadequate for the full-fidelity TV sound now transmitted by networks and PBS (up to 15,000 Hz).

Another way to conserve tape is to use very narrow tracks of about 29 to 58 micrometers (1.2 to 2.3 mils) wide. This is only about one-tenth the width of a stereo sound track on a cassette tape. Under these conditions, crosstalk can become a severe problem. One way to avoid the problem is to leave blank "guard" bands (Fig. 5A) between adjacent tracks, as is done with audio and earlier video recorders. But this wastes tape area. Hence, the Betamax and VHS systems omit the guard bands, relying on differences between adjacent tracks to reduce crosstalk. (Fig. 5B)

One such difference relies upon the "azimuth" recording method. Here, the angle between the head gap and its path along the tape is offset slightly from the usual 90°. The two heads are offset in opposite directions; ±7° in Betamax and ±6° in VHS recorders. At the high frequencies of the luminance signal, the 14° or 12° "misalignment" between the playback head and the crosstalk signals from the neighboring tracks greatly reduces the head's pickup of those undesired signals. (In the single-head

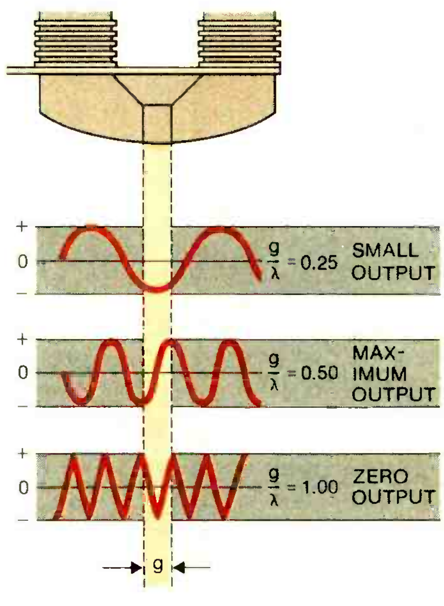


Fig. 2. Tape head output peaks when wavelength (λ) is 2X head gap width (g), drops to 0 when both are equal.

Quasar Model VR-1000, of course, this technique cannot be used. It uses guard bands instead.)

The lower frequencies and longer wavelengths of the chroma signal are less sensitive to azimuth differences. Therefore, another way of reducing crosstalk must be used. Here, the electrical phase of the recorded signal on adjacent tracks is changed so that phase cancellation can be used on playback. Phase changes are based on horizontal sweep periods so that crosstalk on adjacent scan lines will cancel out and not be visible on the screen.

But crosstalk is not the only problem caused by the narrow video tracks. There is also the problem of noise. This becomes worse in the extended-play machines, whose track width is only about half that of the "normal-play" Betamax and VHS systems. Both systems therefore incorporate nonlinear pre- and de-emphasis systems, somewhat similar in principle to Dolby noise-reduction. Extra high-frequency pre-emphasis is

Video color cameras, now costly, promise to drop in price.

added to the luminance signal during long-play recording. But, as in the Dolby system, this pre-emphasis is reduced when the high-frequency amplitude is already sufficient to override the noise. If the pre-emphasis were not reduced for strong high-frequency signals, the tape would be overmodulated. The playback de-emphasis circuit is also nonlinear, of course. Sony claims that this noise reduction is actually greater than the noise increase caused by the narrower track. In fact, they specify a signal-to-noise ratio 2 dB *better* at its slower than at its faster speed.

In playback, synchronizing the head drum with the tape so that each head scans its proper track correctly requires the special control track mentioned above. This is usually a 60-Hz square-wave signal. During recording, pulses derived from the 60-Hz vertical sync pulse at the beginning of each TV field are recorded on this track. Then, during playback, this sync pulse is used to control the speed of the drum and tape transport (Fig. 6). It is also used to insure that the switchover from one head to the other occurs when it would not be visible on the screen. The head drum is controlled by a feedback servo system, usually with a manual "tracking" adjust trimmer in the servo loop to "fine tune" playback for tapes recorded on another machine or for stretched tapes. This is standard practice in video recorders, but it is important in the new home VCR's, where tracks are so narrow.

The use of narrow tracks can cause dropout problems. Dirt and minute tape imperfections that momentarily disturb tape-to-head contact cause these dropouts, which are seen as short streaks on the TV screen. Dropout-compensation circuits are used to combat this problem. A typical circuit stores each line in a delay circuit, where it can be used to substitute for the next line should a dropout occur. Up to three or four sequential lines can contain the same information before the viewer notices that something is amiss.

Threading the Tape. Since the tape inside the cassette must wrap around the head drum—just over half way in the two-head Betamax and VHS systems, and all the way in the Model VR-1000—fairly complex tape paths must be used. Most complex of these is Betamax's (Fig. 7A), a simplification of the "U-load" system used in professional U-Matic cartridge machines. Small arms in the transport pull the tape out from the cassette and wrap it around the head drum, audio and control-track heads, and several tape guides.

The VHS system's "M-load" scheme is simpler (Fig. 7B). Here, the tape is

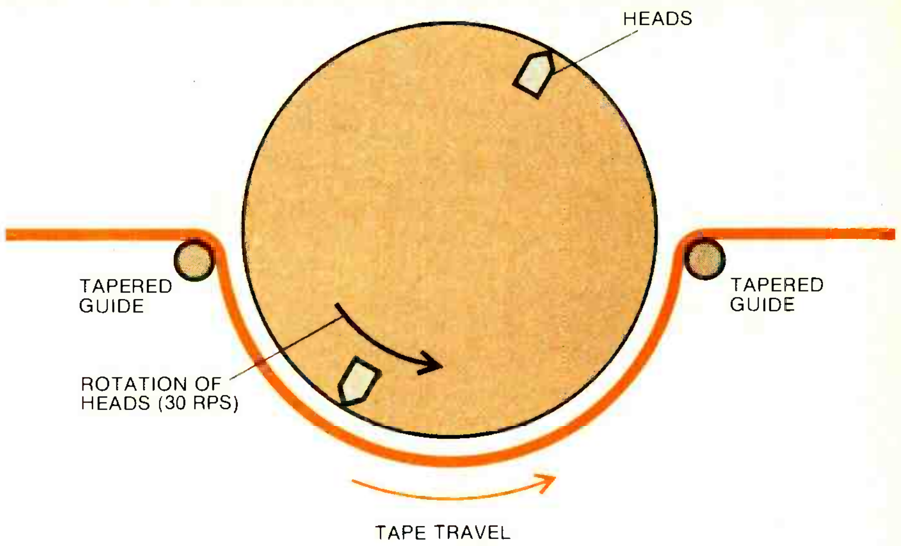


Fig. 3. Tape on rotating head drum allows second head to write second field as first head completes recording its field in this half-wrap helical scan format.

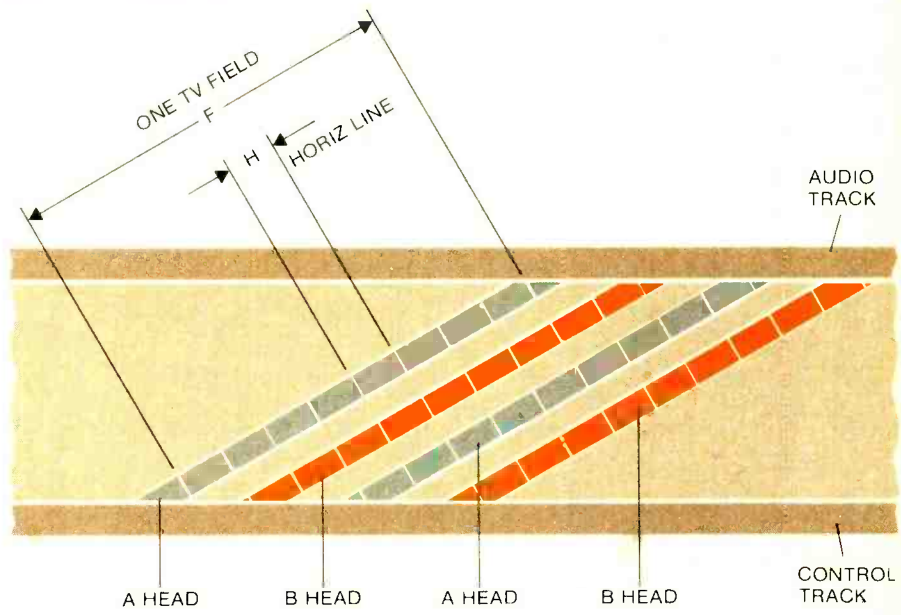


Fig. 4. Head drum axis is tilted so that video heads write diagonal tracks. Audio and control tracks are recorded by stationary heads.

Programmers are available (Panasonic shown) that can be set to automatically select channels and times for a week's recordings.

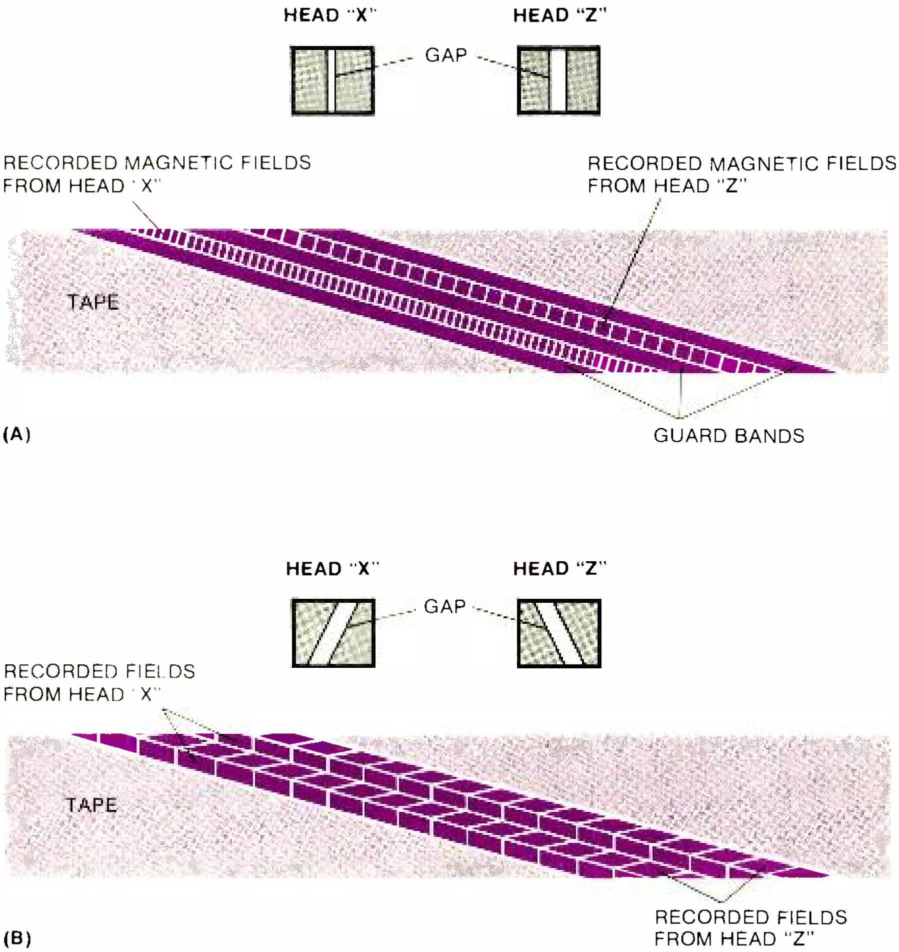


Fig. 5. Blank bands between tracks in early video recording (A) prevented crosstalk. Today's VCR's (B), except Quasar VR-100, incline video heads in opposite directions to eliminate blank areas.

drawn almost straight out of the cassette at two points. Then it is wrapped halfway around the head drum.

The "Alpha-wrap" system employed in Quasar's Model VR-1000 is the simplest of all (Fig. 7C). The necessarily higher speed of the single-head drum permits the drum to be smaller for a given "writing" speed. Also, the faster tape speed requires more tape for the same running time and, thus, a larger cartridge. The small drum can easily fit inside the large cartridge. In loading, the cartridge is simply lowered over the drum. No arms are required to pull tape from the cartridge because the tape is already in its wrap position. The tape's full wrap around the head drum resembles the Greek character "alpha" (α), hence the origin of its name. The Model VR-1000's cartridge has another difference: its two tape hubs are arranged one above the other rather than side-by-side, as in Betamax, VHS, and audio cassettes.

Tape lengths vary. For the Betamax, there are tapes that run for 30, 60, and 90 minutes at standard-play speed or 60, 120, and 180 minutes at the long-play speed. In addition, an accessory changer with a two-cassette capacity may become available to effectively double these times, with a break of less than 15 seconds for the change cycle. VHS cassettes are available now in lengths running 60, 120, and (later) 180 minutes at normal speed and twice

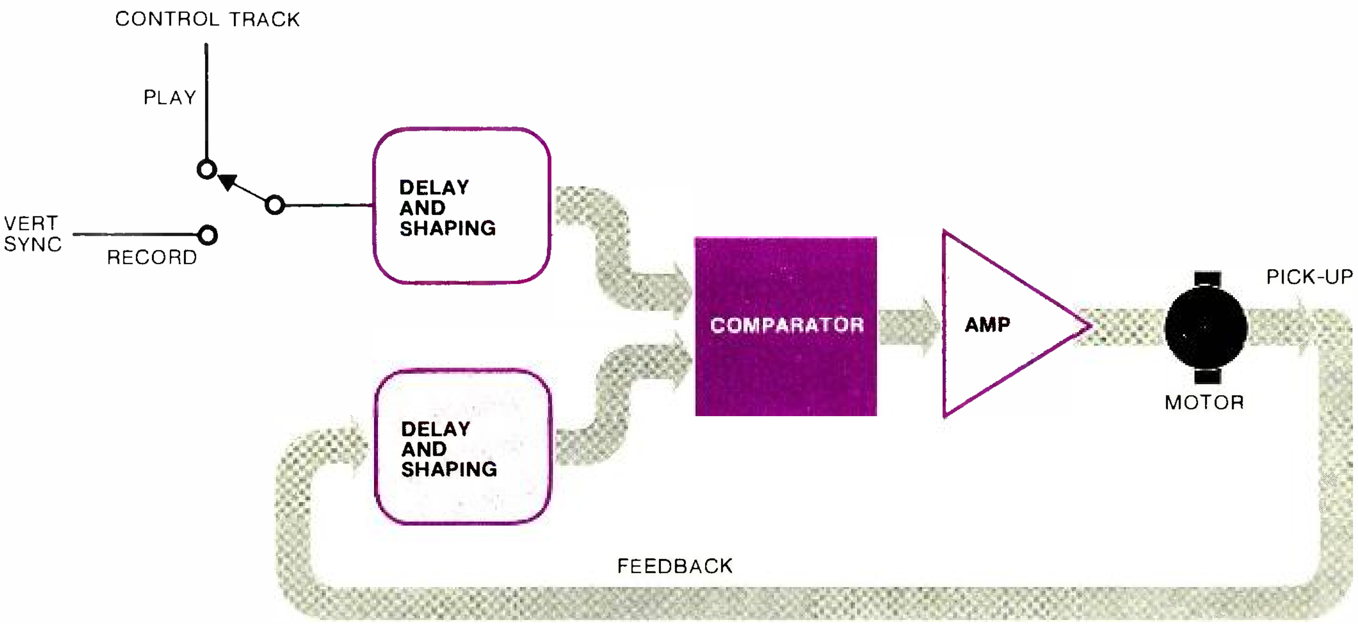
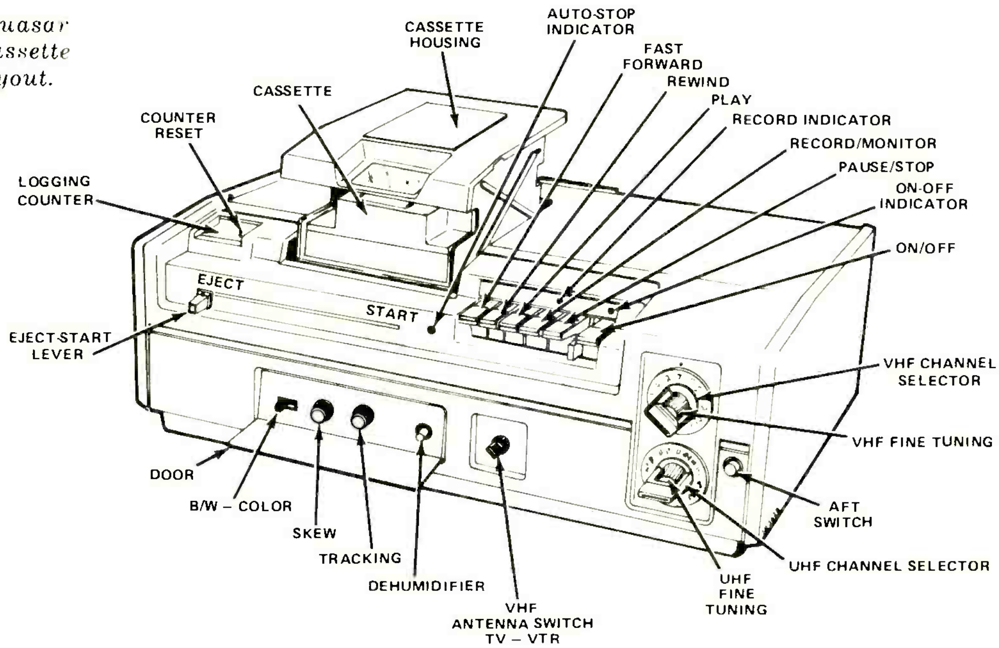


Fig. 6. Vertical sync signal on control track controls playback motor speed so video heads scan correct video tracks.

Here's an example (Quasar VR-1000) of a video cassette recorder's control layout.



these times at slow speed. The single-speed Model VR-1000's cartridge offers either 60- or 120-minute lengths.

What to Look For. The home video cassette recorders on the market at this writing offer basically similar features. But there are some differences. First is the matter of recording time and tape cost. There's very little on the air that runs more than two hours (and 3-hour cassettes are coming for the 2-hour machines), so longer recording time may or may not be a factor to consider. However, recording at a slower speed does lower tape cost, which almost certainly will count in your decision. Two-speed machines will also be more compatible with other video recorders than will a one-speed machine. On the other hand, two-speed decks cost more (though the tape savings should take care of that). Decks operating only at the higher speed may have better picture quality, too, because of their wider track. (This will not be true when playing tapes made on a two-speed machine because the wider-track head will "read" some of the random noise between the narrow tracks.) When it comes to judging pic-

The most popular VCR application is automatic taping of programs you'd miss because you're away, busy, or even watching another channel. But with the addition of a video camera, you can also make home "movies," as shown here.

HOW VCR FORMATS WORK

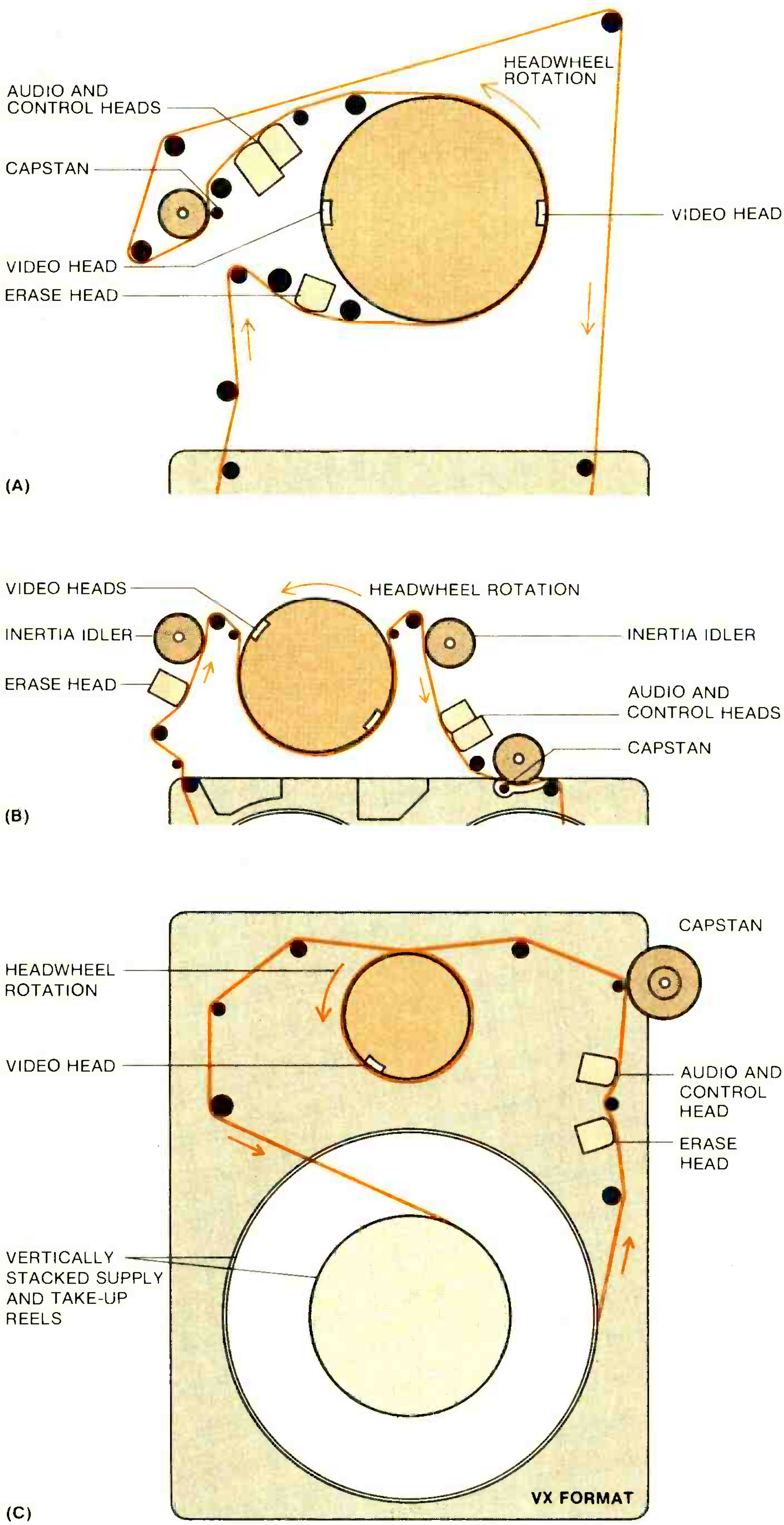


Fig. 7. Various ways of video-tape passage through VCR machine: (A) Betamax's modified "U-load;" (B) simpler "M-load" used by VHS; (C) "Alpha-wrap" on Quasar's VR-1000.

ture quality, you may have trouble spotting differences when looking at a small screen. If you want to be sure you get the best possible picture, try to find a store that uses a large-screen TV projection unit for its VCR demonstration.

In comparing VCR prices, check whether the timer is included in the price or not—it always is on models whose timers are built-in, but external timers may or may not be included in the price. You might prefer to get a unit without a timer if one of the new "programmer" units (which change channels as well as turning the set on and off at present times) has been announced for that VCR. Such a programmer makes a 4-hour recording capacity more worthwhile, too, as you can then record several programs on one tape. This can be done even if they're on different channels with time-gaps between them.

There are differences in weight and size, too—ranging from the Quasar VR-1000 (22½" x 16-⅛" x 8½", 44 lb.) to the compact JVC "VidStar" (17-⅞" x 13-15/16" x 5-13/16", 30 lb).

So, too, are there differences in tape cartridge prices and local availability. Depending on brand and tape length, a blank cartridge could cost anywhere from $13 to $28. Prerecorded movie prices retail from $30 and up.

In Closing. In addition to the details given above, different manufacturers emphasize special features for their VCR's. These include audio dubbing, tape counters, a pause control, and a "dew" indicator and lockout circuit. Several VCR's, for example, contain amber lights that come on when there is excessive moisture in the area around the rotating drum. When this occurs, the drum will not rotate, in which case, the power must be left on until the moisture evaporates and the indicator extinguishes. Quasar's VR-1000 has a heater to accelerate evaporation.

Home VCR's have really been on the market only since 1977 in any quantity. So we can be fairly certain that advances and changes will occur as the market and product matures. For example, JVC has just introduced a variable-speed VCR that features stop-frame and slow motion. Also, portable video tape recorders show promise of being marketed. And, if camera prices decrease appreciably, one can take advantage of the "home movies" capability of VCR's, which costs only 20 cents a minute vs. $3 a minute with photo equipment. ◇

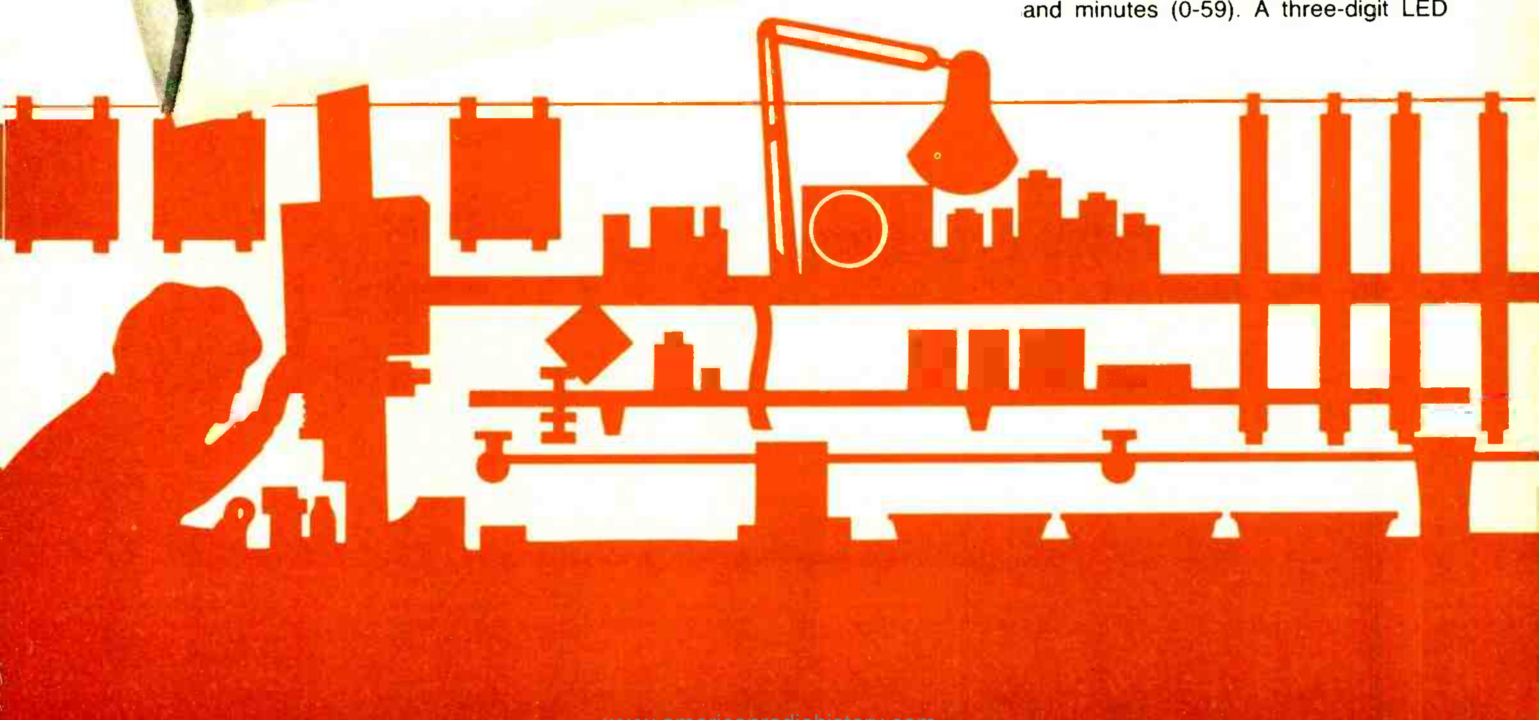
BY MICHAEL S. ROBBINS

BUILD A DIGITAL DARKROOM TIMER

A solid-state precision interval timer to control an enlarger or other time-powered device.

A DARKROOM or other precision-application timer should possess the following attributes: accuracy; precise repeatability; provisions for setting the timing interval in minutes and seconds or hours and minutes; and a method of displaying elapsed time clearly in low ambient light levels. Most commercially available timers are electromechanical devices which fall short in one or more of the cited areas. The "Digital Darkroom Timer" described here, however, offers all of these features.

Its accuracy and precise repeatability are ensured by the use of a digital clock IC whose timebase is the 60-Hz ac line frequency. The timing interval is easily set by rotating three thumbwheel switches calibrated in minutes (0-9) and seconds (0-59). At the flip of a switch, the calibration is changed to hours (0-9) and minutes (0-59). A three-digit LED



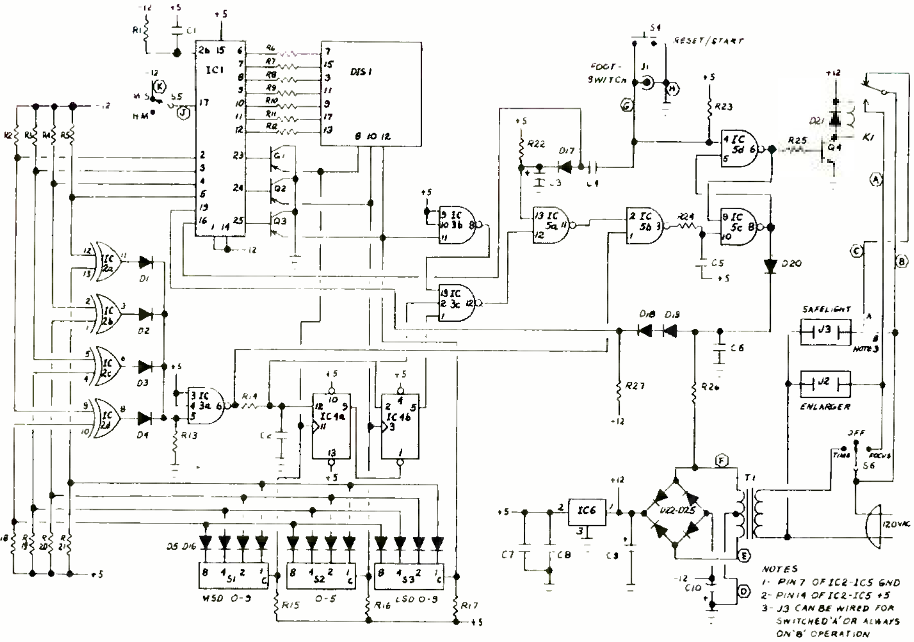


Fig. 1. Schematic diagram. PMOS clock chip IC1 counts 60-Hz pulses and produces seven-segment and BCD outputs.

display indicates elapsed time, and is useful when dodging or burning-in small areas of a print or when timing multiple-chemical processes. The display is rather small and not too bright, so it won't affect most black-and-white printing. (For film processing or work involving very sensitive paper, a deep red filter can be placed over the display.)

Two ac power sockets are mounted on the project enclosure, one for an enlarger and the other for a safe-light. The timer employs a three-position toggle switch labelled FOCUS/OFF/TIME. In the FOCUS position, the enlarger's power socket is energized. This allows the user to install a red filter under the enlarger lens and adjust the focus without exposing the photographic paper. In the TIME position, a panel-mounted pushbutton switch or optional footswitch resets the circuit and initiates the timing interval. In the OFF position, power is removed from the timer, the enlarger, and, at the builder's option, the safelight.

Of course, the timer can be used in many applications outside the darkroom. As is, it can function as a delayed turn-off switch for a radio, portable television, or a small lamp. When connected to an outboard relay or thyristor, the project can power a large television receiver, an audio system, home lighting, or even a coffee pot!

About the Circuit. A schematic diagram of the timer is shown in Fig. 1. The heart of the project is *IC1*, a National Semiconductor MM5309 full-function PMOS clock chip. The MM5309 has multiplexed seven-segment and binary coded decimal (BCD) outputs as well as a reset input. These features make the IC ideally suited for use in this project.

Momentarily closing RESET/START switch *S4* causes *C4* to apply a negative-going pulse to pin 16, the RESET input of *IC1*. Upon receipt of this pulse, the clock chip resets its counters to 00:00:00. The ac waveform at the secondary of *T1* is sampled by *R26*, rectified and level-shifted by *D18*, *D19*, and *R27*. The resulting 60-Hz pulse train is applied to pin 19, the timebase input of *IC1*.

