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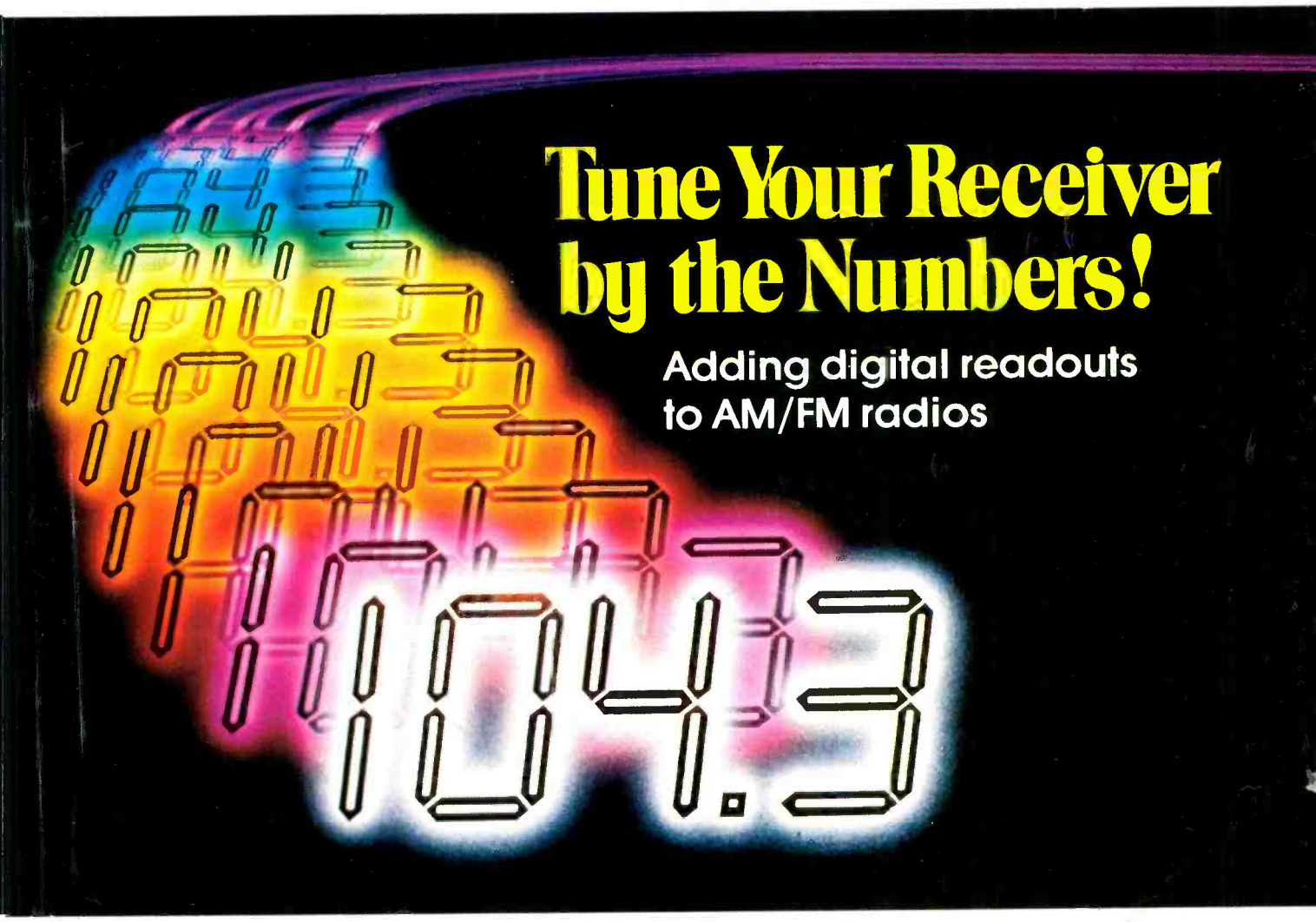
WORLD'S LARGEST SELLING ELECTRONICS MAGAZINE OCTOBER 1981/$1

DXing TV Satellites for Entertainment & News

Aftermarket Add-ons for Apple Computers

THE ELECTRONIC WORLD
Guide to Home Video Movie Making



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Tested in this issue

Netronics "Explorer" Microcomputer
dbx 20/20 Computerized Equalizer/Analyzer
Toshiba CB965 19" Tabletop Color TV
Simpson 260 Model 7 Analog Multimeter

Reddy Chirra improves his vision with an Apple.

Reddy is an optical engineer who's used to working for big companies and using big mainframes.

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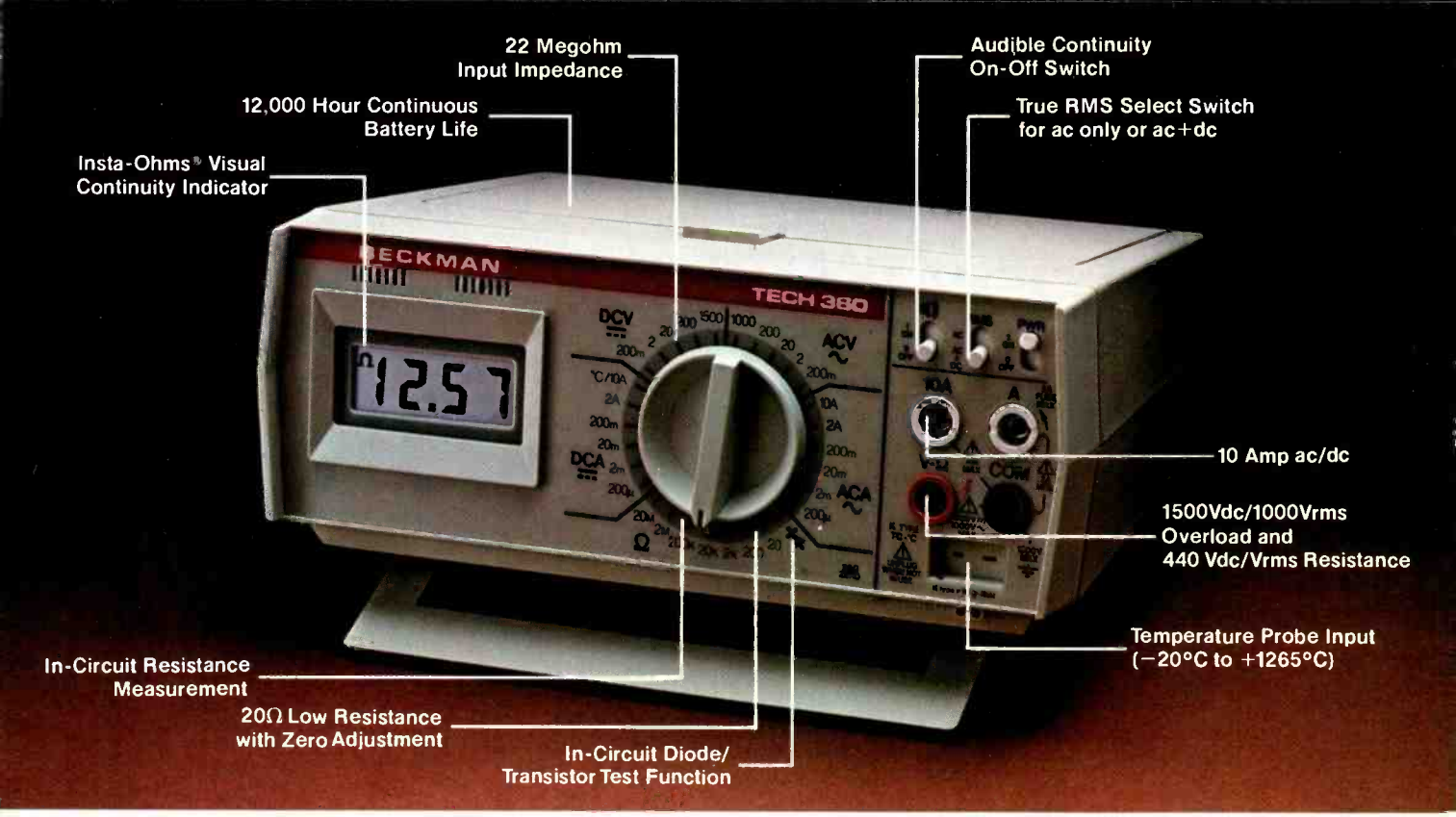

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OCTOBER 1981 VOLUME 19, NUMBER 10

Popular Electronics

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

Feature Articles

The Electronic World: Video 81

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Equipment Reviews

Columns

Departments

TWELVE STRONG HEATH/ZENITH YOUR

Pick a strong partner

A computer purchase is the beginning of a long term partnership between you and the people you buy from. Your ongoing need for software and accessories requires a partner who will stand by you with a growing line of products. And nowhere will you find a more complete line of hardware, software and accessories than at your Heathkit Electronic Center. Here are twelve strong reasons to make Heath/Zenith your partner.

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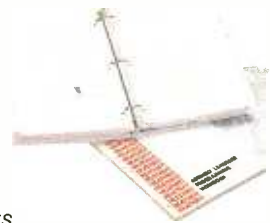
8. Self-Study Courses



Learn at your own pace with *Programming Courses* that teach you to write and run your own programs in Assembly, BASIC, Pascal or COBOL.

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Personal Computing is a complete introduction to the fundamentals for the novice. Every Heathkit/Zenith course is professionally designed for easy, step-by-step learning.

All Heath/Zenith Computer Products are available completely assembled and tested for commercial use. Or in easy-to-build, money-saving kits.

REASONS TO MAKE COMPUTER PARTNER

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Pick the store nearest you from the list at right. And stop in today for a demonstration of the Heath/Zenith 89 Computer System. If you can't get to a store, send $1.00 for the latest Heathkit® Catalog and the new Zenith Data Systems Catalog of assembled commercial computers. Write to Heath Co., Dept. 010-824 Benton Harbor, MI 49022.

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EDITORIAL

Experimenting With Electronics

It's easier than ever before to experiment with electronic circuitry, thanks to the advent of solderless breadboards and integrated circuits. It has meant no more fuss and muss in connecting and changing components.

As most readers know, "experimenting" is a highly fruitful way to learn how certain devices work. There's nothing like quickly strapping together a circuit, making some changes, and observing the end results to truly understand what makes it all tick. Furthermore, one can toy with a circuit on a solderless breadboard until it's just right before duplicating it in more permanent fashion on perf or printed-circuit board.

Such a "hands on" approach is epitomized by Forrest Mims' monthly column, "Experimenter's Corner." As our loyal readers probably know, it's the most popular editorial section in our magazine, as evidenced by reader survey after reader survey. Running since our October 1975 issue, with Forrest's fertile mind supplying fresh material without ever faltering, it has been a boon to creative, ever-learning electronics enthusiasts. Now Forrest has written a book based on his monthly installments, titled *103 Projects for Electronics Experimenters,* published by Tab Books. For readers who missed some of his columns or for those who wish to have them wrapped up in one package, here's a special opportunity to experiment with analog and digital ICs, converters, optoelectronics, and power supplies.

In many instances, there are end products that result from following Forrest's experimenting suggestions. These include a microphone amplifier, touch switch, intercom, tone-burst generator, hexadecimal keyboard encoder, solid-state oscilloscope, single-digit voltmeter, light-activated relay, LED-LED transceiver, TTL supply, solar cell arrays, and more. More importantly, one learns how the circuit works and thereby knows how to roll modified versions to suit special purposes.

There are few sources available to get such hands-on experience. To a lesser extent, there are some other books, such as *Integrated Circuits for Electronics Technicians* by Edward Pashaow from McGraw-Hill, Inc. But they're almost as rare as auk's eggs. Also, using a more formalized approach, Heathkit/Zenith's educational courses employ experimenter packages with built-in solderless breadboard sockets, power supplies, and signal sources, taking this method of learning farther.

Judging from reader letters and our 400,000+ sales every month, there are a lot of people out there who are not merely resigned to pushing buttons. With the dearth of electronics engineers and technicians available for gainful employment, this is a happy circumstance. Even so, there is expected to be a shortage of electronics-trained personnel at least into 1985.

Interestingly, Japan produces more electronics engineers than the U.S., though its population is so much smaller. Seems that four years of high school math and three years of a natural science, as required in Japan and most European schools, are options that fewer and fewer Americans are choosing, which doesn't lay the seeds for future technical graduates. Perhaps if PE readers would pass along Forrest Mims' columns to youngsters and work along with them, it would spark more interest in seeking a technological career such as electronics.

Art Salsberg

Popular Electronics

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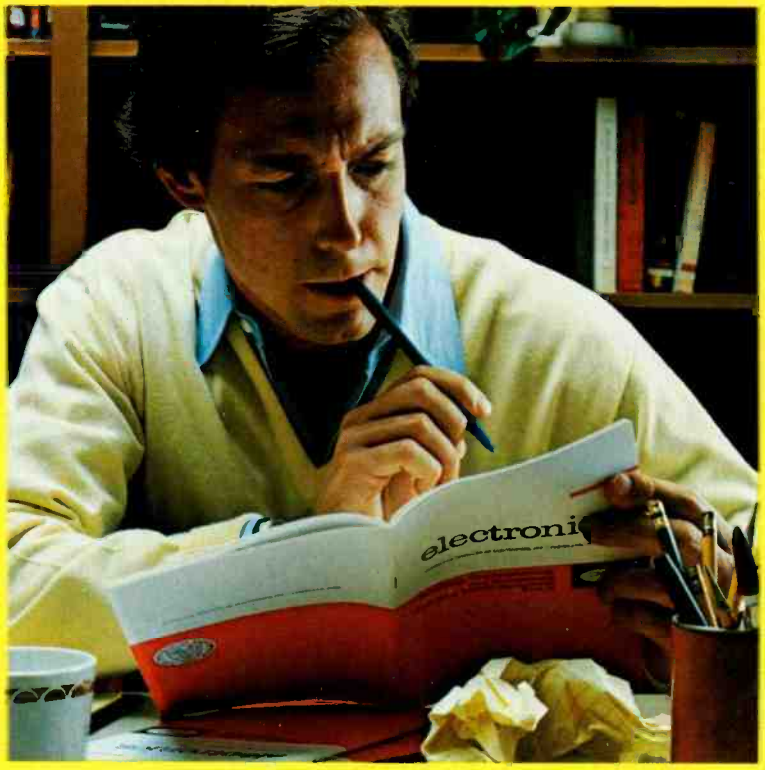

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NEW PRODUCTS

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

Car Stereo Expander

A version of the Omnisonix Imager designed for car stereo systems is now available to increase the apparent size of a listening area. Model 801-A plugs directly into most car stereo systems that incorporate a separate power amplifier. For self-contained systems, a wiring connection must be made. Designed to operate from 12 V dc, negative ground, the Imager is also adaptable to home music systems, connecting between the preamp and power amp. Specifications: input impedance, 25 kΩ; frequency response, 10 to 20,000 Hz (±0.5 dB); THD, 0.03%; noise output, −60 dBV; S/N, 68 dB; power, 40 mA; size, 4¾"W x 5¼"D x 2"H. Bracket or velcro mounted. $149.95

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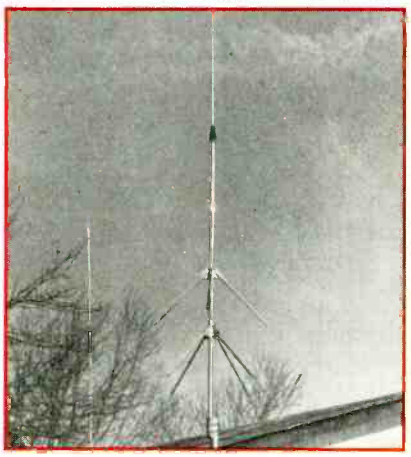
Vertical Double Zepp Antenna



The two-meter V-2 from the Hy-Gain division of Telex Communications is an extended double-zepp vertical consisting of two stacked 5/8 waves decoupled inside the antenna. Said to be resistant to severe weather, and impedance-matched to the transmission line, the V-2 mounts on any mast up to 2" in diameter. Two sets of ¼-wave radials and a centered feedpoint are said to eliminate power loss into the sky. Operating from 138 MHz to 174 MHz, the antenna has a VSWR on the order of 1.5:1 at resonance, and a 2:1 VSWR bandwidth of at least 7 MHz. Isolation from the supporting mast is 20 dB. $49.95.

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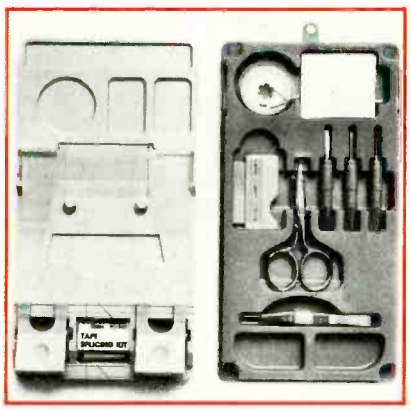
Tape Splicing Kit



A self-storing splicing kit from Osawa, marketed under the Nagaoka brand name, is available for editing and repairing cassette and microcassette tapes (including Philips format). The Nagaoka PC-507 has a plastic top section that contains cutting jigs for each of the three tape formats, cassette positioning sections, and recesses for screws or clamps. A lower section houses miniscissors, a razor/cutter, screwdrivers, a marking pin, tweezers, pressure pads, splicing tape sheets, leader tape, an assortment of Philips head screws, and one cassette hub. $24.95.

CIRCLE NO. 86 ON FREE INFORMATION CARD

Direct-Drive Turntable

The HT-500 from Hitachi features the Unitorque motor, which is said to provide constant torque as the platter rotates. The motor is brushless, slotless, and coreless; and is regulated by reference pulses from a crystal oscillator. Sensing tonearm position optically, the unit is fully automatic. The tonearm itself is a straight low-mass design. The platter is of aluminum alloy. S/N is 78 dB; wow and flutter, 0.025% wrms. $330.

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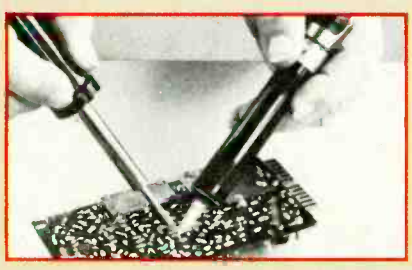
Desolder Pump



The new DP-1 desolder pump from OK Machine and Tool Corp. features all-metal construction and compact size for one-hand operation. Suction is said to be precisely regulated to minimize damage to delicate circuitry. Self-cleaning on each stroke, the DP-1 can be disassembled without tools for maintenance or repair. The tip is made of Teflon. $10.95.

CIRCLE NO. 87 ON FREE INFORMATION CARD

Smartmodem

Designed to interface with an RS-232G-compatible computer, the Hayes "Smartmodem" is a 300-baud originate/answer modem that can be controlled using any programming language. Thirty different commands can be written into a user's program or can be entered directly from a keyboard. An internal speaker permits monitoring of connections as they are made, whether Touch-Tone or pulse. Features include automatic answering and dialing, loop-back self-testing, and LED status indicators. Data format is serial, binary, asynchronous 7 or 8 bits, and 1- or 2-stop bits with odd, even, or no parity. Dimensions are 1.5" x 5.5" x 9.6".

CIRCLE NO. 91 ON FREE INFORMATION CARD

(Continued on page 14)

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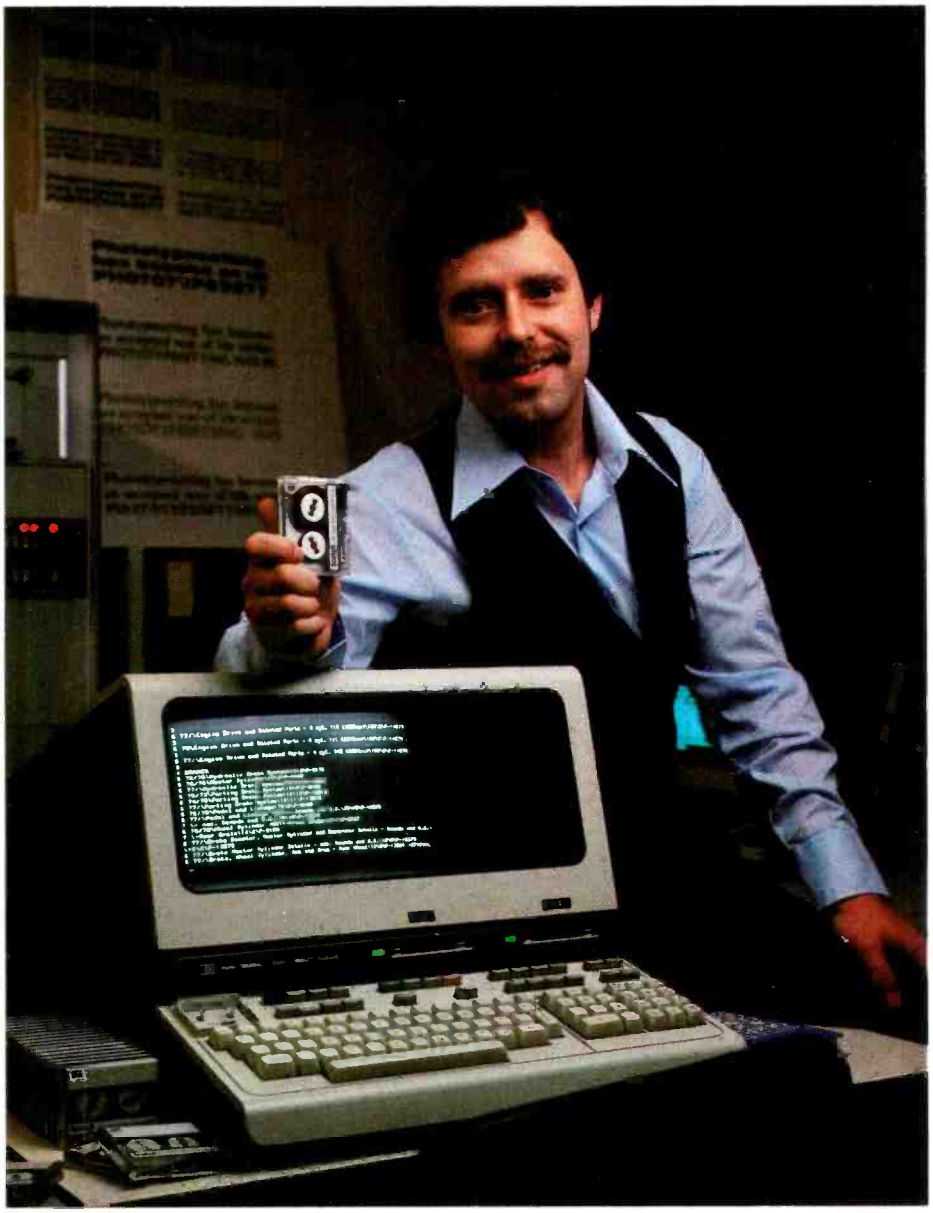

Bill Birkett, Vice President, Trade Graphics, Inc., Livonia, Michigan

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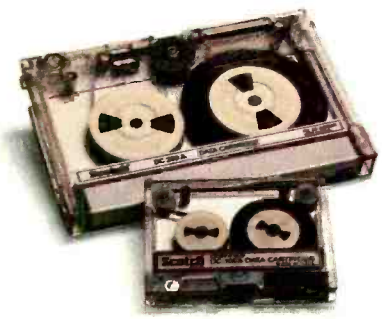


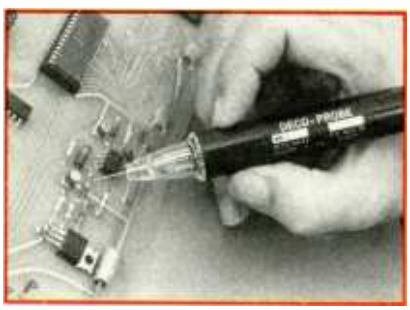
3M

Two-Way Floor-Standing Speaker

The S11 from Speakerlab is a two-way speaker with a leaf tweeter using a samarium-cobalt magnet structure and 8″ polypropylene woofer working into a vented enclosure. The S11 features an "edgeless box" in which the drivers are mounted on a raised frontboard surrounded with foam. This, it is claimed, reduces blurring of the primary wavefront by eliminating secondary radiation caused by diffraction. Crossover frequency is 3.8 kHz; nominal impedance, 6 ohms; drivèr power (per channel), 15 min./75 max. Dimensions are 28¼″H x 11¾″W x 10¾″D. Housed in oak cabinets, fully assembled units have a suggested retail price of $189 each.

