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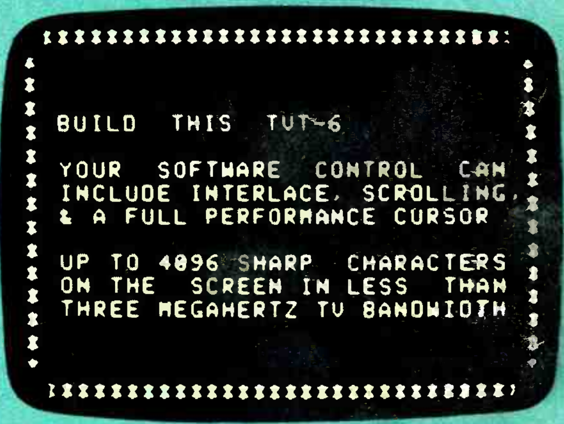

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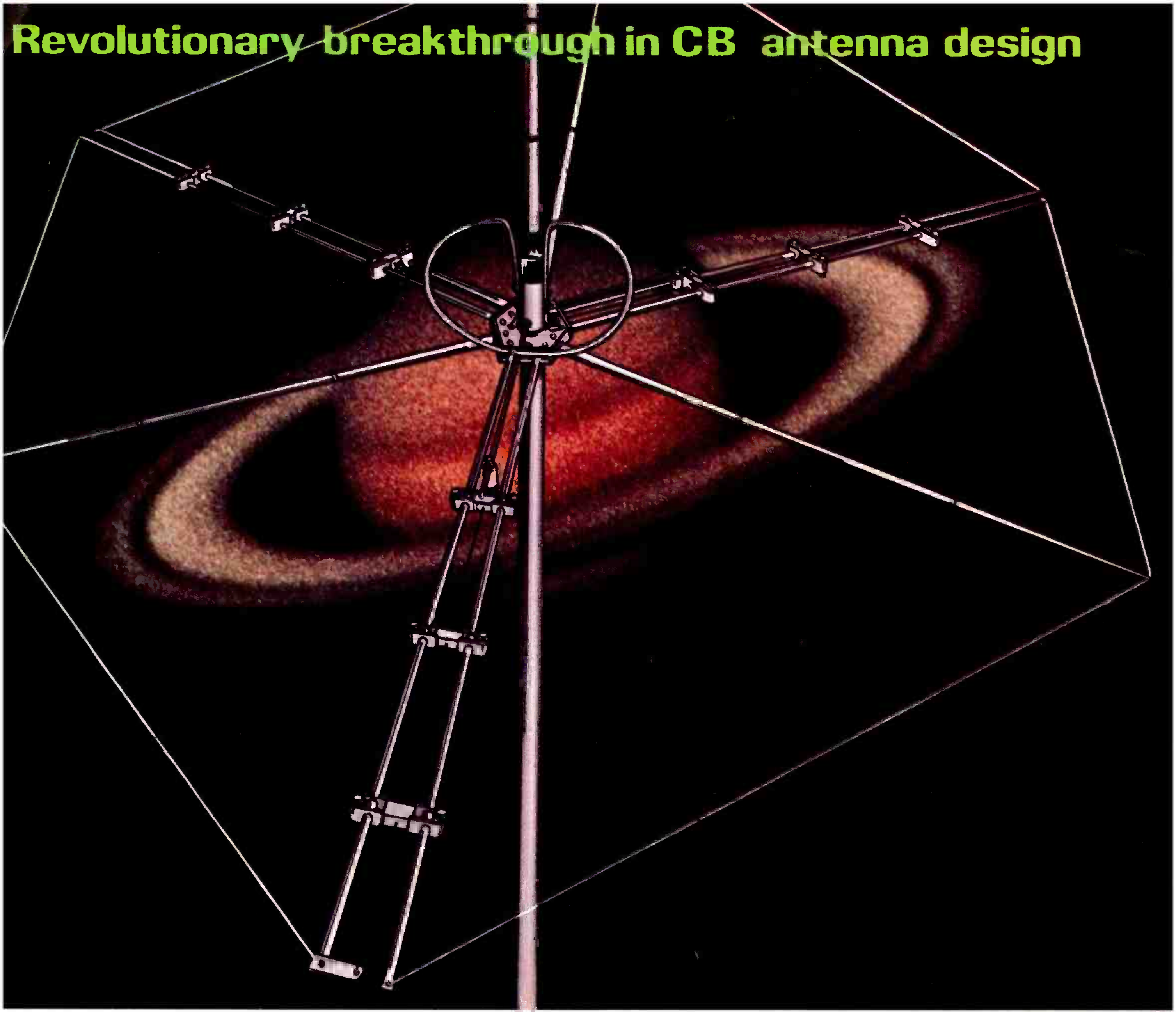

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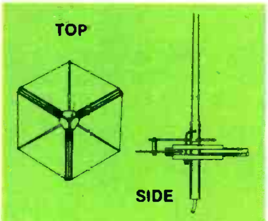

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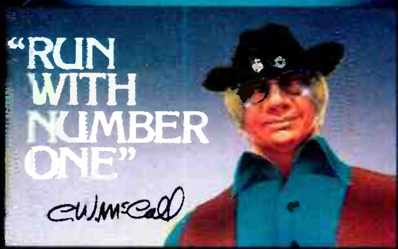

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ZIFF-DAVIS PUBLISHING COMPANY
Popular Electronics
Editorial and Executive Offices
One Park Avenue New York, New York 10016
212-725-3500
Hershel B. Sarbin, President
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Midwestern Office
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Lincolnwood, Illinois 60646, 312 679-1100
Thomas Hockney, Michael Neri, Gerald E. Wolfe
Western Office
9025 Wilshire Boulevard, Beverly Hills, CA 90211
213-273-8050; BRadshaw 2-1161
Western Advertising Manager: Bud Dean
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Editorial

SOLAR ENERGY NEWS NOTES

¶ A recent energy policy study by the MITRE Corp. concludes that nuclear power is the economical choice for at least the remainder of the century. . . . If other than economic considerations are counted, coal might eventually prove more attractive. . . . Solar energy for heating houses will be practical in the near future in favorable situations, but there's little prospect for competitively priced solar power in this century. (A Fusion Energy Foundation spokesman, however, says that the total study was justification to cut the Clinch River Tenn. fast-breeder reactor program.)

¶ In contrast, the latest paper from Worldwatch Institute (*Energy: The Solar Prospect*) concludes that subsidizing energy forms other than solar makes devices for the latter appear relatively costly. Removing subsidization would, according to the paper, make solar resources able to provide 40 percent of the world's energy needs by the end of the twentieth century. Researchers at the University of New Mexico, in a study prepared for the Joint Economic Committee of Congress, also claim that solar energy could compete with other energy sources (by 1990).

¶ President Carter asked Congress to downplay the future use of nuclear energy in his overall energy conservation/production proposals.

¶ At IBM Corp.'s Palo Alto facilities, powerful computers are exploring solutions to the problems of tapping the sun as a widespread and economical source of energy.

¶ Carl Pepper's amazing solar heating machine provides 55 percent of the heating needs in his 3200-square-foot home in Granton, Ontario, Canada. Cost is said to be $1300, with projected savings in fuel oil of more than $3000/year by 1996. The builder sells solar construction plans for $10 and a differential thermostat for $60, the latter said to be reversible for cooling the house in the summer. (See *Harrowsmith*, Jan./Feb. 1977 issue, $1.00, published by Camden House Publishing, Camden East, Ontario, Canada, KOK-1J0.)

¶ An advertiser in *Newsday*, a Long Island, N. Y., newspaper, offers swimming-pool solar energy heaters for $1900.

¶ A selection of texts on solar energy: *The Solar Energy Handbook*, Time-Wise Publications, P. O. Box 4140, Pasadena, CA 91106 (87 pages, soft cover, $3.95, plus $.50 handling); *Solar Energy Directory*, Centerline Corp., 401 S. 36th St., Phoenix, AZ 85034 (108 pages, soft cover, $7.50); *Wind/Solar Energy*, by Edward Noll, Howard W. Sams & Co., Inc., Indianapolis, IN 46268 (208 pages, soft cover, $7.95); *Solar Cells*, (IEEE Press Selected Reprints), John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016 (504 pages, $29.95 cloth, $8.95 soft cover).

Judging from the response to our annual tongue-in-cheek "April Hobby Scene," which included an implausible solar cell project, there's an extremely high level of interest in solar energy. Perhaps these serious observations will partially whet it. As an aside, I wonder what the new budget for energy research will be. Solar thermal research for fiscal-year 1976 was budgeted for only 89-million dollars; not much by any standard, and only some 4.5 percent of the total revised energy R & D budget. However, the Carter administration's new energy package seems to promise that solar devices will soon have their day in the sun.

Art Salsberg

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Letters

DOCTORS SAY NOT TO WORRY

No matter how "spacey" the rest of the world got, I could always depend on good ole PE to be swimming in the "real" world of parts specifications and product news. Then I saw April's "How to DX Earth Radio From Outer Space." I still talk to myself and my hands shake, but the doctors tell me not to worry. Just kidding. I can't begin to tell you how much I enjoy reading your magazine. *—Michael Swaney, Erie, PA.*

ETC HAS ROM MONITOR

I read with interest the April 1977 Computer Bits column and was not pleased that the only remark about our product was an unfavorable comparison with a competitor, especially when this remark was based on misinformation. The Model ETC-1000 Basic System includes a 40-key keyboard that is operated by a monitor system that permits the user to effectively operate a minimum system or to initialize and perform other housekeeping operations in systems with terminal interfaces. Our terminal monitor version comes in two packages, the 8k and 16k configuration (the latter including an assembler), and disassembler, Basic, cassette I/O, Utilities, and a variety of other program packages. *—E.S. Bjornsson, Electronic Tool Co., Hawthorne, CA.*

Our apologies for the erroneous description of the ETC-1000. The ROM monitor system indeed uses 40 buttons to allow calling routines from the monitor without need of a terminal. Debugging is simplified by using a built-in break-point routine, and included is a thorough memory diagnostic system.

"DIGISTART'S" COLLAPSING FIELD

After reading the "Digistart" (April 1977) article, I noticed a minor omission in the circuit that might cause operating problems. When the *Q1* transistor cuts off, the collapsing field of the *K1* coil could induce a large enough back emf to destroy the transistor. To remedy this, it is suggested that a diode be installed across the relay's coil in reverse bias. To be on the safe side, the rectifier diode should be rated at no less than 100 PIV at 1 ampere.*—Alan Bradford, Derry, NH.*

"APRIL FOOL" IS 2-WAY STREET

We were intrigued with the high-efficiency solar cell described in the April Hobby Scene. Because the corresponding ketone (3,7-dimethylpentadecan-2-one) is available in large quantities, at least in the midwest, by ether extraction from the saliva of pregnant sows, this seemed like the logical starting point. Reduction of this ketone with sodium borohydride gave the alcohol that, upon treatment with propionyl chloride in pyridine, gave the desired propionate ester in good yield.

The solar cell was then constructed pretty much as described, except that a glass spray bottle could not be used to apply the compound to the sand. This is because the chemical also reacts with the silica in the glass and the resulting deoxygenation process is violent. A plastic bottle, however, works quite well. The cell actually is more efficient than the one described, providing about 87% conversion. *—Dr. C.T.C.Creedy and co-workers, Charles F. Kettering Research Laboratory, Yellow Springs, OH.*

You stated that car-radio frequency drift was due to the Doppler effect and that the problem should be corrected with a phase-locked loop. My God, tell the fool to slow down! For an audible Doppler shift to occur in the commercial AM band (let's say 5 Hz, to be conservative), this person would have to be driving faster than 5000 mph. By helping him to keep his radio tuned, you are aiding and abetting this reckless and unlawful operation of a motor vehicle.*—Walter Satre, Chairman, Electrical & Electronics Technology Dept., Vermont Technical College, Randolph Center, VT.*

In discussing the well-known effect of radiation pressure from car stereo speakers in the April Hobby Scene, Marcia Swampfelder overlooked the most important application of them all: swinging the speakers forward to assist in braking. Such dynamic air braking does not wear down the tires and has been used effectively for years in fire engines. When close to the fire, the driver swings his siren around to hasten the stop. You can determine the precise moment when he does this from the change in pitch, caused by the Doppler effect, provided you are not close to the fire. *—Harry E. Stockman, Arlington, MA.*

DX'ING EARTH ON CHANNEL 68

The statement that there is only one channel 68 in North America in "How to DX Earth Radio From Outer Space" (April 1977) is incorrect. Independent station WBTB TV in Newark, NJ operates on channel 68. *—John J. Dynarski, Carteret, NJ*

FREQUENCY READOUT PROJECT A HIT

I wish to thank POPULAR ELECTRONICS and author David L. Mattis for the "Digital Frequency Readout for Shortwave Receivers" (February 1977). After connecting it to my receiver, it was surprisingly accurate and stable. I can set my receiver to a predetermined frequency and just wait for the signal to fade in. Also, the display is especially bright and clear and can be read from clear across the room.

Incidentally, the hookup point given in the article is incorrect for my 1973 Lafayette Radio Model HA-600A receiver. The correct tie point is the junction of *C31* and *R16*. The circuit board in the receiver is already drilled to permit such a connection.*—Stephen E. Franklin, Ellicott City, MD*

I built the "Digital Frequency Readout" project from a kit supplied by Mattis Electronics and am delighted with it. I was impressed by the fine kit of parts supplied. Everything was included and the project worked immediately upon completion.*—D.C. Mead, Greensboro, NC*

AN ERROR IN SWITCHING

In "Build a Digital Bicycle Speedometer" (March 1977), it is stated that, to calibrate the project one must "depress *S2* and adjust *R2* until the display indicates the wheel's diameter." Since *S2* is the power switch, the instructions should read: "depress *S3* . . ."*—Rick Stievenart, Carbon, IN.*

THANKS FOR THE "ELF"

My thanks to Joe Weisbecker for designing the "COSMAC Elf Microcomputer" (August 1976). I built my micro using slide switches, discrete LED's, and a 555 timer IC for economy. (In my project, the 555 timer can be placed in either of two positions in a 16-pin DIP socket to give me either a high or a low clock.)

The basic construction technique I used in assembling my Elf was Wire Wrap, with two bus strips for power distribution. My main problem during assembly was trying to find 22-pin Wire Wrap sockets. Since I couldn't find them anywhere, I had to build my own from Molex Soldercons, Vector J pins, and epoxy cement. My next project is to build my Elf with a hex keyboard and 1024 words of memory. *—Charles J. Billwiller, Rancho Cordova, CA.*

SLIDE SYNCER STEERS MOTORBOAT

I enjoyed building "The 35-mm Slide Syncer" (November 1976). Found the circuit to be so stable that I plan to use two of them in a programmable steering system for my motorboat. The only "bug" in the system is that it will trigger from some momentary signals other than its center-frequency signal. This problem can be eliminated by increasing the value of *C6* to 20 or 30 µF.

I also found that the circuit refused to trigger at low signal levels. I discovered that by paralleling *R2* with a 50,000-ohm potentiometer, this second problem could be eliminated. These modifications ensure excellent circuit operation.*—Mark Irgang, New York, NY.*

MORE SOLAR VIEWING SAFETY

"Propagation Forecasts For Radio Communications" (November 1976) contains an error regarding the use of the Kodak #4 neu-

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tral-density filter which could have serious consequences. The safest way to view the sun through binoculars or a telescope is by projection. If direct viewing is required, it should be done only through full-aperture filters of the deposited-metal-film type such as that shown on the telescope in Fig. 3 of the article. These filters effectively block all harmful radiation.

Another method is to use one or more layers of black and white (not color) film that has been exposed to direct sunlight and then developed. These are suitable for direct viewing but not photography because they degrade the image.

Another area of danger is in the use of the so-called "sun filters" supplied with many inexpensive telescopes. These filters are meant to be used on the eyepiece. Since they will be near the focal plane of the main objective lens or mirror, it is possible that sufficient heat could be built up in the filter to cause it to crack. The damage to the eye would occur before the observer could move away from the eyepiece.—*John Hudak, Vice President, Hamilton Centre of the Royal Astronomical Society of Canada, Ontario, Canada.*

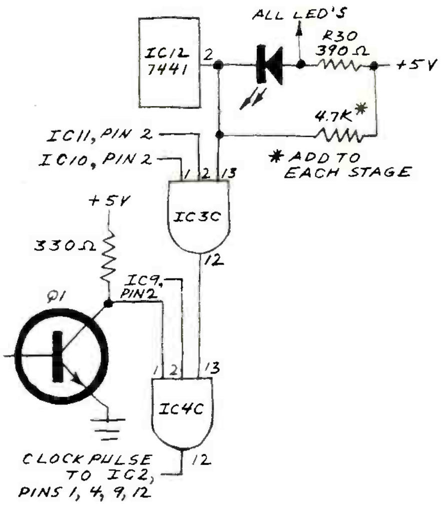
ANOTHER CLASS OF AMPLIFIER

We read with interest "Classes of Audio Amplifiers" (March 1977) and noted that although the article covered classes A through G, it failed to mention the class K "reference shift" amplifier. The class-K amp is similar to the class-A amp except that the average direct current to the power amplifier is controlled as a function of the audio level. Thus, no more power is consumed than is necessary to minimize distortion for a particular audio level. This makes its average efficiency appreciably higher than for the class-A amplifier. The principal virtue of the class-K amplifier is that it yields about twice the power output of a class-A system, using the same tube or transistor. Of course, the class-K system is not suitable for hi-fi without special refinements because of difficulties in handling transients. But it performs well in voice applications, such as in modulating communication equipment.—*Dale Hileman, WB6NTR, Topanga, CA*

Out of Tune

In "Bicycle Speedometer" (March 1977), the segment-f pin of *IC2* in Fig. 1 was incorrectly identified as pin 16; it should be pin 10.

In "LED Racing Game" (March 1977), pins 7 and 8 of *IC13* in Fig. 4 are reversed. Also, pin 16 of *IC6, IC7,* and *IC8* must be connected to the +5-volt bus (see Fig. 6). If you add a 4700-ohm, ¼-watt resistor to *IC9* through *IC12* as shown here, the two unused 7411 gates can be used to block the clock pulse



when any one of the four players reaches the finish first. This will eliminate any doubt as to the winner if all four players wish to race at the same time.

In the "Digistart Lock" (April 1977), contact bounce problems in flip-flop A can be reduced by connecting pin 1 (J) to +5V and pin 4 (K) to gnd. On *IC5*, the Q output is pin 1. For more stability in the one-shot multivibrator, change *R6* to 39,000 ohms (¼-watt) and *C1* to 120 µF.

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New Products

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

DYNACO INTEGRATED AMPLIFIER

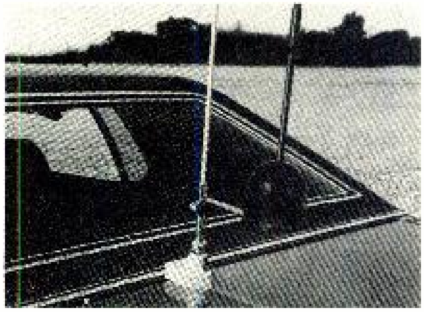
The Model SCA-50 integrated amplifier is available from Dynaco/Dynakit either factory assembled or in kit form. It is rated at 25 watts/channel continuous average power with less than 0.5% THD with 8-ohm loads. The bass and treble control circuits are de-

signed to have little or no effect on the mid-range. The turnover in the bass control system is variable, while that in the treble system is fixed and has a hinge frequency that is higher than is usual. In the amplifier section, the output circuit is full complementary symmetry, and the bias supply thermally tracks the output transistors. A thump-suppression circuit (for turn-on/turn-off) is standard. In addition to the line fuse, protection includes separate fuses at each of the four power supply outputs, current limiting, and a thermal circuit breaker. $149 kit; $249 factory wired.

CIRCLE NO. 89 ON FREE INFORMATION CARD

RAYMALEE CB MOBILE ANTENNA

The Solar Hot Rod, from Raymalee, is a power-gain CB antenna featuring a self-contained solar-powered device with built-in solar storage. It clamps to the user's present mobile or base-station antenna with no addi-

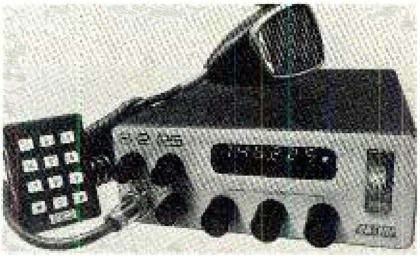


tional wiring required. The Solar Hot Rod is said to provide 14 dB of signal gain to the receiver with less than 2 dB of noise gain. The Solar Power Supply is claimed to be able to maintain a fully charged supply, enough to provide several months operation in total darkness. $89.95.

CIRCLE NO. 91 ON FREE INFORMATION CARD

AMCOMM 2-METER FM TRANSCEIVER

The Model S225 2-meter mobile FM transceiver from AMCOMM (American Communications Corp.) features a digital synthesizer that provides complete coverage of the 2-meter ham band in 5-kHz increments. Operating frequency is determined by three rotary

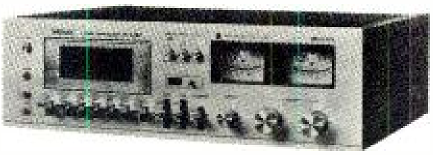


switches and is displayed to the nearest kilohertz on a six-digit LED display. Transmit offsets are switch selectable for +600 kHz, −600 kHz, +1 MHz and −1MHz. R-f output power is continuously variable from 2 to 25 watts, with spurious harmonic output at −60 dB. Receiver sensitivity is rated at 0.5 μV for 20 dB quieting. Local oscillator frequency stability is claimed to be ±5 ppm. Audio output power is rated at 4 watts into the built-in 8-ohm speaker with less than 10% distortion. The transmitter is phase modulated (±5 kHz with 100% modulation at 1000 Hz), and T/R switching is solid state. A Touch-Tone encoder is optional.

CIRCLE NO. 92 ON FREE INFORMATION CARD

OPTONICA FRONT-LOAD CASSETTE DECK

Sharp Electronic Corp.'s Optonica Model RT-2050U is a two-motor, front-loaded cassette deck. Wow and flutter is rated at 0.045% weighted rms, and S/N ratio is 64 dB with its Dolby noise-reduction system switched in. An automatic program find sys-

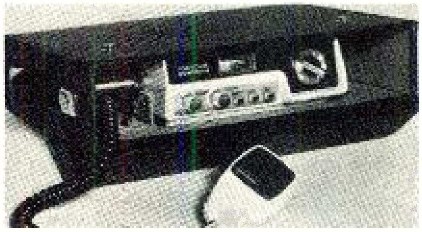


tem (APFS) enables the user to move to the next selection or to return to the start of the current selection simply by pushing a button. Among other features are: a space setter, peak level meters (respond to signals in 10 ms), electronic automatic stop, and three-position BIAS and EQUALIZER tape selection switches, pause switch, counter, stereo headphone jack, separate record level controls, and a ganged output control. $299.95.

CIRCLE NO. 93 ON FREE INFORMATION CARD

MOTOROLA CB RADIO CARRYING CASE

A Universal Carrying Case for mobile CB transceivers has been introduced by the Motorola Communications Group Parts Dept. The case permits easy removal of a CB radio so it can be carried by the owner from an unattended vehicle. Separate compartments



in the case hold microphones, the power cable, and a portable antenna. The case is designed so a mobile radio can be operated without removing it from the case. Openings at the top and bottom of the case allow the speakers to be heard, while a large opening at the back permits antenna and power connections. The front flap folds down so that the transceiver controls and microphone jack are readily accessible. Covered with Texion vinyl that simulates genuine leather and equipped with a heavy-duty handle, the case measures 12″ × 9″ × 3″ (30.5 × 23 × 7.6 cm).

CIRCLE NO 94 ON FREE INFORMATION CARD

SENCORE AUDIO-VHF FREQUENCY COUNTER

Sencore's FC45 frequency counter offers continuous frequency check capability from audio through vhf (uhf-band coverage to 600 MHz with optional PR47 prescaler). A direct-reading eight-digit dispaly with pushbutton

action makes the FC45 easy to use. Incorporates a crystal checker. Counter sensitivity is 25 mV average throughout the band; accuracy is 1 ppm, using a temperature-controlled oven. The basic unit comes with all testing leads at $395. The PR47 prescaler is $125.

CIRCLE NO 95 ON FREE INFORMATION CARD

NAKAMICHI FM TUNER/PREAMPLIFIER

The Model 630 FM tuner/preamplifier from Nakamichi is said to provide an extremely low-noise, low-distortion preamplifier section. Noise is ratec at 80 dB below 1 mV, and distortion is claimed to be virtually impossible to measure. A phono overload of 250 mV and a switch-selectable phono input sensitivity ensure compatibility with a wide variety of cartridges. The preamp section also provides tone and contour controls, tape deck monitor

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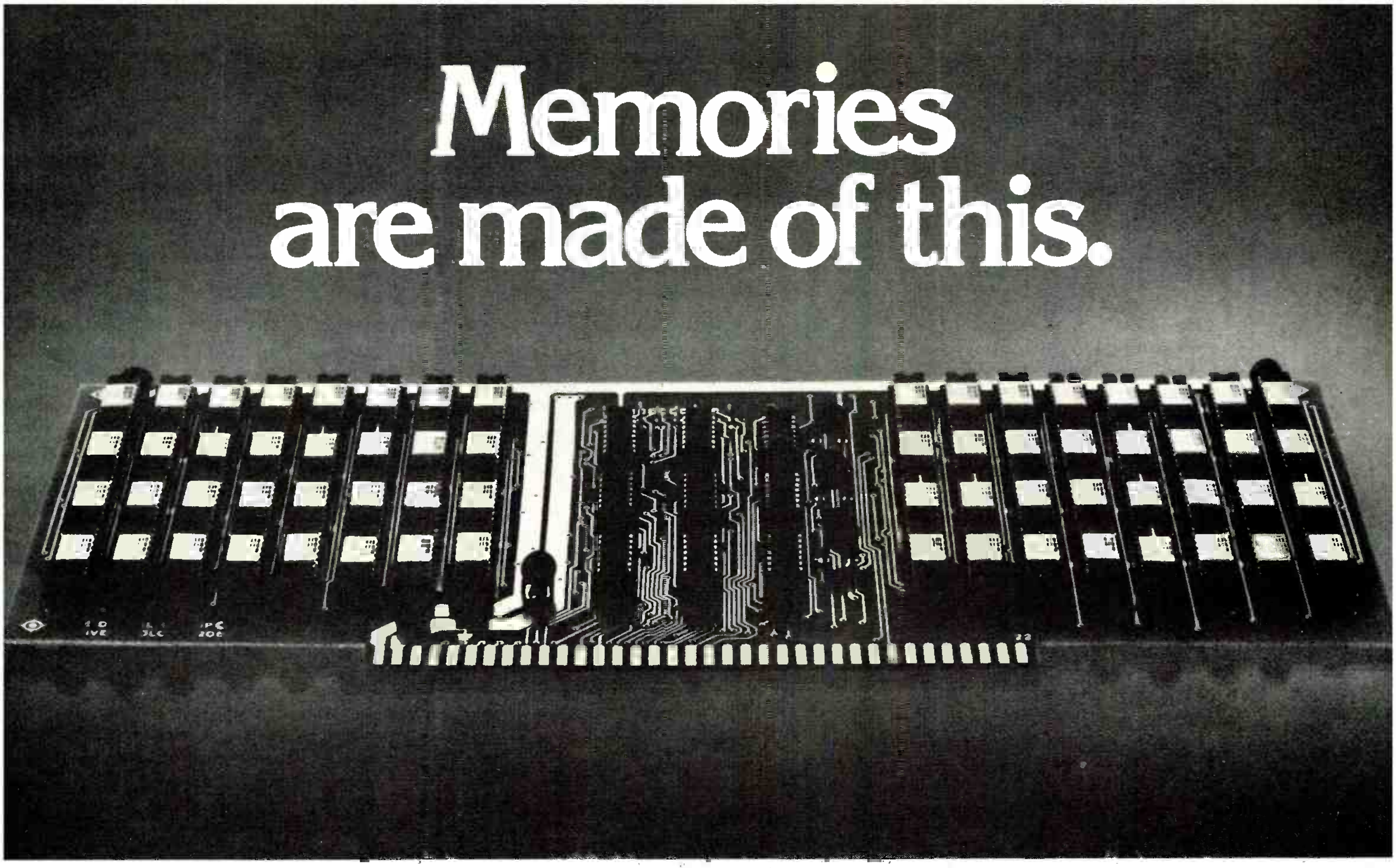

32K. One Card. One low price. Only from the Digital Group.

Now, on only one *fully static* card, the Digital Group has squeezed in a whopping 32K of memory. Which, with a little quick addition, means a full 64K architecture now requires only 2 boards instead of 8. That's a 4-to-1 space reduction ...and leaves one extra memory slot on the Digital Group's standard motherboard still available for future products.

All this and one low price, too.
It just may be the best news of all. Our full static, assembled and tested 32K memory board is only $995. Now that's worth remembering. It's substantially less than our equivalent assembled 8K board prices. (Please note: We're initially offering this 32K board assembled only, but kit versions will soon be available, too—at even lower prices.)

Here's what you get.

Specifications:
- 32K on single card
- Speed—450ns. All of our current CPUs will operate at full-rated speed.
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Features:
- May be intermixed on Digital Group systems with our 8K memory cards
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Price:
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☐ Remember me? I'm already on your mailing list, but I need the memory spec sheet desperately.

CIRCLE NO. 12 ON FREE INFORMATION CARD

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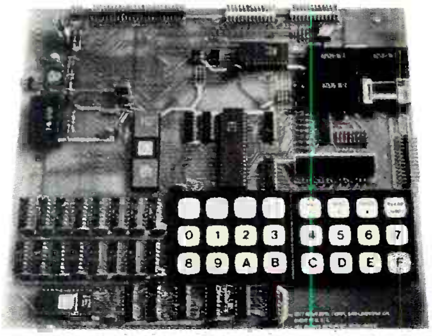
and copy facilities, and a high output headphone amplifier. The FM tuner section features low-noise dual-gate MOSFETs, a six-element LC network, and a switch-selectable wide/narrow-band response. FM sensitivity is 8.75 dBf (1.5 μV for 30 dB quieting), and a capture ratio of 1 dB. Incorporates a Dolby noise-reduction unit with 25-μs deemphasis. $600.00.

CIRCLE NO. 96 ON FREE INFORMATION CARD

IMSAI SINGLE-BOARD COMPUTER

IMSAI's new 8048 control computer is a completely programmable computer and hardware control system on one 8½" × 10" board. It is powered by a 5-V supply or 6-V battery and allows standard electric tools, instruments, and appliances to be attached and controlled directly without requiring any intervening hardware other than wire. The 8048 8-bit CPU contains 1k words of program memory, and the system has cassette interface, RS232 current loop, and five relays. The control computer incorporates the Intel 8048/8748 microcomputer chip, which will accommodate three separate and unique memory stages: program memory, internal register memory, and external RAM. Input a program through the onboard keyboard, attach the device, and immediate control of the



devices is said to be obtained. Both kit and assembled versions are available: ROM version ($249, kit; $299, assembled), EROM version ($399, kit; $499, assembled). A 5-V power supply is $99.

CIRCLE NO. 97 ON FREE INFORMATION CARD

CROWN ELECTRONIC CROSSOVER

The Crown Model VFX-2A is the successor to the Model VFX-2 electronic crossover. Internally, the VFX-2A uses six quad op amps in-

stead of the 10 dual op amps used in the earlier model to obtain better slew rates and handling of transients. Additionally, the new op amps are claimed to allow a greater range on the level control. One quad op amp operates as an isolation amplifer to eliminate impedance mismatching problems. Continuously variable filters, two per channel, can be used to perform either crossover or bandpass functions. Each filter in the dual-channel system is variable from 20 to 20,000 Hz with a fixed rolloff of 18 dB/octave. Output impedance is 300 ohms in both inverted and noninverted modes, with greater than 6 volts maximum into 600 ohms. IM distortion and noise are rated at 0.01% and more than 100 dB below the rated output with 0 dB of gain, respectively. $329 for VFX-2A, $49.95 for optional walnut-veneer cabinet.

CIRCLE NO. 98 ON FREE INFORMATION CARD

TRIPLETT PORTABLE DMM

A single switch provides five functions and 22 measurement ranges on the compact battery-powered Model 3000 digital multimeter from Triplett. The 3½-digit display features

Aircommand 40-channel CB.

From the people who bring you Marantz—the world's finest stereo systems—comes the Aircommand CB-640—the finest in 40-channel CB. With Aircommand you get over 25 years experience in outstanding 2-way communications products.

Full 6 Watts of audio power. Provides plenty of punch so your speaker cuts through freeway noise.

Dual-conversion superheterodyne receiver with dual-cascaded ceramic filters. Together, both features provide the most complete rejection of unwanted signals, assuring you unsurpassed selectivity and sensitivity.

4 big Watts of RF power. Aircommand delivers the maximum power legally allowable to let you belt out the big sound.

100% modulation capability. Even when you talk softly into the mike, your message cuts through loud and clear, thanks to one of the most advanced mike preamp and compressor designs in CB today. With Aircommand, you don't have to spend an extra $30 to $40 on a "power mike." You can't buy better modulation than Aircommand.

Specially tailored frequency response.

LED 40-channel selection display. Easy-to-read, night or day.

8-LED (light emitting diode) meter display. Provides an easy-to-read display of SWR (standing wave ratio), modulation, and incoming or outgoing signal strength—instantly, accurately.

Special emergency Channel 9 scan with exclusive Aircommand "beep" alert. No matter what channel you're on, a special Aircommand CB-640 circuit continuously and silently monitors Emergency Channel 9. When someone starts transmitting on Channel 9, a unique "beep" alerts you, so you can tune yourself in and give assistance.

Public address capability. The versatile Aircommand CB-640 public address package lets you (1.) Talk into the CB mike and out an exterior public address speaker. (2.) Attach a tape recorder to the auxiliary jack on the

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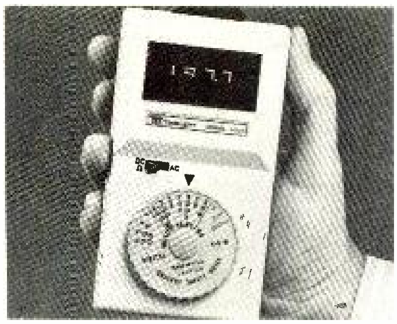


seven-segment LED's with blinking over-range, auto-zeroing, and autopolarity indication. All decimal points light up when the battery is low. Ranges include: 0 to 0.2, 2, 20, 200, and 600 on both ac and dc volts; 0 to 2, 20, and 200 mA on ac and dc; 0 to 200, 20k, and 2M ohms on low-power ohms; and 0 to 2k, 200k, and 20M ohms on conventional ohms. Typical ratings include 0.9% dc accuracy, 10-megohm input resistance on all voltage ranges, and 600-volt overload protection on all ranges. The DMM is powered by four Ni-Cd cells, for which a battery-charger/eliminator is provided. Size is 5⅜" × 3" × 1⅜" (13.7 × 7.6 × 3.5 cm) and weight is 10 oz (310 g). $140.

CIRCLE NO. 99 ON FREE INFORMATION CARD

INFINITY ELECTROSTATIC HEADPHONES

Infinity System's ES-1 headphone system consists of headphones with a claimed frequency response of 20-25,000 Hz ±2 dB and an adapter containing a power supply and matching transformers. Other specs include: less than 0.3% THD at 100 dB SPL, 50 watts at 1 kHz maximum input, and 118 dB SPL maximum output. The low-mass conductive diaphragms are made of an extremely light material called "Polyurethin." The power supply is housed in a walnut enclosure, which is connected between the amplifier and speakers. Front-panel switching allows head-

phones to remain connected whether they or the speaker systems are being used. The headset weighs 9 ounces. The complete system is $275.

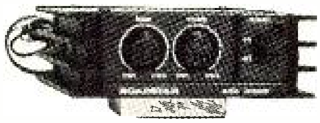
CIRCLE NO. 100 ON FREE INFORMATION CARD

ONE-HAND SOLDERING

The Kager KL-3000 is Minitool's answer to the problem of one-hand soldering on electronic circuits. The gun has adjustable, automatic feed of preset amounts of solder. It accepts various diameters and brands of solder wire, interchangeable elements and tips (20-30-40-60-watt elements available), and has optional accessories for practically any type of soldering work. The standard kit is $49.50 with interchangeable heating elements $13 each; soldering tips, $7.30; solder reels $2.25 and $5.95 depending on size. Address: Minitool, 15076 Dickens Ave., San Jose, CA 95124.

ROYAL MOBILE AMPLIFIER

Royal Sound has a new mobile stereo high-fidelity power amplifier module, the RS-55, that's normally driven by speaker output leads of an FM/AM radio with cassette player. The module increases amplifier output for car audio equipment by providing a power output of 15 watts/channel. Self-contained, the RS-55 is ruggedly constructed to withstand shock and vibration. It also has sepa-



rate bass and treble controls, on/off switch, power indicator light, and quick-connect terminals, and can be mounted anywhere in a car or van. Operates on 12-volt dc negative-ground only. $90.00

CIRCLE NO. 101 ON FREE INFORMATION CARD

...You never heard it so good!!!

CB-640 rear panel, and boom your tape out through the same external speaker. (3.) Mix your voice from the CB microphone with the program material on the tape recorder. Both voice and tape sound at the same time through the external speaker. (4.) Beam your **received signal** through the external speaker.

Built-in standing wave ratio circuitry. Measures the efficiency of the antenna system for optimum performance.

Other outstanding features include: Delta fine tuning control, digital synthesizer with phase-locked loop, automatic noise limiting switch, noise blanking switch, squelch control, RF gain control.

Also available: Aircommand CB-140; Aircommand CB-340. All 3 units bring you state-of-art design, flawless craftsmanship and day-in, day-out reliability. Try them out now at your Superscope Aircommand dealer.

TM Aircommand by SUPERSCOPE.

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New Literature

HEATHKIT CATALOG

The new 96-page Heathkit Catalog describes over 400 electronic kits. Product categories include amateur radio, hi-fi components, color TV, test instruments, digital clocks, radio control equipment and auto accessories. Among the new products introduced are a 3-way bookshelf speaker system, a battery monitor device for radio control modelers, a two-way freezer alarm and a touch-control light switch. A section of fully assembled brand-name 40-channel CB radios has also been included. Address: Heath Co., Dept. 350-11, Benton Harbor, MI 49022.

EDMUND CATALOG

Edmund Scientific's 164-page Spring Catalog #772 contains over 4500 items for experimenters, students and hobbyists. Among the many items described are an AM/FM deluxe wall radio; a storm alarm which is triggered by a signal from a local National Weather Service station; and a Sol-20 computer with Basic 5 language. Address: Edmund Scientific Co., 555 Edscorp Bldg., Barrington, NJ 08007.

WINEGARD CB ANTENNA CATALOG

Winegard Industries offers its first CB Antenna Catalog #770. The catalog illustrates the company's line of 40-channel CB mobile antennas and accessories, providing technical information and specifications. A listing of available antenna replacement parts is also included. Address: Winegard Industries, Inc., 3002A Winegard Dr., Burlington, IA 52601.

MOTOROLA HEP CATALOG

The new, 184-page edition of the HEP Semiconductor Cross Reference Guide and Catalog is offered by Motorola. Includes replacement HEP semiconductors for over 60,000 discrete devices and IC's, with 198 new products. Covers discrete silicon and germanium power transistors, thyristors, small-signal FET's and bipolar transistors, zeners, digital IC's, voltage regulator and op amps. The Educator II microcomputer power supply kits are also included. Address: HEP/MRO Operations Headquarters, Motorola Products, Inc., PO Box 20902, Phoenix, AZ 85036.

ADWAR VIDEO EDITING GUIDE

Adwar Video's 8-page guide offers advice on editing with half-inch tape and video cassette equipment. It begins with basic tips on avoiding quality losses and editorial confusion, and goes on to deal with scene edits; search and review; insert editing; and quality-enhancing modifications to VTR's. New video processing and portable field editing are also highlighted. Address: Adwar Video Corp., 100 5th Ave., New York, NY 10011.

SYNC TAPE RECORDERS & PLAYERS

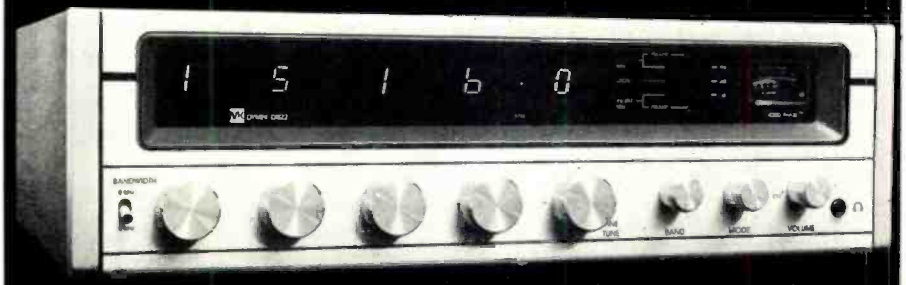
A 4-page brochure from Audiotronics describes its line of SYNC Classette tape recorders and players. The units, designed as aids for synchronized presentations of recorded audio tape to slide/filmstrip projectors, include Model 144S, which plays both superimposed and separate track synchronized cassette tapes. Another, Model 152-2, features an automatic stop program. The brochure illustrates each device and describes the different sync functions. A specification chart allows for easy comparison of models. Address: Audiotronics Corp., 7428 Bellaire Ave., N. Hollywood, CA 91605.

SPERRY MULTI-TESTER BROCHURE

Bulletin SP-73 (Issue B) from a.w. Sperry describes its line of V-O-Ma-T multi-testers. The 7-page pocket-sized brochure provides detailed specifications, applications information, and a list of special features for each tester. Accessories are also described. Address: a.w. Sperry Instruments, Inc., 245 Marcus Blvd., Hauppauge, NY 11787.

ARE YOU READY TO RECEIVE THE WORLD?

ALL NEW fully synthesized **DR22 Receiver** general coverage receiver from McKAY DYMEK **$995.**



FEATURES

- Shortwave, CB, ham radio, ships at sea, overseas phone calls, etc.
- Hi Fi, SWL, commercial, industrial and government uses.
- High level RF front end for excellent intermodulation rejection and sensitivity.
- Crystal filters in first and second IF amplifiers, ceramic filter in third IF.
- Quartz crystal tuning accuracy at all frequencies, no crystals to buy.
- Built in power supply for 110-120 or 220-240 VAC switchable, 50-60 Hz.
- Solid state, phase locked, digital synthesis tuning.
- Extreme ease of tuning at all frequencies.
- No mechanical tuning dial error or backlash.
- Switch selectable 4 or 8 kHz RF bandwidth.
- Built in monitor speaker with external speaker connectors.

SPECIFICATIONS

Frequency coverage:	50 kHz to 29.7 MHz, continuous. Digital synthesis in 5 kHz steps, fine tune for ±5 kHz.
Reception modes:	AM, upper sideband, lower sideband, CW.
Sensitivity for 10 dB S + N/N:	100 kHz / 200 kHz / 300 kHz-20MHz / 20-29.7 MHz — CW, SSB: 10 μV / 2.0 μV / 0.5 μV / 1.0 μV; AM: 30 μV / 6.0 μV / 1.0 μV / 2.0 μV
RF Bandwidth:	−3dB @ 4 kHz or 8 kHz, and −60dB @ 10 kHz or 14 kHz
Dimensions & Wt.:	(W x D x H) 17.5 x 14.5 x 5.1 inches. Shpg. Wt. 19 lbs.

DR22 features and specifications unmatched under $2900.

McKay Dymek Co.
675 N. Park Ave.
P.O. Box 2100
Pomona, CA 91766

Order factory direct, call toll free today. Exclusive rent/own plan available.
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Tel. 416/484-0800

CIRCLE NO. 27 ON FREE INFORMATION CARD

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We've just made the impossible...
a professional 3½ digit DMM Kit for less than $60.

The Sabtronics Model 2000 is an impossible $59.95! And that price still includes phenomenal accuracy, range and professional features.

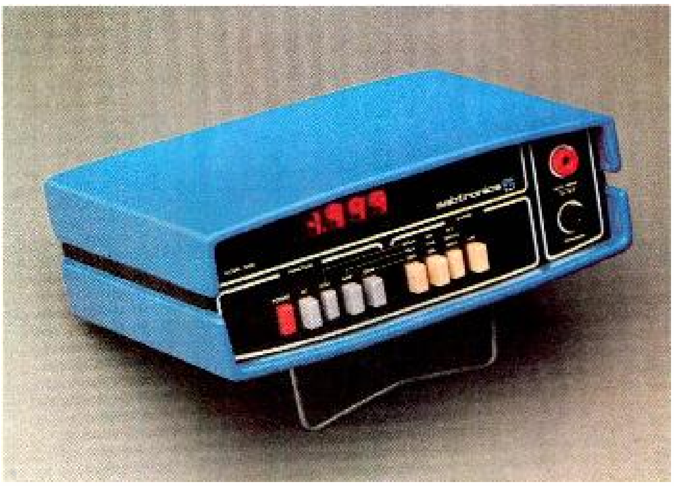
This all-new bench/portable multimeter, reading to ±1999, has a basic accuracy of 0.1% ± 1 digit, and has five functions giving 28 ranges, 100% overrange and overload protection. So you know it's no toy!

Besides, what toys are as automatic as the 2000? With automatic overrange indication, automatic polarity, even automatic zeroing!

Yet the 2000 is easy to assemble. We send you all the parts you need, even the high-impact case. We also send you clear, step-by-step assembly instructions.

So you end up with a professional quality 3½ digit DMM for the unheard-of price of less than $60. From Sabtronics, specialists in digital technology. And manufacturers of the impossible.

Order yours today!



Made in U.S.A.

sabtronics
INTERNATIONAL INC.

P.O. Box 64683 Dallas, Texas 75206 (214) 369-7310

GUARANTEE:

Our guarantee to you; examine the 2000 DMM kit for 10 days. If you're not satisfied, return it unassembled for a full refund of purchase price.

SPECIFICATIONS: (condensed)

DC volts in 5 ranges: 100μV to 1000V.
AC volts in 5 ranges: 100μV to 1000V.
DC current in 6 ranges: 10nA to 2A.
AC current in 6 ranges: 10nA to 2A.
Resistance in 6 ranges: 1Ω to 20MΩ
Input Impedance: 10MΩ
Display: 9mm (.36") LED.
Power requirements: 4.5 VDC to 6.5 VDC (4 "C" cells-not included).
Size: 8"W x 6.5"D x 3.0"H.
(203W x 165D x 76H mm).

To: Sabtronics International, Inc. PE7
P.O. Box 64683, Dallas, TX 75206

Please send me ________ Sabtronics Model 2000 DMM kit(s) at $59.95 each. ____________ subtotal

Shipping and Handling, $3.50 per unit* ____________ subtotal

Texas Residents Add Sales Tax ____________

TOTAL enclosed ____________

Name ______________________________

Street Address ______________________________

City ______________________________

State ______________ Zip ______________

*USA only. Canada, $4.50. All Other Countries, $9.00

CIRCLE NO. 45 ON FREE INFORMATION CARD

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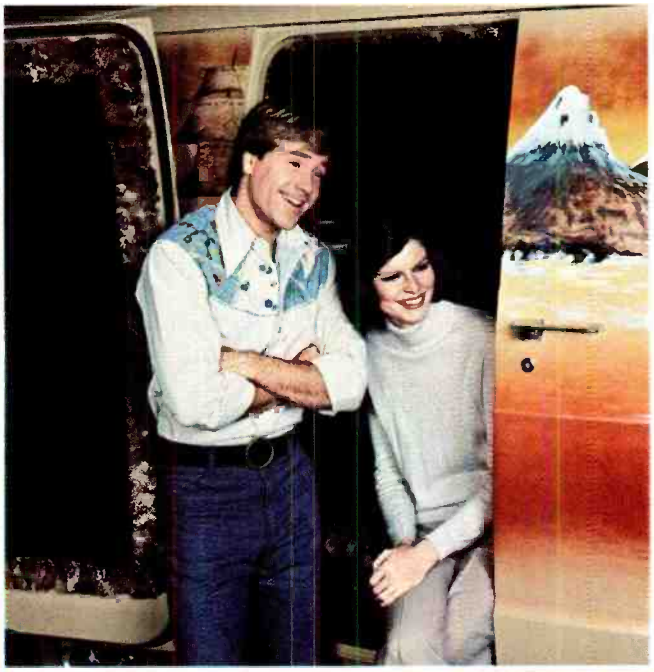
Go after the best of everything.



Don't settle for less. Especially when it comes to electronics training . . . because everything else in your life may depend on it. That's why you ought to pick CIE!

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You've probably seen advertisements from other electronics schools. Maybe you think they're all the same. They're not!

CIE is the largest independent home study school in the world that specializes exclusively in electronics.

. . .

Meet the Electronics Specialists.

When you pick an electronics school, you're getting ready to invest some time and money. And your whole future depends on the education you get in return.

That's why it makes so much sense to go with number one . . . with the specialists . . . with CIE!

There's no such thing as bargain education.

If you talked with some of our graduates, chances are you'd find a lot of them shopped around for their training. Not for the lowest priced but for the best. They pretty much knew what was available when they picked CIE as number one.

We don't promise you the moon. We do promise you a proven way to build valuable career skills. The CIE faculty and staff are dedicated to that. When you graduate, your diploma shows employers you know what you're about. Today, it's pretty hard to put a price on that.

Because we're specialists, we have to stay ahead.

At CIE, we've got a position of leadership to maintain. Here are some of the ways we hang onto it . . .

Our step-by-step learning includes "hands-on" training.

At CIE, we believe theory is important. And our famous Auto-Programmed® Lessons teach you the principles in logical steps.

But professionals need more than theory. That's why some of our courses train you to use tools of the trade like a 5 MHz triggered-sweep, solid-state oscilloscope you build yourself – and use to practice troubleshooting. Or a beauty of a 19-inch diagonal Zenith solid-state color TV you use to perform actual service operations.

Our specialists offer you personal attention.

Sometimes, you may even have a question about a specific lesson. Fine. Write it down and mail it in. Our experts will answer you promptly in writing. You may even get the specialized knowledge of all the CIE specialists. And the answer you get becomes a part of your permanent reference file. You may find this even better than having a classroom teacher.

Pick the pace that's right for you.

CIE understands people need to learn at their own pace. There's no pressure to keep up . . . no slow learners hold you back. If you're a beginner, you start with the basics. If you already know some electronics, you move ahead to your own level.

Enjoy the promptness of CIE's "same day" grading cycle.

When we receive your lesson before noon Monday through Saturday, we grade it and mail it back – the same day. You find out quickly how well you're doing!

CIE can prepare you for your FCC License.

For some electronics jobs, you must have your FCC License. For others, employers often consider it a mark in your favor. Either way, it's government-certified proof of your specific knowledge and skills!

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Stereo Scene

By Ralph Hodges

INSTRUMENTS I HAVE MIKED

I'LL BE honest and admit I haven't actually made recordings of all the instruments to be mentioned here. Sometimes I have assisted others while they recorded them, or fulfilled the function of interested observer and general nuisance at a session. And in many cases, my experience with any given instrument is hardly what you'd call exhaustive. I have only recorded a large orchestra once, for example. (I found it rather easy; beginner's luck, no doubt.)

Every once in a while I pick up a piece of data about a particular instrument or recording situation that seems directly pertinent to the logistical problem of placing microphones. Sometimes this datum immediately suggests a solution to a miking situation; other times, after further examination, it proves totally irrelevant. In either case, the information is good to have.

The few really useful *general* guidelines for placing microphones—the various ways to achieve a good stereo pickup, the maintaining of acoustic separation between mikes when you're multitracking, etc.—are ably covered in the several good books on studio technique now available. The indispensable rules of mike placement—pulling the mikes back to increase the contribution of room reverberation, avoiding the close-up use of cardioid mikes because of various frequency-response errors it can introduce, and so on—are surely well known to anyone who has taken the slightest interest in live recording. However, approaching a specific instrument, or assemblage of specific instruments, gives almost everyone pause, I think.

How do you begin? What's the first logical move? Having a definite approach, whether it is vital to the proper capturing of the sound or not, is confidence-building for all of us, and that's what I mean to focus on here.

Drums and Such. The bass drum, surprisingly, is evidently a highly directional instrument. I first learned this when I happened on an unguarded bass drum in a rehearsal room at the New England Conservatory of Music. Ecstatic, I hefted the heavy lead-loaded mallet, poised it well to the side of the drum head, swung from the hips and shoulders, and . . . nothing! After a while I realized that the drum heads, apparently moving in tandem, were giving rise to an almost perfect acoustic cancellation around the periphery of the drum, and I was therefore standing in a huge node. Not so an innocent passerby outside, who met the enormous pressure wave as it swept up the corridor.

From time to time I've encountered audible evidence of this cancellation node at considerable distances from the drum itself. So if you're ever puzzled as to why your mike is missing the near-infrasonic throb you expect from a bass drum, try turning the drum so that one head faces the mike directly. Conversely, if you're getting too much throb, turn the drum so that you get a more edge-on perspective.

Tympani (kettledrums) present no comparable problems, although they have a well-known tendency to shake the stage floor and any microphone stands on it, which may cause vibration pickup. Sometimes a failure to get the sound you want from a kettledrum is attributable to the way in which it's played. Striking the drum in the exact center of its head produces a rather ridiculous, overdamped "boomp." As the mallet progresses out toward the edge, the drum acquires that characteristic baleful, almost metallic timbre. A light roll at the very edge produces almost a rustle. Tympani are played either with sponge (or perhaps a spongy synthetic) or felt mallets; the sonic results from each are quite different. Felt mallets are exceedingly rare nowadays, however. Some recordists apparently fear that it's impossible to properly balance the tympani with the rest of the orchestra unless they are recorded with a separate mike(s) and mixed in later. It's not.

Professional recordists take elaborate pains with a drum set (kick drum, tom-tom, snare, and one or more cymbals), festooning it with microphones and stuffing towels in the kick drum. They all do it somewhat differently, so there are no general rules, except perhaps in the case of the cymbal. High-hat cymbals move considerably when they are played. If two differently placed microphones happen to be picking up the cymbal, and you intend to mix the outputs of these two mikes, you can wind up with a very weird Doppler effect that you may like, but which won't sound natural. (A two-mike pickup exaggerates the effect.) The best approach with a drum set is often a simple stereo pickup, balanced by ear.

The Strings. A celebrated concert violinist has said that a violin doesn't be-

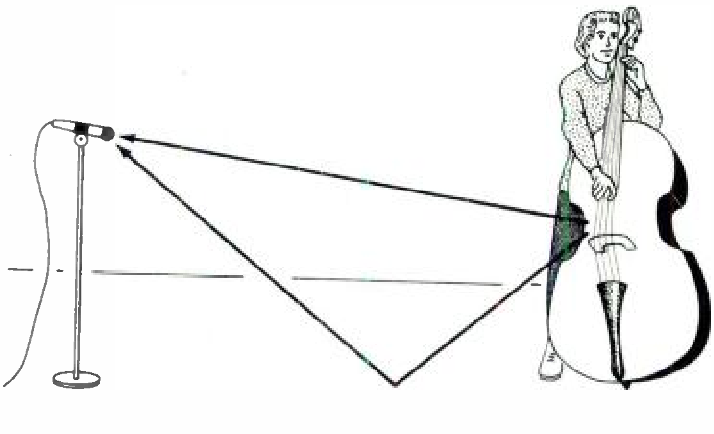

Fig. 1. Phase differences between direct and reflected signals present a problem when miking a string bass or cello.