The clock chip counts the pulses and produces multiplexed seven-segment (pins 6 through 12) and BCD (pins 2 through 5) outputs. The seven-segment outputs are connected via current-limiting resistors *R6* through *R12* to the segment enable lines of *DIS1*, a nine-digit, calculator-type LED display. Of the nine digits in the display only three are used. Driver transistors *Q1* through *Q3* interface the appropriate digit enable outputs of the clock chip and digit enable lines of the display.

The BCD outputs of the clock are routed to one set of inputs of a digital comparator comprising the four exclusive-OR gates, a diode OR gate composed of *D1* through *D4* and *R13*, and NAND gate *IC3A*. The other set of comparator

PARTS LIST

C1—0.005-µF disc ceramic
C2, C4, C5, C7, C8—0.1-µF disc ceramic
C3—5-µF, 12-volt electrolytic
C6—0.01-µF disc ceramic
C9—1000-µF, 16-volt electrolytic
C10—100-µF, 16-volt electrolytic
D1 through D20—1N914 signal diode
D21 through D25—1N4001 rectifier
DIS1—9-digit common-cathode calculator display (National Semiconductor No. NSN-198 or equivalent)
IC1—MM5309N PMOS digital clock chip (National Semiconductor)
IC2—SN7486 quad exclusive-OR gate
IC3—SN7410 triple three-input NAND gate
IC4—SN7474 dual D-type flip-flop
IC5—SN7400 quad 2-input NAND gate
IC6—LM340T-5.0 5-volt regulator
J1—RCA phono jack
J2, J3—Ac power socket
K1—Spdt 12-volt relay (Sigma No. 78RE1-12DC or equivalent)
Q1, Q2, Q3—2N3906 pnp transistor
Q4—2N3904 npn transistor
The following are ¼-watt, 5% tolerance carbon-composition or film resistors:
R1—330,000 ohms
R2 through R5—7500 ohms
R6 through R12—330 ohms
R13—680 ohms
R14—220 ohms
R15 through R21—4700 ohms
R22—22,000 ohms
R23, R24—1000 ohms
R25—10,000 ohms
R26—100,000 ohms
R27—1 megohm
S1, S2, S3—Thumbwheel switches with BCD outputs
S4—Normally open momentary contact pushbutton switch
S5—Spst toggle switch
S6—Spdt toggle switch
T1—18-volt, 150-mA center-tapped transformer (Triad No. F161XP or equivalent)
Misc.—Printed circuit board, IC sockets or Molex Soldercons, pc standoffs, suitable enclosure, hookup wire, line cord, strain relief, misc. hardware, solder, etc.
Note—The following are available from California Industrial, Box 3097, Torrance, CA 90503: Complete kit less enclosure (No. DTK), $34.95; aluminum/hardwood cabinet (No. DTCAB), $12.95; etched and drilled printed circuit board (No. DTPC), $7.95; 9-digit display (No. DTDIS), $1.39; Spdt 12-volt relay (No. DTRY5), $1.39; thumbwheel switches with BCD outputs (No. DTS1), $1.39 each (three required). California residents please add sales tax. Orders accompanied by check or money order will be shipped postpaid within the U.S.A.

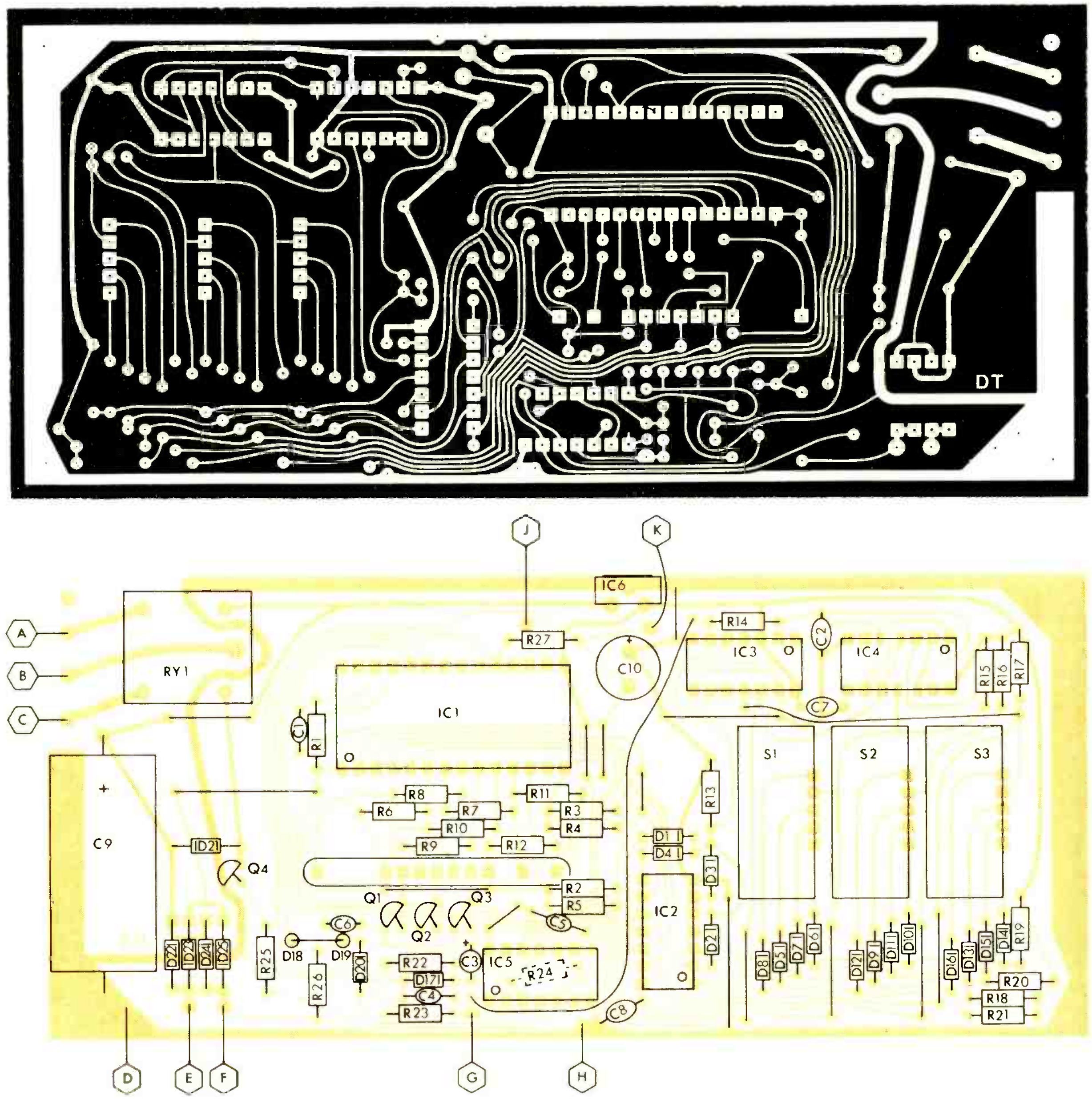
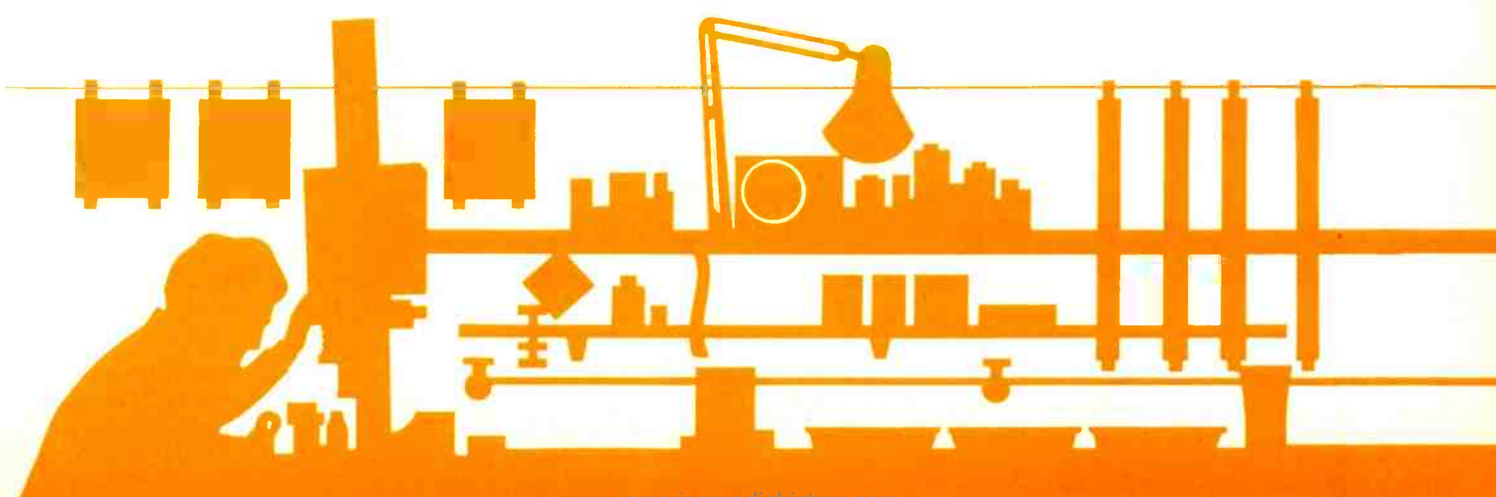


Fig. 2. Full-size etching and drilling (A) and parts placement (B) guides for a suitable printed circuit board.

inputs receives the BCD outputs of thumbwheel switches *S1*, *S2* and *S3*. Because the BCD outputs of the clock are multiplexed, those produced by the thumbwheel switches must be time-multiplexed in a synchronous manner.

This is accomplished by connecting the common (C) switch lugs to the display driver transistors *Q1*, *Q2*, and *Q3*. When, for example, the BCD equivalent of the first time digit is being applied to the comparator, *Q1* simultaneously acti-



vates the appropriate display digit and thumbwheel switch *S1*. Diodes *D5* through *D16* are used to isolate the BCD outputs of the inactive switches from those of the thumbwheel switch activated at any given instant.

The digital comparator generates an output pulse each time the BCD output of the clock chip matches that produced by the corresponding thumbwheel switch. Because all the BCD numbers produced by both the clock chip and the thumbwheel switches are not available simultaneously (again, due to multiplexing), some means of "remembering" the coincidence pulses is required. This function is performed by a memory or latch comprising two D-type flip-flops (*IC4A* and *IC4B*), several NAND gates, and an RS flip-flop formed by two cross-coupled NAND gates (*IC5C* and *IC5D*).

The first D flip-flop is set when the most significant BCD number generated by the clock chip is the same as that generated by *S1*. Similarly, the second flip-flip (*IC4B*) is set when the BCD output of *S2* matches the next-most significant BCD number generated by the clock chip—only if *IC4A* has already been set. This is so because the Q output of *IC4A* is connected to the CLEAR input of *IC4B*, whose PRESET input is tied to +5 volts. Therefore, the Q output of *IC4B* will be held low as long as that of *IC4A* is low.

If the least significant BCD number generated by the clock chip matches the BCD output of *S3* and the two D flip-flops have been set, the RS flip-flop formed by *IC5C* and *IC5D* will be set. Thus, when the elapsed time in BCD form equals the three BCD numbers generated by *S1*, *S2* and *S3*, the RS flip-flop changes state and deprives relay driver *Q4* of base current. The transistor then turns off and deenergizes the relay, removing line power from *J2*, the enlarger power socket. If the safelight power socket (*J3*) is connected using the "A" wiring (see schematic), power will be removed from it when the relay is energized. If *J3* is "B" wired, the relay will have no control over the flow of power to the socket. The safelight will remain powered no matter what position FOCUS/OFF/TIME switch *S6* is in, or whether *K1* is energized or not.

The RS flip-flop is also used to control the application of the 60-Hz timebase to the clock chip by means of a biased diode network (*D18*, *D19*, *D20* and *R27*). When the flip-flop is reset, 60-Hz pulses with high and low levels sufficient to drive the clock chip are applied to pin 19, the chip's timebase input. After the timing interval has elapsed, however, *IC5B* changes state and the dc level at the cathode of *D18* shifts so that the 60-Hz pulse train can no longer trigger *IC1*. The clock chip no longer counts and the display is frozen at a three-digit number which matches the setting of the thumbwheel switches. The setting of *S5* determines the range of the timer—either hours/minutes or minutes/seconds.

Transformer *T1*, diodes *D22* through *D25* and electrolytic capacitors *C9* and *C10* comprise a bipolar, full-wave power supply which produces ±12 volts dc. The relay requires +12 volts, and the clock chip's V_{DD} terminal −12 volts. A third supply voltage, +5 volts, is required by the TTL IC's. Also connected to +5 volts is the V_{SS} terminal of the PMOS clock chip. This allows the chip to drive the TTL IC's directly with no need for level shifting. Voltage regulator *IC6* derives the required +5 volts from the +12-volt supply. Capacitors *C7* and *C8* ensure the stability of the regulator IC and keep noise off the +5-volt line.

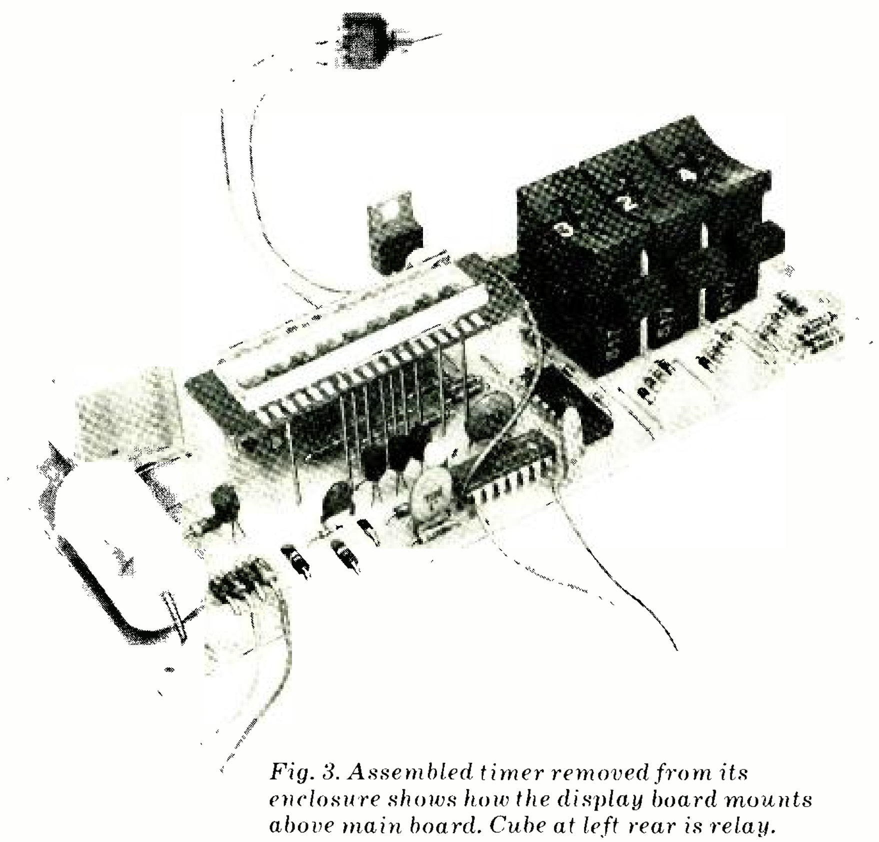


Fig. 3. Assembled timer removed from its enclosure shows how the display board mounts above main board. Cube at left rear is relay.

Construction. The use of a printed circuit board will simplify project assembly. Etching and drilling and parts placement guides for a suitable board are shown in Fig. 2. All components except the power transformer, switches *S4*, *S5* and *S6*, the power sockets and jack *J1* mount on the circuit board. Assembly is straightforward, but here are a few hints that will save you some time.

Begin by mounting the jumpers and fixed resistors on the pc board. Save the cut-off resistor leads to mount the display. Note the position of *R24* relative to that of *IC5*. If this IC is to be soldered directly to the board (which is not recommended) or mounted via a standard DIP socket, mount *R24* on the foil side of the board. However, if the IC is installed using Molex Soldercons, *R24* can be mounted on the component side. The resistor will sit in the "channel" formed by the Soldercons, which will also provide sufficient clearance between the bottom of the IC package and the top of the pc board to accommodate the body of the resistor.

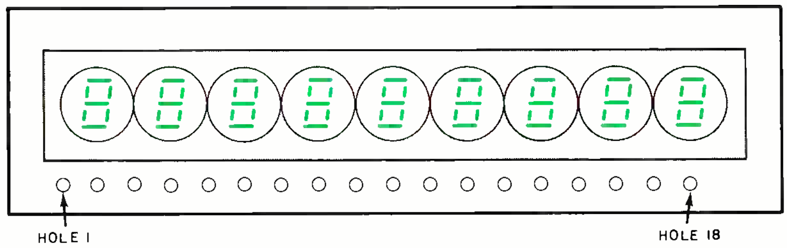
Next, install the silicon diodes, using the minimum amount of heat consistent with the formation of good solder joints. Excessive heat can destroy delicate semiconductors like diodes, transistors and IC's. Also, avoid using too much solder when making a connection. Otherwise, solder bridges between adjacent foil areas might be formed inadvertently. Semiconductors and polarized capacitors must be installed with due regard to pin basing or polarity. Be sure that the diodes are installed so that their banded ends (cathodes) are positioned as shown in Fig. 2. Diodes *D18* and *D19* must be mounted vertically. Install *D18* so that its cathode is down (banded end nearest the board) and *D19* so that its cathode is up. Connect the two remaining leads together.

The capacitors can now be installed, paying close attention to the polarities of *C3*, *C9* and *C10*. The remaining capacitors can be installed either way as they have no polarity. Using sockets or Molex soldercons, mount the TTL IC's, but do not mount the clock chip yet. (That should be the last step of the assembly procedure.) Also, install the digit driver transistors oriented as shown in Fig. 2.

The switches and display can be connected to the pc board using Figs. 3 (photo) and 4 as guides. The layout and pinout details of the display are shown in Fig. 4. No connections are made to holes 1, 2, 4, 5, 6, 14, 16 and 18, the decimal point anode and the cathodes (digit enable lines) of the three left- and right-most digits of the display. Either straight pins or the clipped resistor leads can be used to support the display (see Fig. 3). The supporting leads or pins should first be soldered to the display pads and then, after properly positioning the display, soldered to the row of square pads on the main circuit board just above digit driver transistors *Q1*, *Q2* and *Q3*. Clip off any excess lead length.

Connections between the pc board and those components not mounted on it are denoted in Figs. 2 and 3 by letters enclosed by hexagons. For example, a length of hookup wire should be connected to pad *A* on the board (normally open contact of *K1*) and the FOCUS lug of *S6* and one side of *J2*. The safelight outlet, *J3*, can be wired so that it is not powered when the enlarger is (A) on or so that it remains powered (B). Jack *J1* is included to accommodate a footswitch. As shown in the schematic, the footswitch can be used to reset and start the timer. Alternatively, the "hot" side of *J1* can be connected to the collector of *Q4* for footswitch control of the relay—a great convenience for those who do a lot of dodging.

A heat sink must be provided for *IC6*, the 5-volt regulator. If the timer is housed in an aluminum enclosure, the tab of the IC can be fastened to it. A mica insulating washer is not required, but a small amount of silicone thermal compound should be spread on the back of the tab. This will improve the transfer of heat from the IC package to the project enclosure. If the timer is in a nonmetallic enclosure, a bolt-on heat sink should be used. Either a homebrew heat sink formed by bending aluminum stock or a preformed commercial heat sink is suitable. Again, a thin film of silicone thermal compound should be smeared on the back of the IC's tab before it is secured to the heat sink.



DISPLAY DETAILS

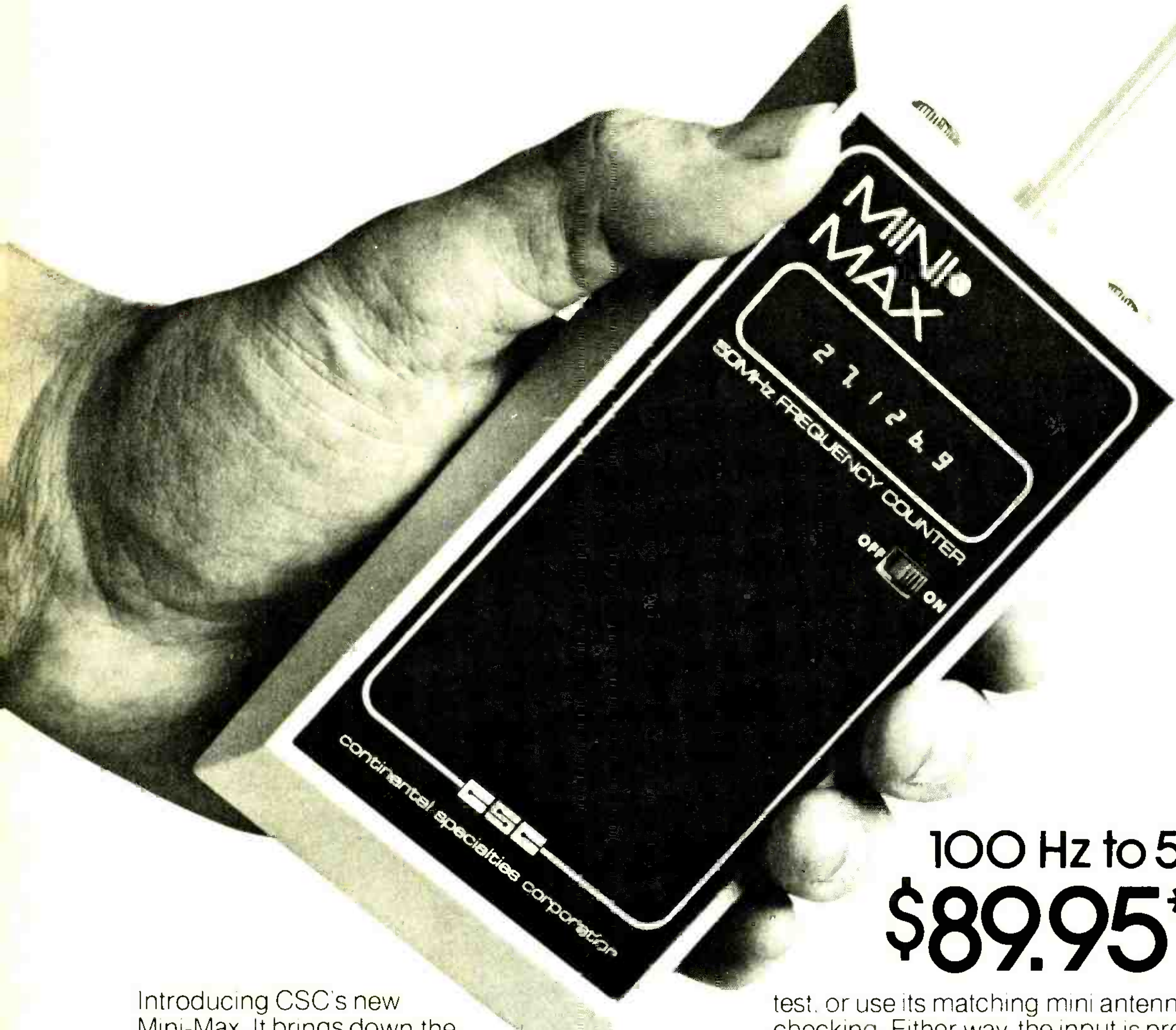
1-no connection	10-digit 5 cathode
2-digit 1 cathode	11-segment D anode
3-segment C anode	12-digit 6 cathode
4-digit 2 cathode	13-segment G anode
5-decimal point anode	14-digit 7 cathode
6-digit 3 cathode	15-segment B anode
7-segment A anode	16-digit 8 cathode
8-digit 4 cathode	17-segment F anode
9-segment E anode	18-digit 9 cathode

Fig. 4. No connections are made to holes 1, 2, 4, 5, 6, 14, 16, and 18 on display board.

Using the Timer. The project should be used as you would a mechanical timer, except that the timing interval is selected by three detented switches rather than by rotating one large knob. Having preset the timing interval, you should load and focus the enlarger, place *S6* in the TIME position, and start the timer by closing *S4* or the footswitch connected to *J1*.

Although the project has been designed with the darkroom in mind, it has many nonphotographic applications in the home, shop, lab or classroom. To name just a few, the project can be used to time chemical experiments, as a quiz timer, or as a delayed turn-off switch for a television receiver or audio system. Without a doubt, you'll be able to think of many more. ◇

FREQ OUT. FOR LESS.



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CIRCLE NO. 9 ON FREE INFORMATION CARD

Personal Computers for Small-Business Applications

More and more "home" computers are being used for commercial purposes. Here's why.

BY PORTIA ISAACSON

ALTHOUGH there are no industry statistics on the percentage of personal microcomputer (μC) sales that are made to businesses, computer store owners generally agree that more than 50% of their local sales are for business purposes. [Among POPULAR ELECTRONICS subscribers, a recent study revealed that primary uses are: business, 37.1%; home, 31.3%; both, 29.6%. This includes computer store *and* mail-order purchases. And "business" here combines commercial, industrial and engineering uses.]

Lower cost is the major reason for a business man to choose a "personal-use" μC. A typical business μC system with 32 kilobytes of memory, dual floppy disks, and a hard-copy terminal can be bought for about $6000. A similarly configured commercial μC system can cost as much as several times that price.

Differences in Price. There are several reasons why a commercial μC system (that is, business systems not sold through computer stores or by mail) costs more than a personal μC system. The major ones include small-industry pricing methods, lower sales overhead, less-stringent quality control measures, and less investment in software. Let's examine these in greater detail.

The personal μC industry was originally created around the S-100 bus. (The S-100 bus, as are other types, is a

set of electrical, mechanical, and logical specifications for the interconnections between the various plug-in subassemblies that transmit or receive data over the bus.) At this writing, there are more than 30 companies manufacturing computers using the S-100 bus and more than 150 companies with plug-in board subassemblies compatible with the S-100 bus. There are also some companies with S-50, IEEE and other bus systems. Since the competition centered on the S-100 bus and others is fierce, prices for personal-use computers and subassemblies are quite close to the lowest they can be set for the companies to realize a profit. Competition, therefore, tends to hold down prices for a personal-use computer, whether used at home or by the businessman.

Another reason for the price difference is the method of marketing used. A traditional commercial computer company might make several calls on a customer at the customer's location before making a sale. Following the sale, the customer will probably require assistance in using the system. These extra services cost money and raise the manufacturer's operating overhead.

A personal-use computer, in contrast, is marketed in a retail store where a salesperson's time is used much more efficiently, or by mail. Both methods of selling low-cost μC's make it possible to have a much lower markup and still realize a profit. Even such large companies as IBM have recognized the efficiency of the computer-store approach to marketing. IBM has opened several retail outlets for its small business computers, calling them "demonstration centers."

Though it is true that traditional commercial computer companies have more rigorous quality control, the experience of business users of personal-use computers has been very positive. This is supported by the fact that many computer stores offer a maintenance contract at nominal additional cost. Under the terms of the contract, the computer store agrees to repair any failure in the customer's system at the customer's location. Prices for the typical maintenance contracts are very competitive with those of the traditional commercial computer companies.

Business Hardware. A data-processing application typically requires a central-processing system, memory, dual-disk drives, and a hard-copy printer. (A CRT terminal might also be used for data observation and manipulation.) The central-processing system and its associated memory make up the nucleus of the system, while the disks are required for random or rapid sequential access of the data. Dual disks are necessary for reasonable copying operations capability. A hard-copy printer generates the necessary paper forms.

A typical μC configuration may use an 8080 microprocessor unit (MPU). With seven central registers, eight-bit-wide data paths, eight-bit integer arithmetic, and an instruction execution time of 2 to 9 μs, the 8080 can directly address 65K of memory. In terms of path width, instruction execution time, and memory size, the 8080 is roughly compatible to the IBM S/360 Mod 30, the workhorse computer of the 1960s. A 32K memory is usually sufficient for most business applications. In fact, 32K is the typical memory used in many IBM S/360 Mod 30 installations.

In personal or hobby μC systems, BASIC (the most commonly used high-level language) typically occupies 12 to 20K of memory, while the remainder of the memory is used for applications programs. Memory expansion to 65K is possible if an application requires it. Memory management software to support the use of greater than 65K of memory is not currently available. The memory speed is on the order of 500 ns access time, which is five times the speed of the S/360 Mod 30 system.

For most data processing applications, the most important decision will be the choice of a disk since the disk is approximately half the cost of the entire system. Disk performance ground rules are the same in low-cost computing as they have been in other forms of computing. Data processing applications tend to be limited by the disk, which determines the amount of data that can be accessed at one time and also determines the speed at which it can be accessed. Since the disk is largely mechanical, it will also be one of the least reliable components in the system. Another reason for caution in the selection of a disk is that, in mixed vendor systems, the system software comes from the manufacturer of the disk.

Floppy-disk sizes popularly used today are 8" (20.3 cm) and 5¼" (13.3 cm). Dual 8" floppy-disk drives, which store 500 to 600K total, have a 100-400–ms access time and 32-60K byte/second transfer rate. They cost about $3000, including the required disk controller. Dual 5¼" floppy-disk drives in contrast, store about 150 to 630K and have an average access time of 780 ms. This type of system has a transfer rate of 16-60K/second and it costs about $1800, including the controller. Many personal computer makers offer these disk systems.

We can expect to see some significant increases in the amount of storage we can obtain per dollar in the near future. In fact, Motorola is already delivering its 5¼" dual-floppy disk drives that can store 630K for about $1900, including controller. We can also expect to see hard disks for low-cost computers.

Most computers use the standard RS-232C serial interface for terminals and printers. This is the same interface used by time-sharing terminals, minicomputer terminals, and some printers. Since any terminal or printer that uses the RS-232C interface can be used with hobby computers, a wide selection of these terminals is available.

At the low end of the printer category useful in a business environment, is an impact printer that uses roll paper at 120 characters/second and sells for about $750. The Digital Equipment Corp. DECwriter Model LA36 terminal accepts continuous forms, prints at 30 characters/second, and costs about $1500. The Texas Instruments Model 810 impact printer prints 150 characters/second and costs $2100. For word-processing applications, the Diablo terminal plots and prints at 30 characters/second and costs $3000.

If a printer is chosen, a CRT terminal is also needed. It should be noted that the terminal and/or printer can be one of the most costly components in a computer system. And since the printer is largely mechanical, it may also be a source of maintenance problems.

Most personal computers sold to businesses are fully assembled, burned in, and tested. Such purchases are usually made through computer stores rather than mail order houses because of the convenience of having local support services. Where an owner or employee is also a computer enthusiast, a kit route may be taken, of course.

Business Software. When comparing the capability of personal-use computers to larger computers and time-sharing services, the most obvious shortcoming of the personal-use computer is in the software area. There is less business/industry application available compared to that from traditional computer makers.

BASIC is the language most often used in programming personal-use computers for small business applications. Fundamentals can be learned in a few hours. COBOL, FORTRAN, PL/I, and APL are among the most popular languages used by the traditional computer makers. They're more difficult to learn, however. The use of BASIC is growing, here too, since it is a terminal-oriented language and is well-suited to time sharing.

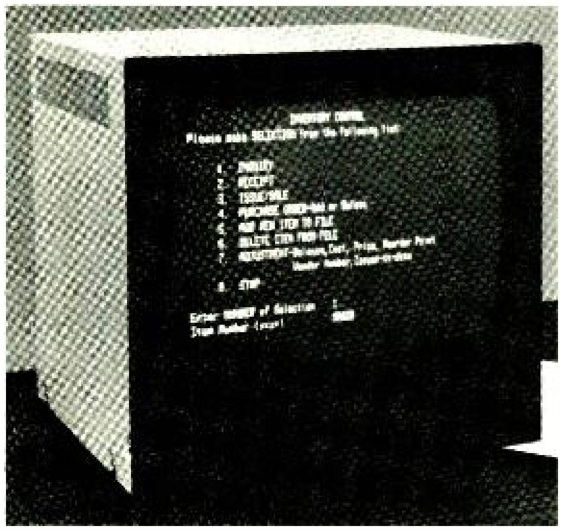
Fortunately, many of the available BASIC's have been extended especially for business applications. These usually include formatted input/output, disk-file manipulation (including random access), decimal arithmetic, string processing, subroutine parameter passing, and chaining of programs. The cost of a BASIC interpreter is about $100.