CIRCLE NO. 92 ON FREE INFORMATION CARD

"Cone of Light" Logic Probe



The Deco-Probe from Deco Sales is intended for use on TTL, CMOS, and microprocessors with voltages from 5 to 18 V. The circuitry is said to automatically adjust thresholds and to detect logic levels. Pulse detection is claimed for intervals down to 50 ns. The red and green LED display illuminates the point of circuit contact through a light-pipe nose piece. $19.95, kit form; $29.95, assembled.

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Tuneful Car Horn

The Heathkit CH-1276 Programmable Musical Car Horn permits a user to select from 16 preprogrammed tunes or program a tune of his own. It connects to any vehicle with 12 V dc, negative ground. A full keyboard inside the main unit has 13-note octave, rest and hold keys; and allows for the changing of tunes as often as desired. An external control is provided for tempo adjustment. The three-button external keypad, which mounts on the steering wheel or instrument panel, lets the user select from three different tunes, either preprogrammed or original. A weatherproof 4-ohm, 4-W speaker is included with the kit. $77.95.

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Multifeature Phone

The Intelli-Phone from Universal Security Instruments, Inc., Model Tel-1000, will store and dial up to ten telephone numbers. When calls are placed, the receiver can be left on hook until the called party is heard over the loudspeakers. The system will redial busy numbers once a minute for up to ten minutes. A fluorescent display functions as both digital snooze alarm and call timer. A 9-V battery (not included) preserves memory up to 24 hours in the event of a power failure. $199.95.

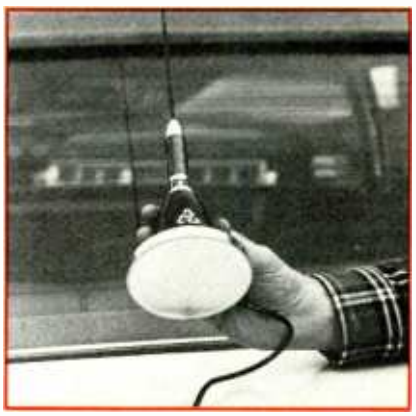
CIRCLE NO. 94 ON FREE INFORMATION CARD

Logic-Switched Preamplifier

The SAE P101 uses circuitry that isolates the audio signal in the rear portion of the unit, well away from the front-panel controls. This shortens the signal path and is said to reduce the likelihood of signal degradation. A dedicated logic array replaces mechanical switching. A moving-coil input incorporates a preamplifier and eliminates the need for an outboard head amplifier. Channel levels are adjustable in 1.5-dB steps over a range of 94.5 dB and are displayed on a digital readout. Also featured is a video input that accepts the audio signal from a TV receiver, VCR or disc player. $650.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Hollow-Coil CB Antenna



The MAG-20 magnetic-mount mobile CB antenna from Armstrong Industries is rated to give an SWR below 1.2:1 from 26.5000 to 28.000 MHz. A 42-inch stainless-steel whip is attached to a ball joint, permitting a 45° tilt from all mounting angles. Copper plating is said to add 1 dB of gain. Power rating is 500 W continuous or 1000 W intermittent. The loading coil form and cover are made of glass-filled plastic for weather resistance. No soldering is required for installation. $50.50 with optional shock spring.

CIRCLE NO. 96 ON FREE INFORMATION CARD

"Quiet" Portable Stereo

DNR (Dynamic Noise Reduction) is the major feature of Technidyne's model 140 Hip Pocket Stereo. DNR, a low-pass filter system whose cutoff frequency varies with program content, is said by the manufacturer to rid the program source of noise, as well as to prevent noise from being added by the playback equipment. In the model

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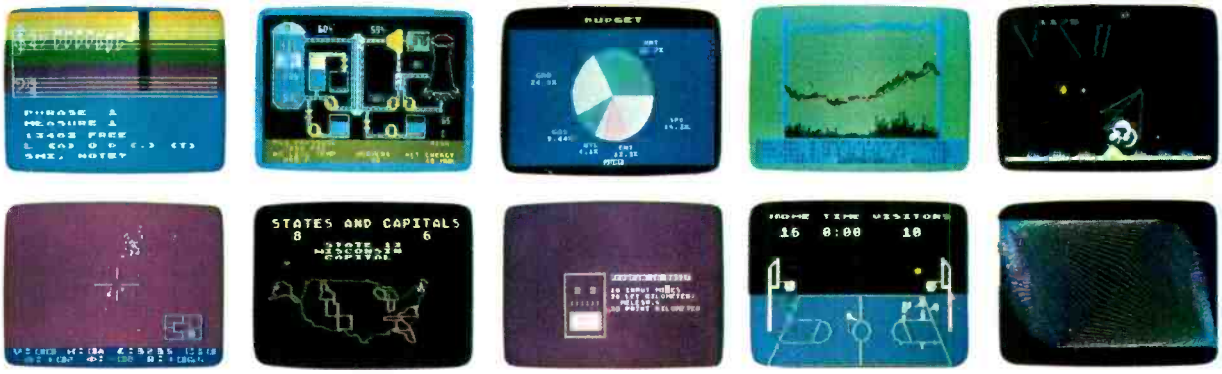

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140, 14 dB of noise reduction is claimed. Weight, with headphones and without batteries, is 12⅛ oz. Price without FM tuner pack, $139.95.

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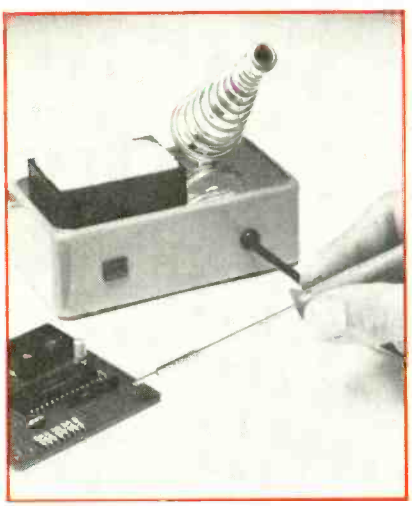
Stereo Mikes

The D-40 from AKG is a moving-coil microphone sold in matched stereo pairs. Frequency range is 80-15,000 Hz, rated impedance is 600 ohms, and sensitivity at 1,000 Hz is −55 dBV. A pair of D-40s, whose pickup patterns are cardioid, comes packaged in a kit with two stands and eight-foot shielded cables. $99 a pair.

CIRCLE NO. 99 ON FREE INFORMATION CARD

Soldering Station for Miniature Circuits



Wahl's new Model 7230 is designed for fine, heat-sensitive work. The 6-watt iron weighs ¼ oz, and has 14 interchangeable tips from 0.04 to 0.16 inches. The tips are said to cool down quickly from 360°C and to resist seizure. Other features include a double-insulated transformer, a tip-cleaning sponge and sponge well, an indicator lamp, and an internal safety fuse. $39.95.

CIRCLE NO. 100 ON FREE INFORMATION CARD

Audio Product of the Month

CHOSEN BY THE EDITORS OF POPULAR ELECTRONICS

The dbx 20/20 Computerized Equalizer/Analyzer

THE dbx 20/20 is a computerized octave band equalizer and real-time spectrum analyzer, including a pink noise source (pseudo-random type) and an LED display of level VS frequency.

It can automatically equalize the frequency response of a sound system, as measured by an omni-directional microphone included with the 20/20, to be flat within ±1 dB from approximately 30 to 16,000 Hz in only 15 seconds (assuming that the initial response irregularities do not exceed the +14 to −15-dB range of the 20/20). The resulting equalization curve can be stored in one of its 10 memories and recalled at any time by the touch of a button. Any combination of as many as 10 stored curves can be averaged.

The EQ functions can also be performed manually with its individual octave switches, and a real-time analyzer (RTA) mode is available for monitoring the spectral content of program material fed to the MIC or LINE input.

The dbx 20/20 measures 19" W x 12¼" D x 5¼" H, and weighs 21 pounds. It is finished in black, and the panel is slotted for mounting in a standard EIA rack. Suggested retail price is $1,500.

General Description. Functionally, the dbx 20/20 is based on a conventional octave band equalizer whose 10 individually adjustable filters have center frequencies of 31.5, 63, 125, and 500 Hz, and 1, 2, 4, 8, and 16 kHz. The gain in each band is unity and can be adjusted from +14 to −15dB in steps of 1 dB.

Also within the dbx 20/20 is a real-time analyzer consisting of 10 filters whose characteristics are identical to those of the equalizer sections. Since the filters are all one octave wide, they respond equally to pink noise, which has equal energy per octave of bandwidth.

The dbx 20/20 connects into the tape-monitor loop of the amplifier or receiver (or between the preamplifier and power amplifier). A button on the 20/20 panel replaces the program with a pink noise signal, and the small omnidirectional electret microphone supplied with the instrument is placed near the listening position. After the acoustical level has been adjusted to a suitable value (the sound pressure level in dB is displayed on the front panel in the RTA mode), the AUTO EQ button is pressed.

If the display is the in the RTA mode, it "freezes" at that moment. The changes in the timbre of the pink noise signal can be heard as the computer adjusts the individual band gains to flatten out the overall response. In about 15 seconds the process is complete; the display reverts

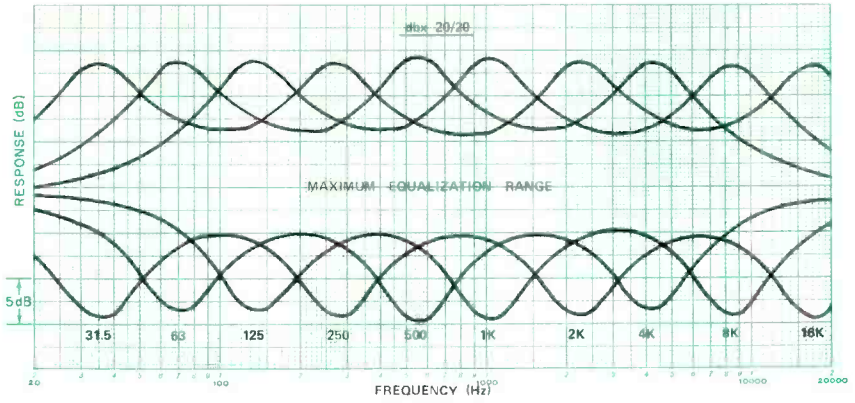


Fig. 1. Equalization filter curves for the dbx 20/20.

to its active form with an essentially flat line, and the overall variations in response are typically within ± 1 dB (the random nature of the noise signal causes the individual lights to bounce up and down by perhaps — 2 dB, but their average is usually within the instrument's ratings).

To see the final EQ curve, press the EQ DISPLAY MODE button. If the original response was so irregular that the equalizer lacked the range or resolution to flatten it, the automatic process will be repeated up to 18 times, after which it stops. To store the final EQ curve in a memory, press the ENTER MEMORY button and one of the numbered MEMORY buttons. If batteries have been installed in the 20/20, the curve will be retained in that memory location until erased.

The SET FLAT button provides an instantaneous comparison between the equalized and unequalized sound. If the equalization is performed with several different microphone positions, somewhat different curves will be obtained. They can be averaged by pressing the AVERAGE button, followed by the MEMORY buttons for each of the curves to be averaged. A touch of the COMPUTE button will then average the curves. The final result will be seen on the display and can be stored in any available memory position. Because many people find a flat room curve excessively bright, the 20/20 includes the HFR CURVE button to introduce a fixed rolloff extending upward from 2 kHz.

The RTA can monitor the spectral content and level of program material. If the PEAK-HOLD button is pressed, the RTA displays only the maximum level in each band. The RTA display is calibrated in dB levels from 60 to 110 at the center point; with a LINE input, the center level corresponds to a 300-millivolt input; and when the MIC supplies the input, the center corresponds to the sound pressure level (SPL) at the microphone.

The comprehensive instruction manual does not mention the equalization of *stereo* systems as such. Speakers in different locations will probably require different equalization curves, but there is no provision for this in the 20/20. It treats both channels identically, on the basis of the signal at its microphone.

OPERATING FEATURES

Front Panel:

LED Display: A 10-band, 30-level display of electrical or acoustical signal levels over a 30-dB range in 1-dB steps, for each of the octave bands from 31.5 Hz to 16 kHz.

Manual Equalizer Controls: Ten spring-return center-off toggle switches that change the gains in the individual bands by 1 dB each time they are moved up or down and cause it to continue stepping automatically while the switch is held at either limit.

PINK NOISE LEVEL: A horizontal slider for adjusting the level of the pink noise test signal supplied to the system under adjustment.

POWER: A pushbutton switch

MIC: A ¼-inch phone jack for the electret microphone furnished with the equipment. Power is also supplied to the microphone.

(Note: The following controls are momentary-contact pushbuttons, most with adjacent LEDs to show when they are active.)

DISPLAY MODE: Allows either the EQ response or the RTA output to be shown on the LED display.

RTA SENSITIVITY: Shifts the input sensitivity of the RTA UP OR DOWN by 10 dB each time one of the buttons is pressed, or steps it automatically while it is held in. The center scale SPL value at the microphone (in dB) is shown by numbers on the LED display. When using the LINE input, 0 dB = 300 mV.

RTA SOURCE: Selects either MIC or LINE input sources for the RTA.

RTA MODE: Changes display to show either a running average (AVG) of the program level or (in PEAKHOLD) the highest peak levels encountered.

PINK NOISE: Replaces the LINE program source with the pink noise signal from the 20/20.

MONITOR: Selects either SOURCE or TAPE programs for listening.

AUTO EQ: Initiates automatic computer-controlled equalization process.

ENTER MEMORY: Must be pressed before storing an equalization curve in one of the memories.

MEMORY 1-10: Store or recall equalization curves. Any curve is recalled by pressing its button.

HFR CURVE: Adds a fixed high-frequency rolloff to any EQ curve.

SET FLAT: Resets the EQ to center (flat) conditions.

AVERAGE: Pressing ENTER allows contents of any two or more MEMORY locations to be averaged, by then pressing COMPUTER.

Rear Panel:

LINE input and output phono jacks (to amplifier TAPE jacks).

TAPE recorder input and output jacks (replacing amplifier TAPE jacks).

PINK NOISE output phono jack (for testing tape recorders and amplifiers).

MIC input jack (same as front panel jack but preempted by it).

LINE FUSE holder (¾-amp AGC).

Battery Compartment. Holds two AA cells to retain memories with power disconnected.

Laboratory Measurements. Filter curves of the 20/20 are shown in Fig. 1. Bandwidths are reasonably accurate, and the ranges of gain adjustment are as specified. Gain in the 0-dB position was 1.0. Total response variation in the FLAT condition was 0.8 dB from 20 to 20,000 Hz. The HFR CURVE response started to roll off at 1 kHz, reaching a plateau of −6.5 dB in the 8-to-17-kHz range. When we averaged several arbitrary and sometimes extreme EQ curves with the computer, the results seemed correct, although we did not verify the calculations mathematically.

Distortion at outputs up to 3 volts was less than 0.01% and reached only 0.056% at 6 volts. (Clipping occurred at 6.8 volts.) Output noise was 300 microvolts unweighted, and was unmeasurable (less than 100 microvolts) with A-weighting. The maximum level of the pink noise output was 150 millivolts at the LINE jacks and 45 millivolts at the rear PINK NOISE jack. Crosstalk between the two channels was −76 dB at 1 kHz and −52 dB at 20 kHz.

Most of our evaluation of the dbx 20/20 was done by using it to equalize various loudspeakers. About 8 pairs of speakers were tried over a period of several months. The microphone was placed at our usual listening position, about 12 to 15 feet from the speakers. It was soon apparent that the subjective effect of equalization was strongly dependent on the speakers we used, in the sense that the better speakers needed relatively little equalization.

The most striking discovery of the tests was that while the 20/20 did indeed give practically the same final response curve for *any* speaker after

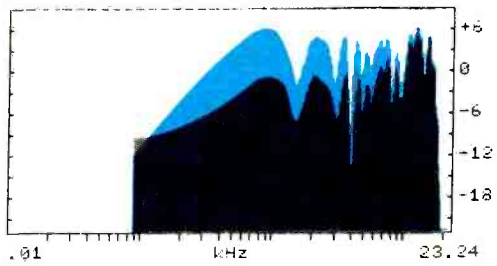


Fig. 2. The upper outline of the area in color is the on-axis frequency response of a loudspeaker prior to equalization; that of the gray area is after equalization by the 20/20. Broad segments of the curves differ, but the fine detail—which gives the speaker its characteristic sound—remains.

equalization, the various speakers retained their individual sonic character after equalization.

We therefore concentrated on four very different-sounding speakers: an expensive, highly regarded three-way system, a fairly expensive dipole (bidirectional) radiator system, a moderately priced conventional three-way bookshelf system, and a small two-way bookshelf system. The B&K calibrated microphone we use for speaker measurements was mounted at the listening position, close to the dbx microphone. Speaker response was measured with the B&K microphone, using the 18-microsecond pulses generated by an FFT (Fast Fourier Transform) spectrum analyzer (a special program for an Apple II computer), both before an after equalization by the 20/20. This was done only for the left speaker, since our microphones were on its axis and about 12 feet from it. After each speaker was equalized, the EQ curve of the 20/20 was plotted with our GenRad sweeping oscillator and recorder combination, and also with the FFT analyzer. This was done for each of the four speakers in turn.

This test verified that each of the speakers gave essentially the same flat response at the dbx microphone. The variation was within the rated ±1 dB, except for some greater low-frequency deviations in the case of the smallest speaker, which could not be made flat down to 30 Hz. Nevertheless, after equalization, the four speakers had virtually identical (and flat) frequency-response characteristics as shown on the LED display of the 20/20 .

Once again, despite the similarity between their RTA readouts, the speakers retained much of their orignal sonic personalities. In fact, whether the equalization resulted in any net quality improvement for *any* of the speakers is questionable. The change was always easily audible by comparision with the SET FLAT condition, but was heard as a different sound quality, rather than a clear-cut improvement.

The FFT data (Fig. 2) gave a clue to what was happening. The 20/20 was equalizing the total integrated sound level at the microphone, most of which was reverberant and had lost much of its high-frequency content by absorption. The axial response sensed by the B&K microphone, even at a considerable distance, contained a large proportion of direct, first-arrival sounds. Despite some irregularities, presumably caused by room effects, the FFT curves showed the differences between the axial and fully dispersed outputs of the speakers.

The EQ tended to boost the highest frequencies, compensating for room absorption and thus overcompensating the axial response. Also, because many of the major response variations of the speakers would require much narrower filters than those of the 20/20 for complete correction, they remained in the final curves. The observed effects of the EQ explained the need for the HFR CURVE; in every case we found it desirable to temper the excessive brightness introduced by the equalization.

User Comment. We devoted more time to evaluating the dbx 20/20 than we have to almost any other component in memory. While it was obvious that this ingenious, beautifully conceived and executed product was doing exactly what it was meant to do, we were at first puzzled by the subjective effect.

Our experience in the lab suggests that the total sound quality of a speaker results from both direct-arrival sounds and reflected sounds, and that there is no present way to equalize them separately to optimum conditions. Either can be made relatively "flat" with respect to the speaker's acoustic output versus its electrical input, but then the other will not be correct. We found that, with the microphone close to the speaker, the 20/20 did a fairly good job of flattening out the axial frequency response, but this does nothing to compensate for room acoustics.

In the final analysis, the dbx 20/20 is as useful for room and speaker correction as any 10-band graphic equalizer with comparably accurate filters and adjustments. Its automatic adjustment feature means that the device will always do the best job possible under the given constraints. Its ability to store up to 10 equalization curves and average them as desired can be a great convenience when one is trying to equalize for different speakers or rooms. And the possibility of convenient recall of EQ for specific records and tapes is another notable advantage. It must be said that while an octave-band equalizer is not the tool of choice for all occasions, as such devices go, this one stands out for versatility and accuracy.—*Julian D. Hirsch*

ENTERTAINMENT ELECTRONICS

By Ivan Berger

The Problem of Video Camera Compatibility

IN SHOOTING pictures with a video camera, you may encounter problems of camera/recorder compatibility. On a recent project, I had planned to use Technicolor's Model 212 video recorder and Sony's HVC-2200 camera—the Technicolor because it's by far the lightest and most compact portable around, using nonstandard 1/4" tape cassettes, and the Sony because it's one of the most versatile yet one of the easiest-handling cameras I've ever used.

The plug connections didn't match, but Technicolor lists an adapter for precisely this purpose; so no problem, right? Wrong. The Sony cameras use a special connector that only Sony makes, and which is almost impossible to get. Technicolor had run out of Sony connectors, so I tried a similar adapter, from Toshiba. Alas, this didn't make the necessary connections either—the camera got power, but the recorder stayed in PAUSE. Nor did it make the right connections to feed the playback picture to the camera's electronic finder screen.

Next I tried a JVC camera, with the same plug as the Technicolor. That one wouldn't work without a different Technicolor adapter, so I took a GE portable recorder that I'd just gotten for test, and tried both the Sony (with adapter) and the JVC on that. The JVC worked fine, but with the effect of the trigger reversed (I had to hold it in to stop the deck, and release it to start again). The Sony worked fine, too, but wouldn't stop the tape. (Every other press of its trigger stopped the tape for an instant, then recording resumed.) Since it had an electronic viewfinder and the JVC did not, though, I used that with the GE for most of my shots.

The comedy came to an end when a Technicolor camera arrived. Since I'd already started my test shots on the GE VHS cartridge, I tried the Technicolor camera on the GE. It worked like a charm, and the balance of the test shots were made with it.

Matching of cameras and recorders is only a problem with portables. For convenience in the field, all camera connections are made through single, multipin connectors. Table-model recorders all have RCA-jack video inputs, and either RCA or 3.5-mm mini-phone jacks for audio. For use with these, the cameras plug into accessory adapter boxes (sometimes provided with the camera, sometimes sold at extra cost) which include a power supply, a jack to match the camera's plug, and separate video and audio output jacks to feed to the recorder.

When it comes to single-jack camera connections, though, there are no standards. Sony, Sanyo, Toshiba and Zenith use 14-pin plugs; most of the VHS machines (and Technicolor) use 10-pin ones. Akai's VHS deck uses a 7-pin plug, though Akai sells an adapter for 10-pin cameras. A few other manufacturers use 8-pin or other, nonstandard connectors.

Even when the plugs match (as in the JVC/Technicolor combination), other things may not. The camera connector must carry audio, video, and start/stop switching from camera to recorder, and camera power from recorder to camera. It may also carry video and audio from the recorder to the camera so the operator can check his last shot by replaying it through the camera's electronic finder screen. Then there are one-of-a-kind functions, like the REMOTE STOP, START, REWIND, PLAY and RECORD facilities built into Sanyo's lastest portable camera and recorder.

Power Differences. Even simple things like start/stop switching and camera power can pose compatibility problems. Some recorders, for example, supply 12-volt power, some 9-volt. In some, but not all, the voltage is regulated. Start/stop switching may be normally open or normally closed, and may switch to either the 9-volt (or 12-volt) hot line or to ground. All told, there seem to be at least nine different camera/recorder jack setups.