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Fig. 2. Trumpet waveform miked on axis in anechoic chamber. From a Denon record made with pulse-code-modulation process.

gin to sound good until you're at least ten feet distant, so that the "garbage" has had a chance to fall away. Good miking advice too rarely taken. At their loudest, massed violins are never *very* loud compared with the real heavyweights in a symphony orchestra. In their upper registers, however, they have a penetrating tone that will often rise above the most astounding ruckus. If one balances too much in favor of the violins (a fault of many commercial recordings), the aforementioned penetrating tone will give the feeling of going right in to your eardrums.

For a natural-sounding recording, restraint in the handling of violins is admirable. They should not *always* be audibly strong, and they should have a certain fragility, even thinness, of tone. Where possible, give them a chance to balance naturally with the rest of the orchestra. And don't ride gain on them to any excess.

The string bass, when miked from any distance, encounters problems from reflecting surfaces. Figure 1 shows how the first reflection from the floor bounces up to the microphone, causing a complex pattern of reinforcements and cancellations, all wavelength-dependent. A solid wall behind the instrument will produce much the same thing. When you're miking several basses, as in an orchestra, the most productive approach is usually to ignore these complications and press on regardless, hoping the randomness factor will solve your problems for you. For a single bass, as in a jazz combo, it's a frequent practice to mike the instrument quite closely, which will tend to get rid of the room and, hence, the reflections. Electric basses are almost invariably miked closely (at the amplifier's speaker), or even fed directly into the recorder, bypassing the amp.

Woodwinds. It may be obvious, but the proper place to mike a woodwind is *not* at the bell of the instrument where you'd expect most of the sound to emerge. In general, the right place for the mike is directly in front of the musician, as if he were going to speak into it. Usually he will play so that the bell is pointing toward the floor (or, in the case of the bassoon, toward the ceiling). This is fine. Move the mike(s) closer or farther away as appropriate, but don't try to get too close.

The Brass. The trouble with the brass is eloquently demonstrated by Figure 2, a drawing of an oscilloscope trace made by a trumpet in full cry. The vicious spikiness of this waveform will never be revealed by any VU meter, and yet it has to be taken into account because any significant tampering with this crest will be audible. In jazz clubs you'll often see a trumpet played directly into a microphone. Apparently, the sound-reinforcement system can usually take this onslaught in stride. But it's murder on tape. I tried to record this trumpet waveform with a good cassette machine. Finally, I had to drop the recording level down to the point where the meters (peak reading) were barely stirring, and still the waveform peaks were appreciably abbreviated.

Your defense against the brass, which can easily overload microphone preamplifiers and the built-in preamps of condenser mikes as well as tape, is to get away and off-axis. Discourage brass players from pointing their instruments directly at the microphone or put the mike where they can't conveniently aim at it. Even then, a French horn, which projects rearward in line with the player's elbow, and which often has his fist stuck up into its bell, can cause trouble. Distance is your only recourse then, and here it usually sounds good.

Piano. Don't we wish we could make consistently good piano recordings. The trouble is, the instrument is too big to close-mike with one microphone, and when we try to mix the output of several microphones there is inevitable trouble with interference. Other complications intrude as well.

Presently, for grand piano, I favor the stereo pickup shown in Figure 3. Note that the two mikes (cardioids or omnidirectionals, or a coincident pair embracing a moderate angle) are aimed down into the piano's case approximately in line with the instrument's lid. This theoretically avoids reflections from the lid (which I believe to be detrimental to clarity) from reaching the mikes directly. The mikes are brought forward or pulled back as necessary to provide that right touch of room reverberation.

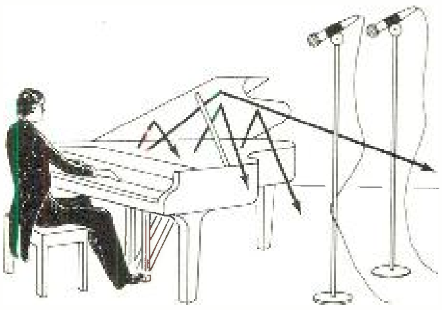

Fig. 3. This mike positioning for piano avoids pickup of direct reflections from bottom of lid.

There are many other ways of recording a piano that I'm itching to try as soon as I get the chance. Some of these are described in a Shure Brothers' publication, "The Music-Maker's Manual of Microphone Mastery." Although intended for sound reinforcement at live performances, you can extrapolate its advice into a recording situation with relative ease. It's free. (Shure Brothers, 222 Hartrey Ave., Evanston, IL 60204.)

The Sound Field. All of us are intrigued by the examples of recording

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professionals and hope to emulate their results in time. Here's a piece of advice offered by several recording professionals I have talked to: Forget it! A professional recording session costs multi-dollars with every tick of the clock. There is scarcely time for aesthetic considerations or lengthy consideration of microphone respositioning. Ideally, a professional recordist would like to capture every instrument in complete isolation and later mix all the instruments together (along with appropriate reverberation) at his leisure. Hence he turns to the multimiking approach, which by-and-large sacrifices all the good things—depth, spaciousness, authentic perspective—of a simple stereo pickup. If you don't believe me, read John Woram's book, *The Recording Studio Handbook* (Sagamore Publishing Co., 1120 Old Country Road, Plainview, N.Y.) for some frank discussion of the subject.

If you're an amateur recordist, and time is not pressing, you have the luxury of being able to attempt a miking of the "sound field"—the whole musical event, balanced naturally, and presented to the ultimate listener with startling realism and an impressive stereo panorama. It will not sound like a professional mix on one of the big labels, but if you're familiar with the sound of live music you'll appreciate that it sounds, in many respects, better. Above all, have a good time, and fulfill yourself while inching toward capturing the full realism of the music. Even if the final goal cannot be wholly reached, you'd be surprised at how forgiving the human ear is.

More on Decontaminating Discs. Dr. Bruce Maier, president of Discwasher, has favored us with some comments on the recent "Decontamination Squad" column (May 1977) that I'd like to share.

He observes that "It has been our experience that once you begin wet-playing a record you can never, never play the record dry again. After two wet plays, playing the record dry will blow you out of the room with surface noise.

"The reason is fairly complex," says Dr. Maier, offering some research conclusions concerning wet playing of discs:

(1) Wet playing causes an intense disequilibrium in temperatures between the vinyl at the stylus pressure point and the liquid layer on the disc surface. This temperature differential causes (by actual electron microscopy investigation) disorientation or cracking or injury to the surface molecular structure, just as you might fracture a glass cup if you heated it when it contained cold water.

(2) Wet playing allows an interface layer of liquid to extract tiny amounts of surface stabilizer into a slurry. When this slurry is allowed to dry back onto the surface, there is a concomitant lack of stabilizers in the right place plus little globules in the wrong places.

(3) Wet playing literally shorts out some cartridges by wicking up the cantilever and causing the generator assemblies of some cartridges to corrode very quickly.

Dr. Maier disagrees with my suggestion that record-cleaning substances and lubricants can be evaluated by treating just 180 degrees of a record side and then listening for any difference between the two halves. He points out (quite rightly, I suspect) that the transition points between the halves will always be audible. Had my description been more complete, it would have been clear that the evaluator should listen for any differences between the two halves *other* than the noise occurring at the actual transition points, of which there should be two per revolution. As I suggested, the slower the playing speed, the easier it will be to distinguish the transition points from the rest of the disc surface. ◇

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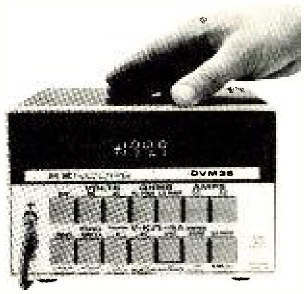

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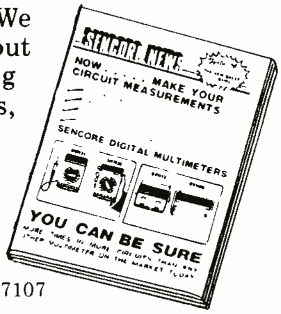

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RC CIRCUIT QUIZ

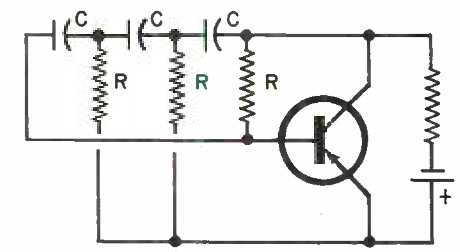
BY ROBERT P. BALIN

Resistance-capacitance circuits are not always as simple as they might seem. For example, in dc circuits, the charging time of the capacitor, as controlled by the resistance, is used to determine oscillator frequency.

In ac circuits, the RC combination is used as a frequency-sensitive voltage divider or filter. And, in circuits involving both dc and ac components, it is used to block the dc component. Other examples could be given.

However, whenever the RC circuit has a different application, it seems to acquire a different name for its function. To test your knowledge of RC circuits, see if you can match the circuits (A to J) with the functions (1 to 10).

1. Band Suppression Circuit ______
2. Coupling Circuit ______
3. Decoupling Circuit ______
4. Differentiator ______
5. Equalizer ______
6. Frequency Control ______
7. Integrator ______
8. Phase Shifting Circuit ______
9. Timing Control ______
10. Tone Control ______



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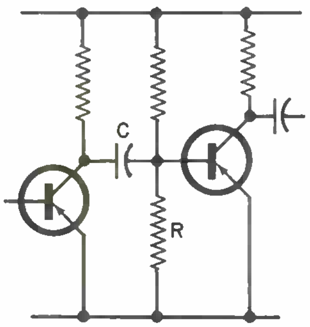

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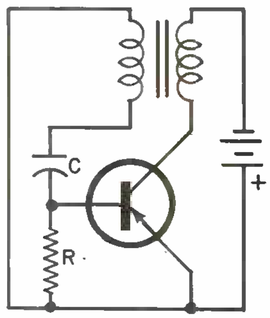

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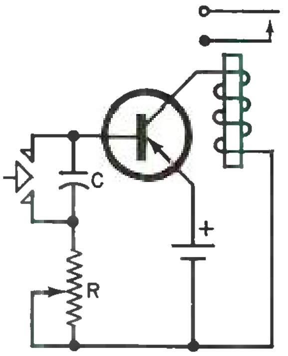

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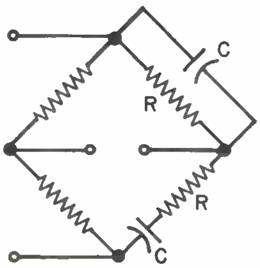

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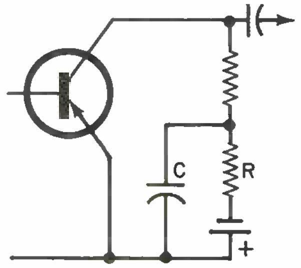

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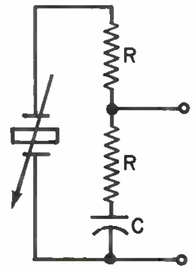

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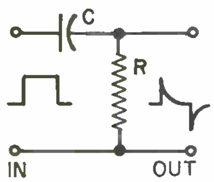

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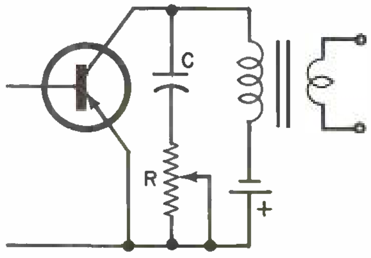
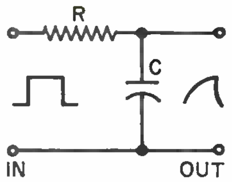


I.



J.

ANSWERS: 1-E, 2-B, 3-F, 4-J, 5-G, 6-C, 7-H, 8-A, 9-D, 10-I

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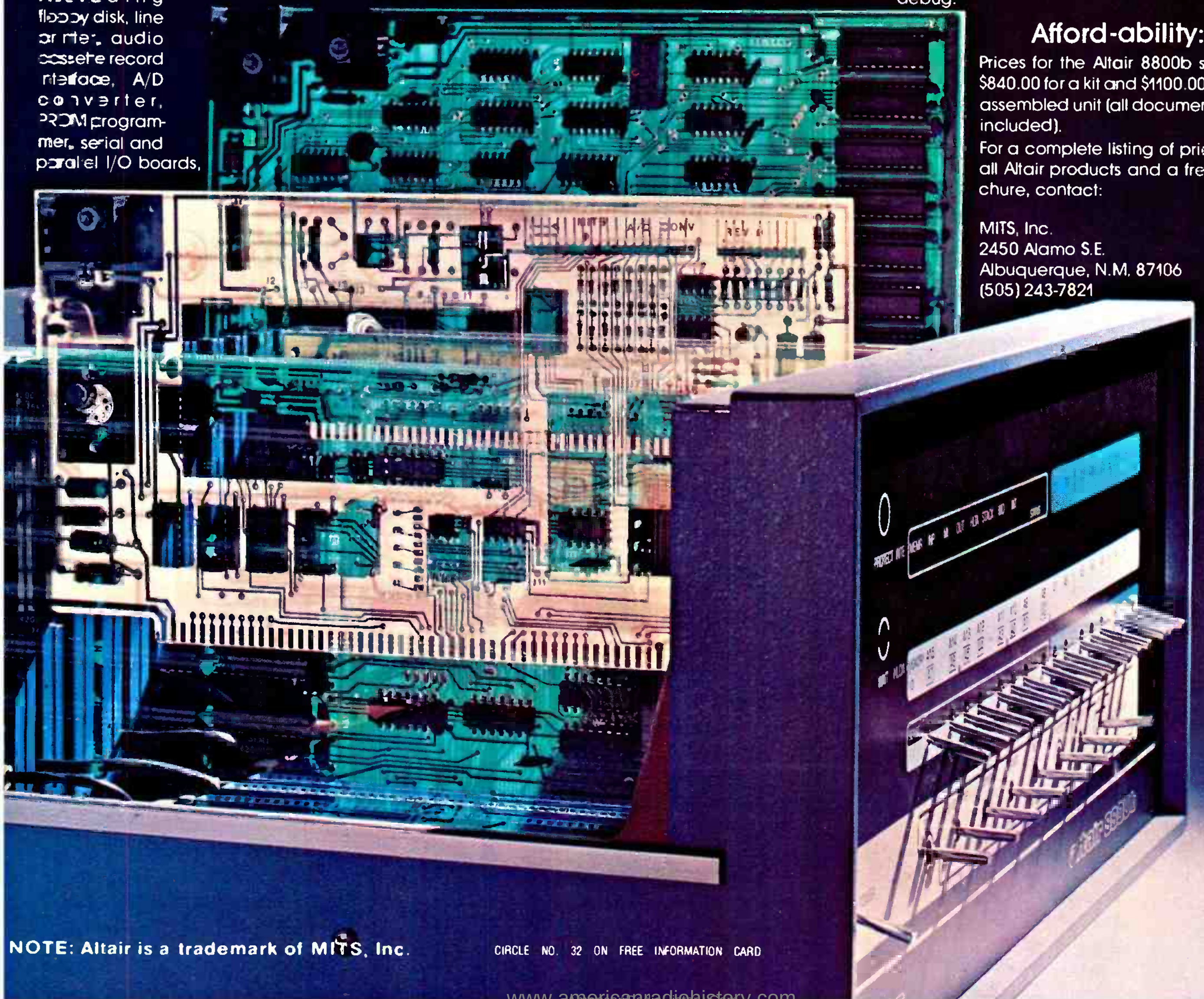

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Julian Hirsch Audio Reports

HIRSCH/HOUCK LABORATORIES

NOISE FILTERING FOR HI-FI

From high fidelity's earliest days, audiophiles have faced the problem of dealing with the various effects that we lump together under the heading of "noise." Noise is defined in the current ANSI standard as "unwanted disturbances super-imposed upon a useful signal that tend to obscure its information content." In the case of sound reproduction systems, this is modified to exclude harmonic, subharmonic, and intermodulation distortion products, and flutter and wow.

For most hi-fi listeners, noise falls into two broad categories: high-frequency hiss or scratch and low-frequency noises, such as rumble or hum. All are essentially steady-state effects, though they are usually random in nature. Another category includes impulse noise, composed of discrete pulses that occur at regular or irregular intervals, such as automobile-ignition interference and record ticks or pops.

To some degree, all of these forms of noise are present at all times in reproduced music, and eliminating or reducing their objectionable qualities has been the goal of many talented engineers for decades. No panacea has yet been discovered for noise, but by attacking the problem on several fronts, it has been possible to greatly reduce its audible effects.

The basic problem is that the noise energy and the music program occupy the same frequency spectrum, often simultaneously. Noise may extend well beyond the program bandwidth or, as in the case of power line hum, may occupy a small discrete portion of the spectrum. The more successful noise-reduction systems operate by virtue of achieving a greater reduction of noise than of program content, though some sacrifice of the latter is unavoidable.

The simplest, oldest, and least-effective anti-noise technique is to use fixed low-pass or high-pass filters to attenuate noise energy outside the main spectrum of the program bandwidth. If bandwidth is limited (as in the case of 78-rpm records or AM radio) it is possible to cut off most of the hiss with little loss of program quality. The shellac-based 78-rpm phonograph records were noted for their high "scratch" level, and a fixed filter cutting off above 3000 or 4000 Hz could be very helpful. Since turntable rumble was concentrated at frequencies below 100 Hz, a filter cutting off at that frequency could clean up the bass reproduction without too much loss of content.

The wider bandwidth of LP records was fortunately (and not accidentally) combined with low-noise vinyl record materials so that the full frequency range could frequently be enjoyed without too much disturbance from noise. Nevertheless, even as records and playback systems were improved, one's enjoyment of a wide-range recording was increasingly likely to be marred by extraneous noises. The fixed filter, being by far the cheapest "cure," continued to be offered as a solution to this problem, although it usually solved nothing at all.

Unlike the situation with 78's, the recorded material on an LP disc usually had useful energy up to 10,000 Hz or higher. Cutting off the noise above 10,000 Hz was of no help, since the change could not be heard by most people. Cutting off an octave lower, at 5000 Hz, might produce a noticeable lowering of the hiss level, but would certainly dull the program to an undesirable degree. The low-frequency noise problem was much less severe. For one, most of it was under the listener's control, in the sense that using a better turntable would eliminate much of the rumble at its source. Since most speaker systems have considerably reduced output at very low frequencies, only the unfortunate combination of a poor turntable, good speaker system, and high listening level was likely to result in a disturbingly high rumble level.

We have been referring to filter action as "cutting off" at a certain frequency. If filters worked that way, they would be much more effective. Unfortunately, a real filter, the simple type used in home entertainment electronic products, attenuates the response gradually, on both sides of its cutoff frequency. Most filters used in hi-fi amplifiers or receivers have a cutoff slope of 6 dB/octave (which requires only a single resistor and capacitor, hence its popularity). The effect of the filter begins more than an octave below the cutoff frequency, at which point its response is down 3 dB. By the time the frequency has gone an octave or more above the cutoff point, the rate of attenuation approaches its ultimate value of 6 dB with each octave increase (doubling of frequency).

In fact, the typical filter response curve is virtually identical to the treble tone control response with the control set to minimum. The filter switch is thus a convenient substitute for the tone control—but it is

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no more effective as a noise-reducing device! A similar situation exists at the low frequencies, with many rumble filters beginning to cut the frequency response as high as 150 or 200 Hz. Fortunately it is possible, by selecting a cutoff frequency between 50 and 100 Hz, to make a worthwhile reduction in rumble without undue loss of program content because most recorded music has little energy below 100 Hz.

For better results, filters can be made with a sharper cutoff action so that a greater proportion of noise can be removed without harmful effects on the program. It is not too expensive to build filters with a 12 dB/octave slope, and in some active filter configurations the cutoff "knee" can be made much sharper so that program material will be less affected. Some of the better amplifiers and receivers do have such filters, and if their cutoff frequencies are well chosen (and preferably selectable) they can be useful.

Nevertheless, no fixed filter, no matter how steep its attenuation slope or where its cutoff action begins, can do a really effective job of noise reduction without impairing program quality. A number of ingenious dynamic filters have been developed in which the attenuation and the frequency at which the filter becomes effective are controlled by the program itself. The psychoacoustic phenomenon of masking is used in the design of these filters. High-frequency hiss is audible only in the absence of high-frequency program content; when the music is loud or contains appreciable high-frequency energy, the hiss is masked and cannot be heard. Similarly at the low end, rumble cannot be heard when the program is loud or contains strong low-frequency material.

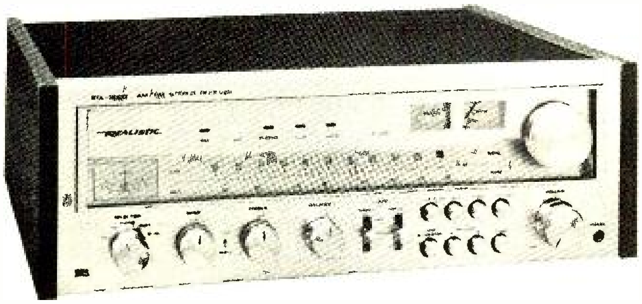
It would seem logical to use a high-cut (low-pass) filter whose operating frequency and/or slope are controlled by the program so that its filtering action occurs only under conditions that allow the hiss to be heard. This logic is correct, but there is the problem of selecting the dynamic characteristics, including the basis for filter operation, its actual response characteristics, and the rate of attack and decay of the filtering. Failure to do this correctly will result in audible swishes and other clues that the filter is working; a noise reduction device whose action can be heard is not of much value.

There are a handful of add-on noise-reduction systems that truly do a fair-to-good job of minimizing noise without any noticeable effect on program material. A new NR accessory, announced by SAE recently, even claims to remove ticks and pops from record reproduction. But these are *accessories*.

As strongly implied, the fixed filters built into most receivers and amplifiers, especially those having 6-dB/octave slopes, are virtually worthless as noise-reduction devices. In spite of this, many receivers and amplifiers above the lowest price ranges include some sort of "filter," presumably because their designers feel that it is expected of them. Perhaps a counter-trend is under way, since we noted with interest that Radio Shack's deluxe Realistic Model STA-2000 receiver, reviewed in this issue, eschews *all* filters. We did not miss them for a moment. ◇

REALISTIC MODEL STA-2000 STEREO RECEIVER

Company's top-of-the-line, 75-W/channel receiver boasts notable features and smooth performance.



HIRSCH-HOUCK LABS REPORT

Radio Shack's Model STA-2000 heads the "Realistic" brand's list as its top AM/stereo FM receiver. Its amplifiers are rated to deliver 75 watts/channel into 8-ohm loads at less than 0.25% total harmonic distortion (THD) from 20 to 20,000 Hz. The front panel is satin-finished aluminum with matching control knobs and switch buttons. A large clear glass window, behind which the dial scales are angled back for better visibility, dominates the upper two-thirds of the panel. All controls, except the large tuning knob, are located on the lower third of the panel. The single tuning meter indicates center-of-channel for FM and relative signal strength for AM.

The receiver measures 19"W × 16½"D × 6⅞"H (48.3 × 41.9 × 17.5 cm) and weighs 40 lb (18.2 kg). Supplied with genuine walnut-finished end plates, the receiver is catalog priced at $499.95.

General Description. A row of colored indicator lights above the dial scales illuminate to identify the selected input (AM, FM, PHONO, AUX1, AUX2) and when a stereo FM station is being received. Two small meters above the dial scales monitor the output power of the audio channels. The meters are calibrated at decade intervals from 0.1 to 100 watts, based on 8-ohm loads.

In addition to the input SELECTOR switch, there are BASS and TREBLE tone controls with 21 detented positions, including a FLAT setting at the center, and a BALANCE control with a center detent. The volume control operates in steps with 41 detented positions. Tone controls are concentric, permitting individual channels to be adjusted.

Eight pushbutton switches are arranged in a two-row matrix. The upper

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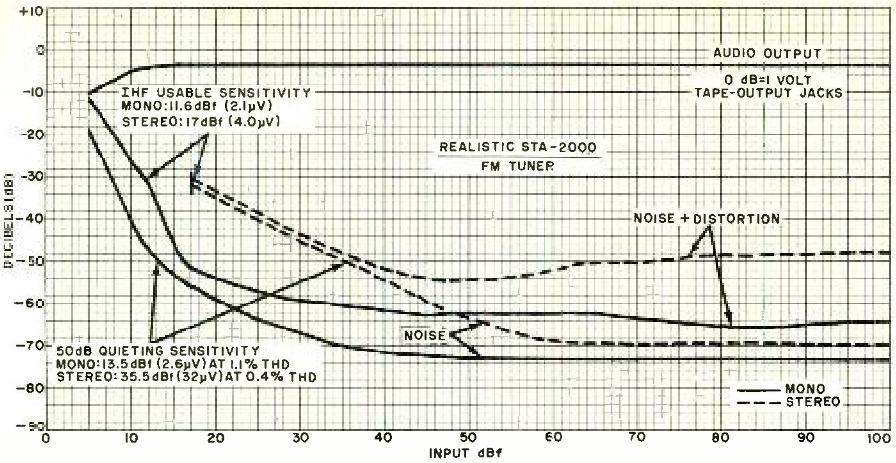


Noise and sensitivity curves for FM section of Realistic receiver.

row is for switching in and out an FM MPX FILTER (reduces noise in stereo reception by partially blending the channels at higher audio frequencies), FM MUTE circuit, MONO/STEREO mode, and LOUDNESS compensation. The lower row of switches contains switching for a 20-dB audio ATTENUATOR (for temporary interruption), A and B SPEAKERS selection, and POWER. Two lever switches are provided for controlling the tape recording functions for two tape decks. The DUBBING switch crossconnects the decks for copying a tape from either deck to the other or connects both decks for recording from the program source to which the SELECTOR switch is set. The MONITOR switch connects the playback from either deck or the selected source to the receiver's audio amplifiers.

On the rear apron of the receiver are insulated binding posts for the two pairs of speaker systems that can be accommodated. (The connectors are exceptionally easy to use and do not require the wire to be wrapped around the posts.) Their functions are duplicated by two pairs of phono jacks for speaker system cables equipped with phono plugs. The various signal input and output connectors are phono jacks, and the two sets of tape recorder connectors are duplicated in DIN sockets. Two sets of auxiliary outputs are also included. Preamplifier outputs and power amplifier inputs are brought out to separate phono jacks that are joined together by removable jumper links. There are antenna terminals for 75- and 300-ohm FM antennas as well as a wire-type AM antenna. There is also a fully hinged and pivoted AM ferrite rod antenna. The line cord has a capacitive coupling clip that can be connected to one of the 300-ohm FM antenna inputs so that the power line can be used as an antenna in strong signal areas. One of the two accessory ac outlets on the rear apron is switched.

Laboratory Measurements. During the one-hour preconditioning of the amplifier at one-third rated power, the metal cover above the output transistors became quite warm, but the receiver as a whole remained cool. The outputs of the amplifiers, when driving 8-ohm loads at 1000 Hz, clipped at 90 watts/channel. Into 4- and 16-ohm loads, the output was 106 and 55 watts, respectively.

The 1000-Hz THD was less than 0.01% from 0.1 to 20 watts. It increased very slowly to 0.05% at 80 watts. The IM distortion was between 0.03% and 0.1% from 0.1 to 80 watts. At outputs of a few milliwatts, the IM distortion increased to several tenths of a percent.

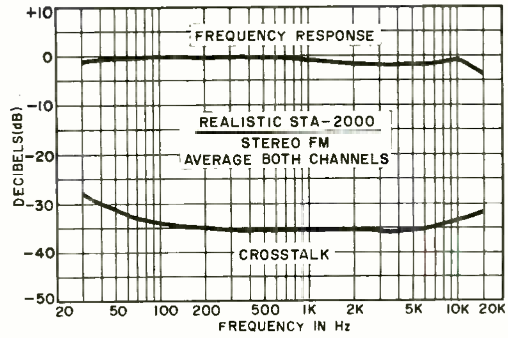
At the rated 75-watt output, the distortion was between 0.02% and 0.05% over most of the audible-frequency range and never exceeded 0.09%. It was much the same at lower output powers, measuring about 0.01% at middle frequencies and from 0.1% to 0.14% at 20,000 Hz. Through the AUX input, the amplifier's sensitivity was 50 mV for a reference 10-watt output with a 74-dB S/N ratio. The phono sensitivity was 0.83 mV with a 66-dB S/N ratio. The phono input at 1000 Hz didn't overload until a very high 220 mV was reached.

The bass tone control had a variable turnover frequency. It provided a moderate boost or cut below 100 Hz at partial settings, with negligible effect at higher frequencies. The turnover frequency increased to about 500 Hz at the control's extremes. The treble control characteristics were hinged at about 3000 Hz. RIAA phono equalization was flat within ±0.5 dB from 60 to 20,000 Hz, dropping slightly at lower frequencies to −2 dB at 30 Hz. Because the phono preamplifier stage effectively isolates the cartridge from the feedback components, the phono response was completely unaffected by the cartridge inductance.

The loudness compensation boosted only the low frequencies as the volume control setting was reduced. The boost at normal listening levels was slight, avoiding the unnaturally heavy sound that is typical of most loudness-compensation systems. The power meters provided only a rough approximation of the actual output, with typical errors being 50% to 100%. They had a fairly slow response time and were well damped, following average program levels to our satisfaction.

The FM tuner section had an IHF sensitivity of 11.6 dBf (2.1 μV) in mono and 17 dBf (4.0 μV) in stereo. The steep limiting curve yielded 50 dB of noise quieting at only 13.5 dBf (2.6 μV) in mono, with 1.1% THD, and 35.5 dBf (32 μV) in stereo, with 0.4% THD. The 1000-Hz distortion was about 0.08% in mono and 0.32% in stereo at a 65-dBf (1000 μV) input. The stereo THD, with L − R channle modulation, was 0.75% at 100 Hz, 0.1% at 1000 Hz, and 0.2% at 6000 Hz. The S/N was 72.5 dB in mono and 69 dB in stereo.

The FM frequency response had a slight dip in the midrange and high-frequency response, plus the usual drop at 15,000 Hz due to the multiplex pilot carrier filter. Overall, the response was still within ±1 dB from 30 to 12,500 Hz,



Frequency response and crosstalk averaged for both channels in stereo FM.

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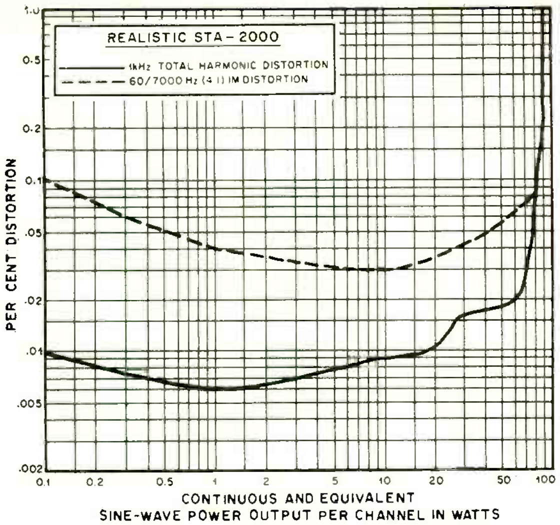
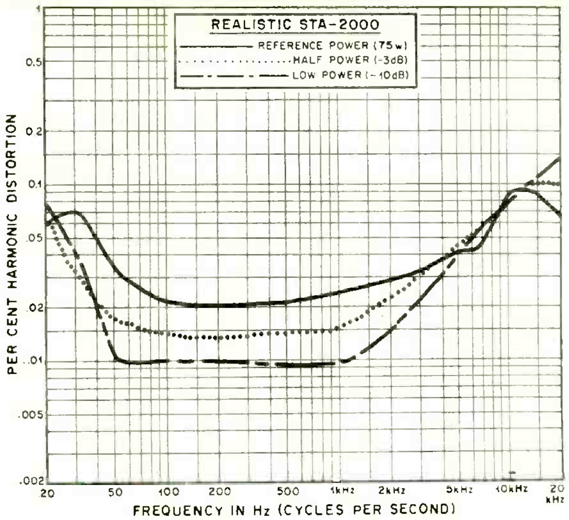


Total harmonic distortion and 60/7000-Hz distortion.



Harmonic distortion at three power levels.

down about 3.7 dB from midrange levels at 15,000 Hz. The stereo channel separation was very uniform, about 35 dB over most of the audio range. It was a very good 27.5 dB at 30 Hz and 31.5 dB at 15,000 Hz.

FM capture ratio was 1.75 dB at 65 dBf and 1.9 dB at 45 dBf (100 μV) inputs. The AM rejection was an exceptional 83 dB. Image rejection also measured 83 dB. The alternate-channel selectivity was 76 dB, and adjacent-channel selectivity was 4.6 dB. Muting and automatic stereo switching thresholds were identical at 17.2 dBf (4 μV). The 19-kHz pilot carrier leakage into the audio outputs was −70 dB, and tuner hum was a very low −75 dB. The AM tuner section appeared to be relatively sensitive, with a notable freedom from buzzing noises, and a wider-than-usual frequency response that was down 6 dB at 4500 Hz and 3.5 dB at 20 Hz, from the midrange levels.

User Comment. There are some interesting in-use observations to be made concerning this receiver that don't show up by examining specifications. For example, unwanted noises and switching transients have been eliminated with notable success. This is accomplished by effecting a slight delay

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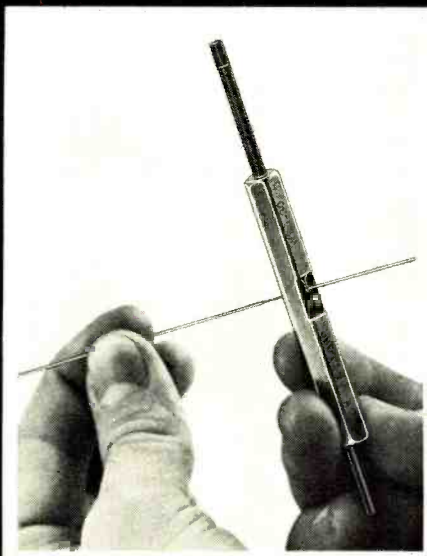

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after power is applied, whereupon a relay connects the speakers to the output transistors. Furthermore, when the FM muting switch is activated, FM tuning action is completely free of transients and noise bursts.

The output transistors are protected against damage from overload, including short circuits, by a circuit that silences the receiver until it is reset by turning off the power for a few moments and then turning it on again. We verified the effectiveness of the overload protection by driving the receiver into shorted outputs, which immediately shut off the amplifiers without damaging them. It is also thermally protected against excessive operating temperatures, although we never reached such a condition.

Realistic has chosen to omit some "features" usually found in receivers of the Model STA-2000's price range that are of little value in any receiver such as low- and high-cut audio filters. Unless such filters have cutoff slopes of 12 dB/octave or more, they are useless for their intended purpose. However, the tape recorder dubbing connections, and the separate preamplifier outputs and power amplifier inputs that are indeed useful have been included. The same for its FM multiplex noise filter. We particularly like the large pushbutton switches as compared to rotary switches. They're most convenient to use. The 20-dB attenuator switch is a nice touch, permitting the user to lower volume temporarily without losing the volume-setting place previously used.

Comparing the actual measured performance of this receiver to that of similar products we have evaluated, we find that the Model STA-2000 is at the least a competent performer in every respect and outstanding in many. It has the unmistakable "sound" of a good control amplifier, giving the sense of not having a device between the source and the speakers.

The physical smoothness and precision "feel" of the controls are consistent with the receiver's excellent performance. Though it is not a "super-power" receiver, the Model STA-2000 is more than powerful enough for the majority of users and is a very good value.

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KOSS MODEL K/145 STEREO HEADPHONES

Comfortable to wear with fine bass performance in moderate price range.

Heading a new line of low-cost "Slimline" stereo headphones from Koss is the Model K/145. This circumaural headphone features rectangular ear cushions that exclude most outside sounds. Each earcup contains a dynamic driver with a 38-mm polyester diaphragm. The frequency range of the phones is specified at 20 to 20,000 Hz. Impedance is rated at 90 ohms at 1000 Hz, while sensitivity is specified at 0.25 volt at 1000 Hz (or 0.11 volt rms with pink noise) for a 100-dB sound pressure level (SPL). Harmonic distortion is claimed to be less than 0.5% at 1000 Hz and 100 dB SPL.

The phones are finished in textured brown vinyl and come with a matching padded headband. A separate knurled wheel protruding slightly from each earcup allows independent volume level adjustment in the left and right channels. The cords that attach to the earcups come down to form a Y joint about 2′ (60 cm) from the earcups before joining to the coiled cord that goes to the driving amplifier. The total length of the cord is 10′ (about 3 meters). The phones weigh 1 lb (454 g), less cord. Price is $45.

Laboratory Measurements. We tested the phones on a modified ANSI headphone coupler, the type used by Koss for making in-plant measurements. The bass frequency response was very flat and smooth, confirming the effectiveness of the "Pneumalite" ear cushions in sealing the phones to the ears. The output varied by only ±1.5 dB from 20 to 300 Hz.

At higher frequencies, the output dropped at about a 6-dB/octave rate, to −20 dB in the 3000-Hz range. The usual high-frequency response irregularities were visible above 4000 Hz in our chart plots, including peaks at 5500 and 14,000 Hz. These irregularities can be due, at least in some degree, to the coupler and cannot be definitely attributed to the headphones themselves.

With a 0.25-volt drive at 1000 Hz applied through a source resistance of 100 ohms, the phones delivered their rated 100-dB SPL output. The total harmonic distortion at this level was between 0.1% and 0.2% from 300 to 10,000 Hz, which is well below the rated 0.5%. At lower frequencies, the THD increased, due to the larger excursions of the diaphragm, to between 0.6% and 0.9% in the 20-to-100-Hz range. We also measured the distortion with the drive level increased to 1 volt, which corresponds to a 112-dB output at 1000 Hz. The THD at this level, although far in excess of normal listening levels, was 0.3% to 0.8% at most frequencies above 100 hertz and 1.8% at 20 hertz.

The impedance of the phones was a constant 90 ohms from 20 to 20,000 Hz with the level controls set to maximum. At the center positions of the controls, the impedance increased to 700 ohms, while at the minimum settings, it was about 1000 ohms.

User Comment. In our use tests, we found these snug-fitting phones to be comfortable to wear, even over prolonged listening periods. We noted that the sound quality is pleasant and listenable throughout, though it lacks the brilliance or crispness exhibited by, say, electrostatic types. (The latter are much costlier, of course.) However, we observed no apparent loss in the high-frequency range. The bass and lower midrange were strong and solid.

In an overall evaluation of performance, we find these new Koss phones to be fine performers, though sounding a bit "soft" for our personal tastes. But other listeners may indeed prefer it this way. Since headphones, like speaker systems, are best judged subjectively by the listener, we strongly recommend a personal audition of these comfortable, relatively inexpensive phones.

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news HIGHLIGHTS

Automotive Developments

Ford Motor Company recently announced plans to use the resources of major semiconductor producers to help in the design of future automotive models. Specially designed large-scale integrated circuits and microcomputers will shortly control many engine functions. Two new concepts which will be pioneered by Ford in 1978 include an electronically controlled carburetor and an electronic engine control system for spark timing and exhaust gas recirculation. The new devices, to be installed on a limited volume of 1978 models, are intended to improve fuel economy, emissions and performance. Chrysler and General Motors have also announced plans to use microprocessors in some auto models.

TV Color Organ

A new entertainment system developed by Atari, called "Video Music," electronically synchronizes images and colors to music from a stereo receiver. A cable which connects the Video Music to a stereo receiver and a switch box connected to the vhf antenna terminals of a television set allow the music signals to be conducted directly to the video screen. Five front-panel potentiometers and twelve pushbuttons on the Video Music enable the viewer to adjust the color, shape, brightness and size of the geometric image, producing an enormous number of possible picture combinations which pulse and beat to the rhythm of the music. Uses five IC's, two transistors and twelve diodes, and comes with an FCC-approved r-f switch box.

RCA To Market 4-Hour VTR

RCA has announced plans to market a home video-tape recorder made by the Matsushita Electric Industrial Co. of Japan. The new video tape recorder, called "VHS," will have a mode switch for either 2- or 4-hour recording with the same cassette, vhf and uhf tuners, and a clock for automatic recording. Moreover, a company spokesman said that optional microphones and cameras will be made available to allow consumers to produce home movies on the video tape cassettes. Thus, a VTR war for consumers' hearts appears to be shaping up between the VHS models and Sony's Betamax models, the latter, a two-hour video recorder to be marketed by the Zenith Corp. Too bad that standards are dissimilar.

An R-F People Finder

The Trakatron "Silent People Finder" by Intersonics Corp., New York, NY, is an electronic system that locates people in an office or plant without paging them. Each person has a transponder and is assigned a button on a console locator. A sensor is placed in certain desired areas. When the console's button is pressed, the proper signal goes throughout the covered areas. If the person sought is in a room with a sensor, his or her transponder unit responds, whereupon a signal goes back to the console, giving the location and telephone extension (if any). The inquirer can then either go to the area indicated or call on the extension. Shades of 1984!

Digital Watch Firsts

Intertime Corporation has introduced the latest in diving equipment, an *underwater* digital watch. Named "Maritime," the watch uses LED's to display month, week, date, hours, minutes and continuous counting seconds. Activation of a single button displays red numerals designed for easy underwater visibility, and a ratchet bezel graduated in minutes is provided for elapsed time reference. The housing is Swiss made, produced from a solid block of stainless steel. It's equipped with double "0" rings to prevent water leakage and fogging, and has been factory tested to a depth of 600 ft. $250.00.

Another innovative digital watch to be introduced is the "programmable message" model from the Solid State Products Division of Hughes Aircraft Company. The watch module features a personalized five-word, five-letter-per-word message programmed by the wearer and displayed in an electronic readout. The message can be changed as desired by the user, a procedure which takes less than five minutes. The five standard functions of month, date, hour, minute and second are also included, with five LED's providing the letter, symbol and number readouts. A spokesman for the company suggests that the watch can be used for important appointment reminders or medical instructions, among other applications.

Solar-Powered Calculator

"The Sun Man," a new solar battery-powered calculator recently introduced by Sharp Electronics, is believed to be the smallest such instrument on the market. With dimensions of 0.35" thin × 2.6" wide × 7.5" deep (9 mm × 66 mm × 109 mm), the solar-powered calculator is said to have a longer life span than the ordinary calculator battery, needing only two hours of window light to recharge. It performs six functions, and uses a liquid crystal display. $99.95.

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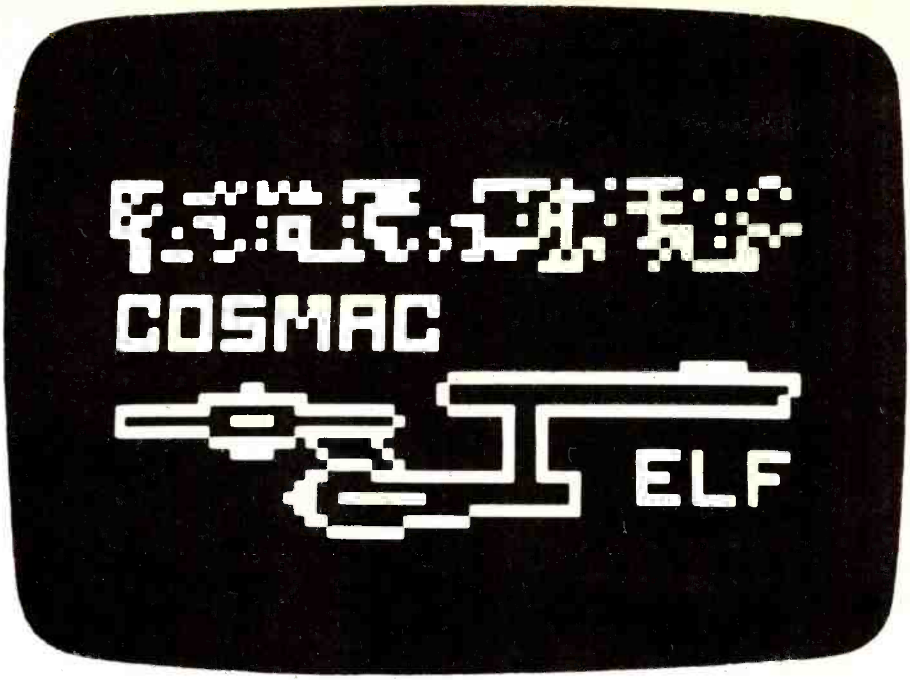


PE TESTED

BREAKTHROUGH PROJECT

BY JOSEPH A. WEISBECKER

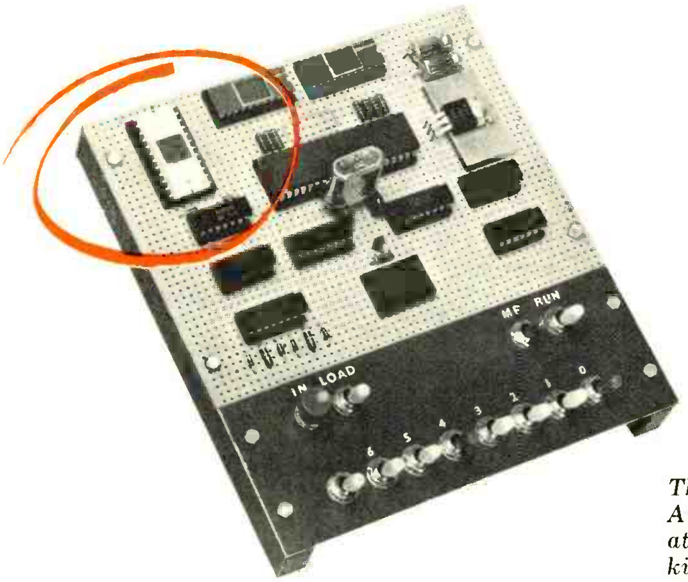
PART IV: Build the PIXIE Graphic Display

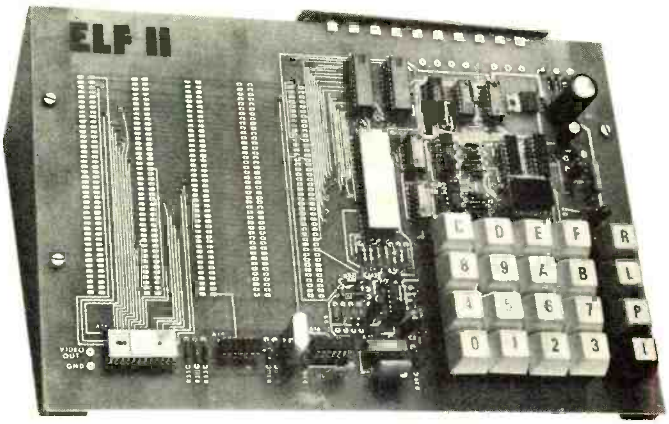
Adding one chip to the Elf provides complete video interface and animated graphics capability for less than $25.

If you own an Elf microcomputer (see POPULAR ELECTRONICS August 1976) or are planning to build one soon, the addition of a single IC and a handful of support components, and a change in the crystal frequency, can give you Pixie graphics. The entire graphics system is built into the new CDP 1861 LSI chip that sells for less than $20 from RCA parts distributors. (A complete kit is available; see Parts List.) The two other IC's in the optional add-on system are for a crystal oscillator that allows the graphics IC to generate the correct TV horizontal and vertical sync pulses.

The photo at the top of this page illustrates what can be done with the original 256 bytes of memory in the Elf when the Pixie graphics system is added. In this article, we will show you how to install and program the Pixie system to produce this type of graphics.

Some Details. The unique Pixie graphics system employs the direct memory access (DMA) capability built into the 1802 microprocessor in the Elf





The basic Elf project orginally published in the August 1976 issue of POPULAR ELECTRONICS *is shown at left with Pixie components added. Elf II is a complete kit including a pc board, hexadecimal keypad, Pixie graphics components and expansion bus (see Parts List).*

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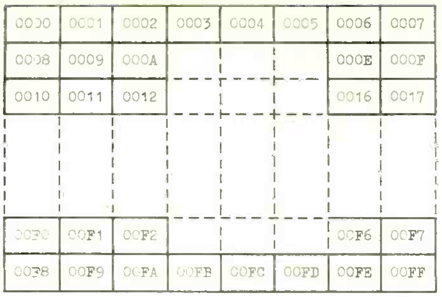

Fig. 1. Memory addresses of bytes mapped onto TV screen in sample program.

to work in conjunction with the new graphics IC. This allows you to display any 256-byte segment of memory on a CRT monitor or TV receiver. The output of the new chip is a 1-volt composite video/sync signal.

The selected segment of memory appears on-screen as an array of small squares that represent individual memory bits. If a memory bit is a 1, the appropriate square will be white, while if a bit is a 0, the square will be dark. Changing the bit pattern within the memory will change the pattern that appears on-screen. You can store several different bit patterns (pictures) in memory and,

TABLE I—TEST PROGRAM

Label	M	Bytes	Comments
Start	0000	90 B1 B2	R1.1,R2.1=00
	0003	B3 B4	R3.0,R4.0=00
	0005	F8 2D A3	R3.0=(main)
	0008	F8 3F A2	R2.0=(stack)
	000B	F8 11 A1	R1.0=(interrupt)
	000E	D3	P=3 (go to main)
Return	000F	72	restore D, R2+1
	0010	70	restore XP,R2+1
Interrupt	0011	22 78	R2-1, save XP @ M2
	0013	22 52	R2-1, save D @ M2
	0015	C4 C4 C4	no-op (9 cycles)
	0018	F8 00 B0	
	001B	F8 00 A0	R0=0000(refresh ptr)
Refresh	001E	80 E2	D=R0.0
	——	———	8 DMA cycles (R0+8)
	0020	E2 20 A0	R0-1,R0.0=D
	——	———	8 DMA cycles (R0+8)
	0023	E2 20 A0	R0-1,R0.0=D
	——	———	8 DMA cycles (R0+8)
	0026	E2 20 A0	R0-1,R0.0=D
	——	———	8 DMA cycles (R0+8)
	0029	3C 1E	go to refresh (EF1=0)
	002B	30 0F	go to return (EF1=1)
Main	002D	E2 69	X=2, turn TV on
	002F	3F 2F	wait for IN pressed
	0031	6C A4	set MX,D,R4.0=toggles
	0033	37 33	wait for IN released
	0035	3F 35	wait for IN pressed
	0037	6C	set MX,D=toggles
	0038	54 14	set M4=D, R4+1
	003A	30 33	go to M33

PIXIE ANIMATION PROGRAM

BY EDWARD C. DEVEAUX

THE PROGRAM given here can be used with the Pixie version of the Elf microcomputer to create animation graphics using only the original 256 bytes of memory. The interrupt routine uses the same timing as described in previous Elf articles. However, a counter has been added to this routine, and we load the refresh address into R0 from R4. The main line of the program has been completely rewritten and contains shift, roll, and INPUT switch read routines.

The shift routine shifts 16 lines of the display to the right one bit at a time; bits shifted off the rightmost byte are shifted back onto the display in the

```
LOC  COSMAC CODE   SOURCE LINE

                   .. AN 1802 ANIMATION PROGRAM by E. DEVEAUX
                   ..
78                 BEGSFT=#78   .. ADDRESS OF FIRST LINE SHIFTED.
                   ..
                   .. THIS PROGRAM PROVIDES VARIABLE SPEED
                   .. ANIMATION OF THE IMAGE LOCATED AT #78 to
                   .. #F7 IN MEMORY.
                   .. SPEED CONTROL IS PROVIDED BY INPUT SWITCHES.
00   90                      GHI R0          ..ZERO HIGH ORDER OF
01   B1                      PHI R1          ..R1 R2 R3.
02   B2                      PHI R2
03   B3                      PHI R3
04   B4                      PHI R4          ..R4 POINTS TO REFRESH
05   A4                      PLO R4             ADDRESS
06   F816                    LDI A.0(INTRPT)
08   A1                      PLO R1
09   F813                    LDI A.0(STACK)
0B   A2                      PLO R2
0C   F831                    LDI A.0(MAIN)
0E   A3                      PLO R3
0F   D3                      SEP R3          ..GO TO MAIN_LINE
10   01020300                DC#01020300     ..STACK AREA
13                 STACK =*-1
                   ..
                   ..THIS PROGRAM USES A MODIFIED VERSION
                   ..OF THE INTERRUPT ROUTINE THAT APPEARED
                   ..IN COSMAC ELF PART 4.
                   ..
                   ..A SHIFT ROUTINE HAS BEEN ADDED THAT MOVES THE
                   .. STARSHIP FROM LEFT TO RIGHT ACROSS THE CRT.
                   ..
14   72               RETURN:LDXA
15   70                      RET             ..CYCLES
16   22               INTRPT:DEC   R2        .. 2
17   78                      SAV             ..4 R5 COUNTS REFRESH
18   22                      DEC   R2        ..6 CYCLES, USED TO
19   52                      STR   R2        ..8 DETERMINE WHEN TO
1A   15                      INC   R5        ..10 SHIFT /ROLL.
1B   C4                      NOP             ..13
1C   94                      GHI   R4        ..15 R4 TO R0
```


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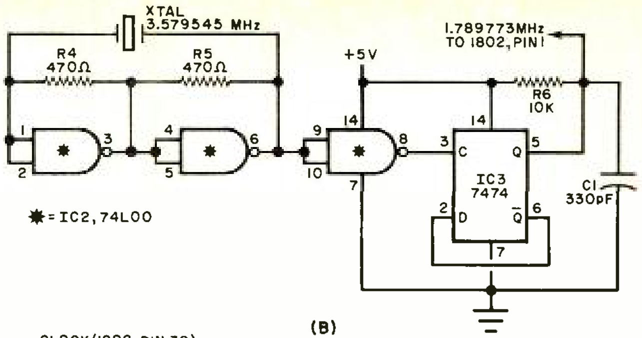
using software, display them successively onscreen to produce animation effects. Low-resolution alphanumerics can also be created.

Since the basic Elf has only 256 bytes of memory, we will show how to display the entire memory on the screen. The memory is mapped as shown in Fig. 1, in an array of 64 spots wide (eight bytes with eight bits/byte) by 32 spots high to make a total of 256 bytes.

The byte at M(0000) is displayed at the upper-left of the screen; each row on the screen is equivalent to eight memory bytes. Byte M(00FF) appears at the bottom-right of the screen.

Circuit Operation. The entire schematic diagram for the Pixie graphics display system is shown in Fig. 2A. It consists of five components: the 1861 chip, a phono jack for the video output, and three resistors. The circuit shown in Fig. 2B may be used to replace the original crystal used in the Elf microcomputer. This is necessary because, to use the graphics display, the original crystal frequency must be changed to approximately 1.760640 MHz to generate the correct TV horizontal and vertical sync pulses. Crystals of this frequency may be expensive. The Fig. 2B circuit uses a



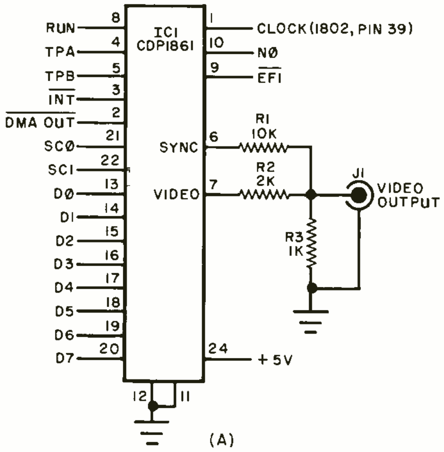


Fig. 2. Video display chip connections are shown at (A), Optional circuit to replace original Elf crystal is at (B).

"PIXIE" PARTS LIST

C1—330-pF disc capacitor
IC1—CDP 1861 video IC (RCA)
IC2—74L00 low-power quad 2-input NAND gate IC
IC3—7474 dual-D flip-flop IC
J1—Phono jack

All resistors ¼-watt, 10% tolerance:
R1, R6—10,000 ohms
R2—2000 ohms
R3—1000 ohms
R4,R5—470 ohms
XTAL—3.58-MHz crystal
Misc.—Printed circuit or perforated board; IC sockets (one 24-pin, two 14-pin); spacers; machine hardware; hookup wire solder; etc.
Note: The following are available from Netronics, 333 Litchfield Rd., New Milford, CN 06776: kit including all of above Pixie components except those under "Misc." at \$24.95; complete Elf II kit (basic Elf plus Pixie components and hexadecimal keyboard), including pc board, keyboard support IC's and expansion bus at \$99.95, plus \$3.00 shipping. Connecticut residents, add 7% sales tax.

high-order position of the first byte on the line.