A few application packages are available. They include general ledger, payroll, inventory control, word processing, accounts payable, and accounts receivable. The prices of these programs vary greatly, but $1000 to $2000 is typical. Application software packages are available from the manufacturers in some cases. For the most part, however, they are offered by individual computer stores. Significant additional offerings can be expected soon, primarily packages for particular types of small businesses, such as medical clinics, personnel agencies, real-estate firms, lawyers, motorcycle shops, and astrologers.

If a business requires custom software for its own particular needs, the programs are usually written by the computer store or a consultant. Custom software can be very expensive, naturally. Since it is not uncommon for a consultant to charge $1000 per week for writing programs, the cost of custom software can easily exceed the cost of the hardware.

Presently, the availability of software is the primary factor limiting the use of personal computers in business applications. Many more programs are needed than just the standard business bookkeeping applications. Nearly an endless number of programs are needed to fill the requirements of specialized types of businesses. For example, a personnel agency needs an application package to maintain a file of job applicants and to search that file on command for applicants with certain job qualifications. A multiple-doctor clinic needs a program that can schedule appointments, answer inquiries, and each day print the doctors' schedules. A ready-mix concrete company needs a billing program that will take into account different mix formulas delivered to different customers. The list goes on and on.

Programs for personal computers in business applications are and will likely continue to be written by independent consultants, computer stores, and business persons with programming ability. It's expected that there will be a growing number of companies to serve as a distribution center for these independently produced programs in much the same way that book companies publish the work of independent authors and recording companies distribute the works of many independent musicians. Here, the original author of the program will be paid a royalty on each sale, while the distribution company will market and support the software nationally.



Typical video display as used in small business systems. This is usually the entry point for the system operator. It is from the data seen on the screen that the operator selects the program, or part of the program, he wishes to run.

Maintenance. While a computer enthusiast may enjoy spending many hours getting an ailing computer back to working order, a business must get its computer operational as soon as possible. Since most businesses do not have the wherewithall to perform their own computer repairs, they must look to the computer store to provide the necessary service. (As a rule, the only service a personal computer manufacturer provides is through the mail or by phone, which is a time-consuming procedure.)

The degree of service offered by computer stores varies greatly. Some stores offer repair service only in the store, charging by the hour (typically $20 or so) or by the type of board (usually a fixed percentage of the initial cost of the board). Some stores make service calls at the customer's location.

Many computer stores sell maintenance contracts on business computers. Such a contract is similar to a health-care plan: for a fixed annual fee of, say, $1000 to $1500 for a $10,000 business computer system, repairs and/or replacements will be effected in a timely manner at the customer's location.

A well-tested and burned-in personal computer is very reliable. One company that has 200 business computers in the field reports that, on the average, the cost of customer service for a system over a year's time has been $90. As a result, many customers dropped their maintenance contracts.

The Role of the Computer Store. Without the computer store there would be virtually no business market for personal computers since typical businesses need help from the planning stages right on through to a maintenance contract.

Many computer enthusiasts are happy enough to master the enormous amount of information that must be assimilated before the various sections of a computer are selected. A hobbyist usually purchases one section at a time, testing the system as he builds it. Typically, there is no particular end use in mind and, therefore, no particular requirement for the size of his computer system—it just grows as his budget and new applications allow. Business, on the other hand, has a specific use or uses for the computer. Business executives want to be sure that the computer system selected will not only work, but do the required job. Thus, the computer store's first service to the business is to answer the question, "Will a personal computer do the job I want done?" If that answer is yes, the store proceeds to configure (choose the parts of) an appropriate system. Some typical important considerations are the amount of disk storage, the size of memory, and the speed of the printer. The computer store must consider the business application very carefully in making these decisions.

The next service performed by the store is to put the computer system together. Some stores actually do the assembly from kits. If various boards are purchased assembled from manufacturers, the computer store will burn in and test the system before delivery to uncover any infant mortality problems.

Probably the most important service provided by computer stores to businesses is ongoing repair service. Businesses usually cannot do their own repairs, and service from manufacturers by mail is obviously not a satisfactory route to take.

Nearly all computer stores, certainly the older ones, originally saw their market as being only the computer hobbyist. However, when disks became available for personal computers in 1976, business applications rapidly became common. At first, computer enthusiasts started applying personal computers to business problems. Then computer stores started developing standard business software packages for less knowledgeable users with some stores starting to specialize in the business customer.

The physical appearance of some stores started to change, too. Instead of a tile floor and a repair counter in plain view, stores were remodeled to have carpeted floors and no service counter with IC's in view.

With the appearance of the disk drive on the consumer market, computer store owners and personal computer makers have been developing standard business software packages for the businessman. The most common commercial business applications for personal-use computers are bookkeeping and word processing.

The bookkeeping functions include general ledger, accounts receivable, accounts payable, and payroll. Different types of small businesses can make use of the same application software.

Use of Personal Computers in Business. Word processing is useful to many different businesses, including large companies. In word processing, the computer is used with a typewriter-like terminal to edit manuscript and print form letters.

Here are some examples of how personal computers have been used successfully in the small-business world.

Savings and Loan. A savings and loan association is an excellent example of a business that has a wealth of applications ideally suited to a μC. Two Dallas, Texas savings and loan associations recently installed μC's for their daily operations of taking deposits, paying interest, and making home loans. Software was developed by a consultant and a former savings and loan data processing manager.

The first of these companies to install a μC was a medium-sized operation with $100-million in assets and about 50 employees. Most of its data-processing needs were satisfied by an on-line system provided by a service bureau. However, there were enough small applications not being performed by the service bureau to easily justify the μC. In fact, the savings and loan estimates a $7000 annual savings based on just those applications initially delivered.

The μC system uses an 8080 microprocessor with 32K of main memory, dual 8" floppy disks that store 512K, and an extended BASIC interpreter, all for a total price of about $5000. A DECwriter LA36 was leased, with maintenance, for $86 per month to take care of input and output requirements.

Application software was written entirely in BASIC in less than four weeks. The package comprised eight different applications that consist of about 2700 BASIC statements.

One application for the μC system is the preparation of new account letters and closed account stuffers. Form letters are stored on the disk and written on demand to a list of names and addresses entered in a different disk file. The new account letters give the company a marketing advantage as well as a dollar savings on the required twice-yearly audits.

Employees of the savings and loan, including secretaries, accountants, and tellers who use the μC system have accepted it as a working member of their team. One reason for this was the use of a "people-oriented" user interface that gently guides the user through the programs. Each program was almost completely self-instructing.

The second Dallas savings and loan company to install a μC was a medium-size association having 35 employees. It uses an in-house IBM System/3 for most data-processing functions. Several applications, however, were found to be more suited to the μC. The system identical to the one described above, uses most of the same software and has six additional applications. Including the hardware and the software, the system cost less than $9000.

Before the μC was installed, the association's employees spent two days to prepare 30 required reports on loans sold to the Federal Home Loan Mortgage Association. The reports are now prepared in only two hours.

A card file that used to keep track of the due date on 10,000 insurance policies was replaced by a seven-page BASIC program that performs the function of the card file and also sorts the policies by insurance agents. Fewer checks are written, fewer errors are made, and a substantial amount of money is saved.

Before the μC was installed, the payroll was done manually by the controller. Now the controller still makes up the payroll, but he has a computer to assist him. The payroll program used consists of 750 BASIC statements, can handle up to 250 employees, and maintains a pass-word-protected file of information on employees. The 800 bytes of data maintained on each employee can be displayed and modified as required.

Possibly the most interesting application is a program that selects packages of loans for resale. A buyer of a loan package can specify a wide variety of parameter ranges that must be satisfied by the loans in the package. For example, all loans in a package might be required to be between 8½% and 8¾% and also satisfy several other conditions. In fact, any combination of 12 unique types of constraints can be applied to a given package.

Before the μC was in use, up to two days were required to select a loan package. Now the same operation can be done in only 40 minutes, giving the association a significant competitive advantage when several associations are bidding loan packages to the same buyer.

A set of ledger cards was previously used to keep track of real estate owned by the association. All transactions associated with each piece of property were recorded on the cards. Now the μC has replaced the ledger cards and provides timely, accurate reports on the status of each piece of real estate.

A tickler file for loan commitments was needed to plan cash requirements more accurately. The μC proved to be perfect for this application.

The association has calculated that its total saving due to the μC is \$450 per month. This compares favorably with the \$350 per month μC amortization cost over a three-year period.

Tour Agency. A tour agency that operates dedicated flights out of 16 U.S. airports to exotic vacation spots like the Bahamas, Jamaica, and Acapulco, recently installed a personal μC for business purposes. Bookings are accepted from travel agents from all parts of the country. Each booking involves the date and destination, hotel reservations, meal service, and other travel options. Follow-up paperwork and record keeping is extensive. Confirmations and invoices must be issued, alphabetized manifests are required by the airline, and hotel lists must be drawn up.

Seats can be sold right up to the time of departure, so there is little time for paperwork and error checking. Currently, the agency produces its manifests five days prior to tour departure and implements later changes by telephone. The agency may hold more than 20,000 individual reservations at any one time and may schedule 25 different flights during any one three-day weekend. The entire operation is controlled by five to eight clerks staffing the telephones and controlling the flight boards.

The computer setup consists of a distributed data processing network containing 10 personal μC's and one minicomputer. An IBM Series-1 minicomputer controls a database that contains information on all flights and reservations, while 10 PolyMorphic μC's (eight 8810's and two 8813's) interface with it (using a 9600-baud line) to provide reservation, documentation, accounting, and management information. Six of the 8810's, each with a 90K minifloppy diskette, serve as intelligent terminals (to the Series-1) for the individual travel clerks.

Documentation is by two Texas Instruments Model 810 printers under the control of an 8810 and an 8813 with two diskettes. A second 8813 provides support to the accounting function of the agency, while an 8810 provides on-line management information to the general manager. This terminal can also provide trend analysis and other statistical anlayses of the database.

The interface between the personal computers and the IBM computer is a set of microprocessor-controlled RS-232 serial ports. There was no special hardware constructed for the system.

For the individual travel clerks, the system can call up current availability of seating, options, and flights from the database on request and display it on a formatted screen at their location. When the system is first turned on, a list of available services is automatically presented. After signing on with an individual password (used to assign responsibility, prevent unauthorized use of the system, and limit access to some stored data), the operator selects the appropriate function. A formatted screen display is then presented, using software, with a blinking cursor to indicate the entries required. Reservation details are sent to the Series-1, which updates the database and instructs its printer to automatically produce the required confirmations and invoices.

The system provides excellent backup, too. The Series-1 automatically produces a magnetic tape of transactions as they are received from the operators' terminals. If the system "crashes," the tape can be used to recreate the data from the point of failure without having to return to the backup disk produced the preceding night.

If the Series-1 goes down, each μC can conduct limited business by retaining reservation requests on its own minifloppy disk. This allows the agency to continue near-normal operation. When the Series-1 comes back on-line, rapid transfer of information from the μC's to the database can be accomplished.

The system also provides impressive growth potential. The starting six operator positions can be increased to about 18 without changing the configuration of the Series-1.

The Future. Several factors will contribute to the increasing usage of personal computers for small businesses. First, the new and much lower cost threshold for the feasibility of application will open many new areas. More and more packages that include hardware, software, maintenance, and training will be developed for particular types of business applications.

Next, a misconception held by some people that personal computers are not sufficiently powerful or reliable enough for business purposes will be dispelled. As noted earlier, today's personal computer compares quite favorably and closely to the IBM S/360 Mod 30 that was the data-processing workhorse of the late 1960's. And the cost of personal computers is much lower. So we can expect a rapidly increasing use of personal computers by businesses. ◇

BY CLEMENT S. PEPPER

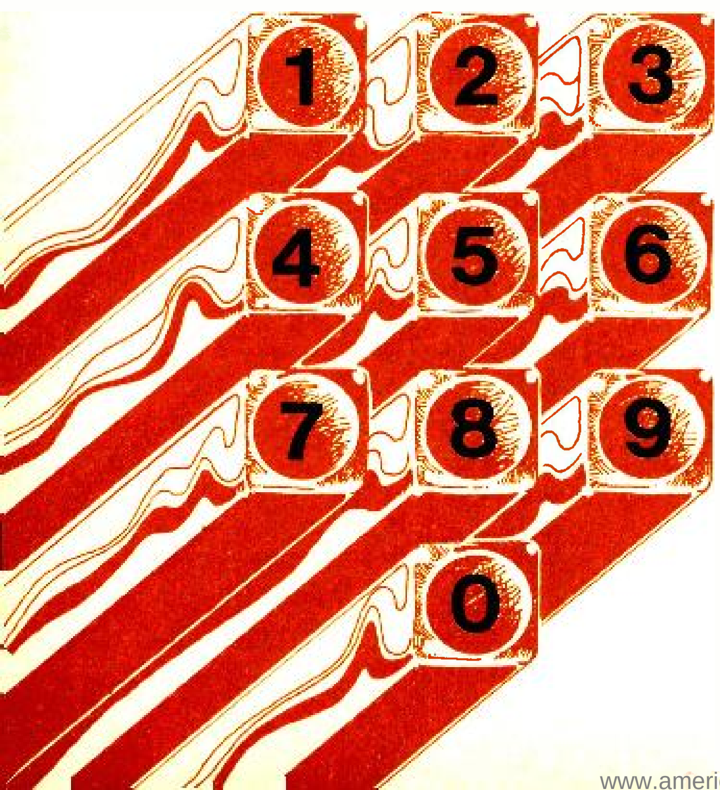
THE VERSATILE KEYPAD

How to interface these important mechanical devices with digital circuits.

THERE ARE an ever-increasing number and variety of low-cost decimal and hexidecimal keypads available to the electronics experimenter. To successfully use these keypads, one must observe certain criteria to be sure mutually compatible signals are available. You cannot just connect any keypad to any circuit and expect the system to operate properly. Either the keypad selected must be specifically designed for the digital circuit it is to drive, or the digital circuit must be designed to suit the specific keypad.

One major problem with keypads (and most other mechanical switches) is that they are not ideal switches. Instead of producing a single pulse when they are opened and closed, they produce a "train" of brief pulses as they mechanically settle. In ordinary switching applications, this "bouncing" is not a problem. But when switches are used with high-speed electronic counters, each pulse within a train (Fig. 1) can appear as a separate toggle signal, resulting in false counting.

Most keypads are decimal (0 to 9), while many electronic circuits require a binary-coded-decimal (BCD) input. Hence, a decimal-to-binary decoding system to make the conversion is required. Too, many counting circuits also require a "start" or "sync" signal to "tell" them when a key has been depressed. Therefore, some kind of key-closure sensing system must be used.



Debouncing. A basic debouncing circuit for a switch is shown in Fig. 2, accompanied by its truth table. The circuit consists of an AND and an OR gate. When the switch is closed, input A goes low and forces the output of the AND gate low. This low signal is connected to the C input of the OR gate and is additionally used to toggle the bounce-inhibit monostable multivibrator. In response to the low at its input, the multivibrator sends a low signal to the D input of the OR gate for a period of time determined by the monostable time constant. Since both inputs to the OR gate are low, the output of the gate also goes low.

The switch can now be released, causing the A input to go high, due to the pull-up resistor. With the low output of the OR gate connected to the B input, the output of the AND gate remains low. The circuit will remain in this state until the monostable time constant times out and sends a high signal to the D input of the OR gate.

As explained above, the very first closure of the switch causes the circuit to operate but locks out any subsequent bounce-produced signals. The only thing to keep in mind is that the bounce-inhibit monostable time constant must produce an output slightly longer than any expected bounce interval.

The circuit shown in Fig. 3 illustrates the use of the debounce circuit with a BCD coding scheme. A function truth table is also shown. You may be surprised to see a hexidecimal table for a 10-key array. If you wish to obtain a hex A (10),

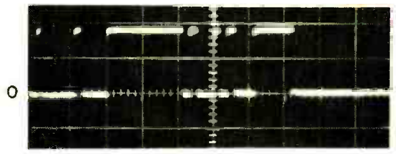
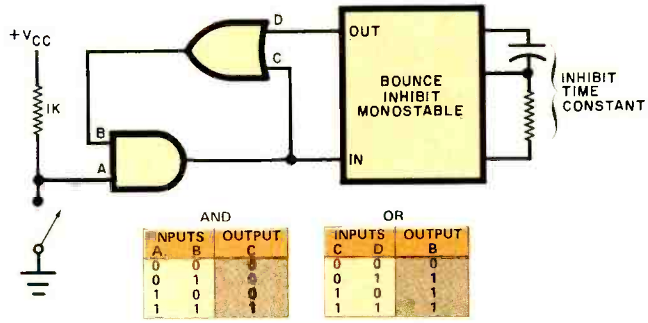


Fig. 1. Pulse train resulting from switch contact bounce. Sweep time is 50 μs/div.

both the 8 and 2 keys must be pressed simultaneously. Similarly, a hex F (15) requires simultaneous operation of the 8 and 7 keys. If you plan to use a hex keypad, use the same AND-OR gate logic for all 16 switches and substitute the circuit shown in Fig. 4.



AND

INPUTS A	B	OUTPUT C
0	0	0
0	1	0
1	0	0
1	1	1

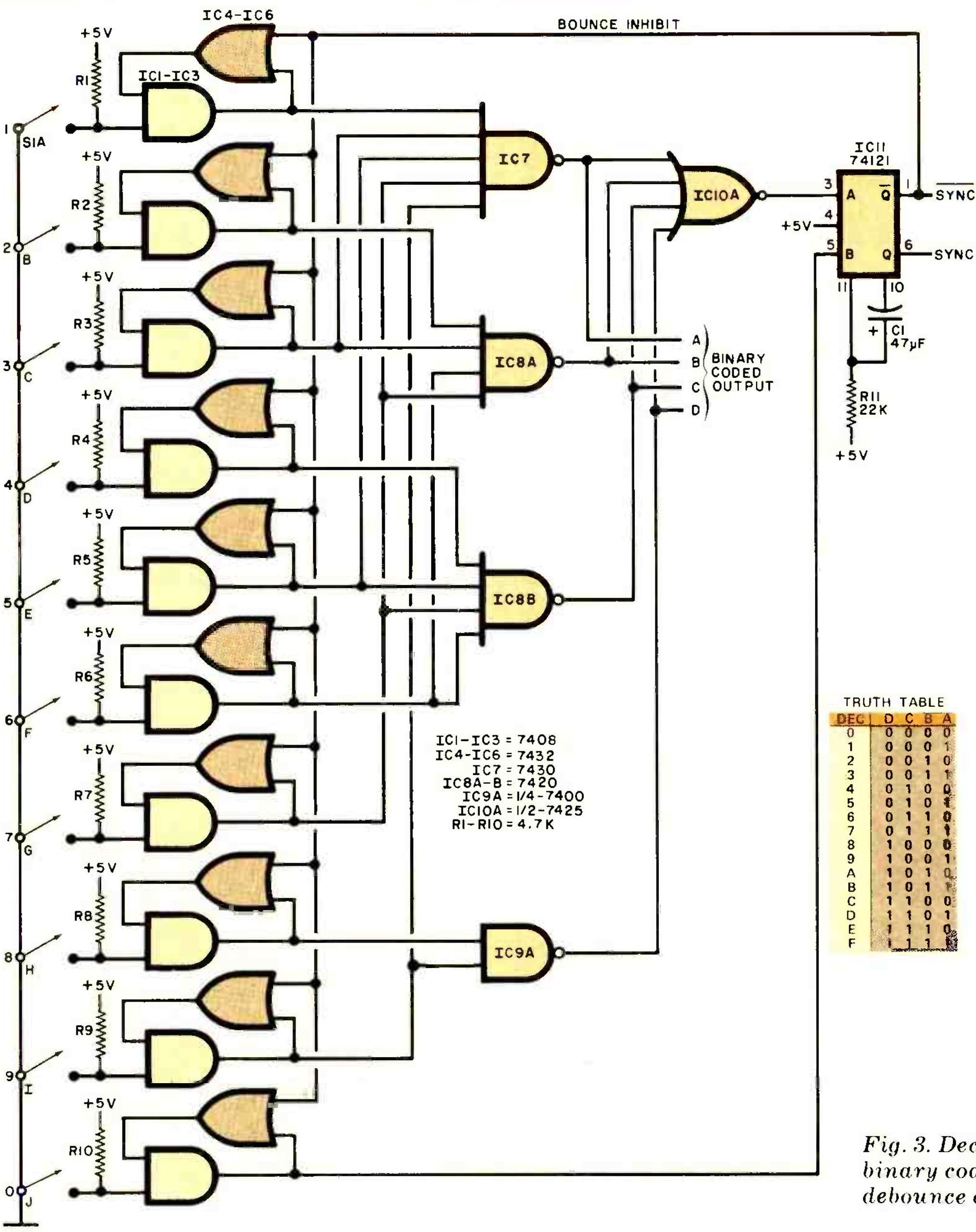
OR

INPUTS C	D	OUTPUT B
0	0	0
0	1	1
1	0	1
1	1	1

SWITCH CIRCUIT LOGIC

STATE	A	B	C	D	
0	1	1	1	1	Switch open
1	0	1	0	1	Switch closure
2	0	0	0	0	Debouncer response
3	1	0	0	0	Switch bounce
0	1	1	1	1	Switch open, Debounce reset

Fig. 2. Switch debounce circuit is formed from AND-OR gate logic.



TRUTH TABLE

DEC	D	C	B	A
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
A	1	0	1	0
B	1	0	1	1
C	1	1	0	0
D	1	1	0	1
E	1	1	1	0
F	1	1	1	1

Fig. 3. Decimal keyboard binary coding and switch debounce circuitry.

Referring back to Fig. 3, when all keyswitches are open, their associated AND gate (*IC1* through *IC3*) inputs are high. Hence, the outputs of the four encoding NAND gates (*IC7* through *IC9*) are low. Closing any keyswitch except 0 forces at least one of the NAND gate inputs high.

The bounce-inhibit circuit uses a 4-input NOR gate (*IC10A*) to trigger bounce-inhibit monostable multivibrator *IC11*. When any of the four NOR gate inputs go high (any key closed), the output of the NOR gate goes low and triggers the multivibrator. The multivibrator, in turn, sends a low signal to the OR gate associated with each key. This implements the debounce function. For the RC values given in Fig. 3, the debounce period is about 700 ms. For the 74121 monostable multivibrator, the timing equation is T = 0.69RC, with R kept at a value of less than 40,000 ohms.

The circuit remains in the debounce condition and ignores any switch bounce until the monostable multivibrator times out. When this occurs, the circuit resets back to where another key can be operated. Note in Fig. 3 that the multivibrator also produces a "sync" signal in exact time step with the input pulse. This is for use with an external counting or other enabling circuit.

The 0 key requires a different approach from that discussed. Although it has the same debounce circuit as the other keys, when the 0 key is closed, a separate input trigger, B, on the multivibrator is used.

Controlled Pulse Generator. One use for a debounced and BCD-coded keypad is as a controlled pulse generator that delivers a number of output pulses determined by the decimal number inserted via the keypad. The basic logic for this circuit is shown in Fig. 5.

Pressing any key on the keypad in the Fig. 5 circuit sends a sync pulse to an enabling latch and the BCD-coded signal to the inputs of a binary down counter. The latch signal enables the counter's preset input and a controlled-pulse generator. The pulse generator is designed so that both pulse width and pulse period can be controlled. Each time a pulse appears at the ouput, the binary down counter is decremented by one. When the counter reaches zero, it resets the latch and stops the operation.

The actual circuit, shown in Fig. 6, is straightforward. The *IC1A/IC1B* latch is made from conventional TTL NAND gates, with RC coupling at the inputs to

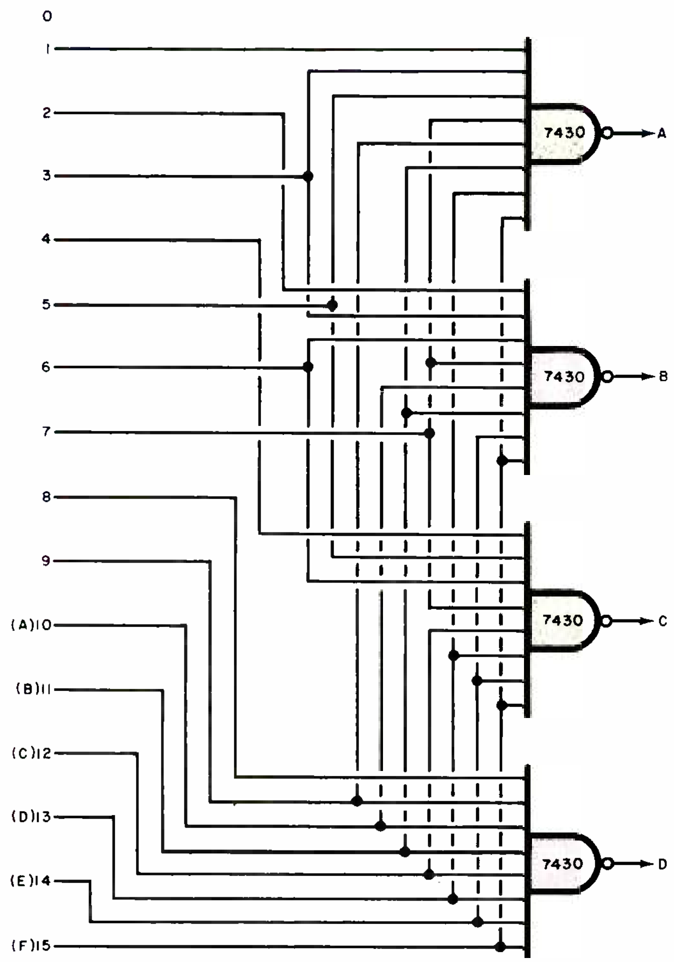


Fig. 4. Decoding logic for a hexidecimal keypad. This circuit is an addition to that in Fig. 3.

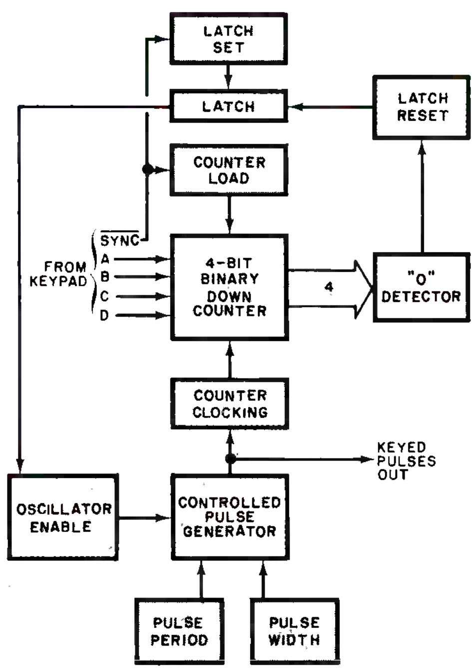


Fig. 5. Function diagram for a controlled-pulse generator.

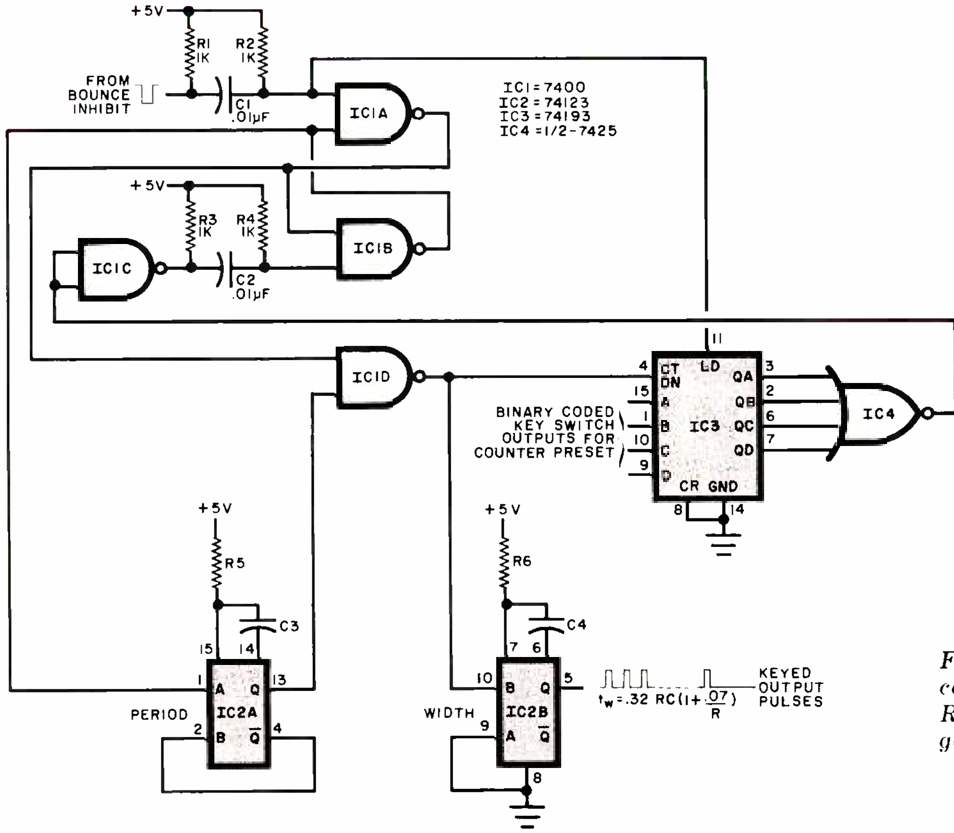


Fig. 6. Schematic of controlled-pulse generator. RC coupling allows generation of fast pulses.

allow rapid action—in fact, a complete pulse train can be generated within the width of the sync pulse. Without RC coupling, the latch would be locked for the duration of the sync time. A transient input is a must to avoid lockout. The *IC3* down counter has its LOAD enable input RC coupled to the sync input. This input requires a transient input to operate.

The controlled-pulse generator (*IC2*) is made up of both halves of a 74123 dual monostable multivibrator. The RC timing of *IC2A* sets the pulse period. The Q output at pin 13 is connected to NAND gate *IC1D*, with the second input of this gate connected to the latch. With the latch reset, the NAND gate is locked and its output remains in the high state, regardless of what the multivibrator is doing. In reality, *IC2A* is not doing anything, since its A input trigger at pin 1 is also enabled by the latch.

The first cycle of the operation is initiated when the latch is set. This causes a high-to-low transition at the A input. When the multivibrator triggers, the Q output at pin 4 goes low. When the multivibrator times out, the low-to-high transition at the Q output retriggers the multivibrator. Because the transition is so fast, the multivibrator appears to be continuously in the triggered state.

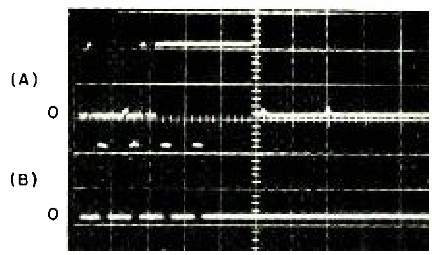


Fig. 7. Scope trace (A) shows switch bounce, while (B) shows four pulses initiated by switch closure. Sweep time is 50 µs/div.

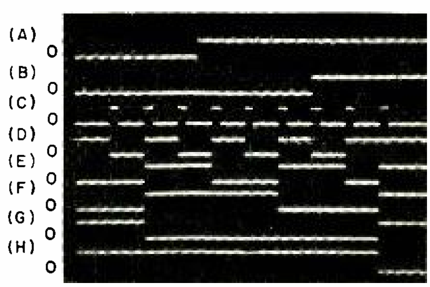


Fig. 8. Nine pulses generated by key switch closure (50 ms/div): (A) key closure; (B) sync; (C) outputs of 74123; (D) output QA; (E) output QB; (F) output QC; (G) output QD; all of IC3; and (H) latch input to IC1D.

The output of gate *IC1D* decrements the *IC3* counter and triggers the second monostable multivibrator (*IC2B*). The timing of this circuit controls the width of the pulse.

The only limitation on the frequency and width of the keyed pulses are those determined by the multivibrators. Very long and very short pulses over almost any range can be generated once the counter is preset. The keypad plays no role in this part of the operation.