Some cameras, especially the VHS ones, try to get around this to a certain extent. Many camera manuals, for example, don't state whether the tally light in the finder indicates that the recorder is off or on, because its meaning depends on the recorder used. Such cameras usually have push-push triggers, rather than the momentary-contact type, which also means you can set the camera up on a tripod and get into the frame yourself. RCA's CC-010 and CC-011 have compatibility switches to match its trigger to most VHS recorders. Several manufacturers (Quasar and Hitachi, for example) wire different camera models in their lines in different ways.

The moral of all this is to check very carefully before getting any portable VCR and camera not specifically recommended for use with each other, and to double-check (either by querying both manufacturers—who may not know—or by carefully reading both schematics) before plugging them together. I haven't heard of anyone actually blowing a camera or recorder through a pin mismatch, but I believe it could happen.

Adapters. If the camera and recorder you want don't seem to talk to one another, don't despair. Technicolor sells three adapters for its portables which should also, judging from my experience with Technicolor's camera, work on GE and some other VHS decks. The Cable Works (4228 Santa Ana St., P.O. Box M, South Gate, CA 90280) has a line of adapters to fit five camera types to four different recorders. Comprehensive Video Supply (148 Veterans Dr., Northvale, NJ 07647) sells 28 adapters that match any of five different recorder connectors to any of seven different camera types. Plugs and jacks from which you may be able to make up your own adapters are available from WIDL (5245 W. Diversey Chicago, Il. 60639), RMS Electronics (50 Antin Pl., Bronx, NY 10462), Comprehensive, and Total Video Supply (9060 Clairemont Mesa Blvd., San Diego, CA 92123). ◇

Comprehensive's adapter for connecting camera to VCR.

Popular Electronics Tests

The Netronics Explorer 85 Computer

The Explorer/85 computer from Netronics Research and Development is one of a rare breed—a simple, low-cost, yet exceedingly well-designed computer that starts as a basic kit, and can easily be expanded as the builder/user requires. Through the addition of other low-cost kits, the Explorer/85 can be expanded into an excellent and useful general-purpose computing system whose final price undercuts comparable systems.

The basic one-board system called Level-A ($129.95) contains an 8085 CPU (a "grandson" of the famous 8080) that is 100% compatible with 8080 software. It includes eight RST vector interrupts and four hardware interrupts that are automatically channeled to the monitor with a register save routine, and RAM area addresses that redirect the processor to the desired interrupt routine. The 13¼" x 10¾" glass epoxy board features plated-through holes with solder mask, and has provisions for serial I/O and another 25-pin socket for a hex keypad, a cassette recorder circuit with motor control, a speaker output, a LED indicator on the 8085 serial output line, a printer interface (less drivers), and four 8-bit plus one 6-bit I/O ports. The 8085 operates at 6.144 MHz. Other hardware includes a programmable 14-bit binary counter/timer, 256 bytes of RAM at F800 that can be expanded to 4K on the mother board or to 64K via the S-100 bus.

A very useful monitor contained in a 8355 2K ROM (located at F000) includes tape LOAD/DUMP with label, EXAMINE/CHANGE MEMORY contents, INSERT data, provisions for a warm start (register save input) that is useful for breakpoint debugging, EXAMINE/CHANGE registers, single-step with register display at each break point, and GOTO execution address. Monitor routines in the terminal version (not available in the hex keypad version) can move data blocks from one location to another, fill memory blocks with a selected value, display memory blocks, select baud-rate automatically, and control variable line length (1 to 255 characters/line). Also included is a channelized I/O routine with 8-bit parallel output for a high-speed printer, and a serial console I/O so that the monitor can communicate with serial I/O ports. The monitor source listing is available. The system can be used with a conventional terminal or hex keypad. Level-A detects the baud rate of a terminal and readjusts itself accordingly.

The Level-B Expansion Kit ($49.95) provides the signals plus buffer drivers to support up to six S-100 boards. Included in this portion are the address decoding for on-board 4K RAM expansion selectable in 4K blocks, address decoding for on-board 8K EPROM expansion selectable in 8K blocks, address and data bus drivers, a jumper-selectable wait-state generator to allow use of slow memory, and two separate 5-volt regulators to provide stability and reduce bus noise. Besides installation information, the manual for this kit also contains a description of the S-100 bus used in this computer.

The Level-C Expansion Kit ($39.95) is mainly metalwork (card cage) that increases the number of S-100 board connectors (not supplied) to five, and also provides a trouble-shooting socket for vertically mounting an S-100 board. The metal structure mounts directly on the motherboard.

Level-D ($49.95) provides an additional 4K of on-board static RAM to the original 256 bytes in the basic system. It also has a power-supply regulator and decoupling, and requires the installation of Level-B. The additional memory can be located at any 4K block from 0000 to EFFF.

Level-E ($5.95) provides the sockets, power-supply regulation, filtering and decoupling components, and allows the use of up to 8K of 2716 or 2516 EPROMs. Jumpers are provided to allow these sockets to be used with RAM.

(MEMR and MEMW signals are available for this purpose.) This add-on requires the installation of Level-B, as well as an external +8 volts at 700 mA, unregulated.

Power for the system is provided by the AP-1 Power Supply ($39.95) that provides +8 and −8 volts dc, and 20 volts peak-to-peak ac. The output current is 5 amperes and switches accommodate both line and load conditions.

Memory expansion is via the "Jaws" S-100 dynamic RAM board with the 16K version at $149.95, expandable in 16K increments (at $50 per 16K), to a full 64K. This board takes so little power, even with 64K installed, that heat sinks are not required for the regulators. It uses the Intel D8202 arbitrator IC to keep the chip count to a minimum.

The 8″ CDC (Control Data Corp.) disk drive has a single-density capacity of 401,016 bytes or double-density capacity of 802,032 bytes unformatted, LSI controller, write protection, and an access time of 25 ms (one track).

The Disk Controller-I/O Board can handle up to four 8″ drives, uses a 1771A controller, and has an IBM-compatible data separator, two serial I/O ports with independent rates to 19,200 baud, autoboot-to-disk on system reset (allowing a full 64K byte RAM for actual program use), and operating software in a 2716 EPROM.

Software is Microsoft BASIC ($64.95) which requires Level-B and 12K of RAM, or the BASIC comes in ROM ($99.95) which requires Levels B and E and at least 4K of RAM. There is a disk version at $325 that requires Level-B, 32K of RAM, a floppy disk controller ($199.95), and an 8″ disk drive ($499.95). The disk can be housed in a metal cabinet with the disk power supply ($69.95) with the required cables at $25. CP/M 2.2 is available for $150.

The system we built consisted of Levels A and B, the disk controller, two double-density, single-sided CDC 8″ drives, the necessary cables, power supplies, and metal enclosures.

The system was constructed in accordance with the information in the manuals—which was just about equal to the task. A couple of phone calls to the plant were necessary to clarify a couple of points.

Since the disk controller contains the start-up (from RESET) utility in ROM (and also contains the ports for the printer and terminal), we elected to use the full 64K Jaws board ($299.95). Although Netronics has a terminal kit, we used a Heath H-19 terminal and a Teletype Model 43 printer.

Once the system was interconnected, power was turned on. We installed the CP/M diskette, hit the RESET pushbutton on the front panel of the Explorer, and the CP/M signed on immediately.

The computer enclosure houses the mother board, the S-100 bus expander, the small power supply, and a ventilating fan. Since, after many hours of use, the computer barely got warm, we disconnected the fan to quiet the tiny noise it made.

Evaluation. Since, in this configuration, the Explorer is a dedicated CP/M machine, we elected to challenge it with WordStar/MailMerge that contained a large number of files that we use at our computer club. As users of this word-processing software know, it really exercises the disk drives. The Explorer performed well, with typical Z-80 execution speed, and the CP/M, a disk operating system, behaved as it should.

Since, in our experience, the limiting factor in using a computer of this type in extreme environments is operator comfort, we decided to limit temperature stresses to those that would make a typical human surrender. To check high-temperature operation, we used hair dryers, one aimed into the computer housing and the other at the disk-drive housings. With the internal temperature of the housings at 105-110°F, the system went about its business free from problems, churning out form letters and spinning both disk drives merrily. Then we positioned the Explorer and its disk

drives in the direct blast of an air conditioner, where the temperature was 55°F. Once again, the system ran without a hitch. Using a variable transformer, we varied the power-line voltage between 105 and 123 volts, still causing no problems.

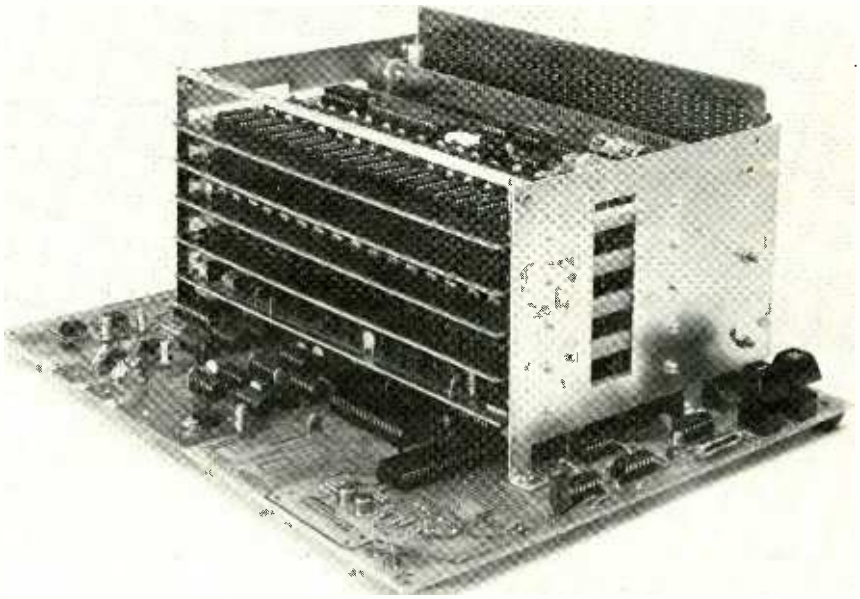
Like many other disk-drive manufacturers, CDC feels that too many programs have been "bombed" by the operator's pounding on keys before the drive had finished its job, so these disk drives do not have a LED indicator to show disk activity. The user is expected to wait until the cursor (or other screen action) shows up as a positive indication that disk activity has ceased. The CDC drives are a little noisier than some others but not excessively so.

The instruction manual contains all the information on constructing the basic system and a complete discussion on the use of the monitor. However, the information is sparse. The manual gives but one illustration of program development, and a schematic diagram and component-installation guide are the only illustrations.

Comments. The Explorer is an excellent, well-designed system whose performance is comparable to that of machines that cost significantly more. You can start with a low-cost basic computer kit that can be used as a trainer for learning machine language or as a device controller. Through a series of low-cost add-ons, the system can be expanded to a resident editor-assembler to work with assembly language and then to a full-blown computer (with disks) that can hold its own with most other machines on the market.

Using this approach, the builder can configure the system as he desires, without having to pay for unwanted elements. For example, in the Explorer, there is no requirement that you buy BASIC (or any other language). You buy what you need. While construction of the Explorer/85 is not particularly arduous, it does require some previous kit-building experience.

Looking into the computer enclosure can be quite a shock, as there seems to be almost nothing there. The large mother board contains a small handful of chips, and there are only two plug-in boards on the S-100 bus—the 64K Jaws board and the disk controller board, as compared to a typical computer's seven boards. Such sparseness of components should contribute to reliability. An old engineering maxim has it: "that which you ain't got, ain't going to hurt you."



Fully expanded Explorer with levels A, B, C, D, and E.

A wide variety of applications is within easy reach, as the S-100 bus enables plugging in of optional peripherals. For example, we used the Explorer with an S-100 high-resolution graphics board, a set of music boards, and a speech system, all of which worked quite well. The Explorer (or its disk controller) has two RS232 ports, each with an independent baud rate. This enables connections to a terminal and printer (or other RS232 device).

The Explorer system has some other appealing niceties not traditionally available. For example, CP/M is supplied with patches to operate with the CDC drive's controller so that I/O is automatic. This means that the disks can be simply plugged into an old Altair, Processor Tech, or similar computer and give turnkey operation. Also, the optional CP/M comes with a program to test any disk for quality.

Clearly, the Explorer is not an "appliance" computer. Rather, it is a computer learning machine that can expand to a powerful data-processing system. If you are an experienced kit builder and want to learn microcomputing from the ground up, the Explorer offers an economical way to do just that.

—Leslie Solomon

COMPUTER BITS

By Carl Warren

Sweeten Your Apple

IF YOU have an Apple II Plus and are anxious to sweeten it up a bit, here are some items to consider.

I. Hardware

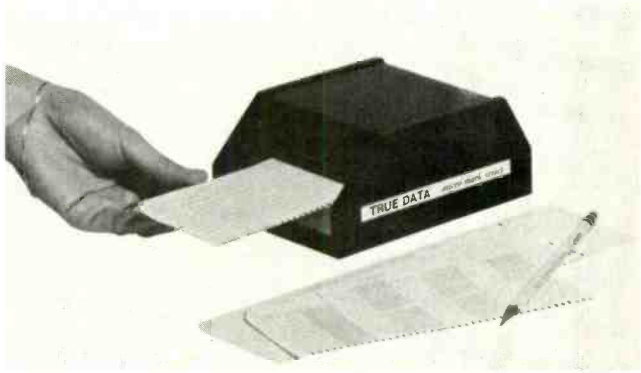
From **Epson**, comes the **MX-100 full carriage dot-matrix printer.** This $945 unit sports a print rate of 80 cps bidirectionally and can handle bit-image graphics with a density as high as 120 dots per inch on the horizontal axis. It also permits double-emphasized characters (8x18 matrix) and can support as many as 233 characters per line in the compressed-character mode.

The standard MX-100 has a Centronics-style, 8-bit parallel interface with RS-232 and IEEE-488 optional. The normal 1K buffer is expandable to 2K, and the print head is disposable—one of the key features of Epson printers.

To improve throughput, consider adding **Vista's Model 150 type-ahead buffer.** This $49.95 module is compatible with all Apple II computers and software and is attached simply by plugging it in between the keyboard and the system. Model 150 provides a 40-character buffer for entering commands. This add-on is almost critical if you're planning to use an Apple for data input.

For developing innovative applications, think about adding a *prototyping/hobby card.* This handy $24 item from Apple is available at most Apple dealers and can be used to build up any circuit you might need.

Vista also offers the **Vision 80**, an 80x24 video card, for $350. This plug-in has both upper and lower case and, when working in tandem with some of Vista's PROMware, can even produce impressive script displays. With the proper drivers, the card can be used in



The Micro Mark I card reader from True Data Corp. is a low-cost ($900) alternative to volume data collection.

CIRCLE NO. 61 ON FREE INFORMATION CARD

concert with either a plotter or graphics printer for making hardcopy of the scriptset.

The **Videx Videoterm** 80x24 video board at $345 supports inverse video, alternate character sets, and graphics symbols. Apparently, you can contact Videx and they will provide a unique character set off the shelf or, for a price, create one to your specification.

To give voice to the Apple, the **Vista Vocalizer** should be available soon for about $250. It is based on National Semiconductor's DT-1050 speech processor.

I think it might be interesting to develop software that talks to you—especially if it's asking for data input. And, in general, the speech area offers some unique opportunities to be inventive. All you need is the aforementioned protoboard, a set of chips either from National or TI, and time to play.

System capability can be easily extended by attaching **Microsoft's Z-80 Softcard** and adding memory with **RAMcard.** The $349 Softcard gives CP/M capability without losing the use of the Apple's 6502 processor. The $195 RAMcard gives you 16K at a fraction of the cost of other memory add-ons. This card works well with both Softcard systems and garden-variety Apples.

One very important feature of the Microsoft cards is that you have the ability to upload and download CP/M compatible software from other systems. In addition, you can use a number of the sophisticated communications packages written for CP/M.

To connect your Apple with the world, you need either a serial or parallel interface—preferably both. **SSM's AIO serial and parallel Apple interface** is a likely candidate. This $195 Apple bus card supports switch-selectable serial rates from 110 to 4800 baud. Rates as high as 19.2K baud can be achieved by changing hardwire jumpers. This serial port is ideal for setting up communication with a modem.

To make the board flexible, an 8-bit parallel port is included to support a variety of printers including the Epson MX-100. To use the parallel interface, you'll have to part with another $25 for the ROM that supports the printer of your choice.

Although you can get a communication board designed just for the Apple bus—the **Hayes Microcomputer Micromodem,** for example—you may want to consider either the board from SSM or the Apple serial board, and use either an acoustic-coupled modem such as that available from **Tek-Com** or a direct-connect modem like those from the **Microperipheral Corporation** or **Universal Data.** All of these have been discussed in this column previously. We have found that you probably should consider the Apple with the Hayes board wired in.

II. Software

In the August column, I mentioned **Personal Software's Visiterm,** which gives you communication ability—if you're in a world that is compatible with Personal Software. If you're not, and still want a communication package designed to work with the SSM board, look toward **Agent Computer Services.** This is the software house I wrote about last year that does all that neat graphics ware for the OKI printers. It has come up with a humanized communication package called **The Buffered Modem.** This program, written in Apple BASIC, is priced at $85, is delivered on a 13-sector Apple disk (conversion to 16-sector takes about 3 minutes), and permits configuring the system to whatever you have on the bus including the Hayes board, a wide range of video display boards, and several printer interfaces.

Once I had the program ready to boot, it came up quickly and greeted me with the sign-on menu. The first chore is to configure the package to your system, and everything in the screen display and manual directs you toward this end. You must, however, know what slots contain the various cards.

A really nice feature of Agent's software is that when you choose a menu item, the program doesn't just take off, but asks again if you're sure. The same philosophy is used on the control codes that turn various functions such as the printer on and off. You must precede that function with a control-A to signal the software that the next command is a valid control command.

A potential problem you should be aware of is that if you are using an **Apple Silentype printer,** you'll be unable to download files directly to the printer without losing characters. The reason is that printers like this (or software intensive cards) make use of the system's 6502 processor. As a result, the data stream gets ahead of the output and everything gets dumped. The solution is to download the file and save it on disk (the program is very clear on how to do this), then dump it to the printer.

MORE INFORMATION

For additional information about products or services mentioned, contact the companies directly.

Agent Computer Service
RR #3
Columbia City, IN 46725
219-625-3600

Apple Computer Inc.
10260 Bandley Dr.
Cupertino, CA 95014
408-996-1010

Edu-Ware Services Inc.
2222 Sherman Way, Suite 102
Canoga Park, CA 91303
213-346-6783

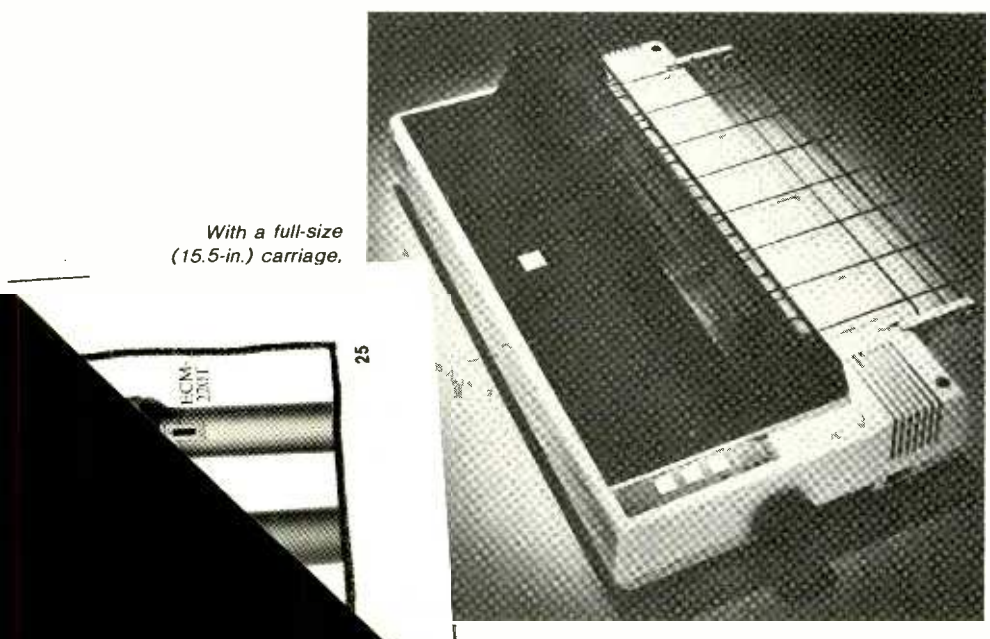
Epson America Inc.
23844 Hawthorne Blvd.
Torrance, CA 90505
213-378-2220

SSM Microcomputer Products
2190 Paragon Dr.
San Jose, CA 95131
408-946-7400

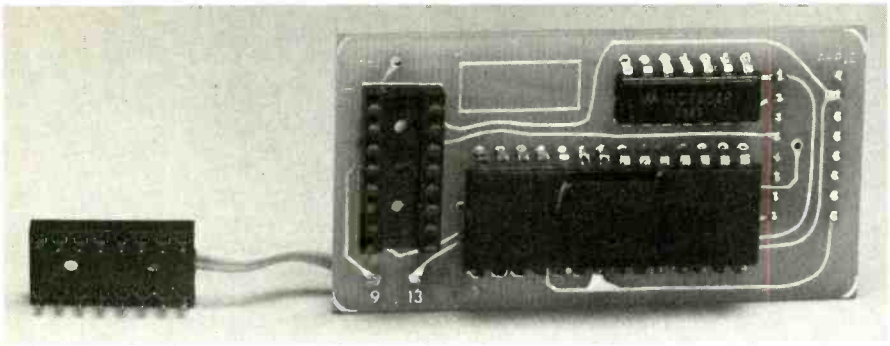
True Data Corp.
17092 Pullman St.
Irvine, CA 92714
714-979-4842

Videx
897 N.W. Grant Ave.
Corvallis, OR 97330
503-758-0521

Vista Computer Co.
1317 E. Edinger Ave.
Santa Ana, CA 92705
714-953-0523



With a full-size (15.5-in.) carriage,



Vista's Model 150 provides a 40-character buffer for the Apple.

Currently, the Buffered Modem only permits the up- and downloading of text files without checking or referencing. In a later version, the ability to send packets of information, either sequential or random files, with error checking, will be available. Moreover, this updated version will be able to handle track-by-track or sector-by-sector transfers. Since this is still in the works, you'll need to contact Agent Computer Services directly for more information.

One of the mainstays of this machine has been courseware for Computer Aided Instruction (CAI). One company that has been harvesting the fruit of this growing market is **Edu-Ware.** It is dedicated to developing software designed to teach skills, techniques, or concepts. The program supplied us was Algebra 1. This unique program uses Apple graphics and numerous menus to guide you through the algebraic problems and solutions. Set theory is covered, and chances to check your skills are provided with the program.

To maintain interest, if not excitement, the program combines high-resolution graphics and color, and is priced at $39.95. I found that the course was interesting in its basic design, but problematic for even the interested student. The main annoyance is the slowness of the program. Moreover, to avoid at least one notable omission, the authors could have used graphics to represent sets and demonstrate an intersection. Since Apple tells you the machine's secrets, such as the location of the disk drivers, they could have been turned on early to speed things up, and more frames could have been loaded at a time. Nonetheless, Edu-Ware's effort is laudable.

Further enhancing the Apple as a teaching machine is **True Data Corporation's Micro Mark I** hand-fed card reader. This unit, priced at $900 with a serial interface, is designed to read cards for collecting data on test scores, and the like. The unit reads marks that are made with a pencil and relates them to specific spaces. The read head contains a light source and 14 phototransistors (one for each of the 12 data rows and one for reading the format marks on either edge of the card). Light reflected into the lens of a phototransistor is defined as the no-signal condition. When the reflected light level drops due to a data block (pencil mark, preprinted mark, or punched hole) the corresponding phototransistor yields a signal output.