The 32 lines of the display can be moved up one line by incrementing the starting refresh address by eight between refresh cycles. Decrementing register 4 (R4) allows the display to be rolled down. Hence, varying the frequency of shifts or rolls varies the animation speed of the displayed image.

Control of the speed is via the Elf's conventional INPUT switches. Setting all switches to zero and depressing the INPUT pushbutton causes a hex 00 to be read into location 13 (stack), in which case, there will be no movement of the displayed image. Loading any nonzero bit through the INPUT switches will animate the image. Any bits loaded are compared to the bits in the low-order byte of register 5 (R5). A shift or roll routine is initiated whenever there is a match between the bits of the low-order byte of R5 and the bits in the byte read into location 13. Register 5 is used to count the refresh cycles and is incremented by one every interrupt cycle.

```
1D  B0          PHI  R0          ..17 REFRESH ADDRESS
1E  84          GLO  R4          ..19
1F  A0          PLO  R0          ..21
                                 ..
20  80          GLO  R0          ..23
21  80          GLO  R0          ..25
22  80  REFRESH:GLO  R0          .. 27
23  E2          SEX  R2          .. 29   8 DMA CYCLES
                                 ..
24  E2          SEX  R2          ..
25  20          DEC  R0
26  A0          PLO  R0          ..      8  DMA CYCLES
                                 ..
27  E2          SEX  R2
28  20          DEC  R0
29  A0          PLO  R0          ..      8 DMA CYCLES
                                 ..
2A  E2          SEX  R2
2B  20          DEC  R0
2C  A0          PLO  R0          ..      8 DMA CYCLES
                                 ..
2D  3C22        BNI  REFRESH     .. ON EF1 REFRESH
2F  3014        BR   RETURN      .. IS OVER.
31  E2     MAIN:SEX  R2          .. RX=2
32  69          INP  1           .. TELL 1861 TO
                                 ... TURN ON CRT.
    ..SPREAD READS INPUT SWITCHESTO CONTROL
    ..SPEED OF SHIFTS/ROLLS.
    ..INPUT SWITCH IS STORED AT STACK M(R2).
    ..
    ..INITIAL VALUE OF STACK IS ZERO AND THERE IS
    ..NO MOVEMENT OF STAR SHIP UNTIL A NON ZERO BIT
    ..IS INPUT.
33  3F38   SPREAD:BN4   CKSHIF   .. IF NO INPUT GO SEE
35  3735   WTREAD:B4    WTREAD   .. IF TIME TO SHIFT.
37  6C          INP     4        .. READ INTO STACK.
    ..                           ..
38  85     CKSHIF:GLO   R5       .. GHI R5 VARY/SPEED
39  F2          AND              .. OF STAR SHIP.
3A  3233        BZ      SPREAD   .. SHIFT/ROLL BIT MATCH.
3C  F800        LDI     A.1(BEGSFT)  ..BR ROLL 3061
3E  B9          PHI     R9           ..ROLL NO SHIFT.
```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readily available 3.58-MHz color-TV crystal and frequency divider to generate 1.789773 MHz, which is close enough for the 1861 chip to perform properly.

The 1861 chip uses the same clock as the 1802 µP chip to trigger internal counters to provide the TV-like composite sync at pin 6. The graphics display is directly refreshed from the memory 60 times each second, accomplished by an interrupt request sent to the 1802 at the same rate.

When the 1802 receives the interrupt request, it temporarily stops the program it is executing and immediately branches to the interrupt routine previously stored in memory. This branch occurs when P is automatically set to 1 and X is set to 2. The interrupt routine program counter is always R1, which must be set to the address of the interrupt routine before the 1861 is activated and starts sending interrupts to the 1802. A pulse from NO is sent to pin 10 of the 1861, permitting this chip to start sending interrupts. A 69 instruction can be used to generate the 1861 activation pulse. The 1861 is always turned off when the Elf is stopped with the RUN switch down.

In the program shown in Table I, R1 is set to the address of the interrupt routine at M(0011), R2 is set to the address of the work area (or stack) used subsequently for byte storage, R3 is set to the main program starting at M(002D), and setting P=3 causes a branch to M(002D) with R3 as the program counter. The main program permits entry of the bytes at any time via the Elf's toggle switches. This permits you to see what is happening to the CRT screen as memory bytes are changed. The program loops on itself until an interrupt signal is generated by the 1861, activated by the 69 instruction at M(002E).

Exactly 29 machine cycles after the initiation of the interrupt routine, the 1861 requests eight sequential memory bytes by pulling down the DMA-OUT (pin-2) request line for eight bytes (eight machine cycles). This automatically causes eight memory bytes, addressed by R0, to be sequentially fetched and transferred to the 1861 via the data bus. Note that the C4 instructions at M(0015) are special no-op instructions that re-

TABLE II—SPACESHIP PROGRAM

M	Byte Sequence							
0040	00	00	00	00	00	00	00	00
0048	00	00	00	00	00	00	00	00
0050	7B	DE	DB	DE	00	00	00	00
0058	4A	50	DA	52	00	00	00	00
0060	42	5E	AB	D0	00	00	00	00
0068	4A	42	8A	52	00	00	00	00
0070	7B	DE	8A	5E	00	00	00	00
0078	00	00	00	00	00	00	00	00
0080	00	00	00	00	00	00	07	E0
0088	00	00	00	00	FF	FF	FF	FF
0090	00	06	00	01	00	00	00	01
0098	00	7F	E0	01	00	00	00	02
00A0	7F	C0	3F	E0	FC	FF	FF	FE
00A8	40	0F	00	10	04	80	00	00
00B0	7F	C0	3F	E0	04	80	00	00
00B8	00	3F	D0	40	04	80	00	00
00C0	00	0F	08	20	04	80	7A	1E
00C8	00	00	07	90	04	80	42	10
00D0	00	00	18	7F	FC	F0	72	1C
00D8	00	00	30	00	00	10	42	10
00E0	00	00	73	FC	00	10	7B	D0
00E8	00	00	30	00	3F	F0	00	00
00F0	00	00	18	0F	C0	00	00	00
00F8	00	00	07	F0	00	00	00	00

```
3F   F878   84            LDI    A.0(BEGSFT)
41   A9     85            PLO    R9              ..R9=FIRST LINE
42   F810   86            LDI    16              ..TO SHIFT.
44   A6     87            PLO    R6              ..SHIFT 16 LINES.
45   99     88    NXTLNE:GHI    R9
46   BA     89            PHI    RA          ..SAVE ADDRESS OF 1st
47   89     90            GLO    R9          ..ON LINE IN RA
48   AA     91            PLO    RA
49   F807   92            LDI    7           ..R7=BYTES TO SHIFT-1.
4B   A7     93            PLO    R7
4C   09     94            LDN    R9
4D   B8     95            PHI    R8          ..SAVE 1ST BYTE ON
4E   76     96            SHRC               ..LINE IN R8.1
4F   19     97   NXTBYT:INC   R9             ..POINT R9 TO NEXT BYTE.
50   09     98          LDN   R9             ..LOAD NEXT BYTE.
51   76     99          SHRC                 ..SHIFT RIGHT.
52   59     100         STR   R9             ..STORE BYTE
53   27     101         DEC   R7
54   87     102         GLO   R7             ..CHECK IF ALL BYTES
55   3A4F   103         BNZ   NXTBYT         ..SHIFTED.
57   98     104         GHI   R8             ..PUT BIT 0 of 8TH
58   76     105         SHRC                 ..BYT ON BIT 7 OF
59   5A     106         STR   RA             ..1ST BYT ON LINE.
5A   19     107         INC   R9             ..R9=BYTE 0 NXT LINE.
5B   26     108         DEC   R6
5C   86     109         GLO   R6             ..CHECK IF 16 LINES
5D   3A45   110         BNZ   NXTLNE         ..SHIFTED.
5F   3033   111         BR    SFREAD         ..SKP 38 ROLL AND SHIFT.
61   84     112   ROLL:GLO    R4             ..INCREMENT R4 ONE LINE
62   FC08   113         ADI   8              ..ROLL SCREEN UP.
64   A4     114         PLO   R4
65   94     115         GHI   R4             ..CHANGE LNNO 116 TO
66   F800   116         LDI   00             ..ADCI 0 7C00 IF MORE
68   B4     117         PHI   R4             ..THAN 256 BYTES.
69   3233   118         BZ    SFREAD
6B   84     119         GLO   R4
6C   B4     120         PHI   R4
6D   3033   121         BR    SFREAD
6F   00     122         DC    #00
            123 ..ENTER IMAGE TO BE SHIFTED IN LOCATIONS
            124 ..X'78' - x'F7'.
            125         END
```

The numbers in the program flow chart (right) refer to the line numbers in the program. The program can be set up to shift or roll, or shift and roll. The program is loaded into locations 78 through F7. (Try using the program for the starship shown in Table II of the Pixie article.) Only the data loaded into 78 through F7 is shifted, but the entire area from 00 through FF is rolled.

Loading the program exactly as it is listed here will enable the shift routine only. Loading a 38 (SKP instruction) in location 5F (line 111) will enable both shift and roll routines. Loading 30 61 (BR ROLL) in locations 3C and 3D (line 82) will enable only the roll routine.

After loading and running the program, animation of the display will begin after any nonzero byte is loaded via the INPUT switches and operation of the INPUT pushbutton. By varying the INPUT bit pattern, you can control the speed of the animation.

If you have never seen a stack in "motion" when a program is running, take a look at displayed location 13. Then vary the speed. ◇

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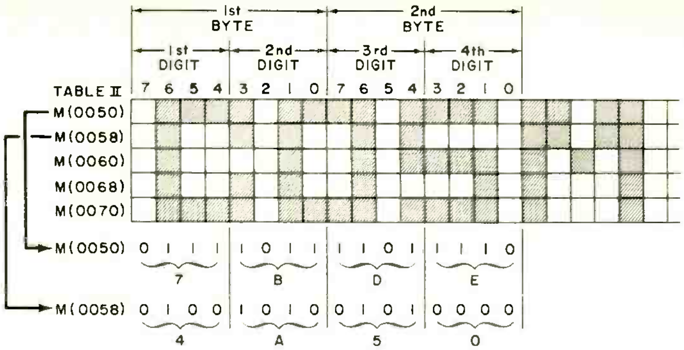


Fig. 3. Diagram showing how to create your own display. This one is for parts of five lines of Spaceship Program.

quire three cycles for each execution. These are used only to provide the delay required between the beginning of the interrupt routine and the first eight-byte DMA request generated by the 1861 display circuits.

Each of the eight display refresh bytes requested by the 1861 is internally converted to a bit serial form and used to provide the luminance (brightness) pulses that come out of the 1861 at pin 7. The actual raster display consists of 262 horizontal lines for each frame, and there are 60 frames per second. Each display spot is four raster lines high, which means that each eight-byte display row must be repeated four times. With the interrupt routine, R0 is initially set to M(0000), which means that the first DMA request causes the eight bytes from M(0000) to M(0007) to be fetched and displayed. The time of each raster line is exactly 14 machine cycles to permit the transfer of eight bytes (eight cycles) plus the execution of three two-cycle instructions during each raster line time. Following the eight DMA cycles required to refresh the first eight bytes, R0 is restored to its original value so that it remains pointing at the same eight bytes.

The E2 20 A0 instructions at M(0020), M(0023), and M(0026) are used to occupy six machine cycles between the DMA requests and to restore R0 to its initial value before incrementing it by eight during the eight-byte DMA request. The 20 instruction decrements R0.1 back to its initial value if a 256-byte page boundary was crossed during the preceding eight DMA cycles.

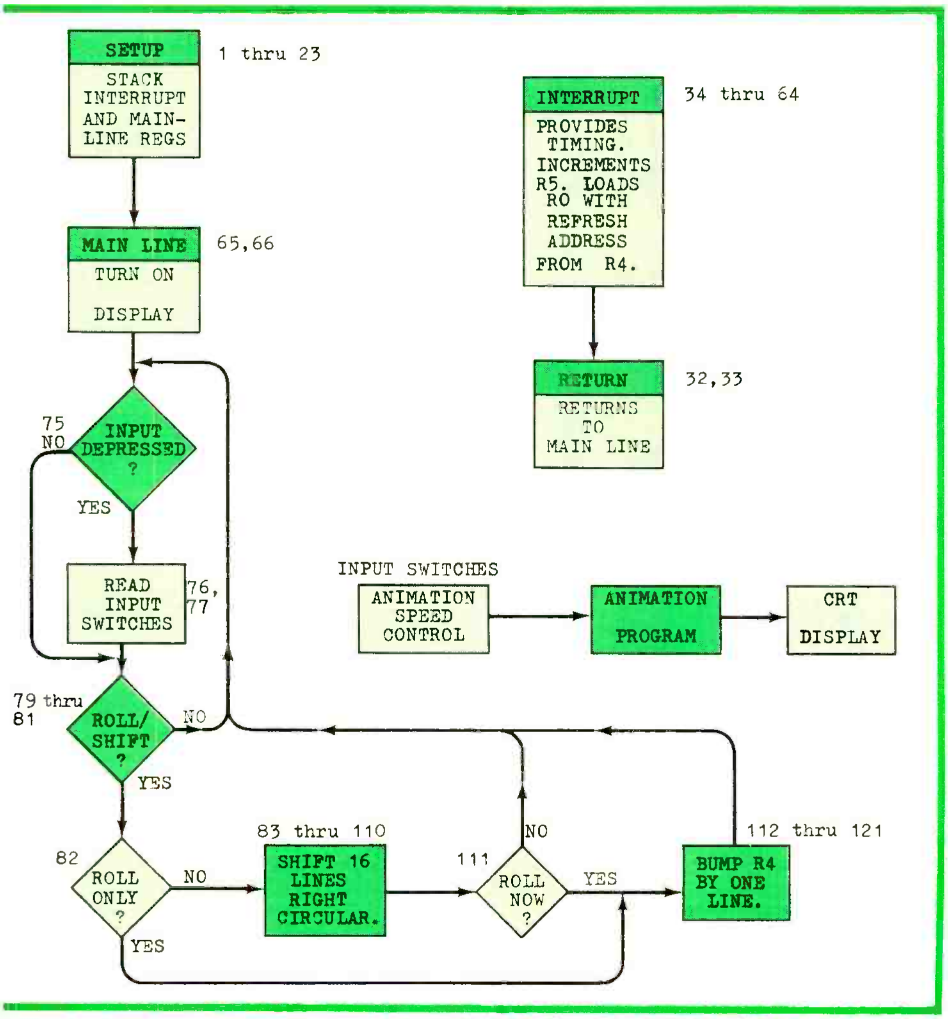
After the first group of eight bytes has been displayed for four raster line times, R0 is permitted to advance to the next group of eight bytes to be displayed. This process is continued until 32 groups of eight bytes each (256 total) have been displayed. At this time, the circuits in the 1861 chip cause line EF1=1 (at pin 9) and the interrupt routine terminates.

Other Considerations. The raster refresh involves the display of 32 groups of eight bytes, and each row of eight bytes is repeated on four raster line scans. This means that the display refresh ties up the 1802 μP for slightly more than 128 raster lines (32 × 4). Since there are 262 raster lines per frame, the μP spends about 50% of its time performing the display-refresh function.

Since the 1802 and 1861 clocks must remain synchronized, none of the three-cycle instructions described in the 1802's user's manual should be used in programs that run concurrently with this display. The only exception is the use of the C4 instruction in the interrupt routine.

The sample program given in Table I was designed to run in expanded-memory systems as well as in the basic 256-byte Elf. In the expanded system, just change the bytes at M(0019) and M(001C) so that R0 initially points to any 256-byte segment of the memory you wish to display on the raster. You can write any other main program to run concurrently with this interrupt routine.

The 1861 chip can also be used to display any number of memory bytes from eight to 1024 by rewriting the interrupt routine. For example, change the byte at M(0024) from 20 to 80, and you will see 512 bytes displayed on the CRT screen as 64 spots horizontally by 64 spots vertically. If you have only 256 bytes of memory in your system, you will see the same 256 bytes repeated twice on the screen. When displaying 512 bytes, each spot represents half the



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height of those displayed when 256 bytes are displayed.

One of the main advantages of mapping main memory directly into the monitor or TV raster is the ability to manipulate the display using the normal instruction set. In systems that employ an external frame buffer for refresh, specialized instructions are required to change buffer contents. The buffer memory also costs more money. With the refresh buffer approach toward animation, you must store two picture patterns in memory and alternately transfer them to the buffer memory. Using the Pixie graphics display described here, you store the same two-picture patterns in memory but you need only change the initial value of R0 to alternately display them. Not only do you save the cost of a refresh buffer, you can greatly simplify the programming.

Construction. The Pixie circuit can be mounted on the original Elf board by relocating the crystal and two capacitors to the center of the board. Now, the 1861 IC goes on the upper left of the board, the resistors on the bottom of the board, and the output jack on the rear apron of the chassis.

Remove the crystal from the Elf and wire the Fig. 2B frequency divider to pin 1 of the 1802 μP. Then interconnect the two boards exactly as shown in Fig. 2A and B, including the power lines. Jack *J1* can be mounted on a small metal bracket and secured to the add-on board with No. 4 machine hardware. Also, mount *R1* and *R2* on the add-on board via "flea" clips because they may have to be changed for different-value resistors to suit the modulation requirements of the particular monitor you are using.

Sample Display Program. To test the Pixie, load the program given in Table I, starting at location M(0000). When this program is run, a random spot pattern should be displayed on-screen. At this time, you may have to alter the values of *R1* and *R2* to produce a tight sync lock and the desired modulation level of the spots. These are only level-adjust resistors and play no role in the actual sync or video production. The displayed pattern represents whatever is stored in the Elf's memory. The top eight rows represent the program given in Table I.

You can familiarize yourself with the new graphics ability of your computer if you visualize a grid of 64 boxes wide by 32 boxes deep, assuming a 256-byte memory. Bear in mind that the operating program given in Table I occupies the top eight lines. Since the program ends at memory location M(003B), load 00 into memory location M(003F) to complete that line.

Now, to display the spacecraft shown in the lead photo, load the programs given in Tables I and II in that order, starting the Table II program at memory location M(0040). Reset and switch to RUN.

If you wish to create your own display, Fig. 3 illustrates how to arrive at the correct hex digits. (In this case, the example used is for a small area of the program in Table II.) Use graph paper to "draw" your picture, shading in the "spots" you want to be white on the CRT screen. Then transfer the line bit pattern into the eight hex bytes per line as shown in Fig. 3.

Conclusion. The Pixie system described here adds video graphics to your Elf microcomputer at very low cost. So far, we have described how the Pixie system can be used to put simple, stationary images on-screen. Accompanying this article is a program that will put the graphics in motion. ◇

Electronic "Bell" for a TVT-II

Lets you know when you are near the end of a line on a TV typewriter.

BY DENNIS J. DEUTSCH

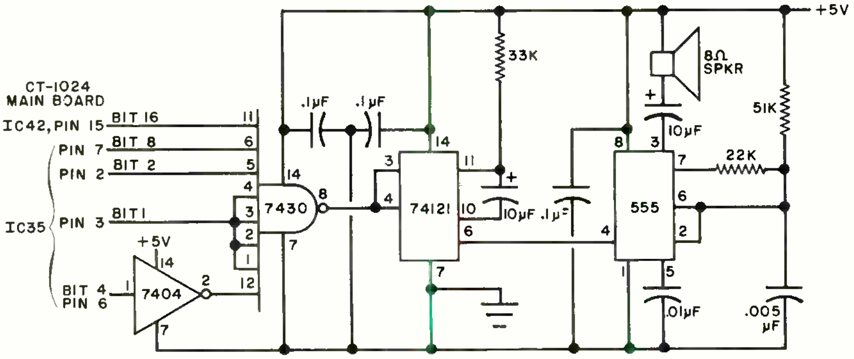
Here is an add-on circuit for the computer hobbyist that will give his set-up the effect of a bell ringing near the end of a line as it does on a typewriter. The circuit, as shown in the diagram, is for use with the Southwest Technical Products CT-1024 TVT-II terminal.

The CT-1024 produces 32 characters per line, for which access is required to bits 1, 2, 4, 8, and 16 on the CT-1024. These are located at IC35 and IC42.

The circuit as shown is set up to produce the tone on character 27. (Bit 4 is inverted in the 7404 IC so that it is "NOT'ed".) The character number trap consists of an 8-input NAND gate in the 7430 and the single inverter (which can be a single transistor if desired). If you want to stay at character 27, eliminate the inverter and bit 4.

Once the character is counted, the resulting pulse turns on the 74121 one-shot for a short period of time. The timing values of the one-shot can be altered by changing the circuit's time constant.

The one-shot triggers a 555 timer used as a tone generator to drive a small 8-ohm speaker. To alter the tone, change the value of the capacitor between pin 6 of the 555 and ground. ◇



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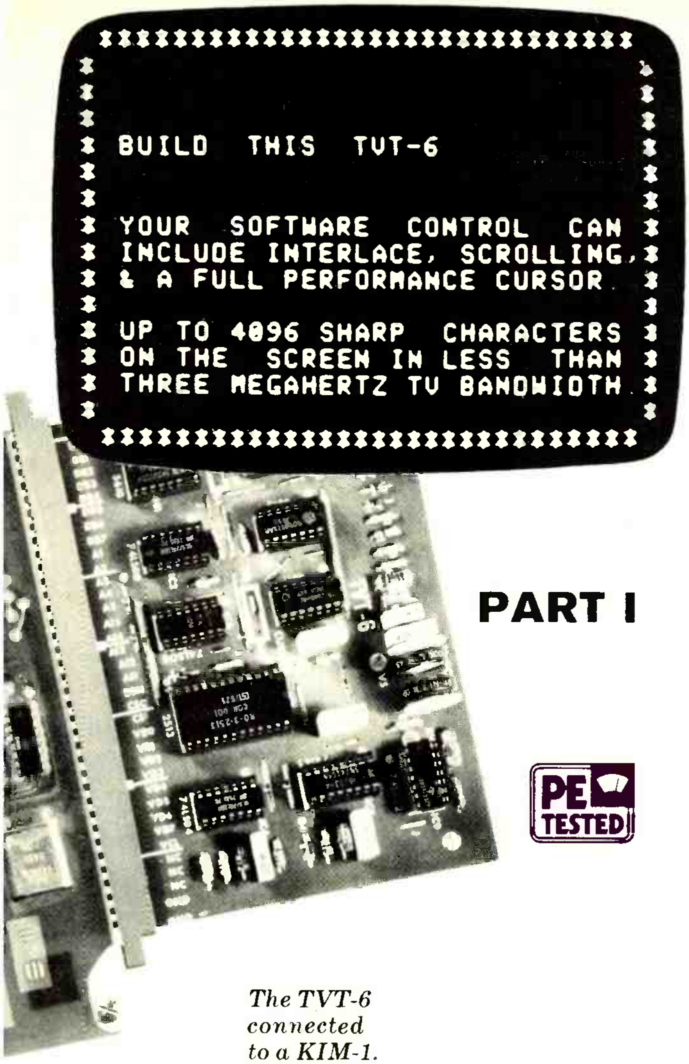

The TVT-6 connected to a KIM-1.

PART I

Build the TVT-6: A Low-Cost DIRECT VIDEO DISPLAY

$35 microcomputer "add-on" provides:

- ***User-selectable line lengths***
- ***Scrolling***
- ***Up to 4k on-screen characters with only 3-MHz bandwidth***

BY DON LANCASTER

Thanks to some software tricks, a simple and low-cost add-on circuit, and a new way to speed up a microprocessor, you can now build a video interface for your microcomputer for an investment of only $20 to $35. The TVT-6 video system described here permits the choice of virtually any format including 16/32 (16 lines of 32 characters), 16/64, or 32/64. It also features full editing capability and full-performance cursor.

In spite of its simplicity (10 low-cost IC's), the circuit employs a new approach to video processing that permits up to 4000 characters to be displayed on-screen within a 3-MHz bandwidth. Although the TVT-6 was designed for the 6502 microprocessor based KIM-1, software can be used to easily map into the JOLT, EBKA, or Ohio Scientific microcomputers. In addition, the TVT-6 can be adapted to other microprocessors, including the popular 6800, 8080, and Z80. It is easiest to use with 16-address-line systems that operate on a single 5-volt supply and 1-μs cycle time.

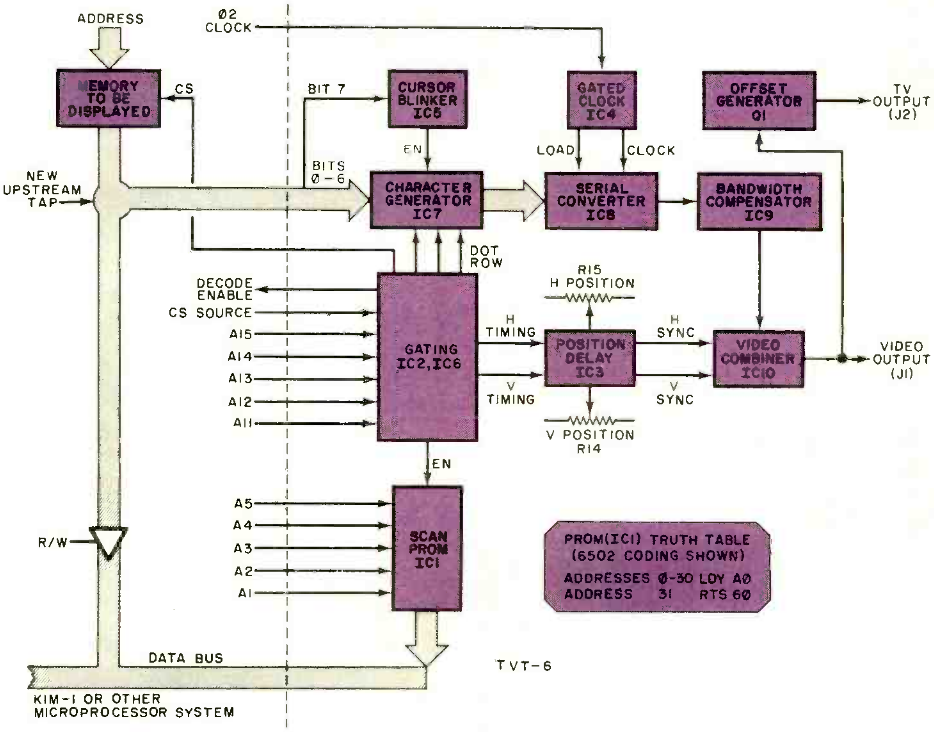

Fig. 1. TVT-6 block diagram and truth table for the PROM.

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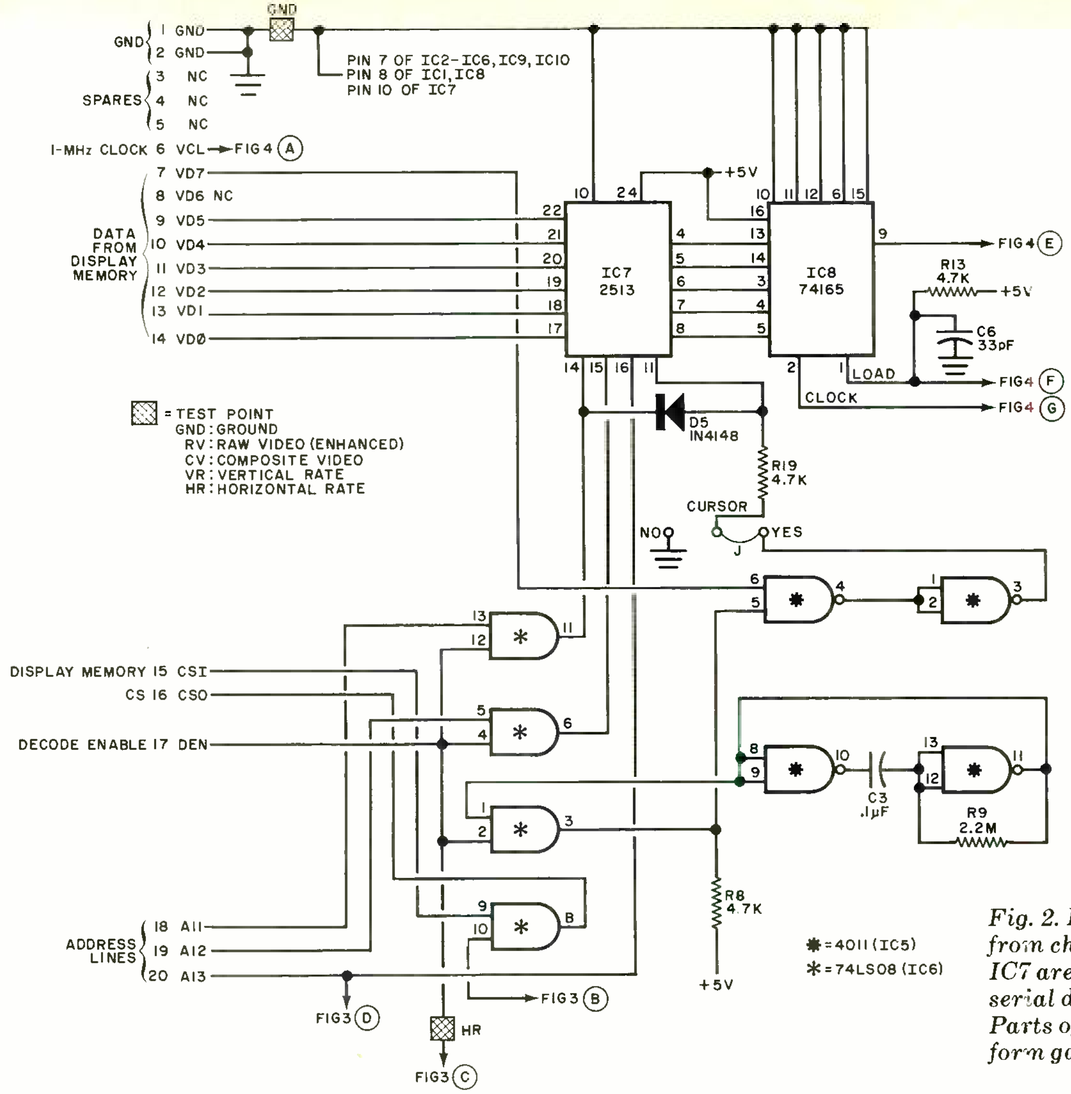

Fig. 2. Parallel outputs from character generator IC7 are converted into serial data in IC8. Parts of IC5 and IC6 form gating circuits.

Other systems will require software and microprogramming translation for their particular machine languages.

In this first of a two-part article, we will cover the hardware and construction details for the TVT-6. Next month, we will cover debugging, some useful software for the system, and provide instructions on how to couple the TVT-6 to other microprocessors.

Circuit Operation. A block diagram of the TVT-6, as used with the KIM-1 system, is shown in Fig. 1. The complete schematic diagram of the video system is shown in Figs. 2 through 4.

As shown in Fig. 1, bits ϕ through 6 from the "upstream tap" on the KIM display memory drive character generator *IC7* whose blanking and formatting are helped along by the AND gates in *IC6*. The cursor bit (bit 7) is stripped off the upstream tap and routed to cursor blinker *IC5*, which introduces a blinking cursor into the character generator's enable input.

The parallel outputs from *IC7* go to

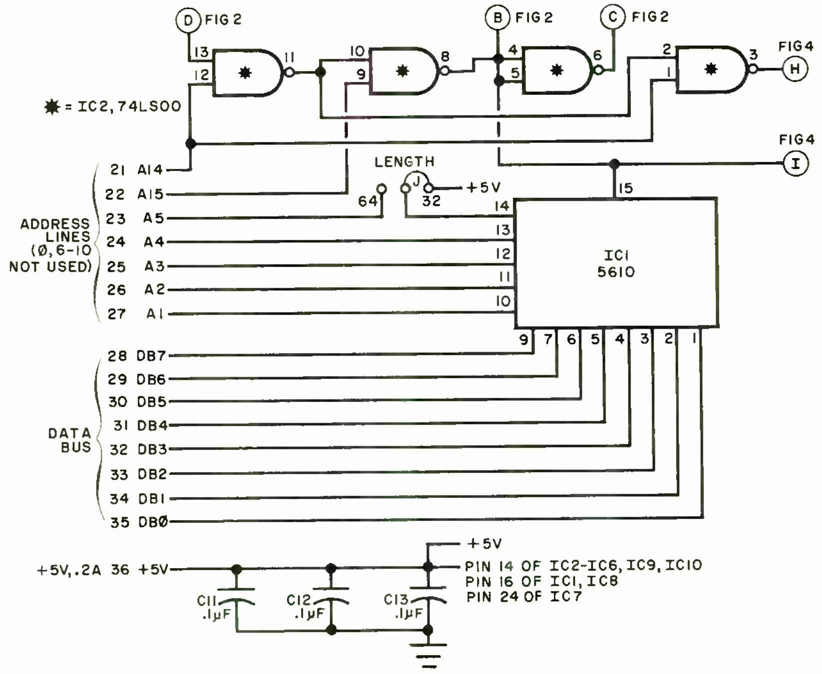

Fig. 3. New SCAN instruction uses PROM IC1, which also has the line length option in its circuit.

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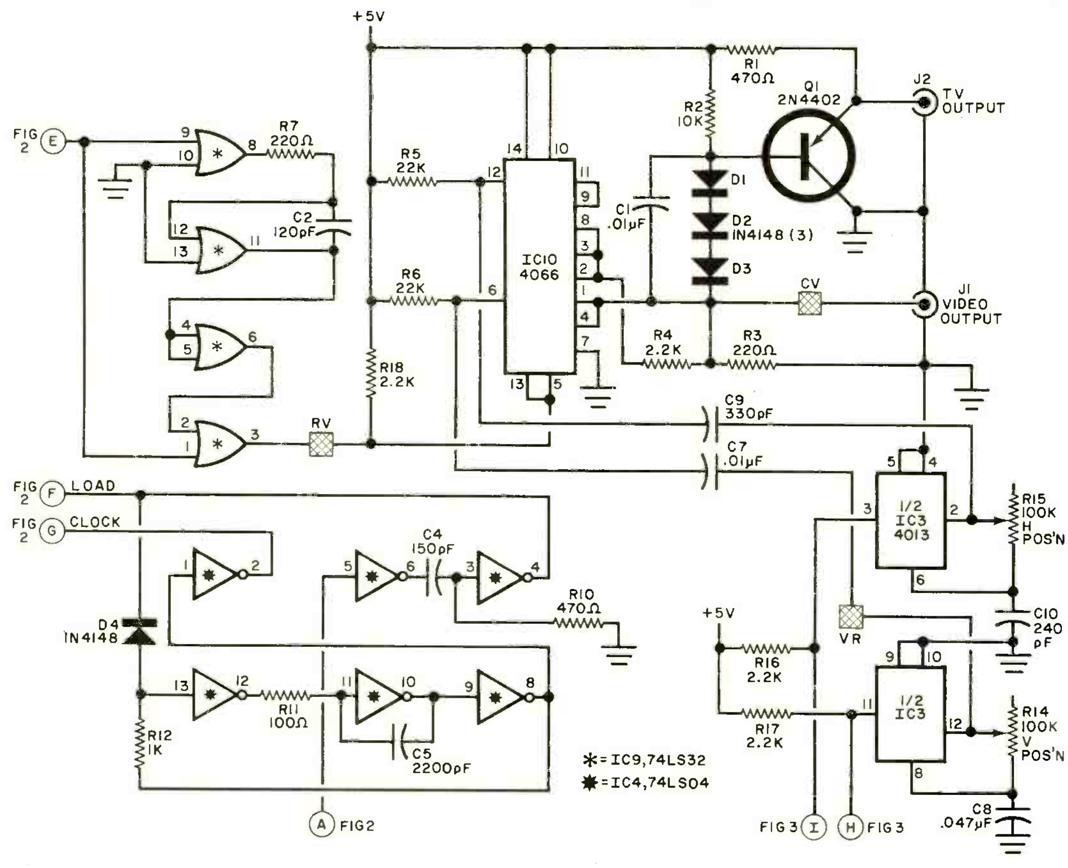

Fig. 4. Video combiner (IC10), offset generator (Q1) and sync delay circuits deliver video to TV. Gated clock (IC4) controls parallel-to-serial converter.

PARTS LIST

C1, C7—0.01-μF Mylar capacitor
C2—120-pF polystyrene capacitor
C3, C11, C12, C13—0.1-μF Mylar capacitor
C4—150-pF polystyrene capacitor
C5—2200-pF polystyrene or Mylar capacitor
C6—33-pF polystyrene capacitor
C8—0.047-μF Mylar capacitor
C9—330-pF polystyrene capacitor
C10—240-pF polystyrene capacitor
D1 through D5—IN4148 silicon diode
IC1—IM5610 32×8 PROM (or similar)
IC2—74LS00 quad tri-state NAND gate IC
IC3—4013 dual-D flip-flop IC
IC4—74LS04 hex inverter IC
IC5—4011 quad NAND gate IC
IC6—74LS08 quad AND gate IC
IC7—2513 character generator (must be single-supply type, such as General Instruments No. RO-3-2513)
IC8—74165 PISO shift register
IC9—74LS32 quad OR gate IC
IC10—4066 quad analog switch IC
J1, J2—Pc-mount phono jack (Molex No. 15-24-2181 or similar)
Q1—2N4402 or MPS6523 (Motorola) transistor
The following resistors are ¼ watt, 10% tolerance:
R1, R10—470 ohms
R2—10,000 ohms
R3,R7—220 ohms
R4,R16,R17,R18—2200 ohms
R5,R6—22,000 ohms
R8,R13,R19—4700 ohms
R9—2.2 megohms
R11—100 ohms
R12—1000 ohms
R14,R15—100,000-ohm pc-type (upright) potentiometer
Misc.—Sockets for IC's (seven 14-pin, two 16-pin, one 24-pin); 36-contact edge connector with 0.156" centers (Amphenol 225 or similar); solid hook-up wire for jumpers; insulated sleeving; test-point terminals (5); solder; etc.

Note: The following items are available from PAIA Electronics, Box 14359, Oklahoma City, OK 73114: No. PVI-1PC printed circuit board for $5.95; complete kit of all parts, No. PVI-1K, for $34.95 (specify blank or KIM-1 programmed *IC1*); KIM-1 coded cassette, with programs, No. PVI-1CC, for $5.00. All prices postpaid.

shift register *IC8*, where they are converted into a serial video signal. The clock and load commands for *IC8* come from gated oscillator *IC4*, which derives its signals from the microcomputer's clock. It is important that the correct clock phase be selected to permit the loading of *IC8* to occur when the output of the character generator is valid and settled. This is phase 2 in the KIM-1. (If you are using a different μP based computer, check this detail.)

The serial video from *IC8* goes to the TV Bandwidth Compensator in *IC9*, which predistorts the video by delaying the video output and OR'ing it against itself. This widens the vertical portions of all characters to generate clean and crisp characters that require minimum bandwidth. The amount of widening is determined by *C2* (Fig. 4). The optimum value of *C2* is obtained when the generated M or W in the video display just barely closes.

The vertical and horizontal timing signals from *IC2* in the gating circuit are delayed by *IC3*. The display positioning can be varied by potentiometers *R14* and *R15*. The vertical and horizontal sync signals are combined with the enhanced video from *IC9* into video combiner *IC10*. The output from *IC10*, available at *J1*, is composite video, with the sync tips at ground, black at 0.4 volt, and white at 1.6 volts. This output can be used to drive conventional video moni-

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tors and converted TV receivers. The video output from *IC10* is also fed to *Q1*, which is offset to deliver a +4-volt output for the white level. This output, available at *J2*, can be connected directly to the first video amplifier of most transformer-powered solid-state TV receivers (see box for details) without requiring biasing, coupling, or translation circuits.

Two options are provided with the TVT-6, both of which are jumper selected. The LENGTH option allows a choice of either 32 or 64 characters/line. The CURSOR option gives the choice of either no cursor or allows the cursor to be displayed under software control.

Construction. The actual-size etching and drilling guide for the printed circuit board used in the TVT-6 is shown in Fig. 5, along with the component-installation diagram. Start assembly by installing and soldering into place the 21 jumpers and test points. (Note that insulated sleeving must be used on two of the long jumpers.) Install the IC sockets, resistors, capacitors, diodes, jacks, and position controls *R14* and *R15*. Do not install the IC's at this time. The correct IC installation sequence and the waveforms to be observed will be discussed in Part 2 next month.

Computer Interface. Detailed in Table I are the requirements of each of the edge connector contacts on the TVT-6 and how to use each contact. Table I also contains the KIM-1 interface connection instructions. The interface consists of adding a new connector and making some add-on connections. One circuit board trace is cut on the KIM-1's pc board to permit an optional changeover switch (or jumper) to be added to the microcomputers. This permits KIM-1 to be used with or without the TVT-6.

General Operation. Since most of today's TVT circuits are used with a microprocessor or microcomputer, it is best to do as much of the display control as possible with the microprocessor and some software. What may not be obvious is that almost all of the timing in the system can also be done using the microprocessor. All this takes is a few dozen words of code.

The four key secrets of operation for the TVT-6 are:

1. Carefully choose how the address lines are defined for TVT operation.

2. Add a new instruction, which we call SCAN, to rapidly address 32 or 64 sequential memory locations.

3. Permanently connect an upstream

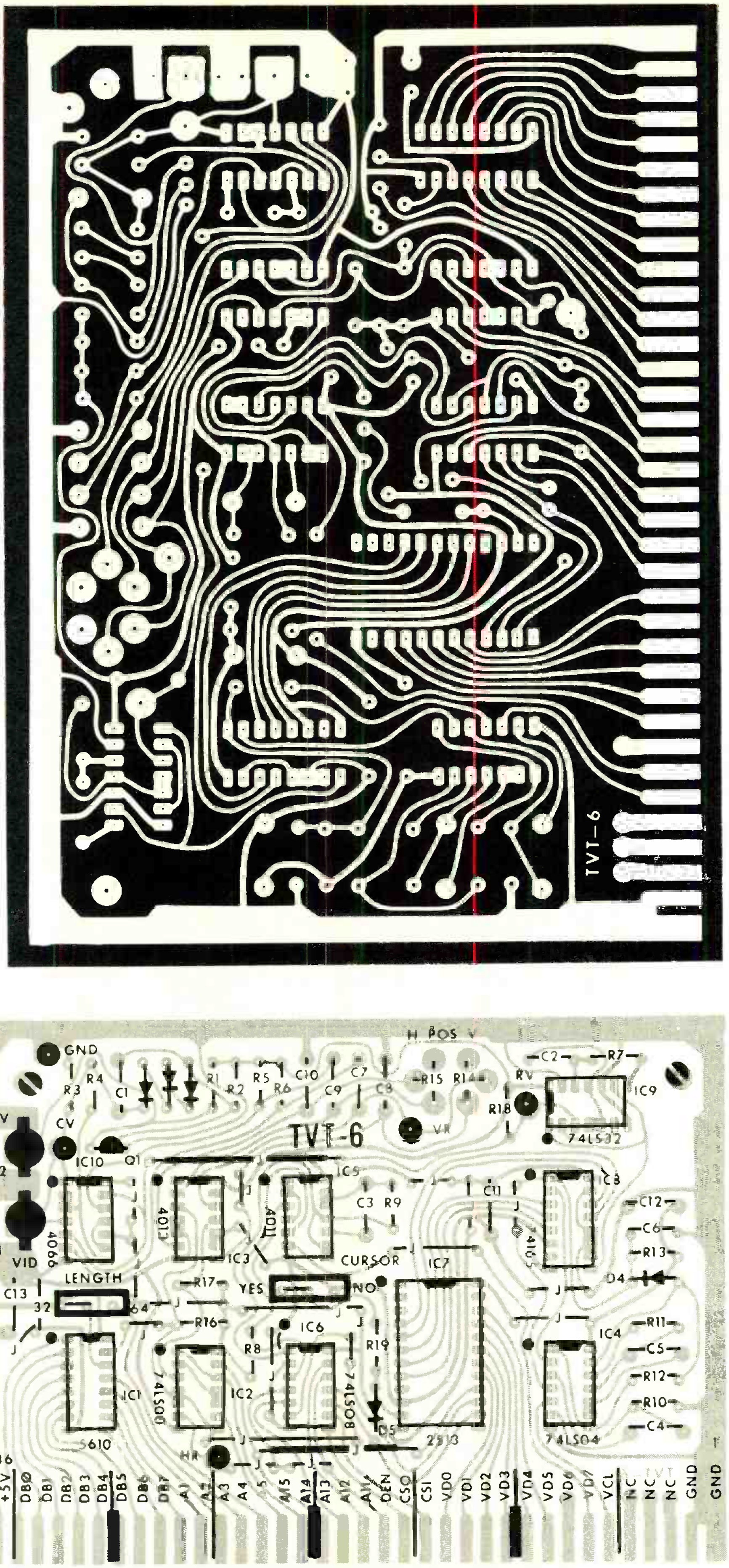

Fig. 5. Actual-size foil pattern (top) and component installation (below). Use sockets for all IC's. Edge connectors go to KIM-1.

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TABLE I
TVT-6 PINOUT AND KIM-1 INTERFACE

TVT-6 CONTACT	NAME	REMARKS
1,2	GND	Heavy wire to expansion contact 22 or similar point in KIM-1
3, 4, 5	NC	Spares
6	VCL	1-MHz clock from expansion contact U(φ2). (In other systems clock phase must be selected so that load pulse arrives when CG is valid.)
7,8,9,10, 11,12,13, 14	VD7, VD6, VD5, VD4, VD3, VD2, VD1, VDΦ	Data output from memory display; drives character generator. For KIM-1 to display any part of pages 00 through 03, connections must be made as follows: TVT-6 contact: — to pin 12 of KIM-1 IC: 7 — U5 8 — U6 9 — U7 10 — U8 11 — U9 12 — U10 13 — U11 14 — U12
15	CSI	Display memory chip select from μP; negative logic OR combined with TVT-6 chip select. From pin 1 of U4 on KIM-1.
16	CSO	Display memory chip select source; enables display memory when either TVT-6 is active or contact 15 is low. Goes to pin 13 of U5 through U12 in KIM-1 when displaying any part of pages 00 through 03. Existing Kφ connection in KIM-1 must be broken.
17	DEN	Decode enable; goes low when μP is operated in normal mode, high when TVT-6 is doing an active scan. Goes to KIM-1 Applications contact K. Any external ground on applications contact K should be removed.
18,19,20, 21,22,23, 24, 25, 26, 27	A11, A12, A13, A14, A15, A5, A4, A3, A2, A1	Address inputs from μC, positive true. Addresses AΦ, A6 through A10 not sent to TVT-6. Connections to KIM-1 expansion: KIM-1 contact: — to TVT-6 contact: N (A11) — 18 P (A12) — 19 R (A13) — 20 S (A14) — 21 T (A15) — 22 F (A5) — 23 E (A4) — 24 D (A3) — 25 C (A2) — 26 B (A1) — 27
28, 29, 30, 31,32,33, 34, 35	DB7, DB6, DB5, DB4, DB3, DB2, DB1, DBΦ	μP data bus; tri-state active high from IC1 during active scan, not used at other times. Connections to KIM-1 expansion: KIM-1 contact: — to TVT-6 contact: 8 (BD7) — 28 9 (DB6) — 29 10 (DB5) — 30 11 (BD4) — 31 12 (DB3) — 32 13 DB2) — 33 14 (DB1) — 34 15 (DBφ) — 35
36	+5V	Regulated +5-volt (200-mA) power bus; should be heavy wire. From KIM-1 expansion contact 21 or similar point to contact 36 in TVT-6.

Note: KIM-1 conversion consists of breaking one foil trace and adding a new 36-pin socket (Amphenol 127 or similar). Connection to be broken originates as KΦ(pin 1 of U4). Routing of KΦthat goes to memory chip select pin 13 of U5 through U12 should be broken. Other KΦ connections, such as that to pin 1 of U16 should remain intact. Any external ground connections to Application connector contact K (decode-enable) must be removed. All wiring should be made with a wiring pencil.

When KIM-1 is used *without* displaying video, it will behave normally and transparently as long as TVT-6 is plugged in and addresses 8000 through DFFF are not used. To restore KIM-1 operation with TVT-6 out of socket, or to use available addresses for other programs, jumper pin 15 to pin 16 and separately jumper pin 1 to pin 17 in the KIM-1. Note that this jumpering is to be done only when TVT-6 is out of its connector. I you wish, a dpdt changeover switch can be added to perform the jumpering. Switch positions should be changed only when power is off.

memory tap to the character generator and display circuit.

4. Create special software that will allow TVT-6 scanning.

All 16 address lines are used, assigned as shown in Fig. 6A for a 32-character/line system or as shown in Fig. 6B for a 64-character/line system. Address A15 is the horizontal sync pulse and the key to jumping to the new SCAN instruction. This pulse is followed in descending address order by the vertical sync (A14) and three lines (L4, L2, L1) that produce the "what row of dots do we want?" information for the character generator. The lower address lines are used to select a page of display memory and to select the character that goes into any particular horizontal and vertical location on the display.

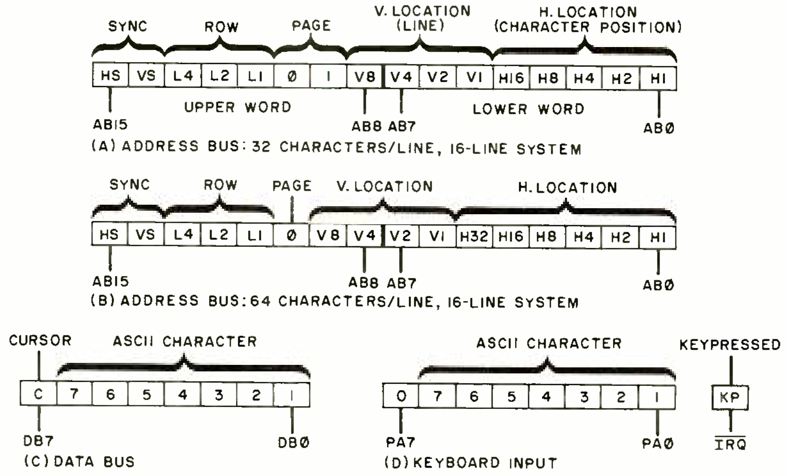

Fig. 6. Bus definitions as used with the TVT-6. All 16 address lines are used as described in text.

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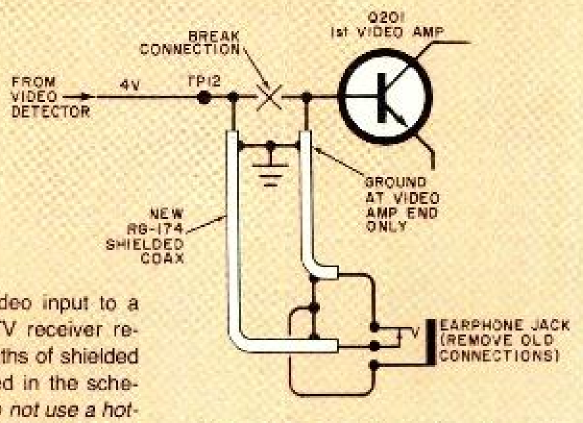
DIRECT-VIDEO INPUT CONVERSION



Adding a TVT-6 direct-video input to a small-screen solid-state TV receiver requires only two short lengths of shielded coaxial cable, as illustrated in the schematic. (Important Note: *Do not use a hot-chassis TV receiver!* Make absolutely certain that the TV receiver you use is transformer powered from the ac line.) The conversion circuit shown here is for the Sears No. 562-50260500 (Sams Photofact No. 1565-1). Other TV receivers can be modified in a similar manner.

The earphone jack in the circuit provides automatic changeover from normal receiver performance to video access. Correct bias is provided by TV output of the TVT-6. As an option, you can defeat the sound trap in the Sears TV receiver by lifting one end of capacitor *C201*.

The data within the machine (see Fig. 6C) uses the lowest seven bits as ASCII character storage. This is arranged by putting the least-significant ASCII character bit in the least-significant data slot, and so on up through the more significant bits. The eighth data bit (DB7) is reserved for a cursor. If DB7 is a zero, a character is displayed, while if it is a one, a cursor box is optionally displayed.

The existing KIM-1 keypad can be used as an ASCII keyboard for many applications, particularly for setup and debugging. If you wish to add an external ASCII keyboard and encoder, connect it to the KIM-1's parallel interface A, following the assignments shown in Fig. 6D. The seven ASCII bits go to the seven low-order data lines, while PA7 is hard wired for a zero. The keypress, or strobe, signal from the keyboard must pull the IRQ (interrupt request line) to ground for 10 μs to enter a character or machine command.

The truth table for PROM *IC1* is shown in Fig. 1. This truth table stores the SCAN instruction, activated by addresses 8000 through DFFF. When *IC1* is enabled, it causes the microprocessor's program counter to appear on the address lines for 32 or 64 consecutive scans that advance one count per microsecond. This automatically and sequentially addresses the display memory and produces exactly the data needed for a horizontal scan of TVT characters. The scan instruction runs at least twice as fast as the microprocessor normally moves, which is the key to TVT timing with a microprocessor.

To use the SCAN instruction, jump to a subroutine whose starting address is within the 8000 to DFFF range. For example, if you call JRS 8200, the SCAN instruction will deliver a horizontal sync pulse and initiate operation on the top row of characters, starting with the first character on page 2. After a selected 32 or 64 characters, the SCAN instruction automatically jumps back to the main program.

The SCAN instruction can be viewed as a "portable subroutine" because it readily moves around to automatically output the correct page and character generator's row information, starting with an easily computed JSR address. Addresses above DFFF will not activate the SCAN instruction. This includes the interrupt and reset vectors on the KIM-1 so that the operating system will work compatibly and properly with the new SCAN instruction.

There are many possible codings for the SCAN program with the limitation that the last address is a return-to-subroutine (RTS) instruction. The obvious choice of NOP or EA runs at only half speed and can't be used. Of the three dozen instructions that operate at full speed, the choice of LDY is the one that does not disturb the accumulator or its flags. This adds flexibility to other programs. The Y register can be viewed as a write-only memory in the SCAN software and we can think of the whole SCAN instruction as a group of double-speed fetch-but-don't-execute instructions. Theoretically, a 64-word PROM would be required for a 64-character line, but this can be overcome by ignoring address Aϕ and changing the PROM's address every second cycle of the machine.

Upstream Tap. The SCAN instruction will sequentially address 32 or 64 memory slots per horizontal scan line at a rate of one-per-clock cycle (1 μs). These addresses are presented to the entire memory in the computer, including the memory to be displayed. However, during the display times, the SCAN instruction and its PROM have control of the data bus so that the display memory (or anything else) cannot output information to the data bus.