The oscilloscope waveforms for the Fig. 6 circuit are shown in Fig. 7. The upper trace shows switch contact bounce, while the lower trace shows four pulses initiated by the first switch closure. Note the immunity to switch noise and the fast response possible. The traces in Fig. 8 show the timing of those functions that will be helpful in understanding the operation of the circuit.

Combination Lock. The logic for a four-digit combination lock that can be operated only by someone who knows the code is shown in Fig. 9. This circuit can easily be expanded so that several functions can be derived from a single keypad. Appropriate interfacing must be

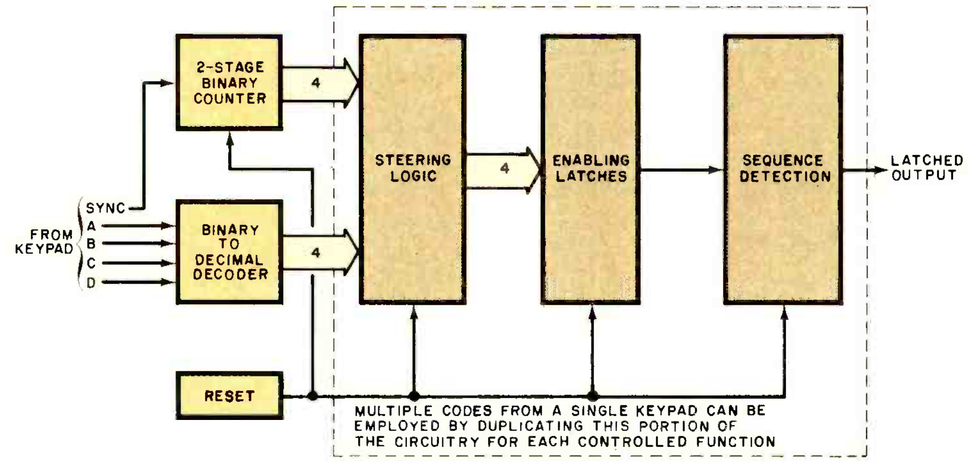
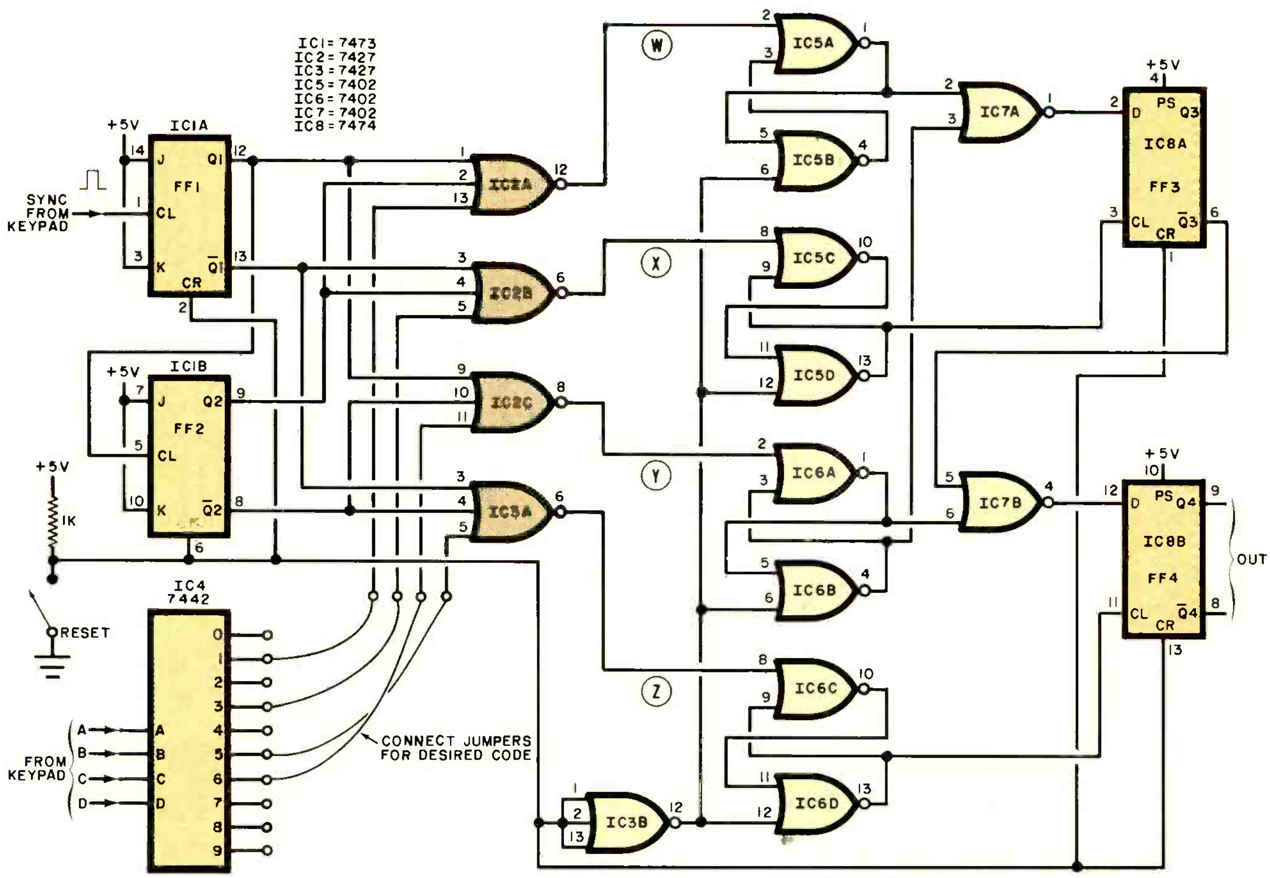


Fig. 9. Four-digit combination lock that works with only one selected set of input digits.



FUNCTION TABLE

DEC	FF2		FF1		LATCH IN				FF3	FF4
IN	$\bar{Q}_2$	Q_2	$\bar{Q}_1$	Q_1	W	X	Y	Z	$\bar{Q}_3$	Q_4
0	1	0	1	0	1	0	0	0	1	0
1	1	0	0	1	0	1	0	0	0	0
2	0	1	1	0	0	0	1	0	0	0
3	0	1	0	1	0	0	0	1	0	1

Fig. 10. Four-digit lock with combination 1365. Keyed code must match jumpered connections to operate lock.

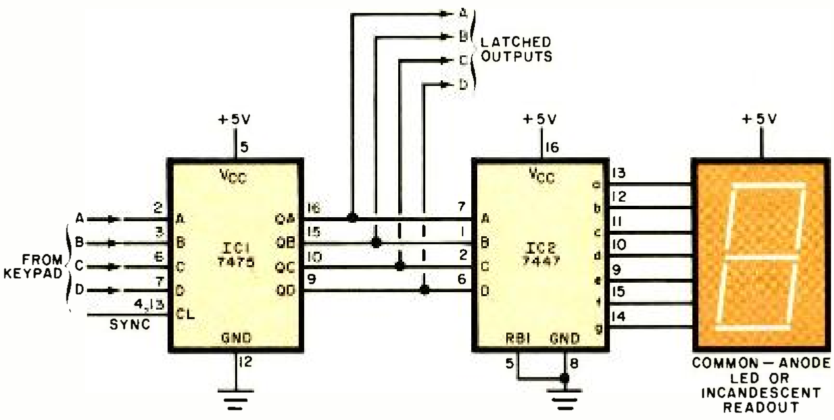


Fig. 11. Latched output for a keypad. Display is on a 7-segment LED readout.

added between the circuit and any external devices to be controlled. The actual circuit for the combination lock is shown in Fig. 10.

Operation of the lock begins with the reset mode. This is necessary because the reset can be initiated at any time in the event an incorrect digit is keyed. The output of a two-stage counter is decoded in the steering logic, and the BCD signals from the keypad are integrated into the counter's decoding logic so that a specific digit only can be passed through the enabling latches if both signals are coincident. It is mandatory that the four latches be set in the proper sequence (W,X,Y,Z) because any other combination will be defeated in the sequence detector.

A function table for the lock is given in Fig. 10. The 0 on the DEC IN line is the reset mode. The outputs of *FF1* and *FF2* assume a 0101 state. The *FF1* and *FF2* blocks are clocked flip-flops, with the clocking occurring on the trailing edge of the input pulse. The outputs of the keypad are fed to *IC4*, the outputs of which are selected to form the inputs to the associated NOR gates.

If the correct first digit is keyed in, line W goes to the high state, setting *IC5A/IC5B*. Both inputs to NOR gate *IC7A* are now low, setting the D input to *FF3* (*IC8A*) to high.

The sync pulse from the keypad has once more clocked the counter. If the second digit is correctly keyed in, line X goes high and sets the *IC5C/IC5D* latch. This clocks a low to one input of (*IC7B*). Once again, the keypad is operated with the correct digit to cause the associated latch to operate and placing a high on the Y line. This puts a low on the second input of *IC7B*. This sets the D input of *IC8B* to high.

The keypad is operated one more time with the final correct digit to set the Z line high. The Z latch clocks *IC8B* to change its output status. Either of the *IC8B* outputs can be used to interface to an external circuit.

If any of the four latches is set out of sequence, the clocking of *IC8A* and *IC8B* will be disrupted. The circuit is reset by operating the RESET switch.

Although the Fig. 10 circuit shows the use of a 1-to-10 decoder for the keypad input, a 1-of-16 decoder can be used for a hexidecimal input.

Switch Latch & Display. One difficulty with a keypad is that it is momentary. Once a key has been released, the action ceases. The addition of a quad latch, as shown in Fig. 11, will hold the switch outputs as long as dc power is applied. The *IC1* quad latch is used to drive BCD-to-7-segment decoder/driver *IC2* and a common-anode 7-segment LED display. This combination holds the last key depression and also produces a visible display of the digit depressed.

In Conclusion. In this article, we have described the major problems encountered when using mechanical switches—specifically keypad arrays—with digital circuits. We have offered some examples of how to deal with the problems and given hints on interfacing keypads with the electronic circuits. It is suggested that for further study and understanding of the material presented here you breadboard the circuits presented and do some experimenting on your own. ◇

BY GENE NELSON

AUDIO ALARM BACKS UP CAR WARNING LIGHTS OR METERS

Easy-to-build circuit sounds an alarm so you won't miss your car's visual warning.

PEOPLE often fail to notice immediately when a red indicator on the dashboard of a car lights to warn that service is required. The "Audible Car Protection Alarm" described here corrects this problem by simultaneously issuing an audio signal when a dashboard warning indicator is activated. It can spell the difference between a minor and a major car repair, or even save lives.

When any one or more of the warning indicators in your vehicle lights, the audio alarm sounds an insistent beeper. Then you can check the indicators to determine what service is required.

In addition to serving as an automatic fault monitor, the alarm can also remind you to turn off headlights and rear-window defogger. The system can easily be expanded to monitor dozens of points in a vehicle's or boat's electrical system.

About the Circuit. As shown in Fig. 1, triple three-input NAND gate *IC1* serves three separate functions. Section A operates as a conventional three-input NAND gate. If one or more of its normally high A, B, and C inputs goes low, the pin-10 output of this gate also goes high.

Section B, also used as a three-input NAND gate, has a 1500-Hz signal applied to its pin-2 input, a 1-Hz signal applied to its pin-1 input, and the output from section A of *IC1* applied to its pin-8 input. Hence, when the output from section A goes high, the circuit oscillates at 1500 Hz and is gated on and off at approximately half-second intervals.

Section C of *IC1* is configured as an inverting amplifier whose output is coupled back to its input via *R1* and oscillates at a frequency determined by the values of *R1* and *C1*.

The output of section B drives *Q1*, whose collector load is a conventional miniature 8-ohm loudspeaker. The combination of *C3*, *R2*, and *R3* functions as the system's 1-Hz oscillator. Capacitor *C3* charges through *R2* and discharges through *R3*. This capacitor must be initially charged before the circuit can os-

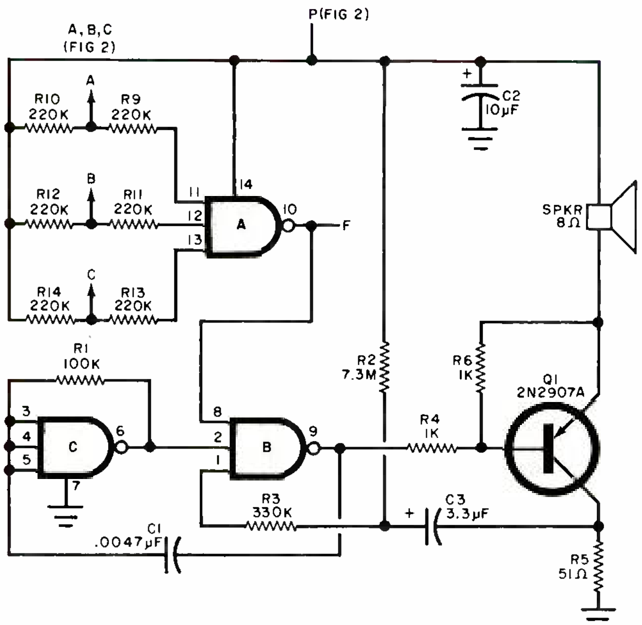


Fig. 1 Gates IC1C, IC1B, and Q1 form a 1500-Hz oscillator gated on and off by a 1-Hz signal.

PARTS LIST

C1—0.0047-µF Mylar
C2—10-µF, 16-volt electrolytic
C3—3.3-µF, 25-volt tantalum
D1 through D5—1N4148 or similar silicon diode
IC1—CD4023AE (RCA) CMOS triple three input NAND gate
LED1—Red light emitting diode
Q1—2N2907A or similar pnp transistor
The following resistors are ¼-watt, 10%:
R1—100,000 ohms
R2—5.1 and 2.2 megohms in series
R3—330,000 ohms
R4,R6,R15—1000 ohms
R5—51 ohms
R7—22 ohms
R8—2200 ohms
R9 through R14—220,000 ohms
SPKR—8-ohm, 100-mW loudspeaker
Misc.—14-pin DIP socket; plastic case; printed circuit or Wire Wrap board; splice-in connectors; hookup wire; solder; machine hardware; etc.
Note: A basic Autotel™ kit consisting of all parts except D1, D2, D4, D5, LED1, R13, R14, R15, is available for $4.95 plus $1.00 shipping and insurance from James Electronics, Box 822, Belmont, CA 94002.

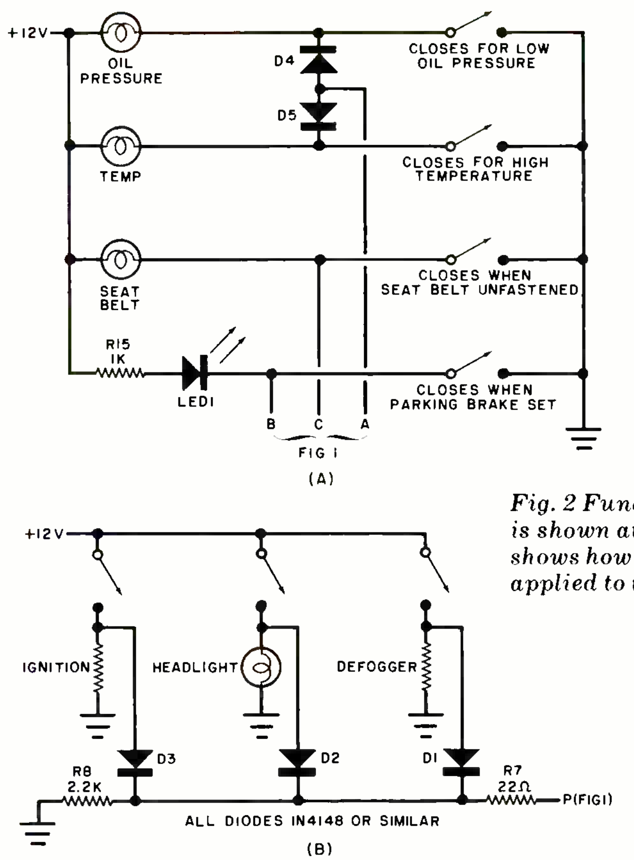


Fig. 2 Function sensing is shown at (A) while (B) shows how dc power is applied to the alarm circuit.

cillate. With the value shown for *C3*, a delay of about 15 seconds is provided before the alarm enables. This allows time for normal engine starting and the build-up of oil pressure. Consequently, during normal operation, the alarm will not sound.

To see how the circuit operates under actual in-use conditions, let us assume that the oil pressure drops. As shown in Fig. 2A, the oil-pressure sender grounds the oil-pressure lamp, which then comes on. Simultaneously, the cathode of *D4* is placed at ground potential. At this point, *D4* conducts through *R10* and pin 11 of *IC1A* goes low, causing the output of this gate to go high. As long as *C3* is charged, *IC1A* allows the 1500-Hz oscillator to operate. When the potential across *C3* reduces sufficiently, the oscillator ceases operating until *C3* recharges. Therefore, the 1500-Hz oscillator is gated on and off by the *R2, R3, C3* circuit at 0.5-second intervals. The beeping of the alarm continues until all of the circuit's A, B, or C inputs are ungrounded.

In Fig. 2B, diodes *D1* through *D3* are connected to the ignition, headlights, and defogger (if any) circuits so that when any of these switches is closed, the associated diode is forward biased and conducts to apply power to the alert circuit via *R7* and its associated *C2* filter capacitor.

As an example of the foregoing, assume that the ignition is turned off, but either the headlights or the defogger is left on. The alarm will then receive power through the diode attached to the headlight or defogger switch, thereby sounding off and continuing to do so until the headlight or defogger switch is turned off. This is because when the engine is turned off, the oil pressure drops to close its sensor switch, thus activating the alarm. This action will also occur even if the oil-pressure lamp is burnt out, since the A input will still be grounded. The rear window defogger is also included since in many cars, this accessory will still operate when the ignition is turned off.

Construction. The simple circuit that makes up the system can be wired by any convenient means, including a printed circuit board, Wire Wrap, and point-to-point. Since there are no high frequencies with which to contend, lead dress is not critical.

The alarm can be mounted in any box that will accommodate it and the speaker. A barrier strip, mounted on the enclosure, can then be used to make all power, ground, and sensor connections.

The diode coupling technique shown in Fig. 2A can be used to increase the number of sensing points to monitor other elements in a mobile system. Each NAND-gate input can handle a large number of inputs, connected in parallel.

Note in Fig. 2A how a LED parking brake set circuit can be added to the alarm circuit. The switch associated with this sensor can be a conventional microswitch mounted so that, when the parking brake is set, the switch closes. The LED can be mounted on the dashboard and suitably identified.

Installing the System. Before the alarm is installed in a vehicle, it should be tested for proper operation. Connect a 9-volt battery between the ignition input and ground. Temporarily connect sensor input A to ground. After about 15 seconds, the alarm should begin to beep. Disconnect the sensor input from ground; the alarm should cease beeping. Repeat this procedure with sensor inputs B and C. The positive terminal of the battery can be connected with a jumper wire to the headlight and defogger inputs to test the operation of these functions.

Make all connections to the various points in the vehicle's electrical system securely and with care, preferably with splice-in connectors where possible. If you use a strip-and-wrap splice, make sure you cover each connection with vinyl electrical tape.

Dress all wires to protect them from mechanical and heat damage. Do *not* connect the ignition input to the ignition coil; otherwise, it may be damaged by transients from the coil. It goes to some accessory that is powered only when the ignition switch is turned on. Make sure that the headlight and defogger input power connections are made as shown in Fig. 2B.

After installation is complete, turn on the ignition but do not start the engine. (Set the ignition switch to the ON position only.) Since the low-oil pressure switch will be closed, after the delay period, the alarm should begin to beep. Turn on the headlights and turn off the ignition. The alarm should continue to beep and stop only when you switch off the headlights.

The alarm circuit can be used for monitoring other dc electrical systems. If failure modes are indicated by a "high" voltage, these can be diode OR'ed at input F (see Fig. 1) with the output of *IC1A*. ◇

Solid State

ON THE LIGHT PATH

By Lou Garner

A FEW OF THE advantages that fiber-optic coupled communications systems offer over conventional wired systems are greater noise immunity, smaller diameter, and absence of crosstalk. As a result, subsidiaries of the enormous Bell System have installed optical systems in a number of locations for exhaustive field tests. Several major electronics manufacturers, including industry giant *RCA*, are now offering fiber-optic communications systems and components as standard "off-the-shelf" products. If present trends continue, then, the wave-of-the-future might well be a light wave, at least as far as communications links are concerned. What's more, the increasing interest in optical communications and the resulting improved availability of special optoelectronic components and devices has opened new and exciting areas for the serious experimenter and hobbyist.

Illustrated diagrammatically in Fig. 1, *RCA*'s new optical communications link, Type C86003E, is designed specifically for digital data applications. With a 20-megabit (Mbs) capability, it can be used in computer links, digital telephone, data processing and process control systems as well as in high-voltage optically-isolated systems. The system consists of two basic units—a transmitter and a receiver. These are connected to opposite ends of a suitable optical fiber cable (*Dupont* type PFXS120R or equivalent), which can range in length from a few meters up to one kilometer. Self-contained within a two-inch square by one-inch thick module, the transmitter requires only a signal source and a 5-volt dc power supply. It includes a TTL buffer, a GaAlAs LED and LED modulator/driver circuits. Housed in a similar-size package, the receiver comprises a silicon *pin* photodiode, an amplifier, threshold detector circuitry, and a TTL buffer. Supplying digital output signals, it requires a dual ±6 V dc power source in addition to a +6 to +45 V dc bias supply for operation.

Although excellent for many commercial, industrial and laboratory applications, *RCA*'s C86003E system, which is currently priced at $850 each (exclusive of optical fiber cable), is rather on the expensive side for typical experimenter and hobbyist projects. Even where cost is not a factor, however, most experimenters prefer to assemble their own circuits and systems using individual devices. With a little imagination, a little care, a willingness to modify and adapt standard circuits, and a modicum of skill, such projects are well within the reach of the average experimenter's budget and can be assembled using readily available commercial components.

As a general rule, IR (infrared) emitting diodes or injection diode lasers are used as transmitting sources. These are more efficient than visible light LED's and can develop higher peak output levels. As a further advantage, the silicon photodiodes used as detectors are more sensitive to infrared than to visible radiation. A typical IR emitter driver circuit is illustrated in Fig. 2. Using standard devices, this circuit was abstracted from *RCA*'s 24-page booklet *Solid State IR Emitters and Injection Lasers*, publication No. OPT-113C. In addition to this and other practical circuits, the publication includes outline drawings of typical devices, condensed specifications, definitions of special terms, a discussion of safety considerations, characteristic curves, and a valuable review of basic theory.

Featuring a CA3085A/B positive voltage regulator IC, the simple driver circuit given in Fig. 2(A) permits IR emitters to be driven by unregulated dc sources of from 7 to 11 volts. It provides adequate voltage regulation and limits maximum forward current to protect the emitter diode. This basic circuit may be modified for use as an optical digital data transmitter by keying the IR emitter on and off using a series control transistor or other switching device capable of handling currents of up to 100 mA.

Much higher radiant flux outputs may be obtained from IR emitters when they are operated in pulsed rather than dc (CW) modes. For example, the *RCA* SG1010A will deliver approximately 7.0 mW when driven at its maximum continu-

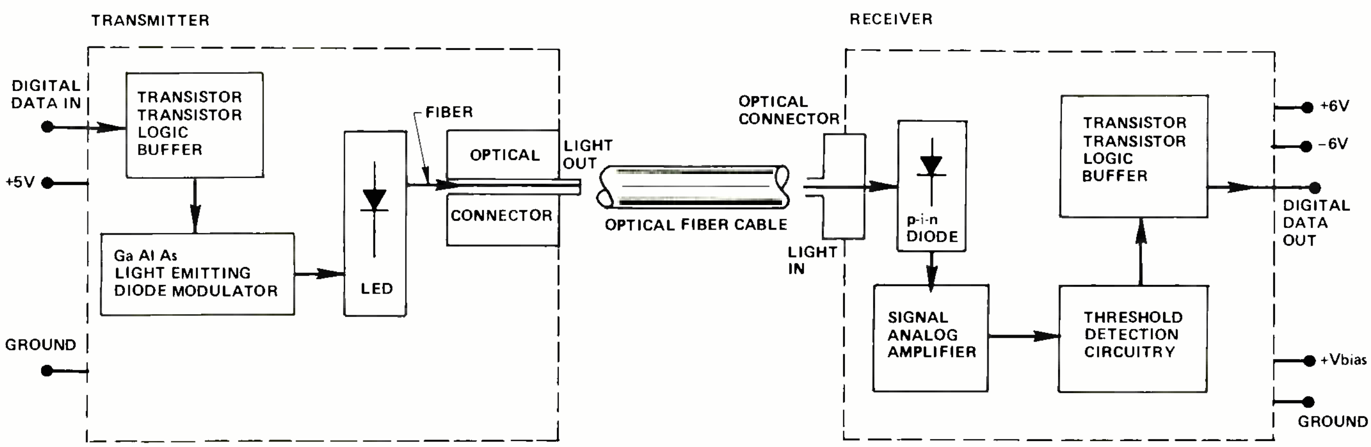
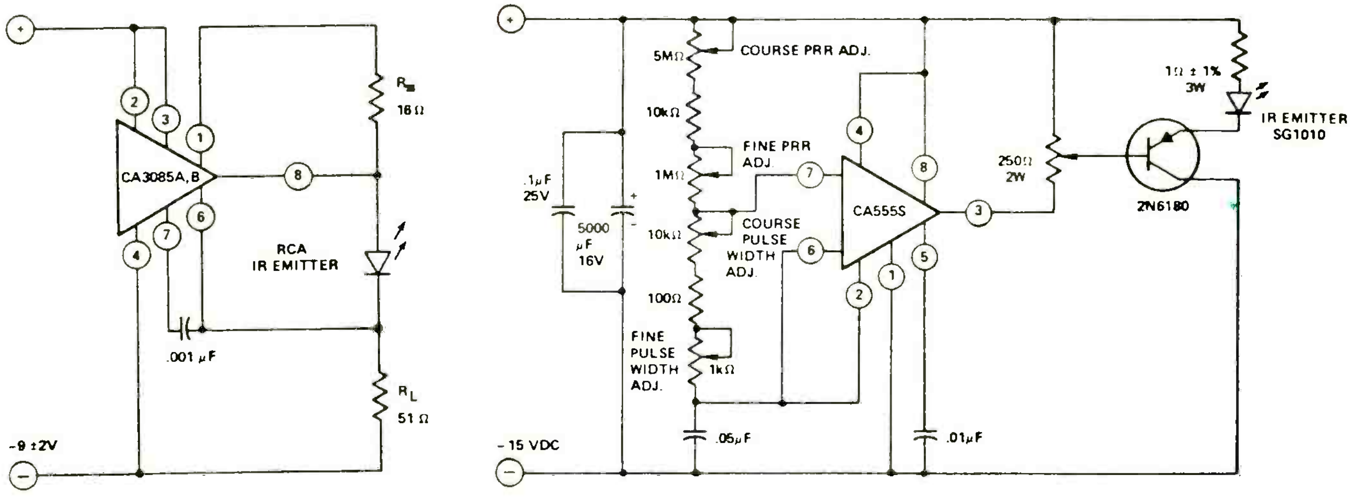


Fig. 1. Block diagram of RCA's C86003E fiber-optic data link.



A B

Fig. 2. Basic IR emitter-driver circuits: (A) direct current; (B) simple pulser.

ous forward dc rating of 100 mA. If pulsed with a peak forward current of, say, 3.5 A, however, its peak radiant flux output is better than 120 mW. Naturally, when an IR emitter is operated in a pulsed mode, the pulse width and pulse repetition rate (PRR) must be adjusted so that the *average* power dissipation is within the maximum limits of the device. In addition, heat sinking may be required for some applications.

A simple pulser for IR emitter diodes is shown in Fig. 2(B). Here, a CA555 timer IC serves as the pulse oscillator. The oscillator output is applied through a 250-ohm drive amplitude control potentiometer to the base of a 2N6180 *pnp* transistor which, in turn, furnishes the drive current to the IR emitter diode. Coarse and fine adjustments are provided for both the pulse width and pulse repetition rate (PRR). With the component values specified, the pulse width can be adjusted from 4 μs to 250 μs while the PRR range is from 6 Hz to 3 kHz. In practice, the pulse width is adjusted first, *then* the PRR for optimum performance without exceeding the diode's rated power dissipation. When operated on a 15-volt dc source, this circuit can supply pulse currents of up to 3.5 amperes.

(Continued on page 72)

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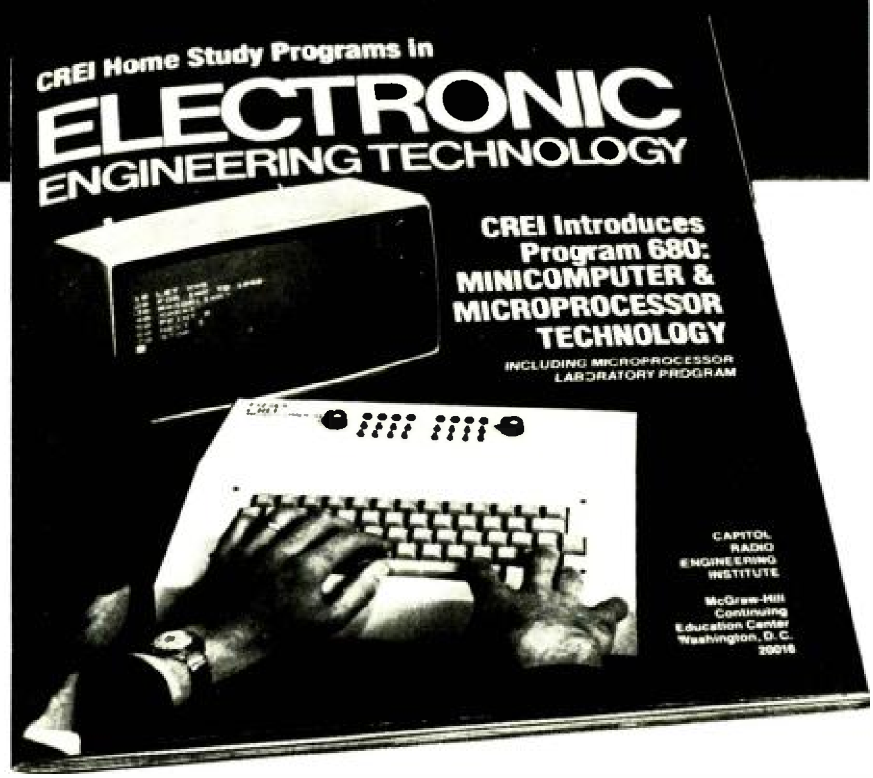

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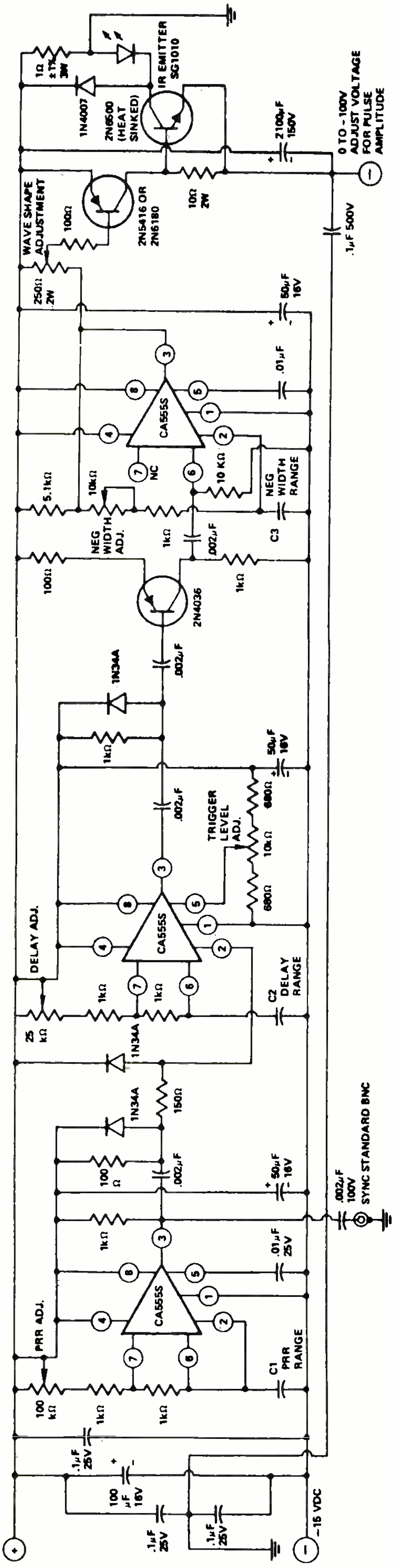


Fig. 3. Schematic of a high-performance infrared emitter-pulser circuit.