The software development is basically simple, requiring only the transistor signal relative to position. This information can then be translated into meaningful data. Lots of possibilities are available with this device, and it can be used with almost any system. ◇

COMPUTER SOURCES

By Leslie Solomon
Senior Technical Editor

Hardware

Small Terminal. The LEX-21 features a built-in modem, full-function 59-key keyboard, and an upper/lower case, 40-column thermal printer using a 5 × 7 dot matrix in an 8½" × 11" × 2 ¾", 5-pound package. Contains a 2K-byte RAM memory for text composition, and a 1K-byte line buffer. Baud rates are 10 or 30 characters per second. Options include a leather carrying case, acoustic cups, numeric keypad, and FCC approved access connector for direct phone connect. **Address:** Lexicon Corp., 8355 Executive Center Dr., Miami, FL 33166 (Tel: 305-592-4404).

Micro Winchester. The MPI Model 10, Super-Micro Winchester has 12.06 megabytes unformatted, and 10 megabytes formatted storage. Access time is 25 ms to maximum 40 ms, with track-to-track at 3 ms. The head settle time is 2 ms and the 5¼" system features micro stepping. Transfer rate is 5 megabits/s and it uses the ST506 or SA1000 interface. MTBF is claimed at 10,000 power-on hours. Error rates are soft: 1 in 10^{10} bits read; hard: 1 in 10^{12} bits read; and seek of 1 in 10^6 seeks. The unit is 3.25" H × 5.75"W × 8"D. **Address:** Micro Peripherals Inc., 9754 Deering Ave., Chatsworth, CA 91311 (Tel: 213-709-4202).

Atari Modem. The Microconnection is a direct connect modem for the Atari 400/800 systems that replaces acoustic-coupled devices. An Autodial/Auto-answer option permits dialing or responding to other computers automatically. It is Bell 103 compatible and operates in the originate or answer mode at 300 baud. A voice-grade cassette recorder can be plugged in to store on-line communications for later playback. A European version is also available. $199.50. **Address:** The Microperipheral Corp., 2643 151st Place, N.E., Redmond, WA 98052 (Tel: 206-881-7544).

SS50 RAM. The 64K-byte CMOS Static RAM Board, with battery backup is designed for the SS50/C bus and is guaranteed for 2-MHz operation with no wait states or clock stretching needed. Power requirement is less than 250 mA at 8 volts. The contents remain intact for a minimum of 21 days with a fully charged battery. The board can be hardware protected. $1088.64. 56K version (socketed for 64K) is $994.56. **Address:** Gimix Inc., 1337 West 37th Pl., Chicago, IL 60609 (Tel: 312-927-5510).

Real Time Clock. TCHRON is a real-time clock for the TRS-80 that has its own power supply, and provides month/date/year, day of week, hour/minutes/seconds, and a.m./p.m. information, using its own crystal oscillator. Time set software is included. $99.95. **Address:** WEB International, Box 96, Corona Del Mar, CA 92625 (Tel: 714-494-2869).

Multi User System. The 5005 Multi Share System features a Z80-based central processor, a 5-megabyte Winchester disk, a 630K-byte floppy disk, and a sophisticated error-correcting disk controller. Up to five users can combine almost any mix of application programs. It can support two printers, one serial and one parallel. The error-correcting technology is based on the IBM approach and up to five erroneous bits in every 256 bytes transferred from disk to processor are automatically corrected, eliminating errors due to disk contamination, aging, surface defects, and all but the most severe disk damage. Software includes CP/M-2, SCOPE editor, RAID debugger, ZSM assembler, and Microsoft BASIC 80. $8995 with single terminal. **Address:** Vector Graphic, Inc., 31364 Via Colinas, Westlake Village, CA 91362 (Tel: 213-991-2302).

New Printer. The Model 739 can provide standard print, and under software control will generate characters in an *n* × 9 dot matrix for proportional spacing and 7 × 8 for 80- or 132-column lines. It can handle single sheets, roll, or fan-fold paper. It permits true lower-case descenders, underlines, and high-resolution graphics. Other features include 100-cps monospacing, 80-cps proportional spacing, 74 × 72 dots/inch graphics, a paper-out switch, top of

form, self test, parallel or RS-232 interface, and right justification. Parallel is $995, RS-232 version is $1045. **Address:** Centronics Data Computer Corp., 1 Wall St., Hudson, NH 03051. (Tel: 603-883-0111).

Super Paddles. The Super Paddles are made from high-precision linear potentiometers and a large (1/2" diameter) industrial-quality pushbutton within a 4" x 2" x 1" metal case that matches the Apple. A 5-foot cable forms the interconnect. $39.95. The Super Joy Stick provides linear control to 1/10 of 1% making it suitable for high precision. $59.95. **Address:** Peripherals Plus, 39 East Hanover Ave., Morris Plains, NJ 07950 (Tel: 201-540-0445).

STD Bus EPROM Card. The 7705 provides eight on-board sockets to allow up to 32K bytes of 2732 EPROM memory. All 32K are continuous and can be mapped to either the upper or lower half of the 64K memory map. Responding to the STD Bus MEMEX line, it allows two banks of memory to occupy the same memory space. $99. **Address:** Pro-Log Corp., 2411 Garden Rd., Monterey, CA 93940 (Tel: 408-372-4593).

TRS-80 Remote Control. The Plug 'n Power Controller (26-1182) connects to the cassette output of any TRS-80 Model I, Model III, or Color Computer and translates instructions from the host computer into controlling signals that are coupled via the ac power lines to Plug 'n Power remote appliance and

lamp dimmer modules (sold separately). Up to 256 remote modules can be controlled, groups of 16 can be controlled together, and 16 such groups are accessible. Software is provided. The system includes a real-time clock for accurate timekeeping. $39.95. 15-ampere Appliance Module (61-2681) for 15-ampere control is $16.99; Lamp Dimmer (61-2682) for 300 watts is $16.99: Wall Switch (61-2683) for 500 watts is $17.99: and Universal Appliance Module (61-2684) is $17.99. At Radio Shack Stores and Computer Centers.

SS50 Interface. The Universal Interface occupies one I/O slot of the SS50 system, and allows the user to design his own custom I/O port. Space is provided for two ACIAs or one PIA chip, buffering, and any other required logic. Provi-

sions are made for two D-type connectors, and a ribbon cable header connector with up to 50 pins. The card supplies +5 volts with an on-board regulator, and all bus connections have pads. Options are available for baud rate and interrupt selection, including external clock inputs. $14. **Address:** Quality Research Co., Box 7207, Spokane, WA 99207.

Software

Apple WordStar. The WordStar word processor and MailMerge are now available for the Apple. WordStar requires the Microsoft SoftCard, 48K bytes of RAM, and an 80-column video board. All WordStar functions run without modifications and the Apple version is identical to that used with CP/M. Available on 13- or 16-sector Apple format diskette. **Address**: MicroPro International, 1299 Fourth St., San Rafael, CA 94901 (Tel: 415-457-8990).

Linking Loader. LYNX, an overlay linking loader for Microsoft FORTRAN, COBOL, and MACRO-80, will also work with other language translators which produce Microsoft compatible relocatable files such as BASIC compiler. It allows programs that use all available memory including that used by LYNX. Requires CP/M. $250. **Address**: Westico, 25 Van Zant, Norwalk, CT 06855 (Tel: 203-853-6880).

List Management. PRISM/LMS is a data base management program designed for maintaining lists of customers, parts, subscribers, patients, employees, property listings, vendors, and other such items. It allows creation of mailing labels, envelopes, preprinted forms, Rolodex cards, personalized form letters, contracts, and other specialized forms. Selected fields can be merged into surrounding text or printed at specified locations. Will run on CP/M, MP/M, CP/M-86, Onix and Model II TRSDOS with CBASIC as host language. $225. **Address**: Micro Applications Group, 7300 Caldus Ave., Van Nuys, CA 91406 (Tel: 213-881-8076).

Apple Software Catalog. The catalog covers Super-Text, word processor, Address Book, Data Plot, a series of games using hi-res graphics, the Voice that enables the Apple to speak, and a number of other utility and game programs. Hardware, including a lowercase adapter, is also covered. **Address**: Muse Software 330 N. Charles St., Baltimore, MD 21201 (Tel: 301-659-7212).

OSI BASIC. FBASIC runs under the OSI OS-65D3 operating system and is a subset of OSI/Microsoft BASIC specially suited to systems-level programming. It produces stand-alone 6502 machine code modules. Special features include user-definable array locations, WHILE loops, GOTOs and GOSUBs to absolute addressess, direct access to registers, and more. It can also link compiled modules to the OSI interpreter. Requires 48K memory. $155. **Address**: Pegasus Software, Box 10014, Honolulu, HA 96816.

Computational Utility. T/MAKER II is a CP/M-based utility that produces charts and exhibits for reports, has screen editing controls, creates complete reports, integrates text and numerical data, and can produce reports in a letter format by merging preprogrammed mailing lists, without changing disks. The user defines relationships between rows and columns (similar to Visicalc), and the program will compute established equations and place answers in their appropriate positions. Changing a number automatically recalculates corresponding rows and columns. Automatic functions include percentages, averages, logarithms, and transcendentals. $275. **Address**: Lifeboat Associates, 1651 Third Ave., New York, NY 10028 (Tel: 212-860-0300).

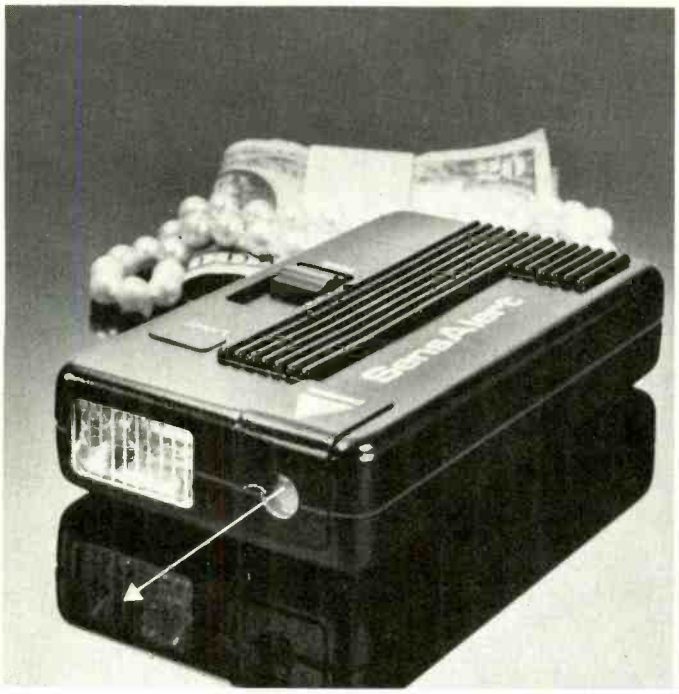
Apple Monitor Extender. The Monitor Extender for the Apple II is a cassette-based utility that allows different display formats and ASCII text entry. It includes search, fill and move commands and a disassembler that creates a labelled ASCII file in disk or cassette memory. In addition to normal hex, memory can be displayed in ASCII or binary. The disk commands work with 3.2,3.2.1, or 3.3 DOS. Memory usage is 1¼K bytes, disk buffer is 256 bytes, and the text buffer is variable. It will run on any page boundary. **Address**: Image Computer Products, 615 Academy Drive, Northbroook, IL 60062 (Tel: 312-564-5060).

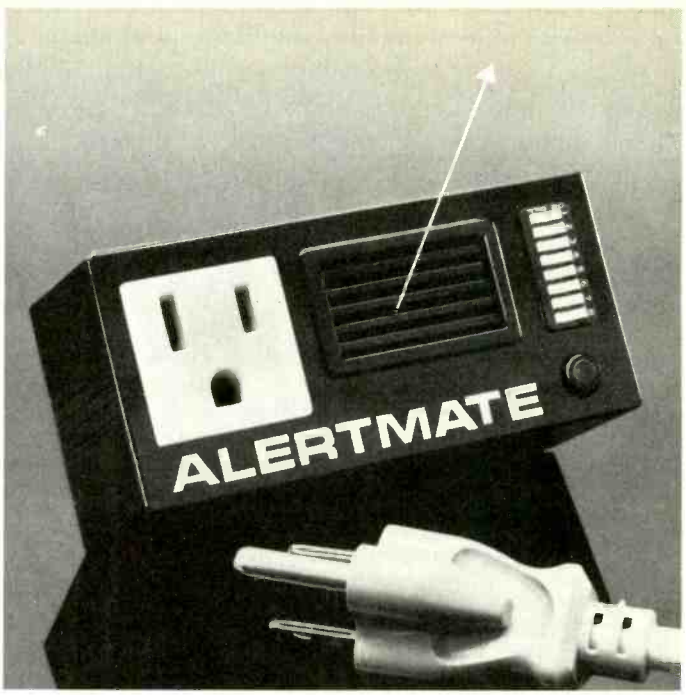
TRS-80 Assembly Language. PDS is an assembly language development system running under TRSDOS for the Model III. It includes a relocating macro assembler, linkage editor/linking loader, string-oriented text editor, interactive editor/assembler, trace debug/monitor, disk disassembler, and several utilities that extend the power of TRSDOS. It is available on 5" double-density Model III diskettes. $99. **Address**: Allen Ashley, 395 Sierra Madre Villa, Pasadena, CA 91107 (Tel: 213-793-5748).

New BASIC. "Energy BASIC" is an interpreter designed for energy management systems that contains many of the usual BASIC constructs plus a number of energy unique statements such as MODE, SET, ANSW, ELAP, ORIG, PSWD, TEMP, and TIME. It runs under CP/M 2.2 on 8" diskette, or resident in two 2716 PROMs. The Users Manual is $20. EB010 AND EB080 are $195. **Address**: International Data Systems, Inc., Box 17269, Dulles International Airport, Washington, DC 20041 (Tel: 703-661-8442).

TRS-80 Word Processor. "Word" is a complete text/file merge option that enhances the Word-M2 on the Model II, Word-IV on Model I, and Word-M3 on Model III. It can merge a text file with elements of a data file or mailing list, and the same document can be printed repeatedly. Word users return diskette and $37. The Word program with this option is $79. **Address**: Micro Architect Inc., 96 Dothan St., Arlington, MA 02174. (Tel: 617-643-4713).

TRS80 Medical Office. The Medical Office System (26-1568) is designed for the TRS-80 Model I and Model III with printer and disk. The software can store up to 3960 (Model I) or 4200 (Model III) patient records and can record and store up to 3685 (Model I) or 7700 (Model III) transactions per month. Insurance forms can be printed on demand. It also provides space for 200 different procedures, and 200 different diagnoses. Accounts receivable can be aged to 120 days. $299. **Address**: Radio Shack stores and Computer Centers. ◇





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Popular Electronics
OCTOBER 1981

TUNE YOUR RECEIVER BY THE NUMBERS!

Add a 4-digit display and locate stations quickly and accurately

BY GARY McCLELLAN

A DIGITAL frequency display on a radio is a special nicety. If you own an AM/FM or FM-only receiver that has the old-fashioned analog dial, here is how you can add an LED digital display that will make it easier to tell what frequency you're on and will also help you locate any station.

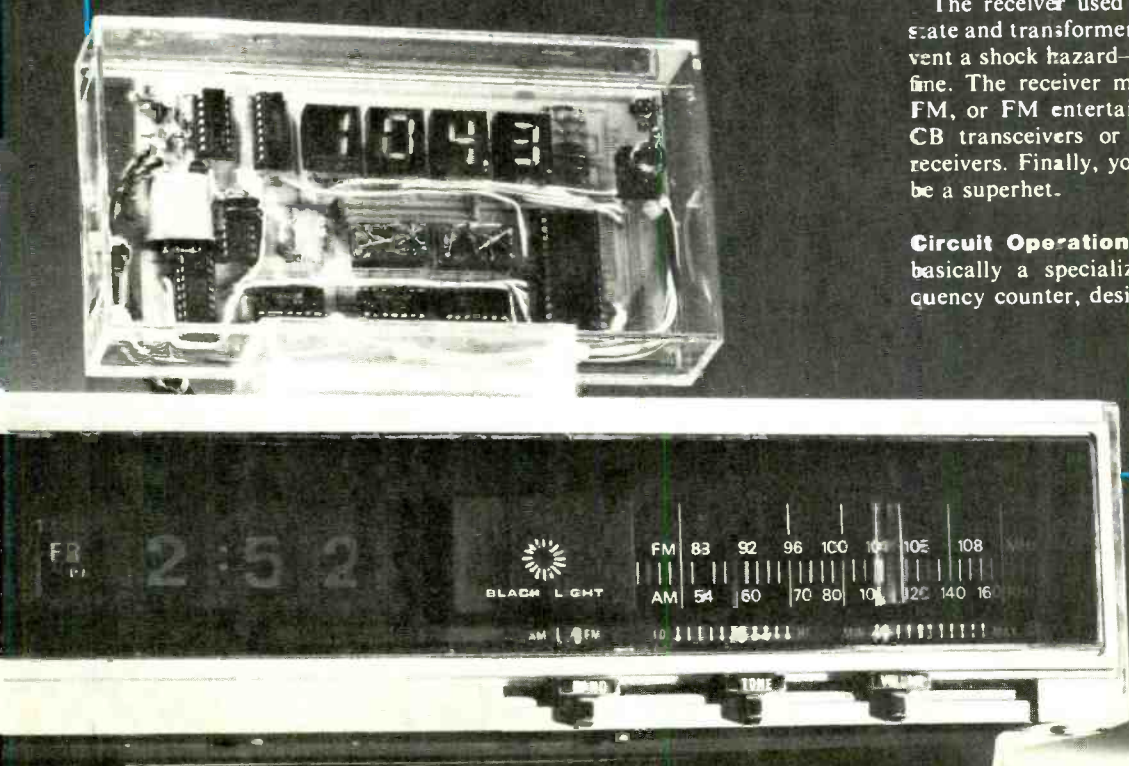
The display indicates AM frequencies to the nearest 1 kHz and FM frequencies to the nearest 100 kHz. Also, the project can be used at long-wave frequencies.

Besides superior resolution as compared to a dial, the display project offers a display update of ten readings a second, fast enough to "follow" the tuning knob. Also, it is adaptable to a wide range of receivers having different intermediate frequencies. Two simple PROMs, made out of a few diodes, program the project to suit the circuit.

Only three connections to the receiver itself are required (AM local oscillator, FM local oscillator, and ground). It is suggested that you obtain the schematic of your receiver as this will make installation much easier. In addition, a tiny module is installed inside the receiver for FM signal processing. The display itself is separate from the receiver to allow for convenient positioning. If desired, the display can be built inside the receiver, as it is small enough to replace most tuning dials.

The receiver used should be solid-state and transformer-powered to prevent a shock hazard—battery sets are fine. The receiver must be an AM/FM, or FM entertainment type—no CB transceivers or communications receivers. Finally, your receiver must be a superhet.

Circuit Operation. The project is basically a specialized type of frequency counter, designed to measure



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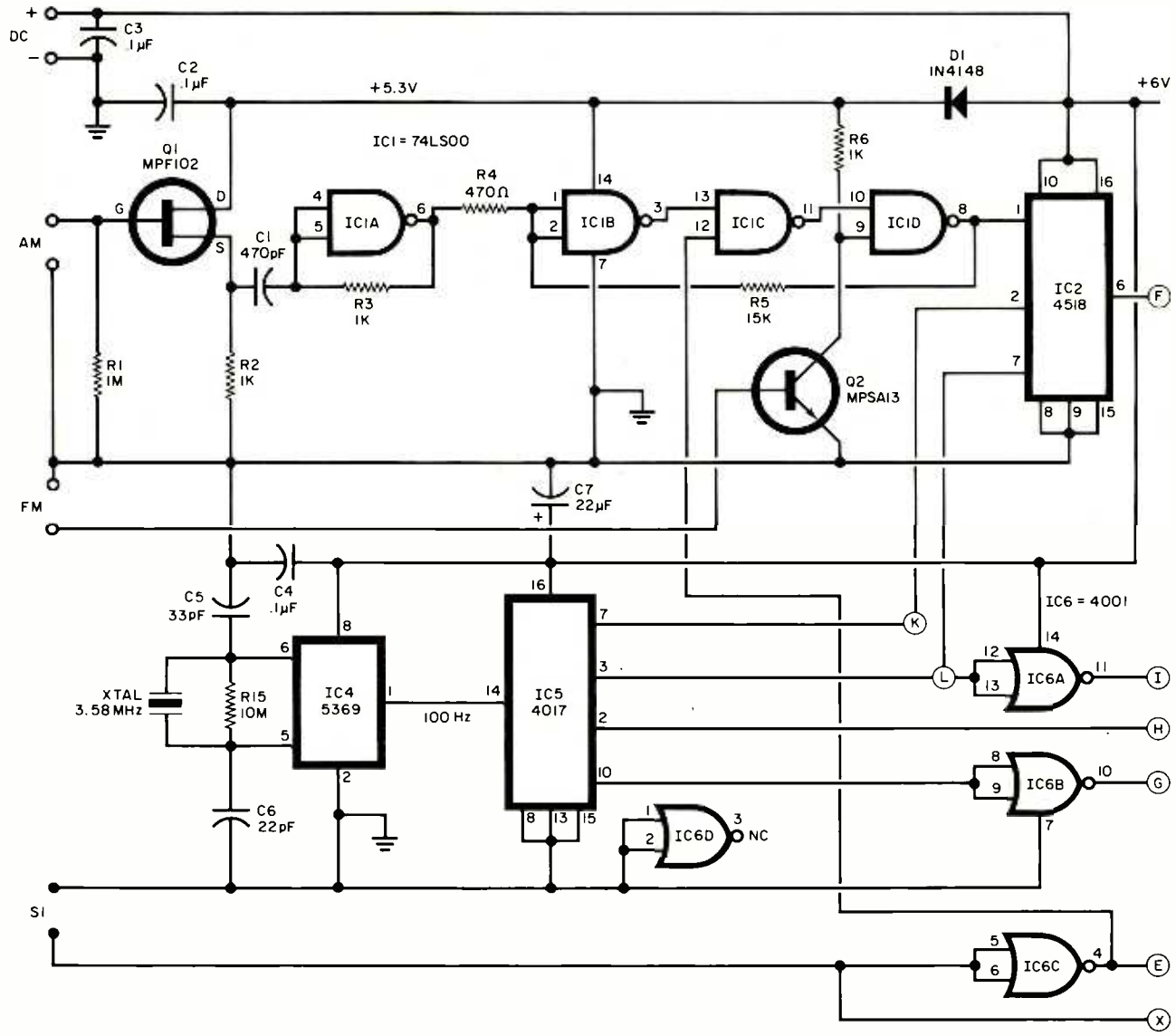


Fig. 1. The schematic for the digital display circuit, shown on these two pages, can be divided into three functional sections: AM input, time base, and programmable counter.