The upstream tap is added as shown in Fig. 7. This tap is always outputting information to the character generator in the TVT-6. The output information is present even (and especially) when the display memory data bus drivers have been inactive. ◇

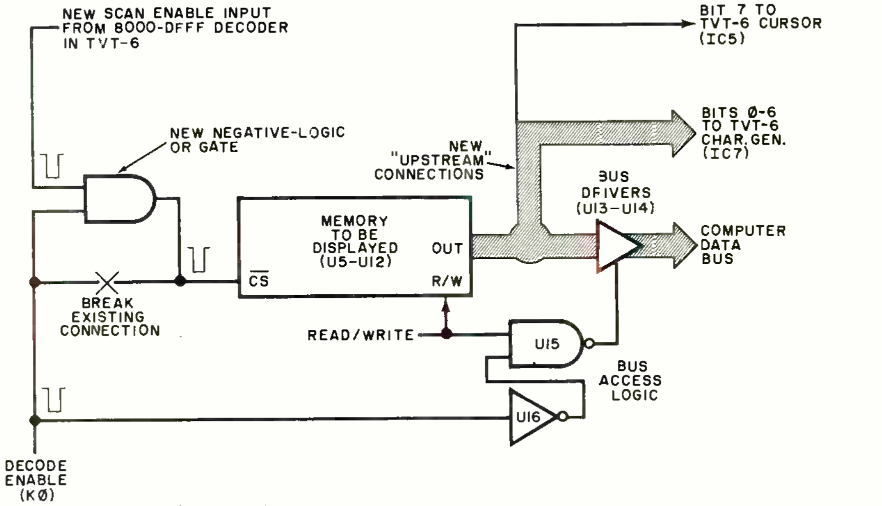


Fig. 7. Adding the upstream tap to the memory to be displayed.

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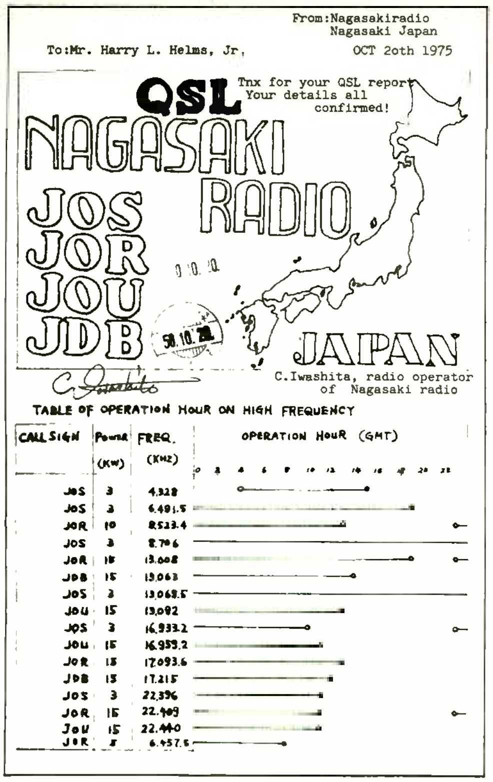

From: Nagasakiradio
Nagasaki Japan

To: Mr. Harry L. Helms, Jr.

OCT 20th 1975

QSL

Tnx for your QSL report
Your details all
confirmed!

NAGASAKI RADIO

JOS JOR JOU JDB

JAPAN

C. Iwashita, radio operator
of Nagasaki radio

TABLE OF OPERATION HOUR ON HIGH FREQUENCY

CALL SIGN	Power (KW)	FREQ. (KHZ)	OPERATION HOUR (GMT)
JOS	3	4,328	
JOS	3	6,491.5	
JOR	10	8,523.4	
JOS	3	8,706	
JOR	15	13,008	
JDB	15	13,063	
JOS	3	13,068.5	
JOU	15	13,092	
JOS	3	16,933.2	
JOU	15	16,953.2	
JOR	15	17,093.6	
JDB	15	17,215	
JOS	3	22,396	
JOR	15	22,409	
JOU	15	22,440	
JOR	5	6,457.5	

JOS, JOR, JOU, JDB (Nagasaki Radio) acknowledges reception with informal QSL which lists call signs, power (kW), frequency (kHz), and operating hours (GMT).

BY HARRY L. HELMS, JR.

END THAT "UTILITY FUTILITY"

DXing CW without knowing Morse code

If you're like a lot of SWL's, you're not getting full use of your shortwave receiver. You DX the international and tropical broadcasting bands for sure, and you probably eavesdrop on the amateurs, broadcast band, and international radiotelephone circuits from time to time. But what about those CW stations—Morse code. Tune outside the broadcasting bands and you'll find scads of those dit-dah stations dotting and dashing away around the clock. Have you ever tried your hand at DXing these stations?

Prime DX lurks in the CW utility bands! Countries such as Iceland, Bermuda, Barbados, and the Canal Zone are missing from many SWL logbooks because they are extremely difficult to hear on the broadcasting bands. But these countries and others are active. They're often heard on the CW utility bands, and they readily verify reports as well!

"But I don't know CW," you may protest. If that's all that has prevented you from DXing the dah-dit stations, *relax*. For the simple fact of the matter is that you don't have to know the code to DX and verify CW stations!

Markers Make it Easy. There's nothing magical about DXing CW stations if you don't know the code. CW stations offer a ready-made DX aid in the *marker transmission*, which is a repeated taped transmission used by a CW station to establish contact or to hold onto a frequency while waiting for traffic.

Marker transmissions often follow this general format: the tape starts with a series of the letter "V" (VVV VVV VVV, etc.) or a series of CQs (CQ CQ CQ, etc.). This is almost certainly followed by "DE," which is French for "from". Next comes the station callsign, usually repeated three times. Thus, typical marker transmissions read something like this: "VVV VVV VVV DE WXX WXX WXX" or "CQ CQ CQ DE WXX WXX WXX." The marker often contains additional items, such as the Q-code abbreviations "QRU?" ("Do you have anything for me?") or "QSX" (I am listening on _____). And often you will hear the letters "K," "SK," or "AR" sent at the end of a marker. All three are generally used to denote the end of the text of the marker. Thus you're likely to hear a marker running something like this: "VVV VVV VVV DE WXX WXX WXX QRU? QSX 6 8 12 MHZ AR." Translated, this means that station WXX is not busy at the moment and is asking listening stations if they have any traffic for WXX, and that WXX is listening on the 6, 8, and 12-MHz utility bands for a reply.

How can one translate those dits and dahs into readable letters if one doesn't know CW? The secret lies in the fact

PRIME MARITIME CW DX BANDS

4231-4361 kHz	12689-13170.5 kHz
6345.5-6514 kHz	16917.5-17255 kHz
8459.5-8728.5 kHz	22374-22624.5 kHz

CW MARKER ABBREVIATIONS & CODES

VVV	General opening for a marker; usually sent in a series of three
CQ	General call to any station, often used to start marker
DE	French for "from," precedes station callsign.
QRU?	Do you have any traffic for me?
QRX	I will call on the frequency of _____
QSX	I will be listening on the frequency of _____
QSY	I am changing frequency to _____
K	At end of marker, denotes end of message
AR	Same as K, meaning end of message
SK	Station work completed

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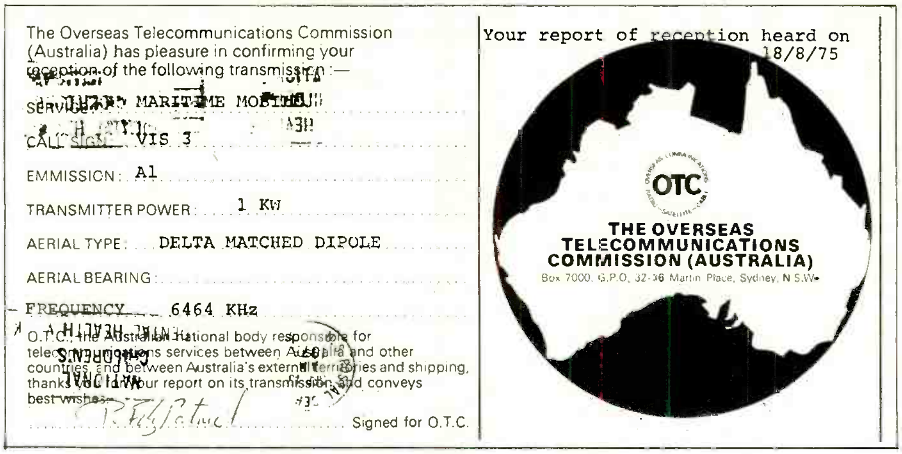
COMMONLY HEARD FOREIGN CW STATIONS

4352	NBA	Balboa, Canal Zone
6376	VPN	Nassau, Bahamas
6379	8PO	St. Philip, Barbados
6383	EAD	Madrid, Spain
6386	HKC	Buenaventura, Colombia
6393	ZLO	Waiouru, New Zealand
6439	OXZ	Lyngby, Denmark
6446	OXZ	Lyngby, Denmark
6463	HKB	Barranquilla, Colombia
6464	VIS	Sydney, Australia
6467	JCS	Choshi City, Japan
6470	IAR	Rome, Italy
6487	VRT	Bermuda
6491	PJC	Willemstad, Curacao
6491	JOS	Nagasaki, Japan
6512	TFA	Reykjavik, Iceland
8472	NMR	San Juan, Puerto Rico
8479	JCU	Choshi City, Japan
8481	VIS	Sydney, Australia
8483	DAN	Hamburg, West Germany
8511	DAL	Hamburg, West Germany
8521	VIS	Sydney, Australia
8523	JOR	Nagasaki, Japan
8530	IAR	Rome, Italy
8574	HKC	Buenaventura, Colombia
8598	OXZ	Lyngby, Denmark
8647	JDC	Choshi City, Japan
8666	OXZ	Lyngby, Denmark
8666	HKB	Barranquilla, Colombia
8666	HKC	Buenaventura, Colombia
8670	IAR	Rome, Italy
8682	EAD	Madrid, Spain
8686	JCT	Choshi City, Japan
8690	TFA	Reykjavik, Iceland
8694	PJC	Willemstad, Curacao
8710	VPN	Nassau, Bahamas
8718	8PO	St. Philip, Barbados
8718	VRT	Bermuda
8726	NMR	San Juan, Puerto Rico
12709	8PO	St. Philip, Barbados
12709	VRT	Bermuda
12718	NMR	San Juan, Puerto Rico
12832	DAF	Hamburg, West Germany
12943	ZLO	Waiouru, New Zealand
12952	VIS	Sydney, Australia
13065	EAD	Madrid, Spain
13069	TFA	Reykjavik, Iceland
17170	PJC	Willemstad, Curacao

that a marker is repeated for several minutes at a time, usually at a code speed considerably below that normally used, and the message is the same each time it is repeated. In fact, you may find some markers repeated for hours at a stretch. Thus, you need persistence and patience to bag CW DX, not code proficiency.

Your task will be greatly simplified if you have some form of tape recorder, either reel-to-reel or cassette. If you do, it helps to record several minutes of the marker. If you don't have a tape recorder, you can still log CW stations, but


The Overseas Telecommunications Commission (Australia) has pleasure in confirming your reception of the following transmission:—

SERVICE: MARITIME MOBILE

CALL SIGN: VIS 3

EMMISSION: A1

TRANSMITTER POWER: 1 KW

AERIAL TYPE: DELTA MATCHED DIPOLE

AERIAL BEARING:

FREQUENCY 6464 KHz

O.T.C. the Australian national body responsible for telecommunications services between Australia and other countries and between Australia's external territories and shipping, thanks you for your report on its transmission and conveys best wishes.

Signed for O.T.C.

Your report of reception heard on 18/8/75

OTC

THE OVERSEAS TELECOMMUNICATIONS COMMISSION (AUSTRALIA)

Box 7000, G.P.O. 32-36 Martin Place, Sydney, N.S.W.

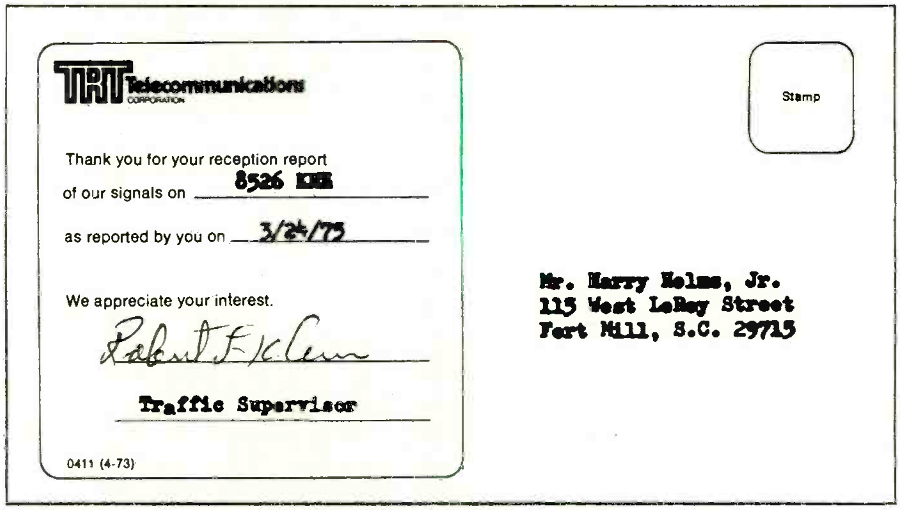
The Overseas Telecommunications Commission (Australia) sends this QSL with service, call sign, emission, transmitter power, antenna type, and frequency as part of the confirmation of one of its transmissions.

you'll have to work quickly and accurately. With practice, you'll find that it will only take a couple of minutes, even without the aid of a tape recorder.

The Morse code is a language of sound, with only two sounds to learn: the dit (a short, staccato sound) and the dah (approximately three times as long as the dit and drawn out). Forget all about dots and dashes—those are relics left over from the days of landline telegraphy—and also forget any visual code table you may have memorized. On radio, CW is *sound.*

Learn to recognize the "V" or "CQ" series that open markers by their sound in CW. A "V" comes out as "dididi*dah*" and "CQ" sounds like "*dah*di*dah*dit *dahdah*di*dah*." Memorize these sounds and practice them by repeating them to yourself or by whistling those sounds. Using this technique, you'll be able to recognize the "V" or "CQ" that indicates that you're hearing a marker. Listen carefully to the transmissions that follow the opening. Is it repeated over and over? If so, turn on your tape recorder, get a pencil and paper, and grab the code table that accompanies this article. We are now going to end your utility futility!

The next thing you are likely to hear after the "V" or "CQ" series are the letters "DE," explained earlier. In CW, they make the sounds "*dah*didit dit," and should be memorized along with "V" and "CQ." The call letters of the station are almost invariably next. Concentrate on getting the first letter. As soon as you hear it, look on our code sound table until you find the letter that matches the sound. As an example, suppose that the first sound you hear following "DE" is "di*dah*dah." As soon as you hear it, concentrate on the sound, perhaps by repeating it to yourself—"didahdah, didahdah . . ."—until you locate it on our code table. In this case, you'll find that "didahdah" represents the letter "W." So you'll now have the first letter in the station's call. Repeat this process with the next letter, and the next, until you have the station's complete call sign.


TRT Telecommunications CORPORATION

Thank you for your reception report of our signals on 8526 KHZ

as reported by you on 3/24/75

We appreciate your interest.

Traffic Supervisor

0411 (4-73)

Stamp

Mr. Harry Helms, Jr.
115 West LeRoy Street
Fort Mill, S.C. 29715

TRT Telecommunications Corporation acknowledges reception by confirming the transmitting frequency on the day and date.

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This may sound like a long and tedious process, and it may be so at first. But after a little practice you'll be able to copy the complete text of the marker within minutes. If you have trouble with the code sounds, try adjusting your receiver's beat frequency oscillator (BFO) for a different pitch.

Verifications. It's a snap to prove to the CW utility station that you heard them. Simply copy the complete text of the marker transmission and report in the usual manner. Normally it's a no-no under international law to repeat the details of a utility station transmission. Fortunately, markers are an exception. Include the date and time in GMT. Avoid using common reporting codes such as SINPO and SINFO. Plain English will do fine. Make particular note of any hum or frequency shifting of the signal.

Estimate the frequency as best you can. If you are one of those fortunate SWLs with direct-frequency readout receivers, this is no problem. But if you're like most of us and use a general coverage receiver not calibrated so accurately, estimate the frequency to the best of your ability. If you get deeply involved with CW DXing, you may find an external frequency standard that puts out markers every 100 kHz will be a good investment. They often run around $30 more or less.

It is always wise to include a prepared card with your report. Put the station call and location on the card, along with the date and time the station was heard. If you had to estimate the frequency, leave a space blank for the station operator to include the exact frequency. You might like to leave some space for the station operator to make some remarks, along with a line for a signature and station stamp. Frequently, a station will have its own QSL cards or will send a letter, but a prepared card is the best way to ensure a reply.

Included here is a list of the major CW utility bands. They're mainly used by coastal stations. Also presented is a list of commonly heard stations and the frequencies on which they have been active of late. More complete listings of CW stations can be obtained from Handler Enterprises, Box 253, Deerfield, Illinois 60015 and Gilfer Associates, Box 239, Park Ridge, NJ 07656. You might also be interested in joining a radio club that features coverage of CW DX. Three such clubs are American SWL Club, 16182 Ballad Lane, Huntington Beach, Calif., 92649; Newark News Radio Club, Box 539, Newark, New Jersey, 07101; and SPEEDX, Box E, Elsinore, Calif., 92330. Enclose a self-addressed stamped envelope with your requests for information to these clubs, and you might enclose $1 if you want to examine a sample bulletin. ◇

WHERE TO SEND CW DX RECEPTION REPORTS

KFS, ITT World Communications, Box 56, Half Moon Bay, Calif. 94019
KHK, RCA Global Communications, 223 S. King St., Honolulu, Hawaii 96804
KLB, ITT World Communications, 3620 Old Hiway 99, Marysville, Wash. 98270
KOK, ITT World Communications, 18500 S. Bloomfield Ave., Cerritos, Cal. 90701
KPH, RCA Global Communications, 135 Market St., San Francisco, Calif. 94105
WAX, TRT Telecomunications, Box 8876, Fort Lauderdale, Florida 33310
WCC, RCA Global Communications, Box 397, North Chatham, Mass. 02650
WLO, Mobile Marine Radio Inc., Box 743, Mobile, Alabama 33601
WMH, Dundalk Marine Terminal, 2700 Broening Highway, Baltimore, Maryland 21222
WNU, TRT Telecommunications, P. O. Drawer E, Pearl River, Louisiana 70452
WNY, RCA Communications Inc., 60 Broad St., New York, NY 10004
WOE, RCA Communications Inc., 8580 Lawrence Rd., Lake Worth, Florida 33460
WPA, RCA Global Communications, Box 1328, Port Arthur, Texas 77640
WSC, RCA Global Communications, Box 34, West Creek, New Jersey 08092
WSL, ITT World Communications, Mackay Marine Div., Amagansett, New York

CW CHART BY SOUND

A	didah
B	dahdididit
C	dahdidahdit
D	dahdidit
E	dit
F	dididahdit
G	dahdahdit
H	didididit
I	didit
J	didahdahdah
K	dahdidah
L	didahdidit
M	dahdah
N	dahdit
O	dahdahdah
P	didahdahdit
Q	dahdahdidah
R	didahdit
S	dididit
T	dah
U	dididah
V	didididah
W	didahdah
X	dahdididah
Y	dahdidahdah
Z	dahdahdidit
1	didahdahdahdah
2	dididahdahdah
3	didididahdah
4	dididididah
5	dididididit
6	dahdididididit
7	dahdahdididit
8	dahdahdahdidit
9	dahdahdahdahdit
0	dahdahdahdahdah
?	dididahdahdidit
/	dahdididahdit
•	didahdidahdidah

COMMONLY HEARD AMERICAN CW STATIONS

4247	KPH	San Francisco, Calif.
4274	KFS	Palo Alto, Calif.
4283	KOK	Cerritos, Calif.
4310	WNU	Slidell, Louisiana
4322	WPA	Port Arthur, Texas
4331	WSC	Tuckerton, New Jersey
4346	WMH	Baltimore, Maryland
4349	KLB	Marysville, Wash.
6376	WCC	Chatham, Mass.
6390	WAX	Ojus, Florida
6411	KLB	Marysville, Wash.
6411	WOE	Lantana, Florida
6435	WPA	Port Arthur, Texas
6463	KOK	Cerritos, Calif.
6477	KPH	San Francisco, Calif.
6495	WNU	Slidell, Louisiana
6502	WSC	Tuckerton, New Jersey
6519	WNY	New York, New York
8486	WOE	Lantana, Florida
8502	WMH	Baltimore, Maryland
8514	WSL	Amagansett, New York
8526	WAX	Ojus, Florida
8542	KHK	Honolulu, Hawaii
8558	KFS	Palo Alto, Calif.
8570	WNU	Slidell, Louisiana
8582	KLB	Marysville, Wash.
8586	WCC	Chatham, Mass.
8590	KOK	Cerritos, Calif.
8610	WSC	Tuckerton, New Jersey
8618	KPH	San Francisco, Calif.
8630	WCC	Chatham, Mass.
8642	KPH	San Francisco, Calif.
8658	KLB	Marysville, Wash.
8658	WSL	Amagansett, New York
8686	WMH	Baltimore, Maryland
8714	WLO	Mobile, Alabama
12808	KPH	San Francisco, Calif.
12844	KFS	Palo Alto, Calif.
12925	WCC	Chatham, Mass.
12993	KOK	Cerritos, Calif.
12997	WSL	Amagansett, New York

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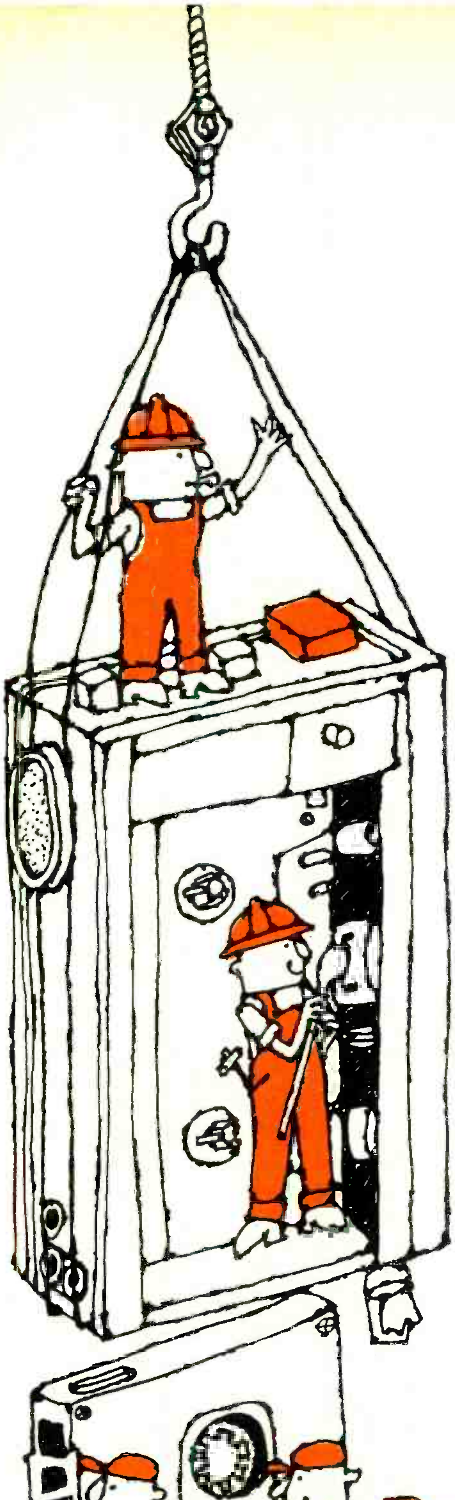

TAPE RECORDER HYGIENE

How to maintain tape recorders and tapes in peak condition.

BY CRAIG STARK

APART from inquiries about specific product recommendations, the subject of most concern to readers is how to care for their recorders and tapes.

In addition to routine household dusting, recorders need two kinds of periodic cleaning: physical and magnetic. The tape has yet to be made that does not shed *some* of its oxide particles with every playing, and unfortunately these tend to accumulate on tape heads and guides, pressure pads, and the capstan/pressure-roller drive system. If not removed, this debris can cause slippage in the drive mechanism. The resulting wow and flutter is heard as inconstancy or "graininess" in pitch. In addition, the oxide accumulations on the heads cause momentary "drop-outs" in the signal and loss of treble response.

Happily, the solution is as near as a bottle of isopropyl or rubbing alcohol and an ordinary cotton-tipped swab. If the tape you use has a brown surface, the chocolate-colored band that develops on the black pressure roller is an obvious warning that housekeeping is in order. If the tape you use has a black oxide, you will have to look more closely to see the shiny band that appears. In any case, the build-up of flaked-off oxide particles *must* be removed from *all* parts in the head assembly and anywhere the tape contacts the recorder.

Magnetic Considerations. Though unseen, residual magnetism induced in heads, guides, and capstan represents an even greater potential danger to your tape collection, and preventive or therapeutic treatment is indicated at least as often as physical cleaning. Professional studios "degauss" their machines daily (every 8 to 20 hours of operating time is the usual recommended rule of thumb) to guard against this insidious force. A magnetized component anywhere in the tape path will create some hiss and per-

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manent loss of high-frequency signal whether you're recording or simply playing back a tape.

Fortunately, head demagnetizers are inexpensive accessories available from all dealers, and using one properly takes less than a minute. Start by turning your recorder off and removing all tapes from the immediate vicinity. Remove the head covers (you should have done this already for the physical cleaning); and, holding the tape-head degausser at arm's length, plug it in, push its "on" button (if it has one), and bring it in close proximity to each of the surfaces that contact the flowing tape. Then, with the demagnetizer still on, withdraw it slowly and smoothly. Turn it off when it is at arm's length from the machine and the job is done. *Note:* to avoid any danger of scratching the tape heads, it is a good idea to put a piece of plastic tape over the tip(s) of the degausser. (Because of differences in physical design, it is not possible to get every tape-head demagnetizer to the heads of every recorder. Check with your dealer to make sure there will be no problem.)

For most audiophiles, lubrication of a recorder is best left to a yearly visit to the service technician. Too much is as great a danger as too little! Obviously, though, bearings and sliding and rotating surfaces must have lubricants. If you want to do the job yourself, follow the manufacturer's instructions carefully.

Caring for Tape. Tape care is no less important. Always keep tapes in their containers when not in use, and put tape reels on edge—*not* piled atop one another. I recommend the professional practice of leaving tapes in a *played,* not a *fast-wound* condition, for the latter tends not only to create an unevenly wound tape "pack," but also to put internal stresses on the tape layers that may cause damage. For the same reason, it's a good idea to play—not rewind—a tape at least twice a year. Avoid storing tapes next to a radiator, in the immediate vicinity (within 2 to 3 feet) of strong magnetic fields (loudspeakers, motors, or power transformers in hi-fi equipment), or in a car trunk during warm weather. Given proper care, your tapes should outlast their owner!

Accidental erasure, especially of the high frequencies, *is* something to worry about. I once ruined a $35 test tape by using a screwdriver, that I didn't know was magnetized, for some head adjustments; and a friend once tearfully played for me a master tape on which his five-year-old had momentarily placed a magnet from the kitchen memo board, "to see if it would stick." The magnet didn't, but the once-around blip did.

To assess the potential dangers, I consulted several experts and found they agreed that most fears about accidental damage from magnetic fields—generated by radar, house wiring, home appliances, power transformers, and even loudspeakers—are exaggerated.

The reasons are two formidable-sounding but relatively straightforward factors: "tape coercivity" and "the inverse square law." Coercivity is simply an index of the amount of magnetic energy necessary to erase a tape and is measured in oersteds (Oe). Tapes generally have a coercivity in the 280- to 450-Oe range, but this value is a kind of an average (some oxide particles require more field, some less, for erasure). The consensus among the experts was: a good rule for general tape safety is to keep the absolute peak level of stray fields to less than 10 per cent of the tape coercivity. For ferric-oxide tapes, this amounts to 25 to 30 Oe, and for chromium-dioxide tapes, 45 Oe. One gentleman reported measuring a magnetic field of only 10 Oe at the case of an electric drill, so it surely would be safe to use in the vicinity of most tapes. (In fact, home-appliance motors aren't that different in principle from those used in tape decks.) However, for really critical tapes, it was suggested that external fields should be kept below about 10 and 15 Oe for iron and chrome tapes, respectively, since high frequencies tend to be more easily erased.

The other factor is a function of distance. Even a bulk tape eraser that may generate a powerful 1,000-Oe field measured at a distance of ½ inch measures only one fourth that field at one inch, and one sixteenth at two inches. That's the effect of the inverse square law, and it holds, generally, for magnetic recordings. Thus, even a few inches of separation from potentially damaging fields—magnetic latches on cabinets for example—can prevent signal damage.

You can measure *steady-state* or "permanent" fields (around a speaker cabinet or from magnetized tape heads, guides, and capstans) with an inexpensive ($6.80) magnetometer from R. B. Annis, 1101 N. Delaware St., Indianapolis, Ind. 46202. Multiply your readings by ten or even a bit more on recorder parts that touch the tape directly. You'll find with speakers that the magnetic "leakage" field varies from model to model and, of course, the point on the cabinet at which it is measured. ◇

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An Introduction to Gyrator Theory

How inductors can be simulated using resistors, capacitors, and op amps.

BY BRYAN T. MORRISON

A GYRATOR, believe it or not, is an inductor without any turns of wire. Although the theory behind this interesting circuit has been established for some time, only within the past few years have synthesized inductors been used on a wide scale. Before we examine the gyrator in detail, let's review some basic properties of inductors.

A pure inductance is a circuit element whose opposition to the flow of alternating current (*inductive reactance*) varies directly with frequency. At dc or zero hertz, the ideal inductor has zero ohms of resistance (a perfect conductor) and zero ohms of reactance. Therefore, we can say that it also has zero ohms of impedance—the vector sum of resistance and reactance. However, as we move into the realm of ac, the reactance of an inductor increases according to the formula $X_L = 2\pi fL$; where X_L is measured in ohms; *f* (frequency) in hertz; and *L* (inductance) in henries. Its resistance remains zero ohms. At infinite frequency, the inductor has infinite reactance, and will permit no ac to flow.

So far we have been talking about an *ideal* inductor. Actually, every inductor has a certain amount of resistance and capacitance as well as inductance. As shown in Figs. 1A and 1B, an iron-core inductor can be modeled as an inductance in series with a resistance, *R1*; and this combination is in parallel with a capacitance and series resistance, *R2*. An air-core inductor (Figs. 2A and 2B) behaves as an inductance and series resistance *R1* would. In both cases, *L* is the inductance of the coil, and *R1* is the resistance of the wire which comprises the coil. The iron-core inductor contains two additional elements, *R2* and *C*, which represent losses within the core. With dc, there are no core losses, and consequently, our model's *C* permits no current to flow through *R2*. At higher and higher frequencies, core losses increase. Thus, in our model, increased current flows through *R2* as the capacitor's reactance decreases.

Synthesizing an Inductor. By combining resistors and a capacitor with a gain stage, we can create a circuit which appears to the "outside world" as a real inductor. To understand how, we will analyze the inductor models (Figs. 1B and 2B) in terms of "port admittance." A *port* is a point through which energy can enter or leave. In the case of an electrical circuit, it can consist of a pair of terminals to which a circuit element is connected. The inductors and their models in Figs. 1 and 2 are ports, and when a voltage source is connected across them, an imput voltage (V_{IN}) is applied an an input current (I_{IN}) flows.

Admittance, measured in *mhos*, is the reciprocal of impedance. In other words, admittance is the ratio of current to voltage. If an element's admittance is zero mhos, no current will flow through it no matter how high the voltage is across it. Such an element is a perfect insulator or open circuit. On the other hand, an element with infinite admittance will conduct infinite current, even if a low voltage source is connected across it. It is a perfect conductor or a short circuit. Combining these two terms, port admittance is the ratio of the current flowing into the port (I_{IN}) to the voltage across the port (V_{IN}).

Referring to Fig. 1B, we can see that resistors *R1* and *R2* set the limits of port impedance at both very high and very low frequencies. At dc, the admittance of the inductor *L* is infinite (a short circuit), and only *R1* limits the current through it. Capacitor *C* behaves as an open circuit with zero admittance, so *R2* is removed from the circuit. At an infinite frequency *L* is an open circuit and *R1* is removed from the circuit. However, *C* is a short circuit and current through it is limited only by *R2*. Between these frequency extremes, *L* will determine the port's admittance, because it is much larger than *C*.

The port admittance of the air-core coil at dc is simply the reciprocal of resistance *R1*, since *L* has infinite admittance. At an infinite frequency, the port admittance is zero, because the inductance acts as an open circuit, and no input current can flow.

Analyzing the Gyrator. Now let's apply these concepts to the gyrator circuits (Figs. 1C and 2C). As in the equivalent circuits, *R1* represents the ohmic resistance of the coil wire, and *C* and *R2* are core losses which increase in step with the applied frequency. However, something new has been added—a gain stage. Any active device can be used, but here we choose an op amp for its simplicity, high gain, almost infinite input impedance, and very low output impedance. The gyrator op amps are strapped for unity-gain, noninverting operation. So, within the frequency limits of the device (assume infinite bandwidth), the voltage at the output is exactly the same as that at the noninverting input.

If we apply a dc voltage across the input terminals of Fig. 1C, capacitor *C*

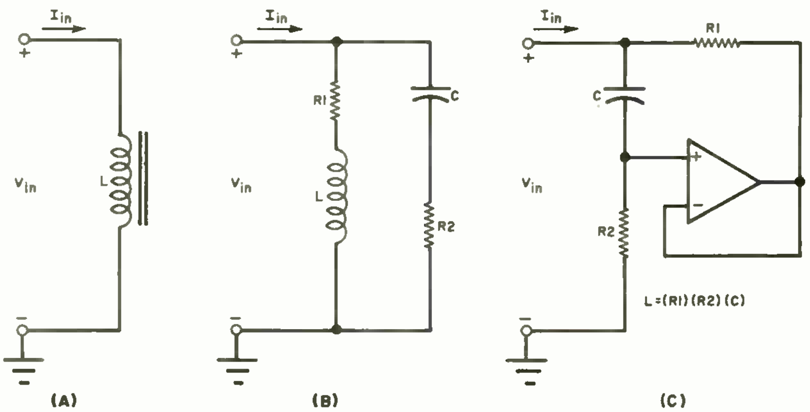

Fig. 1. Iron-core inductor (A) can be modeled as shown in (B) and simulated using the gyrator circuit in (C).

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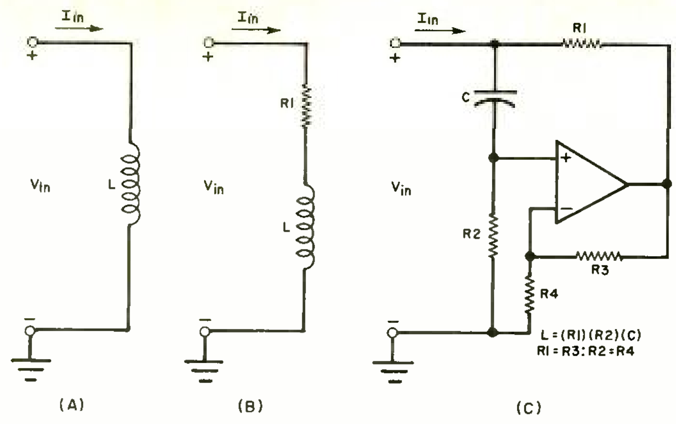

Fig. 2. An air-core coil (A) has an equivalent circuit shown in (B). Op amp gyrator (C) simulates the coil's behavior.

does not conduct, and the voltage at the noninverting input is zero. The output is also at ground potential, and because the op amp has very high output admittance (low output impedance), we can safely say that *R1* is connected across the port. So, I_{IN} will flow only through *R1*. This agrees with the behaviour of the equivalent circuit of Fig. 1B. The port admittances are maximized at dc, limited only by the values of both *R1*'s (assumed to be equal).

At infinite frequency, *C* is a short circuit, and therefore the voltage at the op amp's noninverting input (as well as that at the output) is equal to V_{IN}. Since there is no voltage drop across *R1*, it is effectively removed from the circuit. The only admittance path is through *R2* to ground, which is the same behavior we noted in the equivalent circuit.

For frequencies between zero and infinity, *C* and *R2* act as a high-pass filter, causing less and less voltage drop across *R1* as frequency increases, and thus less port admittance until *R2*'s limiting effect comes into play. The reactive characteristics of the capacitor have successfully been inverted or gyrated so that the port behaves as an inductor. The equivalent inductance in henries is expressed by the formula $L = (R1)(R2)(C)$, with resistances in ohms and capacitance in farads.

With the addition of two resistors, an air-core inductor can be simulated. Air-core coils have essentially no "core" loss, and therefore have no parallel resistance in their equivalent circuits. Because of this the gyrator (Fig. 2C) uses the additional resistors to set the gain of the op amp. When the values are properly selected, they provide enough gain to compensate for *R2*'s losses at high frequencies. But the amount of gain must be carefully chosen—otherwise the circuit might oscillate! If *R3* equals *R1* and *R4* equals *R2*, the circuit will be stable and exhibit no parallel resistance. In practice, however, little is gained over the circuit of Fig. 1C as long as the ratio *R2/R1* is at least 90 to 100, because the effects of parallel resistance are negligible in most audio applications commonly encountered.

PROPERTIES OF GYRATORS

Advantages

1. Immunity to ambient magnetic fields; no coupling or crosstalk between "inductors."
2. Very small size required for large values of inductance.
3. Inexpensive, use readily available components.
4. Accurately predictable "saturation" levels.
5. Parameters can be fixed by choice of resistors.

Disadvantages

1. Active device generates noise (can be held to low levels if proper devices are selected).
2. More complex circuits are required to simulate "floating" inductors.
3. Inductors with low series resistance and high current handling characteristics are difficult and impractical to simulate, as the circuits require high-power active devices.
4. Simulated inductors are frequency limited by their active devices' usable bandwidths and slew rates (not a problem at audio frequencies in most cases).

Practical Design. In synthesizing a useful "inductor," the same basic rules that govern the optimization of wound coils should be followed. For example, series resistance *R1* should be kept as small as possible and parallel resistance *R2* as large as possible. This corresponds to a coil wound from the heaviest wire practicable on the least lossy core available. For best performance, *R1* should be no lower than the op amp's minimum recommended load resistance, which falls between 100 and 2000 ohms for common op amp types. The largest acceptable value for *R1* is desirable, so as not to load the op amp too much, thus preventing high distortion and heating effects. To simulate a high-quality toroidally wound coil, *R2* should be at least 100 times greater than *R1*, but not so large as to become a major contributor to the op amp's input noise. As a rule of thumb, keep *R1* around 1000 ohms and *R2* between 10 kilohms and 1 megohm.

Once the values of *R1* and *R2* have been chosen, use the formula $C = L/(R1)(R2)$ to find the required capacitance in farads. At least 100 pF should be used to avoid the detuning influences of stray capacitances.

It is important to keep the op amp functioning within acceptable circuit and signal parameters. If for any reason it begins to deviate from the role of a voltage follower, the "inductor" won't work properly. Input signals must lie within the operating bandwidth of the device, and their amplitudes must not cause the output stages to clip. In a gyrator, clipping in the gain stage is analogous to core saturation, which can cause high distortion levels.

However, this is not usually a problem with gyrators. Because they will most often be operated from the same power supplies that other audio stages use, they will not start to clip until the other amplifiers do. Unlike iron-core coils, whose saturation characteristics are functions of core material, size, number of turns, and applied current, the gyrator's saturation point is accurately predictable, and does not occur before the other active stages of the system also saturate or clip.

Using either of the gyrators we have examined will result in high-quality coils with inductances ranging from millihenries to hundreds or thousands of henries. Commonly available parts—including relatively small capacitors—can be employed. Added benefits include high magnetic field immunity and saturation characteristics, and (paradoxically) small amounts of required printed circuit board "real estate." However, there is one limitation. The gyrators we have described are single ended. That is, one side is grounded. To simulate "floating" inductors, neither side of which is connected to ground, more complex circuits using two op amps can be designed. But such gyrators are beyond the scope of this article. ◇

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That dead cell may not be completely gone. A properly applied high current can often clear a fault, making the cell useful again.

BY DOUGLAS C. MYERS

THE NICKEL-CADMIUM cell is a paradox. Capable of being charged many hundreds to many thousands of times, it occasionally fails long before its claimed life cycle comes to an end. Most people simply replace a cell that has failed with a new cell. Considering that most Ni-Cd cell failures are reversible, this is a waste of money.

In this article, we will discuss the most common reason for early Ni-Cd cell failure and how the great majority of all failures can be reversed. The procedure described here will restore just about any dead Ni-Cd cell to provide its entire claimed useful life.

Why Cells Fail. In general, most devices powered by Ni-Cd cells employ more than a single cell. As the battery of cells is discharged and recharged, the time available between recharges reduces. Almost invariably, this is due to the weakening of a single cell in the battery.

To understand the cause of such a failure—one cell "dead" while the others are still good—refer to Fig. 1, a schematic of a typical Ni-Cd power supply for small battery-powered devices. Without the charging source connected to the circuit, the 200-ohm load "sees" 5 volts and draws 25 mA from the battery of cells. Since each cell must pass the entire 25 mA and each cell's potential is 1.25 volts, Ohm's Law tells us that each cell sees the equivalent load of 50 ohms. Ideally, the four cells deliver identical performance and, hence, share the load equally.

In practice, no four cells in a battery

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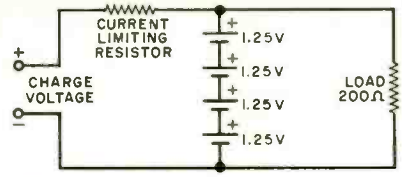

Fig. 1. Schematic of a typical NiCd supply for a small load.

ever exhibit exactly the same output voltage. Assume that one cell is delivering only 1.20 volts, while the other cells are delivering their rated 1.25 volts. Now, the 200-ohm load sees 4.95 volts and draws 24.75 mA. Since all four cells must pass the entire 24.75 mA, each of the strong cells at 1.25 volts sees an equivalent load of 50.5 ohms. This means that the weak cell sees only 48.5 ohms. While this does not seem to be too unequal a distribution, note that the weak cell is working into the heaviest load and, as a result, will discharge more rapidly than the other cells in the battery. Similarly, when the cells are recharged for only a short period of time, the weak cell, which has been working the hardest, is also the one that receives the least charging power.

This unequal loading and recharging is of little consequence in normal operation. The inequality is small for any given charge or discharge cycle, due to the relatively flat output voltage Ni-Cd cells exhibit over most of their range. And a good charge tends to equalize any energy differences between cells. However, during heavy usage, one is tempted to "quick charge" the battery just enough to restore service. A combination of shallow charges and deeper-than-normal discharges tends to exaggerate the energy difference between a weak cell and the other cells in the battery system. Operated continually in this manner, the weak cell inevitably reaches its "knee," the point at which its voltage decreases sharply, long before the other cells reach the same point.

At the knee, the picture changes dramatically. Suddenly, the weakest cell sees an increasingly heavy load, which causes its voltage to drop even faster. This avalanche continues until the cell is completely discharged, even as the other cells continue to force current to flow. The inevitable result is that the weak cell begins to charge in reverse, which eventually causes an internal short.

Once an internal short develops, recharging the cell at the normal rate is futile. The short simply bypasses current around the cell's active materials. (Even though the cell is apparently dead, most of its plate material is still intact.) If the small amount of material that forms the short could be removed, the cell would be restored to virtually its original capacity once again.

Clearing the Short. Using the circuit shown in Fig. 2, the internal short can be burned away in a few seconds. In operation, energy stored in the capacitor is rapidly discharged through the dead cell to produce the high current necessary to clear the short. Current is then limited by the resistor to a safe charge rate for a small A cell.

Several applications of discharge current are usually necessary to clear a cell. During the "zapping" (restoration) process, it is a good idea to connect a voltmeter across the cell to monitor results. Momentarily close the normally open pushbutton switch several times to successively zap the cell, allowing sufficient time for the capacitor to charge up between zaps, until the voltage begins to rise. Then, with the toggle switch closed, watch as the potential across the cell climbs to 1.25 volts. If the potential

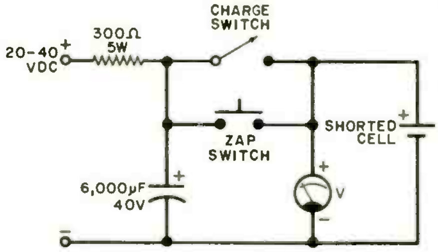

Fig. 2. Shorted cell is cleared by energy stored in capacitor.

stops before full voltage is reached, some residual short still remains and another series of zaps is in order. If you observe no effect whatsoever after several zaps and shorting out the cell and taking an ohmmeter measurement indicates a dead short, the cell is beyond redemption and should be replaced.

Once full cell potential is achieved, remove the charging current and monitor battery voltage. If the cell retains its charge, it can be returned to charge and eventually restored to service. But if the cell slowly discharges with no appreciable load, the residual slight short should be cleared. To do this, short circuit the cell for a few minutes to discharge it, zap again, and recharge it to full capacity.

Not all Ni-Cd cells can be restored by the method described here, but most can. After restoration, a cell's life expectancy will be roughly the same as that of the other cells taken from the same service application. ◇

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Build a PINK NOISE GENERATOR for AUDIO TESTING

Uses a new MOS noise generator IC.

BY DENNIS BOHN

AN INCREASING number of audiophiles are incorporating graphic equalizers into their hi-fi music systems. The new component is most often used as a "super" tone control that offers a degree of frequency response compensation beyond the capabilities of bass and treble controls. However, adjusting 10 to 30 controls to compensate for acoustic deficiencies in the listening room can be challenging. This project—a pink noise generator—makes the job a little easier. It provides a reference signal for performing equalizer adjustments, and uses just one IC and a few passive components.

The IC, National Semiconductor's MM5837, is a digital pseudo-random sequence generator which will produce a broadband white noise signal for audio applications that's converted to pink noise by a passive filter. Unlike traditional semiconductor junction noise sources, the MM5837 provides uniform noise quality and output amplitude. Although it was originally developed with electronic organs and synthesizers in mind, it is equally suited to room equalization applications. A block diagram of the MM5837 is shown in Fig. 1.

White vs. Pink Noise. The output of the MM5837 is broadband white noise. Since pink noise is used in most audio work, it is helpful to understand the difference between the two.

White noise is a composite signal with contributions from all frequencies and a spectral density substantially independent of frequency (equal energy per constant bandwidth). It is characterized by a 3-dB increase in amplitude per octave of frequency change. In comparison, pink noise has a flat amplitude response per octave of frequency (equal energy per octave). Pink noise allows correlation between successive octave equalizer stages by insuring that the same amplitude of input signal is used for each as a reference.

The network required to convert white noise to pink noise is simply a −3-dB/octave low-pass filter; but it presents an interesting problem in circuit design. If capacitive reactance (and thus the response of a simple RC or first-order filter) varies at a rate of −6 dB/octave, how can a slope of less than −6 dB/octave be obtained? The solution lies in cascading several stages of lag compensation so that the zeros of one stage partially cancel the poles of the next stage. Such a network, shown in Fig. 2, has a −3-dB/octave characteristic (±¼ dB) from 10 to 40,000 Hz.

The complete pink noise generator in Fig. 3 gives a flat spectral distribution (per octave) over the audio band from 20 to 20,000 Hz. An 11.5-V p-p random pulse train appears at pin 3 of the IC, and is attenuated by the filter. The actual output across *C5* is about 1 V p-p ac of pink noise riding on an 8.5-V dc level.

Construction. Since the circuit is fairly simple, it can be constructed on a small circuit board using printed circuit, point-to-point wiring, or Wire-Wrap techniques. Resistors in the filter network should have close tolerances. Premium-grade tantalum and polystyrene, ceramic, and film capacitors are recommended. Observe standard precautions in handling the MOS device, and use an IC socket or Molex Soldercons. ◇

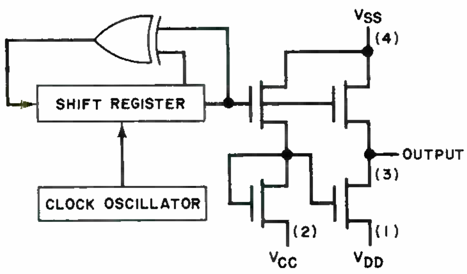

Fig. 1. Block diagram of the MM5837 noise source.

PARTS LIST

C1—1-μF, 35-V tantalum capacitor
C2—0.27-μF, 35-V tantalum capacitor
C3, C4—0.047-μF capacitor
C5—0.033-μF capacitor
C6—100-μF, 35-V electrolytic capacitor
IC4—MM5837 noise generator IC
R1—6800-ohm, ¼-W, 5% resistor
R2—3000-ohm, ¼-W, 5% resistor
R3—1000-ohm, ¼-W, 5% resistor
R4—300-ohm, ¼-W, 5% resistor
Misc.—Circuit board, 15-volt regulated supply, output jack, output connector, IC socket or Molex Soldercons, hookup wire, solder, suitable enclosure, etc.

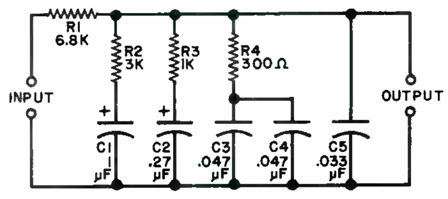

Fig. 2. Low-pass filter with −3-dB/octave response.

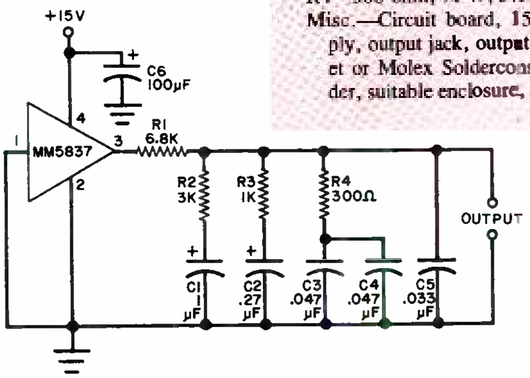

Fig. 3. Schematic diagram of the pink noise generator.

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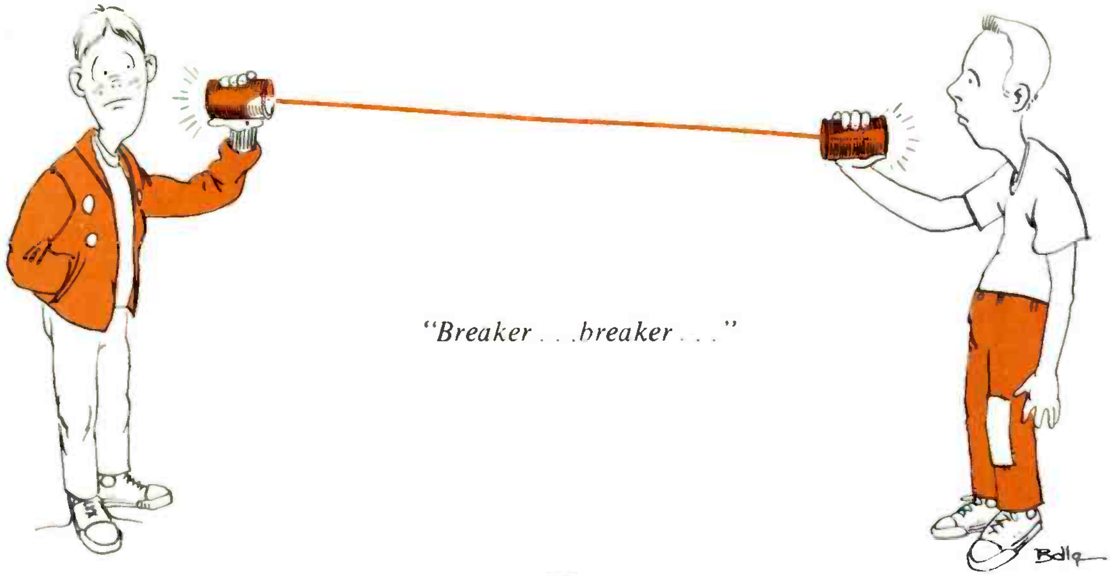
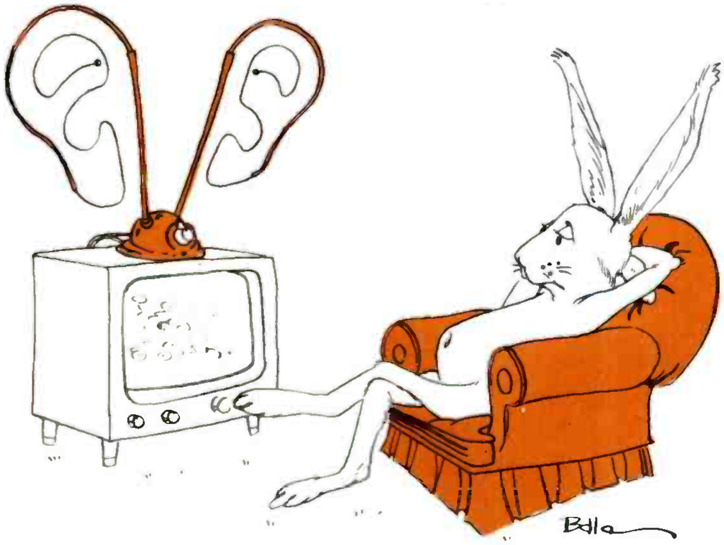
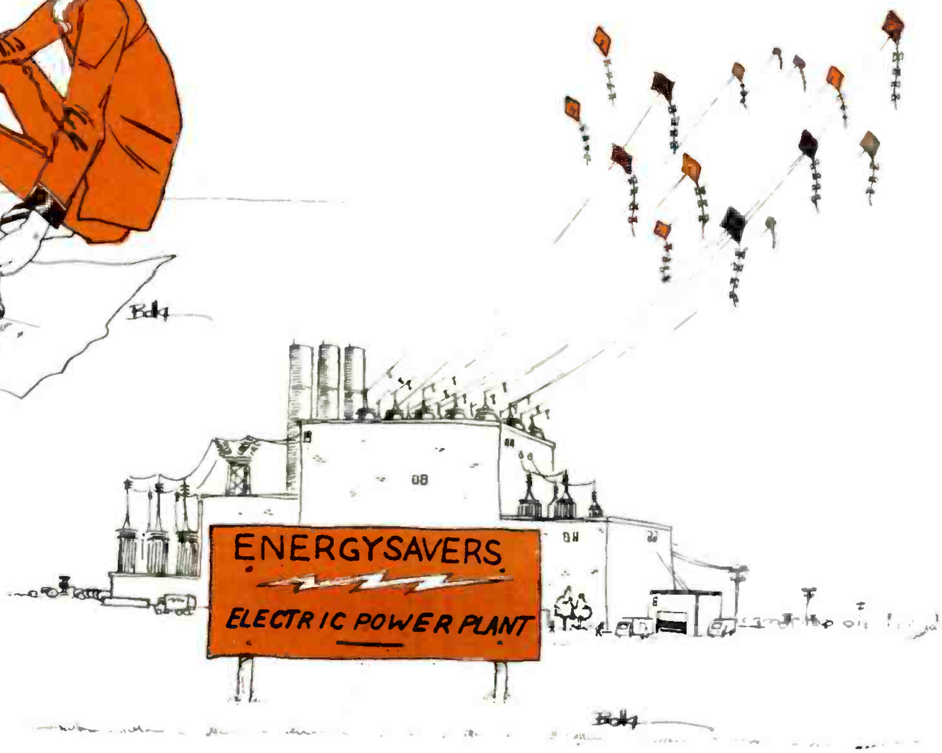


"Breaker . . . breaker . . ."

The World of Electronics

BY FRANK BOLLE





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AVERAGE, PEAK, AND RMS VALUES

What is meant by the various ways of specifying ac potentials and currents.

BY HECTOR FRENCH.

WHEN dealing with dc potentials, there is no ambiguity about what *kind* of voltage is meant. A dc volt is a dc volt. When it comes to ac voltage, however, the picture is very different and often confusing. For example, a potential specified as 100 volts ac has little or no meaning unless it is followed by an identifier like "peak," "rms," "average," or "effective," each of which has a different meaning from the others.

To illustrate what we mean, consider your common 117-volt ac power-line potential. This figure specifies the rms voltage of the power line. The peak potential is actually 164.66 volts, which is 39.8% greater than the rms potential. The average potential, at 11% lower than the rms potential, is 104.52 volts.