(Continued from page 67)

Offering greater output, the more complex high-performance pulser circuit illustrated in Fig. 3 uses additional CA555 devices to provide a time delay, to permit synchronization of the pulse with an external signal, and to shape and invert the drive signal waveform. With an appropriate dc source, this pulser can supply current pulses of up to 10 amperes at PRR's from 1.5 Hz to 3.7 kHz, pulse widths of from 0.2 to 1200 μs, and a delay range of 2.8 to 1000 μs. In operation, capacitors *C1*, *C2* and *C3* determine the PRR, delay, and pulse width ranges, respectively. With *C1* at 10 μF, the PRR range is 1.5 to 36 Hz, for 1 μF, 15 to 365 Hz, and for 0.1 μF, 150 to 3.7 kHz. The time-delay range varies with *C2*'s value as follows: 0.001 μF, 2.8 to 20 μs; 0.005 μF, 13.8 to 100 μs; 0.01 μF, 28 to 200 μs; 0.05 μF, 138 to 1000 μs. Finally, with C3 at 1 pF, the pulse width range is 0.2 to 1.2 μs, for 0.001 μF, 1.1 to 12 μs, for 0.01 μF, 11 to 120 μs, and for 0.1 μF, 110 to 1200 μs. Unless otherwise indicated, all resistors are half-watt types, all smaller value capacitors either high-quality ceramics or Mylar film types, and larger capacitors electrolytics, except for timing capacitor *C1*, which should be a tantalum type. The pulse oscillator, wave-shaping and control circuits are operated on a standard 15-volt dc source, while an adjustable 0 to 100 volt (negative to ground) dc power supply is required for the output driver stage. The 2N6500 *npn* output transistor must have an adequate heat sink.

Another and different type of IR emitter driver circuit is shown in Fig. 4(A). Using a 741 type op amp in conjunction with an *npn* transistor power stage, this circuit was designed originally for use with *RCA*'s unique three-element C30121 optically-coupled isolator, shown schematically in Fig. 4(B). Comprising a GaAs IR emitter and two coupled silicon *pin* photodiodes, the C30121 is supplied in a modified TO-5 package. Within the circuit configuration, one photodiode serves as an output device, the other as a feedback element and bias control. The basic design can be modified readily, however, for use as a linear IR emitter driver for fiber-optic communications systems, although the light power output and effective maximum range will be much lower than can be obtained with pulsed emitter systems. As with many other standard op-amp circuits, the design requires a dual (±12 V) dc power supply for operation.

Where greater radiant flux power levels are needed for maximum range, higher switching speeds for maximum digital data transfer, or superior high-frequency responses for analog communication systems, injection laser diodes are preferred over conventional IR emitters as fiber optic system transmitters. Although they also are p-n junction diodes, injection lasers differ in construction from conventional LED's in that they employ an optical cavity and are designed for higher injection carrier densities. The optical cavity—essentially a short section of optical waveguide—is formed by cleaving and polishing the opposite ends of the diode junction to form partially reflecting surfaces, then sawing the adjacent sides to complete the rectangular structure.

Unfortunately, space limitations have limited our discussion to light sources, the *transmitter* end of fiber optic communications systems. In a future column, we'll examine photosensor and amplifier circuits suitable for use at the "other end" of the cable, that is, as *receivers*.

Reader's Circuit. From deep in the heart of Texas, reader Thomas Jay Hubbard (5603 Colmesneil, Pearland, TX 77581) has written to offer a capacitance measurement circuit which should be of interest to experimenters who like to assemble

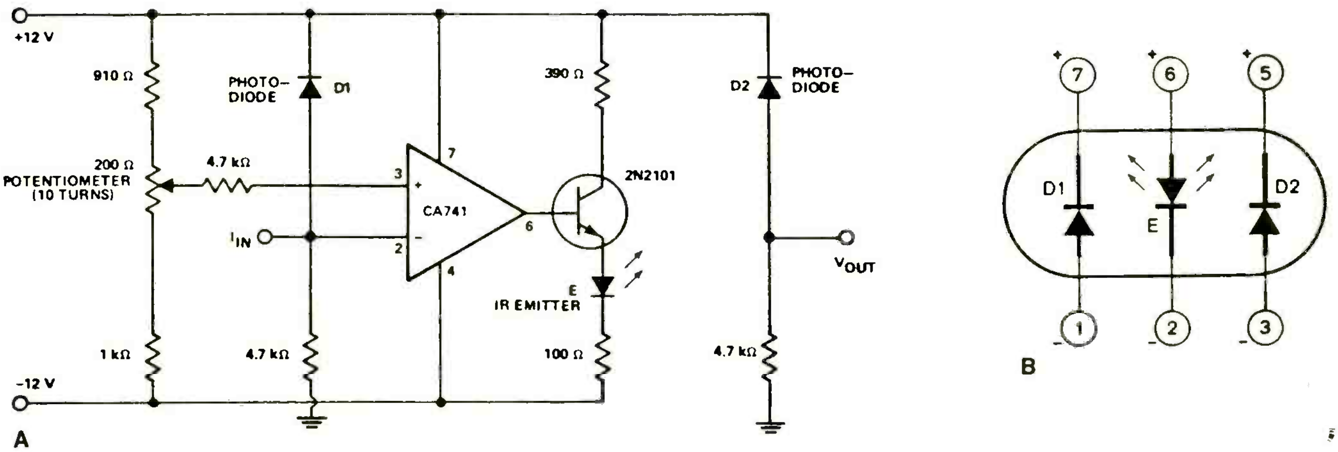


Fig. 4. RCA's C30121 optically coupled isolator: (A) driver circuit; (B) lead connections.

their own test instruments. According to Tom, his design is accurate to within ±10% and is capable of measuring units ranging in value from 10 pF to 10 μF. Tom also indicates that his circuit, illustrated in Fig. 5, can be assembled for well under 20 dollars, exclusive of the external meter used as a null indicator.

Referring to the schematic, Tom has used the ubiquitous 555 timer, *IC1*, as an oscillator. Transistor *Q1* provides a discharge path for range capacitor *CK* complementary to the IC's internal discharge circuit (pin 7) across the unknown test capacitor, *Cx*. The *RK-CK* and *RF-Cx* networks are connected from *IC1*'s output terminal 3 to each side of the power source, *B1*, with the voltage here applied through "L" filter *R4C2* to an external zero-center meter, *M*, where it is compared to the source's mid-point voltage, established by voltage-divider *R2-R3*. Shunt diodes *D1* and *D2* limit the maximum voltage across the meter.

The values of capacitor *CK* and resistor *RF* are preselected for the desired measurement range. In operation, then, potentiometer *RK* is adjusted for a 50% duty cycle, as indicated by a "0" reading on the null meter, *M*. At this point, *RK*'s value will be directly proportional to the value of the unknown test capacitor, *Cx*, permitting it to be calibrated directly in the desired capacitance values.

Neither layout nor lead dress should be overly critical, so the circuit can be duplicated using point-to-point wiring on perf board, wire-wrap, or a suitable board, at the builder's option. The fixed resistors are half-watt types, *C1* a low-voltage ceramic or plastic film capacitor, and *C2* a 10- to 15-volt electrolytic. Jacks *J1* through *J4* may be binding post or plug-in types. Standard general purpose diodes are used for *D1* and *D2*, but the 555 timer, *IC1*, and type 2N2222 *npn* transistor, *Q1*, should be high-quality, low-leakage devices. The critical components are *CK*, *RK*, *RF*, *R2* and *R3*. Of these, *CK* should be a high-quality, low-tolerance polystyrene or Mylar plastic film capacitor, while *RK* consists of a 68K fixed resistor in series with a 1-megohm potentiometer, the latter a good-quality unit with a linear taper. Resistors *RF*, *R2* and *R3* should be low tolerance (5%, 2%, or lower) types. Different values are used for *CK* and *RF*, depending on the measurement range needed, as specified in the table below. If a full-range instrument is preferred, the basic design may be modified by adding a multi-section, multi-position rotary switch, wired to select any of the listed values in order.

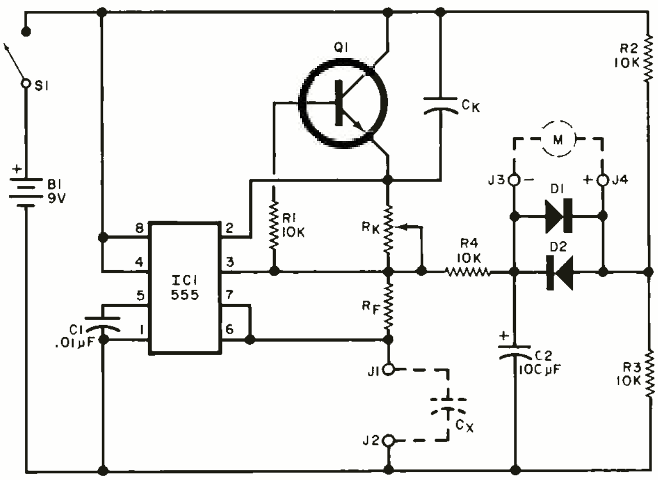


Fig. 5. Capacitance measurement circuit is said to be accurate to within 10%, in either direction, and will measure values from 10 picofarads to 10 microfarads.

RANGE	Cx	RF	CK
A	8 pF - 130 pF	820K	100 pF
B	80 pF - 1300 pF	82K	100 pF
C	800 pF - 0.013 µF	82K	1000 pF
D	0.008 µF - 0.13 F	8200	1000 pF
E	0.08 µF - 1.3 µF	8200	0.001 µF
F	0.8 µF - 13 µF	820	0.001 µF

Once the instrument's assembly and wiring have been completed and double checked for errors, shorts, opens and correct polarities, *RK*'s scale may be calibrated by measuring known capacitors within each range. Intermediate values may be interpolated easily as needed to complete the scale. The external null meter, *M*, should be a high impedance VTVM or FET voltmeter with a 1.5 V range, adjusted to zero at the center of the scale. ◇

Hobby Scene Q&A

By John McVeigh

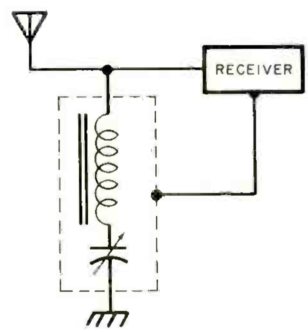
LONGWAVE IMAGE

Q. ***Recently, while tuning across my shortwave receiver's longwave band, I picked up WOAI, a local radio station, at a frequency of 280 kHz. Is this some type of relay broadcast or is my receiver faulty?—Troy Hollan, Fowleston, TX.***

A. My copy of the World Radio and TV Handbook (available from Gilfer Associates, Box 239, Park Ridge, NJ 07656, for $11.95 postpaid) lists WOAI as operating on 1200 kHz with a transmitter power output of 50,000 watts. The station broadcasts from San Antonio. I don't know how far that is from Fowleston, but you say it's a local.

If your receiver has an i-f of 460 kHz, then its local oscillator is running at 740 kHz. The AM broadcaster's signal is probably so strong that a portion of it is getting past the front end and into the receiver's mixer. The signal is there heterodyning with the local oscillator to produce a frequency-shifted version of WOAI's program at 460 kHz—the i-f frequency. The i-f stage can't distinguish this *image* signal from one original at 280 kHz, so it amplifies the signal and passes it to the detector. Actually, most receivers have a 455-kHz i-f, not one at 460 kHz. If this is the case with your receiver, you are actually tuned to 290 kHz if the image is twice the i-f away at 1200 kHz. Perhaps your receiver's calibration is off somewhat on the longwave band.

Considering the strength of the image station, I don't think that you should consider your receiver "faulty." A 455-kHz i-f can result in image problems on the higher shortwave bands, where the image is less than one octave away from the desired one. However, 1200 kHz is almost five octaves above the frequency to which the receiver is tuned, so the front end will attenuate the broadcast-band signal to a high degree. The signal is so strong that, even after this attenuation, enough is getting to the mixer to produce the image.



You can supplement your receiver's image rejection by installing the wave trap shown in the figure at the antenna input. The inductor is a ferrite-loop antenna coil such as the Radio Shack No. 270-1430, and the capacitor a 365-pF variable tuning capacitor. Mount the components in a metallic box. The antenna lead-in can be connected to the wave trap via a binding post. Be sure that both the wave trap enclosure and the receiver chassis are grounded to earth ground by way of a direct, low-resistance path. To attenuate the image-causing station, simply tune the capacitor so that the circuit resonates at that frequency. (Some capacitors come equipped with knobs with frequency markings for the AM band imprinted on them, making tuning a simple task.) The same circuit can be used to alleviate the cross modulation that strong, local AM stations produce in some receivers on the lower shortwave bands. ◇

Experimenter's Corner

By Forrest M. Mims

DIGITAL TO ANALOG CONVERTERS, PART 2

LAST MONTH, we saw how an *R-2R* resistor ladder network can be used as a rudimentary digital-to-analog (D/A) converter. We're now going to expand it into a full-fledged D/A converter and connect the converter to a few digital IC's. First, let's look at the circuit we'll be using to provide a binary input to the D/A converter.

A Simple Binary Input Circuit. A BCD (binary coded decimal) counter makes a convenient input circuit for the D/A converter. If you prefer, however, you can use a 4-bit RAM (such as the 7489) or any other chip with a 4-bit output. You can assemble both the binary input circuit and D/A converter on a plastic solderless breadboard.

Figure 1 shows the counter circuit along with a simple clock oscillator made from two of the inverters in a 74C04 hex inverter. I used CMOS chips, but you can use the TTL equivalents for the specified IC's. The pin numbers are the same for both.

If you use TTL chips, be sure to use a 5-volt power supply. If you don't have a suitable supply, use a 6-volt battery. Insert a IN4001 diode in series with the positive power supply lead to reduce the battery voltage to about 5 volts.

You can vary the clock frequency and count rate of the decade counter by varying the values of *R1* or *C1* or both. Increasing the capacitance of *C1* from 0.1 to 1.0 should give enough range.

The D/A Converter. Figure 2 shows how to add an operational amplifier to the *R-2R* resistor ladder network we experimented with last month. After you assemble the circuit, connect the binary inputs of the ladder network to the BCD counter outputs and then connect the probe of an oscilloscope between the output of the op-amp and ground. (If you don't have access to a scope, we'll shortly show you how to observe the operation of the circuit with a voltmeter.) With the clock running, you'll see a scope trace something like the diagram shown in Fig. 3. Obviously, the scope is showing the stepped voltage ramp coming from the op amp as the counter cycles through its 0000-1001 sequence.

Notice the ramp has not sixteen (as you would have expected from a 4-bit D/A converter), but ten, voltage levels. The reason for this, of course, is that the 74C90 is a BCD and not a pure binary (0000-1111) counter. Use a binary counter and you'll get a ramp with sixteen voltage steps.

The simple circuit in Fig. 2 can be used to synthesize waveforms digitally. A capacitor across the output will smooth the stepped waveform. The sequentially counting 74C90 will produce only ramps, but you can program a 7489 16-by-4-bit RAM to produce more complex waveforms.

Improving the D/A Converter. It's possible to improve the performance of the basic D/A converter by adding a second op-amp. The output voltage from the first swings from negative to positive as the ramp is created by the stepped voltage. It would be convenient to be able to adjust the ramp so that its baseline is ground, or any voltage you specify. The offset adjustment available to the first 741 isn't adequate for this purpose.

The second op amp (Fig. 4) makes adjusting the baseline of the ramp easy. In operation, the BCD counter is allowed to reach a count of 0000. The clock is then disabled to stop the count and the output of the second 741 is adjusted for any desired voltage. When the clock is reactivated, the output voltage will step through a ramp of ten voltage levels and automatically recycle as before.

You can set the 0000 count to equal 0 volt, so it's easy to use a voltmeter to

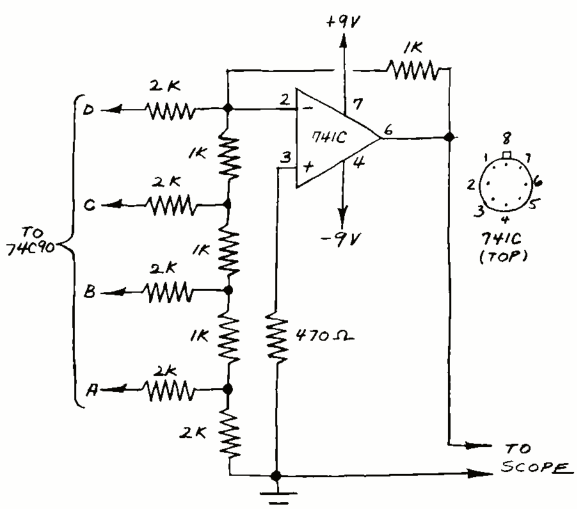


Fig. 2 How to connect an op amp to the resistor ladder D/A converter.

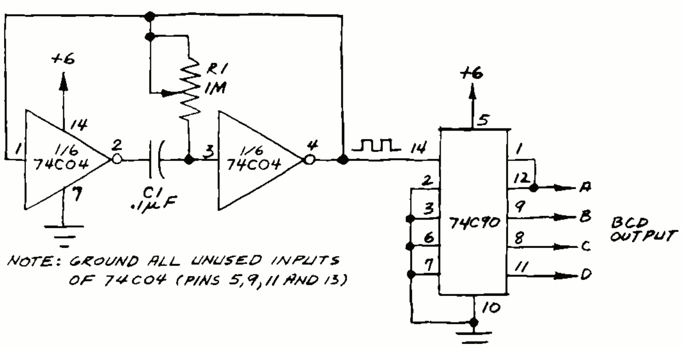


Fig. 1. CMOS clock and BCD counter for supplying binary inputs to D/A converter.

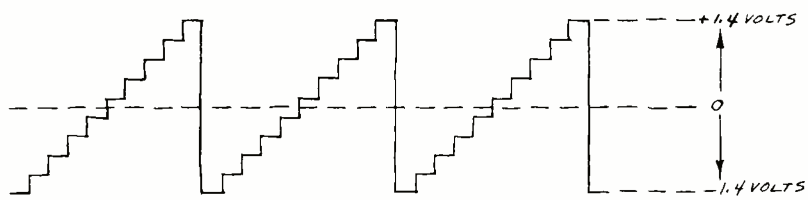


Fig. 3. Ramp voltage output from D/A converter in Fig. 2.

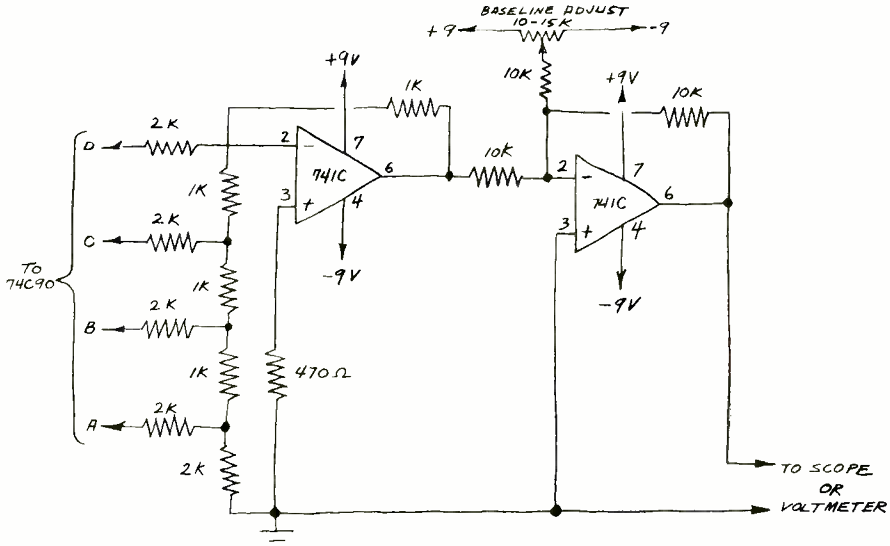


Fig. 4. Schematic of an improved D/A converter.

see the circuit in operation if you don't have access to a scope. First, insert a 10-μF capacitor in parallel with *C1* to slow down the clock to a few hertz. Then connect a voltmeter between pin 6 of the second 741 and ground. The needle on the meter will jump to about 3 volts and fall toward 0 volt in equally spaced increments. The cycle will then repeat.

Notice that the second 741 reverses the slope of the voltage ramp. The ramp from the first 741 goes from a low to a high voltage, while the ramp from the second 741 goes from high to low.

It's possible to reverse the slope of the ramp by inverting the binary input to the resistor ladder. The clock circuit uses only two of the inverters in the 74C04, so you have four uncommitted inverters, just enough to do the trick. Simply connect one inverter between each BCD counter output and the respective input to the resistor ladder.

Using the D/A Converter. By now, you should have a good understanding of the operation of a basic D/A converter. Let's use the circuit we've built in a practical application. Last month we noted that a D/A converter permits you to control the brightness of a lamp *digitally*.

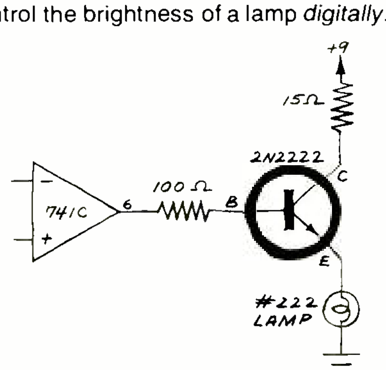


Fig. 5. Driver added to converter.

Figure 5 shows how a single driver transistor can be connected to the second 741 in our D/A converter to control the brightness of a 222 lamp.

Be sure to adjust the D/A converter so that a 0000 input gives an output of 0 volt. This will ensure that the lamp receives the highest voltage for a binary input of 1001. The lamp I used with the prototype circuit displayed six distinct brightness levels for binary inputs of 0100-1001. The counts 0000, 0001, 0010, and 0011 produced too little voltage to light the lamp.

You can also use the driver transistor circuit to power a small dc motor. In this mode, the D/A converter functions as a digital-motor speed controller. When the clock is slowed to a rate of less than a few Hz, you can easily observe the speed variations as the motor slows from a relatively fast clip to a full stop.

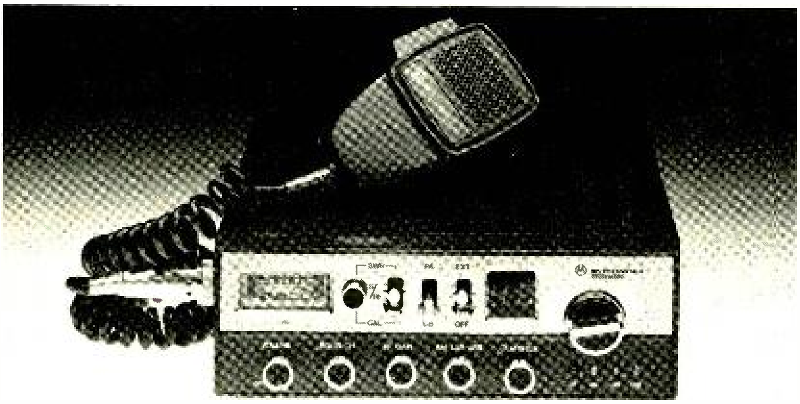
Remember, you can supply binary inputs to the D/A converter with a 4-bit memory such as the 7489 (see "Experimenter's Corner," December 1977 and January 1978). This means you can program any sequence of analog voltages you choose.

Further Reading. In a future column we'll explore the world of analog-to-digital (A/D) converters. Meanwhile, if you've found these experiments with D/A converters interesting, you'll want to read more on the subject. For starters, see "The How's and Why's of D/A and A/D Converters" by Robert D. Pascoe in the April 1977, POPULAR ELECTRONICS. For more details about resistor ladder networks, see "Fundamentals and Applications of Digital Logic Circuits" by Sol Libes (Hayden Book Company, 1975, pp. 131-138). ◇

Product Test Reports

MOTOROLA MODEL CM550 MOBILE AM/SSB CB TRANSCEIVER

Switchable noise blanker provides good range on AM and SSB.



THE Motorola Model CM550 is a mobile AM/SSB 40-channel transceiver for Citizens Band communications. Full-band operation is accomplished with the aid of the usual phase-locked-loop (PLL) frequency synthesis system.

The transceiver's features include: large numeric LED channel display; r-f, audio, and squelch controls; S/r-f/SWR meter; clarifier control; switchable noise blanker; transmit indicator; AM/LSB/USB mode indicators; PA operation; external-speaker jacks; detachable push-to-talk microphone with built-in preamplifier and gain control; top-facing speaker; electronic voltage regulation; operation from a nominal 13.8-volt, negative-ground dc source; and reverse-polarity protection.

The transceiver measures 9"D × 7"W × 2⅜"H (22.9 × 17.8 × 6 cm). Price is $319.95.

Technical Description. A 10,695-kHz i-f is employed in the receiver, with selectivity obtained with crystal and ceramic filters. Dual-gate MOSFET's in the r-f amplifier and mixer stages assure good signal-handling capabilities. IC's are employed in the AM and product-detector and agc circuits, while amplified squelch is obtained with transistors.

A full-time automatic noise limiter (anl) is provided for AM, with part of the audio system using transistors and an IC that contains the power-output stage. The power-output stage is also used to modulate the transmitter in the AM mode.

A signal derived from a 10,240-kHz crystal oscillator provides the standard reference for the PLL system. The signal at the mixer from the local heterodyning oscillator is 10,695 kHz above the CB signal and is initiated by the voltage-controlled oscillator (vco). The PLL system employs an IC for the various divide functions.

On transmit, the signal derived from the vco is sum-mixed with a 10,695- or 10,700-kHz signal, depending on the selected transmitting mode. This produces the on-channel frequency at a mixer output, which for AM goes directly to an r-f amplifier stage and then to a driver and the r-f power-amplifier stages. The driver and power-amplifier stages are collector-modulated.

The SSB signal is generated in an IC balanced modulator and a crystal filter. The modulator and filter are located ahead of the mixer.

Automatic modulation control (amc) is provided to prevent overmodulation on AM. An automatic level control (alc) system provides the same thing on SSB.

The output from the power amplifier goes through a multisection network that provides correct impedance matching to 50-ohm loads and that greatly attenuates spurious responses. This network also serves as part of the input circuit for the receiver to enhance image and other unwanted-signal responses and to minimize receiver-antenna radiation.

The antenna circuit also contains a transformer-coupled directional wattmeter for providing SWR indications. Transmit/receive transfer is conducted via a relay and diode switches.

Laboratory Measurements. No specifications were provided with our test transceiver. Hence, we had nothing against which we could compare our test results.

The sensitivity of the receiver measured better than is the usual case. It was 0.4 μV for 10 dB (S + N)/N on AM at 30% modulation at 1000 Hz and 0.1 μV on SSB. The squelch threshold range was 0.5 μV on AM and 0.2 μV on SSB up to a nominal 1000 μV. The S meter registered S1 with a 0.5-μV signal and S9 with a nominal 30-μV signal. Image and spurious- and adjacent-channel rejection were excellent at 90, 80, and 65 to 70 dB, respectively. I-f signal rejection was 63 dB, while unwanted-sideband suppression was 50 dB on LSB and 60 dB on USB at 1000 Hz.

The overall 6-dB audio response was 400 to 2000 Hz on AM and nominally 500 to 3800 Hz on SSB. The audio output measured 2.5 watts with a sine-wave input into 8 ohms at 10% THD on AM and 2% THD on SSB. With slight clipping, the output was as high as 3 watts.

Operating the transceiver from a 13.8-volt dc source, the AM carrier output measured 3.9 watts. Using an audio tone of 1000 Hz, modulation was limited to 85% to 90% with a THD of 1.75% and 2.75%, respectively, with inputs of 16 and 25 dB greater than required for 50% modulation. Under these conditions, splatter was 60 dB down at 1000 Hz and 55 dB down at 2500 Hz. During dynamic operation (voice), the modulation kicked slightly beyond 100% on both the positive and the negative peaks, with the microphone gain control at its maximum setting. At that point, splatter was 55 to 60 dB down. The overall 6-dB response, not including that of the microphone preamplifier, was 500 to 4500 Hz.

On SSB, the output measured 11 watts PEP with a two-tone test signal. It was 14 to 16 watts PEP during dynamic operation. The overall 6-dB response was nominally 600 to 2700 Hz. Sideband suppression at 1000 Hz was a minimum of 60 dB, while carrier suppression was 55 dB on LSB and 60 dB on USB. The third-order distortion products were 30 dB below PEP.

The output frequency tolerance of the transmitter held to within ±10 Hz of +30 Hz on any channel.

User Comment. This rig's symmetrical front-panel layout is certainly neat. We would have liked to have seen larger rotary control knobs, however, as well as easy-to-see position markers. The CLARIFIER control, though, has a detented center position, which helps when making adjustments. Also, the mode switch's detents are quite tight on our sample, which can make operation somewhat stiff with the very small control knob. The small edgewise-mounted meter's black background against its white pointer provides an easy-to-read contrast.

During operation, the use of the noise blanker effectively extended the range of the receiver on weak signals by attenuating certain noises to improve the sensitivity-versus-S/N under adverse man-made noise conditions. From the circuit diagram, it was noted that a full-time anl is provided for AM, but in our on-the-road experience, it was not quite as effective as we have come to expect. On the other hand, switching in the noise blanker gave us excellent noise suppression. Even on SSB, the noise blanker was very effective.

As was apparent from our audio output tests, the distortion on AM was somewhat greater than on SSB. Hence, AM signals at fairly high levels may not sound as clean as SSB signals.

In on-the-road tests, this transceiver provided high-quality performance, with high sensitivity, excellent signal-handling capabilities, and fine rejection of unwanted signals. We also produced good-quality transmissions. We did note, however, that on transmit, the microphone gain had to be reduced on occasion to prevent excessive modulation, particularly on SSB. A built-in modulation indicator would have aided in setting the proper mike level, of course.

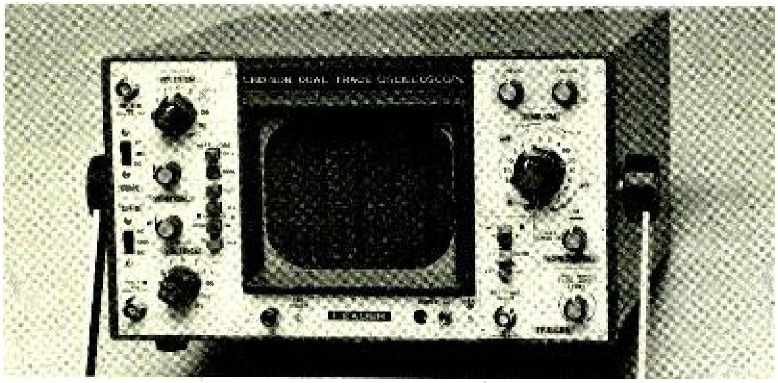
As with other new CB SSB models, the Motorola CM550 gave clear evidence that SSB performance is greatly superior to AM.

CIRCLE NO. 104 ON FREE INFORMATION CARD

(Test Reports continued overleaf.)

LEADER ELECTRONICS MODEL LBO-508 OSCILLOSCOPE

Dual-trace, triggered-sweep 5" scope has 20-MHz bandwidth.



DURING the past few years, a number of excellent laboratory-grade oscilloscopes have come onto the market at moderate prices. Most of them offer a host of functions and features that just a decade ago were found only in true laboratory instruments at a cost of several thousand dollars. A good example of the current crop of high-performance scopes selling for moderate prices is the Leader Electronics Model LBO-508 dual-trace, triggered-sweep scope, at a suggested selling price of $769.95. Included with the Model LBO-508 oscilloscope is a pair of low-capacitance probes.