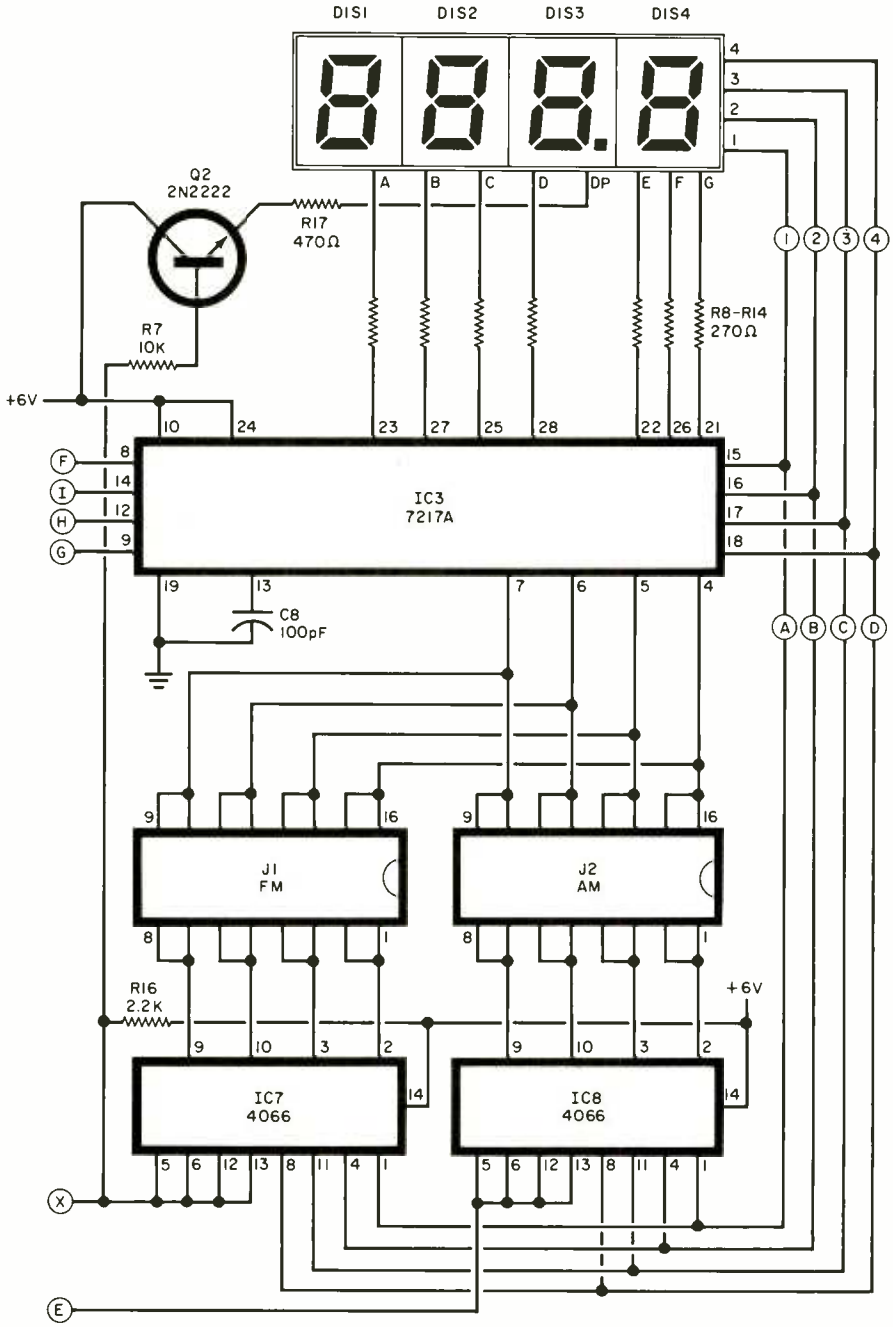
the receiver's local oscillators, and subtract the i-f to display the actual (not local oscillator) frequency to which the receiver is tuned. CMOS logic is used for low current drain.

The schematic, shown in Fig. 1, can be broken down into three sections; AM input, time base, and programmable counter. Each section will be described in detail.

Signals from the AM local oscillator appear at the gate of *Q1*, a FET source follower. This stage has no gain, but simply insures that the input will have a high impedance to reduce loading of the local oscillator. The output of *Q1* drives *IC1A*, a TTL gate wired as an amplifier, to boost the sensitivity. The output of *IC1A* drives *IC1B* and *IC1C*, which converts the local oscillator sine-wave signal into a square wave, suitable for driving digital circuitry. Gate *IC1D* allows either the AM or FM signal to pass to the remainder of the counter.

The FM signal, converted to a square wave, comes from an external board and drives *Q2*, which passes the signal on to *IC1D*. The output of *IC1D* drives *IC2*, a divide-by-10 counter. This counter scales the input frequency by 10 to drive the slower counter circuit that follows. The one-count error inherent in other frequency counters is also reduced by *IC2* because it is reset (via pin 7) with the remainder of the circuitry. This produces a stable display—one where the last digit isn't constantly changing. The AM input circuit has a sensitivity of 40 mV at 2 MHz, at least four times more than required in most applications.

The time-base circuitry consists of *IC4*, *IC5*, and *IC6*. The 3.58-MHz color-TV crystal generates the stable timing frequency while *IC4*, a CMOS time base designed for this type of application, provides the necessary oscillator for the crystal and divides its frequency down to 100 Hz. The 100-Hz signal drives decade counter *IC5*. This device has 10 decoded outputs and each output is high for 10 ms (the period of 100 Hz). Pin 3 goes high first to reset counters *IC2* and *IC3* to zero. Then pin 2 goes high to force



PARTS LIST
(Display Board)

C1—470-pF disc capacitor
C2,C3,C4—0.1-μF, 16-V disc capacitor
C5—33-pF disc capacitor
C6—22-pF disc capacitor
C7—22-μF, 16-V electrolytic
C8—100-pf disc capacitor
D1—1N4148 diode
DIS1 through DIS4—FND-503 common-cathode LED display (Radio Shack 276-1647)
IC1—74LS00 TTL quad NAND gate
IC2—CD4518 decade counter
IC3—Intersil ICM7217A programmable counter
IC4—National MM5369 EST/N timebase
IC5—CD4017 decade counter
IC6—CD4001 quad NOR gate
IC7,IC8—CD4066 switch
J1,J2—16-pin IC socket
Q1—MPF102 JFET transistor
Q1—MPSA13 Darlington transistor
R1—1-MΩ, 1/4-W, 5% resistor
R2,R3,R6—1-kΩ, 1/4-W, 5% resistor
R4,R17—470-Ω, 1/4-W, 5% resistor
R5—15-kΩ, 1/4-W, 5% resistor
R7—10-kΩ, 1/4-W, 5% resistor
R8 through R14—270-Ω, 1/4-W, 5% resistor
R15—10-MΩ, 1/4-W, 5% resistor
R16—2.2-kΩ, 1/4-W, 5% resistor
XTAL—3.579-MHz crystal
Misc.—IC sockets, Molex Soldercons, wire, solder, etc.

Note: The following is available from Technico Services, Box 20 HC, Orangehurst, Fullerton, CA 92633: set of two pc boards (for display and prescaler), #DISP-1, for $12.00. Outside US, add $3.00 for shipping and handling. California residents, add sales tax.

counter *IC3* to load a preset value (the i-f we want to subtract). After that, pin 7 goes high. When this signal occurs, a gate inside *IC2* is enabled, allowing the signal from the receiver local oscillator (via *IC1*) to be counted. Finally, pin 10 goes high to update the display, showing the correct frequency.

The gates of *IC6* are wired as inverters, and interface the time base to the different parts of the circuit. One section, *IC6C*, is important in that it provides AM/FM display switching. When the *S1* terminals are open, the FM frequency is displayed because the input to *IC6C* is high due to *R16*. This, in turn, enables *IC7*, a quad electronic spst switch, connecting the FM diode PROM in *J1* to the counter. Simultaneously, *Q3* is turned on, causing the decimal point in the display to glow. Since the output of *IC6C* is low, this disables *IC1C* so that any signal from the AM local oscillator won't trigger the counter. When the *S1* terminals are shorted, the project displays AM frequency. The output of *IC6C* is high, enabling *IC1C* so that AM signals can get through. And finally, *IC8* is enabled, connecting the AM diode PROM in *J2* to the counter.

Programmable counter *IC3* is set to a value determined by the *J1* or *J2* plug-ins. It counts frequency from this point and displays the result on four seven-segment displays (*DIS1* through *DIS4*). Since the operation of the reset, count, and latch functions of *IC3* were described in the time-base section, all that's left is the programming circuitry. This is the job of *IC7*, *IC8*, *J1*, and *J2*. Transmission gates *IC7* and *IC8* each contain four switches, and making the four enable lines (pins 5,6,12,13) high turns them on. Because of *IC6C*, either *IC7* or *IC8* will be on at a given time. For example, when *IC7* is on, the lines from *J1* (FM) are connected to the output of *IC3*, enabling *IC3* to program itself to whatever data is on *J1*. In this project, the *J1*, *J2* plug-ins use a few diodes to program the counter. Conversely, when *IC8* is on, *IC7* is off. Then *J2* is connected to the counter.

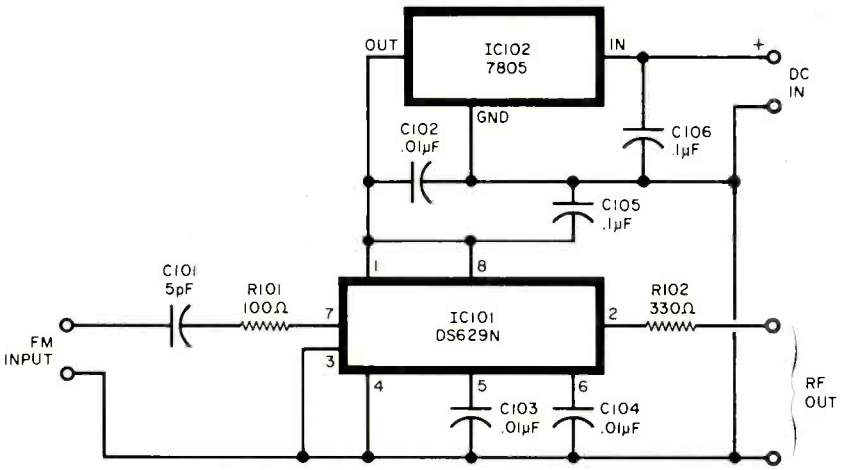
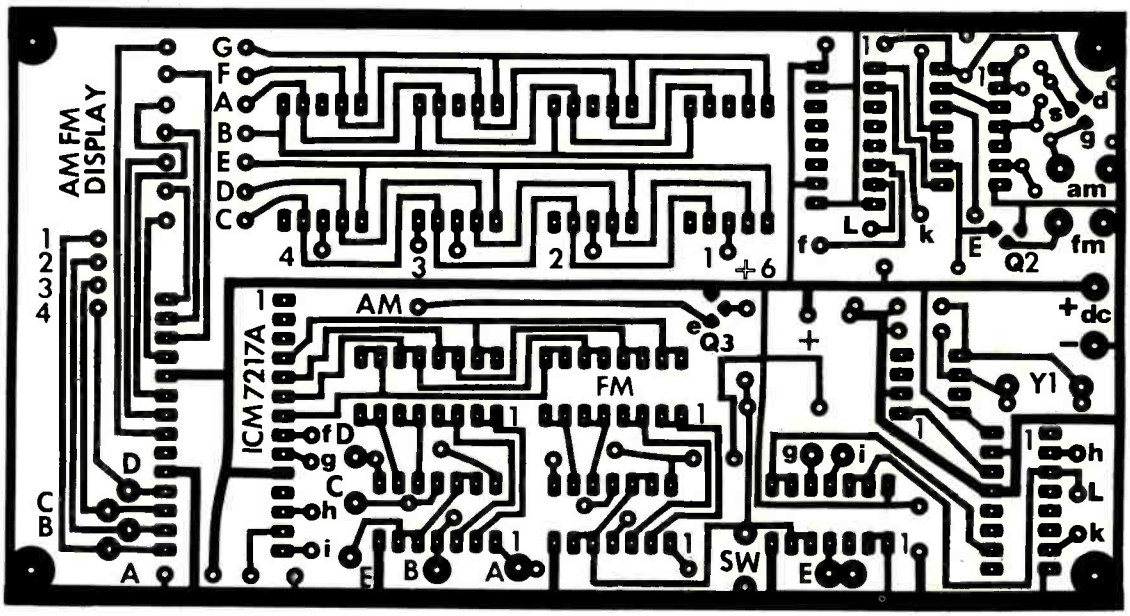


Fig. 2. The FM prescaler circuit is installed inside the receiver and connected to the FM local oscillator.

PARTS LIST
(Prescaler)

C101—5-pF disc capacitor
C102,C103,C104—0.01-μF, 50-V disc capacitor
C104,C106—0.1-μF, 16-V disc capacitor
IC101—National DS8629N VHF prescaler
IC102—7804, 5-volt regulator
R101—100-Ω, ¼-W, 5% resistor
R102—330-Ω, ¼-W, 5% resistor
Misc. IC socket, cable, wire, solder, etc.
Note: See Display Board Parts List for ordering information on pc board.



The FM prescaler board (Fig. 2) is installed inside the receiver and connected to the FM local oscillator. Otherwise, the long cables required to bring out the FM local-oscillator signal would detune the oscillator, making the FM section inoperative.

This board contains vhf prescaler *IC101*, especially designed for this type of application. It features a built-in preamplifier, and a divide-by-100 counter. Input sensitivity is about 25 mV at 100 MHz, or about five times more gain than is required. This insures good performance with almost any FM receiver, including battery types with low-level oscillator outputs. The output of the prescaler board drives the FM input on the display board. The signal is in the 1-MHz range, and is at TTL level. Voltage

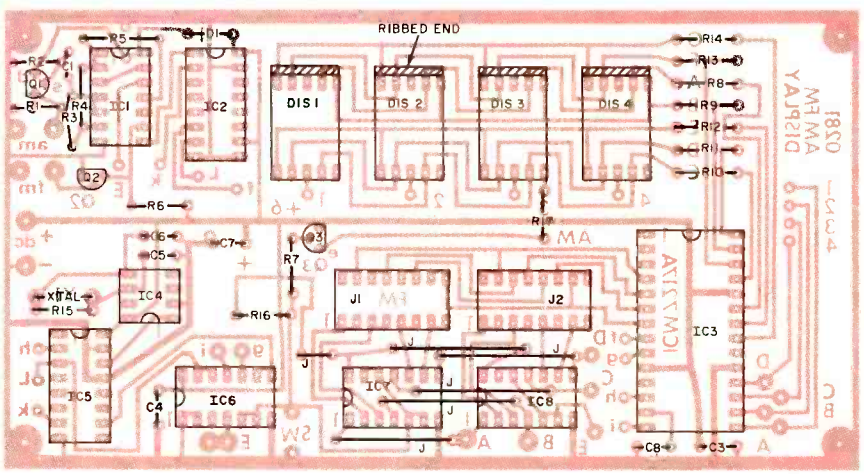
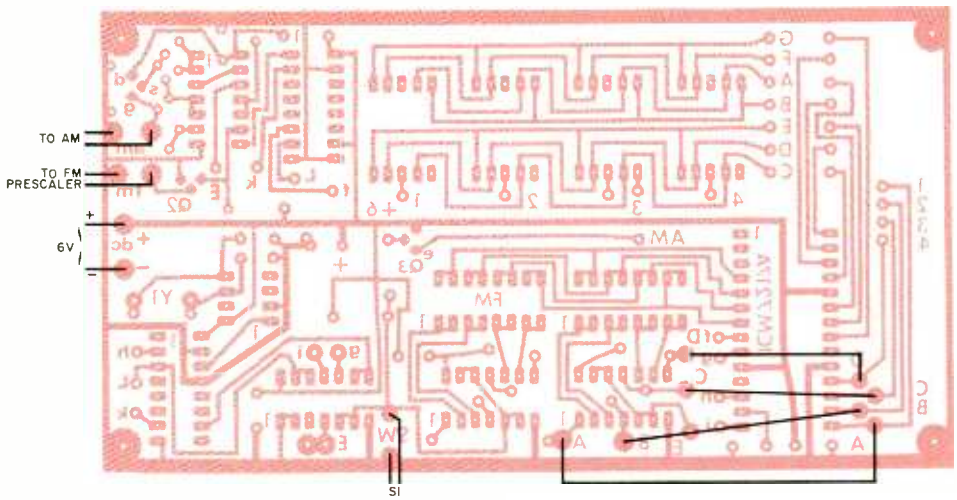


Fig. 3. Foil pattern (top) and component layout (bottom) for the display board. Note the bare-wire jumpers which must be installed before the components.



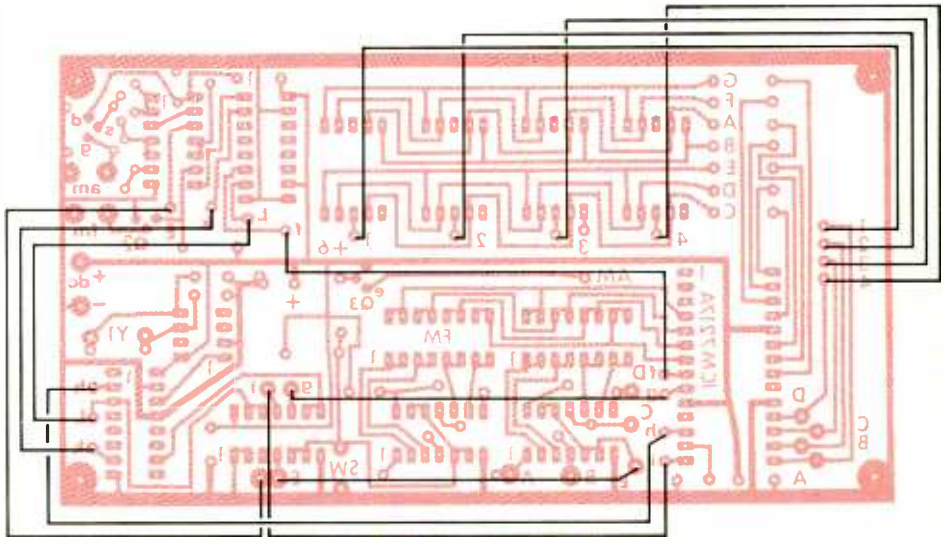


Fig. 4. At left and below are additional jumpers of insulated wire to be installed on the display board. Use RG-174 coaxial cable to make the connections off the board.

regulator *IC102* ensures that there is a low-impedance 5-volt power source available, and keeps r-f noise off the power leads.

Construction. The foil pattern and component installation for the main board are shown in Fig. 3.

Install the sockets for all the ICs and *J1* and *J2*. Molex Soldercons may be used for the four LED displays. Install the jumpers as shown in Fig. 3 using bare wire as required. Make sure that these jumpers are flush against the pc board. Then install the remainder of the components. Carefully install sockets for *IC7* and *IC8* making sure that no shorts are made to the jumpers on the board. Then install insulated jumpers as shown in Fig. 4. Upon completion of all wiring, and after it has been checked, install the ICs. Use lengths of RG-174 coaxial cable for the connections off the board shown in Fig. 4.

The foil pattern and component installation for the FM prescaler board are shown in Fig. 5. Use a socket for *IC101*. Use the shortest possible lead length when installing the capacitors on the board, and *do not* use Mylar capacitors in this application.

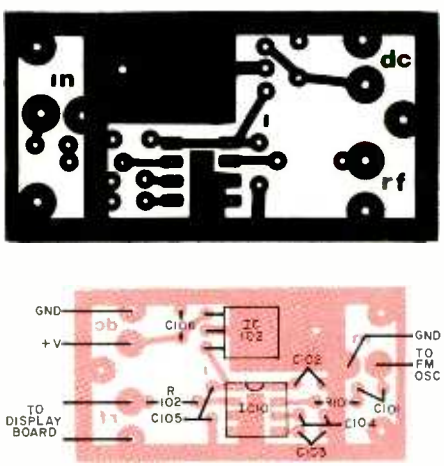


Fig. 5. Foil pattern and component layout for the prescaler board.

Installation. The necessary connections to the receiver are shown in Fig. 6. Figure 6A shows the circuit to use when the receiver has a single-stage converter approach; Fig. 6B shows use with a conventional local oscillator; while Fig. 6C illustrates the connections for a typical AM converter. In the FM mode, mount the prescaler as close to the FM converter/oscillator as possible to reduce detuning due to long leads.

Start the installation by removing the receiver power plug. Carefully remove the top and bottom covers to gain access to the r-f circuitry. In some cases it may be necessary to remove a shield to get at the r-f circuit. Using the schematic, locate the

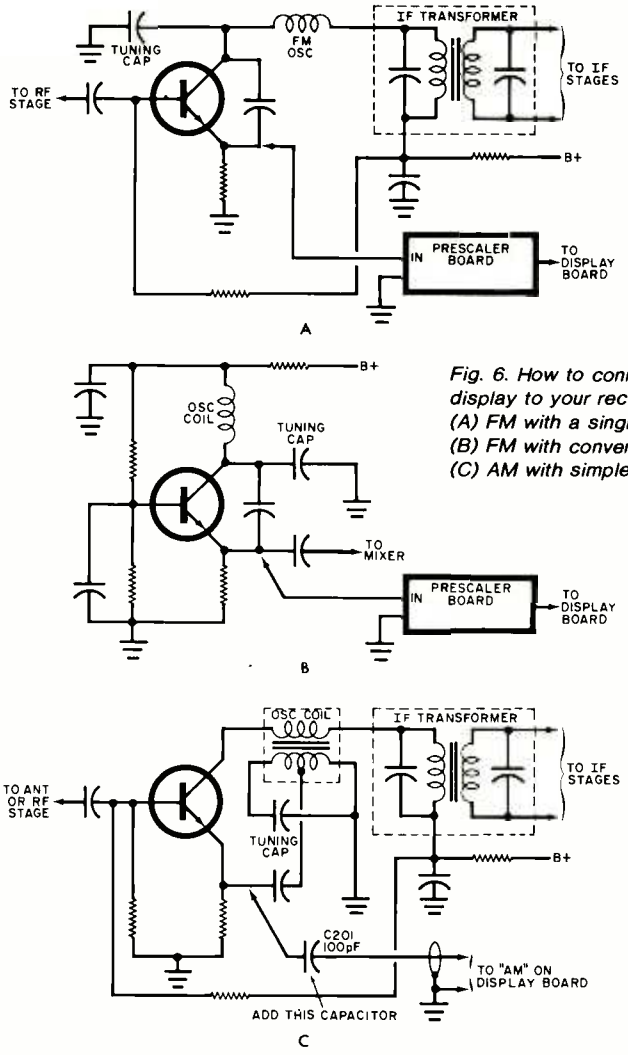


Fig. 6. How to connect the digital display to your receiver: (A) FM with a single-stage converter; (B) FM with conventional local oscillator; (C) AM with simple converter.

antenna input connections and trace the circuitry towards the i-f section to locate the local oscillator. In many cases, this will be identified on the schematic. Note that in some sets a "converter" may be used instead—this circuit serves as both a mixer and the local oscillator.

Once you have located the AM/FM local oscillators, or converters, use the appropriate circuit of Fig. 6 to make the connections. Start with the FM connections by referring to the diagram that is closest to your circuit. Chances are, either the converter of Fig. 6A, or the grounded-base oscillator of Fig. 6B will match your circuit. Note that in both cases, the prescaler board connects to the emitter lead of the transistors. The emitter lead is chosen because it is the lowest impedance point in the circuit and connecting elsewhere may excessively load the converter/oscillator and stop oscillation. For the AM connection, simply make the connection to the emitter of the converter transistor as shown in Fig. 1C. Capacitor *C201* has been included to decouple any dc component, and reduce circuit loading to the bare minimum.

The FM prescaler board must be positioned very close (within two inches) to the FM local oscillator. Also, the board must be securely mounted to the chassis or receiver circuit board. The ground lead of the prescaler connects to the ground on the tuning capacitor, and the signal lead is soldered directly to the emitter of the converter transistor. Your particular installation may be different, depending upon how much space you have available. Study the layout of your receiver carefully, and you will probably find several ways to install the prescaler. One more tip if you plan to mount the prescaler on the main circuit board: use heat sparingly on any i-f transformers you use for mountings, as the plastic elements inside these transformers can melt, and change the alignment. Quickly tin the transformer case, and allow it to cool. Then sweat solder the prescaler board in place. To connect the AM cable, connect one end of *C201*, a 100-pF disc capacitor, to the emitter lead of the AM converter transistor. Then cut a 3-foot length of RG-174 coax cable, and prepare both ends. Connect the shield to ground near *C201*, and connect the other end of the capacitor to the center conductor of the coax cable.

To finish up the receiver, route the wires and cables through a hole, such as a vent, in the rear panel, then cut the cables the same length. Prepare the ends, and install a male connector on them. Any of the low-cost Molex connectors should work fine, and the choice of connector is up to you. The receiver top and bottom covers may now be reinstalled.