The peak voltage is the maximum potential of the entire waveform. This voltage is extremely important for designing the insulation of high-voltage ac circuits. An 11,500-volt (rms) line, for example, has a peak potential of 11,500 + 4577 = 16,077 volts. That difference of more than 4500 volts must be considered when specifying components.

The peak potential is easy to find with the circuit shown in Fig. 1.

The capacitor charges up to the peak voltage during the first positive alternation of the ac input. The charge then slowly drains off through the resistor until the next positive alternation comes along. (For a negative output, the diode and capacitor are simply reversed.)

The average voltage is important for two different reasons. First, it is easy to find with simple circuits. Second, it is reliably close to the rms voltage with sine waves. The basic circuit for finding the average ac voltage is illustrated in Fig. 2.

In this case the output is a series of half-waves of the same polarity. (Again, to change the output voltage polarity, simply reverse the diodes.) A meter placed between the output point and ground provides the reading and is usually calibrated with a scale that is compressed just the right amount to give a relatively accurate rms reading with sine-wave signals. This is the type of circuit used in most ac voltmeters ranging from inexpensive portable to expensive laboratory instruments.

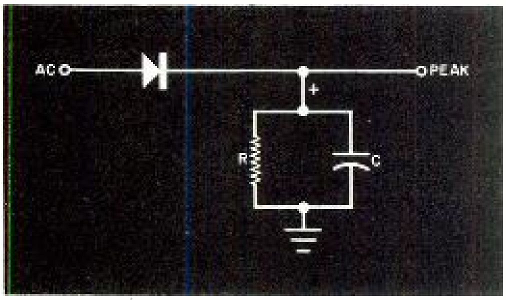

Fig. 1. Simple RC and diode circuit is used to find peak potential.

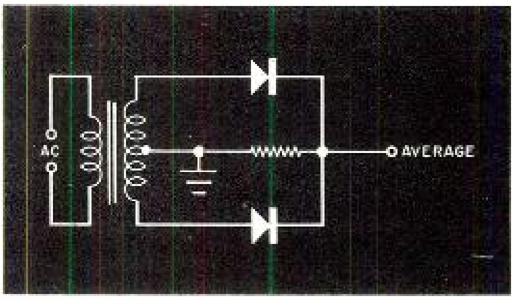

Fig. 2. Series of half waves is measured to find average value.

At this point, you are probably wondering where rms voltage comes into the picture. Well, the purpose of the rms measurement is to specify the dc voltage that has the same power capacity as the ac voltage it represents. "Rms" stands for "root mean squared," which is shorthand for saying that to find the rms voltage, you must square the ac waveform, find the average of the squared waveform, and find the square root of that average. About the only simple way of showing an rms detector system is as in Fig. 3.

The average-law circuit gives an output in terms of rms with sine waves. What about nonsinusoidal waveforms? If we take a 117-volt sine wave and allow only one alternation in 10 to come through, the peak potential is still 164.66 volts. Since only a half wave out of every 10 cycles comes through, our average potential would be divided by 10 (104.52/10 = 10.452 volts).

If we allow only one alternation in 10 cycles to come through for a 117-volt ac rms waveform, we cannot simply divide by 10 to find the new rms potential. First, we must square 117, which yields 13,689. Then, we find the average by dividing 13,689 by 10, yielding 1368.9. Finally, we must find the square root of 1368.9, which results in 37 volts rms. This last figure is a long way from the average reading of this one-in-10 waveform, even when the average scale is compressed to indicate in make-believe rms. Using the compressed scale, the indicated reading would be almost 70% low!

As you can see from the foregoing, when dealing with pure sinusoidal waveforms, you can use a peak-, average-, or rms-indicating circuit to convert from one type of ac voltage to another without introducing errors. But when you are dealing with nonsinusoidal waveforms, watch out. All your readings might be so grossly inaccurate as to be useless for anything other than to indicate the presence or absence of a potential. ◇

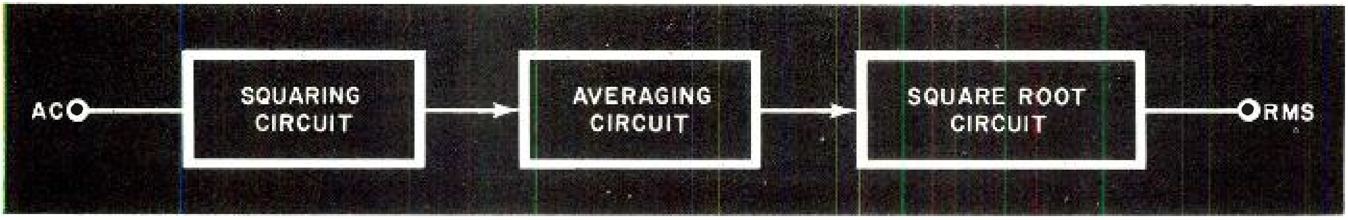

Fig. 3. Simple block diagram of an rms detector circuit.

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BUILD A

SOLAR CONTROLLER

Electronic temperature comparator for solar energy systems or attic fans

BY JERALD M. COGSWELL

THE SEARCH for new energy sources has encouraged amateurs as well as professional engineers to experiment with solar energy hardware as used in space heating. A typical solar heating system consists of three functional parts: solar energy collection, heat storage, and heat distribution. Automatic controls are required to operate the fans, blowers, pumps, etc. and coordinate operation of the overall system.

Because the backyard (or rooftop) experimenter may be discouraged by the high cost or unavailability of suitable controls, the Solar Controller described here should come in very handy. It can be built for about $35 and can be easily adapted to turn on attic fans when needed. It thus reduces the cooling load and prevents costly over-running of fans.

The Solar Controller is a temperature comparator that turns on a blower or pump when the air or fluid in the solar collector is at a sufficiently high temperature to justify a transfer to the storage medium. In the fan application, control is by the temperature difference between the attic and outside air (or between ceiling and floor of a large room).

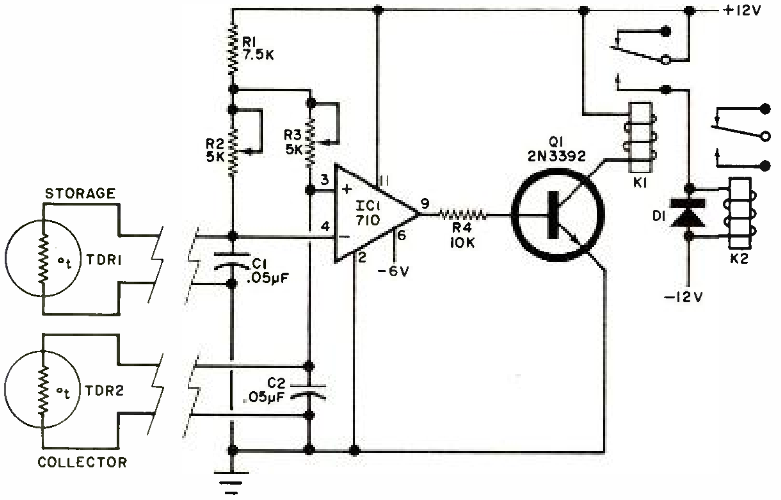

Fig. 1. Comparator IC1 turns on or off depending on resistances of TDR1 and TDR2. When IC1 is on, Q1 and the relays are energized.

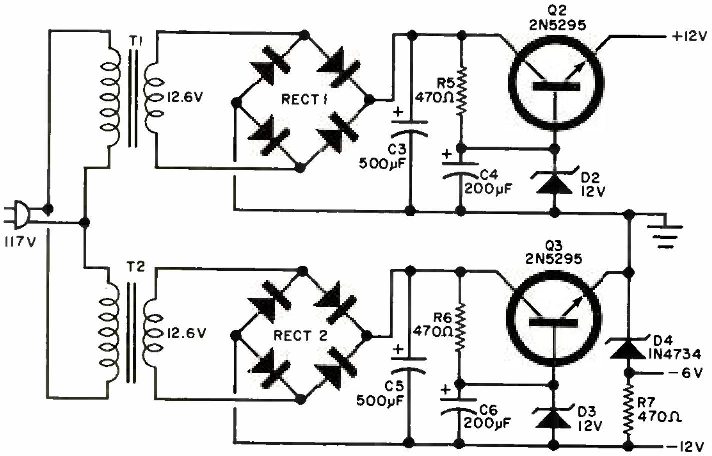

Fig. 2. The power supply for the solar controller is standard design and provides regulated positive and negative outputs.

Circuit Operation. The basic controller circuit is shown in Fig. 1. In *IC1*, a voltage comparator, the resistances of two temperature-dependent resistors (*TDR1* and *TDR2*) are compared, with *TDR1* placed in the storage medium and *TDR2* in the solar collector. When *TDR1* is warmer than *TDR2*, its resistance is higher and the higher voltage at the inverterting (-) input to *IC1* keeps its out-

PARTS LIST

C1,C2—0.05-μF, ceramic disc capacitor
C3,C5—500-μF, 25-V electrolytic capacitor
C4,C6—200-μF, 25-V electrolytic capacitor
D1—General-purpose silicon rectifier diode
D2,D3—12-V, 1-W zener diode (1N4742, or similar)
D4—6-V, 1-W zener diode (1N4734 or similar)
IC1—710 voltage comparator
K1—12-V, 600-ohm coil relay
K2—24-V, 10-ampere contacts relay
Q1—2N3392 transistor
Q2,Q3—2N5295 transistor (or similar)
R1—7500-ohm, ½-W resistor
R2,R3—5000-ohm multi-turn trimmer potentiometer
R4—10,000-ohm, ½-W resistor
R5,R6,R7—470-ohm, ½-W resistor
T1,T2—12.6-V, 300-mA transformer (Radio Shack 273-1385 or similar)
TDR1,TDR2—TG-1/8, 100-ohm, ±5% Sensitor
Misc.—Suitable enclosure, perforated or pc board, socket for IC1, twin lead cable for sensors, heat sinks(2), power cord, mounting hardware.
Note: The Sensitors are available from Texas Instruments semiconductor dealers, or from Texas Instruments, 2916 Holmes St., Kansas City, MO 64109 at $2.40 each.

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put in the low state. When *TDR2* gets warmer, the voltage across it gets higher and, when it is about 5 millivolts higher than the voltage across *TDR1*, the output of *IC1* goes high.

When this happens, transistor *Q1* is turned on and activates low-power relay *K1*. The latter, in turn, activates a 24-volt heavy-duty relay, *K2*, which handles the power requirements of the system.

Capacitors *C1* and *C2* prevent transients from affecting the inputs of *IC1*. Trimmer potentiometers *R2* and *R3* are used to preset the voltages on *IC1*. Diode *D1* is a general-purpose silicon rectifier used to protect the contact of *K1*. If desired, *Q1* can be replaced by a power transistor (such as RCA 40594) and one of the relays can be eliminated.

The power supply for the Solar Controller is shown in Fig. 2.

Construction. All components except the power transformer and relays can be mounted on a 3" x 6" piece of perforated board or pc board. Use small solder clips for connections to *TDR1*, *TDR2* and the relay. The entire system can be mounted in any type of enclosure. Use a heat sink for *Q2* and *Q3*.

The temperature sensors can be mounted at a distance from the rest of the circuit provided the resistance of the interconnecting leads does not exceed a few ohms. Use #14 wire or conventional slender twin leads. Solder the leads to the sensors carefully (and quickly) and anchor the soldered ends in silicone or epoxy. Be sure the bodies of the resistors are exposed to insure fast thermal response to temperature changes.

Adjustment. Set trimmer potentiometer *R2* at about its 3/4-resistance point. Then place the body of *TDR1* in a bowl of water that has been heated to the average temperature you expect in the storage medium. Place *TDR2* in another bowl of water that is between 5° and 10°F hotter than the first bowl. You will have to determine the exact temperature difference you want the circuit to detect.

Once both temperature sensitive devices are in their water bowls, and the water temperature difference is what you want, adjust trimmer *R3* until relay *K1* activates. The circuit can be made as sensitive as your needs demand. Note also that although the device appears passive when both probes are at room temperature, a gust of warm breath, or the touch of a finger on *TDR2*; or a drop of cool water on *TDR1*, will cause *K1* to be energized. ◇

Portable 60-Hz "CLOCK" OSCILLATOR

Crystal-controlled time base for field use.

BY CHARLES F. SMITH

MOST digital clocks and sports timers are energized by the ac line—not so much for power as for the 60-Hz frequency that is used as the time base. This means that such digital devices cannot be used in vehicles or boats or for timing outdoor events that are not near an ac power outlet.

The 60-Hz crystal-controlled time base described here (Fig. 1) can be powered by any dc supply between 3 and 15 volts. It has low power consumption, is stable within 2 parts per million and is small enough to fit inside the case of many digital clocks and timers.

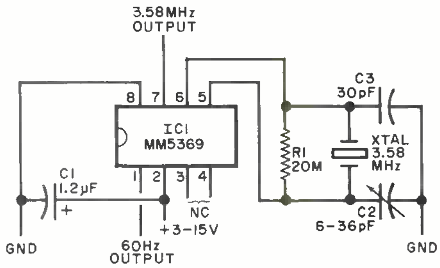

Fig. 1. Schematic of circuit.

PARTS LIST

C1—1.2-µF, 35-V tantalum capacitor
C2—6-36-pF trimmer capacitor
C3—30-pF capacitor
IC1—MM5369 programmable oscillator/divider, for use with a 3.58-MHz crystal (National)
R1—20-megohm ¼ watt resistor
XTAL—3.579545-MHz color-TV crystal
Note: The following are available from Bill Godbout Electronics, Box 2355, Oakland Airport, CA 94614: etched and drilled pc board (068) at $2.50; complete kit of parts, including board at $5.95. California residents, please add 6% sales tax.

How It Works. The integrated circuit used in this time base is an MM5369, a recently introduced 17-stage, mask-programmable oscillator/divider. Although masking options are available for use with almost any crystal frequency, the IC used operates with a low-cost, readily available 3.58-MHz color-TV crystal and delivers 60 Hz at its output pin. Trimmer capacitor C2 allows for exact frequency adjusting, and a buffered 3.58-MHz output is available. Current drain is approximately 1.2 mA with a 10-volt supply.

Construction. Because of the high frequencies involved, a small pc board (or perforated board) such as that shown in Fig. 2 should be used. Figure 2 also shows component installation. Since the IC is a MOS type, take the usual precautions when installing.

Adjustment. If you have a frequency counter, or a calibrated oscilloscope, check for the presence of 3.579545 MHz at pin 7 of the IC. You can adjust trimmer capacitor *C2* for the correct value. If you do not have a frequency counter, use the Lissajous-figure approach with a scope, with the output of a conventional 6-volt transformer as the horizontal sweep and the output of *IC1* pin 1 for the vertical signal. Adjust *C2* until a very slow-moving square appears on the scope. If you have neither a counter nor a scope and are planning to use the clock with a portable timing device, use some form of accurate time signals such as those from WWV, CHU, etc., to start the timer at a one-minute "beep" and stop it at the next minute "beep." Adjust *C2* to obtain the correct time interval. ◇

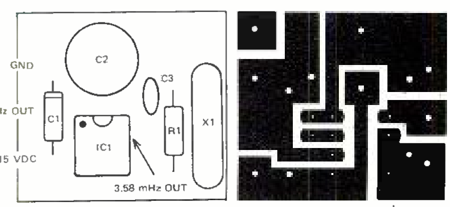

Fig. 2. Actual-size etching and drilling guide (far right) and component layout. Components are mounted on nonfoil side.

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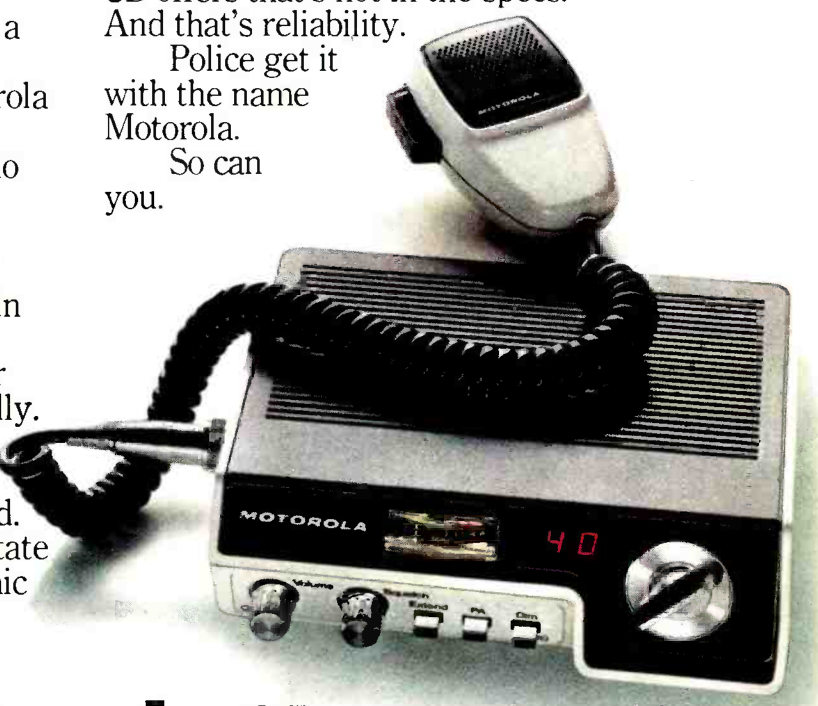

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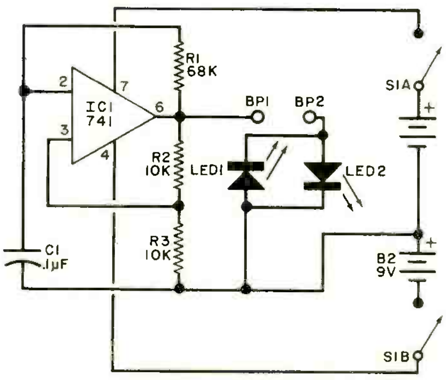
ONE-TOUCH DIODE TESTER

Identifies good/bad diodes, and tells which end is anode/cathode.

BY DAVID MARKEGARD

MOST electronics experimenters seem to have plenty of diodes in their junk boxes—either salvaged from old equipment or purchased at low bulk prices. The problem, usually, is to find out which ones are good, which are bad, and, in the case of the former, which end is which (cathode or anode). Of course, most diodes can be tested using a conventional ohmmeter. However, there are simpler ways, and one is to use the diode checker described here. Simply by touching a diode's leads to its binding posts (in either polarity), you can tell whether or not it is good and identify the anode and cathode.

How It Works. Op amp *IC1* forms a simple square-wave oscillator whose output swings from almost full positive to full negative levels with respect to ground.



IC1 is square-wave oscillator. Tested diode turns on either LED.

PARTS LIST

B1,B2—9-volt battery
BP1,BP2—Five-way binding post
C1—0.1-µF capacitor
IC1—741 op amp
LED1,LED2—Red LED (about equal brightness)
R1—68,000-ohm resistor
R2,R3—10,000-ohm resistor
S1—Dpst switch
Misc.—Perforated board, socket for IC1, battery holder, suitable enclosure, grommets for LED's, mounting hardware, etc.

If a good diode is connected between *BP1* and *BP2* with its cathode toward *BP1*, *LED1* is forward biased and glows. *LED2* remains dark because it is reverse biased. If the diode is reversed so that its anode is at *BP1*, *LED2* glows and *LED1* is dark. With the LED's properly identified and placed close to *BP1*, an unknown diode lead connected to *BP1* is easily identified.

Construction. The circuit can be assembled on a small piece of perforated board and mounted in small enclosure along with the batteries in holders. The two binding posts and the power on/off switch should be mounted about an inch apart on top of the enclosure. Put the two LED's in rubber grommets near *BP1* and identify them properly.

Before installing the LED's, be sure they are of equal brightness. The values of *R1, R2, R3,* and *C1* can be varied if the specified values are not available—as long as the circuit oscillates.

Use. Connect a diode to be tested between the two binding posts. If only one LED glows, the diode is good and the glowing LED will identify the cathode. If both LED's glow, the diode is shorted. If neither LED glows, the diode is open.

Transistor junctions can be tested by connecting the collector to *BP1* and the base to *BP2*. If *LED1* glows and is brighter than *LED2*, the transistor is npn. If *LED2* glows, or is brighter than *LED1*, the transistor is pnp. ◇

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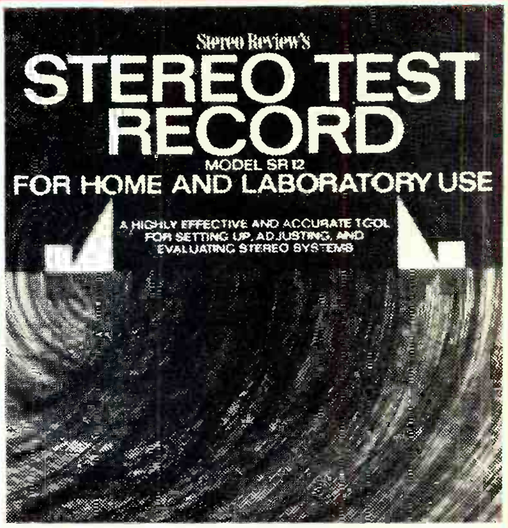

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Solid State

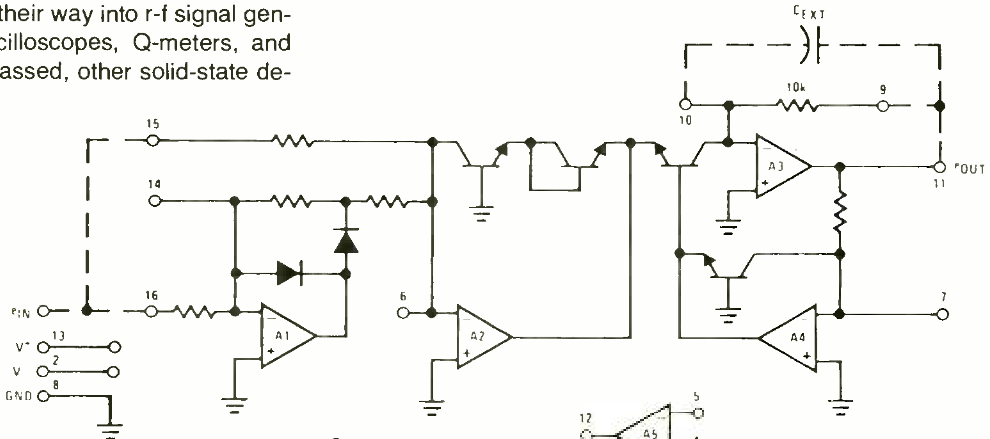
By Lou Garner

IC's FOR TEST INSTRUMENTS

SURPRISING as it may seem, solid-state test instruments were manufactured and used long before the transistor itself was invented. Featuring crystal diode circuitry, the early units were relatively simple instruments—r-f test probes, square-wave clippers, oscilloscope calibrators, dc reference voltage sources, outboard signal generator modulators, etc. Historically, the transistor's first significant commercial use was in hearing aids. Shortly thereafter, however, the recently invented device found its way into pocket AM radio receivers and, almost simultaneously, into portable test instruments. With its small size and low voltage and current requirements, compared to the then standard vacuum tube, the new device was certainly ideal for such applications. Initially, its use was limited to such products as signal tracers, simple meter amplifiers, and limited-range signal generators. Later, as better transistor designs were developed and manufacturing techniques refined, transistors found their way into r-f signal generators, function generators, oscilloscopes, Q-meters, and even microwave gear. As time passed, other solid-state devices were added to test instrument complements, including FET's, SCR's, triacs, diacs, and LED's, culminating in the use of integrated circuits. Today, almost all solid-state test instruments use at least one IC and many a dozen or more. There are, in fact, a number of special-purpose IC's designed specifically for test instrument applications.

For the experimenter and hobbyist, the evolution of integrated circuits and the ready availability of special purpose IC's has made possible the home assembly of inexpensive but sophisticated test instruments which would be both costly and prohibitively large if based on the use of either vacuum tube technology or discrete semiconductor devices. In addition, the development of complex IC's has permitted the efficient use of advanced design concepts and techniques in test equipment design, including phase-locked loops, gyrators, automatic ranging, frequency synthesis, automatic unit conversion, and digital counting and display.

Introduced recently by the National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, CA 95051), the LH0091 is one of the latest IC's developed primarily for test instrument applications. Suitable for use in digital voltmeters (DVM's) and digital multimeters (DMM's) as well as in noise, vibration, audio and power meters, the new device is designed to generate a dc output equal to the *true rms value* of any ac or composite ac/dc input signal from 0 Hz (dc) to 2 MHz. With an inherent accuracy of 0.5% of reading, the device can be adjusted using external trimming for accuracies down to 0.5%. In typical applications, it has an input impedance of 5000 ohms and an output impedance of 1 ohm. When operated with a dual ±15-volt dc power source, the LH0091



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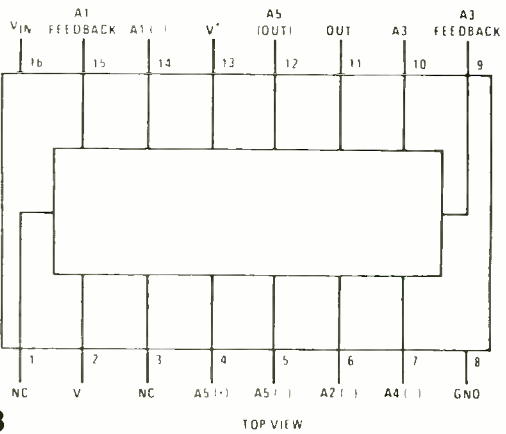

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Fig. 1. Simplified schematic (A) and lead connections (B) for LH0091 rms converter IC.

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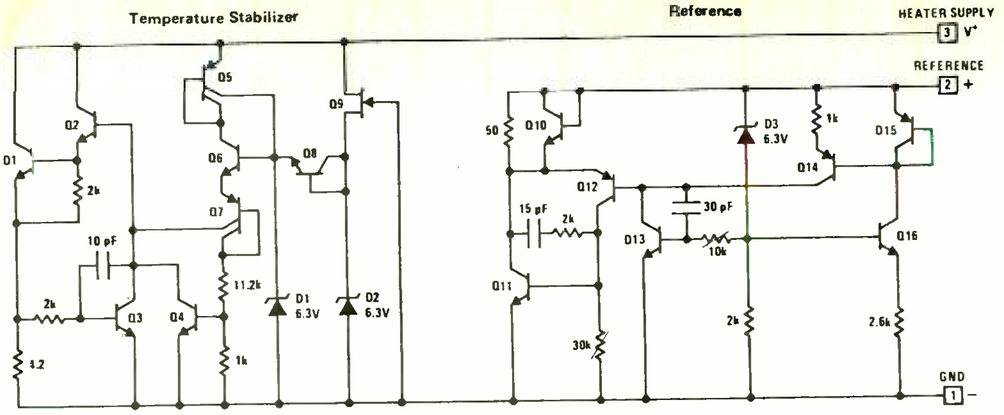

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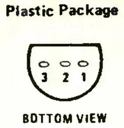

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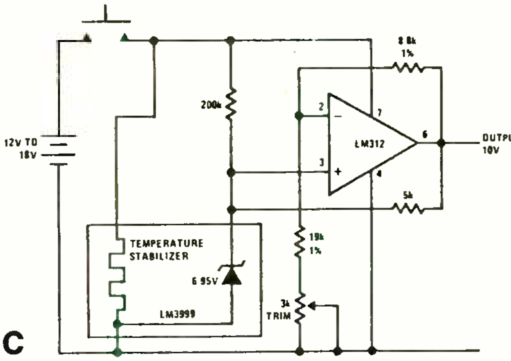
Fig. 2. National's LM3999 voltage reference: (A) equivalent schematic; (B) lead connections; (C) voltage calibrator using the device.

will accept input signals of up to ± 15 volts peak. As shown in the unit's simplified schematic diagram, Fig. 1A, the IC includes an uncommitted amplifier, *A5,* which may be used for filtering, to provide additional gain, or for other applications. Supplied in 16-pin DIP's, with lead connections as identified in Fig. 1B, the LH0091 is available in two versions—one in a metal case, for the standard military temperature range (−55° to +125° C) and the other for commercial operation (−25° to +85° C).

A unique device, the LH0091 is, of course, but one of a substantial number of IC's developed specifically for test instrument applications. Special, as well as general-purpose IC's useful in test equipment designs, are available not only from National Semiconductor but from virtually all other solid-state device manufacturers, including AMI, Exar, Fairchild, Intersil, Motorola, Plessey, RCA, Signetics, Siliconix, and Texas Instruments.

Suitable for power supply and general purpose as well as test instrument applications, another National Semiconductor IC, the LM3999, looks deceptively like an inexpensive transistor, for it is assembled in a three-lead, type TO-92 plastic package. Despite its simple external appearance, however, the unit is a monolithic precision voltage reference which combines a multi-device temperature stabilizing circuit with a zener controlled regulator, as shown in its equivalent schematic diagram, Fig. 2A. Its pin connections are identified in Fig. 2B. In operation, the LM3999 behaves as a highly stable 6.95-volt zener diode with a low dynamic impedance of only 0.5 ohm and an effective current range from 0.5 to 10 mA. Accepting dc inputs from 9 to 36 volts, the separately powered stabilization circuit permits operation from 0° to +70° C with a temperature coefficient of 0.0005%/°C and a long term stability of 20 ppm. The circuit for a portable voltage calibrator circuit, one of the many possible test equipment applications for the LM3999, is given in Fig. 2C. Here, the LM3999 is used in conjunction with an LM312 operational amplifier. Supplying a precise 10-volt output level for equipment calibration, the instrument requires a warm-up time of ten seconds, but may be used intermittently without degradation of long term stability.

If your instrument project plans include one or more digital meters, you'll want to investigate yet another new National Semiconductor device, the DM7700, a monolithic IC which contains all of the active circuitry, except for display, needed for a 2½-digit meter. As illustrated by its simplified block diagram, Fig. 3A, the DM7700 comprises amplifier, reference voltage, voltage-to-frequency converter, clock, time-base, counter and latch circuits. Analog-to-digital conversion is



C

accomplished through the use of a dual voltage-to-frequency technique. One voltage-to-frequency converter generates a signal proportional to the input voltage while the other provides a sample window and determines the clock frequency for counting the output of the first. Requiring +5- and −15-volt dc sources for operation, the IC features a temperature compensated reference and both autopolarity and over-range output indicators. With an input impedance of 500,000 ohms, the device offers a full-scale analog range of ±1.99 volts, a conversion time of 1 second, and an accuracy of ±1.0%. Two versions of the IC are offered by the manufacturer, differing only in their temperature ratings. The standard DM7700 is specified for operation from −20° to +95° C, the less expensive DM8700 for operation from 0° to +50° C. Both versions are supplied in standard 24-pin double-width DIP's, with pin connections as identified in Fig. 3B, and both can provide adequate current drive for standard LED numeric displays. A typical application circuit for the DM7700 (or DM8700) is given in Fig. 3C. Except for the IC, the NSN-33 LED readout, and the dc power supply, the only components needed for operation are three capacitors, three fixed resistors, and two potentiometers.

After the multimeter and the oscilloscope, many technicians feel that the basic signal tracer is the next most valuable of bench service instruments. Essentially a self-contained audio amplifier with integral loudspeaker, the signal tracer can be used with appropriate accessory probes for checking radio and TV receivers, CB transceivers, intercoms, PA systems, tape recorders, record players, hearing aids, and stereo installations. The medium power audio amplifier IC's offered by many semiconductor manufacturers are ideal for assembling signal tracers. A typical circuit is shown in Fig. 4. Abstracted from a Fairchild Semiconductor (464 Ellis St., Mountain View, CA 94042) data sheet, the design features a type TBA800 monolithic audio amplifier IC. Assembled in a 12-pin power

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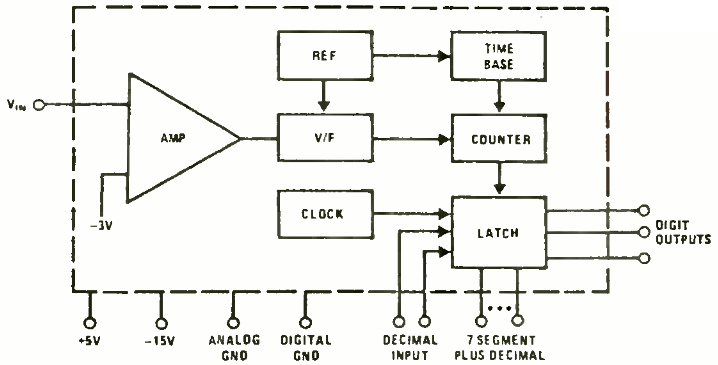

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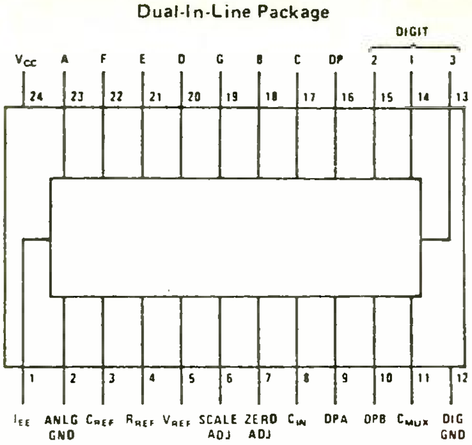

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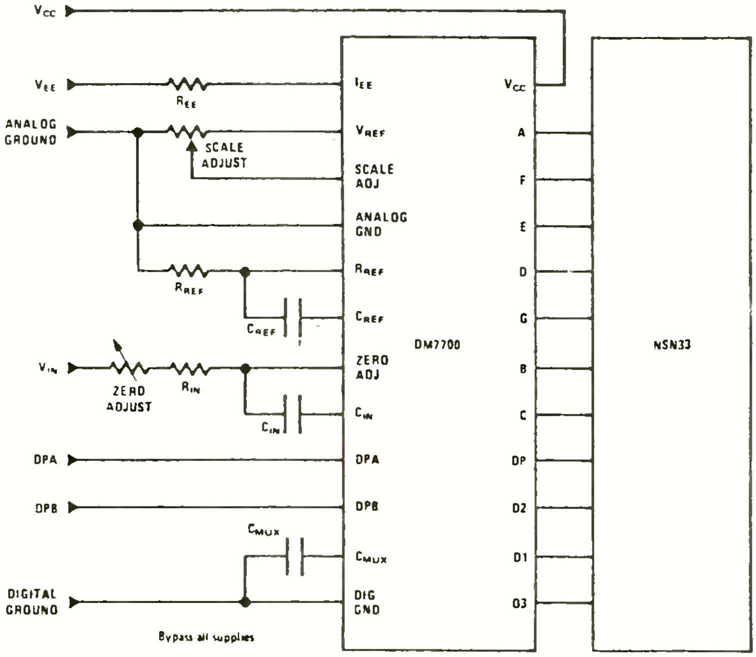
Fig. 3. *Functional block diagram (A), lead connections (B), and typical application circuit (C) for DM7700 analog-to-digital meter converter integrated circuit.*



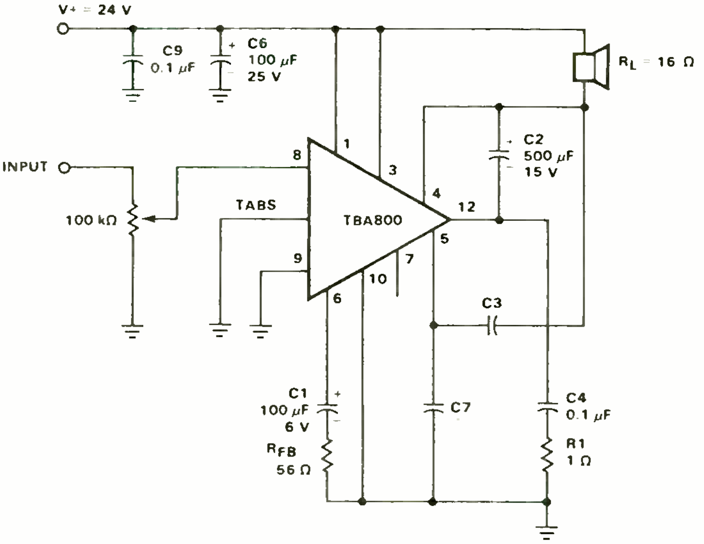


Fig. 4. *With a TBA800 audio amplifier, this circuit can be used to make a basic signal tracer.*

package with external cooling tabs, the TBA800 has a maximum voltage rating of 30 V and a maximum peak current capability of 2 A. With a modest heat sink, the device can deliver up to 5 watts to a 16-ohm load. At moderate output levels, the amplifier has a specified frequency response flat within 3-dB from 40 Hz to 20 kHz and an open-loop gain of 80 dB, with a typical total harmonic distortion of only 0.5%. Requiring but 80-mV input for full output, the IC's input resistance of 5.0 megohms permits it to accept all standard test probes. Properly matched to its load, the TBA800 is rated for 75.0% efficiency at full output. Referring to the schematic diagram, the circuit requires an external 24-V dc source for operation. This may be provided by batteries or by a well-filtered line-operated power supply, as preferred. All component values are specified except for *C3* and *C7*, which are part of the compensation network. These capacitor values are chosen to provide the overall frequency response needed for the circuit's application. Generally, *C7* will be approximately five times as large as *C3*. For most projects, *C3* can be a 330-pF low-voltage ceramic capacitor and *C7* a 1500-pF unit.

Although special-purpose IC's are ideal for instrument designs ranging from digital meters to multi-output function gen-

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erators, operational amplifiers, as a broad class, are probably the most versatile of all IC's for general test equipment applications. Op amps may be used, typically, in sine-wave oscillators, pulse generators, oscilloscope preamps, active filters for signal analysis, bridge amplifiers, frequency meters, and staircase generators. Two representative examples of the many possible op amp test equipment circuits are given in Figs. 5 and 6. Both circuits were abstracted from application notes published by Intersil, Inc. (10900 N. Tantau Ave., Cu-

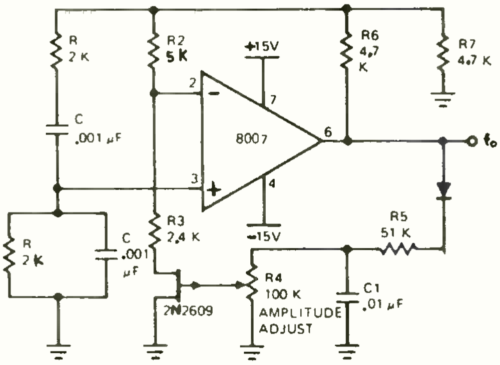

Fig. 5. Op amp Wein bridge oscillator described in an Intersil application note.

pertino, CA 95014), both feature FET-input op amps, and both are designed for operation on standard ± 15-volt dual dc power sources.

Capable of delivering an output signal of 20 volts peak-to-peak, the Wein Bridge oscillator circuit shown in Fig. 5 may be used either alone as a test-tone source or as part of a complete audio-signal generator design. A type 8007 op amp serves as the basic oscillator, with a 2N2609 JFET used as a feedback element to provide amplitude control. In operation, the circuit's output frequency is determined by the values of the resistors and capacitors in the bridge feedback network and may be calculated from

$$f_0 = 1/2\pi RC,$$

where the frequency, f_0, is in Hz, R is in megohms and C in µF. Multiple output frequencies may be provided by using a number of different RC values, selected by means of a suitable multiposition switch. Continuous frequency coverage within a broad range can be obtained by replacing the two fixed resistors in the feedback network with a matched-pair gang potentiometer. The two techniques can be combined, of course, with switch selectable capacitors establishing different ranges and continuous coverage within each range provided by the ganged potentiometers.

Suitable for use in a variety of test equipment designs from counters to characteristics curve analyzers, the staircase generator circuit illustrated in Fig. 6 develops a cyclic stepped output signal waveform. Its active device complement includes a type 8043 dual op amp, a pair of low-leakage diodes, a type 1H5042 CMOS analog switch, and a type 311 voltage comparator. In operation, a high-frequency clock (square-wave) signal is applied to the first op amp, half of an 8043. Amplified, this signal drives the second op amp, which, in turn, charges a 0.02-µF capacitor in small steps through a pair of low-leakage diodes. The capacitor's instantaneous voltage level is continuously compared to an externally applied dc reference by the 311 voltage comparator. When the capacitor voltage reaches the preestablished level, the comparator applies a signal to close the analog switch, discharging the capacitor to end the cycle and reset the circuit. The relative time width of each step is determined by the initial clock frequency while the number of steps per cycle and hence the cyclic rate is established by the dc reference voltage applied to the 311 comparator.

Looking to the future, the next major evolutionary step in test instrument design probably will be the increased use of microprocessors and memory circuits. The use of these devices will permit the development of a whole family of automatic test instruments . . . units capable of performing a broad series of tests and, perhaps, of even changing the test procedures on the basis of initial results. More sophisticated future instruments may even provide aural outputs, telling the service technician where a circuit defect is located and which component or device should be replaced.

Reader's Circuit. Faced with frequent power interruptions in his area and having electrical equipment which required special start-up procedures if the ac power was removed for more than a few seconds, reader John M. King (1194 Idylberry Road, San Rafael, CA 94903) devised the protective control circuit shown in Fig. 7. The control is designed to maintain power-line contact with the protected equipment for short intervals in the event of a power failure, but to disconnect the equipment if the failure period exceeds a preset limit.

As shown in the schematic diagram, line power is applied to the external equipment connected to the dual outlet (*SO1*) through the contacts of relay *K1* which, in turn, is controlled by a solid-state sensing circuit. Step-down transformer *T1* in conjunction with bridge rectifier *RECT1* and filter capacitor *C1* form a dc power supply for the control circuit. Equipment operation is initiated when pushbutton *S1* is depressed, turning on *SCR1* and energizing *K1*. With *SCR1* conducting, a dc charge is maintained on *C2* by current flow through blocking diode *D1*. Should a momentary power failure occur, *SCR1* will continue to conduct until *C1* is discharged below the SCR's maintenance voltage, holding *K1* closed and permitting the immediate reapplication of power to the external equipment. Thereafter, the SCR will switch to a high impedance state,

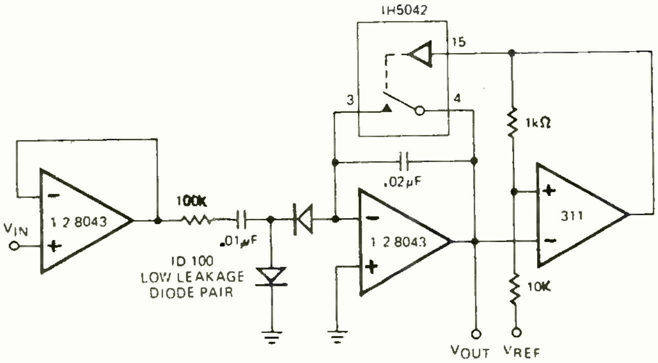

Fig. 6. Another Intersil circuit shown here is an op amp staircase generator.

opening the relay. However, a small gate voltage will be maintained on the SCR for a short while by the accumulated charge on *C2*. Thus, if ac line power is restored before *C2* is discharged below the level needed to "fire" the SCR, circuit operation will be initiated automatically. If the power failure interval is longer than the time required for *C1* and *C2* to discharge, operation must be restarted manually by depressing *S1*, permitting the operator to carry out any necessary start-up procedures required by the protected equipment.

John used Motorola semiconductor devices in his design,

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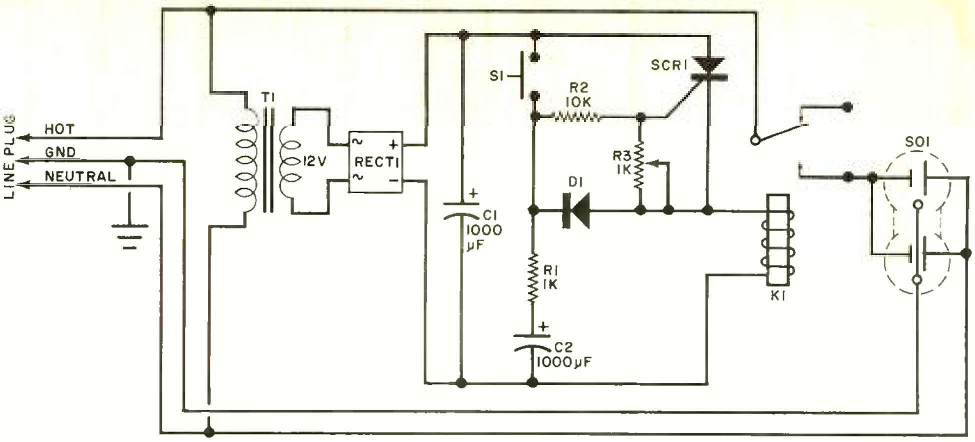


Fig. 7. This circuit maintains power-line contact during short power outages but will disconnect the equipment if failure exceeds a preset simit.

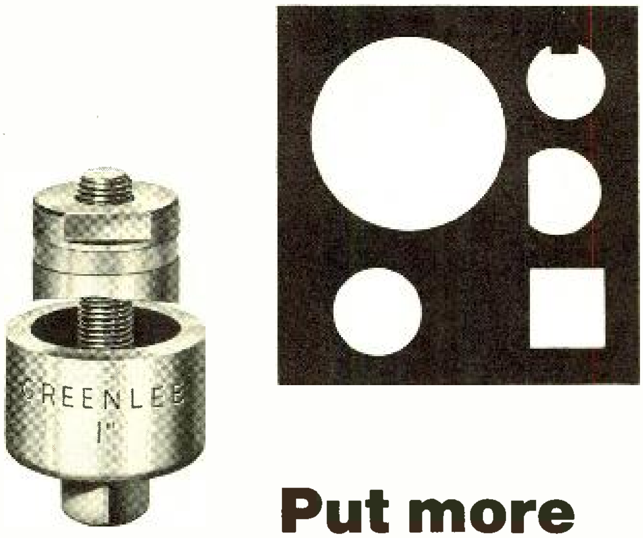
with the bridge rectifier a HEP type R0801, *SCR1* a HEP type R1216, and diode *D1* a HEP R0050. The step-down transformer may be any standard type with a 12-volt, 500-mA secondary. Resistors *R1* and *R2* are half-watt types. Capacitors *C1* and *C2* are 16-volt electrolytics. A 12-volt dc relay with a 95-ohm coil and contacts rated at 10 A is used for *K1,* while the control switch, *S1*, is a spst, momentary contact, NO pushbutton or lever type. Finally, the receptacle (*SO1*) is a familiar 3-wire dual wall outlet.

With neither layout nor lead dress critical, the circuit can be duplicated using any preferred construction technique but, for maximum safety, the wiring should be housed in a sturdy (and grounded) metal case or box. According to John, the time delay before manual resetting is required can be adjusted (by means of *R3*) between 1 and 12 seconds, which is more than adequate for most momentary power interruptions. If, for some reason, a longer delay is required, this may be achieved by increasing the values of *C2, R2* and *R3.* Delays of up to a minute or two should be feasible with standard components.

Device/Product News. RCA's Solid State Division (Box 3200, Sommerville, NJ 08876) has added a new series of devices to its growing family of BiMOS (Bipolar/MOS) operational amplifiers, which feature MOSFET inputs and COS/MOS outputs. The new CA3160 series are frequency-compensated versions of the earlier CA3130 series op amps, and feature gate-protected p-channel MOSFET's in the input stage to provide input impedances of 1.5×10^{12} ohms (typical), very low input currents (5 pA typical at 15 V), and exceptional speed performance. In each, the output stage employs a complementary-symmetry MOS transistor pair capable of swinging the output voltage to within 10 mV of either supply voltage terminal, permitting direct interface with either CMOS or bipolar 7400 TTL series devices. Other features include wide bandwidth (15 MHz), high slew rate (10 V/µs unity-gain follower), and strobbing capability to reduce standby power consumption. Suitable for applications in sample-and-hold amplifiers, long duration timers, wideband amplifiers, voltage followers, voltage regulators, Wein Bridge oscillators, VCO's, and photo-diode sensor amplifiers, the devices are offered in both standard and dual-inline formed 8-lead TO-5 packages.

In addition to its special purpose test instrument IC's, National Semiconductor has announced a new family of positive regulators with several fixed output voltages in three temperature ranges. Identified as the LM140LA series, the new devices have a 2.0% output voltage specification, 0.04%/volt line regulation, a 0.01%/mA load regulation, and can deliver up to 100 mA with adequate heat sinking. Offered in metal TO-39 and plastic TO-92 packages, the new regulators are available with outputs ranging from 5.0 to 24.0 volts. All of the devices are protected by internal current limiting and thermal shutdown circuitry.

International Rectifier's Semiconductor Division (233 Kansas St., El Segundo, CA 90245) has recently introduced a pair of 900-volt npn transistors with power dissipation ratings of 50 watts. Designated types IR 708 and 709, the new units are suited for applications in video deflection circuits, high-voltage switching power supplies, power controls, and switching regulators. Both offer continuous collector current ratings of 3 A with fall times of 1.5 µs, and both are supplied in standard TO-3 metal cases. ◇



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Experimenter's Corner

By Forrest M. Mims

THE 556 DUAL TIMER

IF THERE'S anything better than the popular 555 timer, it's the 556 dual timer. The 556 is two 555's on a single chip packaged in a 14-pin DIP. The pin outline of this versatile chip is shown in Fig. 1. Either or both halves of the 556 can be used for all the standard 555 applications. This month, we'll look at several that use two 555's and are therefore ideally suited for the 556.

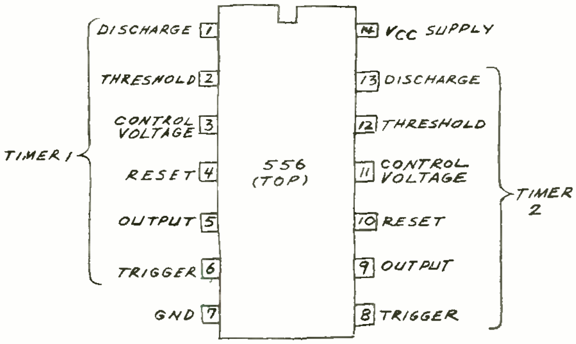

Fig. 1. Pin outline of the 556 timer.

Tone-Burst Generator. Figure 2 shows a circuit for a tone-burst generator using a single 556 dual timer. The first half of the 556 is connected as a monostable multivibrator (one-shot) whose timing period is controlled by *R1* and *C1*. The second half of the 556 is connected as an astable (free-running) multivibrator which produces an audio tone with a frequency governed by *R2*, *R3* and *C4*.

Normally the speaker is quiet; but when pushbutton switch *S1* is pressed, the one-shot begins its timing cycle while simultaneously activating the tone generator. The tone continues until the one-shot's timing cycle is complete. The result is a tone burst which you can use for signaling, alarms, electronic music, and other effects.

You can experiment with the various timing and frequency-controlling components (*R1*, *C1*, *R2*, *R3* and *C4*) to produce different sound effects. Remember that you're looking for a tone which continues *after* S1 is released, so adjust *R1* until this occurs.

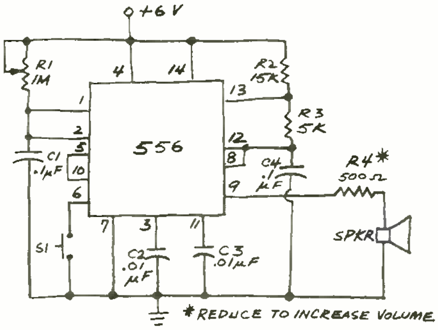

Fig. 2. Tone-burst generator.

Dual-Action Timer Circuit. The maximum time delay of a single 555 timer is limited to ten or fifteen minutes unless you use an expensive low-leakage timing capacitor. The 556 dual timer makes it easy to double the time delay of a single 555 by connecting the output of the first chip to the input of the second. After the first timer completes its timing cycle, it triggers the second timer.

A timer using this principle is shown in Fig. 3 where *R2* and *C1* determine the time delay of the first timer and *R3* and *C4* determine the delay of the second timer. The output of the first timer is coupled to the input of the second by *C5*.

Operation of the circuit is straightforward, and you should easily be able to generate time delays of more than twenty minutes. Though Fig. 3 shows potentiometers for *R2* and *R3*, you can use fixed resistors if you prefer. The potentiometers, of course, are handy for altering the delay of each half of the timer.

You can also use a range of values for *C1* and *C4*. Naturally, large-value capacitors will give long time delays; but if you only need a delay of a few minutes or so, you can use less costly units.

Finally, though the main purpose of this circuit, which I've borrowed from Signetics, is to extend the time delay of a single 555, you might want to take advantage of the first timer's output, too. Lots of interesting sequencer applications are possible since each timer can be adjusted for a different timing period.

Extra-Long Time-Delay Circuit. A neat way to increase the time delay of a single 555 by a factor of ten is to connect a low-cost TTL decade counter like the 7490 to the basic timer circuit. This trick can provide time delays of up to a few hours—even more if you use a high-quality timing capacitor.

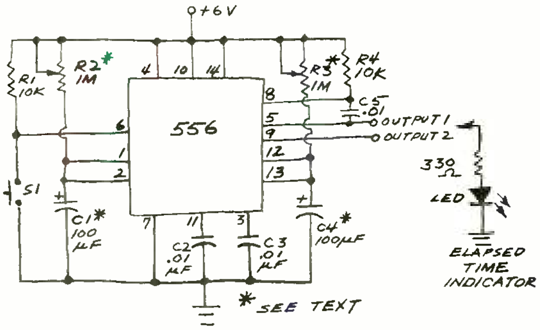

Fig. 3. Dual-action timer circuit using the 556 IC.

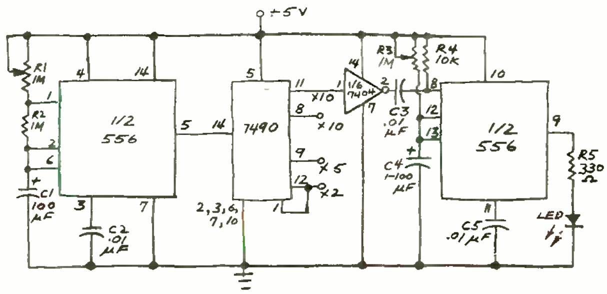

Fig. 4. Extra-long time delay circuit.

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Operation of this circuit is made possible by the divide-by-ten operation of the 7490. The 7490 simply counts input pulses from the 555 until ten have been received. It then produces an output pulse of its own.

It's possible to connect the divide-by-ten output of the 7490 directly to an elapsed-time indicator such as an LED or audio oscillator. A better approach, however, is to connect a second 555 hooked up as a one-shot to the 7490. The one-shot is easy to adjust, and it will turn on the elapsed-time indicator for a fixed length of time. This is a handy feature if you want to use a bell or buzzer as an elapsed time indicator since the second 555 will trigger a quick burst of sound instead of a continuous noise.

Figure 4 shows how everything is connected together. A single 556 takes the place of the two 555 timers. One of the inverters in a 7404 hex inverter complements the output signal from the 7490 to provide the proper triggering potential. If you don't have a 7404 handy, use one of the gates in a 7400 quad NAND gate. Connect the two inputs of one gate together to form the inverter's input. (For example, connect pins 1 and 2 of the 7400 to pin 11 of the 7490. Connect pin 3 of the 7400 to pin 8 of the 556. Connect pins 14 and 7 of the 7400 to the positive and ground connections, respectively.)

The extra long timer circuit has several features you'll want to tinker with. First, note that potentiometer *R1* sets the delay time while potentiometer *R3* sets the on time of the elapsed time indicator. I used an LED for the elapsed-time indicator in the prototype circuit, but you can use a relay if you prefer (Radio Shack 275-004 or equivalent).

Second, note that the 7490 has *four* outputs. Both pins 11 and 8 will provide a time delay ten times that of the first 555 (one pulse out for every ten pulses in). Pin 9 will provide a time delay five times that from the 555. And pin 12 will provide twice the delay available from the 555.