The Model LBO-508 is a multifunction 5" (12.7-cm) oscilloscope whose rated bandwidth is dc to 20 MHz. It measures about 15"D × 11½"W × 6"H (37.5 × 29 × 16 cm) and weighs about 15.5 lb (7 kg). The scope is equipped with a carrying handle that doubles as a tilt stand.

General Description. The two vertical amplifier channels of the scope have a rated bandwidth of dc to 20 MHz in the dc mode and 2 Hz to 20 MHz in the ac mode. The input sensitivity in both cases is rated at 10 mV/cm. An 11-step attenuator, with a 1-2-5 sequence, allows the user to observe input signals with magnitudes up to 50 V/cm at full attenuation, using the associated variable-gain control. Accuracy is specified to be within 3%. Rise time is rated at 17.5 ns.

The input impedance of each vertical channel is 1 megohm shunted by 35 pF. The maximum safe input potential to the scope is 600 volts dc plus peak-to-peak ac. The polarity of channel 2 can be inverted as required by test conditions. The inputs to the vertical channels are BNC type connectors.

The two input channels can be used independently of each other, singly, simultaneously for a conventional dual-channel display, in an X-Y vector mode, or in an algebraically add mode.

The triggered-sweep time base contains an 18-step speed selector, with the speed positions arranged in a 1-2-5 sequence. Its range is from 0.5 μs/cm to 200 ms/cm, with an accuracy of 5%. A 5× magnifier allows observation of 100-ns/cm waveforms.

Both alternate and chopped modes are provided for displaying both channels simultaneously on the 8-×-10-cm screen of the CRT. The chopped mode is automatically selected by the scope with sweep speeds between 200 and 0.5 ms/cm, while the alternate mode is used between 200 and 0.5 μs/cm.

In the vector mode, the frequency response is from dc or 2 Hz to 800 kHz, depending on whether dc or ac coupling is selected. The phase difference in the two input channels is rated at less than 3% at 100 kHz.

Sweep synchronization can be switch selected to be either manual or automatic. The sync can be obtained from either an internal or an external source. Both positive and negative slopes are also selectable. A built-in TV sync clipper allows synchronization from TV-type video. Internal trigger sensitivity is from 2 Hz to 20 MHz with a 1-cm screen signal. External sensitivity covers the same range from a 150-mV peak-to-peak external signal. A built-in line-frequency, 0.5-volt peak-to-peak calibration signal, whose accuracy is rated at 3%, is also available.

Test Results. We used a laboratory-grade dc voltage standard to investigate accuracy of the two vertical channels for attenuation and control operation. Both channels checked out well within published specifications. We performed this test with both channels set to the dc mode and connecting both signal probes simultaneously to our voltage reference. This allowed us to observe the trace positions above (positive) and below (negative) the zero line.

For our frequency-response test, we injected signals from our crystal-controlled audio and low-rf signal generators. At the same time, we took careful note of the stability of the sweep trigger and linearity. The sweep remained stable at frequencies beyond 30 MHz, which is the limit of our burst tester. When we switched from positive to negative slope and back, there was no drift.

Excellent sweep linearity was noted when we used a crystal-controlled square-wave generator. The square waves from our tunnel-diode generator were displayed with neither low-frequency deficiency tilting nor excessive high-frequency response ringing. The 4-MHz upper limit square wave from our generator revealed that the scope had an excellent response out to 40 MHz. At this frequency, the sync was steady and both polarities could be selected.

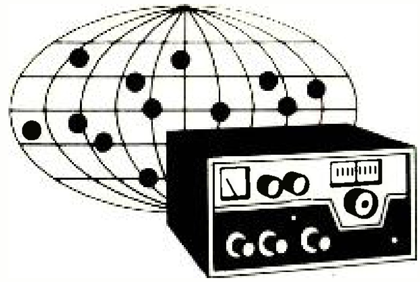
A sine-wave source was fed through a phase-shift network to check the vector display mode of the scope. Both vertical channels tested very close to each other in phase shift, and clear circles were produced at a number of selected frequencies during our test.

User Comment. Leader's LBO-508 oscilloscope was a very easy instrument to use. Its front panel is extremely clean, and the various controls and switches are color coded and clearly identified according to channel and function. This, plus the fact that each control and switch has plenty of room around it for easy manipulation, greatly simplified operation under most any working condition.

We used this oscilloscope for several weeks in our lab after performing initial tests to determine just how useful it really is under actual working conditions. It performed flawlessly during the whole time. In fact, we often found ourselves using it preference to our 10-year-old true laboratory scope.

Before returning the scope to its manufacturer, we ran a few quick tests to determine if any changes in calibrated performance had resulted. There were no detectable changes.

CIRCLE NO. 105 ON FREE INFORMATION CARD



DX Listening

By Glenn Hauser

CURRENT NEWS AND FUTURE PLANS

ADVENTIST World Radio plans to put on a 20-kW shortwave transmitter in Guatemala this year, probably operating on the 9- and 11-MHz bands. This may give us a chance to hear the AWR DX program, so far limited to Europe. The Autonomous University of Nuevo León plans to add not only an FM station in Monterrey, Mexico, but also a shortwave station on 5.97 MHz, no later than September.

Brazil still intends to close down all private shortwave stations on the bands to clear frequencies for Brasilia's big new international service, expected to begin later this year. Radio Renascenca, the Catholic station in Portugal, has purchased shortwave transmitters, expected on the air in early 1979, to reach emigrants wherever possible.

Radio RSA is considering resuming a transmission for western North America. They are heard well there at present, but at inconvenient times.

Radio Australia is rebuilding its cyclone-damaged Darwin relay, actually on the Cox Peninsula, and also installing their transmitters for a Northern Territory domestic shortwave service. A new site in the North West Cape region is also being sought.

Voice of America plans to close down its Dixon CA and Bethany OH sites as satellite feeds to overseas relays make the shortwave feeds obsolete.

France, which has conspicuously ignored us for years, and only recently condescended to broadcast a home service relay in our mornings, has registered with the ITU six frequencies beamed to North, Central and South America for the summer season at 2300-0400 GMT: 9.505, 11.735, 11.745, 11.755, 11.925, 15.135 MHz. There's little prospect of an English program any time in this block. To lobby for this, the Radio France International Listeners Club has been formed. For details, send 26¢ in stamps to Matthew Brown, 3310 Picardy Ct., Mequon, WI 53092.

SSB Broadcasting Update. Switzerland's year-long test began May 7. In addition to the usual AM frequencies, check 17.74 MHz at 1315 GMT and 11.78 at 0145. Then send them a reception report comparing the results. Radio Sweden's home service relay in Swedish on SSB, even though not beamed to North America, often comes in better than Radio Sweden's English programs, which are beamed to North America. The current schedule: 0500-0830 on 21.55, 0930-1600 on 21.555, 1600-2000 on 17.785, 2000-2130 on 15.19 MHz.

DX Conventions. All the following clubs welcome interested nonmembers to their conventions; send an SASE when inquiring. Aug. 4-6, Louisville, KY, Worldwide TV-FM DX Association; details from Box 202, Whiting, IN 46394. Aug. 11-13, Portland, OR, International Radio Club of America (MW only); information from Frank Aden, 1535 NW Ithaca Ave., Bend, OR 97701. Sept. 1-3, Atlanta, GA, National Radio Club (MW only); information from Karl Jeter, 2816 Frontier Trail, N.E., Atlanta, GA 30341.

DX Programs. For the very latest DX news, don't miss our two weekly reports on alternating Sunday broadcasts of Radio Canada International. Also, Clarin-DX, GMT-Sundays at 0000-0030 on 11.70 MHz, includes my regular reports. George Wood is doing an extra DX program, through August only, on Radio Sweden's Thursday broadcasts. After much urging, Austrian Radio has scheduled its "SW Panorama" when North Americans can hear it—GMT Sundays at 0300-0315 on 6.155 and 9.77 MHz. Immediately following, try for "Radio Monitors International" from Sri Lanka, at 0315-0330 on 15.425. It's repeated Mon. at 1115 on 17.85, 15.12, 11.835 and Sun. at 1900 on 17.85, 15.120, 15.115, and 11.87. Also good is 0400 GMT Wed. and Sat. is Radio Budapest's "Calling DX'ers and Radio Amateurs."

Pirate Activity Rising. "From the frozen north," Voice of the Voyage(u)r maintained a regular schedule on 5.85 MHz this spring, GMT Sat. and/or Sun. between 0400 and 0500. The wild-sounding announcers loved to play old, old records. Each time they broadcast a different phone number for listeners to call, and rewarded them with hand-made QSL sheets. Several other pirates have been operating just above 6.20 MHz.

Cuban Clandestines, Too. Most likely using ham equipment, Radio Abdala and Radio Rebelde have both been heard around 7.08 MHz with anti-Castro speeches. Another one bearing the same name as a Cuban government network is La Voz de Cuba, heard in Argentina on 6.100 MHz.

Buzz, Buzz. It seems the FCC does not require private U.S. shortwave broadcasters to monitor their own signals on an ordinary receiver. As a result, for well over a year, WYFR has been broadcasting a "ripple," "hum," or "buzz" on many frequencies, making their signal a pain to listen to. The synthesizer problem cannot be detected on the FCC type-approved direct demodulation monitors they are required to use! Also, their old Scituate plant barely survived an ice storm in February, making them more eager to move to Florida.

HF Happiness. The rapid upswing in the sunspot count this year has led to much improved propagation above 15 MHz. More and more flea-powered harmonics can be heard on a good day in the 23-25- and 30-31-MHz ranges. The 15- and 17-MHz bands stay open all night between Europe and North America. The 21-MHz band is open at very unusual times, such as from Pakistan at 0230-0245, heard in North America on 21.59 with dictation-speed English news. A few more stations are likely to venture into the 25-MHz band, besides Israel on 25.605, Radio Liberty on 25.69 and VOA Greenville on 26.04. During the last sunspot peak, 25 MHz provided excellent reception from the few countries using it. This time, however, we must cope with CB interference. And as in every solar activity peak, while conditions can be excellent, there are also more blackouts in store rather than the generally mediocre reception of the past few years. Various estimates place the peak of Cycle 21 in late 1979 or early 1980 at a maximum of about 150 sunspots. ◇

Computer Bits

By Leslie Solomon

DIRECT-WIRE REMOTE CONTROL

AT VARIOUS times, POPULAR ELECTRONICS has introduced ideas and circuits for using a computer as a remote-control device. Published circuits used the ac power line as the interface between the computer and the remote electrical appliance being controlled. This approach was taken because we assumed that most users would not wish to rewire their homes to accept direct remote control.

Now we find that many readers do wish to direct-wire their systems. This way, any possible signal malfunction due to power-line noise and other unwanted signals on the ac line will not affect the program being transmitted. Moreover, the "bill of materials" would be lower doing it this way. Many readers have also told us that they were either building a new house or renovating an old one, so that direct wiring could easily be included. Here is information on some direct-wire control systems to assist these readers.

Direct-Wiring Accessories. Gimix, Inc. (1337 West 37 Pl., Chicago, IL 60609; Tel: 312-927-5510) has such a system and had, in fact, built a computer-controlled house in the Chicago area. The Gimix system is based on a Driver Relay board that can be obtained directly from the company or a local computer store. The board is designed to drive up to 31 GE RR8 power relays, each of which can handle up to 20 amperes at 250 volts ac. Since this mechanically latched relay requires a 1/120-second (8.33-ms) pulse to turn on or off, standby current is negligible.

The Relay Driver board measures a large 24″ × 5″ (61 × 12.7 cm). Relays are mounted on a separate bracket. Both the pc board assembly and metal relay bracket can be housed in a conventional 30″ × 12″ × 6″ (76.2 × 30.5 × 15.9 cm) electrical case. The only other item required is a low-current 24-volt transformer to supply relay power.

The system is driven from a conventional 20-mA current-loop serial port. Up to four of these boards can be driven in series, and each board is assigned its own specific port number.

A board-generated relay status signal allows the processor to detect faulty relays and permits the use of manual-override switches. Since the data rate can be up to 1200 baud, up to 120 relays can be activated in one second.

The board operates in either the active or the scan mode, as specified by the computer. In the active mode, the board interprets the 8-bit data received as a command to turn on or off a particular relay. Following a brief interval to allow the selected relay to operate, the board senses that relay's status (on or off). If the status is other than expected, the computer takes appropriate action, as determined by the program.

A command received in the scan mode has the same results, except for relay activation. This allows the mode to check relay status at any time.

If the on-board UART detects a transmission error, such as in framing, parity, or overrun, no relays are activated and no status scan occurs.

The Gimix catalog contains listings for a number of other interesting remote-control items. Among them is an Opto-Board, which is a general-purpose interface between 34 switches and the computer. The switches can be from a keyboard, an intrusion alarm system, fire-alarm devices, clocks, timers, thermostats, lighting circuits, etc. Each switch input is through an optical isolator that has a rated 1500-volt isolation.

All switch ports are constantly scanned by an on-board circuit (no processor time required), with 0.9 ms required to scan all ports. A built-in memory buffer saves up to 64 closed-switch signals, permitting the processor to complete lengthy tasks between interruptions. The board connects to any 8-bit parallel port.

Another remote-control Gimix board is its Tone Recevier Board, which converts standard DTMF (telephone) tones into binary signals. This allows the use of

conventional Touch-Tone telephones for remote control. The board also uses an 8-bit parallel port. A 16-button remote-control keypad that can work at distances of up to a mile from the computer is also available.

Z80 Controller. Manufactured by Dynabyte (4020 Fabian, Palo Alto, CA 94303; Tel: 415-494-7817) the Z80-based Basic Controller sells for $750 assembled and tested. The Controller features a variation of BASIC, called ZIBL, which is a proprietary language specifically written for control applications. This single board divides the world into six categories: sense inputs, flag outputs, lights, relays, A/D conversions, and D/A conversions. ZIBL implements 64 channels of each in such a way that the user need know nothing about them, other than their names.

The file structure allows multiple programs to be written into RAM, and each program can be individually loaded, renamed, and run. Any program can access another program as a subroutine while still retaining its own line numbers and variables. Listing, printing, and inputting can be from either the serial or the parallel I/O channel or the built-in CRT I/O. Interaction with the controller is via the user's keyboard and video monitor that can be "plugged" into a board connector.

On-board hardware includes a Z80 microprocessor that operates at 2.5 MHz, 4K of RAM (expandable to 16K), 4K of EPROM with programmer, two RS-232 I/O ports configurable via software with one port having a 20-mA current loop, one parallel input and one parallel output port, 300-baud cassette interface with file handling and motor control, and a keyboard-input port.

The internal video interface generates 16 lines of 64 characters and has standard video output. There are also 32 individual memory-mapped flag outputs, 32 individual memory-mapped sense inputs, and eight relays, four of which handle 0.75 amperes and four of which handle 5 amperes. Other visual outputs include eight individual memory-mapped LED's and one 8-bit light port for displaying the data.

Floppy Update. Southwest Technical Products Corp. (219 West Rhapsody, San Antonio, TX 78216; Tel: 512-344-0241) has announced availability of its Model DMAF1 dual-drive, single-density, double-sided 8" (20.3-cm) floppy-disk system. It sells for $2095 assembled and tested or $2000 in kit form. The hardware consists of an SS-50 bus-compatible DMA controller that is capable of handling up to four drives, two CalComp 143M double-density rated disk drives, both enclosed in a 20½"D × 17⅛"W × 5⅜"H (52.1 × 43.5 × 13.7 cm) aluminum chassis that also contains a regulated power supply, drive-motor control board, cooling fan, diskette, etc.

Software includes a DOS, 8K BASIC with disk file and string function capability. Each diskette holds approximately 600K. Hence, with dual disks, more than one megabyte is provided.

Video News. TDL (Research Park, Bldg. H, 1101 State Rd., Princeton, NJ 08540; Tel: 609-921-0321) has released its VDB at $369 assembled and tested. Consisting of two board assemblies, one piggybacked on the other, only one S-100 connector is used.

The VDB contains its own display buffer with two pages of 25 80-character lines. Since the display memory does not employ a memory address, the entire computer memory is left intact for user programs. In addition to the 96 upper- and lower-case ASCII characters (with descenders), 64 unique display symbols are provided to permit graphic resolution with 160 horizontal and 75 vertical elements. The display can accept data at a 400,000-character/second rate. The blinking cursor is addressable, and a mode register allows any combination of characters to blink, insert, or do both simultaneously.

Ohio Scientific (1333 S. Chillicothe Rd., Aurora, OH 44202; Tel: 216-562-3101) has introduced a Model 540 video display board for the company's Challenger III line. Costing $249, this display features a 32-row by 64-column display of the standard 64-character ASCII display font in a 5 × 7 dot-matrix form. Standard features include programmable 32 × 32 or 32 × 64 formatting. The board also has a keyboard port. The Model 540 also supports a graphics character generator that features lower-case and about 170 special characters for plotting and gaming.

Z80 Board. The company to take up the "standard" for putting a Z80 into every S-100 bus computer is Vector Graphic Inc. (790 Hampshire Rd., Westlake Village, CA 91361; Tel: 805-497-6853) with its Z-80 CPU board that sells for $175 in kit form or $215 assembled. This new board offers fully blocked design with on-board wait-state select and is jumper-selectable for operation at 2 or 4 MHz. All Z80 lines are fully buffered, and the board will operate with 8080 software without modifications.

Upcoming Meetings.

July 22-23
: Amateur Computing 78, Sheraton National Motor Hotel Arlington, VA

Aug 24-27
: Personal Computing 78, Civic Center, Philadelphia, PA

Sept 15-17
: 2nd National Microcomputer Expo and Conference, Coliseum, New York, NY

Sept 29-Oct 1
: International Microcomputer Expo, Dallas Convention Center, Dallas, TX

Oct 5-8
: Midwest Personal Computing Expo, Expocenter, Chicago, IL

Oct 12-15
: Mid-America Personal Compr Show, O'Hare Expo Center, Chicago, IL

Nov 3-5
: 3rd West Coast Computer Faire, Los Angeles, CA ◇

Software Sources

8080 Inventory Package. Inventory-1 is an interactive inventory control system for S-100 bus computers. It is designed to run on Shugart Mini-Floppy drives. The program provides three-second access to any item in the inventory file. "HELP" and "EXPLAIN" commands are available to prompt the firsttime user. The system includes a set of "skeleton" programs which can be used to implement special, user-defined commands; using these "skeleton" programs, the system is claimed to make it possible to produce the software necessary to generate a special report within 5 minutes. $99.95. Write: The Software Works, Inc., Box 4386, Mountain View, CA 94040.

1802 Cosmac Elf Music and Games. This 44-page book includes music programming instructions and several "scores," utility subroutines, random numbers, Tic-Tac-Toe, and others. $2.50 (Connecticut residents add 7% tax). Paul C. Moews, 39 Mansfield Apts., Storrs, CT 06268.

6502 Assembler/Text Editor & Relocating Loader. The Assembler/Editor portion of this program produces relocatable object code on tape (with checksum) and can store executable code in memory during assembly. It can assemble source programs from tape or memory, and has 17 user commands (including tape control and one user-definable command) and 16 pseudo-ops. Labels may be up to 10 characters in length. Lines are automatically numbered, and there are 18 error codes. A manuscript feature allows the program to generate letters and other text. The Relocating Loader can reload relocatable object code at practically any location. The program resides in less than 4K of RAM or ROM (specify hex starting addresses of 0200, 0400, 1000 or 2000), and support up to two tape decks. It is pre-configured for TIM-based systems, but information is supplied on modifying it for other systems. Hex listing and operators manual, $25. C.W. Moser, 3239 Linda Dr., Winston-Salem, NC 27106.

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9000	74H05	.17	3000	74H50	.16	6000	74H65	.16	1000	74H103	.50
1500	74H08	.22	2000	74H51	.17	1000	74H71	.35	2000	74H106	.45
17000	74H10	.16	1000	74H52	.17	2000	74H72	.31	1000	74H108	.49
4400	74H11	.22	6000	74H53	.17	2000	74H73	.49	3000	74H113	.24
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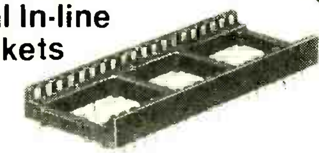
43000	7437	.09	69000	74151	.29	13000	74181	.79
57000	7438	.09	12000	74152	.89	31000	74182	.29
22000	7443	.15	90000	74153	.29	30000	74190	.34
38000	7445	.19	33000	74154	.49	48000	74191	.34
23000	7454	.07	2900	74155	.29	16000	74194	.34
32000	7460	.07	23000	74156	.19	56000	74195	.29
41000	7472	.12	42000	74157	.29	8000	74199	.69
						33000	74283	.49

Dual In-line Sockets



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5700	8251	5.95
1100	8253	14.95
2700	8255	5.95
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840	8259	14.95
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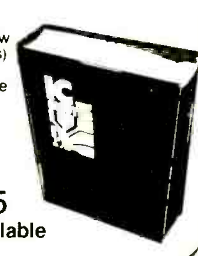

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CY2.50	2.500MHz	HC33	4 95
CY3.27	3.2768MHz	HC33	4 95
CY3.57	3.579545MHz	HC33	4 95
CY3A	4.000MHz	HC18	4 95
CY4.91	4.916MHz	HC18	4 95
CY7A	5.000MHz	HC18	4 95
CY5.18	5 185MHz	HC18	4 95
CY6.14	6 144MHz	HC18	4 95
CY6 40	6.400MHz	HC18	4 95
CY6.55	6 5536MHz	HC18	4 95
CY12A	10 000MHz	HC18	4 95
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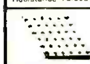
Resistance Values - 50, 100, 500, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K, 1 meg



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GLASS	84P44 062WE	4.50	8 50	2 56	2 31
	169P44 062WE	4 50	17 00	5 04	4.53
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MC6821	Periph. Interface Adapter	11.50
MC6830L8	1024 x 8 Bit ROM	14.95
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	1K x 4	Static 300ns	10 95
2114L-3	1K x 4	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 Bit Accumulator 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	
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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

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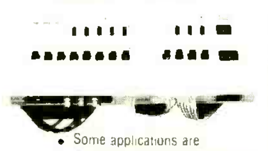
11C90	$19 95	MK40240	$17 50
MC3061P	11 95	DS0026CH	3.75
MC1408L7	4 95	TIL308	10 20
MC1408L8	5 75	95H90	11 95
LD110/111	$25 00/set		
MC4016(74416)	7.50		
4N33	3 95		

TV GAME CHIP SET
AY 3-8500 1 Chip and 2 010 MH2 Crystal **$7.95**

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
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage 0-1000V
AC Voltage 0-1000V
Freq. Response 50-400 HZ
DC/AC Current 0-100mA
Resistance 0-10 meg ohm
Size 6.4 x 4.4 x 2

Model 2800
$99.95

Comes with test leads, operating manual and spare fuse

Accessories:

AC Adapter BC-28	$9.00
Rechargeable Batteries BP-26	20.00
Carrying Case LC-28	7.50

CSC — 100 MHz 8-Digit Counter

- 20 Hz 100 MHz Range
- 6 LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1.75" x 7.38" x 5.63"
- Four power souces, i.e. batteries, 110 or 220V with charger, 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95

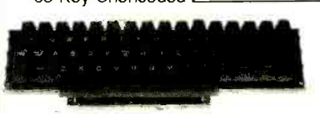
ACCESSORIES FOR MAX 100:

Mobile Charger Eliminator
use power from car battery — Model 100 — CLA $3.95

Charger/Eliminator
use 110 V AC — Model 100 — CAI $9.95

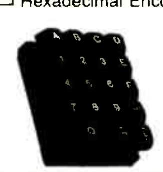
KEYBOARDS

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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California Residents – Add 6% Sales Tax

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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 deal. 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
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- 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
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Heavy Duty Carry Case	$5.95
Stop Watch Chip Only (7205)	$19.95

IMC 3½ DIGIT DPM KIT

- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

Model KB500 DPM Kit	**$49.00**
Model KB503 5V Power Kit	**$17.50**

JE700 CLOCK

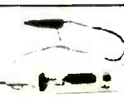
The JE700 is a low cost digital clock, but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6 x 2½ x 1. It utilizes a MAN72 high brightness readout, and the MM5314 clock chip.

12 or 24 Hour
115 VAC

KIT ONLY **$16.95**

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

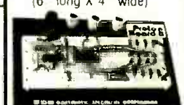
printed circuit board

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
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PB103 - 9" x 6"	59.95
PB104 - 9.5" x 8"	79.95
PB203 - 9.75 x 6½ x 2¾	80.00
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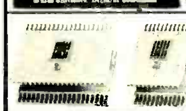

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14 PIN	$4.50
16 PIN	4 75
24 PIN	8 50
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7401	21	7448	1 15	74121	55
7402	21	7450	26	74122	49
7404	21	7451	.27	74123	1 05
7405	24	7453	.27	74125	60
7407	45	7454	41	74126	.81
7408	25	7460	.22	74132	3.00
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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74L00	33	74LS04	45	74LS113	.98
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	65	74S387	1 95

74H00 TTL

74H00	.33	74H11	33	74H53	.39
74H01	33	74H20	33	74H55	39
74H04	33	74H21	33	74H73	59
74H05	35	74H30	33	74H74	59
74H10	.33	74H40	33	74H76	65

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MC663P	2 50	MC1460	3 95
MC666P	1 60	MC1469R	2 50
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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
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MC1352P	1 55	MC4024P	2 20
MC1357	1 70	MC4044P	4 80
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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		

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75450BP	49	LM301H	35	LM741CH	45
75451BP	.39	LM307H	.35	LM747	.90
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75453BP	.39	LM311H	90	LM1458N	.80
75454BP	39	LM318N	1.50	N5556V	1.50
75491BP	79	LM339N	1 85	NE5568	1 00
75492BP	.85	LM351AN	65	NE555V	.60
CA3005	1 60	LM370N	1.25	NE558	1 50
CA3006	3 50	LM380N	1 45	UA702	.80
CA3018	1.10	LM568	2.25	UA703CH	.45
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LM340T-6	1 50
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10MF25	Axial Leads	.15	100MF16	Radial Leads	.19
10MF50	Axial Leads	.16	100MF25	Radial Leads	.24
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25MF35	Axial Leads	.18	1000MF35	Axial Leads	.65

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2N2647	55	MU4894	50
2N4851	.75	2N6027	55
2N4852	75	2N6028	70
2N4870	.50	D5E37	.35
2N4871	.50	MU10	35
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1N60	25	2N1544	80	2N2894	40	2N3414	17	2N3866	1 25	2N4403	.20
1N270	25	2N1554	1 25	2N2903	3 30	2N3415	18	2N3903	16	2N4409	.20
1N914	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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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**

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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**
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nte

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7401	.21	74LS01	.28	74C02N	.25	75453	.61
7402	.21	74LS02	.28	74C04N	.27	75454	.61
7403	.21	74LS03	.28	74C08N	.25	75491	.81
7404	.21	74LS04	.29	74C10N	.25	75492	.84
7405	.21	74LS05	.29	74C14N	.90	75493	1.09
7406	.25	74LS08	.29	74C20N	.25	75494	1.09
7407	.25	74LS09	.29	74C30N	.25	LINEAR	
7408	.21	74LS10	.28	74C32N	.25	MC1488N	.90
7409	.21	74LS11	.28	74C42N	.98	MC1489N	.90
7410	.21	74LS12	.28	74C48N	1.28	CA3046	.75
7411	.21	74LS13	.47	74C73N	.72	CA3086	.50
7412	.21	74LS14	1.02	74C74N	.48	LF351N	.76
7413	.25	74LS15	.28	74C76N	.72	LF356N	1.20
7414	.89	74LS20	.28	74C83N	1.38	LF357N	1.20
7416	.25	74LS21	.28	74C85N	1.38	LF13741	.76
7417	.25	74LS22	.28	74C86N	.40	LM301AN	.44
7420	.21	74LS26	.33	74C90N	.98	LM307N	.64
7421	.25	74LS27	.33	74C93N	.98	LM308N	1.00
7423	.35	74LS28	.33	74C95N	1.10	LM309K	1.80
7425	.25	74LS30	.28	74C107N	.70	LM311N	.98
7426	.25	74LS32	.33	74C150N	2.90	LM317T	3.00
7427	.33	74LS33	.33	74C151N	1.90	LM317MP	1.95
7428	.30	74LS37	.33	74C154N	2.90	LM318N	2.70
7430	.21	74LS38	.33	74C157N	1.90	LM320MP-5	1.30
7432	.25	74LS40	.28	74C160N	1.18	LM320MP-6	1.30
7433	.30	74LS42	.79	74C161N	1.18	LM320MP-8	1.30
7437	.25	74LS47	.79	74C162N	1.18	LM320MP-9	1.30
7438	.25	74LS48	.79	74C163N	1.18	LM320MP-12	1.30
7439	.50	74LS51	.28	74C164N	1.10	LM320MP-15	1.30
7440	.21	74LS54	.28	74C165N	1.10	LM320MP-18	1.30
7442	.53	74LS55	.28	74C173N	1.30	LM320MP-24	1.30
7445	.70	74LS73	.39	74C174N	1.16	LM323K	7.50
7446	.70	74LS74	.39	74C175N	1.16	LM324N	.72
7447	.70	74LS75	.53	74C192N	1.36	LM325N	2.70
7448	.70	74LS76	.39	74C193N	1.36	LM326N	2.70
7450	.21	74LS78	.39	74C195N	1.10	LM327N	2.70
7451	.21	74LS83	.79	74C221N	1.90	LM339N	1.15
7453	.21	74LS85	.49	80C95N	.48	LM340T-5	1.25
7454	.21	74LS86	.39	80C96N	.48	LM340T-6	1.25
7460	.21	74LS90	.57	80C97N	.48	LM340T-8	1.25
7470	.30	74LS92	.57	80C98N	.48	LM340T-10	1.25
7472	.30	74LS93	.57	74C901N	.48	LM340T-12	1.25
7473	.30	74LS95	.98	74C902N	.48	LM340T-15	1.25
7474	.30	74LS96	.88	74C909N	1.78	LM340T-18	1.25
7475	.49	74LS107	.39	74C926N	7.80	LM340T-24	1.25
7476	.32	74LS109	.39	4000 CMOS		LM341P-5	.98
7480	.70	74LS112	.39	4000	.23	LM341P-6	.98
7483	.70	74LS113	.39	4001	.23	LM341P-8	.98
7485	.89	74LS114	.39	4002	.23	LM341P-10	.98
7486	.28	74LS125	.49	4006	1.23	LM341P-12	.98
7489	2.19	74LS126	.49	4007	.23	LM341P-15	.98
7490	.44	74LS132	.81	4008	.79	LM341P-18	.98
7491	.70	74LS136	.39	4009	.44	LM341P-24	.98
7492	.44	74LS138	.73	4010	.44	LM348N	1.60
7493	.44	74LS139	.73	4011	.23	LM349N	1.60
7494	.70	74LS151	.75	4012	.23	LM358N	.72
7495	.70	74LS153	.75	4013	.40	LM386	.85
7496	.70	74LS154	1.10	4014	.96	LM1310N	.84
74100	1.28	74LS155	.75	4015	.96	LM1800N	.94
74107	.30	74LS156	.75	4016	.40	LM1801N	1.70
74109	.33	74LS157	.75	4017	1.05	LM1812N	4.80
74116	1.28	74LS158	.75	4018	1.05	LM1830N	1.30
74121	.35	74LS160	1.02	4019	.23	LM1889N	2.00
74122	.44	74LS161	1.02	4020	1.14	LM2111N	1.25
74123	.61	74LS162	1.02	4021	1.14	LM2907N	1.50
74125	.40	74LS163	1.02	4022	.96	LM2917N	1.50
74126	.40	74LS164	1.02	4023	.23	LM3089N	1.30
74128	.48	74LS168	1.14	4024	.88	LM3900N	.88
74132	.70	74LS169	1.14	4025	.23	LM3905N	.88
74136	.46	74LS170	1.73	4026	1.68	LM3909N	1.40
74141	.88	74LS173	1.34	4027	.40	LM3911N	.69
74145	.70	74LS174	1.06	4028	.89	MC1456V	1.50
74147	1.63	74LS175	.84	4029	1.14	MC1458V	1.00
74148	1.30	74LS181	2.50	4030	.40	MC1496N	.53
74150	1.16	74LS190	1.18	4033	1.51	MC3302P	.70
74151	.70	74LS191	1.18	4034	3.50	NE536T	1.15
74153	.65	74LS192	.98	4035	1.14	NE540L	2.50
74154	1.03	74LS193	1.06	4040	1.14	NE555V	2.04
74155	.70	74LS194	.88	4041	.79	NE556A	.48
74156	.70	74LS195	.86	4042	.79	NE558N	.88
74157	.70	74LS196	.86	4043	.79	NE559N	2.40
74160	.88	74LS197	.86	4044	.79	NE560B	2.40
74161	.88	74LS221	1.26	4046	1.86	NE561B	2.50
74162	.88	74LS240	1.90	4049	.40	NE562B	2.50
74163	.88	74LS241	1.90	4050	.40	NE565A	2.50
74164	.96	74LS242	1.70	4051	1.26	NE566V	1.25
74165	1.15	74LS243	1.70	4052	1.26	NE567V	1.28
74166	1.20	74LS244	1.70	4053	1.26	UA709CV	1.36
74170	2.64	74LS247	.79	4060	1.58	UA710CV	.44
74174	.98	74LS248	.79	4066	.79	UA711CA	.44
74175	.89	74LS249	.79	4068	.23	UA723CA	.53
74176	.79	74LS253	.84	4069	.23	UA733CA	.60
74177	.79	74LS257	.75	4070	.23	UA741CV	.75
74180	.70	74LS258	.75	4071	.23	UA747CA	.44
74181	2.15	74LS260	.34	4072	.23	UA748CV	.70
74182	.79	74LS261	2.00	4073	.23	UA7805CU	.49
74184	2.15	74LS266	.39	4075	.23	UA7806CU	1.25
74185	2.19	74LS273	1.78	4076	.23	UA7808CU	1.25
74189	3.50	74LS283	.79	4081	.23	UA7812CU	1.25
74190	1.23	74LS290	.65	4082	.23	UA7815CU	1.25
74191	1.23	74LS293	.65	4502	.79	UA7818CU	1.25
74192	.88	74LS295	1.12	4510	1.14	UA7824CU	1.25
74193	.88	74LS298	1.30	4511	1.05	UA78L05ACZ	.40
74194	.88	74LS365	.67	4515	2.80	UA78L06ACZ	.40
74195	.88	74LS366	.67	4516	1.26	UA78L08ACZ	.40
74196	.88	74LS367	.67	4518	1.14	UA78L10ACZ	.40
74197	.88	74LS368	.67	4520	1.14	UA78L12ACZ	.40
74198	1.49	74LS377	1.50	4527	1.68	UA78L15ACZ	.40
74199	1.49	74LS386	.39	4528	.88	UA78L18ACZ	.40
74221	.86	74LS395	1.74	INTERFACE		UA78L24ACZ	.40
74251	1.09	74LS670	2.34	8093	.40	UA7905CU	1.70
74279	.55	81LS95	.77	8094	.40	UA7906CU	1.70
74298	.94	81LS96	.77	8095	.67	UA7908CU	1.70
74365	.67	81LS97	.77	8096	.67	UA7909CU	1.70
74366	.67	81LS98	.77	8097	.67	UA7912CU	1.70
74367	.67			8098	.67	UA7915CU	1.70
74368	.67			75450	.88	UA7918CU	1.70
				75451	.61	UA7924CU	1.70
						MISC IC	
						MM5314N	3.75