If you have a power supply that can provide 9-volts dc unregulated at 100 mA, and 6-volts dc regulated at 50 mA, use it. Otherwise, build the simple power supply shown in Fig. 7. A few words about the parts, and construction. The 9-volt dc supply is a calculator type charger plug, al-

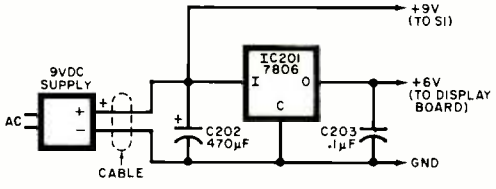


Fig. 7. Schematic of a simple power supply suitable for the digital display circuit.

PARTS LIST
(Power Supply and Final Assembly)

C201—100-pF disc capacitor
C202—470-μF, 16-V electolytic
C203—0.1-μF disc capacitor
IC201—7806 voltage regulator (6V, 1A)
S1—Dpdt miniature toggle switch
Misc.—Cabinet for display board, 9-volt charger plug (500 mA) (Jim-Pak DC-900), DIP headers, fourteen IN4148 diodes, 4-pin cable connector set, perf board, coax cable, wire, solder, etc.

though a separate transformer and full-wave rectifier may be used.

The display board can be installed in a cabinet, or if desired, inside the receiver. However, it is suggested that a separate metal cabinet be used. If a plastic case is used, keep it at least a foot away from the receiver. Regardless of the case you choose, mount the display board on the rear of the case using spacers and 4-40 hardware. Then drill holes in the rear, adjacent to the board for the power and signal leads. Turn to the front of the case, and cut out a rectangular hole for the displays. If desired, a commercial bezel, such as from Radio Shack may be used for a better appearance. After that, finish up the case by drilling a hole for the AM/FM switch, *S1*.

To connect the leads (including power) to the display board, route the cables through one of the holes in the rear of the case, then connect them to the appropriate pins of the connector. Add a third lead to carry +9 volts to switch *S1*. Refer to Fig. 8 for the final wiring details. Finishing touches like bundling wires and cables from the receiver using cable ties, labelling the case using press-on letters, etc., may be added to the project.

Programming. The diode-encoded PROMs for *J1* and *J2* are required. These PROMs are necessary to subtract the i-f from the display to produce the correct tuning frequency of the receiver.

If the display is powered up without the PROMs installed, only the decimal point may be lit. Turn on the receiver, and tune in an FM station between 106 and 108 MHz. Do this carefully, as careful tuning insures maximum accuracy from the project. Set *S1* to FM and note that the display indicates between 116.0 and 118.7 indicating the local oscillator frequency. Determine the frequency of the FM station and determine the required displacement (i-f) as display frequency minus station frequency. Subtract the i-f frequency from 1000.0 (maximum display count) to determine the PROM "number."

For technical reasons, this form of addition must be used to program the display. For example, for an i-f of 10.7 MHz, the PROM number would be "989.3." Record this number. The next step is to program the PROM with the number just determined. This is done using diodes and the following BCD truth table.

Number	"1"	"2"	"4"	"8"
1	X	-	-	-
2	-	X	-	-
3	X	X	-	-
4	-	-	X	-
5	X	-	X	-
6	-	X	X	-
7	X	X	X	-
8	-	-	-	X
9	X	-	-	X
0	-	-	-	-

This table is slightly different from the traditional BCD truth table. In place of a logic 1, an X representing a diode has been used. What this means is that, if you want to display a 1, you'll wire a diode from the BCD 1 pin to the desired digit as shown in Fig. 9A. The same holds true for any other numbers to be programmed. The table shows what diodes are required, and where they connect. In all cases, the diode banded end points toward the desired digit. Study the top view of the *J1/J2* pinouts as shown in Fig. 9A. Note that each function shares two adjacent pins, this makes connecting many diodes easier. Also note the digit numbers along the bottom of the sockets. These numbers correspond to the LED digits on the board, with 4 being the lefthand digit, and 1 the righthand.

Start the wiring by programming digit #4. Using our example of 989.3, this would be the first 9. Referring to the table, a BCD 9 equals diodes from 1 and 8. Two diodes are connected from pins 10 (BCD 1) and 16 (BCD 8) to pin 1 of the DIP header (digit 4). At this point, check your work by plugging the header into *J1* on the display board. With the receiver turned off, set *S1* to FM and note a display of 900.0 Repeat the process for digit 2 (this would be the 8 of our example of 989.3). Look up 8 in the table, and connect the diode between pins 16 (BCD 8) and 3 (digit 3).

Check your work by plugging the PROM into *J1* on the display board. You should get a display of 980.00. Continue with digits 2 and 1 in the same manner. When you are done, try the PROM in the display board, and you should be rewarded with the PROM number you calculated. In all probability, the finished PROM will look like the one of Fig. 9B. This is the

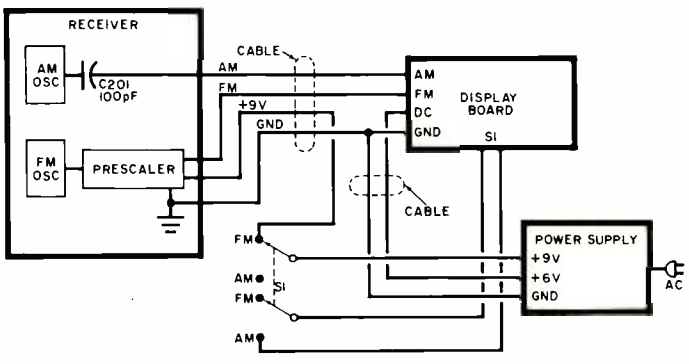


Fig. 8. Connecting the digital display and power supply to the receiver. Note the coaxial cables. Switch S1 can be mounted in any convenient location.

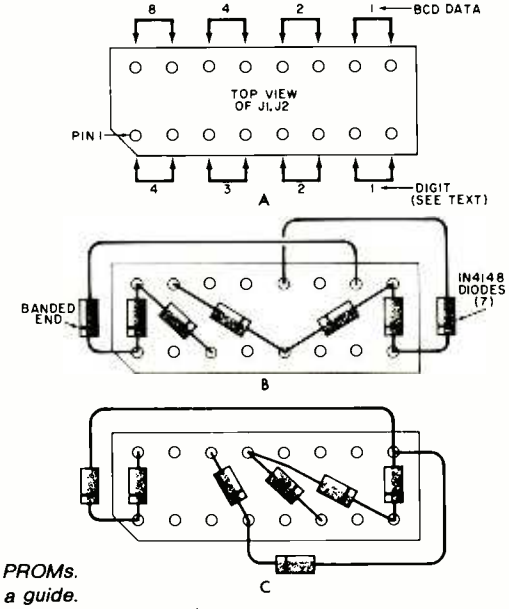


Fig. 9. How to program the diode-encoded PROMs. Use the truth table in the text as a guide. Diagram (B) is for FM; (C) is for AM receivers.

one for 989.3, or a 10.7-MHz i-f. If you get confused about the programming, just build this PROM as shown. It will work with most FM receivers, and be accurate within a few hundred kHz. This completes the FM PROM programming, and the project is ready for use with your FM receiver.

If your receiver has an AM band, continue with the AM PROM programming. It works exactly the same as the FM programming, and the steps are identical. The only differences are the frequencies and the PROM number. This is because of the different frequency coverage, and the i-f, which is usually 455 kHz in AM receivers.

Let's go through the AM PROM programming procedure, starting with the exact i-f. For best accuracy, tune in an AM station as close to the high end of the band as you can. Also, select a fairly weak station, because the tuning is more critical, and that leads to better accuracy. Jot down the frequency displayed by the project with *S1* set to AM. Determine the frequency the station is broadcasting on by looking it up in the newspaper, or waiting for station identification. Jot this value down, and then subtract it from the display frequency to determine the exact i-f.

Convert the i-f to PROM number by subtracting it from 10000. If, for example, your receiver has a 455-kHz i-f, the PROM number works out to 9545. Record the calculated number.

Use the table above to connect the diodes. Start by wiring digit 4, as you did with the FM PROM. Note that the banded ends of the diodes all point toward the digits. Check your work by plugging the PROM into *J2* on the display board. Remember to power down the receiver for the check, otherwise the local oscillator signal will confuse you. Continue with the other digits in order. When they are all done, check the PROM by plugging it into *J2*; you should get a display of the PROM number you calculated. If the programming confuses you, simply build the PROM shown in Fig. 9C. It is for a 455-kHz i-f, and accuracy will be good enough for most applications.

Only a few additional tips on the display's use are in order. Remember to set *S1* to suit the band (AM or FM) you are listening to, otherwise you will get a display of only the PROM number. Second, the FM prescaler may cause a slight detuning of the FM section. In that case, touch up the FM oscillator trimmer to bring the receiver dial back into calibration. ◇

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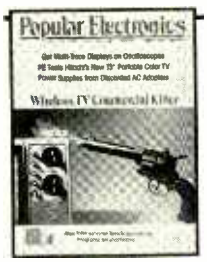

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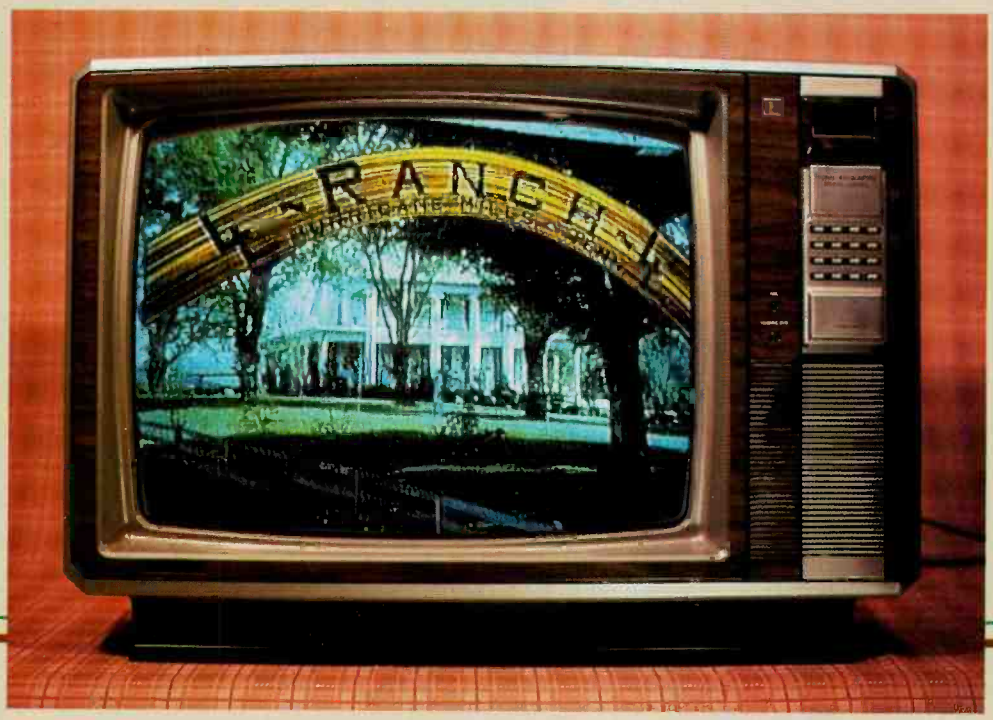


Screen Picture by Discovision

the Toshiba Model CB965 19" Color TV Receiver

TOSHIBA'S new model CB965 is its most versatile 19" color receiver to date. The model features infrared remote control (detachable from the set), CCD comb filter, detail purifier, automatic dark picture intensifier, separate vertical and horizontal resolution controls, room-light sensor, and an earphone output for private listening. Its styrene cabinet is walnut-striped with a silver-colored trim. Dimensions are 25"W x 17¼"H x 18½"D. Suggested retail price is $600.

The set's automatic UP/DOWN channel selector is also a signal-seeker. Thus, one push of the button and the receiver seeks the closest channel on which there is a signal. Without any programming, the scan is continued throughout all 82 u/v channels.

The remote control also has direct address, and after a two- or three-second delay will proceed to any number activated. No ENTER button is used, nor is it necessary to key a leading zero for a single-digit number.

General Description. For the TAC034 chassis, remote control consists of a remote sensor, keyboard, control board, selector, and channel display boards, and the usual hand-held unit. They are followed by a CCD comb filter and a large integrated circuit.

The hand-held remote is a thin three-ounce metal package having 16 feather-touch buttons, a rear hump for three LR44 power-source batteries, and a forward hump for two transistors. There is one 16-pin chip, and a single infrared diode. The IC is pushbutton-controlled.

Remote signal sensing is executed by an infrared detector, followed by a FET and bipolar amplifier output to the remote-control board. Here we find a group of discrete semiconductors that control all on/off relay, audio, and channel-select impulses. Some outputs go directly to the main chassis, while others are routed to the microprocessor. A keyboard unit on the front panel also connects to the microprocessor, and contains VOLUME UP/DOWN, CHANNEL UP/DOWN, POWER ON/OFF, and two potentiometer knobs for vertical and horizontal resolution.

The selector board supports an LSI 42-pin microprocessor, a pair of LED readout drivers, prescaler and phase-locked-loop ICs, an interface chip, three voltage regulators, a pulse amplifier, and a half-dozen automatic fine-tuning amplifiers.

As the set is turned on, a relay is activated on the remote board, delivering full power to the chassis. Thereafter, selected modulation pulses are detected by the microprocessor, which executes the appropriate functions, and excites the two readout driver ICs to produce green LED channel numbers. The remote-sensor unit amplifies the channel-select or volume signal, routing it to additional amplifiers and a tuned frequency-selective circuit on the remote board.

In the direct-address mode, individual broadcast frequencies are selected by their numbers. When a channel is

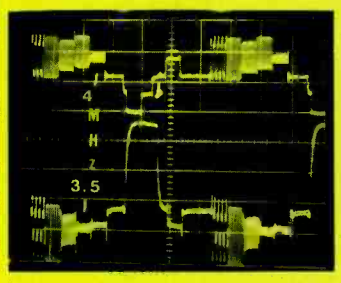


Fig. 1. Multiburst test shows full 4-MHz bandpass at video detector and 3.5 MHz at cathode ray tube.

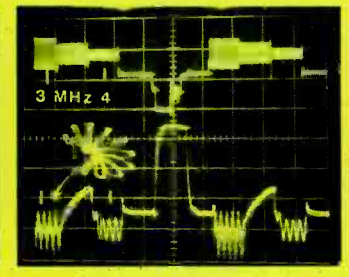


Fig. 2. Chroma test shows a little AM at video detector and some noise at 3.08 MHz at CRT. Vector is good.

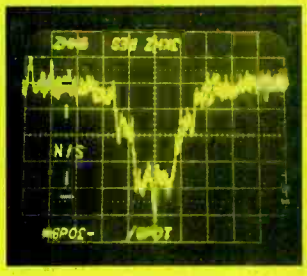


Fig. 3. Display in spectrum analysis shows 43 dB signal/noise at cathode ray tube which is considered quite good.

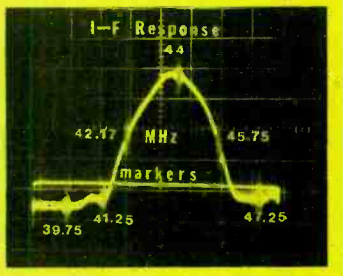


Fig. 4. Factory alignment is good except for placement of lower audio adjacent channel marker, which could be closer to response curve.

picked, each number is sampled for aft response by gating until sync/equalizing pulses are detected. When this occurs, aft crossover and tuner up/down action ceases, and the channel remains locked. In this way, all 82 u/v channels can be covered in a very short time without preprogramming. Prescaler and phase-locked-loop ICs compare channel frequencies by synthesis to ensure correct tuning. Thus, even if a signal is weak, channels are quickly identified and securely held.

Since Toshiba manufactures RCA's CCD comb filter, it's not surprising to see the same device in the CB965. There have been some minor changes, but the signal inputs/outputs, operating connections, and locally generated power voltages are unaltered.

Comb filtering, whether done by IC charge-coupled devices or by glass delay lines with additional active and passive components, simply amounts to a cleaner means of separating 1-3-MHz luminance from the band-restricted 3.08-to-4.08-MHz chroma. A color receiver with a 3.58-MHz subcarrier trap in the luminance channel can only develop 3 MHz at the cathode ray tube (about 240 horizontal lines) regardless of the passband at the video detector. With comb filtering, luminance expands to about 4 MHz, and chroma, in the I color sideband, *could* increase by a full 1 MHz, although Q sidebands would remain at their broadcast bandwidth of 500 kHz. Q sidebands produce colors ranging from yellow-green to purple, while I signals contain hues between bluish-green (cyan) and orange. At the moment, designers are giving new high-end sets between 3.5-MHz (270-line) and 4-MHz (330-line) luminance response in most comb-filter-equipped receivers, but with little or no increase in chroma bandpass, which is now restricted to ±500 kHz. Even so, most comb-filter receivers today can produce better composite pictures than those broadcast by many TV stations.

To compensate for lost vertical resolution due to combing, pin 12 of Toshiba's TL8500P IC is connected to a potentiometer and choke that vary the gain of the luminance amplifier output at pin 13, via a dc voltage. The horizontal resolution control is an R-variable LC device in the emitter of a luminance picture amplifier, i.e., the usual sharpness control you've been finding in the better TV receivers for the past 10 years. Theoretically, the best horizontal display should approach 4 MHz, or 330 lines; while vertical resolution should amount to 400 lines (525 scan lines, less overscan and vertical blanking).

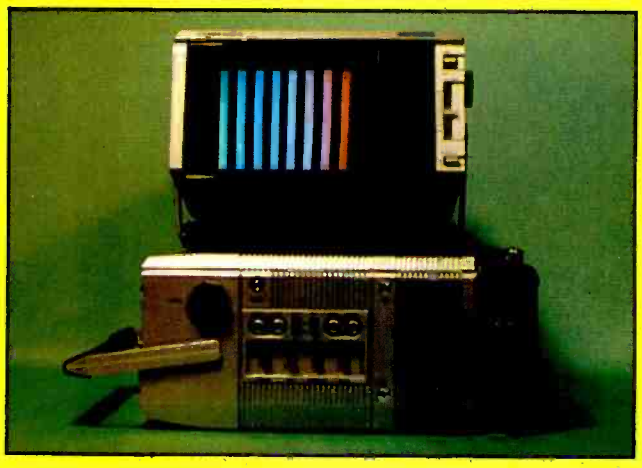
Composite video enters the 683.5-element CCD and outboard amplifiers, which are clocked from an external frequency tripler at three times the usual 3.58-MHz chroma subcarrier rate. Luminance information proceeds to the upper amplifier, and chroma to the inverting lower amplifier, both of which are manually gain-controlled. The CCD element delays composite video for 63.5 μs, a full horizontal line. It then passes the signal to summing amplifiers. After in-phase video lines have been summed (luminance with some additional delay) they are routed through the output via a lowpass filter. When 180° out-of-phase lines are summed, luminance is eliminated, and only chroma may proceed. The VDO (vertical detail output) contains some chroma which cancels (combs) the luminance signal through its own lowpass filter. This is also where RCA's 4-diode variable peaking amplifier operates to heighten vertical detail between 3% and 30%—a feature that is manually accomplished by Toshiba's front-panel resolution controls.

I-f, aft, agc, and video detector are

TOSHIBA MODEL CB965 RECEIVER LABORATORY DATA

Parameter	Measurement
Tuner/receiver sensitivity (min. signal for snow-free picture):	
	vhf (Ch. 6): −6 dBmV (−54.8 dBm)
	uhf (Ch. 30): −1 dBmV (49.8 dBm)
Voltage regulation (line varied from 105-130 V:	Low voltage: 123-V supply—91.2%
	12-V supply—90.1%
	High voltage: 27-kV supply—90.8%
Luminance bandpass at CRT:	3.5 MHz
Luminance bandpass at video detector:	4 MHz
Dc restoration:	82%
Agc response before white/black level changes or sync clipping (−6 dBmV to + 55 dBmV):	61 dB
S/N ratio at CRT	43 dB
Horizontal overscan:	18%
Convergence:	99%
Audio bandpass (3 dB down):	90 Hz to 8.5 KHz
Aux. audio output impedance:	9 ohms
Power requirements (signal applied, incl. remote):	97 W

NOTE: Instruments used in these measurements are Tektronix 7L12 spectrum analyzer; Telequipment D66, D67A oscilloscopes; Sadelco FS-3D VU F/S meter, Winegard DX-300 amplifier; Sencore VA48 video analyzer (modified), CG169 color bar generator, PR57 power analyzer; B & K-Precision 1248 and 1250 color bar generators, 3020 function generator; Data Precision 245, 248, 258 multimeters; Canon Ftb and Tektronix C-5A cameras.



TOSHIBA'S TINY TIM

Another Toshiba model (the CA045) for 1981-82 is a 4.5-inch color portable that operates on a 12-V battery or 120-V ac. Weighing 7.5 lb, this little TV produces a remarkable picture for its size, with adequate definition and good color.

The set has a uhf/vhf slide-rule dial, with a pair of flashing red bar indicators that act as an "off channel" signal (a green bar lights up when the tuning is correct). This little fellow also has a cold chassis, audio and video inputs/outputs, and an earphone jack. Overall luminance bandwidth is listed at better than 3 MHz, even without a comb filter. A full set of controls is positioned on the side, beneath the audio/video inputs.

Video and audio external monitor signals play directly to the set's cathode ray tube, and to the 3-inch top-mounted speaker. Companion outputs monitor demodulated r-f and audio—either from the airwaves or from another product with an r-f modulator (e.g., a computer, video disc, video cassette, etc.). A battery pack is available at extra cost.

Comments. This Toshiba isn't inexpensive ($449.95), but its design is better than average (5 ICs); and the main chassis board comes nicely marked and well laid out for easy service. Power consumption on ac is less than 25 W (with input signal) and 15 W on batteries. Signal inputs into the monitor from a 600-ohm audio generator produced a potential between 200 mV and 7 V without noticeable distortion. Inputs (sync positive) from a 75-ohm video generator produced 0.5 to 1.5 V potentials before raster or color bar change occurred. Overall, clean audio ranged from 120 Hz to 9 kHz.

included in a single TA7607AP integrated circuit, and sound is amplified and demodulated by a TA717AP IC; but the sync and vertical/horizontal oscillators have been combined in a 42-pin large-scale integrated circuit, along with luminance and chroma. This brings the actual chassis active device count to three ICs, 24 transistors, and one surface wave filter located between the tuners and i-fs.

A 42-pin, heat-sunk IC (TA7644AP) carries virtually the entire sync/oscillator load for the receiver, although several outboard discrete components are still required for impedance matching/driving, and for additional amplification. Dielectric isolation in the chip must be considerable to prevent interaction of all the different signals. It's the first time we've seen anything like it, and it may become a standard for the future.

Comments. As of this writing, we can rate the CB965 model as one of the best Japan-made sets in its class. Remote and local controls are fine; picture colors are good; definition and resolution are excellent; and luminance is adequate. Audio is above average in its class. Serviceability is good, made easier by socket-mounting of ICs.

Minor improvements could include softer initial turn-on volume, less touchy remote controls, and a full 4-MHz bandpass instead of 3.5 MHz (Fig. 1). But it should be kept in mind that many broadcast stations are not delivering more than 3.5-MHz bandpass even on exceptional programs (although a good laser disc player will exceed that bandwidth by 500 kHz). The 18% overscan is also a bit sloppy, and the 91% voltage regulation could be improved, as could the minor CB interference apparent on Ch. 2. In Fig. 2, noise is seen at 3.08 MHz, while the vector response is relatively good. The spectrum analysis displayed in Fig. 3 shows a video S/N of 43 dB at the CRT, which is outstanding.