Finally, if you want *really* long delays, you might consider connecting one or more additional 7490 decade counters in series with the first. Just connect pin 11 of the first 7490 to pin 14 of the second 7490. Pin 11 of the second 7490 goes to still another 7490 or to the inverter. Incidentally, note that this circuit is a repetitive, free-running timer. In other words, it begins a new timing cycle immediately upon completion of the first. Keep this in mind if you decide to tinker with super-long time delays. ◇

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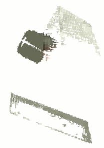

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Hobby Scene Q&A

By John McVeigh

STATIC CRASHES

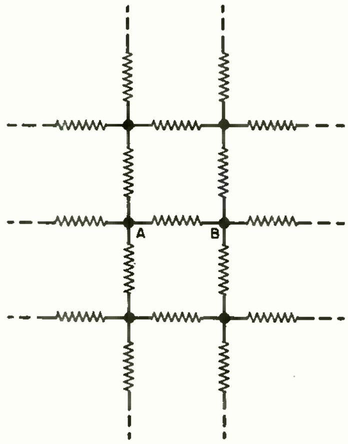
***Q.** Please advise how to eliminate unbearable noise that my school's heating system produces on my Hallicrafters SX62A shortwave receiver. A line filter was tried to no avail. The most deafening noise is heard for two or three seconds between 5 and 18 MHz.—Gerard Richard, Sherbrooke, Quebec, Canada.*

A. It sounds like a thermostat or thermostat-controlled power relay is arcing and generating r-f crashes. If you can "sniff out" the source with a small field-strength meter or even a portable radio (the static should also affect the AM broadcast band), try placing a suitable bypass capacitor across the arcing thermostat or relay contacts. A 0.1-µF, 1000-V ac disc ceramic capacitor should squelch the r-f. If you can't locate the source, try the "Ear Saver" circuit shown in the Hobby Scene column on p. 34 of the January 1977 issue.

RESISTOR QUIZ

***Q.** Here's a problem which was posed by one of my professors. You have an infinite lattice of 1-ohm resistors as shown in the diagram. What's the effective resistance between points A and B?—Bryan Baker, Houston, TX.*

A. Offhand, I think the *effective* resistance is zero ohms. There is an infinite number of resistors in parallel, and

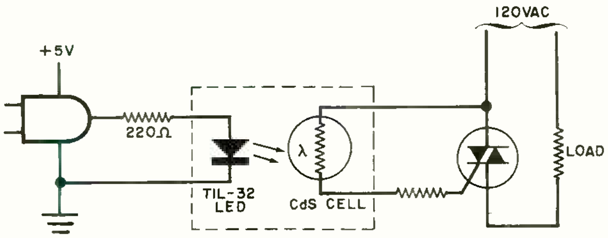


even though the further away from A and B the more series resistors you have in each parallel combination, it looks like the resistance will go to zero. The only other solution I could possibly see is a finite limit in the parallel combinations. But my tendency is to say zero ohms. Actually, the effective resistance of an ever-increasing number of parallel resistors will *approach* zero ohms, but will never reach it—just like the graph of a hyperbola or an exponentially decaying function. If any reader comes up with different solution, feel free to send it in!

TRIGGERING THYRISTORS

***Q.** I would like to control 120-volt ac devices with TTL logic without using relays. Is there a way to do this using triacs or SCR's? They would only have to handle 1 or 2 amperes.—Dominick Testa, Skokie, IL.*

A. The easiest way to trigger an SCR or triac from a TTL output is to use an optoisolator. It is essentially a LED, a current limiting resistor, and a photocell. Of course, you can make your own optoisolator by enclosing the LED and CdS cell in a light-tight box. Connect the optoisolator as shown in the figure. An external current limiting resistor may be needed to keep the thyristor's gate current to a safe value. This depends on the lit resistance of the CdS cell. Using a 10,000-ohm, ¼- or ½-watt series resistor will limit gate current to 17 mA peak.



TVI AND CB TRANSCEIVERS

***Q.** I have a TVI problem whenever I use my CB transceiver. My neighbors get very upset and tell me to turn off the radio. Is there anything I can do without going off the air? —Dwayne Edwards, Canton, NY.*

A. If your CB transceiver is a fairly recent vintage, type accepted, and used properly, it should not be generating TVI. Often, the interference is the result of overload within the TV receiver in the presence of a strong 27-MHz signal. The way to identify overloading is to determine the extent of the interference at the TV receiver. If TVI occurs on all channels, receiver overloading is the culprit. Visual interference can range from fine cross-hatching to a completely dark screen. When the *sound* portion of the program is also subject to interference, overloading is taking place.

The cure for this problem is to prevent the CB signal from reaching the TV. This can usually be done by attaching a high-pass filter such as the Drake TV-300-HP (for twinlead) or TV-75-HP (for RG-59-U coax) at the antenna terminals on the back of the receiver. In some cases, the filter will have to be installed at the tuner input inside the receiver's enclosure. When the CB signal is really strong, the use of the high-pass filter might have to be supplemented by more effectively shielding the receiver. Fine copper or brass screening or flashing *carefully* installed (beware of accidental shorts!) can be installed on the inside of the TV enclosure and grounded.

When visual interference occurs only on TV channels harmonically related to the 27-MHz Citizens Band (principally Channel 2 at 54 MHz and Channel 5 at 81 MHz), the transceiver is radiating undesired signals. This can occur when the transceiver circuitry is improperly adjusted or operated. Over-modulation from "power mikes" is a common cause of harmonic radiation. Don't overmodulate the transceiver and don't use a power amplifier. If the harmonic suppression of the transceiver must be improved, insert a low-pass filter in the coax transmission line close to the transceiver. Be sure you use a filter with a cut-off frequency around 40 MHz and attenuation of at least 60 dB at TV frequencies (Drake TV-42-LP or equivalent).

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

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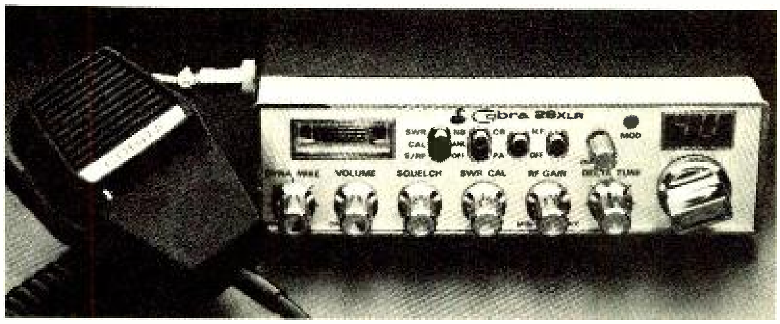
Product Test Reports

COBRA MODEL 29XLR MOBILE 40-CHANNEL CB TRANSCEIVER

Digital readout AM rig provides strong transmission punch.



DYNASCAN's Cobra Model 29XLR is a handsome 40-channel AM CB mobile transceiver that uses digital frequency synthesis and a red LED numeric display for channel identification. It incorporates such features as: display dimmer control, illuminated S/r-f/relative-power meter, LED transmit/modulation indicator, microphone and r-f gain controls, and switchable noise blanker (NB) and automatic noise limiter (anl). In addition, the transceiver has audio, squelch, and Delta tune controls; PA facilities; external-speaker jacks; automatic modulation control (amc); detachable dynamic microphone; bottom-facing speaker; line filter; and reverse-polarity protection. Operation is from a nominal 13.8-volt dc source with negative or positive ground.

The transceiver measures 9½"W × 7¼"D × 2¼"H (24 × 18.5 × 5.6 cm). Suggested list price is $229.95.

Technical Details. The receiver employs double conversion, with frequency control provided by a phase-locked-loop (PLL) frequency synthesis system. A 10,695-kHz first i-f is obtained by heterodyning the CB signal with the PLL's voltage-controlled oscillator (vco) signal in the range of 37,660 to 38,100 kHz. The second conversion is to a 455-kHz i-f with a 10,240-kHz crystal oscillator, from which a 10-kHz standard reference for the PLL system is also derived through dividers. The 10-kHz vco comparison signal is set up by combining the output of the vco with a 36,570-kHz crystal signal at a "down" converter (mixer). The difference frequencies are extracted and go to an IC divider that is controlled by the channel-selector switch.

Inductively coupled circuits at the input of the r-f amplifier and output of the second mixer, along with a bandpass-coupled circuit between the mixers, aid in good image and unwanted-signal rejection. This is augmented by a 10,695-kHz ceramic filter after the first mixer. The 455-kHz selectivity is also obtained with a ceramic filter.

Two i-f stages are followed by a diode detector and agc, the switchable anl, squelch system, and an IC audio section. The noise blanker employs an IC r-f amplifier/detector and three pulse amplifiers for gating the output of the second mixer. Electronic voltage regulation is supplied for all critical circuits.

The transmitter combines the output of the vco with a 10,695-kHz crystal oscillator signal, using the difference frequencies, at a dual-gate MOSFET transmitter mixer that is followed by bandpass coupling and the usual r-f stages. The multi-section output network includes a TVI trap. The SWR bridge is a trough-line type. The collectors of the driver and power amplifier stages are modulated by the receiver's audio output stage, providing the customary high- and low-level class-B modulation. Amc is obtained with a bootstrap setup around an IC microphone amplifier. Transmit/receive transfer is conducted electronically.

It is interesting to note that the 29XLR utilizes ferrite beads at strategic points in place of wire-wound r-f chokes. These beads slip over a lead of the circuit to be isolated or stabilized. The beads save space, hold down circuit resistance, minimize resonance effects, and are highly effective in comparison to the wire-wound chokes.

Test Results. Receiver sensitivity of the Cobra 29XLR measured 0.5 μV (with 30% modulation at 1000 Hz). Image and i-f signal rejection measured 80 dB minimum, while spurious response rejection of signals near the CB range was 45 dB. Adjacent-channel rejection and desensitization were nominally 60 dB. The overall 6-dB audio response was 240 to 2400 Hz. The maximum sine-wave output power measured 2.75 watts at 3% THD at 1000 Hz into 8 ohms at the onset of clipping. It measured 3 watts in the PA mode.

The agc held the audio output to within 10 dB with a 26-dB r-f input change at 0.5 to 10 μV and to 13 dB with an 80-dB input change at 1 to 10,000 μV. A nominal 50-μV signal registered S9 on the signal meter. The threshold range of the squelch circuit was 0.3 to 10,000 μV.

The transmitter put out a 4-watt carrier with operation from a 13.8-volt dc source. The modulation capabilities ran up to 100%. With the microphone input level raised 25 dB above the level required for 50% modulation, the THD was 7% at 1000 Hz, and the modulation held to just within the legal limit. The THD with a 400-Hz test tone was noticeably greater in both waveform observation and measurement, the latter varying between 10% and 20%, depending on the level of the amc.

We obtained high average modulation with voice inputs without overmodulation or adverse splatter. With voice input or 1000-Hz tone, the splatter at ±5000 Hz from the carrier frequency was at least 60 dB down. Using a 2500-Hz tone input, it was 50 to 55 dB down. The overall 6-dB audio response of the transmitter was 400 to 2300 Hz. R-f frequency tolerance on any channel was within ±3 Hz of −110 Hz.

User Comment. This is a smartly styled mobile transceiver, set in a black case with brushed silver-colored front panel and chrome-trimmed knobs. The control knobs are located in a row along the lower half of the front panel.

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Our one complaint about the control sequence arrangement is that the DYNA MIKE (microphone gain) control is located at the far left of the panel, where we automatically reach for the more-often used VOLUME control.

The channel selector control knob has a bar grip that makes it easy to manipulate. Other switching functions are handled by miniature toggle switches located in a line across the top of the front panel between the meter and numeric display. Two of these switches have three positions that do not have much lever swing, which sometimes makes it difficult to stop at the center position. A two-position switch, H.F./OFF, switches in and out a "hash" filter that is a fixed-setting tone control that drops the upper frequency response to minimize high-pitched noises.

The edgewise meter is easier to read than most other similar meters we have encountered. It is illuminated whenever the transceiver is turned on except when in the PA function. Hence, instead of having the numeric readout display the letters PA, as is generally the case, the meter's light extinguishes to indicate that the transceiver is in the PA mode.

We determined that, when the transmitter is working into a nonreactive 50-ohm load (representing a 1:1 SWR), the actual r-f output was accurately indicated at any point on the meter's SWR scale. (This does not necessarily hold true for other loads or high SWR's.)

Use of the noise blanker allowed readability of weak signals in the presence of high impulse noise from our impulse-noise generator. It was similarly effective on ignition noise in a vehicle, where it almost entirely eliminated the noise (with a slight loss in signal level). The anl also performed well.

Although the speaker in this transceiver is bottom facing, its sound reproduction is clean and crisp without the usual muddyness associated with bottom-facing speakers. It provided good readability in our on-the-road tests. It should be noted that the microphone must be plugged into its connector to permit the speaker to function.

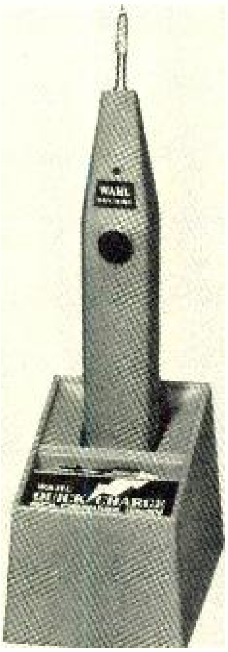
On-the-air, we obtained a hefty punch from the amc system, which prevented overmodulation even when the microphone gain was fully advanced. We experimented with the DYNA MIKE control to determine its best setting. The cleanest sounding signal was obtained with the mike gain reduced to the point where the MOD indicator blinked only occasionally. At this point, we still obtained a high average modulation level without sacrificing intelligibility.

The excellent performance of the Cobra 29XLR transceiver far outweighs the minor criticisms noted here. It provides high sensitivity and fine selectivity, has a good transmitted signal without adverse splatter, and possesses effective noise-handling capabilities.

CIRCLE NO. 104 ON FREE INFORMATION CARD

WAHL MODELS 7700 AND 7800 CORDLESS SOLDERING IRONS

Battery-powered irons with recharging stands.



Iso-Tip Quick-Charge Model 7700.

When electrically powered cordless soldering irons first appeared, we lauded them because they gave us freedom from the ac line. Especially useful in the field, they also proved to be very practical on our workbench. We did, however, observe one shortcoming—we could not use the cordless iron for major project and kit building that required hundreds of connections to be soldered. It was not that a fully charged iron provided just 100 to 150 soldered joints, but that it required up to 14 hours to recharge to full capacity. Now, however, there are "fast-charge" cordless soldering irons, as examined here.

The two fast-charge soldering irons from Wahl are the Iso-Tip "Quick Charge" Model 7700 that requires about four hours to recharge and the Iso-Tip 60 Model 7800 that comes up to full charge in about 60 minutes. Both irons come with their own recharger stand. The Model 7700 retails for $24.95, the Model 7800 for $34.95. Available as an option is the Model 6500 ($10.95) printed circuit board drilling attachment that fits all Wahl cordless soldering irons.

General Description. The two soldering irons feature a couple of improvements that were not part of the original Wahl cordless soldering iron we tested five years ago. The first is that the header has been redesigned to hold tips firmly in place by friction instead of with the tiny Allen-type setscrews used on the original iron. This makes installation and removal of tips a simple plug-in/pull-out operation. Of course, the tip can still be semi-permanently fixed to the header by loosening the header screws, inserting the tip, and retightening the screws.

The second improvement is in the power-on pushbutton switch. The button is rotatable so that its index can be set to either of two positions. To use the iron, the index must be set to the USE position before it can be depressed. Only in this position can the button be depressed far enough to close the switch contacts and allow power to be applied to the tip. Whenever the iron is not in use, the button is rotated until the index is pointing to the LOCK legend molded into the iron's housing. When the button is in the LOCK position, the iron cannot be accidentally turned on, which is a good safety feature on a bench or in a crowded toolbox.

The major improvement in the new irons is the fast-charging feature. The Model 7700 iron's average four-hour recharging cycle is roughly a third of that required by the original Wahl iron. For just $10 more, the Model 7800 cuts the recharging time of the original iron to less than a tenth. Needless to say, with either iron, you can make many times more solder joints in a workday than was possible before. Hence, you can tackle a fairly large project or kit-building job without resorting to a line-powered iron.

Special nickel-cadium cells are used in the new irons. These cells, plus the newly designed charger stands, are responsible for the new fast-charge rates. In addition, the Model 7800 is equipped with a thermostat that automatically re-

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duces the full fast-charge rate to a safe "trickle" once the cells have come up to full charge. When the cells are fully charged, and as long as the iron is still in its stand, a LED near the power switch comes on to indicate the full-charge status. A RESET switch on the left side of the iron must be pushed down to allow the iron to charge at the fast rate again.

Both irons are equipped with screw-in lamps that illuminate the work area near the tip when the power button is pressed. Also, both come with two tips, one a standard chisel and the other a fine configuration for IC soldering.

The new irons are equivalent to 50-watt line-powered soldering irons. The tips come up to soldering temperature within about five seconds after the power button is pressed, and each iron is rated to deliver approximately 160 twisted-tail solder connections, using 22-gauge wire, from full charge.

User Comment. The first test we performed on these new soldering irons was to fully charge them from the completely discharged states in which they arrived. The Model 7700 took almost exactly four hours to come up to full charge, the Model 7800 about 50 minutes. Both irons became warm to the touch, especially the Model 7800, which was quite warm when the full-charge LED came on.

Our next test was to determine approximately how many solder joints each iron would deliver from full charge. To do this, we did not replace the irons in their respective stands between solder operations as recommended by Wahl. We performed this test three times each for twisted-tail, solder-lug, and pc-board connections with both the chisel and fine points installed, recharging fully after each run. We obtained averages of 187 joints for 22-gauge twisted-tail wire connections, 131 for solder-lug connections, and 217 pc-board connections with the fine tip installed. Using the more massive chisel tip, the counts averaged 152, 114, and 180 connections, respectively. The averages were about the same for both irons.

As we were performing our solder-joint count test, we kept track of the times required for recharging to full capacity. Though the charging times did vary from charge to charge, they were well within 10% of the four-hour and 60-minute ratings specified by Wahl.

Our next test was to tackle two rather large construction projects, one a 4-k computer memory board and the other a computer I/O interface board, both of

Iso-Tip 60 Model 7800.

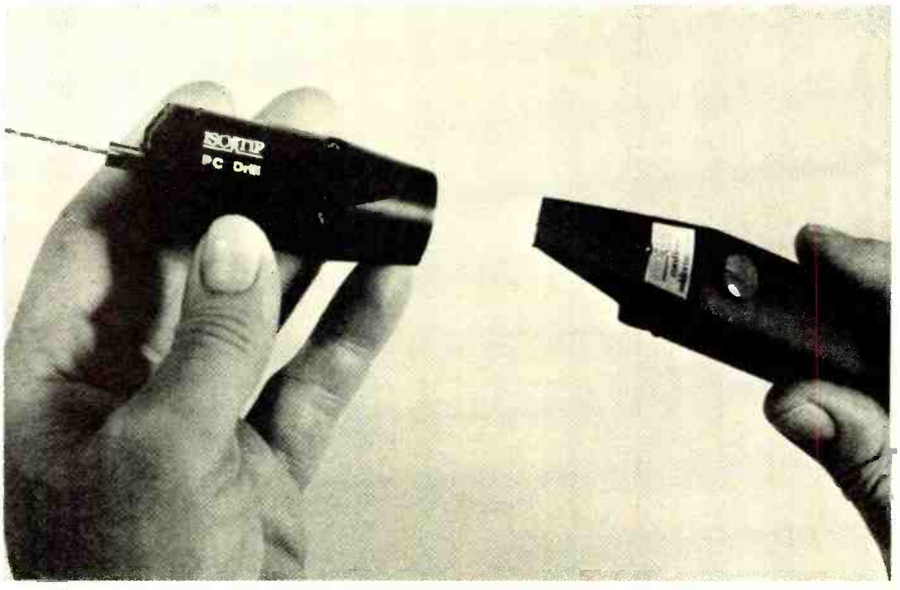
which required several hundred connections to be made. We found that intermittent operation of the Model 7800 iron, replacing it in its charging stand whenever it was not being used to solder a connection, allowed us to complete the entire memory board in two four-hour stints, which is about the amount of time one would normally spend on a project even with a line-powered iron. The Model 7700 iron provided enough soldering power in intermittent operation to allow us to assemble completely the I/O port in three one-hour stints. Needless to say, we were favorably impressed by the performance we obtained from both irons, particularly the Model 7800.

In our final test, we used the irons to operate the optional pc-board drilling attachment. The attachment itself accepts a single size (No. 56) drill bit, which is good for just about all component-lead and IC-pin holes. The attachment snaps onto the tip-header end of the irons and snaps into place on the newer irons or is held in place by a small screw on the older Wahl irons. During our tests, the high-speed drill effortlessly drilled holes through paper-phenolic, polyester, and epoxy-fiberglass boards, both clad and unclad, with great accuracy and at a high-volume rate. We did not attempt to run down the power packs in the irons with the drilling attachment because, after drilling several hundred holes in each case, the irons were still going strong.

Using the irons in both field service work and on our bench, we found no faults in their performance. They are nicely contoured and light enough in weight to eliminate user fatigue. The built-in lamps accurately illuminate the work area and are very convenient when working in chassis with deep recesses. Also, the tips came up to operating temperature almost immediately.

In all, we consider either Wahl quick-charge cordless soldering iron an excellent tool for any hobbyist's workbench, the choice dictated by the amount of continuous soldering time generally needed. We also highly recommend the drilling attachment.

CIRCLE NO. 105 ON FREE INFORMATION CARD



The Model 6500 pc drilling attachment fits all Wahl cordless irons.

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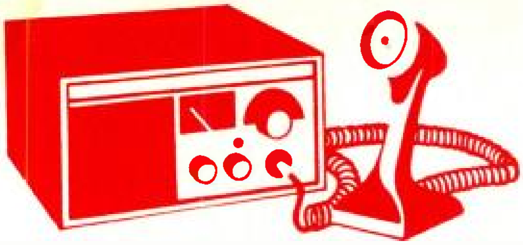

CB Scene

By Ray Newhall, KWI6010

THE ANATOMY OF CBRS

ALL OF US who have traveled the green stamp with wheels on our CB rigs (driven on turnpikes with mobile CB radios in our cars) know that CB makes driving safer, provides additional security in case of vehicle breakdown, and is *fun* to use. It keeps the driver awake and busy on the road and it makes the trip seem shorter. But does its usefulness to highway users account for the CB fever that has spread throughout America? Why have ten million people shelled-out \$100, \$200, or \$300 each for CB rigs during 1976? What prompted nearly a million new CB license applications to flood FCC offices during the single month of January 1977?

The sociologists who keep watch on the habits of the public are eyeing the CB syndrome and believe it is more than a fad which will soon pass on. They consider that it may signal an entirely new shift in sociological behavior. One Columbia University psychologist recently remarked to an FCC assemblage that the growth of CB may be one of the most healthy sociological events since the demise of the telephone party-line. For the first time in forty years there are extensive personal "one-to-one" communications occurring between people who are total strangers.

Oddly enough, this new form of personal communication we call CB has characteristics which are distinctly different from our more traditional communication forms. It is *not* "face-to-face" and projects an aspect of anonymity. Opinions exchanged through this media are apt to be more candid and open in nature because there is no fear of "peer disapproval" or reprisal. It is a medium in which the young and the old can communicate on common grounds and with similar interests; a far cry from the tragically common communication failures which occur between parents and their teenaged children.

Most CB'ers have given a great deal of thought to the selection of their CB handles. Handles serve a far greater purpose than to provide temporary identification between strangers on "the party line." They also serve a somewhat paradoxical purpose of revealing much of a CB'ers personality while concealing his true identity. I know several people who are making collections of the most unusual handles they hear. Some of the oddest ones are those "pairs" of handles used by a CB'er and his XYL or other members of his family.

The CB "lingo" is also unique. Although it is colorful and mystic to newcomers, it is concise and descriptive to those familiar with it, serving a true communication need. Its use gives CB'ers the feeling of belonging to a group, just as Hams are joined by their knowledge of Morse code. In fact, it is sometimes implied that one who doesn't bother to learn the CB language is not too welcome on the band.

The CB Radio Service as we see it today is a unique and useful "game" for young and old alike, and it serves the need of a mobile community. However, it is far from the type of personal radio service the FCC had in mind when the Citizen's Band was first authorized. CB was originally conceived as a two-way radio service for use by families and small businesses. Until recent years, there were only a few channels for communications between different station licensees. As the CBRS has developed today, it is not too effective for its original purpose in heavily populated areas. Yet, the need for such a service still remains!

GMRS, The Other CB Service. The CBRS (formerly the Class D service) is not the only personal radio service available to the general public. The General Mobile Radio Service (GMRS), formerly called Class A, was the first CB radio service. It was authorized in the early 1950s. Eight pairs of uhf frequencies were allocated above 460 MHz. The Class B service authorized low-power mobile two-way radio in the same frequency spectrum. Neither of these two CB services was used extensively because, until recently, we have not had the radio technology to mass produce suitable transceivers at a price the personal user could afford. In fact, the Class B service was abandoned because it had not found any practical personal application.

However, the GMRS service is still available and has now become a high-quality, practical CB service for personal-use radio communications, although equipment cost is substantially higher than Class D gear. The new 460-MHz police communications equipment operates on assigned frequencies very close to the 462/467-MHz GMRS frequencies, and this equipment can be used. It is now feasible to mass-produce solid-state equipment to operate on uhf. On GMRS you may operate up to 50 watts input power and raise your antenna up to 200 feet in height. Line-of-sight FM transmission is most normally used. Repeaters and auto-patches are currently permitted, just as the Hams now use them on the 2-meter band.

In the Chicago, Cleveland and Dallas areas, to name but a few, GMRS "CBers" have banded together to set up community repeaters. They use 15-watt mobile units or 2½-watt hand-held transceivers to reach the repeaters for reliable rebroadcast to other stations as far as 25 to 40 miles away. In this way, they can contact their families or offices through the repeater, or they can dial direct landline calls to business associates by use of a touch-tone pad on the back of their mikes. Tone-encoded squelch circuits are said to work so well that these FM transceivers will be activated only by those calls intended specifically for them.

As a matter of fact, this columnist just mailed a Form 400 for a GMRS license to the FCC this morning. I have a standard CBRS AM unit in my car for use on the road, but it is not too practical to call my home (located in a densely populated Eastern Seaboard area) unless I'm rather close by. I operate a small consulting service and I intend to use GMRS radio to keep in touch with my customers from my car while I am within 25 miles of my home.

GMRS is not for everyone, but it does meet the needs of those who want high-grade personal and business communications. The cost is from two to five times as much as the current prices of CBRS equipment; more if you hang on all these accessories. But for many people it serves a practical purpose and in many cases may eliminate the need for telephone answering service or even a secretary. ◇

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Computer Bits

By Hal Chamberlin

ASSEMBLERS

ACCORDING to a recent magazine survey, one of the most popular applications of personal computers is software development, or simply writing programs. As anyone who has been bitten by the programming bug undoubtedly knows, each new program is always bigger and fancier than the last. Beyond a certain point in program complexity, however, the use of an assembler program is almost mandatory to eliminate most of the drudgery associated with hand coding in octal or hex. This is particularly true when one wishes to make a "small improvement" to a hand-assembled program which otherwise requires it to be rewritten.

Functions of an Assembler. Using an assembler in machine language program development has three important advantages over hand coding. First, an assembler allows the programmer to use operation mnemonics such as "LDA" for the "load register A" operation rather than the octal code 072 (8080 microprocessor). When looking at a program you wrote several weeks ago or one written by somebody else, the LDA is much more meaningful than the 072, which in turn makes the program easier to understand.

The second and most important advantage is that the addresses of sections of code and data items can be given *symbolic names* and referred to by name. Again, a name like TAXTAB used to refer to a table of tax rate data is more meaningful than its address which might be 005:120. The most important benefit of symbolic names comes when a program is changed for some reason. With a hand-coded program, some of the addresses used in the program would probably have to change as sections of the program and data are shuffled around to make room for additions. Then, every reference to addresses that were changed would also have to be changed. The result is that, in a large program, a considerable number of changes may be necessary for what would otherwise be a minor addition. With symbolic names, the assembler can do all of the address shuffling when the program is reassembled and the programmer need be concerned only with the additions. The concept is analogous to solving an equation in general using symbols and algebra and then substituting actual values into the *solution* rather than solving the equation for each set of values needed.

A third advantage is that the use of an assembler tends to develop good program documentation habits which adds to the value of a program. All assemblers allow the latter part of each statement to be used for comments. A well-written program has an English explanation of what the machine instructions are accomplishing as comments on nearly every statement. A neat assembly listing of a program is also much easier to reproduce and read than hand scrawls on coding sheets. Conversely, buying a machine language program without documentation in the form of commented assembly listings is like buying electronic equipment without a schematic.

Using the assembler program itself is generally quite simple. First the assembly language program which is called a *source* program is converted into machine readable form. Such a form may be ASCII characters on paper tape, audio or digital cassette records, floppy disk sector records, or even ASCII data in memory depending on the system and assembler used. Usually some kind of program editor is used to aid in entering and editing the source program. Next the assembler is loaded and executed. During execution, the assembler will scan the source program and produce a *listing* file containing a copy of the source program along with the octal machine codes and an *object* file containing only the machine codes.

The assembler may also flag some statements as having errors. Common errors that an assembler can catch include using non-existent instruction mnemonics and undefined symbols. The latter is the case when a reference is made to a symbolic address but an actual address is never assigned to the symbol. These and other errors detected by the assembler are usually caused by typing mistakes. After editing the source program to eliminate errors and reassembly, the object program is ready to be loaded into memory and executed.

Types of Assemblers. Although all assemblers perform basically the same function, there is considerable variety in the implementation and use details. Perhaps the most distinguishing characteristic is the number of scans or *passes* over the source code done by the assembler.

A classical assembler makes two passes over the source program. During the first pass, all symbol definitions are searched out and placed in a *symbol table* maintained by the assembler. During the second pass, the mnemonics are translated into their octal equivalents and the listing file and object file are generated. The two passes are needed because a reference to a symbolic address may occur in the program ahead of the definition of the symbol. This is called forward referencing. If the assembler is to know what octal address to substitute for the symbol, it will have to see the definition first.

Several attempts have been made at one-pass assemblers and a couple of these are available on hobbyist systems. The advantage of a one-pass assembler is increased assembly speed since the source file, which may be many thousands of characters in length, needs to be read only once. Often however the one-pass assembler imposes

```
         .MACRO
*        MACRO DEFINITION FOR A DOUBLE PRECISION ADD FROM MEMORY
*        MACRO-INSTRUCTION
*        ADDS THE CONTENTS OF $ADDR AND $ADDR+1 TO REGISTERS B AND
*        C WITH THE RESULT IN B AND C, CONDITION FLAGS UNAFFECTED

$LBL     DPAD $ADDR                DOUBLE PRECISION ADD PROTOTYPE

         PUSH H                    SAVE H AND L
         LHLD $ADDR                GET TWO BYTES TO ADD IN H AND L
         DAD  B                    ADD THEM TO B AND C
         MOV  B,H                  COPY RESULT INTO B AND C
         MOV  C,L
         POP  H                    RESTORE H AND L
         .MEND
```

Fig. 1. Example of macro definition.

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restrictions on program organization and the free placement of symbols. This is due to the "look ahead" problem mentioned earlier. Sometimes a one-pass assembler is "faked" by a two-pass one. In this case the source file is read for the first pass and then saved in memory for the second pass which is invisible to the user. The difficulty with this approach is that a large amount of memory is needed to assemble a reasonably large program.

Occasionally a "three-pass" assembler is seen. These are really two-pass assemblers with the second pass split in two to accommodate a Teletype with built-in paper tape. These machines cannot punch the object file at the same time as printing the listing file so a separate pass is required for each function.

A *conversational* assembler is another variation. Basically a combination of a simple text editor and a conventional assembler, the conversational assembler is very convenient for experimentation and testing of short programs and subroutines. Operation of a conversational assembler is much like most BASIC language systems. The program is typed in line-by-line and edited using line numbers and simple editing commands. When a RUN command is given, the program is quickly assembled directly into memory and executed. Program size is limited since the source program ASCII text, symbol table, and object program as well as the conversational assembler program itself must all fit into memory at once.

Advanced Assembler Features. As assembly language programming experience increases, some of the more sophisticated assembler features available will be appreciated. Although these features have been rare in hobbyist oriented systems, the assemblers being supplied with recently announced floppy disk systems generally have most of them.

One such feature is *macro-instruction* capability. A macro-instruction (often abbreviated as "macro") is one that may generate many machine language instructions when assembled. When writing a program, macro-instructions may same dummy argument in the LHLD instruction as in the prototype. The .MEND signals the assembler that the macro definition is complete. The definition is then saved by the assembler in a special table in memory reserved for that purpose.

Figure 2 shows the use of this macro-instruction in a program (octal). In this example all of the instructions generated when the macro was expanded are shown on the listing with a preceding minus sign. Generally the assembler will have a command that would suppress printing of these expansion instructions if desired. With a good library of macro definitions, assembly language programming may become almost as easy as programming in a higher level language.

Another advanced feature is called "relocatable object code" capability. An assembler having this feature supplies additional information in the object file so that it may be later loaded into memory *anywhere* desired completely auto-

```
                              *         EXAMPLE PROGRAM SEGMENT ILLUSTRATING USE OF DPAD MACRO

001:100 116                   MOV  C,M           LOAD ORIGINAL RAW VALUE (16 BITS)
001:101 043                   INX  H
001:102 106                   MOV  B,M
001:103                       DPAD CORR          ADD IN CORRECTION FACTOR
001:103 345             -     PUSH H             SAVE H AND L
001:104 052 200 001     -     LHLD CORR          GET TWO BYTES TO ADD IN H AND L
001:107 011             -     DAD  B             ADD THEM TO B AND C
001:110 104             -     MOV  B,H           COPY RESULT INTO B AND C
001:111 115             -     MOV  C,L
001:112 341             -     POP  H             RESTORE H AND L
001:113 160                   MOV  M,B           UPDATE WITH CORRECTED VALUE
001:114 053                   DCX  H
001:115 161                   MOV  M,C
```

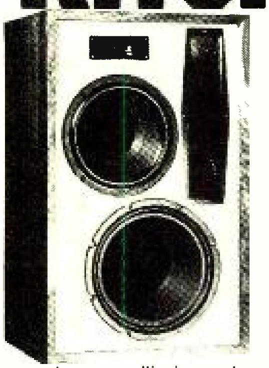
Fig. 2. Example of use of a macro-instruction.

be used just as if the microprocessor actually had them as real instructions in its repertoire.

Macros can be defined by the programmer at the beginning of his program according to his needs. Although exact details of macro definitions and usage differ among various assemblers, a typical macro definition is shown in Fig. 1. The .MACRO on the first line alerts the assembler that a macro definition follows rather than ordinary program instructions. The next line gives the macro *prototype* which defines how the macro-instruction would look in a source program. The symbols preceded by dollar marks are sometimes called "dummy arguments" because, when the macro-instruction is actually expanded by the assembler, they are effectively replaced by the actual symbols used in the macro-instruction. Following the prototype are the actual machine instructions that would be generated when the macro-instruction is used. Note the use of the matically without difficulty. A special *relocating loader* must be used to interpret this extra information and load the object file into memory. Not only are the addresses of all jump, call, and direct addressing instructions changed, but address constants and other location dependent symbolic references are changed. An additional feature of the relocating loader allows several object files that were generated at different times to be linked together into a single coherent program with all calls and jumps between the separate "modules" properly adjusted. This feature greatly facilitates the use of subroutine libraries without having to copy all of the source code into the program being developed every time a subroutine from the library is needed.

With this little bit of background, the reader should be able to evaluate more fully the assembly language program development facilities of a particular system. ◇

SPEAKER KITS.



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HOBBYIST COMPUTER CLUBS COMPILED BY Popular Electronics

(Additions to list published April 1977)

CALIFORNIA

Association for Educational Data Systems
c/o Dr. Jane D. Gawronski
Dept. of Education
6401 Linda Vista Rd.
San Diego, CA 92111

Inland Computer Society
c/o Tom Munnecke
P.O. Box 55052
Riverside, CA 92517

Southern California Computer Society
P.O. Box 54751
Los Angeles, CA 90054

ILLINOIS

SCCS 5063
c/o Roy Emerson
14904 S. Calis Ave.
Posen, IL 60469

St. Louis Area Computer Club
c/o Lou Elkins
Box 1143, St. Louis, MO 63188

MASSACHUSETTS

Boston Computer Society
c/o Donald Bradley
123 Commonwealth Ave.
Boston, MA 02116

Greater Boston Computer Users Group
c/o Steven Hain
40 Wilshire Dr. (Door 2)
Sharon, MA 02067

MINNESOTA

Minnesota Computer Society
P.O. Box 35317
Minneapolis, MN 55435

MISSOURI

St. Louis Area Computer Club
c/o Lou Elkins
Box 1143, St. Louis, MO 63188

NEBRASKA

Mid-America Computer Hobbyists
c/o Lt. Tom Smith
2708 Calhoun St.
Bellevue, NB 68005

NEVADA

SCCS
Quentin C. West
15 Ballerina
Henderson, NV 89015

NEW JERSEY

SCCS
c/o William Staatse
Box 947, McGuire AFB, NJ 08641

NEW MEXICO

US Robotics Society
Box 26484, Albuquerque, NM

NEW YORK

Stony Brook Homebrew Computer Club
c/o Dr. Ludwig Braun
College of Eng. and Applied Science
State University of New York
Stony Brook, NY 11794

OHIO

Dayton Microcomputer Association
Dayton Museum of Natural History
2629 Ridge Avenue
Dayton, OH 45414

North Central Ohio Computer Club
c/o Bill Hicks
618 Teakwood Court
Galion, OH

OKLAHOMA

Tulsa Computer Society
P.O. Box 1133
Tulsa, OK 74101

PENNSYLVANIA

Northeast Computer Association
834 Lawler Street
Philadelphia, PA

St. Thomas District HS Computer Club
1025 Braddock Avenue
Braddock, PA 15104

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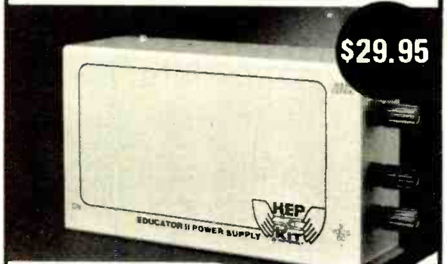

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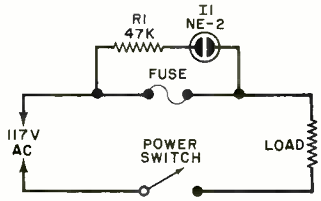


current will flow through *R1* and *I1*, an NE-2 neon bulb. If the fuse blows, the ac takes the alternate path through *R1* and *I1*. A 47,000-ohm, ½-watt resistor is used to limit current through *I1* to a safe value. Mount *I1* in any convenient (but visible) location.—*Ross Thompson, Listowell, Ontario, Can.*

DESOLDERING BRAID

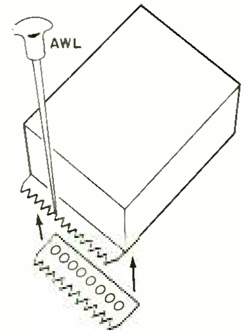
An inexpensive source of desoldering "wick" is the outer conductor of RG-58 and RG-59 coaxial cable. Cut your scrap into 8- to 10-inch (20.4- to 25.4-cm) lengths. Hold the braid and inner conductor firmly with pliers, and pull off the outer insulating jacket with your free hand. Then, push the two ends of the braid together to loosen it, and pull out the inner conductor and surrounding insulation.—*Arnold Irvine, Coopersburg, PA.*

TEST JACK ADAPTER

Have you ever bought a new meter or other piece of test equipment only to discover that none of your standard ¾-inch spaced test plugs will fit the jacks on it? If you can't or don't want to modify your new piece of gear by slotting the test jack mounting holes, consider this simple adapter you can make to rectify the situation. All you need are a pair of banana jacks, a pair of noninsulated banana jacks, and a 1¼-inch (3.81-cm) square piece of ⅛-inch (3.2-mm) thick plexiglass or bakelite. Round the corners of the plastic and drill two holes at opposite corners for the jacks, spaced ¾-inch (1.9-cm) apart. Then carefully measure the spacing between the test jacks on the new equipment and drill holes for the plugs in the plastic square to match this spacing. Assemble and wire the plugs and jacks and you're all set.—*Donald R. Hicke, San Diego, CA.*

PC DRILLING GUIDE

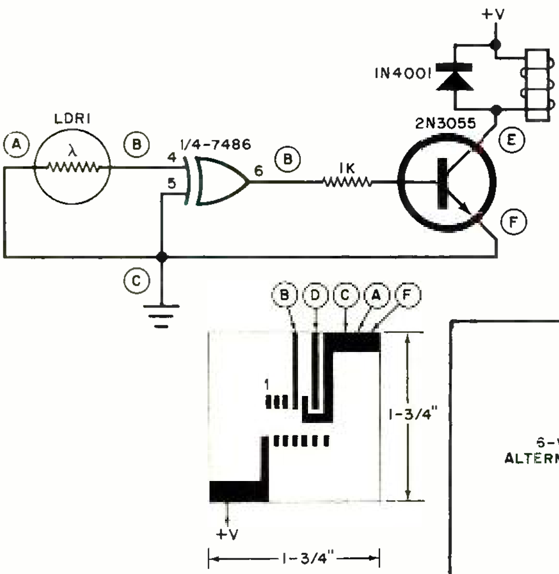
Here's a handy guide for drilling IC pin holes on a pc board. Epoxy a length of discarded Molex Soldercon holder strip to a block of wood as shown. Attach a few strips of double-faced adhesive tape (Scotch No. 666 or equivalent) to the



bottom of the block to prevent slippage. Hold the block on the pc board with one hand and make indentations with an awl at each "valley" along the holder strip. Then remove the block. You will find a line of depressions that can easily be drilled through the board, exactly 0.1" (2.54 mm) apart.—*Robert J. Murrell, Verona, PA.*

INEXPENSIVE ELECTRIC EYE

Here's an electric eye that can be built from junkbox parts. It consists of a CdS photocell, a 7486 exclusive-OR gate IC, an npn switching transistor (2N3055 or similar) and a small electric bell. When no object interrupts the light path from a lamp to photocell *LDR1*, both inputs to the ex-OR gate are low. Thus the gate's output is low and the transistor is cut off. Interrupting the light beam causes the gate output to go high and the transistor to conduct, energizing the bell. A 6-volt lantern battery can be used as a power source. All parts can be obtained for about $3 from a surplus house. A simple pc board is used, and can accommodate up to four independent circuits, each using one gate in the quad ex-OR IC. The entire alarm can be mounted on a TO-3 heat sink.—*Kenneth B. Blois, APO SF 96286.*

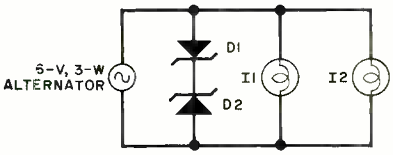


IC SOLDERING AID

To prevent heat or static damage to an integrated circuit while soldering, push the pins of the device through a few sheets of aluminum foil measuring 2" x 2" (5.1 x 5.1 cm). Then mount the IC on the circuit board. The foil will dissipate heat and electrically tie all the pins together. When the IC is in place, tear away the foil. Check carefully for stray pieces of foil before powering the board. The foil will generally come away in a few pieces without leaving tiny scraps.—*Aart M. Olsen, Newark, DE.*

BIKE LIGHT SAVER

I installed a Soubitez alternator to power the head and tail lights on my bicycle. Unfortunately, I found that the bulbs were burning out râther quickly when I was travelling at speeds greater than 15 mph. The problem was solved by installing two zener diodes back-to-back as shown in the figure. Before the modification, the alternator output was 6 volts rms at speeds greater than 6 mph. After the change, the voltage applied to the bulbs dropped to about 4.9 volts rms. Bulb life was considerably extended without significant reduction of light output. In the diagram, left, the miniature headlight (*I1*) is rated at 6 volts and 300 mA. The tailight (*I2*) is rated at 6 volts and 100 mA. The two zener diodes (*D1* and *D2*) are rated at 6 volts and 3 watts. Higher-powered zeners can be used.—*D.F. O'Connell, Palo Alto, CA.*



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Operation Assist

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

American Scientific Development TV-20 tube tester. Schematic, operating manual, chart. Will buy or copy. Terry Nixon, RR 1, Box 182, Potosi, MO 63664.

Sprague TO-3 capacitor checker. Need 15-watt 50-kohm power rheostat. Ray Parsons Jr., Portsmouth Ave., Stratham, NH 03885.

Kris "Match Maker," serial 3302003. Schematic and/or specifications such as frequency, impedance, etc. Bob Dianetti, 80 Billington Rd., East Aurora, NY 14052.

AGS IC-RS-82 eight-track recorder/player. Schematic. Henry D. Mikkelsen, VA Hospital, Marion, IL 62959.

Gran Sonic GS-2 stereo receiver. Schematic, also need power transformer, marked SAT-260 OCM. John D. Gill, Rte. 5, Box 370, Blountville, TN 37617.

RCA WO-91B oscilloscope. Operating manual. Donald R. Anthony, 821 Lantana St., Corpus Christi, TX 78408.

Allied Knight 83Y102 Star Roamer radio. Schematic. Will buy or copy. Gerald Fox, Fox Electronics, Box 890, Rte. 3, New Holland, PA 17557.

RCA WP-23A regulated power supply. Schematic, operating instructions, or service manual. Ronald Gillen, Box 383, Hustisford, WI 53034.

Cartrivision video tape recorder. Source of tapes and spare parts. Donald Weber, 1333 N. Camino Alto, Apt. 245, Valleyo, CA 94590.

Bell & Howell 34 oscilloscope (DeVry Inst. of Tech.). Operating manual, schematic. R. Wood, 465 San Antonio, Palo Alto, CA 94306.

Hickok 640 oscilloscope. Schematic and/or service manual. Robert Zusman, 200 East Indian Spring Dr., Silver Spring, MD 20901.

LLoyd TM-988 AM/FM receiver. Schematic, operating manual and/or parts list. Peter B. Trippett, 581 Glen Rd., Sparta, NJ 07871.

Friden paper-tape readers, typewriters, Justowriters. Schematics, operating instructions. J.I. Taylor, Box 289, Salem, MA 01970.

General Radiotelephone MC-5 CB transceiver. Schematic, manual. Elliott Electronics, RR 2, Box 61, Effingham, IL 62401.

Tektronix 564 scope. Need 3B3 time base, 3A6 vertical plug-in. Ramesh B. Parikh, P.O. Box 17356, Bombay 400 058, India.

Fisher 400 receiver. Schematic and/or information on power transformer. **Magnavox** 9—295HH console. Schematic, power capabilities of 15" woofers that come with console. Thorn Filippeli, Rte. 1, Box 39-Z, Connie Lane, Shingle Springs, CA 95682.

Radio City 488 multimeter, circa 1942. Schematic and any other information. Joe H. Hibbs, 971-87 Borden Rd., San Marcos, CA 92069.

Jackson Instrument 641-A signal generator. Schematic, alignment procedure. J.M. Nightingale, 1675 Comox St., Vancouver, B.C. Canada V6G 1P4.

Devtronics SR-55 calculator. Owner's manual, source of case and keytops. Ivan Dzombak, 621 Spring St., Latrobe, PA 15650.

Kaar TR-505 uhf repeater. Schematic, owners manual or any info. V.C. Reed Jr., 1104 Abbot Ln., Park Forest South, IL 60466.

Solid State Devices Trigsweep, circa late 1960's. Instruction manual, pc artwork, parts list. John A. Harlan, 9720 Prospect Ave., Chicago, IL 60643.

Superior Instruments 707 or 707-A VOM multitester. Schematic, instruction manual, parts list. Buy or copy. Arthur Kneller, 84 Bennett Ave., Neptune City, NJ 07753.

Rutherford B16R pulse generator, serial 171. Service manual and/or schematic. Vilson Silveira, 7708 Regent Ave. N., Brooklyn Park, MN 55443.

Marlux 407 reel-to-reel recorder. Schematic, service manual, or any info. T.K. Flanagan, U.S. Bluefish (SSN 675) FPO NY 09501.

RCA Berkshire, circa 1948. Literature and data, also speaker. Fabris, 3626 Morrie Dr., San Jose, CA 95127.

Transicorder TR300 reel-to-reel recorder. Need erase and record head. Erase head has 230-mH inductance, 1.5-V dc erase, dc bias. Play-record head has 380-mH inductance, 0.2 V bias. Curt Palme, 990 Wavertree Rd., North Vancouver, B.C., Canada V7R 1S5.

Heathkit 0-8 oscilloscope. Schematic and/or construction manual. Frido W. Buschmann, 3736 Pine Rd., Huntingdon Valley, PA 19006.

Heathkit 0-12 oscilloscope. Need power transformer. Kenneth Huffines, 356 O'Brian Dr., Stone Mountain, GA 30088.

Crosley 96 radio. Circa late 30's. Schematic, power transformer. Richard R. Nolette, RFD #1, River Rd., Kennebunkport, ME 04046.

Mercury Electronics 1101 tube tester. Manuals, any information. James B. Martin, 1708 Dave Dr., McAlester, OK 74501.

Atwater Kent 35 radio, serial 772713. Date of production, value. Kenneth J. Roberds, Box 367, Barling, AR 72923.

Transcom RCT 203 audio data terminal with strip printer. Schematic and/or manual. Will pay for copying. J. Bryan Loofbourrow, Box 1237, Mountainside, NJ 07092.

Century VT-10 VTVM. Schemtaic, operating manual, probe. **Eico** 232 VTVM. Schematic, operating manual, probe. **Supreme** 542 multimeter. Schematic, operating manual. Allen C. Fryou, 3735 Fairmont Dr., New Orleans, LA 70122.

Sharpe HA-10A or other Sharpe headphones. Source. Dr. James P. Gaston, 45 East End Ave., Apt 5A, New York, NY 10028.

Precision 100 VOM. **Simpson** 311 VTVM. Schematics. Alan Norville, Rte. #2, Box 283, Forest City, NC 28043.

Hallicrafter S-38-E. Schematic, alignment manual, or any info. Steve L. Porter, 429 Balsam, Rogers City, MI 49779.

Conar 250 oscilloscope. **Motorola** FMTRU80D(A)1C2C mobile 2-meter transceiver. Schematics, operating manuals, any other info. David Eubank, Box 113, Greenup, IL 62428.

Skycrafter "VHF Superphone" AMT-9 transmitter, AMR-4 receiver. Schematics and any other info. Al Gwinn, 3321 Beverly Dr., Dallas, TX 75205.

Radio Shack 28-138 color organ kit. Schematics, parts list, or instruction manual. Gary Girzon, 4665 St. Kevin #3, Montreal, P.Q. Canada H3W 1N8.

A.C. Cossor 1434 preamplifier. Source of 120-V battery. **A.C. Cossor** 1049 MKII oscilloscope. Original camera, CRT. Claude Houde, 7427 Boyer St., Montreal, P.Q. H2R 2R9.

Olson AM-240 50-watt amplifier. Output transformers, 8-ohm output impedance. W.B. Wells, 172 Topsfield Rd., Pittsburgh, PA 15241.

Erie Pacific 720 frequency counter. Service manual, schematic, parts list, source for Elesta EZ10A and Burroughs 5031 tubes for counter. Gordon Wheatley, 9 Lynngrove Ave., Toronto, Ontario, Canada M8X 1M3.

Collins 32V2 transmitter. Instruction manual. Marvin E. Weber, Box 1261, Alamogordo, NM 88310.

Realistic 212 preamplifier, 210 ultra-linear amplifier. Any info. R. A. Rouge, Box 92, Hollywood, CA 90028.

U.S. Govt., RAO-2 Navy shortwave receiver (National type NC-120), Navy CNA-46187. Service manual and/or schematic. David L. Larson, 1301½ S. First, Harlingen, TX 78550.

Precision EV10A VTVM. Schematic, manual. Willis J. Ball, 320 Bloxam Ave., London, Ontario, Canada N6J 3K6.

Crosley Showbox, circa early 1900's. Shematic, any rebuilding or service info. Kenneth Huffines, 356 O'Brian Dr., Stone Mountain, GA 30088.

National SW-3 receiver. Need series 10-20 coils, bandspread if possible. Martin Edelheit, 245-21 77 Crescent, Bellerose, NY 11426.

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WW II Equipment. Model RDO (Navy issue) receiver (circa 1945); Model AN/SPR-2 receiver; Model AN/APA-6A oscilloscope. Schematics and general manuals. John Andrews III, 11011 Waycroft Way, Rockville, MD 20852.

Stephens "Truphonic" midrange speaker systems. Circuitry and parts information. Frank J. Burris, 35640 Avenue F, Yucaipa, CA 92399.

Bunker Ramo Model 203-B-MON teleregister video display. Schematics and/or service manual. F. Ascolillo, Park Lane, North Windham, ME 04062.

Microsystems International DTMF receiver card. Schematics and manuals or any available information on touch-tone receiver cards. James Chochos, Jr., A-E 6107, San Luis Obispo, CA 93409.

Philco Model 41-608, Code 122 radio-phono combination. Schematic, parts list, tubes and parts source. R. Galligan, Box 326, Niantic, CT 06357.

Leak point-one stereo preamplifier and stereo-fifty power amplifier. **Altec Lansing** Model 445A stereo preamplifier. Schematics needed. Bill Rathyen, 19 Broadway, Bayonne, NJ 07002.

Simpson Model 330 tube checker. Schematics, operations manual and current tube sheet. Duane Schuh, 824 La Porte Dr., La Canada, CA 91011.

Meissner Analyst. Operating and service manual. John Graham, Box 186, Wurtsboro, NY 12790.

Superior Instruments Model 77 VTVM Schematic and/or service manual. Mr. Test, P.O. Box 9064, Newark, NJ 07104.

Eldico Model MT 2 2-meter AM transmitter. Schematics and operations manual. Francis H. Bailey, 541 Hill P.O., Dudley, MA 01570.

Kepco Labs Model 150 rack-mount variable power supply. Schematic, parts list and wiring diagram. Also, **Crystal Research Products** Model 203 crystal checker. Schematic and any available information. Craig K. Sellen, Box 293, Carbondale, PA 18407.

Micronta Model 22-012 tube tester. Need tube chart. Charles A. Mizera, 3226 N. Kostner Ave., Chicago, IL 60641.

Clough-Brengle Model 111 frequency modulator. Operations manual or any available information. G.J. Kulp, 1115 Lilac Lane, West Lawn, PA 19609.

Heathkit Model 1G-62 color bar and dot generator. Schematic and/or service manual. Earl D. Kent, 810 E. 1st St., Emmett, ID 83617.

Panasonic Model RF-1006M AM/FM/MB radio. Schematic and operations manual. Bruce Stanley, 350 Beechwood O.T.S., Granburg, TX 76048.

B&K Model 1075 television analyst; Model A107 Dyna-Sweep circuit analyzer; Model 445 CRT tester. Service and operation manuals. Paul S. Panikowski, 5006 Edgewood Rd., College Park, MD 20740.

Cartridge Television Inc. Model MCA-0001 video camera. Schematic and service manual. Michael A. Lizzio, Apt. 8C, Clover Path, Spring Hill Apts., Maple Shade, NJ 08052.

Reflector, 18-in. parabolic. Need source. Albert Bhuataphor, 5008 W. Pullerton Ave., Chicago, IL 60639.

Jackson Model TVG-2 TV/FM sweep alignment generator. Schematic and operation manual. Eden Rubin, 227-12 57th Ave., Bayside, NY 11364.