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14 ST	14 Pin Solder Tail I.C. Socket	.20	1.90/10	17.00/C
16 ST	16 Pin Solder Tail I.C. Socket	.22	2.10/10	18.75/C
18 ST	18 Pin Solder Tail I.C. Socket	.29	2.70/10	24.50/C
20 ST	20 Pin Solder Tail I.C. Socket	.34	3.20/10	29.25/C
22 ST	22 Pin Solder Tail I.C. Socket	.33	3.15/10	27.25/C
24 ST	24 Pin Solder Tail I.C. Socket	.38	3.50/10	32.25/C
28 ST	28 Pin Solder Tail I.C. Socket	.45	4.25/10	38.25/C
40 ST	40 Pin Solder Tail I.C. Socket	.63	6.00/10	53.50/C
8 WW	8 Pin Wire Wrap I.C. Socket	.24	2.30/10	20.50/C
14 WW	14 Pin Wire Wrap I.C. Socket	.30	2.80/10	22.00/C
16 WW	16 Pin Wire Wrap I.C. Socket	.30	2.85/10	25.50/C
18 WW	18 Pin Wire Wrap I.C. Socket	.60	5.70/10	51.00/C
20 WW	20 Pin Wire Wrap I.C. Socket	.70	6.65/10	59.50/C
22 WW	22 Pin Wire Wrap I.C. Socket	.84	8.00/10	71.50/C
24 WW	24 Pin Wire Wrap I.C. Socket	.96	9.10/10	81.50/C
28 WW	28 Pin Wire Wrap I.C. Socket	1.12	10.00/10	95.20/C
40 WW	40 Pin Wire Wrap I.C. Socket	1.38	12.50/10	115.00/C

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

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1N4001	.64	10	5.50/C
1N4002	.66	10	5.60/C
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1N4004	.70	10	5.95/C
1N4005	.82	10	7.05/C
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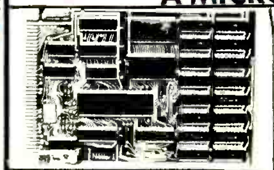

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- 4K NIBL Basic in ROM and 2K of RAM
- Easily Interfaced with CRT or Teletype

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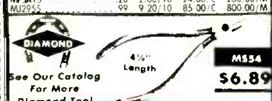
MPS2907A	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3394	.16	1.55/10	13.60/C	130.00/M
MPS3395	.16	1.55/10	13.60/C	130.00/M
MPS3563	.16	1.55/10	13.60/C	130.00/M
MPS3565	.16	1.55/10	13.60/C	130.00/M
MPS3638A	.16	1.55/10	13.60/C	130.00/M
MPS3641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



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

MINIBOX METALIZED POLYESTER CAPACITORS

.001/1000V	.16	1.32/10	10.35/C	.0022/1000V	.16	1.32/10	10.35/C
.0033/1000V	.16	1.32/10	10.35/C	.0047/630V	.14	1.15/10	9.00/C
.0068/630V	.14	1.15/10	9.00/C	.01/630V	.16	1.32/10	10.35/C
.022/400V	.17	1.44/10	11.50/C	.033/250V	.17	1.44/10	11.50/C
.047/250V	.15	1.25/10	10.00/C	.068/250V	.17	1.44/10	11.50/C
.1/100V	.19	1.55/10	12.65/C	.22/100V	.26	2.13/10	17.25/C
.33/100V	.35	2.88/10	23.00/C	.47/100V	.41	3.45/10	27.60/C

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

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MA1002C SET	Module w. Transformer & Switches	~~10.95~~	9.95
MA1003	12 Volt Car Clock with Switches	~~17.60~~	15.95
MA1010A	.84" LED 12 Hour AM-PM Clock Module	~~12.00~~	9.95
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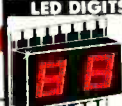

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[illegible] .8" Single Digit CA Red 2.50

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[illegible]	[illegible]	[illegible]	CA DIRECT	2.20
[illegible]	Red	[illegible]	CC MULTI	2.20
[illegible]		[illegible]	CA MULTI	2.20
[illegible]		[illegible]	CA DIRECT	2.60
[illegible]		[illegible]	CC MULTI	2.60
[illegible]	[illegible]	[illegible]	CA MULTI	2.60
[illegible]	Red	[illegible]	CC DIRECT	2.60
NSN584		[illegible]	CA DIRECT	2.60
[illegible]		[illegible]	CA DIRECT	3.00
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[illegible]	[illegible]	[illegible]	CA MULTI	3.00
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[illegible]	[illegible]	[illegible]	CC MULTI	5.20
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[illegible]		[illegible]	CA MULTI	6.00
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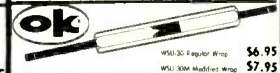

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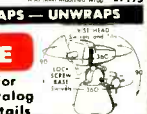

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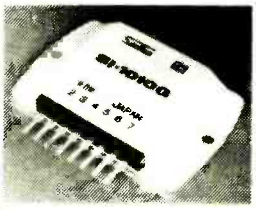
AM25S05DC	12.66
AM25S10PC	3 00
93L00PC	1 08
93L01PC	1 58
93L08DC	3 76
93L09PC	64
93L10PC	1 50
93L11DC	3 32
93L11PC	2 28
93L12PC	1.58
93L14PC	1 48
93L16PC	1 42
93L18PC	3 10
93L21PC	1 58
93L22DC	1 76
93L22PC	1 10
93L28PC	3 20
93L34PC	3.80
93L38PC	4 28

93L40DC	10 60
93L40PC	6.50
93L41PC	4 50
93L60PC	1 70
93L66PC	1 70
96L02DC	2 40
AM2502DC	7 20
AM2502PC	6 60
AM2503DM	14 40
AM2503PC	6 60
AM2504DC	11 20
AM2504DM	22 40
AM2505PC	13 34
9300PC	1 36
9301PC	1 08
9304PC	1 98
9306PC	3.30
9308PC	3.70
9308DC	2 70
9309PC	64
9311PC	2 28

9312PC	64
9314PC	90
9316PC	80
9318PC	1 10
9321PC	80
9322PC	64
9324DC	1 60
9324PC	1 00
9328PC	1 20
9334PC	1 20
9338PC	4 28
9340PC	6 50
9341PC	4 50
9342PC	1 00
9366PC	1 10
AM9600PC	1 70
AM9601DC	98
AM9601PC	.78
AM9607DC	1 60
AM9602PC	1.00

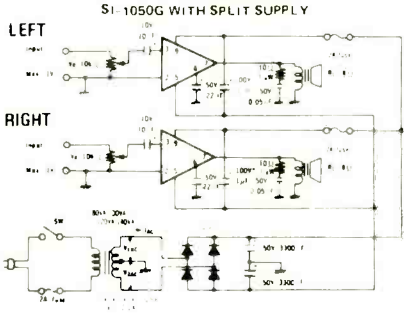


Sanken HYBRID AUDIO POWER AMPLIFIERS

- Multi-purpose linear amplifiers for comercial and industrial applicacations
- Less than 0.5% harmonic distortion at full power level.
- 1/2 dB response from 20 to 100,000 Hz.
- Single or split (dual) power supply
- Rugged, compact and lightweight packages
- Built-in current limiting for SI-1050G and efficient heat radiating construction

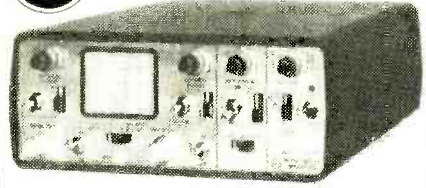
SANKEN Series SI-1000G amplifiers are self-contained power hybrid amplifiers designed for Hi-Fi, stereo, musical instruments, public address systems and other audio applications. The amplifiers have quasi complementary class B output. The circuit employs flip-chip transistors with high reliability and passivated chip power transistors with excellent secondary breakdown strength. Built-in current limiting is provided for SI-1050G and all devices can be operated from a single or split power supply.

TYPICAL CONNECTIONS
SI-1050G WITH SPLIT SUPPLY



SI-1010G (10W output)	$ 6.90
SI 1020G (20W output)	$13.95
A SI 8 (Socket for above)	95
SI-103G (30W output)	$19.00
SI-1050G (50W output)	$27.80
A SI-10 (Socket for above)	95
Data with Application Notes	.50

NLS NEW MS-215 DUAL TRACE MINISCOPE



15MHz PORTABLE OSCILLOSCOPE

- 15 megahertz bandwidth.
- External and internal trigger.
- Time Base—0.1 microseconds to 0.5 Sec/div—21 settings.
- Battery or line operation.
- Automatic and line sync modes.
- Power consumption less than 15 W.
- Vertical Gain—0.01 to 50 volts/div—12 settings.
- Weight is only 3 pounds.

RECHARGEABLE PORTABLE $395 00
2.7"H x 6.4"W x 7.5"D
With Rechargeable Batteries & Charger Unit

MS-15 SINGLE TRACE 15 MHz PORTABLE OSCILLOSCOPE $289 00

OPTIONS: usable on both MS-215 or MS-15

41-140 Leather Carrying Case	$30.00
41-141 10 to 1 Probe with 10 Megohm Input	$24.50

Over 20,000 in Use
Field Proven Lab Accuracy DPM

PM-4 $170
0.02% Accuracy

- ±1, ±10, ±100 or ±1000V range
- Auto zero & polarity
- Programmable decimal
- Range change capability
- Protected input
- 1"H x 2.5"W x 3.25"D
- Large 0.3" LED display

COUNT ON NLS!
PC-4 EVENT COUNTER

All electronic, MOS LSI construction – lowest cost anywhere! Up to 200,000 counts per second.

Unit Quantity- $54.50

Standard Features:
- Count to 19999 events.
- LED display - 0.3" in height.
- Programmable decimal.
- TTL or switch input.
- Electronic reset.
- Display inhibit, dimming and lamp test.
- Leading zero suppression capability.
- Multiplexed BCD output.
- Small size 1"H x 2.5"W x 3.25"D.
- Operates on +5 vdc, 0.75 W.

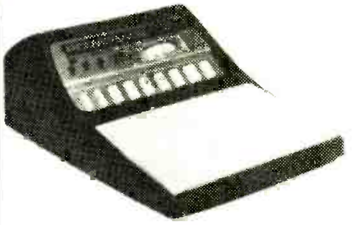
Optional 115 vac operation.

NLS adds to its counter line ... the new small Model PR-5 solid state preset counter

Unit Quantity—$149

Features Include
• Five-digit LED display of count plus 5-digit preset. • Counts at 500 kHz pulse & 300 Hz contact closure. • Small size 2.2" H x 3.25" W x ... fits in the palm of your hand. • Permits multiple presets. • Optional battery back for standby operation. • Solid-state LSI circuitry with high noise immunity.

Use a POWERACE for faster and easier prototyping of all types of electronic circuits



POWERACE 103 $124.95

TRIPLE OUTPUT POWER SUPPLY has outputs of: +5 VDC at 750 mA; +15 VDC at 250 mA; and -15 VDC at 250 mA. Ripple/noise is 10 mV at full load for all outputs. Line and load reulation is 1% for all outputs. 15-volt outputs track.

METER is built in 15 0 15 VDC. Input is accessible at tie point block on control panel which allows monitoring power supplies or circuits. Meter accuracy is 5% of full scale.

TWO LOGIC INDICATORS (LED's) have buffered inputs that require 1 microamp max.

TWO LOGIC SWITCHES, momentary, with debounce circuitry. Both Q and Q̄ outputs can sink 15 mA, and source 5 mA.

TWO DATA SWITCHES with logic 1 and logic 0 outputs have unlimited sinking capabilities and can source 10 mA.

CHECK THESE IMPORTANT FEATURES
- 1680 solderless, plug-in tie points ... will hold up to 18 14-pin DIP's
- Breadboard elements accept all DIP sizes ... including RTL, DTL, TTL and CMOS devices, TO-5's and discretes with leads up to .032" dia
- All connections to/from switches, indicators, power supplies and meters are made via solderless, plug in, tie point blocks on control panels.
- Interconnect with any solid 20 to 30 AWG wire
- Breadboard elements are mounted on ground planes ... ideal for high-frequency and high-speed/low-noise circuits.
- Short-circuit-proof fused power supplies.
- Operate on 110 to 130 VAC at 60 Hz.
- Space-age compact styling and high-grade components permit convenient, organized and quick prototyping.

ALSO AVAILABLE FROM ANCRONA

POWERACE 101	$ 84.95
POWERACE 102	$114.95

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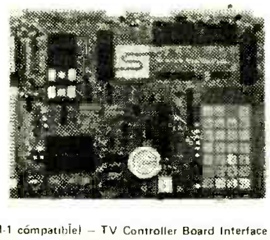
VIM-1 THE COMPLETE MICROCOMPUTER SYSTEM



The VIM-1 is a fully assembled and completely integrated system that features KIM-1 hardware compatibility utilizing the powerful 6502 Microprocessor. The VIM-1 includes – a 28 double-function keypad (with audio response) – easy-to-view 6 digit HEX LED display – three on-board programmable interval timers – 4K byte ROM-resident monitor – 1K bytes of 2114 static RAM (expandable to 4K bytes on-board – 3 PROM/ROM expansion sockets for 2316/2332/2716 EPROMs. Standard interface include – Audio Cassette Recorder Interface (Two Modes: 135 Baud KIM-1 compatible and Hi-speed 2400 Baud) – Full Duplex 20 ma TTY Interface – System Expansion Bus Interface (KIM-1 compatible) – TV Controller Board Interface – CRT compatible interface – Additional Application Port with 15 Bi-directional TTL lines for user applications. Requires a single 5 Volt supply.

Planned VIM-1 Expansion Features – TV Interface Card (with ASCII Keyboard and Numeric Pad) – Basic Interpreter – Resident Assembler/Editor – Port Expansion Kit – RAM Expansion Kit.

VIM-1 $269 00

DATA AND TECHNICAL BOOKS

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LCC4112	TTL Data Book	$ 4.95	21447	8080A Bugbook	10 50
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LCC4200	Semiconductor Memory Data Book	2 95	HAYDEN		
LCC4241	Linear Control Circuits Data Book	2.95	5104-2	BASIC Workbook	5.50
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SAMS			743	Electronic Music Guidebook	6 95
20969	IC OP-AMP Cookbook	12.95	787	OP-AMP Circuit Design	6.95
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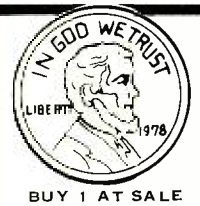

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Cond.		Sale		1¢ Sale
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☐ 5202	2K Prom	2.95	2.96	Type No.
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☐ SN7409	.39	.40	☐ SN7474	.59	.60	☐ SN74156	.39	.40
☐ SN7410	.25	.26	☐ SN7475	.69	.70	☐ SN74157	.99	1.00
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☐ SN7416	.35	.36	☐ SN7482	.29	.30	☐ SN74163	1.39	1.40
☐ SN7417	.35	.36	☐ SN7483	.99	1.00	☐ SN74164	.79	.80
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☐ SN7438	.25	.26	☐ SN7494	.79	.80	☐ SN74180	.49	.50
☐ SN7440	.19	.20	☐ SN7495	.59	.60	☐ SN74182	.49	.50
☐ SN7443	.59	.60	☐ SN7496	.29	.30	☐ SN74190	1.99	2.00
☐ SN7444	.19	.20	☐ SN7498	.79	.80	☐ SN74191	1.75	1.76
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☐ SN7447	1.25	1.26	☐ SN74107	.29	.30	☐ SN74193	.99	1.00
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Case code: T=TO-220 Power Tab; V=Mini dip; K=TO-3; H=TO-5; N=DIP.

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☐ LM301H	.45	.46	☐ LM340T-15	1.49	1.50	☐ LM709N	.49	.50
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☐ LM320T-6	1.49	1.50	☐ LM532N	.25	.26	☐ LM3028H	.65	.66
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☐ LM324N	1.79	1.80	☐ NE540H	5.95	5.96	☐ LM3909V	1.25	1.26
☐ LM339N	1.79	1.80	☐ LM555V	.75	.76	☐ LM4250	1.20	1.21
☐ LM340K-5	1.49	1.50	☐ LM556N	1.79	1.80	☐ LM75451	.69	.70
☐ LM340K-6	1.49	1.50	☐ LM558V	.39	.40	☐ LM75453	.69	.70
☐ LM340K-8	1.49	1.50	☐ LM558H	.39	.40	☐ LM75491	.80	.81
☐ LM340K-12	1.49	1.50	☐ LM561N	1.00	1.01	☐ LM75492	.80	.81
☐ LM340K-15	1.49	1.50	☐ LM565N	1.00	1.01	☐ LM75494	.60	.61
☐ LM340K-18	1.49	1.50	☐ LM565H	1.00	1.01	☐ PA263	1.50	1.51
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☐ 3 __ SOUND TRIGGERS, sound triggers scr w/amp (8E3625)	2.00	6 for 2.01
☐ 10 - CB CRYSTALS, for phase lock loop, HAM, HC/18 (#8E5050)	2.00	20 for 2.01
☐ 100 - DISC CAPACITORS, long leads, marked, asst'd (#8E2598)	2.00	200 for 2.01
☐ 10 __ VOLTAGE REGULATORS, hobby LM320, 340, TO-3 (8E3330)	2.00	20 for 2.01
☐ 30 PANEL SWITCHES, slides, rotaries, mod, etc (8E3268)	2.00	60 for 2.01
☐ 200 __ RESISTOR SPECIAL, ¼ to 1W, carbon, metal (8E3054)	2.00	400 for 2.01
☐ 200 __ HALF WATTERS, resistors, carbon, metal (8E3046)	2.00	400 for 2.01
☐ 100 __ NATIONAL IC BONANZA, linears, 7400s ROMS (8E2860)	2.00	200 for 2.01
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☐ 100 __ TWO WATTERS, resistors, carbon-metal marked (8E2735)	2.00	200 for 2.01
☐ 100 __ POLYSTYRENE CAPS, asstd values, voltage, hi-Q (8E2729)	2.00	200 for 2.01
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☐ 8E2379	1N4003	200	10 for .95	20 for .96
☐ 8E2380	1N4004	400	10 for 1.19	20 for 1.20
☐ 8E2381	1N4005	600	10 for 1.39	20 for 1.40
☐ 8E2382	1N4006	800	10 for 1.49	20 for 1.50
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• 1.5 Amp! • Miniature!

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☐ 600	2.25	2 for 2.26
☐ 800	2.50	2 for 2.51

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☐ 50V	10 for $.59	20 for $.60
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☐ 400V	10 for .89	20 for .90

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3 Amps, 125 VAC contacts, with chrome handles, complete with mounting hardware.

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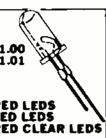

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☐ 9.1V	5 for 1.	10 for 1.01
☐ 11.V	5 for 1.	10 for 1.01
☐ 12.V	5 for 1.	10 for 1.01
☐ 15.V	5 for 1.	10 for 1.01

Order by Cat. No. 8E5210B

5 WATTS	Sale	1¢ SALE
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☐ 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
☐ 15. V	3 for 1.	6 for 1.01
☐ 18. V	3 for 1.	6 for 1.01
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☐ LM3900N	Quad Matched Op Amp
☐ LM558V	Dual 741
☐ SN7401	Quad 2 input NAND, O.C.
☐ SN7403	Quad 2 input NOR, O.C.
☐ SN7406	Hex inverter, buffer, driver
☐ SN7410	Triple 3 input NAND
☐ SN7420	Dual 4 input NAND
☐ SN7440	Dual 4 input buffer
☐ SN7450	Expan 2-wide, 2-in AND-OR-INV
☐ SN7451	Dual 2-wide, 2-3-input AND-OR-INV
☐ SN7453	4-wide, 2-in, AND/OR invert
☐ SN7455	2-wide, 4-in, AND/OR invert
☐ SN7464	4-2-3-2-inp, AND/OR invert
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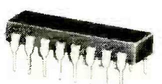

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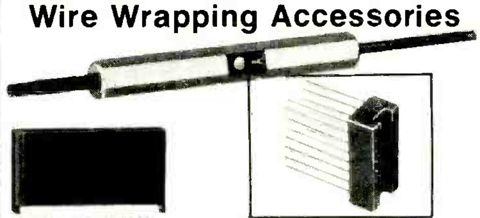

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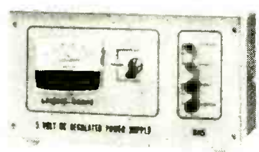

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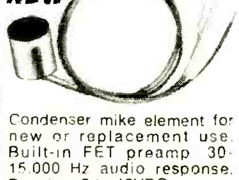

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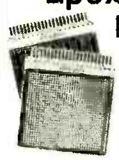

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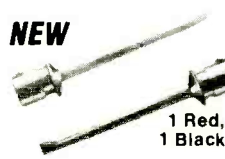

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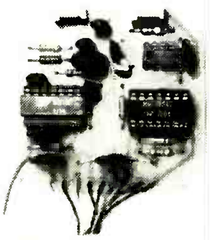

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• Type 103 • Full or half duplex • Works up to 300 baud • Originate or Answer • No coils, only low cost components • TTL input and output-serial • Connect 8 ohm speaker and crystal mic. directly to board • Uses XR FSK demodulator • Requires +5 volts • Board $7.60; with parts $27.50

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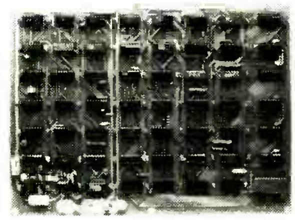

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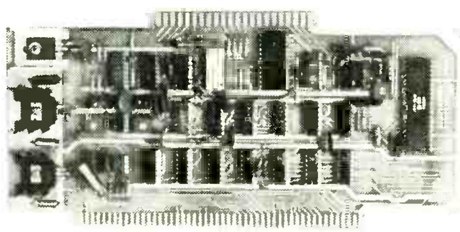
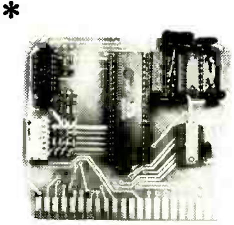


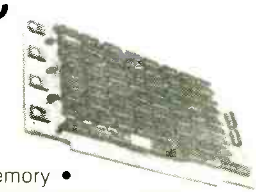
Part no. 112
• Tape Interface Direct Memory Access • Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate. • S-100 bus compatible • Board only $35.00; with parts $110.00

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 with connector add $4.00

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

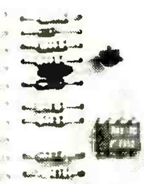
RF MODULATOR *

Part no. 107
• Converts video to AM modulated RF, Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal. Recommended by Apple. • Power required is 12 volts AC C.T., or +5 volts DC • Board $7.60; with parts $13.50

RS 232/TTY INTERFACE*

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

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 with connector add $3.00

ELECTRONIC SYSTEMS Dept. PE, P.O. Box 21638, San Jose, Calif. USA 95151

To Order: Mention part number and description. For parts kits add "A" to part number. In USA, shipping paid for orders accompanied by check, money order, or Master Charge, BankAmericard, or VISA number, expiration date and signature. Shipping charges added to C.O.D. orders. California residents add 6.5% for tax. Outside USA add 10% for air mail postage, no C.O.D.'s. Checks and money orders must be payable in US dollars. Parts kits include sockets for all ICs, components, and circuit board. Documentation is included with all products. All items are in stock, and will be shipped the day order is received via first class mail. Prices are in US dollars. No open accounts. To eliminate tariff in Canada boxes are marked "Computer Parts." Dealer inquiries invited. 24 Hour Order Line: (408) 226-4064

*Designed by John Bell

JADE

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21L02 (450ns) Static Rams 100 @ $1.10 ea.	1702A E—PROM 8 @ $3.75 ea.	6502 Microprocessor 5 @ $11.00 ea.	2708 (450ns) E—PROM 8 @ $11.00 ea.	21L02 (250ns) Static Rams 100 @ $1.36 ea.	Z—80A Microprocessor 5 @ $25.00 ea.	8212 8 Bit I/O Port 25 @ $3.00 ea.	4116 (200ns) 16K Dyn. Ram 16 @ $24.00 ea.
Z-80 Microprocessor 5 @ $20.00 ea.	8224-4 Clk.Gen.&Dvr. 25 @ $8.75ea.	410D (200ns) Static Ram 100 @ $8.75ea.	4096 Dynamic Ram 100 @ $3.50 ea.	4200A (200ns) Static Rams 25 @ $10.00 ea.	74LS367 Hex Buffer 100 @ .70¢ ea.	74LS368 Hex Inverter 100 @ .70¢ ea.	2513 (5v) Character Gen. 5 @ $9.00 ea.

MICROCOMPUTER COMPONENTS

MICROPROCESSOR'S

F8	16.95
Z80	22.00
Z80A	28.00
CDP1802CD	19.95
2650	24.95
AM2901	22.95
6502	11.95
6800	18.95
6802	25.00
8008-1	9.95
8035	22.00
8080A	11.95
8085	27.00
TMS9900TL	75.00

8080A SUPPORT DEVICES

8212	3.50
8214	9.00
8216	3.75
8224	3.50
8224-4	9.95
8226	3.95
8228	7.95
8238	7.50
8251	9.95
8253	21.95
8255	21.95
8257	21.95
8259	21.95
8275	75.00
8279	20.00

FLOPPY DISC CONTROLLER

1771B	55.95
1771B-01	57.95

KEYBOARD CHIPS

AY5-2376	13.75
AY5-3600	13.75

PROM'S

1702A	4.00
2704	15.00
2708	12.00
2716	30.00
2716 Intl	38.00
2758	26.60
D3601	4.50
D3604	13.00
5203AQ	5.00
5204AQ	7.50
6834	17.50
6834-1	14.95
82S23B	4.00
82S129B	4.25
8223B	3.50

6800 SUPPORT

6810P	4.95
68B10P	6.00
6820P	7.50
6821P	7.50
6828P	11.25
6834P	16.95
6850P	9.75
6852P	11.75
6860P	10.00
6862P	14.50
6871P	28.00
6875P	8.75
6880P	2.50

Z80 SUPPORT DEVICES

3881	12.95
3882	12.95

STATIC RAMS

21L02	1.50	1.24	1.18
21L02 (350)	1.60	1.35	1.25
21L02 (250)	1.75	1.60	1.50
410D	10.75	10.00	9.25
1101A	1.00	.90	.80
2101-1	2.95	2.75	2.60
2102	1.25	1.15	1.00
2111-1	3.95	3.50	3.25
2112-1	2.95	2.80	2.69
2114-3	11.00	10.00	9.25
2125L	11.10	9.00	8.30
2147	37.50		
31L01	2.50	2.35	2.00
3106	3.95	3.70	3.25
3107	3.95	3.70	3.25
TMS-4044	9.95	9.00	8.95
4200A	12.95		
TMS-4045	11.00	10.00	9.25
5101	8.30	7.40	7.25
74C89	3.25	3.05	2.85
7489	2.25	2.10	1.90
74S201	4.50	4.00	3.75
P8101	4.20	3.40	2.80
P8155	17.00	14.00	
P8156	21.00	18.00	
8599	1.88	1.75	1.60
9102BPC	1.65	1.45	1.30

CHARACTER GENERATORS

2513	6.75
2513 5v upper	9.75
2513 5v lower	10.95
2516	10.95
MCM6571	10.95
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MCM6574	13.25
MCM6575	13.25

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8038	3.50
MC4024	2.25
566	1.50

DYNAMIC RAMS

416D/4116	32.00
1103	1.00
2104	4.00
2107B	4.25
2107B-4	3.95
TMS4050	4.00
TMS4060	4.50
TMS4070-2	32.00
4096	4.00
4116/416D	32.00
MM5270	4.50
MCM6605	5.00

USRT

S2350	10.75

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AY5-1013A	5.25
AY5-1014A	8.25
TR1602B	5.25
TMS6011	5.95
IM6402	10.80
IM6403	10.80

MISC. OTHER COMPONENTS

N8T20	3.39
N8T26	2.10
N8T95	1.35
N8T96	1.35
N8T97	1.35
N8T98	1.35
81LS95	2.00
81LS97	2.00
1488	1.75
1489	1.75
D3205	4.00
D3207A	4.55
D3208A	14.20
D3211	10.00
B3222	9.75
B3242	10.15
D3245	5.60
C3404	6.75
P3408A	12.00
P4201A	5.20
MM5320	7.50
MM5369	1.90
TMS5501	24.95
DM8130	2.90
DM8131	2.75
DM8833	2.50
DM8835	2.50
DM8837	1.75
MK50240	20.00
MK50250	15.00

JADE 8080A KIT

$100.00 KIT

BARE BOARD $30.00

E—PROM BOARDS

MH 8 (8K uses 2708) with 1K RAM	KIT	$99.50
MH 16T (16K uses 2716) with 1K RAM	KIT	$99.50
MM 16 (16K uses 2708		$99.00
RAM/N ROM (16K uses any E PROM)	KIT	$117.00
JG 8/16 (uses 2708 or 2716)	KIT	$59.95
BARE BOARD		$30.00

TU-1

Convert T.V. set to Video Monitor.