Other strong points include 99% convergence, good tuner/system sensitivity, a good chroma vector, and crisp alignment (Fig. 4). These help to make the CB965 a well-designed, smoothly operating receiver for all 82 standard broadcast channels.—*Stan Prentiss.*

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A practical look at earth stations

BY PE EDITORIAL STAFF

Take a low-noise amplifier (LNA), a 10- or 12-foot metal-embedded or mesh-overcast concave dish, a 4-to-6-GHz receiver, down converter, and demodulator electronics, followed by a modulator for channels 2, 3, or 4, and you have the makings of a satellite earth station. Then find a Satcom or Westar hanging over the equator in stationary orbit, set your dish to the proper azimuth and elevation, and—bingo—in comes a wideband, true-to-life TV picture. And it's free!

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Third Wave TVRO-1 Satellite System

scramble the transmission and rent you a decoder.

Even now the Motion Picture Association of America is complaining about its unpaid artists; and others are loudly demanding protection from legislative and enforcement branches of government. Given today's mood of laissez-faire, such action is unlikely any time soon, but earth-station sellers may eventually become purveyors of descrambling boxes and direct or indirect collecting agencies for HBO and others. Meanwhile, cries of economic anguish will issue from offended suppliers until peaceful coexistence with earth-station owners is established.

Setting Up. To pull in a picture, you first have to determine the basic antenna coordinates (see sidebar), then swing the dish to the approximate position for the satellite you want. When you have checked signal-to-noise ratio on both sides of center, lock your controls or frame in place, and, enjoy the viewing.

Naturally there are different channels from which to choose. For example, if each 500-MHz band begins with zero and is divided into authorized 40-MHz increments, there are 12 channels available with an unused 20-MHz portion left over. If you begin again at the bottom and offset these 40-MHz frequencies by 20 MHz, you have a second set of 40-MHz frequencies situated above the first 12 by a difference of 20 MHz each. This is called vertical and horizontal polarity, and the process makes available a total of 24 channels for each authorized satellite. There are 21 channels in use for the Satcom I, depending on the day of the week and time.

More Satellites Need More Spectrum Space. As the Congress and the FCC struggle with the prospect of more man-made heavenly bodies, Comsat's Satellite Television Corporation (STC) is already reserving space on the Shuttle for one operational and one spare satellite system due for launch in mid-1985. In addition, the Direct Broadcast Satellite Corp. of Bethesda, Maryland, has filed a letter of intent with the FCC to put up a DBS system that will operate as a common carrier. This means that program originators will pay premiums for this new 12-GHz system, rather than having individual homeowners pay as

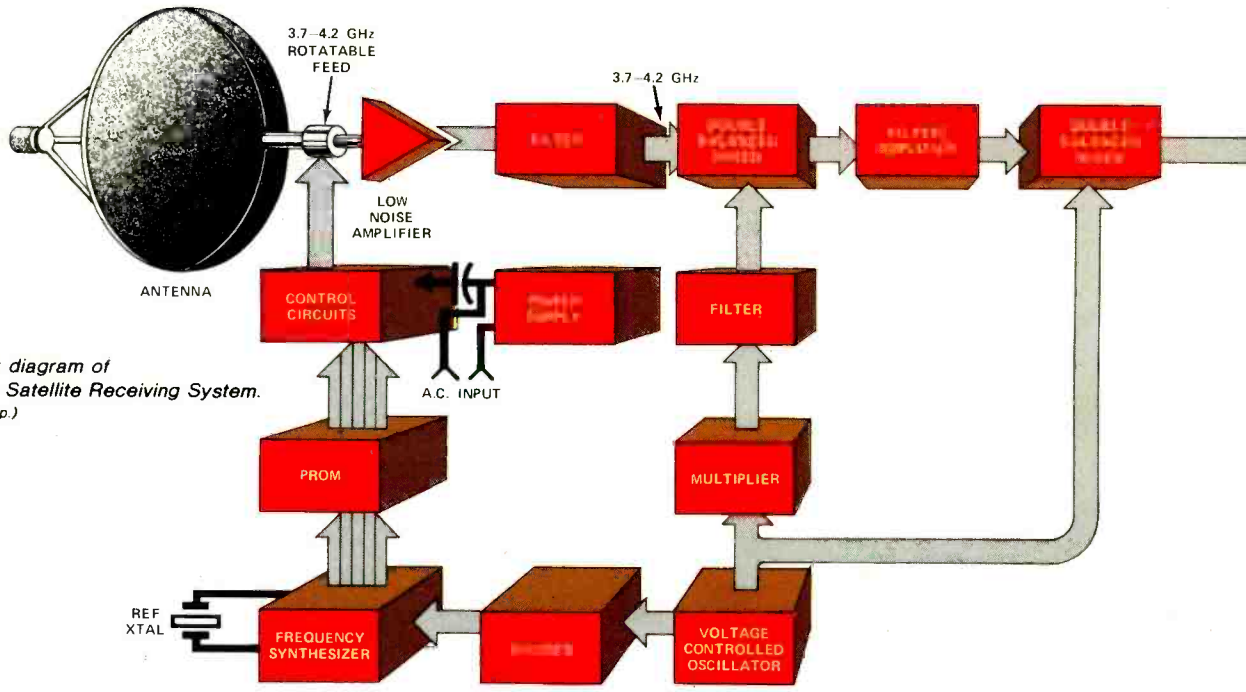


Fig. 1. Basic block diagram of Megastar/TVRO-1 Satellite Receiving System. *(Courtesy Microdyne Corp.)*

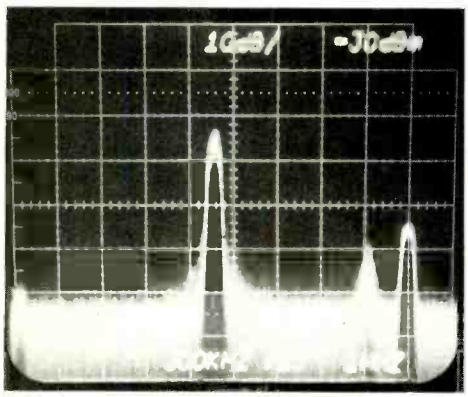


Fig. 2. Video and audio carriers through TVRO-1 and SATCOM.

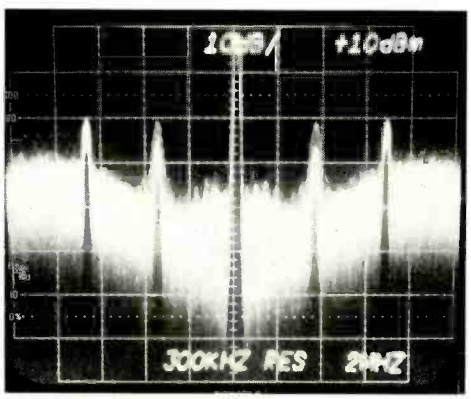


Fig. 3. Unfiltered carriers appear on either side of video reference.

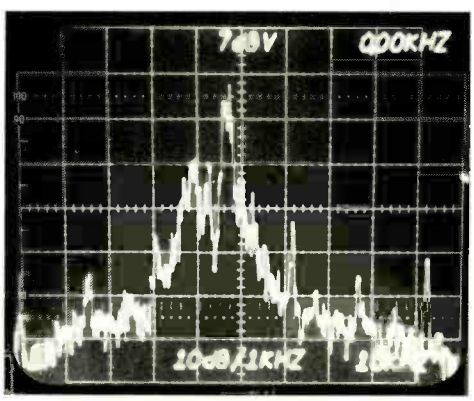


Fig. 4. Wideband audio approaches specified 20-kHz bandwidth.

with Satellite Television Corporation.

With existing spacing in the 4-to-6-GHz spectrum, 48-state coverage for fixed satellites is already filled, and only 3 to 5 positions for 50-state coverage remain available beyond the 20 approved late last year. In the 12-GHz region, however, there are still unassigned spaces for the 1,000-MHz bandspread. At the moment, here's how that spacing looks:

400 MHz between 11.7 and 12.1 GHz set aside for fixed satellites.

200 MHz between 12.1 and 12.3 GHz to be decided upon at the 1983 Region 2 conference on the Western Hemisphere.

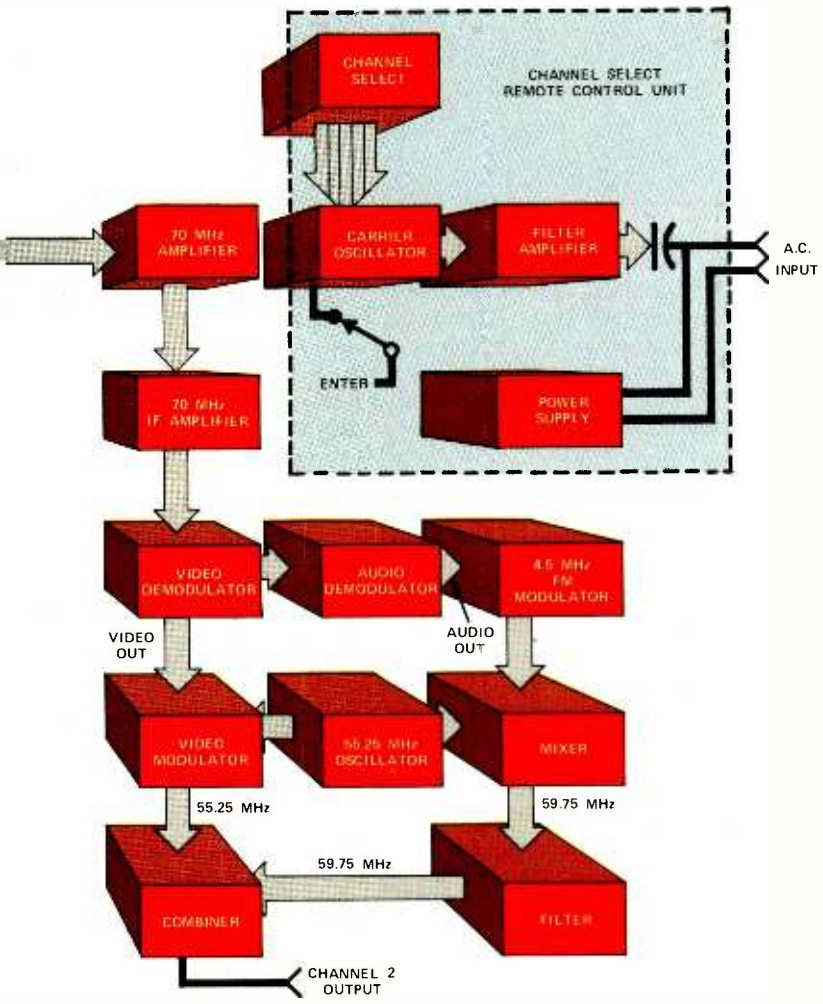
400 MHz between 12.3 and 12.7 GHz assigned to direct broadcast satellites.

Using a Real Earth Station

We have selected the Third Wave TVRO-1 by Microdyne to illustrate the workings of a typical satellite earth station. It is a twelve-foot antenna costing $10,000. The fiberglass dish has zinc embedded in its concave surface, and its gain is 42 dB for signals between 3.7 and 4.2 GHz. A sensitive, low-noise receiver is enclosed in weather-proof plastic suspended at the focal point of the dish reflector. Inside the antenna support structure is an aluminum frame parallel with the dish, acting both as its main support and as a convenient reference for attaching an inclinometer used during initial positioning.

For programming the receiver to a particular channel and polarity there is a hand-held unit inside the house, connected to the power line. It has thumbwheel controls, power and enter buttons, and a LED readout.

When a channel between 1 and 24 is selected, a 120-kHz pilot carrier transmits a 16-bit signal that strobes the receiver several times to ensure accurate tuning. A phase-locked-loop synthesizer then selects and holds the designated channel. An even or odd bit designates the necessary polarity and adjusts the antenna via a drive motor.



All the electronics, from the 120°K, two-stage LNA to the r-f modulator, are integrated into a single package (Fig. 1). This is to compensate for the relatively low gain (30 dB) of the LNA. (Most have 50 dB.) Servicing is thereby made more difficult, because the package must be disassembled in order to get at any one component.

The output of the receiver and LNA is then coupled to a complex dual-conversion downconverter consisting of striplines, an oscillator, and a mixer and amplifier, with a wideband F-M demodulator for audio and video. Video and audio carriers of 55.25 MHz and 59.75 MHz, respectively, are then remodulated as AM video and FM audio on a common carrier, and transmitted via coax to the television receiver.

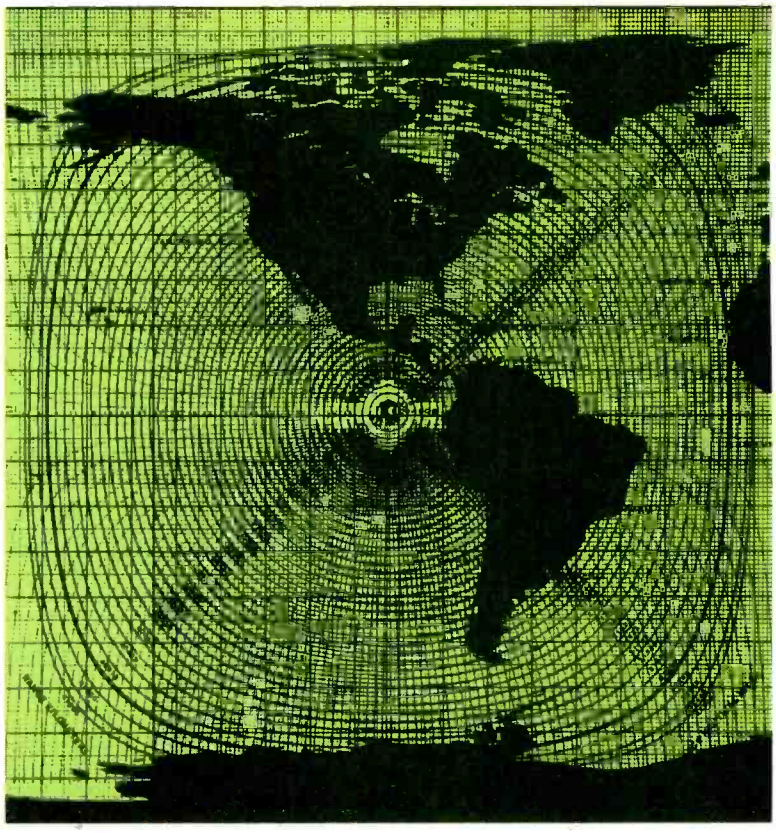
Output signals of the TVRO-1's channel-2 modulator are shown in Fig. 2, with the video carrier, 3.58-MHz color subcarrier, and audio carrier identified from left to right. From the center of "grass" (noise), proceed to the tips of the carriers, and you'll easily read the various signal-to-noise ratios. At 10 dB/division, for instance, the video S/N is 48 dB. The undemodulated FM audio carrier measures out at 25 dB S/N. (This does not represent the overall S/N of the audio section. The manufacturer claims an audio S/N of 59 dB, measured at the demodulator output—a figure we were not able to check.)

When allowances are made for line loss, an excellent (but lossy) home two-set coupler, and a 5.72-dB conversion from 50 to 75 ohms, the final video carrier reading on the spectrum display amounts to 52 dB down at 10 dB/div. The TV receiver actually "sees" −46 dBm, or 2 millivolts, which is plenty for a good, crisp picture. Note also the absence of undesirable harmonics or spurs.

There are also outputs for unfiltered video as well as baseband audio. In Fig. 3 one sees unfiltered carriers of unknown origin placed at about 3.5 MHz on either side of the video reference, while in Fig. 4 audio baseband is seen at 10 kHz/div., at a resolution of 1 kHz. Since we used an off-air test signal (from a talk show), 6-dB down wasn't the best, but at 10 kHz/div., the bandwidth approaches the specified value of 20 kHz. ◇

(See overleaf for instructions on aiming the antenna.)

Perhaps by the year 2000, a large space platform could meet almost all the nation's commercial transceiver needs. As for earth stations themselves, technology is becoming better, prices are dropping, and the selection is growing; and the necessary equipment and programming are available now!



Aiming the Antenna BY DAVID WEBER

Since geosynchronous satellites are positioned over the equator, they appear in the southern half of the sky to an observer in the northern hemisphere. The farther north an antenna is located, the closer to the southern horizon it must be aimed. For dish sites of 5 m or less, the incoming beam is focused wide, and antenna elevation will depend primarily on latitude.

Antenna azimuth, however, will vary sharply because geoynchronous satellites are positioned over different lines of longitude. To an observer in the northern hemisphere, a particular satellite may appear to the east or west of due south. Thus, if you wish to receive signals from different satellites, you must adjust the azimuth accordingly.

A chart like that above will help you aim your antenna. You'll need to know your latitude and longitude, and the longitude of the satellite at which you're aiming (geosynchronous satellite latitude is always 0°). Of course, you'll need the acetate version of the chart, which fits over a map like the one shown. Both are obtainable from NASA Headquarters in Washington, DC; and unless all of you write in at once, they'll remain free of charge.

Remember, the chart is for rough aiming only. To fine-tune an antenna for a particular satellite, "rock" the aim back and forth around the rough setting, checking for changes in signal-to-noise ratio.

Microwave General offers a computerized antenna-pointing program for $10. You furnish exact coordinates, and they will send you pointing angles for each of the TV-relay satellites. Write to: Microwave General, 2680 Bayshore Frontage Road, Mountain View, CA 94043.

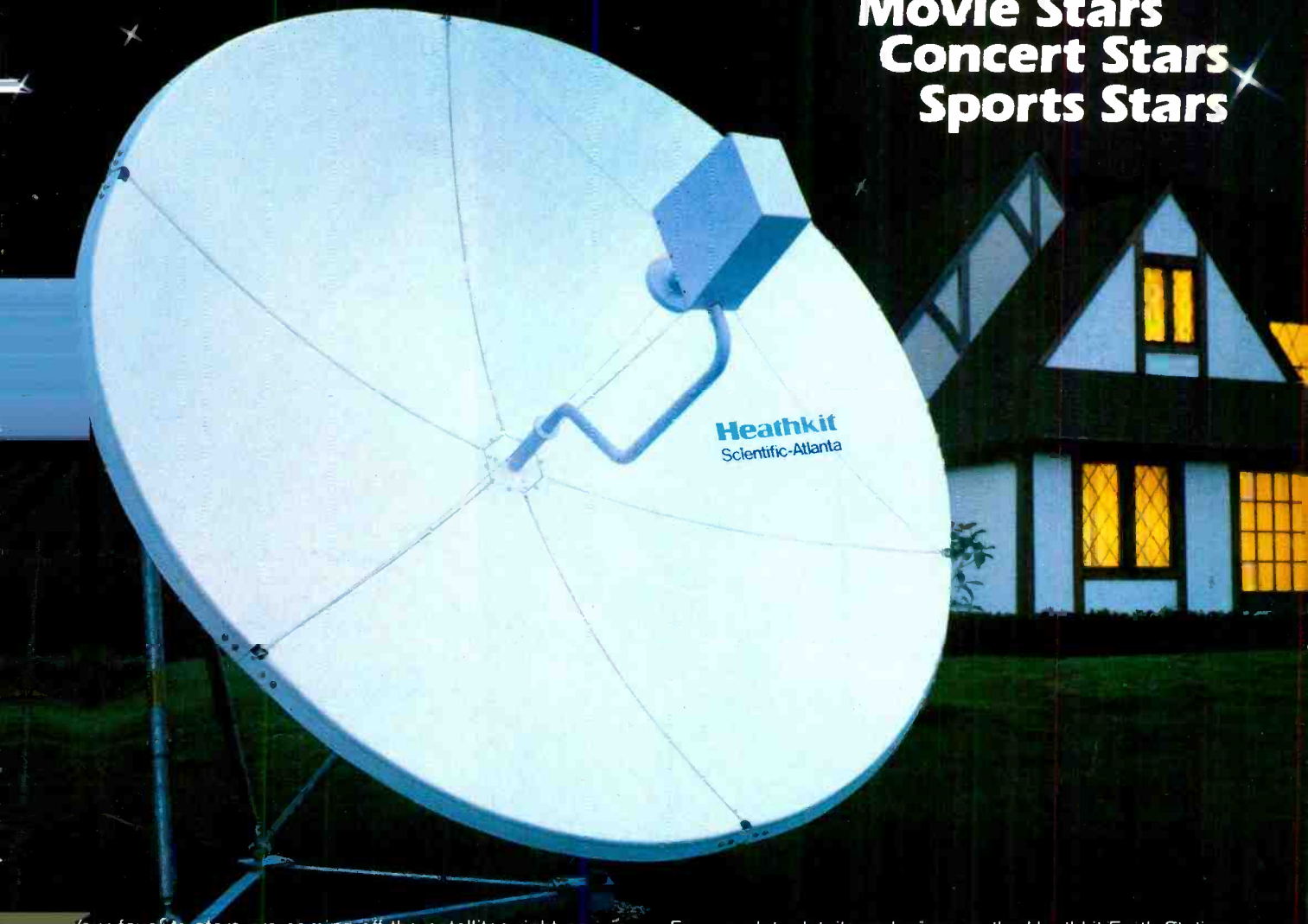
Antenna owners anywhere on the continent of North America should be able to receive programming from each of the satellites listed below. Owners of 5-m dishes on the East Coast and along the Gulf of Mexico may also receive some programs from the European Intelsats and Soviet Molniyas.

Satellite	Longitude
Satcom 4	83° W (scheduled for launch 3 Dec. 1981)
Comstar 3	87° W
Westar 3	91°W
Comstars 1 and 2*	95°W
Westar 1	99°W
Anik 1	104°W
Anik 2	109°W
Anik 3	114°W
Satcom 2	119°W
Westar 2	123.5°W
Comstar 4	127.25°W
Satcom 3	131°W (scheduled for launch 15 Oct. 1981)
Satcom 1	135°

*Comstar 1, previously located at 128°W, was moved to 95°W after the launch of the Comstar 4, in Feb. 1981. Comstars 1 and 2 are now located in the same position, each operating at half-power, effectively as one satellite.

Now the stars are within your reach

Movie Stars
Concert Stars
Sports Stars



Your favorite stars are coming off the satellites right now in one of the greatest selections of family and adult entertainment ever offered. And now there's a new satellite receiver system that puts it all within your reach – at a price that's within reach.

The new Heathkit Earth Station

It includes a *3-meter Satellite Antenna* with a single-axis adjustable mount that lets you direct your antenna to receive signals from the entire satellite arc. It's a heavy-duty, commercial-quality antenna, made by Scientific-Atlanta and designed for long, reliable performance.

Special Low-Noise Amplifier and Down-Converter converts signals to 500 MHz band for transmission on ordinary TV cable.

The Receiver features electronically-synthesized tuning for stable, drift-free reception, and 24 channel selections for a broad variety of programming. It even includes a special Zenith Space Command Remote Control so you can change programs without leaving your easy chair.

Special Earth Foundation Kit anchors your antenna firmly to withstand winds of up to 100 mph.

Unique Site Survey Kit

You can trust Heath to do it right. The first step in establishing your station is the purchase of a special Site Survey Kit that includes everything you need to determine a clear line-of-sight to the satellites. So you know your location is correct before you buy the Station.

Easy-to-follow, step-by-step assembly

Like all Heathkit products, the Satellite Earth Station includes a clearly written manual that guides you every step of the way through assembly and installation. And over-the-phone assistance is always available.

For complete details and prices on the Heathkit Earth Station and 400 other electronic kits for home, work or play, send today for the latest free Heathkit Catalog or visit your nearby Heathkit Electronic Center.

Send for free catalog

Write to Heath Co., Dept. 010-826, Benton Harbor, MI 49022

Visit your Heathkit Store

Heathkit products are displayed, sold and serviced at 56 Heathkit Electronic Centers in the U.S. See your telephone white pages for locations.

Heathkit Electronic Centers are units of Veritechnology Electronics Corporation.