Measurement Control Devices Model 300 oscilloscope. Schematic and manual. Michael E. Headberg, 7760 NW 171 St., Hialeah, FL 33015.

Automatic Radio "Tom Boy" AM radio (circa late 1930's-early 40's). Parts list and/or schematic. C. Walker, 131 Bernard St., San Francisco, CA 94109.

Precise Model 305R triggered scope. Schematic, parts list and instruction manual. William H. Bragg, 1424 College, Des Moines, IA 50314.

Transcom Electronics Model SBT3 SSB transceiver. Alignment instructions, schematic and any other available information. Ari Procopio, QSL Bureau, P.O. Box 22 Labre, Sao Paulo SP 1000, Brazil.

Solid State Model ST-1000 TV camera. Any available information. Leigh Klotz, Jr., 119 Harmony St., McComb, MS 39648.

Honeywell Model TCM-31-C memory. Need PAC card layout. Joe Schram, Box 1818 Washington, DC 20013

Hallicrafter Model S38E shortwave receiver and **Precision** Model E-200 signal generator. Need schematics. S. Bergen Wilson, 1403 Lyttleton St., Camden, SC 29020.

Hammarlund Model FM50A outercom and **Knightkit** Cat. No. 83Y146 oscilloscope. Schematics and manuals. James F. Reuter, 2595 Marlborough, Detroit, MI 48215.

Radio Compass Type R101/ARN6 receiver control box. Handbook and RX mounting rack needed. Lionel L. Sharp, 19 Kelso St., Chermside, Queensland, Australia 4032.

American Concertone Model 505 reel-to-reel tape recorder. Schematic and service information. Duncan Crawford, 206 Cedarwood, Flushing, MI 48433.

Rockland Model 5500 frequency synthesizer. Schematic needed. Thomas Barrett, 39 Lake Drive, Monroe, LA 71201.

Superior Instrument Model 800 allmeter. Schematic and operating manual. Robert E. Heitz, 317 Woodward Ave., Buffalo, NY 14214.

Navy Surplus oscilloscope type TS-34A/AP. Schematic and service manual. James W. Booker, 2808 W. Boyce Ave., Fort Worth, TX 76133.

Magnavox Model FM-16 AM/FM radio. Schematic. Robert J. Hewitt, 318 N. Greenbay Rd., Waukegan, IL 60085.

Burroughs 9350-2 (Friden #7311) computer terminal keyboard/printer. Control unit schematics and maintenance manual. Gary Alderman, 8615 Portsmouth Dr., Laurel, MD 20811.

Grundig Model M72 PX musical instrument. Schematic or tube list. Greg Binverse, 311 Monroe St., Valders, WI 54245.

Advance Electronics Model OS 15 oscilloscope. Schematic and any available information. Anil Rodriques, Gilpin Ave., #1, Wilmington, DE 19806.

Webster wire recorder. Recording wire needed. A. Markowitz, 9 Henneberry Ln., Golf, IL 60029.

EMC Model 600 oscilloscope and Model 400 signal generator. Schematics and instruction manuals. J. Massing, 208 Dickens Dr., Toledo, OH 43607.

Dumont Type 241 oscillograph and **Hickok** Model RFO-5 oscillograph. Schematics and/or parts lists. A. Elliot, 221 N. 4th St., Tonawanda, PA 18848.

Elco Model 221 VTVM. Meter needed. Hervey C. Cain, Box 66, Coal Hill, AR 72832.

Zenith Model 6S532 2-band table radio. Operating manual, schematic, parts and alignment information. A. Hawk, 21 Rivercrest, Hanover, NH 03755.

RCA Model WT-100A electron-tube micromho-meter. Operation manual, schematic and tube chart. Danny Tovar, 4700 Rockmoor Ln, Fort Worth, TX 76116.

Hallicrafter Model CN-1 FM converter. Schematic needed. H.A. Wickert, 5 Deerview Ln, Asheville, NC 28804.

Concert Company Model 8003 "Emitator." Schematic and parts list for servicing. Bud Petersen, 801 Polynesian Dr., Long Beach, CA 90805.

Canadian Marconi Model C-2 frequency indicator (circa 1943). Schematic and operating instructions. M. Armstrong, 243 Howard, Sherbrooke, P.Q., Canada.

McMurdo Model 900 Silver Vomax. Schematic and operating manual. Don White, 109 Burns Street, Essexville, Michigan 48732.

Miranda "Nocturne" stereo tape recorder. Schematic or any available information. Walter Baker, 162 N. Queens Ave., N. Massapequa, NY 11758.

Microsystems International touch-tone receiver. Manual and/or schematic. J. Chochos, Box A-E 6107, San Luis Obispo, CA 93409.

McIntosh Model C-8 or C-8P. Looking for unit. B. Gerber, 8221 Streamwood Dr., Balto., MD 21208.

Hallicrafters Model SX-100 receiver. Operator's manual, schematic or other information. Dale C. Vawter, 117 Altena St., San Rafael, CA 94901.

Racom Model 2174-610 selective voltmeter. R. Reed, 2054 Bradley, Ypsilanti, MI 48197.

Hartman "Hurricane" vhf-FM marine transceiver, 5-channel. Circuit diagram and manual. Paul Smith, 65 West St., New London, CT 06320.

Dumont Type 322 dual-beam oscillograph. Service or schematic. David Paseur, 6327 Everglades Dr., Alexandria, VA 22312.

Military radio receiver Model R-440 (XN-1) manufactured by RCA. Operating manual, service manual, schematics or any available information. Peter Z. Simpson, 18 University Dr., Natick, MA 01760.

Knight Model KG-2000 oscilloscope. Service and calibration data, power transformer data, and/or source. Ron Hunter, 308 Mertens Ave., Racine, WI 53405.

APELCO Model AE-31MA radiotelephone, **AMECO** Model CMA multiband converter and **B&K** Model 500 "Dyna-Quik" tube tester. Service manuals or any available information. Herb. Mitschan, 1688 Baywood Dr., Petaluma, CA 94952.

Philco Model 41-250 radio. Schematic, parts list and parts source. Charles M. Pache, Box 208, Marysville, KS 66508.

Philco Model 19 MK II wireless set with Model 3A MK II control unit. Built for Russian tanks during W.W. II. Need any available information. Cliff Holm, 1900 Grant Dr., Regina, Sask., Canada.

Johnson "Viking Ranger I" transmitter and **Drake** Model 2B receiver. Operation and service manuals. Paul Barbuto, Box 385, Genesee, ID 83832.

DeVry Tech. Model 1-15 5-inch oscilloscope. Builder's manual and calibration instructions. Andy Van Loenen 4684 Wakefield N.E., Comstock Park, MI 49321.

Muse sequencer oscillator, **Western Electric** Model TP25-1 amplifier and **3-M** Model 78-9020 microphone. Schematics and parts source. James D. Craig, 511 Cedar St., Allentown, PA 18102.

Crosley Model Super 11 radio. Schematic and any available information. David P. Lesser, 82 Rolling Green, Amherst, MA 01002.

Teletype Corp. Model 15Y typing unit. Schematic and instruction manual. Martin H. Bunshaft, 29A Forest Acres Dr., Bradford, MA 01830.

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ELECTRONIC TROUBLESHOOTING WITH SIMPLIFIED CIRCUIT ANALYSIS

by Leo Rozman

The author aims to familiarize the reader with a wide variety of circuits, how they operate, and how to localize trouble using symptom analysis, signal injection and/or tracing. Using simple circuits (mostly solid-state) as examples, the author covers troubleshooting via dc and ac measurements, the effects of passive components, identifying circuits, controls and adjustments, and symptom analysis. The stress is on practical, time-saving techniques in repairing radio and TV receivers.

Published by Parker Publishing Co., West Nyack, NY 10994. 240 pages. $12.95 soft cover.

MODERN ELECTRONICS MATH

by Jerrold R. Clifford and Martin Clifford

Immediate application is the keyword here, with electronics first brought into the picture on page 21, in a problem on adding series resistance. Arithmetic, algebra and trigonometry are thoroughly explored, with a multitude of examples taken from electronics. In the section on square root, the reader is shown how to calculate current, given power and resistance. In the chapter on trigonometry, phase angle and impedance calculations are introduced, among many other areas. A chapter on logarithms gets into decibels, power gain, etc. Four chapters are aimed at computer math: binary numbers, octal and hex humbers, other number systems, and Boolean algebra.

Published by Tab Books, Blue Ridge Summit, PA 17214. 684 pages. $9.95 soft cover, $12.95 hard cover.

THE RADIO AMATEUR'S HANDBOOK (54TH ED.)

by the ARRL Headquarters Staff

The 1977 edition of the radio amateur's "bible" has been revised to reflect changes in both technology and amateur radio. An introductory chapter explains the basic characteristics of the amateur radio service, and is followed by chapters dealing with radio theory. The handbook is well illustrated and contains many graphs, formulae, and representative circuits. An expanded chapter on radio propagation, a section on radio and boating, and a frequency chart covering vlf to uhf are included. Among the new projects appearing in the handbook are an 80-to-10-Meter solid-state transceiver with digital readout, a 2-kW 8877 linear amplifier, a 50-MHz frequency counter, and improved RFI filters. New amplifiers and a mobile antenna for 220 MHz are featured. An antenna coupler employing fixed capacitors and a homemade variable inductor helps beat the parts procurement problem.

Published by the American Radio Relay League, Inc., 225 Main Street, Newington, CT 06111. 704 pages. $12.50 hard cover ($13.50 in Canada, $14.50 elsewhere), $7.50 soft cover ($8.50 in Canada, $9.50 elsewhere).

ELECTRONICS ONE-SEVEN, VOLS. 1 AND 2

These two volumes (one on electronics, one on electricity) are revised second editions of elementary self-teaching texts that first came out ten years ago. Each features one topic or concept per page, with at least one illustration on every page. Coverage is thorough, and very little math is used. Each volume is made up of seven parts. The electronics volume covers electronic signals, electronic building blocks, electron tubes, semiconductors, power supplies, oscillators, and auxiliary circuits. The electricity text covers "producing electricity," dc circuits, ac circuits, LCR circuits, test equipment, power sources, and electric motors.

Published by Hayden Book Co., 50 Essex St., Rochelle Park, NJ 07662. Electronics: 1,000 pages, $21.95. Electricity: 992 pages, $20.85. Hard cover.

TV TYPEWRITER COOKBOOK

by Don Lancaster

As the "subtitle" indicates, this is a "complete guide to low-cost television display of alphanumeric and graphic data for microprocessor systems, computer hobbyists, ham RTTY, TV titling, word processing, and video games." The author, who has also written other electronic "cookbooks," covers TV typewriters in depth: IC's for TVT use, memory, timing, cursor and update circuits, keyboards and encoders, serial and TV interfaces, hard copy, and color graphics. Dozens of schematics provide information for building one's own TVT, or serve as background material for the hobbyist interested in knowing what's inside the kit or wired TVT he's bought.

Published by Howard W. Sams & Co., 4300 W. 62 St., Indianapolis, IN 46206. 256 pages. $9.95 soft cover.

ELECTRONIC SYSTEMS THEORY AND APPLICATIONS

by Henry Zanger

This text exphasizes how to use available IC's rather than how to design circuits, so the stress is on the system. There are chapters on system analysis, transducers, components, communications systems, instrumentation, control systems, and reliability and maintainability. The hardware ranges from op

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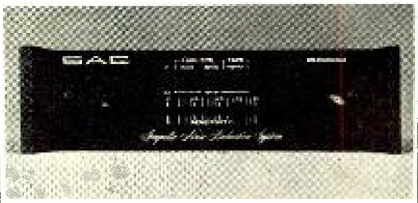

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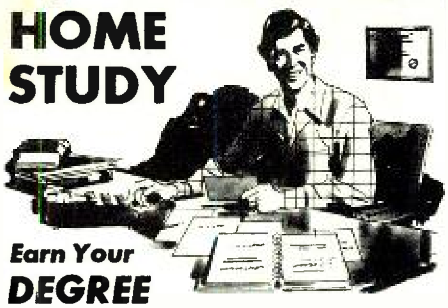

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amps to plotters, the math from Laplace transforms to transfer function analysis, in this technical look at a wide range of systems.

Published by Prentice-Hall, Englewood Cliffs, NJ 07632. 352 pages. $15.95 hard cover.

COLOR TELEVISION TROUBLESHOOTING

by Edward Bannon

Reflecting the rapid advances of electronic technology, this book presents the current status of color TV servicing. It is intended as a teaching tool for instructors, technicians, and technical-school or trade-school students. A fundamental knowledge of radio and TV theory is assumed. Troubleshooting is discussed as it relates to color reproduction problems in the black-and-white sections; bandpass amplifier; color-sync procedures; chroma demodulators; chroma and color matrices; systematic color circuits; color picture tube circuitry; modular procedures; and digital color TV circuitry.

Published by Reston Publishing Co., P.O. Box 547, Reston, VA 22090. 264 pages. $14.95 hard cover.

DIGITAL/LOGIC ELECTRONICS HANDBOOK

by William L. Hunter

This handbook starts out with chapters on numbering systems (binary, octal, hex), basic arithmetic operations, and the laws of logic (Boolean algebra, Venn diagrams, truth tables) assplied to digital circuits. The logic chapter also gets into DeMorgan's Theorem for simplifyingBoolean equations. The next two chapters explore logic circuits such as flip-flops, counters, adders, converters and multiplexers, and basic digital circuits including multivibrators, gates, and the Schmitt trigger. Logic symbols are examined thoroughly, as is the 54/74 family of TTL IC's. The last chapter, on logic applications, looks at a digital-readout timer by Sprague, and four digital Heath Kits (multimeter, clock, calculator, thermometer).

Published by Tab Books, Blue Ridge Summit, PA 17214. 308 pages. $6.95 soft cover, $9.95 hard cover.

A DICTIONARY OF MICROCOMPUTING

by Philip E. Burton

If you are just getting into microcomputing or are just thinking about it, this is one book you might want to get at the start. It translates and defines the meanings of such things as ACIA, DMA, DOS, assembler, emulator, handshaking, iteration time, and a host of other terms and phrases used in computing. For example, it will make clear the difference between software, firmware, and hardware; JUMP and LOOP instructions; bit and byte; etc. Diagrams, drawings, and tables are provided to illustrate the text. The Appendix contains the complete listing of the full ASCII code; tables of binary and hexadecimal numbers; and hexadecimal addition and multiplication tables.

Published by Garland Publishing, Inc., 545 Madison Ave., New York, NY 10022. Hard cover. 171 pages. $12.50.

SEMICONDUCTOR REFERENCE HANDBOOK

Data on Radio Shack's line of Archer brand semiconductors is compiled in this new reference handbook that contains cross-reference data on more than 36,000 semiconductor devices. The handbook also has sections on the care and handling of transistors, soldering precautions, case styles and dimensions, testing of transistors, and a glossary of terms, symbols, and abbreviations used in electronics. The handbook is available from Radio Shack stores.

Published by Radio Shack, Forth Worth, TX 76102. Soft cover, 128 pages. $1.95.

HOW TO DESIGN & USE MULTIVIBRATORS

by Courtney Hall

Various types of multivibrators are examined in this book at the introductory level. Astable, bistable, and monostable multivibrators as well as Schmitt trigger and half-shot circuits are discussed. Other chapters explain the design and applications of multivibrator circuits. The book also presents techniques for tailoring circuits to meet specific demands. A few of the projects covered are pulse generators, electronic counters, lamp flashers, tachometers, phase meters, voice-operated relays, and time-delay circuits.

Published by Howard W. Sams & Co., 4300 W. 62nd Street, Indianapolis, IN 46206. 96 pages. $3.95 soft cover.

RECORDING AND LISTENING GUIDES

Master Hi-Fi Installation (151 pages), by Gordon J. King, describes in a straightforward manner the functions of the main components of a hi-fi system. It details the differences between mono, stereo, and quadraphonic sound and the effects of room acoustics. The guide is designed to help the reader select the right components for his audio system. *Master Stereo Cassette Recording* (112 pages), by I.R. Sinclair, covers just about everything you need to know to record and replay, and to maintain and improve your recording equipment for professional results. Coverage also includes noise-reduction equipment and special techniques and equipment for considerably boosting the quality of recordings. *Master Electronics In Music* (120 pages), by T.D. Towers, is a guide to the proper use and maintenance of such popular electronic instruments as electric guitars, electronic organs, amplifying systems for musical instruments, and other electronic musical equipment.

Distributed by Hayden Book Co., Inc., 50 Essex St., Rochelle Park, NJ 07662. Soft cover. $5.45 per volume.

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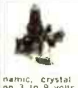

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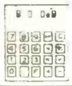

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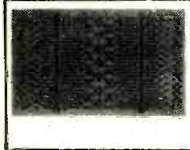

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7443	.73	74125	.54	74194	1.25
7444	.73	74126	.58	74195	.74
7445	.73	74132	.89	74916	1.25
7446	.81	74141	1.04	74197	.73
7447	.79	74145	1.04	74198	1.73
7448	.79	74150	.97	74199	1.69
7450	.17	74151	.79	74200	5.45

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305	.71	381	1.75	747	.71
307	.26	382	1.75	748	.35
308	.89	531	2.95	1458	.62
309K	1.35	540	2.95	1800	2.48
310	1.07	550	.79	3900	.49
311	.95	555	45	7524	.71
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320T	1.39	560	3.39	8038	4.25
320K	1.39	562	3.39	8864	2.25
322	1.70	565	1.18	75150	1.75
324	1.52	566	1.95	75451	.35
339	1.58	567	1.95	75452	.35
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340T	1.49	710	.35	75491	.71
372	2.93	711	.26	75492	.80

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3.3	5	220	10	2.7K	10	39K	10	470K	10
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10	10	330	10	3.9K	10	68K	10	2.2M	5
15	5	470	20	4.7K	20	100K	20	3.3M	5
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SN7427N	.25	SN74163N	.85
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SN7430N	.14	SN74165N	.97
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7409	.21	7492	.44	74193	.88	4021	1.14	LM324A	1.28
7410	.21	7493	.44	74194	.88	4022	.96	LM340T-5	1.25
7411	.21	7494	.70	74195	.88	4023	.23	LM340T-6	1.25
7412	.21	7495	.70	74196	.88	4024	.84	LM340T-8	1.25
7413	.25	7496	.70	74197	.88	4025	.23	LM340T-12	1.25
7414	.89	74100	1.28	74198	1.49	4026	1.68	LM340T-15	1.25
7416	.25	74107	.30	74199	1.49	4027	.40	LM340T-18	1.25
7417	.25	74109	.33	74251	1.09	4028	.89	LM340T-24	1.25
7420	.21	74121	.35	74279	.55	4029	1.14	LM3900N	.88
7421	.25	74122	.44	74365	.67	4030	.23	LM3909N	.69
7423	.35	74123	.61	74366	.67	4033	1.51	MC1456V	1.00
7425	.35	74125	.40	74367	.67	4034	3.50	MC1458V	.53
7426	.25	74126	.40	74368	.67	4035	1.14	MC3302P	1.15
7427	.33	74132	.70	8093	.40	4040	1.14	NE536T	3.24
7428	.28	74141	.88	8094	.40	4041	.79	NE540L	2.04
7430	.21	74145	.70	9095	.67	4042	.79	NE555V	.48
7432	.25	74147	1.63	8096	.67	4043	.70	NE556A	.88
7433	.30	74148	1.30	8097	.67	4044	.70	NE560B	3.83
7437	.25	74150	1.16	8098	.67	4046	1.86	NE561B	3.83
7438	.25	74151	.70	75150	1.16	4049	.40	NE562B	3.83
7440	.21	74153	.65	75450	.88	4050	.40	NE565A	1.25
7442	.53	74154	1.03	75451	.61	4051	1.26	NE566V	1.28
7443	.63	74155	.70	75452	.61	4052	1.26	NE567V	1.36
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7446	.70	74157	.70	75454	.61	4060	1.58	uA710CA	.44
7447	.70	74160	.88	75491	.81	4066	.79	uA711CA	.53
7448	.70	74161	.88	75492	.84	4071	.23	uA723CA	.60
7450	.21	74162	.88	75493	1.09	4072	.23	uA733CA	.75
7451	.21	74163	.88	75494	1.19	4073	.23	uA741CV	.44
7453	.21	74164	.96	82S25	2.19	4075	.23	uA747CA	.70
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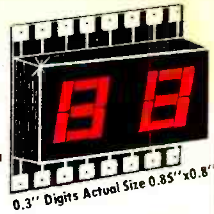

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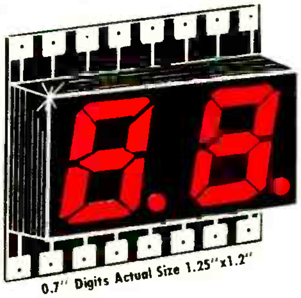

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4.7/50V	.08	.68/10	100/50V	.21	1.71/10	1000/16V	.29	2.35/10
10/16V	.08	.65/10	220/10V	.13	1.08/10	1000/25V	.42	3.33/10
10/25V	.08	.65/10	220/16V	.15	1.16/10	2200/10V	.42	3.33/10
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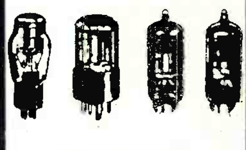

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17DW4	1.58	50EH5	1.55
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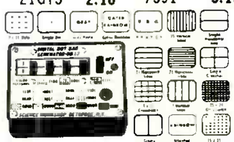

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AN203	3.75	HA1322	5.20	STK415	11.50	TA7203P	7.00
AN208	4.75	HA1339	5.20	TA7045M	3.50	TA7204P	6.50
AN210	3.10	LA1201	4.25	TA7054P	3.05	TA7205P	6.50
AN211	3.30	LA1364	4.70	TA7055P	5.50	TA78005M	2.50
AN214	4.90	LA1366	6.00	TA7060P	1.85	TA78005P	1.95
AN217	3.30	LA1367	5.90	TA7061P	2.25	TA78012M	2.50
AN229	6.35	LA3301	4.85	TA7149P	4.00	TA78012P	1.95
AN234	5.75	LA4030	4.85	TA7063P	2.25	TA78015M	2.50
AN239	6.50	LA4031P	3.50	TA7074P	4.90	TA78015P	1.95
AN241	3.20	LA4051P	4.65	TA7075P	4.90	TC9100P	12.00
AN245	6.50	TBA8105	3.50	TA7076P	4.55	UPC16C	2.50
AN274	3.95	LD3080	4.00	TA7089P	2.90	UPC20C	5.00
AN277B	3.40	LD3120	3.10	TA7102	5.15	UPC41C	3.95
AN288	4.80	LD3141	2.40	TA7106P	3.25	UPC48C	3.95
AN328	4.05	M5112	5.40	TA7120P	2.20	UPC554C	3.90
AN343	3.90	M5115PR	4.80	TA7120P-C	2.20	UPC563H2	8.00
BA511	3.50	M5155	2.85	TA7122AP	2.30	UPC566H	2.25
BA521	3.95	SG613	5.40	TA7124P	1.85	UPC575C	4.10
HA1158	6.30	STK011	10.50	TA7146P	4.10	UPC1001H2	5.15
HA1159	6.60	STK015	6.50	TA7150P	4.55	UPC1020H	5.50
HA1202	3.10	STK025	12.50	TA7153P	6.90	UPC1025	5.50
HA1306W	5.20	STK032	14.20	TA7200P	6.25		

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74L10	.33	74LS10	.39	74LS138	1.89
74L30	.33	74LS20	.39	74LS174	2.50
74L42	1.50	74LS51	.39	74LS386	5.50
74L86	.69	74LS74	.65	74S153	2.25
74LS00	.39	74LS112	.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	.60

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CA3001	.75	LM351AN	.70	SN15946	.55
CA3005	.80	LM741CP	.40	SN158097N	.60
CA3006	1.10	LM1458M	.65	SN72560P	4.50
CA3018	1.60	MFC9020	1.15	SN727410N	.85
CA3018A	1.60	MR995A	1.05	SN72741C	.45
CA3026	2.15	MSC9967P	1.50	SN72748P	.49
CA3035	2.45	N5558	.55	UA703C	.95
CA3039	1.35	N8598B	5.00	UA709C	.40
CA3058	1.90	NE555V	.45	USF7733393	2.40
CK707P	.45	PA771131	.45	995879	6.50
C5134J	1.15	PL994551	.45	996079	12.50
C5135J	1.20	RC14370B	.35	998979	9.00
C5136	1.25	SC9962P	.70	936-5D	1.10
IC3(GE)	1.50	SC9966P	1.25	9313DC	1.20
LM301AN	.35	SN15830N	.50	93L28DC	2.75

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10MF50	AXIAL LEADS	.15
10MF150	AXIAL LEADS	.20
25MF35	AXIAL LEADS	.15
30MF25	AXIAL LEADS	.15
47MF25	RADIAL LEADS	.15
47MF50	RADIAL LEADS	.20
100MF16	RADIAL LEADS	.15
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22	300	910	5.1K	33K
47	330	1.0K	6.8K	47K
51	470	1.5K	7.5K	100K
100	510	2.2K	8.2K	330K
150	560	2.7K	10K	1.0M
220	680	3.3K	15K	
240	750	3.9K	22K	

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2N398B	1.50	2N1304	1.25	2N2325	2.00	2N3250	.50	2N3904	.16	2N5133	.15
2N404	.75	2N1305	.75	2N2326	2.85	2N3375	6.50	2N3905	.16	2N5138	.15
2N443	2.50	2N1306	1.35	2N2327	3.80	2N3393	.20	2N3906	.16	2N5198	3.75
2N456	1.30	2N1307	.75	2N2328	4.25	2N3394	.17	2N3925	3.75	2N5294	.50
2N501A	3.00	2N1308	1.50	2N2329	4.75	2N3414	.17	2N3954	3.50	2N5296	.50
2N508A	.45	2N1309	.90	2N2368	.25	2N3415	.18	2N3954A	3.75	2N5306	.20
2N555	.75	2N1552	3.25	2N2369	.25	2N3416	.19	2N3955	2.45	2N5354	.20
2N652A	1.25	2N1554	1.25	2N2484	.32	2N3417	.20	2N3957	1.25	2N5369	.20
2N677	6.00	2N1557	1.15	2N2712	.18	2N3442	1.85	2N4036	.75	2N5400	.40
2N706	.25	2N1560	2.80	2N2894	.40	2N3553	1.50	2N4037	.60	2N5401	.50
2N706B	.75	2N1605	.35	2N2903	3.30	2N3563	.20	2N4093	.85	2N5457	.35
2N711	.90	2N1613	.30	2N2904	.25	2N3565	.20	2N4124	.16	2N5458	.30
2N711B	1.10	2N1711	.30	2N2904A	.30	2N3638	.20	2N4126	.16	CIO3Y	.25
2N718	.25	2N1907	4.10	2N2905	.25	2N3642	.20	2N4141	.20	C106B1	.50
2N718A	.30	2N2060	1.85	2N2905A	.30	2N3643	.20	2N4142	.20		
2N720A	.50	2N2102	.40	2N2906	.25	2N3645	.20	2N4143	.20		

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2SA564	.50	2SC371	.70	2SC784	.70	2SC1243	1.50	2SD170	2.00
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2SA643	.85	2SC394	.70	2SC789	1.00	2SC1306	4.75	2SD201	1.95
2SA647	2.75	2SC458	.70	2SC793	2.50	2SC1307	5.75	2SD218	4.75
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2SA699	1.30	2SC482	1.75	2SC799	4.25	2SC1325	4.95	2SD315	.75
2SA699A	1.45	2SC491	2.50	2SC802	3.75	2SC1327	.70	2SD316	2.50
2SA705	.55	2SC495	1.10	2SC803	4.00	2SC1338	1.75	2SD317	1.25
2SA815	.85	2SC497	1.60	2SC815	.75	2SC1346	.80	2SD318	.95
2SA816	.85	2SC502	1.50	2SC828	.75	2SC1347	.80	2SD325	1.25
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2SB22	.65	2SC517	4.25	2SC830	1.60	2SC1377	5.50	2SD350	3.25
2SB54	.70	2SC535	.75	2SC838	.70	2SC1383	.75	2SD352	.80
2SB56	.70	2SC536	.65	2SC839	.85	2SC1384	.85	2SD380	5.70
2SB77	.70	2SC537	.70	2SC922	.55	2SC1409	1.25	2SD389	.75
2SB128	2.25	2SC563	2.50	2SC929	.70	2SC1410	1.25	2SD390	.75
2SB152	4.50	2SC607	1.25	2SC930	.65	2SC1447	1.25		
2SB173	.55	2SC614	3.80	2SC938	.65	2SC1448	1.25	2SF8	3.00
2SB175	.55	2SC615	3.90	2SC943	1.50	2SC1449	1.30	2SCF8	3.50
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2SB186	.60	2SC617	4.25	2SC959	3.15	2SC1507	1.25	HEPS3001	3.25
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2SB471	1.75	2SC712	.70	2SC1061	1.65	2SC1973	1.50	2SK33	1.20
2SB474	1.50	2SC713	.70	2SC1069	3.50	2SC1974	4.90	2SK41	1.75
2SB476	1.25	2SC731	3.00	2SC1079	3.75	2SC1975	4.90	3SK22Y	2.75
2SB481	2.10	2SC732	.70	2SC1080	3.75	2SC2028	1.10	3SK40	2.75
2SB492	1.25	2SC733	.70	2SC1096	1.20	2SC2029	4.75	3SK45	2.75
2SB495	.95	2SC735	.70	2SC1098	1.15	2SC2074	3.00	3SK49	2.75
2SB507	.90	2SC739	.70	2SC1115	2.75			4004	3.00
2SB511	.70	2SC715	.70	2SC1166	.70	2SD45	2.00	4005	3.00
2SB531	3.00	2SC756	3.00	2SC1167	4.25	2SD65	.75	40080	1.25
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2N4852	.75	2N6028	.70
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MAGNETS. All types. Specials-20 disc, or 10 bar, or 2 stick or 8 assorted magnets. $1.00. Magnets, Box 192-H Randallstown, Maryland 21133.

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(408) 988-1640

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Same day shipment. First line parts only. Factory tested. Guaranteed money back. Quality IC's and other components at factory prices.

INTEGRATED CIRCUITS

7400TTL	
7400N	.17
7402N	.17
7404N	.19
7409N	23
7410N	.17
7411N	28
7414N	.63
7420N	.17
7422N	1.39
7430N	.20
7440N	.17
7442N	.78
7445N	.85
7447N	.60
7448N	.78
7450N	17
7473N	.36
7474N	32
7475N	.49
7485N	.99
7489N	2.00
7490N	.45
7492N	.45
7493N	.49
7495N	.75
74100N	.90
74107N	.39
74109N	.65
74121N	.39
74123N	.87
74125N	.45
74145N	69
74150N	95
74151N	75
74154N	1 10
74155N	.95
74157N	95
74161N	.95
74162N	1.35
74163N	1.35
74174N	1.19
74175N	90
74190N	1.15
74192N	1.25
74193N	.85
74221N	1.55
74285N	6 00
74298N	1.65
74365N	2.00
74366N	2.00
74367N	2 00
74368N	2 00
74LS00 TTL	
74LS00N	.28
74LS02N	.28
74LS04N	.34
74LS05N	.34
74LS08N	28
74LS10N	.28
74LS13N	67
74LS14N	1 30
74LS20N	.28
74LS22N	.34
74LS28N	.41
74LS30N	.28
74LS33N	39
74LS38N	39
74LS74N	.46
74LS75N	65
74LS90N	1.10
74LS93N	1.10
74LS95N	1 89
74LS107N	52
74LS112N	52
74LS113N	52
74LS132N	1.15
74LS136N	.59
74LS151N	1.60
74LS155N	1.50
74LS157N	1.40
74LS162N	2.05
74LS163N	2.05
74LS174N	1.85
74LS190N	2.60
74LS221N	1.95
74LS258N	2 20
LINEAR	
CA3045	90
CA3046	.95
CA3049	.85
CA3081	1 80
CA3082	1 90
CA3089	2.95
CA3090AQ	4.75
LM301AN	35
LM301AH	35
LM305H	87
LM307N	35
LM308N	.89
LM309H	1.15
LM309K	.95
LM311H	.90
LM311N	.90
LM317T	2.95
LM318	1.35
LM320K-5	1 35
LM323K-5	6 95
LM320K-12	1.35
LM320K-15	1.35
LM320T-5	1.60
LM320T-8	1.60
LM320T-12	1 95
LM320T-15	1.60
LM324N	1.45
LM339N	1.55
LM340K-5	1 60
LM340K-8	1 60
LM340K-12	1 60
LM340K-15	1.60
LM340K-24	1.60
LM340T-5	1.50
LM340T-8	1.70
LM340T-12	1.70
LM340T-15	1.70
LM340T-18	1.50
LM340T-24	1 70
LM343H	4 50
LM351	.60
LM370	1.15
LM377	4.50
LM379	5 00
LM380N	1.00
LM381	1.60
LM382	1.60
LM703H	40
LM709H	28
LM723H	50
LM723N	44
LM733N	1 00
LM741CH	35
LM741N	25
LM747H	62
LM747N	.62
LM748N	35
LM1303N	82
LM1304	1.10
LM1305	1.27
LM1307	2.00
LM1310	2.75
LM1458	59
LM1800	75
LM1812	7.50
LM1889	3 00
LM2111	1.75
LM2902	1.50
LM3900N	55
LM3905	1 75
LM3909N	69
MC1458V	.59
NE540L	3 90
NE550N	65
NE555V	.43
NE556A	1 00
NE565A	1.00
NE566V	1 85
NE567V	1.25
78L05	.90
78L08	90
79L05	1.00
78M05	.75
75107	.50
75108	1.75
75451CN	.39
75452CN	.39
75453CN	.37
75454CN	.37
75491CN	.50
75492CN	.55
75494CN	.89
7805	1.50
A to D CONVERTER	
8700CJ	13.95
8701CN	22 00
8750CJ	13.95
LD130	13.75
9400CJ V to F	7 40
CMOS	
CD34001 Fair.	.50
CD4001	.25
CD4002	.25
CD4006	1 35
CD4007	.25
CD4008	1 50
CD4009	.80
CD4010	53
CD4011	.25
CD4012	.25
CD4013	.40
CD4014	1.25
CD4015	1.25
CD4016	.50
CD4017	1.00
CD4018	2.75
CD4019	2.00
CD4020	1.35
CD4021	1.20
CD4022	1.40
CD4023	.25
CD4024	.85
CD4025	.25
CD4026	3 85
CD4027	.55
CD4028	1 50
CD4029	1.70
CD4030	.42
CD4035	2.00
CD4040	1.35
CD4042	.95
CD4043	2.00
CD4044	2 00
CD4046	2.90
CD4049	.62
CD4050	.55
CD4051	2.10
CD4060	2.10
CD4066	.85
CD4068	.25
CD4069	.40
CD4070	.40
CD4071	.40
CD4072	.40
CD4073	.40
CD4075	.40
CD4076	1.75
CD4078	.40
CD4081	.40
CD4082	.45
CD4116	1.30
CD4490	5.50
CD4507	1.00
CD4508	4.25
CD4510	2.00
CD4511	2 20
CD4515	4.00
CD4516	2.00
CD4518	2 45
CD4520	2 90
CD4527	4.75
CD4528	1 50
CD4553	5 75
CD4566	2.25
CD4583	4.50
CD4585	2.10
CD40192	3.00
74C00	.28
74C04	.33
74C10	.28
74C14	2.10
74C20	.28
74C30	.28
74C48	2 95
74C74	.75
74C76	1.40
74C90	1 15
74C93	1 40
74C106	2.10
74C107	.85
74C154	3 00
74C160	1 44
74C192	2 40
74C221	2 75
74C905	3.00
74C906	1 50
74C914	1.95
74C925	10.50
74C926	10.50
74C927	10.50
INTERFACE	
8095	.75
8096	.75
8097	.75
8098	.75
8T09	1.25
8T10	4.50
8T13	3.00
8T20	5.50
8T23	3.10
8T24	3.50
8T25	3.20
8T26	2.75
8T28	2.75
8T97	2 45
8T98	2.45
MOS/MEMORY RAM	
2101-1	4.50
2102-1	1.80
2107B	8.00
2111-1	5.00
2112-2	7.90
2513B	8.75
21L02-1	2.00
MM5262	.90
MM5320	5.95
MM5330	9.75
PD411D-3	7.00
PD411D-4	8 00
CLOCKS	
MM5309	3 90
MM5311	3 60
MM5312	4.80
MM5313	3.60
MM5314	3 90
MM5315	4.00
MM5316	5 00
MM5318	8.95
MM5369	2.10
MM5371N	5 50
MM5841	10 80
MM5865	9 00
CT7001	5.80
CT7002	6 25
CT7010	6.95
CT7015	7.25
MM5375AA/N	3.90
MM5375AB/N	4.90
7205	16 50
DS0026CN	3.75
DS0056CN	3.75
MM53104	3.75

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Solder Tin Low Profile

PIN	1 UP	PIN	1UP
8	15	24	.36
14	.18	28	.43
16	20	36	.58
18	.27	40	.61
22	35		

3 level wire wrap also avail

MICROPROCESSOR	
8080 with data	16 00
8080A with data	19 00
8212	4.50
8224	8.50
8228	8 50
CDP1802CD	29.50
CDP1802D	35.00
UART/FIFO	
AY5-1013	6.20
3341	6.95
PROM	
1702A	7 95
N82S23	3 25
N82S123	4.00
N82S126	4.85
N82S129	4.85
N82S131	5.00
2708	29.50
DM8577	2 90
RESISTORS ¼ watt 5%	
10 per type	.05
25 per type	03
100 per type	025
1000 per type	.015
KEYBOARDS	
63 Key Keyboard	$18 95
HD0165 encoder	6 95
Hex keyboard	9.95

IC Test Clips

	1	10
Red	.50	.43
Black	50	.43

SCPMP Kit $99.00

SCMP Keyboard Kit $99.00

CRYSTALS

1 MHz	4.50	2 0100 MHz	3.50
2 MHz	4.50	2 097152 MHz	7.75
4 MHz	4.25	2 4576 MHz	7 50
5 MHz	4.25	3 2768 MHz	7.50
10 MHz	4.25	5 0688 MHz	4 50
18 MHz	3.90	5 185 MHz	4.50
20 MHz	3 90	5 7143 MHz	4.50
32 MHz	3.90	6 5536 MHz	4.50
32768 Hz	4.00	14.31818 MHz	4 50
1.8432 MHz	4 50	18.432 MHz	4 50
3.5795 MHz	1.50	22 1184 MHz	4.50

Keyer 8043 14.50 complete with spec. and socket **Solar Cells** ⅝"x¾" 1.10

SPECIAL PRODUCTS	
LM1812N Ultrasonic Trans	6.50
Ultrasonic speaker	1.00
LM3909N LED Flasher/ Oscillator	69
MM5865 Stopwatch Timer	9.00
PC board	7.50
Switches	
Mom. Pushbutton	.50
On off on toggle	1.35
On none on toggle	1.15
Encoder	
HD0165-5	7 50
3 Digit Universal Counter Board Kit Operates 5–18 Volt DC to 5 MHz typ. .125" LED display	**10.50**
Motorola M6800 Kit II All parts including hex keyboard minus power supply	235 00
8080A Microcomputer Kit	195.00
TRANSFORMERS	
12 Volt 300 ma transformer	1 25
12 6V CT 600 ma	3.75
12V 250 ma wall plug	2.95
12V CT 250 ma wall plug	3.50
Data Access Arrangement Kit. Instr. Incl.	10 00
LEDS	
Red T018	15
Green T018	.20
Orange T018	.20
Yellow T018	.20
Jumbo Red	.20
Jumbo Green	.25
Jumbo Yellow	.25
Jumbo Orange	25
Clipite LED mounting Clips (specify red, amber, green, yellow, clear)	8/$1.25

DISPLAY LEDS

MAN1	CA	.270	2.90
MAN3	CC	.125	39
MAN72	CA	300	1.00
MAN74	CC	300	1.00
DL704	CC	.300	1.25
DL707	CA	300	1 00
DL707R			1.00
DL727	CA	.500	1 90
DL728			1.90
DL747	CA	600	2.25
FND359	CC	.357	.70
FND503	CC	500	.90
FND510	CA	500	.90
FND800	CC	800	2.20
FND807	CA	800	2 20

DG8 Fluorescent	1.75
DG10 Fluorescent	1.75
5 digit 14 pin display	2.50
NSN33M 3 digit 6 pin	.39
NSN69 9 digit display	.60
7520 Clairex photocells	.60
TIL311 Hex	9.50
12 hr. clock .5" liquid XTAL 4 digit	15 00
DVM/clock 1.0" liquid XTAL 4 digit	30.00
Watch .12" liquid XTAL 4 digit	6 00
Instrument .5" liquid XTAL 8 digit	22 00
TV GAME CHIPS	
MM57100 6 Games Chip	13.00
MM53104 Clock Driver	3.75
LM1889 Modulator	3 00
GI AY38500-1	18 50
COMPUTER BOARD KITS	
8K RAM Board Kit	225.00
4K EPROM Kit	145 00
I/O Board Kit	44 50
Extender Board w/connector	12.50
Video Interface board kit	149 95
16K EPROM board kit	85.00
16K Static RAM board kit	495 00

CLOCK MODULES
Complete alarm clocks ready to hook up with transformer and switches. Very compact with .50" and .84" digits

MA1002A, C or E .50"	8.95
102P3 Transformer	2.25
MA1010A, C or E .84"	11.95
102P2 Transformer	2 25
Special transformer and six switches when purchased w/module	2 95
MA1003 car module .3" green fluor. display	21.50

Not a Cheap Clock Kit $17.45
Includes everything except case. 2-PC boards. 6-.50" LED Displays. 5314 clock chip, transformer, all components and full instructions. **Same clock kit with .80" displays. $22.75**

Plexiglas Cases Black or white with red bezel in clock sizes. **$5.95**

Digital Temperature Meter Kit
Indoor and outdoor. Automatically switches back and forth. Beautiful. 50" LED readouts. Nothing like it available. Needs no additional parts for complete, full operation. Will measure −100° to +200°F, air or liquid. Very accurate. Complete instructions. **$39.95**

Variable Power Supply Kit
0–12 VDC @½A 7.1% line, load regulation. Remote sense capability. Constant voltage/circuit limit can be modified for other V/I ranges. Complete with board and transformers. **$24.00**

1977 IC Update Master Manual Brand new. Complete integrated circuit data selector from all manufacturers. 1234 page master ref guide to the latest IC's including microprocessors and consumer circuits. 17,000 cross references for easier sourcing of hard to get parts. **Special pricing: $24.95**, with free update service thru 1977. Domestic postage all $2.00. Foreign $6.00.

Function Module Card Kit
Converts any frequency counter into 3½ digit DVM, digital thermometer, pulse & square generator from 10 Hz to 100 kHz. Complete kit minus power supply. **$25.00**

VOLUME SPECIALS

		1	100
MM5262	2K RAM	.90	.50
MM5369	Divider	2.10	1.40
2102-1	500 NS 1K RAM	1.80	1.30
PD411-3	150 NS 4K RAM	8.00	5.75
Momentary Pushbutton Switch		.50	.29

Other parts also available

30 MHz Frequency Counter Kit
Crystal time base. Covers audio, amateur and CB band. 6.5" digits, prescalable with PC board and full instructions. **$55.00**
Fully wired and tested. **$75.00**

Stopwatch Kit $26.95
Full six digit battery operated. 2–5 volts. 3.2768 MHz crystal accuracy. Times to 59 minutes, 59 seconds, 99 1/100 hrs. Times standard, split and Taylor. 7205 chip, all components minus case. Full instructions. White or black plexiglass case. **$5.00**

COSMAC 'ELF'
RCA CMOS Microcomputer
CDP1802 CD **$29.50** Users Manual **$7.50**
Complete kit of parts to build the "ELF" including CDP1802 and users manual as listed in August '76 Pop. Elect. minus power supply and board. **$92.00**

Hobbiest Electronics Course
Beginning course in practical electronics, no theory. Lab experiment format. 12 lessons, can be purchased one at a time. **$10.00 per lesson**

60 Hz Crystal Time Base Kit $4.75 Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy. Kit includes: PC board, MM5369, crystal, resistors, capacitors and trimmer.

Volt/ohm Probe
Batt. oper. AC/DC to 125 V. 2 pos. volt. and 2 neg. volt. plus continuity. Stainless steel, pocket size. comp. assem. **$34.95**

Digital Thermometer $65.00
General purpose or medical 32°–230°F. Disposable probe cover ±.2° accuracy. Completely assembled w/compact case.

2.5 MHz Frequency Counter Kit
As low as 10 Hz .6–.50" digits with PC board and full instructions. **$40.00**

Auto Clock Kit $15.95
DC clock with 4-.50" displays. Uses National MA1012 module with alarm option. Crystal time base PC boards and full instructions. Add $3.95 for a beautiful dark gray case ready to install. This is the best value available anywhere!

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Dallas, Texas 75206

Memorex computer boards with IC's, diodes, transistor, etc. 5 Boards containing 100 – 200 IC's
ONLY $ 4.25

BRIDGE RECTIFIERS

6 Amp	50V	1.10
10 Amp	50V	1.25
25 Amp	50V	1.39

RESISTORS

Over 50,000,000 in stock

*330 ohm	22K ohm
470 ohm	27K ohm
**680 ohm	33K ohm
1K ohm	39K ohm
1.2K ohm	43K ohm
2 2K ohm	47K ohm
3.3K ohm	82K ohm
4 7K ohm	100K ohm
6.8K ohm	150K ohm
10K ohm	220K ohm
20K ohm	

*1/8 W only
**1/2 W only

All resistors are P C. Lead but are not pull offs.
100 min order for each value

NO MIX 100/.99

MK 5005

4 digit counter/latch decoder; 7 segment output only. 24 pin dip with specs.
$ 8.00 EACH

UNSCRAMBLER KIT

for all Scanners

- Tunes easily
- Full instructions included
- Easy to install
- 3½" x 3½" x 1½"

Only $19.95

PLASMA DISPLAY KIT

Kit Includes: 12 digit display .4" Character Power supply for display above Complete specs for hookup.

Line cord Not Included. **ONLY $ 3.95**

SPECIAL DEVICES

82S23	2.19
2513	10.00
MK4102-1	.99

PROJECT CASES

Small	Med.	Large
$1.50	$2.00	$2.75
D 2 1/2"	D-2"	D-2-1/2"
W-4 3/4"	W-4-7/8"	W-7"
H 1 7/8"	H 3 1/2"	H-4"

All cases have a sloped front, white with black wrinkle finish.

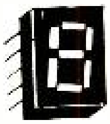
REGULATORS

7805	7818
7806	7824
7808	7905
7812	7912
7815	7915

Your Choice $ .95

READOUTS

Best Value!



FND70 .4"C.C.	.59
FND800 .8"C.C.	1.69
TI 6 digit array C.C.	3/1.00
MAN 8 .3"CA Yellow	.89
LT767 .7" C.C. 4 digit stick	$ 3.95

WATERGATE SPECIAL

Telephone Relay automatically starts and stops tape recorder. No batteries required. Kit complete with drilled P.C. Board.

Parts and Case **ONLY $ 10.95**

VARIABLE POWER SUPPLY KIT NO. 1

*Continously variable from 5V to 20V
*Excellent regulation up to 500 mil.
*4400 Mfd of filtering
*Drilled fiberglass PC Board
*One hour assembly
*Kit includes all components
*Case Included

ONLY $10.95

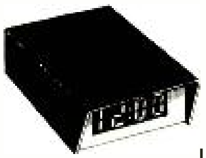
VARIABLE POWER SUPPLY KIT NO. 2

Same as above but with 1 amp output, also with case.
ONLY $13.95

Ni-Cad Batteries

4 Brand New Size "AA" Ni-Cads **ONLY $4.50**

CLOCK KIT



Kit includes
- LT701 clock module
- Power Supply
- Punched Case
- 12 or 24 hour operation

Complete except for line cord

ONLY $ 14.95

LT701E	12 hour clock
LT701G	24 hour clock

BATTERY CLIPS

Standard 9V battery clip with 4-1/2" tinned leads. **25/$1.00**

TRANSISTORS - DIODES

*MJE1103	3/1.00
MJ3001	1.30
2N2222	6/1.00
2N2369	6/1.00
2N2905	4/1.00
*2N2907	15/1.00
2N3906	6/1.00
2N4400	6/1.00
2N4443 SCR	3/1.00
1N4004	15/1.00
1N4007	10/1.00
1N4148 (1N914)	20/1.00
3N201 VHF Pre amp	.80

D40C1 Power Darl – 8/1.00

*House numbered and P.C. Lead

PC BOARDS

4 digit PCB for FND800 or 807	2 50
6 digit PCB for FND800 or 807	3.50
4 digit PCB for DL707	1.50
6 digit PCB for DL707	2 00
4 digit PCB for FND503 or 510	2.00
6 digit PCB for FND503 or 510	3 00
4 digit PCB for DL747	2.50
6 digit PCB for DL747	3.00
4 digit PCB for DL727 or 728	2 00
6 digit PCB for DL727 or 728	3.00
4 digit PCB for FND359 or 70	1.75

NOTE: All PC Boards are multiplexed for adding additional digits.

HARDWARE

New, includes 2-56, 4-40, 6-32 and 8-32 screws and nuts. A very usable selection.

½ pound **$1.50**
1 pound **$2.60**

T T L

7400	.17	7473	21
7401	.17	7474	35
7402	.17	7475	55
7403	.17	7476	.35
74H04	.25	7480	.45
7404	.17	7483	76
7406	.25	7485	.89
7408	.17	7486	.35
7409	.17	7490	.71
7410	.17	7491	.71
7411	.25	7492	.71
7413	.45	7493	.67
7420	.17	7494	.90
7421	.17	7495	.71
7423	.35	7496	.85
7425	.27	74100	.96
7426	.25	74121	.31
7427	.17	74123	.61
7430	.25	74125	.44
7432	.30	74141	.71
7437	.35	74145	.97
7438	.35	74151	.71
7440	.17	74153	.81
7442	.60	74154	.97
7443	.60	74161	.91
7444	.65	74163	1.05
7446	.85	74164	1.05
7447	.81	74174	.91
7448	.81	74175	1.40
7450	.20	74180	.76
7451	.17	74181	2.25
7453	.17	74191	1,20
7454	.17	74192	1.20
7470	.35	74193	.95
7472	.21	74195	.65

L S

74LS00	.25
74LS02	.25
74LS04	.30
74LS08	.25
74LS10	.25
74LS11	.32
74LS20	.31
74LS21	.33
74LS22	.33
74LS27	.30
74LS30	.31
74LS32	.33
74LS37	.40
74LS38	.35
74LS74	.49
74LS90	.85
74LS132	.90
74LS138	.89
74LS139	.89
74LS155	.90
74LS157	1.00
74LS162	1.39
74LS163	1.39
74LS175	1.09
74LS193	1.09
74LS258	1.09
74LS367	.70
74LS368	.70

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CD4011	.16	CD4049	.35
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7427	.25
7437	.20
7438	.20 *
7440	.12 *
7441	.65 *
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7447	.75
7450	.14
7451	.14 *
7473	.28
7474	.28
7475	.40
7480	.40 *
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74150	.60 *
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74152	.90
74155	.60
74157	.60
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74161	.75 *
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74165	.80
74173	1.25
74174	.75
74175	.75 *
74177	.70
74180	.80
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74192	.70 *
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74LS157	1.10
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4010	.42	4024	.75	4050	.40
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7411	.20	7483	.62	74174	.95
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7413	.39	7486	.30	74176	.75
7414	.63	7489	1.85	74177	.75
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7427	.25	7495	.65	74193	.83
7430	.14	7496	.65	74194	.85
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74LS42	.88	74LS196	1.35
74LS73	.43	74LS197	1.35
74LS74	.45	74LS257	1.35
74LS76	.43	74LS258	1.38
74LS90	.89	74LS266	.53
74LS92	.85	74LS365	.68
74LS93	.85	74LS366	.68
74LS109	.50	74LS367	.68
74LS112	.43	74LS368	.68
74LS113	.43	74LS390	2.20
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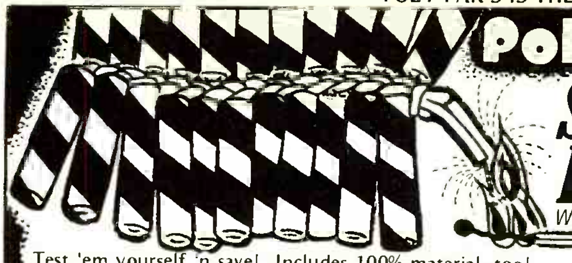

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BARREL KIT #158 MAGNIFIED MAN-3's 20 for $1.98. MAN-3, 7-seg readout, with built-on magnifier. Factory discontinued line. 100% material. Cat. No. 7E3325 1 oz.

BARREL KIT #155 MOLDED CAPACITORS 75 for $1.98 7E3311. Asst. size voltages, red, green, yellow, blue plastic cases, axial leads. 1 lb.

BARREL KIT #154 CLOCK CHIPS 20 for $1.98 hobby. We gathered an assortment of clock chip, alarm, calendar, beepers, who knows, all mixed. Cat. No. 7E3308

BARREL KIT #145 MINI TRANSFORMER 15 for $1.98. outputs, interstage and audio. Only 1" sq. Wt. 2 lbs. 7E3294

BARREL KIT #144 RCA PHONO PLUGS 40 for $1.98. 1,000,000 RCA phono plugs for this one. You hi-fi-ers know wut they are . . . 100% material. 7E3293

BARREL KIT #138 PANEL SWITCHES 30 for $1.98. Did you hear of OAK? Another eqpt maker barrelled all types of rotaries, electric, slides, etc. 7E3268

BARREL KIT #135 MICRO MINI LAMPS 20 for $1.98 1 oz. Imagine! Micro size (¼ x ¼) with wire leads. 3 to 5 VDC, 40 mils. 7E3259

BARREL KIT #128 MINI DIP ICS 100 for $1.98. Large mfgr dumped 100's of lbs into barrels. Includes 741s, LM-380-8, 703, 567, 555, 558—but who knows? Wt. 1 lb. 7E3245 hobby

BARREL KIT #127 AXIAL ELECTROS 40 for $1.98. Asst. capacities and voltages. Cat. No. 7E3227

BARREL KIT #126 UPRIGHT ELECTROS 40 for $1.98. 1mf to 300mf in mixture of voltages. 100% marked 'n good. 7E3226

BARREL KIT #118 MINI SCRS 50 for $1.98. UNBELIEVABLE! TO-92 plastic SCRS in barrels . . . rite from factory. Includes all voltages up thru 200 prv. 7E3135

BARREL KIT #117 OPTICAL FIBERS 2 ozs. 20-MIL 7E3206 200-FT. $1.98. Fiber optics factory bankruptcy purchase! High quality, most-commonly used size (20-mil), CLEAR.

BARREL KIT #115 MOLEX SOCKETS 100% good 200 for $1.98 Cat. No. 7E3144. Calculator maker dump! We gut a zillion of 'em.

BARREL KIT #112 MICRO MINI LEDS 40 for $1.98 Hobby. All the tiny leds, axial, upright of Monsanto, Litronix, variety of colors. Yield 80% or better. 7E3138

BARREL KIT #109 TERMINAL STRIPS 100 for $1.98. Wide asst. of terminal strip connectors, from 1 contact up. Strip manufacturers barrel dump is your gain. Wt. 1 lb. Cat. No 7E3136

BARREL KIT #108 TO-5 PLASTIC TRANSISTORS Cat. No. 7E3101 40 for $1.98. Includes PNP, NPN, 2N-3638, 2N3641, 2N5000 series, etc. Untested.