KIT $8.95

STATIC RAM BOARDS

8K

250ns	ASSEMBLED & TESTED	$189.95
450ns	ASSEMBLED & TESTED	$149.75
250ns	KIT	$169.95
450ns	KIT	$125.00
	BARE BOARD	25.00

6800 ADAPTER to S-100 System KIT $12.95

16K

250ns	ASSEMBLED & TESTED	$435.00
450ns	ASSEMBLED & TESTED	$380.00
450ns	KIT	$335.00

32K

250ns	ASSEMBLED & TESTED	$850.00
450ns	ASSEMBLED & TESTED	$775.00
450ns	KIT	$675.00

DYNAMIC RAM BOARDS

On board Refresh power is provided with no wait states or cycle stealing required +8VDC 400MA DC +18VDC 400MA DC and 18VDC 30MA DC.

EXPANDABLE 32K

8K (375ns)	KIT	$151.00
16K (375ns)	KIT	$259.00
24K (375ns)	KIT	$367.00
32K (375ns)	KIT	$425.00

EXPANDABLE 64K

16K (375ns)	KIT	$281.00
32K (375ns)	KIT	$519.00
48K (375ns)	KIT	$757.00
64K (375ns)	KIT	$995.00

MOTHER BOARD's — S-100 Style

13 slot — w/front panel slot

BARE BOARD $35.00

KIT $95.00

22 slot $149.95

ASSEMBLED & TESTED

THE PROM SETTER

WRITE & READ

EPROM

1702A — 2708 — 2716

5204 — 6834

- Plugs directly into your ALTAIR IMSAI Computer
- Includes Main Module Board and External EPROM Socket Unit
- The EPROM Socket Unit is connected to the Computer through a 25 pin connector
- Programming is accomplished by the Computer
- Just read in the Program to be Written on the EPROM into your Processor and let the Computer do the rest
- Use Socket Unit to Read EPROM's Contents on your Computer
- Software included
- No external power supplies — Your computer does it all
- Doubles as an Eight Bit Parallel I/O
- Manual included

KIT $210.00

ASSEMBLED $375,00

KIM—1

ASSEMBLED & TESTED $245.00

MEMORY PLUS

for KIM—1

8K RAM (21L02)

8K EPROM

ASSEMBLED & TESTED

$245.00

JADE Z80 KIT

—with PROVISIONS for ONBOARD 2708 and POWER ON JUMP

$135.00 EA. (2MHZ)

$149.95 EA. (4MHZ)

BARE BOARD **$35.00**

JADE Z80 "UPGRADE" KIT

Change your JADE 2MHz Z80 to a 4MHz version with this simple kit

only $17.95 with trade

$49.95 purchase.

To trade, you must give us your 2MHz Z80 chip and 8224 clock driver

The "UPGRADE KIT" includes

Z80A chip, 1 8K resistor

8224 4 clock driver, 20 pf capacitor

36MHz crystal

COMPU TIME CT 100

S100 BUS COMPATIBLE

TIME & CALENDAR

Microprocessors need the power that a real time clock can offer. Date and time becomes instantly available. COMPU/TIME does not have to be initialized every time the system is powered up. It possesses a crystal-controlled time base to obtain superior accuracy and has two setable coincidence counters. Time, date, and counters are set via software.

COMPUTATIONAL FUNCTION

Microprocessors need to be complimented by hardware arithmetics to free up memory pages dedicated to floating point routines and mathmatical software. COMPU/TIME provides a 40 function calculator array so that algebraic, trigonometric, basic arthmetic problems can be solved without the need of developing sophisticated software.

Buy It Your Way

COMPU TIME	CT100	$199	KIT	$245	Assembled
COMPU only	C101	$149	KIT	$189	Assembled
TIME only	T101	$165	KIT	$205	Assembled
COMPU TIME	PC Board only	$80			

JADE VIDEO INTERFACE KIT

FEATURES **$99.95**

S-100 Bus Compatible
32 or 64 Characters per line
16 lines
Graphics (128 x 48 matrix)
Parallel & Compositive video
On board low power memory

Powerful software included for cursor, home, EOL, Scroll Graphics/Character, etc.
Upper case, lower case & Greek
Black-on-white & white-on-black

full ASCII PROFESSIONAL KEYBOARDS

Full 128 Character ASCII
Tri-Mode MOS Encoding
MOS DT, TTL Compatable Output
Two-key Rollover
Level and Pulse Strobe
Shift and Alpha Lock
Selectable Parity
Positive or Negative Logic

MODEL 756 (56 keys)

PRICING INFORMATION

Model 756 (assembled)	$75.95
Model 756K (kit)	64.95
Model 702 Enclosure	29.95
Model 710 Numeric Pad	9.95
Model 756MF Mtg Frame	8.95

CONNECTORS

DB — 25P	$3.00
DB — 25S	$4.00
COVER	$1.50
44 Pin — PC & EYE	$1.95
44 Pin — WW	$2.50
86 Pin — (6800) PC	$5.00
86 Pin — (COSMAC ELF) PC	$5.00
100 Pin — (Altair) PC	$4.50
100 Pin — (Imsai) PC	$3.75
100 Pin — (Imsai) WW	$4.25

JADE REAL TIME CLOCK FOR S-100 BUS

1 MHZ Crystal Oscillator
Two independent interrupts
One interrupt uses 16 bit counter in 10 USEC steps
Other interrupt is in decade steps from 100 USEC to 10 sec.
Both software programmable
Board can be selected by 128 device code pairs.
Complete documentation includes software to display time of day.
Double sided solder mask
Silk screen parts layout

JG-RT ASSEMBLED & TESTED	$179.95
JG-RT KIT	$124.95
BARE BOARD with Manual	$30.00

TARBELL CASSETTE INTERFACE

- Plugs directly into your IMSAI or ALTAIR*
- Fastest transfer rate 187 (standard) to 540 bytes/second
- Extremely Reliable—Phase encoded (self-clocking)
- 4 Extra Status Lines, 4 Extra Control Lines
- 37-page manual included
- Device Code Selectable by DIP-switch
- Capable of Generating Kansas City tapes also
- No modification required on audio cassette recorder

JADE KIT* $99.95 ASSEMBLED $175.00

*(6 month warranty from JADE) MANUAL $4.00

JADE PARALLEL/SERIAL INTERFACE KIT

S-100 **$124.95 KIT**

2 Serial Interfaces with RS232 interfaces or 1 Kansas City cassette interface.
Serial interfaces are crystal controlled.
Selectable baud rates.
Cassette works up to 1200 baud.
1 parallel port

DATA COMMUNICATIONS ADAPTER

80-103A Serial I/O and FSK modem for professional and hobby communications

- Completely compatible with your IMSAI, ALTAIR* SOL** or other S-100 microcomputers. Trademarks of *MITS, **Processor Technology
- Designed for use on the dial telephone or TWX networks, or 2-wire dedicated lines, meets all FCC regulations when used with a CBT coupler.
- All digital modulation and demodulation with on board cyrstal clock and precision filter mean that NO ADJUSTMENTS ARE REQUIRED
  - Bell 103 standard frequencies
  - Automated dial (pulsed) and answer
  - Originate and answer mode
  - 110 or 300 BPS speed select
  - Complete self test capability
  - Character length, stop bit, and parity
  - 90 day warranty and full documentation

PRICES:	BARE BOARD and Manual	$49.95
	Assembled (48 hr. burn in)	$279.95
	JG DCA KIT	$159.95

NUMBER CRUNCHER

The CT200 is a number oriented microprocessor intended for use in those applications that require fast versatile mathematical solutions.

THIS IS NOT A CALCULATOR CHIP. THERE ARE NO KEY DELAYS

The CT200 has a unique architecture that is designed to be a TASK processing system within a system. This unique architecture will allow the CT200 to work and run with ANY S100 BUS microprocessor system. It is completely compatible with Z80, 4MHZ version also, 8080, 6800, 6502 microprocessor. A micro incoded instruction set allows programming in a calculator like language. The instruction set includes a full set of test and branch instructions. All decoding of S100 bus signals (for select or control functions) is performed with strobed latches to eliminate the possibility of glitches.

PRICE: $249.00

Includes Manual, ASSEMBLED & TESTED.

JADE Computer Products

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LAWNDALE, CALIFORNIA 90260
(213) 679-3313

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Discounts available at OEM quantities. ADD $1.50 under 10 lbs. for shipping. California residents add 6% sales tax.

NEW CATALOG NOW AVAILABLE

COMPU/TIME CT 100

COMPU/TIME offers A Real Darn Clever Enhancement to users of IMSAI/ALTAIR Microprocessors

S100 BUS COMPATIBLE

TIME & CALENDAR

COMPU/TIME	CT100	$199 Kit	$245 Assembled
COMPU only	C101	$149 Kit	$189 Assembled
TIME only	T102	$165 Kit	$205 Assembled
COMPU/TIME PC Board only			$ 80

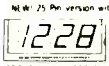
MM16 EPROM

- Utilizing up to 16 2708 EPROMS
- S-100 Bus Computer Systems
- Memory capacity of 8K or 16K bytes by DIP
- 8K boundary addressing by DIP Switch
- 0 to 4 wait cycles by DIP Switch
- Data output address input lines fully buffered
- Hi-grade glass-epoxy with plated-thru holes
- Epoxy solder masked

$99.00

FCS 8000A — 3½ Digit 8 Display

NEW! 25 Pin version with colon & am pm indicator



FRONT VIEW FSC8000

SPECIAL $3.75 ea.

- Connects almost one for one with 3817 3817A or D 3817 available at $5.00 each
- Typical segment current 8mA except colon 10 hrs b & c and 10 min a & d which are 16 mA
- Forward voltage drop 1.5 volts
- MAXIMUM FORWARD CURRENT 25 mA

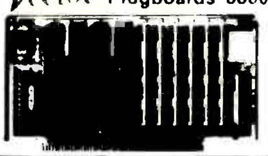
Vector

SLIT-N-WRAP WIRE WRAP TOOL

- Slits and opens insulation exposing bare wire
- No pre-cutting or pre stripping
- Comes complete with two 100 ft spools #28 AWG wire

Model P180 $24.50

Vector Plugboards 8800V



Universal Microcomputer/Processor plugboard, use with S-100 bus complete with heat sink & hardware 5.3 x 10 x 1/16

$19.95

CHANNEL F

Fairchild video entertainment system

$129.95

- Freeze Action • Speed Option
- Automatic time and scorekeeping
- Battery-free AC operation
- Dual controls with 8-way action
- Built-in Pro Hockey and Tennis games
- Easy hook-up on any B/W or Color TV
- Factory warranty

Channel F — additional cartridges — $17.95 ea.

0811 — Tic-Tac-Toe/Shooting Gallery Quadra doodle Doodle
0812 — Desert Fox.Shooting Gallery
0813 — Blackjack (1 or 2 players)
0814 — Spitfire (1 or 2 players)
0815 — Spacewar (2 players)
0818 — Magic Numbers (computer logic)
0819 — Drag strip (1 or 2 players)
0820 — Maze (2 players)
0822 — Baseball (2 players)

D–SUB CONNECTORS

NO PINS	PART NO	PRICE	COVER PRICE
9	DE-9P	1.49	1.25
9	DE-9S	2.15	
15	DA-15P	2.11	1.50
15	DA-15S	3.10	
25	DB-25P	3.00	1.50
25	DB-25S	4.00	
37	DE-37P	4.14	2.00
37	DE-37S	6.00	
50	DD-50P	5.40	2.25
50	DD-50S	8.00	

EDGE CONNECTORS

NO. PINS	TYPE			
20	DUAL	10 PIN	GOLD	$ .50
30	DUAL	15 PIN	GOLD	.75
44	DUAL	22 PIN	GOLD	1.95
44	DUAL	22 PIN	GOLD	2.50
80	DUAL	40 PIN	GOLD	4.95
86	DUAL	43 PIN	GOLD(6800)	5.00
100	DUAL	50 PIN	GOLD(IMSAI/ALTAIR)	4.25
100	DUAL	50 PIN	GOLD(IMSAI/ALTAIR)	4.95
100	DUAL	50 PIN	GOLD(NO EARS-IMSAI	3.50
100	DUAL	50 PIN	TIN (.1 SPACING)	3.25

ALTAIR/IMSAI CARD GUIDES .25¢ EACH

CLOCK CHIPS

MM5309	6 Digit BCD Outputs, Reset PIN	$9.95
MM5311	6 Digit BCD Outputs 12 or 24 Hour	4.95
MM5312	4 Digit BCD Outputs 1 PPS Output	4.95
MM5314	6 Digit 12 or 24 Hour 50 or 60 Hz	4.95
MM5316	4 Digit Alarm 1 PPS Output	6.95
MM5318	Video Clock Chip For Use With (MM5841 $9.95)	9.95
CT7001	6 Digit Calendar Alarm 12 or 24 Hour	5.85

Wire Wrap

	1-24	25-99	100-999	1K
10	39	36	32	26
14	34	33	31	29
16	36	34	32	30
18	70	60	54	40
20	[illegible]	75	67	55
22	95	[illegible]	72	59
24	[illegible]	[illegible]	72	59
[illegible]	95	84	80	71
[illegible]	1.40	1.25	1.08	83
40	1.56	1.40	1.20	[illegible]

I C SOCKETS

Lo Profile-Solder Tin

	1-24	25-99	100-999	1K & Up
(8)	15	14	13	12
(14)	25	20	16	14
(16)	25	20	18	16
(18)	28	27	26	20
(20)	34	33	30	239
(22)	36	35	34	28
(24)	36	35	34	289
(28)	44	43	42	367
(40)	60	58	57	493

7400 TTL Series

7400	18	7443	1.20	74100	1.75	74162	1.90
7401	.20	7445	1.05	74107	.40	74163	1.40
7402	20	7446	1.05	74109	45	74164	1.50
7403	20	7447	85	74110	80	74165	1.40
7404	20	7448	.95	74116	2.00	74166	1.50
7405	.25	7450	20	74120	1.25	74167	3.00
7406	35	7451	.20	74121	55	74170	2.00
7407	.35	7453	20	74122	45	74172	9.75
7408	25	7454	20	74123	95	74173	1.50
7409	.25	7460	20	74125	55	74174	1.10
7410	20	7470	40	74126	60	74175	1.20
7411	.25	7472	35	74128	65	74176	1.50
7412	40	7473	.40	74132	1.50	74177	90
7413	75	7474	.40	74136	1.80	74180	1.00
7414	70	7475	.70	74141	1.15	74181	2.00
7416	35	7476	40	74142	4.00	74182	90
7417	40	7479	2.00	74144	4.00	74184	2.00
7420	20	7480	69	74145	1.10	74185	2.00
7422	75	7482	1.50	74147	2.50	74186	12.00
7425	.35	7483	85	74148	1.75	74190	1.40
7426	30	7485	1.10	74150	1.00	74191	1.25
7427	35	7486	40	74151	1.10	74192	1.10
7428	40	7489	2.25	74153	1.10	74193	1.10
7429	40	7490	55	74154	1.10	74194	1.20
7430	25	7491	1.10	74155	1.10	74195	1.00
7432	30	7492	60	74156	1.10	74196	1.10
7433	40	7493	60	74157	1.20	74197	1.30
7437	30	7494	85	74158	1.75	74198	1.50
7438	35	7495	90	74159	3.60	74199	1.75
7439	36	7496	80	74160	1.30		
7440	20	7497	4.00	74161	1.30		
7441	75						
7442	.50						

CMOS

34001	40	4050	61	4517	8.50		
4000	25	4051	1.10	4518	1.65	MM74C173N	1.39
4001	25	4052	1.10	4519	90	MM74C174N	1.39
4002	25	4053	1.10	4520	1.65	MM74C175N	1.39
4004	3.50	4060	3.25	4521	3.25	MM74C192N	1.71
4006	1.40	4061	7.00	4522	1.75	MM74C193N	1.71
4007	25	4063	2.50	4527	3.00	MM74C195N	1.61
4008	1.25	4066	85	4528	1.75	MM74C200N	10.45
4009	48	4067	6.00	4583	1.45	MM74C221N	2.[illegible]3
4010	48	4068	35	4584	75	MM74C901N	84
4011	25	4069	35			MM74C902N	84
4012	25	4070	85			MM74C903N	84
4013	60	4071	35			MM74C905N	11.20
4014	1.25	4072	35	MM74C00N	38	MM74C906N	84
4015	1.25	4073	35	MM74C02N	38	MM74C907N	84
4016	59	4075	35	MM74C04N	38	MM74C908N	3.80
4017	1.25	4076	1.85	MM74C08N	38	MM74C909N	2.52
4018	1.25	4077	42	MM74C10N	38	MM74C910N	10.45
4019	70	4078	35	MM74C14N	2.18	MM74C914N	2.18
4020	1.25	4081	35	MM74C20N	38		
4021	1.25	4082	35	MM74C30N	38	MM74C915N	1.71
4022	1.25	4085	1.35	MM74C32N	38		
4023	35	4086	1.45	MM74C42N	1.42	MM74C918N	4.19
4024	1.00	4089	3.00	MM74C48N	2.13	MM74C922N	5.65
4025	35	4093	1.75	MM74C73N	84	MM74C923N	5.75
4026	2.25	4098	2.50	MM74C74N	87	MM74C925N	12.00
4027	60	4160	1.75	MM74C76N	84	MM74C926N	12.00
4028	1.25	4161	1.75	MM74C83N	2.00		
4029	1.50	4162	1.75	MM74C85N	2.00	MM74C927N	12.00
4030	60	4163	1.75	MM74C86N	99		
4032	1.60	4174	1.75	MM74C89N	6.75	MM74C928N	12.00
4033	2.00	4175	1.60	MM74C90N	1.32		
4034	3.50	4194	1.80	MM74C93N	1.32		
4035	1.60	4501	38	MM74C95N	1.61	MM80C97N	84
4038	1.60	4502	1.75	MM74C107N	1.89	MM80C98N	84
4040	1.50	4503	1.15	MM74C150N	5.67		
4041	1.45	4506	70	MM74C151N	3.80		
4042	1.25	4507	1.00	MM74C154N	5.67		
4043	1.20	4508	4.00	MM74C157N	3.40		
4044	1.25	4510	1.75	MM74C160N	1.71		
4045	2.50	4511	2.00	MM74C161N	1.71		
4046	1.95	4512	1.50	MM74C162N	2.57		
4047	2.50	4514	4.75	MM74C163N	1.71		
4048	1.00	4515	4.75	MM74C164N	1.61		
4049	61	4516	1.75	MM74C165N	1.61		

74LS00

74LS00	29					74LS196	1.87
74LS01	29					74LS197	1.87
74LS02	29					74LS221	2.00
74LS03	29					74LS240	3.00
74LS04	29					74LS241	3.00
74LS05	35					74LS242	3.00
74LS08	29	74LS60	29			74LS243	2.60
74LS09	50	74LS73	49	74LS151	1.25	74LS244	2.60
74LS10	29	74LS74	49	74LS153	1.25	74LS247	1.68
74LS11	40	74LS75	69	74LS154	3.65	74LS248	1.35
74LS12	50	74LS76	49	74LS155	1.25	74LS251	1.91
74LS13	69	74LS78	65	74LS156	1.85	74LS253	1.75
74LS14	1.70	74LS83AN	1.75	74LS157	1.50	74LS257	1.75
74LS15	40	74LS85	2.25	74LS158	1.55	74LS258	1.95
74LS20	29	74LS86	69	74LS160	1.95	74LS259	4.25
74LS21	40	74LS90	89	74LS161	1.95	74LS260	50
74LS22	40	74LS92	89	74LS162	1.95	74LS266	68
74LS26	39	74LS93	89	74LS163	1.95	74LS273	2.50
74LS27	39	74LS95	1.50	74LS164	1.95	74LS279	79
74LS28	39	74LS96	1.89	74LS165	2.00	74LS283	1.85
74LS30	29	74LS107	55	74LS166	2.00	74LS289	6.16
74LS32	39	74LS109	59	74LS168	2.00	74LS290	1.56
74LS37	48	74LS112	59	74LS169	2.00	74LS293	1.56
74LS38	48	74LS113	60	74LS170	4.00	74LS295	2.00
74LS40	39	74LS114	60	74LS173	2.00	74LS298	2.00
74LS42	1.20	74LS122	60	74LS174	1.87	74LS352	1.65
74LS47	1.75	74LS123	1.25	74LS175	1.95	74LS353	1.85
74LS48	1.68	74LS124	1.80	74LS181	3.69	74LS365	87
74LS51	29	74LS125	87	74LS189	6.16	74LS366	85
74LS52	29	74LS126	1.07	74LS190	2.49	74LS367	87
74LS54	29	74LS132	1.25	74LS191	2.49	74LS368	87
74LS55	29	74LS136	59	74LS192	2.25	74LS386	68
		74LS138	1.25	74LS193	2.25	74LS390	3.00
		74LS139	1.25	74LS194	1.89	74LS395	2.75
				74LS195	1.87	74LS670	3.95

LINEAR

LM300H	1.70			LM2111N	1.35
LM301AH	35			LM2900N	90
LM301AN	35			LM2901N	2.95
LM302H	75			LM2902N	3.00
LM306H	2.50			LM2903N	1.60
LM307H	55	LM702H	79	LM2904N	1.60
LM307N	35	LM703LN	45	LM2917N	2.00
LM308AH	3.75	LM703CH	45	LM3046N	1.25
LM308AN	3.00	LM709CH	40	LM3053N	1.50
LM308H	1.00	LM710CH	60	LM3064N	1.25
LM308N	1.00	LM710N	75	LM3065N	1.00
LM310H	1.15	LM711CH	39	LM3067N	2.60
LM310N	2.00	LM711CN	39	LM3075N	1.75
LM311D	2.00	LM723CH	55	LM3089N	3.00
LM311H	90	LM723CN	55	LM3146N	2.00
LM311N	80	LM725CH	2.50	LM3302N	2.00
LM311N	80	LM725CN	3.00	LM3401N	80
LM212H	2.70	LM733CH	1.00	LM3900N	49
LM318H	1.50	LM733CN	1.00	LM3905N	89
LM318N	1.50	LM739N	1.19	LM3909N	90
LM319N	1.25	LM741CH	35	LM3911N	1.25
LM321H	3.00	LM741CN	35		
LM322N	3.00	LM741CJ	39	LM4024N	2.75
LM324N	1.65	LM741CN	39	LM4044N	3.00
LM339AN	3.00	LM747CH	79	LM4250CH	2.00
LM339N	99	LM747CN	79	LM4250CN	2.00
LM348N	1.85	LM748CH	39	LM4558N	75
LM350N	1.00	LM748CN	39		
LM358N	1.00	LM760CN	3.00	LM5556N	1.75
LM370H	1.15			LM5558N	1.00
LM370N	2.75	LM1303N	90		
LM373N	2.95	LM1304N	1.19	**RCA LINEAR SERIES**	
LM375N	3.00	LM1305N	1.40		
LM377N	2.00	LM1307N	85	CA3013	2.15
LM380N	1.05	LM1310N	2.25	CA3023	2.56
LM380N	1.05	LM1358N	1.00	CA3035	2.48
LM380N	1.05	LM1414N	1.75	CA3039	1.35
LM381N	1.75	LM1458H	1.30	CA3046	1.30
LM382N	1.75	LM1458N	59	CA3059	3.25
LM386H	85	LM1468N	2.90	CA3060	3.25
LM387AN	75	LM1488N	1.95	CA3080	.85
LM387N	95	LM1489N	1.95		
LM388N	1.25	LM1496H	95	CA3081	2.00
LM389N	1.25	LM1496N	95	CA3082	2.00
NE531T/V	2.00	LM1556N	1.75	CA3083	1.60
NE550A	1.30	LM1596J	2.25	CA3086	85
NE555V	39	LM1800N	1.90	CA3089	3.75
NE556B	1.25	LM1808N	2.00	CA3130	1.39
NE560B	5.00	LM1810N	2.00	CA3140	1.25
NE562B	5.00	LM1812N	4.00	CA3401	49
NE565B	1.50	LM1820N	1.25	CA3600	3.50
NE566B	2.00	LM1830N	2.00		
NE566T/V	1.75	LM1845N	1.75		
NE567V	1.59				

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4.0 MHz	4.95
4.0 MHz	4.95
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4.91520 MHz	4.95

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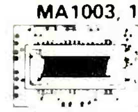

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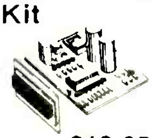

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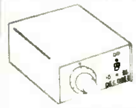

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7402	13	7444	59	7492	43	74160	55
7403	13	7447	68	7493	43	74161	65
7404	15	7448	71	7494	67	74163	65
74L04	29	7450	13	7495	67	74164	85
74S04	44	7451	13	7496	67	74165	89
7406	16	7453	13	74100	30	74174	85
7408	19	7460	19	74104	49	74175	85
7410	13	7470	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
7433	26	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		

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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	74LS123	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

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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
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NE 555	Timer	40
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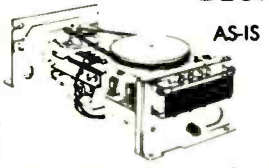

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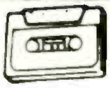

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ESE Model ES210 VOM digital meter. Need schematic of switches and technical manual or instruction book. C. Faulstich Apt. 1314, 14130 Rosemary Lane, Largo, FL 33540.

Collins ARR-15 surplus radio receiver. Schematic diagram and alignment information. E.H. Wilkie, 2828 W. Charleston Ave., Phoenix, AZ 85023.

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Lafayette model KT-200 receiver. Schematics, parts list, instructions. Dick Patten, 1072 Lanette Dr., Cincinnati, OH 45230.

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Presto series 625 tape reproducer with 909 and 915 electronics. Operating manual. Stanley Salek, 3001 N. Ocean Dr., Hollywood, FL 33019.

Uher model 704L open-reel tape recorder. Service manual and schematic. Rick Ryan, 102 Hancock St., Cambridge, MA 02139.

Electro-Voice dual conversion model 4350 communications receiver. Schematic, operating manual, service manual. J. Grant, 701 W. Harrison, Chandler, AZ 85224.

Lafayette Model #Micro P-450. Serviceable unit or uhf front-end. Alignment procedure. Conner TV Service, 709 W. Craighead Rd., Charlotte, NC 28206.

Dura of Itel Model 1051 computer terminal. Schematic, operator and service manuals, component list. Peter Davies, Box 4757, G.P.O., Sydney, 2001, Australia.

Panoramic Model PCA-2, T-200 panadaptor. Schematic or any information. Operating manual. **Sylvania** tube tester, type 620. Schematic and operating manual. **New London Instrument Co.**, Amplifier, Model 160. Allan Vontorcik, 17301 Mapleboro, Maple Heights, OH 44137.

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GPL Precision 1000 video camera driver. Operating and service manual. Richard Ulene, 8943 Enfield Ave., Northridge, CA 91325.

RCA model 242 radio. Schematic. Joe Huber, 1180 S. Pleasantree Dr., Little Rock, AK 72211.

Gonset GR-212. Need alignment and schematic data. Gordon Gillette, 5248 Jepson St., Niagara Falls, Ontario, L3E, 1L2.

Philips GM 3156 oscilloscope. Schematic and service manual. Walter Adelman, Box 6761, APO NY 09633.

Knight model 83YZ-144 oscilloscope. Need troubleshooting data such as voltages, resistances. Samuel Benveniste, 434 Briarwood Pl., Highland Park, IL 60035.

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Jackson Electrical Instrument, Co., model TVG2, television signal generator, sweep and marker tube type. Schematic and operating instructions. Box Grauch, 13946 Stroud St., Van Nuys, CA 91402.

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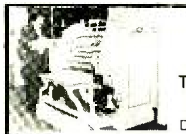

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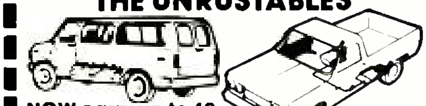

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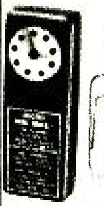

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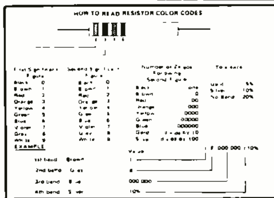

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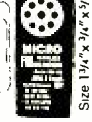

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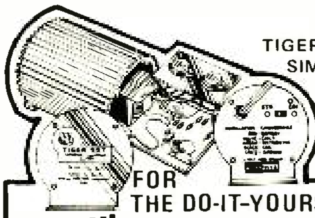

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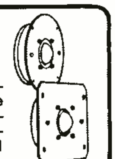

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ELECTRONICS WORLD® News Highlights in Brief

Protection for Private Data

Protecting private data in computer files is becoming a more and more serious problem both for businesses who want to keep their plans and figures from competitors, and individuals who want to keep their personal data limited to the organizations to which that data was originally given. As a result, last year the National Bureau of Standards selected an official Data Encryption Standard as a way of scrambling data so that only those with the authorized key could understand the results. IBM has already produced hardware and software for use of the new standard on its System 370 computers; DES equipment and programs for other computer systems are doubtless in the works. Unscrambling data encrypted according to the new standard requires a key of 56 binary digits. Since more than 70 quadrillion (7×10^{16}) such keys are possible, and the key can be changed frequently, getting unauthorized access to data should be difficult.

Electronic Voices for the Voiceless

A portable speech synthesizer called "Phonic Mirror HandiVoice" from HC Electronics, a subsidiary of American Hospital Supply Corp., can actually talk for a vocally impaired person. The synthesizer is pre-programmed with the English alphabet, 13 morphemes (word prefixes/suffixes), 16 short phrases ("My name is . . . ," "I want . . . ," and so on), 45 phonemes (speech sounds) and a selection of complete words. The

lap-board-style Model HC 110 has a vocabulary of 373 words (in addition to those which can be created with morphemes and phonemes), and a "keyboard" with 128 touch-sensitive pads. Another model, HC120, which resembles a calculator, uses 3-digit numeric coding from a 10-digit keypad and has a pre-programmed vocabulary of 893 words.

Keeping It Clean

Radio waves are used for more than communication: Western Electric uses them to weld, heat, and clean in industrial applications. And to ensure that these operations do not interfere with normal radio and TV reception, airplane navigation equipment, public service radio and the like, they have a watchdog, Jerry Schaeffer. His job is to develop machinery r-f emission standards and to continually monitor the level of stray r-f emissions from Western Electric's industrial machinery. Once every three years he visits each plant in his mobile laboratory to make sure they're not polluting the r-f spectrum with "radio garbage." To see Jerry operating his mobile lab you'd think he was a Smokie operating a radar trap, but he's not. He's just Western Electric's "radio garbage man" keeping the airwaves clean.

New Antennas for Voice of America

The Voice of America's relay station at Delano, California, has a new antenna—a dipole-curtain array type. Currently operating in the 49-Meter (6-MHz) and 31-Meter (9-MHz) bands, with a 250-kW transmitter, the antenna is designed for operation in the 40-meter (7-MHz) band as well. The antenna, a standard Model 611 from Technology for Communications International (TCI), is rated for up to 22 dBi of gain, providing high signal levels in targeted reception areas. The antenna's wideband design will allow VOA to use it for additional frequencies, should the 1979 World Administrative Radio Conference (WARC-79) expand the current shortwave broadcast bands.

Careers in Organ Repair

Electronic organs are becoming increasingly commonplace. More than 200,000 are now sold in this country every year, according to the National Association of Electronic Organ Manufacturers (150 East Huron, Chicago IL 60611). As a result, there is a strong demand for qualified electronic-organ service technicians. How do you learn organ repair? According to NAEOM president Byron Melcher, many technical schools offer courses on the subject, which should include electronics and computer training. Moreover, most manufacturers in the field offer two-day workshops, usually free (though you must pay your way to the workshop). A music background is not necessary, though it would obviously be helpful. An NAEOM spokesman estimates that salary or fees for a full-time career in electronic organ repair and maintenance is $14,000 to $18,000 today.

New Automobile Sound System

Soon to be introduced in some new cars from the Ford Motor Company is a sound system, claimed to be fully electronic and possessing "ultra-fidelity." An AM/stereo FM radio will be combined with a quadrasonic 8-track tape player and high-compliance-cone rear speakers. Other features include: quartz-crystal tuning, memory storage and recall of favorite stations, digital display of frequencies, four tuning modes, and four audio channels. The amplifier will provide 12 watts rms per channel for the rear speakers.

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