BARREL KIT #104 SLIDE VOLUME CONTROLS 10 for $1.98 Cat. No. 7E3057

BARREL KIT #101 RESISTOR SPECIAL 200 for $1.98. Includes: ⅛, ¼, ½, 1, 2 watters, carbon. 8 oz. 100% good. 7E3054

BARREL KIT #99 PHOTO ELECTRIC CELLS 10 for $1.98. Asst. GE types, CDS types. Mixed by factory. Big job for us to separate. 100% good. Cat. No. 7E3052

BARREL KIT #93 HALF WATTERS 200 for $1.98. Resistor factory tried to fool us by mixing 100% color-coded resistors in barrel. But value is there. 4 oz. 7E3046 Untested

BARREL #91 SILVER MICAS 100 for $1.98. Axial, red case, variety of physical sizes & values. Cat. No. 7E3018

BARREL KIT #88 LITRONICS LED READOUTS 10 for $1.98. Hobby singles, triples, etc. .33 to 0.6. Bot from factory, all mixed; have fun! No. 7E2861

BARREL KIT #87 NATIONAL IC BONANZA 100 for $1.98. Types 8000, 7400 series, DTLs, ROMs, registers, clock & calc. chips, linears, etc. Cat. No. 7E2860 Untested.

BARREL KIT #86 HOBBY LEDS 40 for $1.98 Untested. 747's, 727's, singles, triples, etc. .33 to 0.6. Bot from factory, all mixed; have fun! 7E2859

BARREL KIT #83 15 for $1.98 LM-340T VOLT REG. Factory rejected them for length of leads. May include 5, 6, 8, 12, 15, 18, 24 volts. Power tab Cat. 7E2635

BARREL KIT #81 SUBMINI RESISTORS 200 for $1.98. PC, upright type, color coded, ⅛ watt. Asst. values. Came to us in a barrel. Cat. No 7E2746 100% good.

BARREL KIT #76 1-WATT ZENERS 100 for $1.98. Factory same as 400-mw's. Never-to-see-again offer. 6, 8, 10, 12, 15V. under glass. Double plug. Cat. No. 7E2741 Untested.

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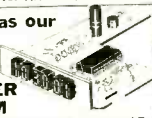

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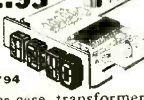

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BARREL KIT #71 CAPACITOR SPECIAL 100 pcs. $1.98. micas, moldeds, plastics, ceramics, discs, etc. Nifty 100% good Cat. No 7E2738

BARREL KIT #68 2 WATTERS 100 for $1.98 100% good. Suppliers throw 'em in the barrel. It's a li'l gold mine. All marked. Cat. No. 7E2735

BARREL KIT #65 MIXED READOUTS 10 for $1.98. Factory returns . . . such numbers as MAN-4's, MAN-7's, MAN-3's, 11 barrels & no time to separate. Hobby Cat. No. 7E2733 Untested.

BARREL KIT #61 POLYSTYRENE CAPS 100 for $1.98. Finest caps made. As a gamble we bought 10 barrels from factory, mixed values; all good. Cat. No. 7E2729

BARREL KIT #58 SLIDE SWITCHES 30 for $1.98. All shapes, sizes, spst, npdt, momentaries, etc. Tremendous shop pak for 100's of switching projects. Cat. No. 7E2726 100% good

BARREL KIT #56 POWERS! POWERS! 100 for $1.98 Cat. 7E2724. Large distributor cleaned house. Barrels of power resistors 3 to 7 watts.

BARREL KIT #54 8 DIGIT READOUTS 10 for $1.98. Bargain of a lifetime! All we got was 1 barrel — the "blisdor digit" types. Multiplexed. Cat. No. 7E2722

BARREL KIT #40 PNP HIGH-POWER TRANSISTORS 20 for $1.98 Hobby. Popular germanium TO-3 case 7E2618 100% good

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BARREL KIT #36 GERMANIUM DIODES Untested 200 for $1.98 Cat. No. 7E2614. Famous maker, popular item. Never grows old.

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BARREL KIT #31 METALLIC RESISTORS 100 for $1.98. Made mostly by Corning, the finest resistor made. Mostly ½ watters, 1% to 5% tol. & a barrel of values. Cat. No. 7E2609

BARREL KIT #30 PREFORMED RESISTORS 200 for $1.98. We got barrels of ¼ and ½" watters for pc use. 100: ¼, 100 ½" No. 7E2608 100% good

BARREL KIT #27 PREFORMED DISCS 150 for $1.98. Hi-Fi mfr's shelf inventory but he dumped 'em in barrels. Preformed, for PC use. Mixed values too! 7E2605

KIT #26 PLASTIC TRANSISTORS 100 for $1.98 Hobby Untested. Type TO-92 (TO-18), all manufacturers, variety of 2N #'s. Cat. No 7E2604

BARREL KIT #25 METAL CAN TRANSISTORS 100 for $1.98. Includes TO-5, TO-1, TO-18, etc., assorted 2N numbers, unmarked etc. Cat. No 7E2603 Untested.

BARREL KIT #20 LONG LEAD DISCS 100 for $1.98. "auction sale". Prime, marked only. Long leads Cat. No 7E2598 100% good

BARREL KIT #19 DIPPED MYLARS 60 for $1.98. Finest capacitors made, shiny finish. Imagine factory dumping 'em in barrels. Cat. No. 7E2597 100% good

BARREL KIT #17 LINEAR & 7400 DIPS 100 for $1.98 Hobby Untested. Marked and unmarked, internal numbers of raw factory stock. Cat. No 7E2431

BARREL KIT #15 MOSFET TRANSISTORS 60 for $1.98. All 4 leaders TO-18 case, includes UHF transistors too! Cat. No. 7E2429

BARREL KIT #14 PRECISION RESISTORS 200 for $1.98. Marked and unmarked ¼, ½, 2 watts. No 7E2428

BARREL KIT #11 POWER TAB TRANSISTORS 40 for $1.98. NPN, plastic TO220 type. Assorted 2N numbers. No. 7E2425 Untested.

BARREL KIT #10 ROMS-REGISTERS 75 for $1.98 Untested Hobby. 28 to 40 pin devices, marked, internal factory numbers, etc Cat. No. 7E2424

BARREL KIT #8 SUBMINIATURE IF TRANSFORMERS 75 for $1.98. Amazing, includes 455kcs, osc, antenna, who knows? Cat. No. 7E2422 100% good

BARREL KIT #7 VOLUME CONTROL 30 for $1.98 100% good. Singles, duals, variety of values, styles, big ones small ones. Cat. No. 7E2421

BARREL KIT #5 SCRS, TRIACS, QUADRACS 40 for $1.98 Raw factory stock! All the 10 amp types. Cat. No. 7E2419 Untested.

BARREL KIT #4 "4000" RECTIFIERS 100 for $1.98 Untested. 1N4000 series. May include 25, 50, 100, 200, 400, 600, 800 and 1000 volters. 7E2417

BARREL KIT #3 1N4148/914 SWITCHING DIODES 100 for $1.98. Imagine famous switching diodes at these prices Cat. No. 7E2418 Untested.

BARREL KIT #2 LINEAR OP AMPS, DIPS 75 for $1.98 Untested. May include 709's, 741's, 703's, 560 series, 555 includes 7E2416 hobby

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SN7438N	.27	SN74123N	.50	SN74191N	1.25
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SN7443N	.75	SN74141N	1.15	SN74196N	1.25
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LM308H	1.00	LM380CN	1.05	LM3065N	.69
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LM320K-15	1.35	NE562B	5.00	75453CN	.39
LM320T-5	1.75	NE565H	1.25	75454CN	.39
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74LS26	.39	74LS93	1.25	74LS191	2.85
74LS27	.39	74LS95	1.95	74LS192	2.85
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74LS30	.29	74LS107	.59	74LS194	1.89
74LS32	.39	74LS109	.59	74LS195	1.89
74LS40	.39	74LS112	.59	74LS257	1.75
74LS51	.29	74LS132	1.25	74LS260	.55
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XC111	Red	10/$1
XC111	Green	4/$1
XC111	Yellow	4/$1
XC111	Orange	4/$1

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XC22	Yellow	4/$1
XC22	Orange	4/$1
SSL-22	RT	4/$1

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XC526	Red	5/$1
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XC526	Yellow	4/$1
XC526	Orange	4/$1
XC526	Clear	4/$1

.200" dia.		
XC556	Red	10/$1
XC556	Green	4/$1
XC556	Yellow	4/$1
XC556	Orange	4/$1
XC556	Clear	7/$1

.085" dia.
MV50 - Red - 6/$1
INFRA-RED LED
Flat 5/$1.00

SPECIAL * — XC556 Red 100/$8.00 1000/$60.00 — SPECIAL *

DISPLAY LEDS

OL707 UL33B

TYPE	POLARITY	HT		TYPE	POLARITY	HT	
MAN 1	Common Anode	270	2.95	MAN 3640	Common Cathode-orange	300	1.75
MAN 2	5 x 7 Dot Matrix	300	4.95	MAN 4710	Common Anode-Red	400	1.95
MAN 3	Common Cathode	125	3/1.00	DL701	Common Anode-red ±	300	.99
MAN 4	Common Cathode	187	1.95	DL704	Common Cathode	300	.99
MAN 7	Common Anode	300	1.25	DL707	Common Anode	300	.99
MAN 7G	Common Anode-green	300	1.95	MAN 4740	Common Anode-Red	400	.99
MAN 7Y	Common Anode-yellow	300	1.95	DL741	Common Anode	600	1.50
MAN 52	Common Anode-green	300	.99	DL747	Common Anode	600	2.25
MAN 64	Common Anode-red	400	.99	DL750	Common Cathode	600	2.49
MAN 74	Common Cathode	300	1.50	DL338	Common Cathode	110	.50
MAN 82	Common Anode-yellow	300	.99	FND70	Common Cathode	250	.75
MAN 84	Common Cathode-yellow	300	.99	FND503	Common Cathode	500	1.00
MAN 3620	Common Anode-orange	300	1.75	FND507	Common Anode	500	1.00

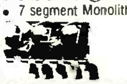
FACTORY REJECTS ATARI GAME BOARDS

BOARD A — 8½" x 16" — $6.95 ea.
Over 60 each reusable IC's
Misc. Transistors, Resistors, Diodes, Caps, Crystals, Switch, etc
ONLY 500 EA. AVAILABLE

DELUXE BOARD B — 11½" x 18" — $9.95 ea.
Over 100 each reusable IC's
Misc. Transitors, Resistors, Diodes, Caps, Crystals, Switches, LEDS, etc
ONLY 500 EA. AVAILABLE

HP 5082-7300 Multi-Digit Series

- ⅛" Ht. • Common Cathode • Dip Package
- 3 to 5 volts @ 5 mils per segment
- 7 segment Monolithic • Red Display



2 Digit	$ .79
3 Digit	.89
4 Digit	.99
5 Digit	1.19

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

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

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin	$ .27	.25	.24	28 pin	$ .99	.90	.81
16 pin	.30	.27	.25	36 pin	1.39	1.26	1.15
18 pin	.35	.32	.30	40 pin	1.59	1.45	1.30
24 pin	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$ .30	.27	.24	24 pin	$ .70	.63	.57
14 pin	.35	.32	.29	28 pin	1.10	1.00	.90
16 pin	.38	.35	.32	36 pin	1.75	1.40	1.26
18 pin	.52	.47	.43	40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
10 pin	$ .45	.41	.37	24 pin	$1.05	.95	.85
14 pin	.39	.38	.37	28 pin	1.40	1.25	1.10
16 pin	.43	.42	.41	36 pin	1.59	1.45	1.30
18 pin	.75	.68	.62	40 pin	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.25 PER ASST.

SPECIAL

		10 OHM	12 OHM	15 OHM	18 OHM	22 OHM		
ASST. 1	5 ea.	27 OHM	33 OHM	39 OHM	47 OHM	56 OHM	1/4 WATT 5%	50 PCS.
		68 OHM	82 OHM	100 OHM	120 OHM	150 OHM		
ASST. 2	5 ea.	180 OHM	220 OHM	270 OHM	330 OHM	390 OHM	1/4 WATT 5%	50 PCS.
		470 OHM	560 OHM	680 OHM	820 OHM	1K		
ASST. 3	5 ea.	1.2K	1.5K	1.8K	2.2K	2.7K	1/4 WATT 5%	50 PCS
		3.3K	3.9K	4.7K	5.6K	6.8K		
ASST. 4	5 ea.	8.2K	10K	12K	15K	8K	1/4 WATT 5%	50 PCS.
		22K	27K	33K	39K	47K		
ASST. 5	5 ea.	56K	68K	82K	100K	120K	1/4 WATT 5%	50 PCS.
		150K	180K	220K	270K	330K		
ASST. 6	5 ea.	390K	470K	560K	680K	820K	1/4 WATT 5%	50 PCS.
		1M	1.2M	1.5M	1.8M	2.2M		
ASST. 7	5 ea.	2.7M	3.3M	3.9M	4.7M	5.6M	1/4 WATT 5%	50 PCS.

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$7.49 ea.**

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$5.00 Minimum Order — U.S. Funds Only
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HOBBY-WRAP TOOL-BW-630

- Battery Operated (Size C)
- Weighs ONLY 11 Ounces
- Wraps 30 AWG Wire onto Standard DIP Sockets (.025 inch)
- Complete with built-in bit and sleeve

$34.95
(batteries not included)

WIRE-WRAP KIT — WK-2-W

WRAP • STRIP • UNWRAP

- Tool for 30 AWG Wire
- Roll of 50 Ft. White or Blue 30 AWG Wire
- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped wire

$11.95

WIRE WRAP TOOL WSU-30

WRAP • STRIP • UNWRAP - $5.95

WIRE WRAP WIRE — 30 AWG

25 ft. min. $1.25 50 ft. $1.95 100 ft. $2.95 1000 ft. $15.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

Plastic Push Button Switch

- 18 AWG Solid Wire - 5" Long
- .50 (wide) X .60 (high) ¾-27 Thread
- 8 AMP @ 14 Volt - 1 AMP @ .10 Volt

		1-9	10-Up
J-188-1	Push On-Push Off	.59	.49
J-188-2	Normally Open	.59	.49
J-188-3	Normally Closed	.59	.49

DIP SWITCHES

SPST Slide Action

#206-4	(8 pin dip)	4 switch unit	$1.75 ea.
#206-7	(14 pin dip)	7 switch unit	$1.95 ea.
#206-8	(16 pin dip)	8 switch unit	$2.25 ea.

TV GAME CHIP SET — $18.50

Includes AY-3-8500-1 chip and 2.010 mhz crystal — if purchased separately would cost $21.90.

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400mm	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	8/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25m	20/1.00
1N5232	5.6	500m	.28	1N4734	5.6	1w	.28
1N5234	6.2	500m	.28	1N4735	6.2	1w	.28
1N5235	6.8	500m	.28	1N4736	6.8	1w	.28
1N5236	7.5	500m	.28	1N4738	8.2	1w	.28
1N456	25	40m	6/1.00	1N4742	12	1w	.28
1N458	150	7m	6/1.00	1N4744	15	1w	.28
1N485A	180	10m	6/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.50
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR	$1.95
C38M	35A @ 200V	SCR	1.95
2N2328	1.6A @ 200V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

MPS A05	5/$1.00			PN4249	4/$1.00
MPS A06	5/$1.00			PN4250	4/$1.00
2N2219A	3/$1.00	PN3567	3/$1.00	2N4400	4/$1.00
2N2221	4/$1.00	PN3568	4/$1.00	2N4401	4/$1.00
2N2222A	5/$1.00	PN3569	4/$1.00	2N4402	4/$1.00
2N2369	5/$1.00	2N3704	5/$1.00	2N4403	4/$1.00
2N2369A	4/$1.00	2N3705	5/$1.00	2N4409	5/$1.00
2N2484	4/$1.00	2N3706	5/$1.00	2N5086	4/$1.00
2N2906A	4/$1.00	2N3707	5/$1.00	2N5087	4/$1.00
2N2907A	5/$1.00	2N3711	5/$1.00	2N5088	4/$1.00
2N2925	5/$1.00	2N3724	$ .65	2N5089	4/$1.00
2N3053	2/$1.00	2N3725	$1.00	2N5129	5/$1.00
2N3055	$ .89	2N3903	5/$1.00	2N5138	5/$1.00
MJE3055	$1.00	2N3904	4/$1.00	2N5139	5/$1.00
MJE2955	$1.25	2N3905	4/$1.00	2N5209	5/$1.00
2N3392	5/$1.00	2N3906	4/$1.00	2N5951	5/$1.00
2N3398	5/$1.00	2N4013	3/$1.00	C106B1SCR	2/$1.00
		2N4014	3/$1.00	2N5432	$2.00
		2N4123	10/$1.00		

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075
100 VOLT MYLAR FILM CAPACITORS							
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22
+20% DIPPED TANTALUMS (SOLID) CAPACITORS							
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS							
Axial Lead				**Radial Lead**			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.15	.13	.10	1.0/16V	.15	.13	.10
4.7/25V	.16	.14	.12	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

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CRYSTALS

THESE FREQUENCIES ONLY

Part #	Frequency	Case/Style	Price
CY1A	1 000 MHz	HC33 U	$5.95
CY2A	2 000 MHz	HC33 U	$5.95
CY3A	4 000 MHz	HC18/U	$4 95
CY7A	5 000 MHz	HC18/U	$4 95
CY12A	10 000 MHz	HC18/U	$4 95
CY14A	14 31818 MHz	HC18U	$4 95
CY19A	18 000 MHz	HC18/U	$4 95
CY22A	20 000 MHz	HC18 U	$4 95
CY30B	32 000 MHz	HC18 U	$4.95

XR-2206KB Kit $29.95 **Special** XR-2206KA Kit $19.95

EXAR

WAVEFORM GENERATORS

XR-205	$8 40
XR-2206CP	4 49
XR-2207CP	3 85

STEREO DECODERS

XR-1310CP	$3 20
XR-1310EP	3 20
XR-1800P	3 20
XR-2567	2 99

MISCELLANEOUS

XR 2211CP	$6 70
XR-4136	99
XR 1468	3 85
XR 1488	5 80
XR 1489	4 80
XR 2208	5 20

TIMERS

XR-555CP	[illegible]
XR-320P	1 55
XR-556CP	1 85
XR-2556CP	3 20
XR 2240CP	3 25

PHASE LOCKED LOOPS

XR-210	5 20
XR 215	6 60
XR 567CP	1 95
XR 567CT	1 70

CONNECTORS

PRINTED CIRCUIT EDGE-CARD

.156 Spacing-Tin-Double Read-Out
Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)	$1.95
18/36	PINS (Solder Eyelet)	$2.49
22/44	PINS (Solder Eyelet)	$2.95
50/100 (.100 Spacing)	PINS (Solder Eyelet)	$6.95

25 PIN-D SUBMINIATURE

DB25P	PLUG	$3.25
DB25S	SOCKET	$4.95

IMC 3½ DIGIT DVM KIT

This 0-2 VDC .05 per cent digital voltmeter features the Motorola 3½ digit DVM chip set. It has a .4" LED display and operates from a single +5V power supply. The unit is provided complete with an injection molded black plastic case complete with Bezel. An optional power supply is available which fits into the same case as the 0-2V DVM allowing 117 VAC operation.

A. 0-2V DVM with Case	$49.95
B. 5V Power Supply	$14.95

Vector

Etching Kits

32 X A-1	P.C. Etch Materials Kit enough for 5 circuit boards	$29.95 ea.
27 X A-1	Etched Circuit Kit Complete kit — only add water	$ 9.95 ea.

Plugboards

3662	6.5 X 4.5 X 1/16 Epoxy glass P-Pattern-44 P.C. Tabs-spaced .156	$ 6.95 ea.
8800V	Universal Microcomputer/Processor plugboard — Epoxy Glass — complete with heatsink and mounting hardware 5.313 X 10 X 1/16 copper clad	$19.95 ea.

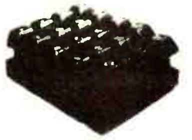
1/16 VECTOR BOARD

	0.1" Hole Spacing Part No	P-Pattern L	P-Pattern W	Price 1	Price 2-Up
PHENOLIC	64P44 062xxxP	4 50	6 50	1 72	1 54
	169P44 062XXXP	4 50	17 00	3 69	3 32
EPOXY GLASS	64P44 062	4 50	6 50	2 07	1 86
	84P44 062	4 50	8 50	2 56	2 31
	169P44 062	4 50	17 00	5 04	4 53
	169P84 062	8 50	17 00	9 23	8 26
EPOXY GLASS COPPER CLAD	169P44 062C1	4 50	17 00	6 80	6 12

HEAT SINKS

205-CB	Beryllium Copper Heat Sink with Black Finish for TO 5	$ .25
291-.36H	Aluminum Heat Sink for TO 220 Transistors & Regulators	$ .25
680-.75A	Black Anodized Aluminum	$1.60

HEXADECIMAL ENCODER 19-KEY PAD



- 1 - 0
- ABCDEF
- Return Key
- Optional Key (Period)
- — Key

$10.95 each

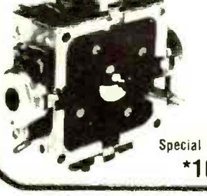
63 KEY KEYBOARD

This keyboard features 63 unencoded SPST keys, unattached to any kind of P.C.B. A very solid molded plastic 13 × 4 base suits most applications.

$19.95

HD0165 16 LINE TO FOUR BIT PARALLEL KEYBOARD ENCODER $7.95

JOYSTICK



These joysticks feature four potentiometers, that vary resistance proportional to the angle of the stick. Sturdy metal construction with plastics components only at the movable joint. Perfect for electronic games and instrumentation.

Special *5K Pots $4.95
*100K Pots $7.95

MICROPROCESSOR COMPONENTS

8080A	CPU	$19.95	8228	System Controller - Bus Driver	$10.95
8212	8 Bit Input/Output	4 95	MC6800L	8 Bit MPU	35.00
8214	Priority Interrupt Control	15.95	MC6820L	Periph. Interface Adapter	15.00
8216	Bi-Directional Bus Driver	6.95	MC6810AP1	128 x 8 Static RAM	6.00
8224	Clock Generator/Driver	10.95	MC6830L7	1024 x 8 Bit ROM	18.00
CDP1802	- with user manual	39.95	Z80	CPU	49.95

CPU'S

8080	Super 8008	24 95
8080A	Super 8008	19 95

SR'S

2504	1024 Dynamic	$ 3.95
2518	Hex 32 BIT	7 00
2519	Hex 40 BIT	4 00
2524	512 Dynamic	2 49
2525	1024 Dynamic	6 00
2527	Dual 256 BIT	3 95
2529	Dual 512 BIT	4 00
2532	Quad 80 BIT	3 95
2533	1024 Static	Special 5 95
3341	Fifo	6 95
74LS670	16 x 4 Reg	3 95

UART'S

AY-5-1013	30K Baud	$5.95

ROM'S

2513(2140)	Char Gen -upper case	$ 9.95
2513(3021)	Char Gen -lower case	9.95
2516	Char Gen	10.95

RAM'S

1101	256 x 1	Static	$ 1.49
2101	256 x 4	Static	5 95
2102	1024 x 1	Static	1 75
2107/5280	4096 x 1	Dynamic	4.95
2111	256 x 4	Static	6 95
7489	16 x 4	Static	2 49
8101	256 x 4	Static	6.95
8111	256 x 4	Static	6.95
8599	16 x 4	Static	3 49
91L02	1024 x 1	Static	2 25
71200	256 x 1	Static	6 95
93421	256 x 1	Static	2 95
MM5262	2K x 1	Dynamic	2 for 1 00

PROMS

1702A	2048	Famos	$ 9.95
5203	2048	Famos	14 95
82S23	32 x 8	Open C	5 00
82S123	32 x 8	Tristate	5 00
74S287	1024	Static	7 95
3601	256 x 4	Fast	3 95
2708	8K	Eprom	29 95
6301-1	1024	Tri-State Bipolar	3 49
6330-1	256	Open Collector Bipolar	2 95
6331-1	256	Tri-State Bipolar	2 95

SPECIAL REQUESTED ITEMS

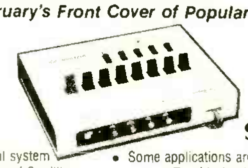
AY-3-8500-1	$16 95					8T97	2.00
MC3061P	3 50	CD4508	6 75	82S115	25.00	3341	6 95
MC4016P (74416)	7 50	CD4515	6 50	5841	9.95	9368	3 95
MC14583	3 50	CD4520	2 70	MK50240	17 50	MC1408L7	9 95
MC14562	14 50	MCM6571	17 50	11C90	19.95	LD110/LD111	25.00 set
CD4059	9 95	MCM6574	17 50	DS0026CH	3 75	AY-5-9100	17 50 ea
CD4070	95	MCM6575	17 50	TIL308	10.50	95H90	13 95

PARATRONICS

ALLOW 1 TO 3 WEEKS DELIVERY

Featured on February's Front Cover of Popular Electronics

Logic Analyzer Kit



MODEL 100A
$189.00/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
- 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

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a complete CMOS instruction manual **$6.00**

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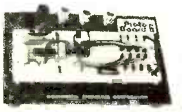
SPECIAL - $42.95

CONTINENTAL SPECIALTIES

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



Other CS Proto Boards

PB100 - 4.5" x 6"	$ 19.95
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PB102 - 7" x 4.5"	39.95
PB103 - 9" x 6"	59.95
PB104 - 9.5" x 8"	79.95
PB203 - 9.75 x 6½ x 2¾	75.00
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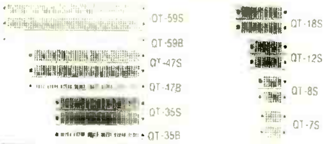
PROTO CLIPS

14 PIN	$4.50
16 PIN	4.75
24 PIN	8.50

DESIGN MATES

DM1 - Circuit Designer 54.95
DM2 - Function Generator 69.95
DM3 - RC Bridge 59.95

QT PROTO STRIPS



QT type	# holes	price
QT-59S	590	12 50
QT-59B	bus strip	2.50
QT-47S	470	10.00
QT-47B	bus strip	2.25
QT-35S	350	8 50
QT-35B	bus strip	2 00
QT-18S	180	4.75
QT-12S	120	3 75
QT-8S	80	3.25
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- 100% Solid State
- Large Red Led Display (.8" high)
- AM PM Indicator
- Seconds display at touch of button
- Power failure indicator
- One year factory warranty

C-8211
Woodgrain Case
$19.95

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SEVEN DIFFERENT INSTRUMENTS!

MEETS OR EXCEEDS ORIGINAL AUTOMOTIVE SPECS.

Please specify which one of the seven models you want when ordering — these do not all come in one unit. Each model must be bought separately

1 TACHOMETER 0-9900 RPM 4, 6 or 8 Cylinders
2 WATER TEMP 100-250° F
3 FUEL LEVEL Percentage Low Fuel Indicator
4 SPEEDOMETER* 0-99 MPH
5 OIL PRESSURE 0-80 PSI
6 OIL TEMP 200-350° F
7 BATTERY MONITOR ±1 Volts From 11-15 VDC

BRIGHT YELLOW ORANGE 3" LED DISPLAY!

Kit includes case, bracket and all components — complete. Nothing else to buy! 12 Volt NEG GRD
DIMENSIONS 4½ x 4 x 2 **KIT: $49.95**
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- Bright 6 Digit LED Display
- Times to 59 minutes 59.59 seconds
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Stop Watch Chip Only (7205) $19.95

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- .7" Hours and Minutes Display
- 12 or 24 Hour Mode
- Time Set Push Buttons
- Alarm Feature

Kit-unfinished (case unassembled) **$59.95**
Assembled-stained (case assembled) **$69.95**

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Elapsed Timer: Hrs, Mins and Secs
12 or 24 Hr Capacity
Simple Reset - Start Pushbutton Control

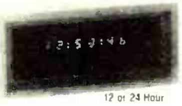
Complete kit includes mounting bracket, case and all components, nothing else to buy. Features MM5314 chip. Large .4" LED's. Accuracy better than ± min. per mo. internal battery backup. 12 volt non-polar operation.

DIMENSIONS 4½" x 4" x 2"
12 or 24 HOUR MODE

Kit: $29.95
Assembled: $39.95

CASE ONLY (includes hardware, mounting bracket and bezel) **$6.50**

JE700 CLOCK



12 or 24 Hour
115 VAC

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

$17.95

DIGITAL CLOCK KIT — 3½ INCH DIGITS

4 DIGIT KIT $49.95 **4 DIGIT ASSEMBLED $59.95**
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This clock features big 3½" high digits for viewing in offices, auditoriums, etc. Each digit is formed by 31 bright 0.2" LED's. The clock operates from 117 VAC, has either 12 or 24 hr. operation. The 6 digit version is 27" x 3½" x 1½" and the 4 digit is 18" x 3½" x 1½". Kits come complete with all components, case and transformer.

Specify 12 or 24 Hour When Ordering

JE803 PROBE

The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test, drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols (HI) - 1 (LOW) - 0 (PULSE) - P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.

$9.95 Per Kit
printed circuit board

T²L 5V 1A Supply

This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only **$9.95 Per Kit**

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POCKET COLOR/BAR GENERATOR kit, 16 patterns, $49.95. Plans, $4.95. Workshop, Box 393PC, Bethpage, New York 11714.

FIVE OCTAVE Touch Sensitive Electronic PIANO Kit. Components $245 airmail U.S.A., Canada. Clef Products, 31 Mountfield Road, Bramhall, Cheshire, England.

CONVERTER KIT: Two meters to AM Broadcast, $8.95 ppd. Send stamp for flyer. Electronics Hobbies, 3421 Hawthorne Rd., Gainesville, FL 32601.

FORTY CHANNEL CONVERSION Kit fits all 23 channel AM rigs. 40 Plus, 11301 Melody 308, Northglenn, Colorado 80234.

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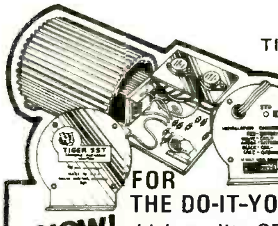

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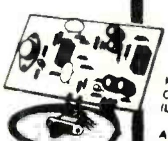
KIT #ALR-1 $9.95



#ALR-1WT WIRED & TESTED $19.95

AN EASY TO ASSEMBLE AND EASY TO INSTALL ALARM PROVIDING MANY FEATURES NOT NORMALLY FOUND. KEYLESS ALARM HAS PROVISION FOR POS. & GROUNDING SWITCHES OR SENSORS. WILL PULSE HORN RELAY AT 1HZ RATE OR DRIVE SIREN. KIT PROVIDES PROGRAMMABLE TIME DELAYS FOR EXIT, ENTRY & ALARM PERIOD. UNIT MOUNTS UNDER DASH - REMOTE SWITCH CAN BE MOUNTED WHERE DESIRED. CMOS RELIABILITY RESISTS FALSE ALARMS & PROVIDES FOR ULTRA DEPENDABLE ALARM. DO NOT BE FOOLED BY LOW PRICES! THIS IS A TOP QUALITY COMPLETE KIT WITH ALL PARTS INCLUDING DETAILED DRAWINGS AND INSTRUCTIONS OR AVAILABLE WIRED AND TESTED.

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12 OR 24-HOUR OPERATION
12 VOLT AC or DC POWERED
SIX LARGE .4" DIGITS
MODEL #2001

- MOUNTING BRACKET INCLUDED

KIT #2001 COMPLETE KIT (Less 9V Battery) $29.95 EA. 3 OR MORE $27.95 EA.

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Assembled Units May Be Mixed With Kits for Qty. Price

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PRIME - 450 NS LOW POWER

1-24	$1.95
25-99	1.75
100-199	1.60
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Over 500	1.40

PROM

1702	E Prom $8.95
5203	E Prom $8.95

OP AMPS

3/$1.00

301	TO-5
709	DIP
709	TO 5
741	DIP
741	M-DIP
741	TO-5
747	TO 5

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IN 4002	1A, 100 PIV	12/$1.00
IN 4005	1A, 600 PIV	11/$1.00
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JUMBO DIGIT CLOCK KIT

A complete Kit (less Cabinet) featuring: six .5" digits, MM5314 IC, 12/24 Hr. time, 50/60 HZ., Plug-Transformer, Line Cord, Switches, and all Parts. (Ideal Fit in Cabinet II) Kit # 5314-5 WITH PC Boards $19.95 ea 2/$38.

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Convert small digit LED clock to large .5" displays. Kit includes 6 - .5" LED's, Multiplex PC Board & easy hook-up info.
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MM 5312	$ 4.95
MM 5314	3.95
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MM 5369	2.50

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Great for Clocks or any LED Digital project. Clear-Red Chassis serves as Bezel to increase contrast of digital displays.

CABINET I 3"H, 6¼"W, 5½"D

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Black, White or Clear Cover

60 HZ. XTAL TIME BASE

Will enable Digital Clock Kits or Clock-Calendar Kits to operate from 12V DC. 1"x2" PC Board Power Req: 5-15V (2.5 MA TYP.) Easy 3 wire hookup Accuracy: ± 2PPM (Adjustable)

#TB-1 Complete Kit $4.95 ea.

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VARIABLE REGULATED 1 AMP POWER SUPPLY KIT

- VARIABLE FROM 4 to 14V
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KIT IS COMPLETE INCLUDING DRILLED & SOLDER PLATED FIBERGLASS PC BOARD AND ALL PARTS (Less TRANSFORMER) KIT #PS-01 $8.95

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[CABINET WILL HOUSE #FC-50, #PS-02, AND A PRESCALER]

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PINS	1-24	25	100
8	$ .25	$ .22	$ .20
14	.25	.22	.20
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18	.31	.28	.26
24	.50	.45	.40
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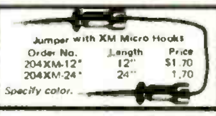
Jumper with X-100W Mini Hooks

Order No.	Length	Price
204-12W*	12"	$1.60
204-24W*	24"	1.60

Specify color

Jumper with XM Micro Hooks



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EXTRA LONG MINI HOOK

XL-1 Mini Hook (5.0" long) combines all the proven features of the X100W with an extra long body. It will make safe, short-free test connections in card racks and through deep wiring nest up to 4" . . . . $1.25 ea.

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Jumper with X-100W Mini Hook

Order No.	Length	Price
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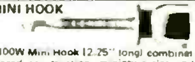
MINI HOOK



X100W Mini Hook (2.25" long) combines rugged construction, miniature size and Finger-eze Hypo Action for all the best test connections. Hook is large enough for component leads, yet small enough to get into tight places . . . . . $.75 ea.

Specify color. ORDER P/N X100W

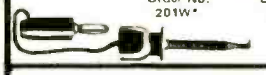
JUMPER, XL-1 MINI HOOK TO STACKING BANANA PLUG

Specify color

Order No.	Length	Price
201XL-1*	32"	$1.95

Jumper X-100W Mini Hook to Stacking Banana Plug**

Order No.	Length	Price
201W*	32"	$1.35



*Specify color   **Square hole tip for hooking laterally to leads or vertically over square wire-wrap pins.*

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Plug-in, wire, test, modify or expand without patch cords or solder. Snap together to form breadboard needed.

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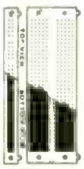
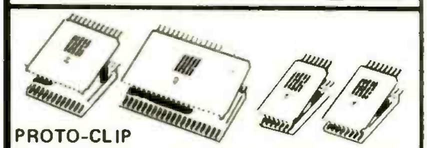
QT59B Bus	20	2.50
QT47S Socket	94	10.00
QT47B Bus	16	2.25
QT35S Socket	70	8.50
QT35B Bus	12	2.00
QT18S Socket	36	4.75
QT12S Socket	24	3.75
QT8S Socket	16	3.25
QT7S Socket	14	3.00





PROTO-CLIP

For power-on/hands off signal tracing. Bring IC leads up from PC board surface for fast troubleshooting.

PC14	14-pin	$ 4.50
PC16	16-pin	4.75
PC24	24-pin	8.50
PC40	40-pin	13.75

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The Solderless Breadboarding System That Saves You Hours On Every Project

Like our QT system, Proto-Board units let you assemble, test and modify circuits literally as fast as you can think. Rugged, heavy duty construction for use in engineering laboratories, in educational institutions, on production lines, etc.

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One preassembled QT-47S socket, two preassembled QT-47B bus strips, four four 5-way binding posts and all hardware.

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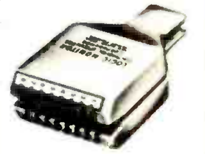
solderless tie-points, twenty-four 14-pin dip capacity.

PROTO-BOARD 203A—Complete. List Price $120.00

LOGIC MONITOR 1



Simultaneously displays static dynamic logic states of DTL, TTL, HTL or CMOS DIP ICs. Pocket size $74.95

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10	100	1.0K	10K	100K	1.0M
11	110	1.1K	11K	110K	1.1M
12	120	1.2K	12K	120K	1.2M
13	130	1.3K	13K	130K	1.3M
15	150	1.5K	15K	150K	1.5M
16	160	1.6K	16K	160K	1.6M
18	180	1.8K	18K	180K	1.8M
20	200	2.0K	20K	200K	2.0M
22	220	2.2K	22K	220K	2.2M
24	240	2.4K	24K	240K	2.4M
27	270	2.7K	27K	270K	2.7M
30	300	3.0K	30K	300K	3.0M
33	330	3.3K	33K	330K	3.3M
36	360	3.6K	36K	360K	3.6M
39	390	3.9K	39K	390K	3.9M
43	430	4.3K	43K	430K	4.3M
47	470	4.7K	47K	470K	4.7M
51	510	5.1K	51K	510K	5.1M
56	560	5.6K	56K	560K	5.6M
62	620	6.2K	62K	620K	6.2M
68	680	6.8K	68K	680K	6.8M
75	750	7.5K	75K	750K	7.5M
82	820	8.2K	82K	820K	8.2M
91	910	9.1K	91K	910K	9.1M

RESISTOR KITS 5% CARBON FILM RESISTORS

COMPLETE WITH STORAGE BIN

1/4 WATT KIT
42 Different Values
(68Ω to 4.7 MΩ)
20 Each Value

1/2 WATT KIT
42 Different Values
(68Ω to 4.7 MΩ)
20 Each Value

1/4W — $24.90 PER KIT
1/2W — $25.90 PER KIT

RESISTOR ASSORTMENTS

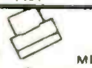
Each assortment contains 5 pcs each of 10 different values.
Values included are shown in (Ohms)
¼W,5% (50 pcs total). . .$1.75 / ½W,5% (50 pcs total). . .$1.85

Asst.1: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56 ohm
Asst.2: 68, 82, 100, 120, 150, 180, 220, 270, 330, 390 ohm
Asst.3: 470, 560, 680, 820 ohm, 1K, 1.2K, 1.5K, 1.8K, 2.2K, 2.7K
Asst.4: 3.3K, 3.9K, 4.7K, 5.6K, 6.8K, 8.2K, 10K, 12K, 15K, 18K
Asst.5: 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K
Asst.6: 150K, 180K, 220K, 270K, 330K, 390K, 470K, 560K, 680K, 820K
Asst.7: 1M, 1.2M, 1.5M, 1.8M, 2.2M, 2.7M, 3.3M, 3.9M, 4.7M, 5.6M,
(½W Assortment No.7 doesn't include 5.6M)
Asst.8R: (All seven assortments above)
¼W,5%,350 pcs total: $10.95 · ½W,5%,350 pcs total: $11.55

MATSUO DIPPED TANTALUM CAPACITORS

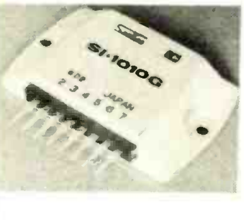
MF	V	$	MF	V	$
.1	35	.33	6.8	16	.40
.15	35	.33	6.8	35	.45
.22	35	.33	10.0	16	.42
.33	35	.33	10.0	25	.45
.47	35	.33	10.0	35	.90
.68	35	.33	15.0	20	.45
1.0	35	.33	15.0	35	1.32
1.5	35	.40	22.0	16	.45
2.2	20	.33	33.0	20	1.32
2.2	35	.40	47.0	20	1.53
3.3	35	.42	68.0	16	1.62
4.7	35	.45			

PLESSEY POLYESTER (CAPACITOR)



MINI BOX

MF	V	$	MF	V	$
.001	1000	.14	.039	250	.15
.0012	1000	.14	.047	250	.15
.0015	1000	.14	.056	250	.15
.0018	1000	.14	.068	250	.15
.0022	1000	.14	.082	250	.17
.0027	1000	.14	.1	100	.17
.0033	1000	.14	.12	100	.18
.0039	630	.14	.15	100	.20
.0047	630	.14	.18	100	.21
.0056	630	.14	.22	100	.23
.0068	630	.14	.27	100	.26
.0082	630	.14	.33	100	.30
.01	630	.14	.39	100	.33
.012	630	.14	.47	100	.36
.015	400	.15	.56	100	.44
.018	400	.15	.68	100	.47
.022	400	.15	.82	100	.54
.027	400	.15	1.0	100	.60
.033	250	.15			



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.

SI-1010G (10W output) . . . $ 6.90
SI-1020G (20W output) . . . $13.95
SI-1050G (50W output) . . . $26.80

Data Sheet with Application Notes — $0.50

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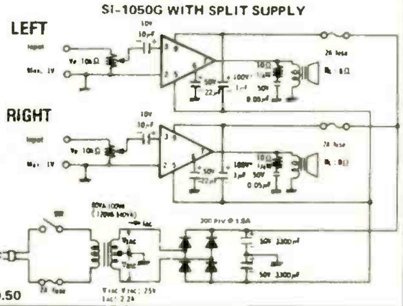
- Multi-purpose linear amplifiers for comercial and industrial applicacations.
- Less than 0.5% harmonic distortion at full power level.
- 1/2 dB response from 20 to 100,000 Hz.
- Single or split (dual) power supply.
- Rugged, compact and lightweight packages.
- Built-in current limiting for SI-1050G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

TYPICAL CONNECTIONS
SI-1050G WITH SPLIT SUPPLY

LEFT

RIGHT



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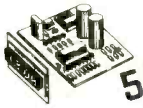
JUMBO LED CAR CLOCK

$16.95 KIT



50,000 Satisfied Clock Kit Customers Can't Be Wrong!

ALARM OPTION – $1.50
AC XFMR – $1.50

The Hottest Selling Kit We Ever Produced!

You requested it! Our first D.C. operatec clock kit. Professionally engineered from scratch. Not a makeshift kluge as sold by others.

Features:
A. Bowmar Jumbo .5 inch LED array.
B. MOSTEK – 50250 – Super Clock Chip
C. On board precision crystal time base.
D. 12 or 24 hour Real Time Format.
E. Perfect for cars, boats, vans, etc.
F. P.C. Board and all parts (less case) included.

Specials!

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28 PIN IC Sockets 3/$1.00

11,000 MFD 50WVDC Computer Grade Cap - $3.

1702A 2K EPROM

We tell it like it is! We could have said these were factory new, but here is the straight scoop. We bought a load of new computer gear that contained a quantity of 1701 A's in sockets. We carefully removed the parts, verified their quality, and are offering them on one heck of a deal. First come, first served. Satisfaction Guaranteed! U. V. Eraseable. (2.3 US access time.) NEW PRICE!

$2.95 each

UP YOUR COMPUTER!

21L02-1 1K LOW POWER 500 NS STATIC RAM

Time is of the essence!

And so is power. Not only are our RAM's faster than a speeding bullet but they are now very low power. We are pleased to offer prime new 21L02 -1 low power and super fast RAM's. Allows you to STRETCH your power supply farther and at the same time keep the wait light off!

8 for $12.95

60HZ Crystal Time Base

$5.95 2/$10.

FEATURES:
A. 60HZ output with accuracy comparable to a digital watch.
B. Directly interfaces with all MOS clock chips.
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G. Small size; can be used in existing enclosures.

Kit includes Crystal, Driver IC, PC board, plus all necessary parts and specs. At last count – over 20,000 sold!

S.D. Sales Exclusive!

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MOS 6 DIGIT UP–DOWN COUNTER

40 PIN DIP. Everything you ever wanted in a counter chip. Features: Direct LED segment drive, single power supply (12 VDC TYPE), six decades up/down, pre-loadable counter, separate pre-loadable compare register with compare output, BCD and seven segment outputs, internal scan oscillator, CMOS compatible, leading zero blanking, 1MHZ. count input frequency. Very limited quantity!

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7402 – 9c	7440 – 9c	74121 – 22c	MH0025CN – 55c
7404 – 9c	7437 – 10c	74123 – 32c	
7406 – 11c	7438 – 10c	74151 – 22c	
7407 – 11c	7451 – 9c	74155 – 22c	
7410 – 9c	7474 – 16c	74193 – 35c	
7416 – 13c	7475 – 24c	8233 – 35c	
7420 – 9c	7486 – 16c	Intel – 1302 – 45c	

IC'S REMOVED FROM PC BOARDS ALL TESTED: FULL SPEC.

1000 MFD
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4/$1.00

SLIDE SWITCH Assortment

Our best seller. Includes miniature and standard sizes; single and multiposition units. All new, first name brand. Try one package and you'll reorder more! Special!

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POWER RESISTOR
15 OHM 25W BY CLAROSTAT

75¢ ea.

RESISTOR ASSORTMENT

¼W 5% & 10%. PC leads. A good mix of values.

200/$2.

P.C. LEAD DIODES

1N4148/1N914 100/$2.00

1N4002 - 1A 100 PIV

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Transistor Grab Bag no. 1

Just received a good, mixed lot of National TO92 plastic transistors. PNP & NPN, even a few FET's. 40 to 50% Yield. Untested. Asst.

500/$3.

DISC CAP ASSORTMENT

PC leads. At least 10 different values. Includes: .001, .01, .05 plus other standard values.

60/$1.00

SIX DIGIT ALARM CLOCK KIT

$9.95 KIT

P.C. Board – $3.00
AC XFMR – $1.50

Do not confuse with Non-Alarm kits sold by our competition! Eliminate the hassle – avoid the 5314!

WE MADE A FANTASTIC KIT EVEN BETTER. REDESIGNED TO TAKE ADVANTAGE OF THE LATEST ADVANCES IN I.C. CLOCK TECHNOLOGY. FEATURES: LITRONIX DUAL ½" DISPLAYS, MOSTEK 50250 SUPER CLOCK CHIP, SINGLE I.C. SEGMENT DRIVER, SCR DIGIT DRIVERS. GREATLY SIMPLIFIED CONSTRUCTION. MORE RELIABLE AND EASIER TO BUILD. KIT INCLUDES ALL NECESSARY PARTS (except case). P.C.B. OR XFMR OPTIONAL.

NEW! WITH JUMBO LED READOUTS!

MOTOROLA SCR
2N4443. 8 AMP 400 PIV.
P.C. Leads. $3/$1.00

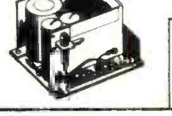
FAIRCHILD - TBA 641
4W. Audio power Amp. Just out! In special heat sink DIP. One super audio IC.
$1.50 with data

AC LINE FILTER
Rated 3 AMPS - 115/230V 50 to 400 HZ.
Noise Proof Your Computer
$3.00 each

GRAB BAG NUMBER 2
Mixed Motorola TO-18 case metal transistors. About 60% yield. PNP & NPN. Untested. A good assortment! 100 for $3.00

PRICES SHOWN SUBJECT TO CHANGE WITHOUT NOTICE.

Price Cut! ~~$15.95~~ $12.



COMPUTER POWER SUPPLY

A very fortunate purchase. One of the best industrial quality REGULATED supplies we have seen. High performance, small size. Input is 120VAC 60HZ. Has the following regulated outputs: –5VDC@800MA; –15VDC@1.25AMP; –25VDC@180MA. Sold at a fraction of original cost. Do yourself a favor and order NOW.

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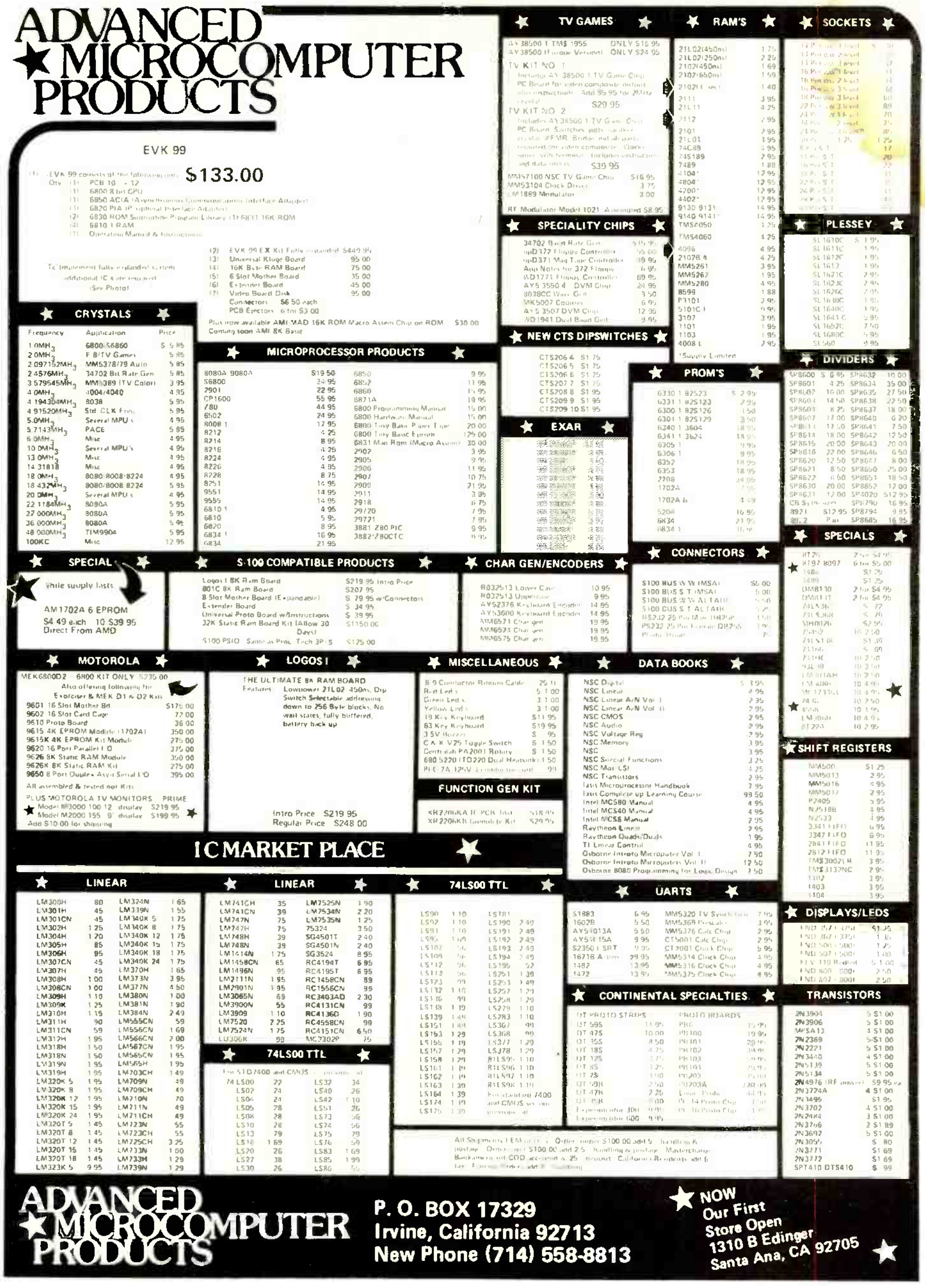

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ULTRA SELECT-A-TENNA (OVER 1000* MILES)

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SAVE 50%! 8 x 20 MONOCULAR

Top quality Spy Scope, a $30 value, now $14.95! Special purchase saves you 50%. 100% coated optics; 393 ft. field of view. Only 2 oz.—stores in pocket, purse, glove box.

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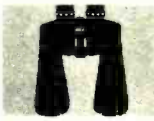

The Astronauts used this super 20X60 binocular (modified) to view Earth! Big 60 mm objective lenses; 173-ft. field of view at 1000 yds. Relative brightness, 9.0. Fully coated optics, more!

No. 1556AV ....(9¼x8½"; 47.5 oz) $99.95 Ppd.

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Hold handy (16 oz.!) low cost Anemometer into the wind, quickly read wind speed on its big dial—from 5 to 70mph. Acc. to ±3% of full scale (2.1 mph); no batts., adjustments, recalibration req.! (7½" HIGH)

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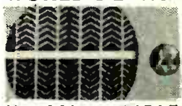

the most powerful silicon, cheapest dollar per watt! 4" dia. giant can put out 1 full watt, over 2 amps of current at .45v. Rated 100mW/Cm² light intens. at .45v.

No. 42,314AV...(TAB LEADS)...............$29.95 Ppd.

No. 42,270AV...(1 AMP ½W 3" DIA.)......$17.95 Ppd.

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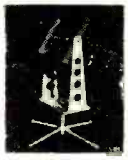

Oversized Fresnel lens enables unit you screw together to attain temperatures over 2000F at prime focus! Use to temper small parts; fire enamel on jewelry, more! 6 parts easily assembled w/instrs.

No. 80,257AV(8½ lb, 34" hi) ....$59.95 Ppd

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Hand-held 5-oz digital stopwatch counts up, down, sounds alarm—w/full range LED display (9 hrs., 59 mins., 59 secs.) Has start/stop (time-out)/reset buttons. Accurate alarm clock! 3 AA batts.

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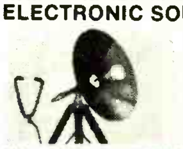

Tune in a whisper at 20 ft., normal conversations up to 100 ft., birdcalls & high freq. sounds at almost 200 ft. Nearly twice as far over water! Check on baby, birds! 18" refl. disc, mike, etc.

No. 80,176AV $32.25 Ppd.

QUALITY DETECTOR UNDER $40

Our fully transistorized BFO unit can locate a quarter at 18". Powerful 6 trans.-oscillator-amplifier circuit. Comp. to others priced 50% more! Aluminum, just 2 lb.

No. 80,222AV $39.95 Ppd.

THERE IS NO OTHER TELESCOPE LIKE IT!
THE NEW EDMUND 4¼", f/4 NEWTONIAN WIDE FIELD REFLECTOR TELESCOPE

Patent Pending

Clear, bright, spectacular wide angle views of stars, moon, comets . . . easy to use . . . ***portable!***

IN SECONDS YOU'RE SCANNING THE ASTOUNDING UNIVERSE, able to see and study the breath-taking cosmos as perhaps you never have before . . . awesome vastness, unbelievable orderliness, stark silent beauty. All the fascinating heavenly mysteries are yours to enter and explore. This new reflector telescope makes it easy for everyone to span a thousand light-years to space-age enjoyment of the heavens and outdoors. No complicated set up! Just insert the eyepiece, focus, and its big 3½° field of view gives you more stars in a single view than any other type of telescope. Bright, crisp, finely resolved images to capture your interest and imagination. It's probably the easiest to use telescope ever . . . over your shoulder, in your lap, on a tripod. Or just rotate the spherical base on its own mount for use on a table, car hood. Take it anywhere (only 17", 10 lb.). Top quality optical system: 4¼", f/4 parabolic primary mirror (⅛ wave, 17" F.L.); prealigned ⅛ wave diagonal on a coated optical window seals optics from moisture and dust; 28mm Kellner eyepiece (gives 15X, higher without other eyepiece or Barlow). Fast focusing (25' to infinity). Bright Scharfanian red (doesn't impair night vision); adj. carrying strap. A "first" scope "must" an ideal second scope!

There is no other telescope like it. NO. 2001AV **$149.95 Ppd.**

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turns brainwaves into an audible or visual signal. $149.95

KNOW YOUR ALPHA FROM YOUR THETA!

For greater relaxation, concentration . . . monitor your alpha/theta brainwaves.

Features Normally Found Only In Units Selling For More Than $200.00—And 3 Feedback Modes.

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