Viewing of some satellite TV channels may require the customer to obtain permission from, or make payments to, the programming company. The customer is responsible for compliance with all local, state and federal governmental laws and regulations, including but not limited to construction, placement and use. For use only in Continental U.S. This device has not been approved by the Federal Communications Commission. It is not, and may not be, offered for sale or lease, or sold or leased, until the approval of the FCC has been obtained.

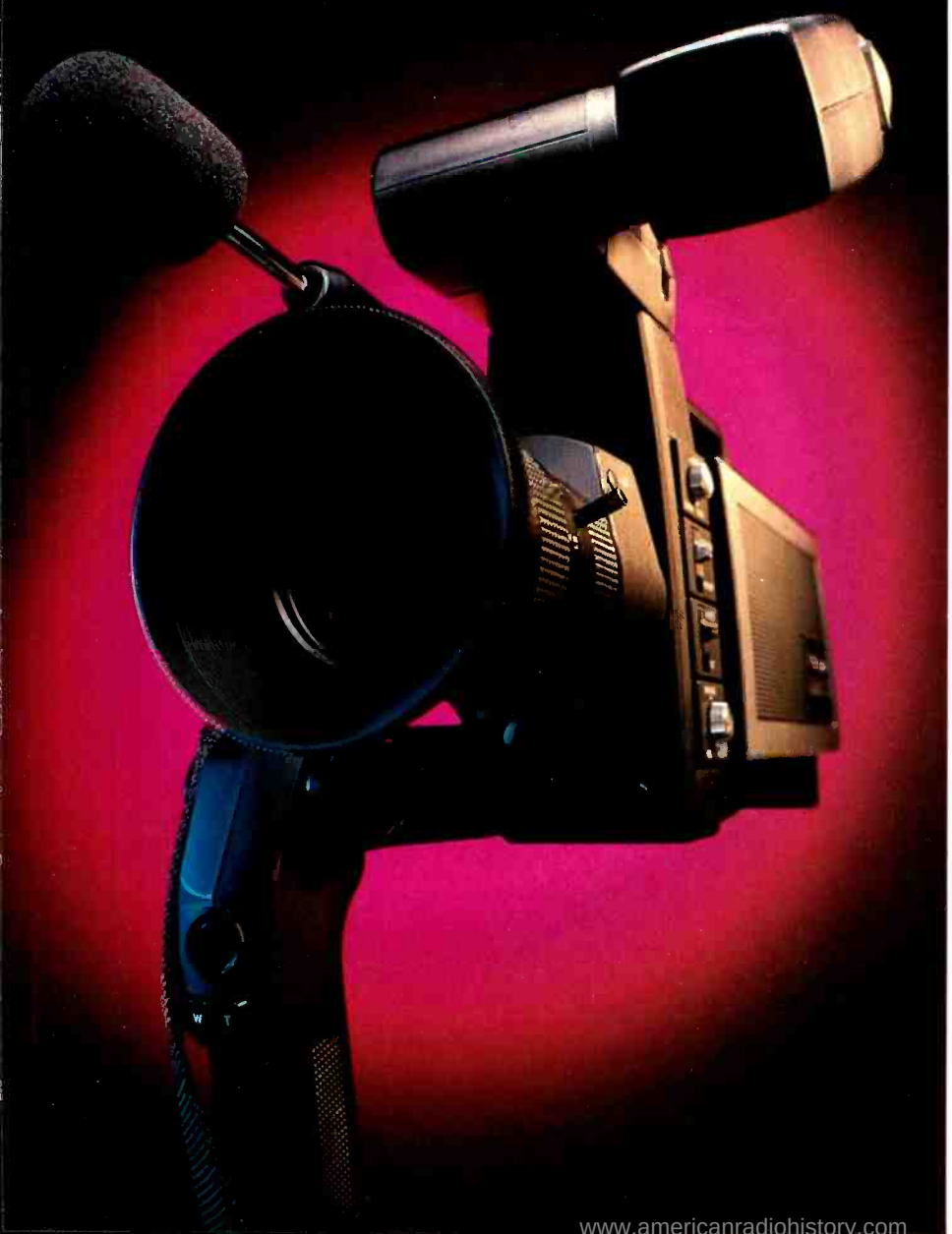
Heathkit

CIRCLE NO. 37 ON FREE INFORMATION CARD

VIDEO 81:

Camera! Action!

A GUIDE TO VIDEO MOVIE MAKING



BASICALLY, a video camera is no more than a movie camera using electronic "film," and you can use it in much the same way. Thus, almost anything you know about movie-making, whether from experience or books, is useful. On the other hand, there are significant differences between the formats as well as the cameras that should be respected.

First, since a TV camera tube can be damaged by too much light, one should never point the camera directly at a concentrated light source such as a lamp or the sun. (You can point it at the sky, however.) Also, whenever you're not actually shooting, your lens should be capped, or its iris closed completely if possible. Using the lens cap offers the bonus of protecting the lens as well as the camera tube.

THE QUESTION OF COLOR. Another significant difference is the way video and film cameras deal with light's changing colors. Sunlight is blue, cloudy light is bluer, lightbulbs are reddish, and fluorescents have a green cast. Your eye and brain correct for this in real life, but not when you're looking at a picture. Photographers compensate by using films corrected for daylight or tungsten (bulb) light, or by using filters. Some video cameras use filters, too, but most balance color via switches or controls.

If your camera has only an Indoor/Day switch and a red/blue adjustment knob, just check the switch position, and set the knob to its center click-stop. If the camera has a color-balance meter or if you have a color monitor screen for viewing the image, you can use it to set the color fine adjustment more precisely. To use built-in color meters or automatic color-setting circuits, the camera must be aimed at a white object—color will cause imbalance.

Fluorescent light demands special

I. Using a Video Camera

measures, especially if your camera has only a red/blue adjustment. To tame the excess green, you might try a photographic filter (an FL-D with the camera set to daylight or an FL-B with an indoor setting) designed for that purpose. While not perfect, the results should be acceptable.

When shooting out of doors, remember that light changes color as the day progresses. Avoid shooting actions at different times of day if they are supposed to be contiguous in time—the color of the light may give you away. If you have a color meter or a monitor, recheck your color every half-hour or so (more at the beginning and end of the day), between sequences. If the color of the light has drifted, don't correct it till the action has shifted to a different time or place.

VERTIGO. Amateur movie makers make mistakes, through carelessness or misplaced enthusiasm, that can make audiences dizzy. The worst of these is forgetting to focus. Electronic, video-screen view-finders make that one rather obvious, and hence easy to avoid. Even so, some amateurs may forget to refocus when the subject moves after the shot begins, and even auto-focus cameras can be fooled when that happens.

Refocusing on a moving target isn't easy. It helps to mark the lens with spots of thick, easily removed tape (such as drafting or gaffer tape) at the near and far focus points. Then you can refocus by feel, with less chance of overshooting. If you can get someone to operate the focus control during the shot for you, so much the better—professionals sometimes use assistants this way.

Camera shake, too, is dizzying, so make sure your camera is as steady as possible. Use a good tripod whenever you can. For shots that require more mobility; use shoulder-pods or shoulder-pods with belly-rest attachments (Akai just introduced one) to steady the camera. When hand-holding the camera, find a stable body position, and use any available rests such as fences, lamp-posts, and parked cars.

Do your best to keep vertical lines vertical and horizontal ones horizontal. When you can't do both at once—as you can't when shooting at an angle to your subject—it's usually best to keep the vertical lines straight and let the horizontal tilt.

Flitting around by use of a zoom is a popular way to send the audience scurrying for motion-sickness pills. Zooming is marvelous where appropriate, but it doesn't go with everything. Don't zoom unless it really contributes to visual imagery. An occasional slow zoom can make a nice transition between long-shot and closeup. A fast zoom can exaggerate the rush as a roller-coaster heads downhill, or serve as a visual exclamation point by suddenly isolating a significant detail. But most often, it's best to zoom between shots, not during them.

Panning and tilting—horizontal and vertical camera movement—should be used only when there is no other choice. They are best executed with the camera on a tripod with a pan and tilt head (which includes most tripods, nowadays).

MAKE THE MOST OF YOUR LENS. Change a lens's focal length—which is what zooming does—and you change both its magnification and its angle of view. Increase the focal length (from 12 mm to 72 mm, for instance), and the angle of view narrows, picking up less and less of the scene, but showing it larger and larger. Decreasing the focal length makes objects within the field look smaller and smaller, but picks up more of them.

By still-photography standards, video shots aren't very wide. The widest angle available on home-video zoom lenses is just about equal to that of a "normal" lens on a still camera. The telephoto effects possible, though, are more extensive than in still photos.

Lens settings can be used in two ways. The simpler is to shoot from any convenient spot and use the zoom to frame the shot. The more subtle and satisfying way is to use lens setting to control perspective.

Image size depends on both the camera's distance from the subject and the lens setting. As you back away, you can use a longer focal length to compensate. That keeps the image size the same, but the perspective changes. Apparent distance between objects depends on their relative distance from the camera. If two people are 10 feet apart, and you're shooting five feet from the nearer one, the other one is three times as far away, and looks it—he'll look considerably smaller, too. But at a distance of 100 feet from the first, the second one is only 10 percent farther away, and both look about the same size.

Relative distance has other effects, too. If you're filling the TV frame with someone's face, don't get too close. Stand about 10 feet away and adjust focal length for proper framing. Moving in closer (which would require a wide-angle setting to avoid cropping the face) will make the subject's nose stand out like a miniature mountain.

CAMERA SHOTS AS LANGUAGE. Lens settings and angles convey messages. For example, a tight close-up head shot concentrates our attention on the subject, and drops the surroundings out of the frame. A wide-angle shot emphasizes the relationship between subject and surroundings. A high-angle shot shrinks things and people; a low-angle, makes them look larger, more imposing.

VIDEO 81:

Standard film structure is to start scenes with a long-shot, to establish everyone's relationship to the scene and each other, then cut to a medium-shot to concentrate attention, then to close-ups. "Standard" shouldn't mean invariable, though. You can change the order of these shots. (Starting with the close-up and leaving its setting a bit of a mystery until the long-shot is a popular trick.) You can omit a shot (long-shots are rarely needed to establish two people talking in a car). And you must vary the timing of each shot according to the action on the screen.

Comic strips are full of artfully mixed long-shots, medium-shots, and close-ups; observe them carefully and you'll learn a lot about how to give a story visual flow. Also, watch and rewatch the best of the shows you've taped. Running at fast-motion speeds sometimes helps one concentrate on structure this way. But once you've learned the structure, go back and relate it to the content: don't stop at learning how a program was put together, keep on till you think you know why.

You'll probably use more close-ups and moderate long-shots for video's small screen than you would if shooting for the movie theater's large one. And don't forget that many video lenses, today, have macro settings that let you shoot small objects large enough to fill the screen. Macrophotography, too, can wear out its welcome quickly, so don't overuse it. Also, at extreme macro settings, your subject may be so close to the lens that you can't light it properly.

A shot with a normal camera angle is shown at left above. At center, a low camera angle was used, making the subject loom large. The chin and nostrils are accented, giving an unflattering rendition of the face. At right, the shot is taken from a high angle so that the subject is compressed and the observer towers above it.

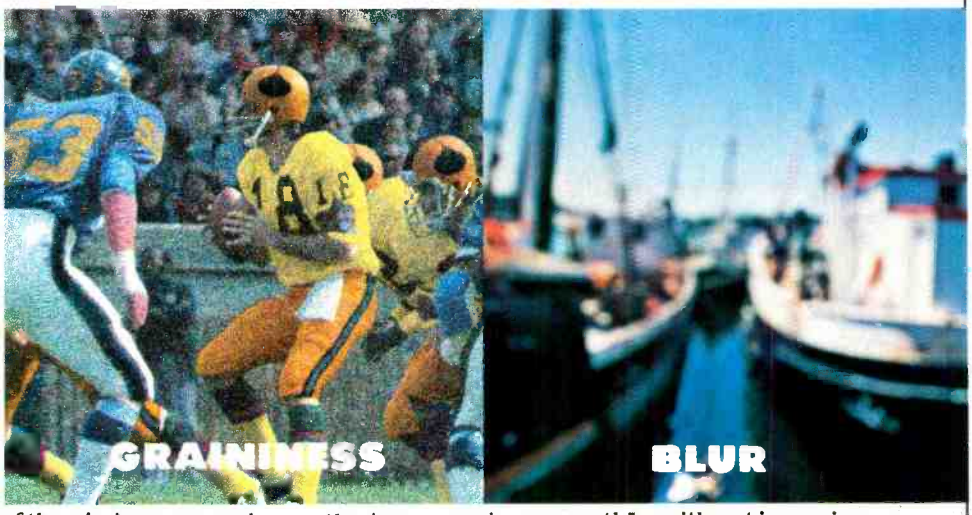
Even when the action is being staged for you, varying your shots takes extra work. The best way to do it is to start the action for the first shot, tape a little past the point where you intend to edit in the next, roll back the tape a little, start the action over for the new shot, then re-start the tape when the action reaches your edit point. The action runs smoother that way than if

Comic strips can be useful as models for sequences of shots. In this example, radical changes of viewing angle—tight closeup to long-shot from the opposite direction and finally to a medium closeup with another reversal of direction—adds tension and suggests action.

IF YOU'RE GETTING A DISTORTED VIEW OF VIDEO,

it could be your videotape. The wrong tape can give you more than your share of problems. You don't see them at first. But after a few passes through the deck, images begin to swim into each other. "Snow" creeps into the picture. Colors fade.

What's worse, the slow speeds of super long play act like a magnifying glass on video imperfections, making them pop out even more. That's not what you were looking for when you sank all that money into your video equipment.



THE SOLUTION IS SUPER AVILYN.

TDK Super Avilyn holds onto its brilliance, time after time. Even under the close scrutiny of the six-hour speed.

Super Avilyn's big advantage begins with its microscopic particles. They're super refined. Even more refined than professional videotape particles. That gives Super Avilyn outstanding frequency response, so images stay crisp and sharp. The perfect alignment of the particles means a high signal-to-noise ratio. That's what keeps the color rich and natural, and keeps the snow away.

A unique TDK process packs and secures the particles on the tape surface, which is then polished to a mirror finish. Oxide particles don't shed.

Images stay impressively true to the original, without ever showing their age.

Surrounding the tape is TDK's equally impressive super precision mechanism. It keeps the tape running smoothly, without jamming.

Our view of video goes beyond tape. We've been involved with home video since its earliest stages. Today TDK supplies precision video heads and other component parts to major videodeck manufacturers. Super Avilyn is therefore remarkably compatible with most videodecks.

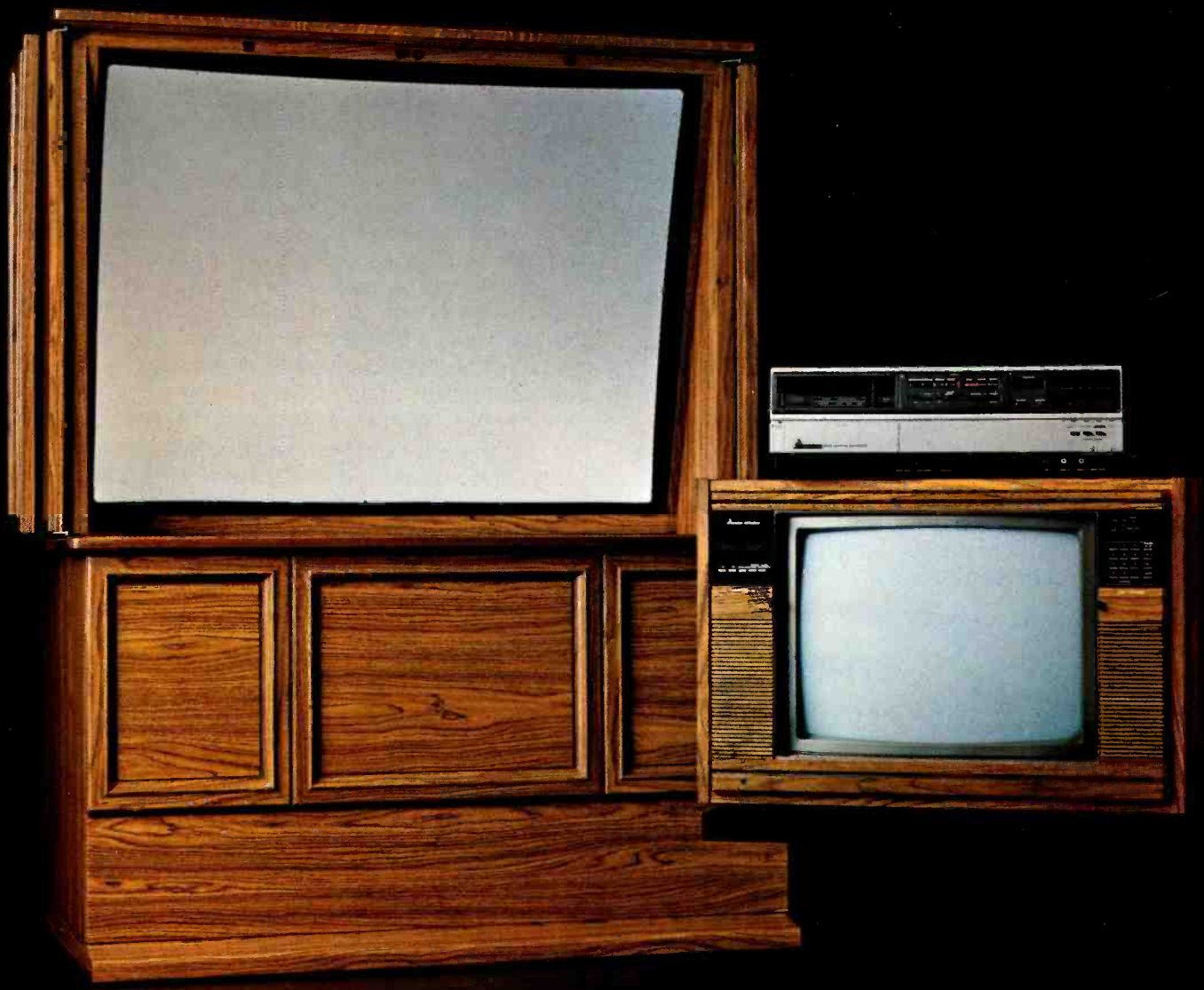
By now it should be clear. When you look at videotape, you should see into the future. TDK Super Avilyn gives you a lot to look forward to.

TDK®
THE VISION OF THE FUTURE

SUPER AVILYN

CIRCLE NO. 54 ON FREE INFORMATION CARD

Watch Your Investments.



It is fair to say that as one living in late 20th Century America, television is one of your prime sources of entertainment and information.

We therefore build MGA/Mitsubishi video products so that they will represent to our customers a major purchase, and be one of several constant fixtures in their lives.

So we invest in every Mitsubishi the level of care, advanced electronic ingenuity, and meticulous craftsmanship required to make your investments in Mitsubishi video products worthy ones.

The great digital advances of the electronic age have been exploited to the degree that entire subassemblies, elaborate circuitry, and moving parts have been supplanted by tiny chips.

A SECURE INVESTMENT.

The happy result is an extraordinary standard of reliability, operating convenience, and picture fidelity, which eclipses even our own legendary traditions.

And even this high degree of proven performance is subjected to our most stringent skepticism. Every new Mitsubishi TV set, for example, comes to you slightly used. We test every set for a number of hours before shipping it out, to weed out any occasional defective component.

The portable shown features the latest computerized touch tuning and a stereo speaker/amplifier system that gives you stereo capability. (Stereo program sources are currently available with FM simulcasts and many video discs, with stereo videotapes on the near horizon.)

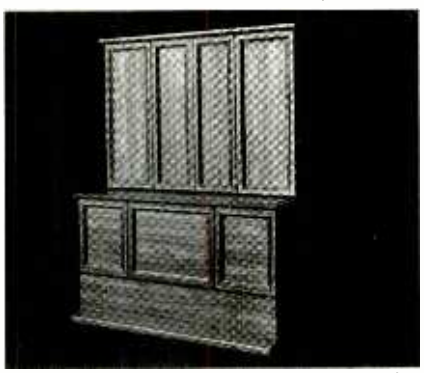
A BIG INVESTMENT.

As technology has made the inner workings of a Mitsubishi smaller it has allowed us also to make enormous improvements in big-screen projection television.

Here, electronics and optical science conspire in a superb four-foot diagonal presentation.

While others use plastic lenses, our in-line, three-gun scanning system processes the picture through three sets of five-stage precision ground optical glass lenses. The same quality glass used in fine cameras.

Along with our immense picture, the Mitsubishi projection TV model shown delivers equally majestic sound through four stereo speakers, powered by two superlative 10-watt amplifiers. The effect is such that you



will have the pleasing illusion of stereo even when the program source is mono.

AN INVESTMENT IN TOMORROW.

Technology now allows you not only to enjoy today's television shows, but also gives you the useful option of recording today's shows for tomorrow's enjoyment.

And Mitsubishi's state-of-the-art methodology has also resulted in, frankly, a technologically superior videocassette recorder.

Though there is good reason to believe you will become very attached to the Mitsubishi VCR, its controls happen not to be.

They're wireless.

You can run the entire remote unit from your chair without benefit of cord. A capability shared by few other VCRs.

Mitsubishi dispenses also with belt drives. And their attendant potential for breakdown.

Instead, each of five play functions is directly driven by micro-computer controlled motors.

Videorecorder, projection TV, and color TV, refined to the point of excellence and beyond.

It may well be that you can't afford to own the best of everything in this world. But for a price well within the realm of reason, you can buy a Mitsubishi.

And own the best of something.

MGA / MITSUBISHI

Are You Ready For A Mitsubishi?

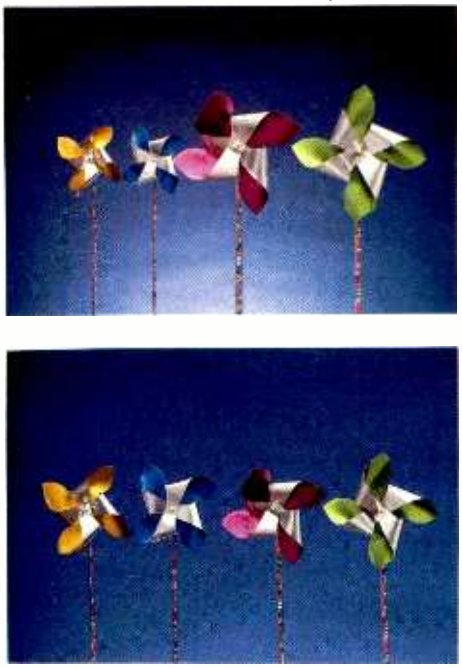
VIDEO 81:

your actors have to start and stop at the very instant that your tape does.

When the action isn't being staged for you, you can't use the above technique. What you can do is zoom between long-shot and close-up (when you must, you must). Or use cutaways: cover up gaps in your action by cutting away from it to something else. Is the character in your medium-shot staring out the window? Then show what he sees before cutting to a close-up or long-shot. Show something silent, and you can dub in more dialogue or narration to go with that shot later.

EXPOSURE. Most video cameras have an autoiris, which opens or closes the lens's diaphragm to keep the amount of light reaching the camera tube relatively constant even when the light on the scene changes. Many also have automatic sensitivity controls, which vary how much light the tube needs. Under normal circumstances, these will be enough to keep you out of serious trouble.

But circumstances aren't always normal. Take the common case of a backlit subject, dark against a bright background like the sky. The camera will set its exposure to the average brightness of the subject and its background. Where the background is big enough to dominate, the result will be a picture whose background is a bit too bright and whose subject so dark as to be in silhouette. The backlight switch on some cameras opens the lens a bit, to give the subject enough exposure (this washes out the background, of course, but that matters less). Opening a manual iris control about one stop past the exposure that the camera's auto-exposure system would set does the same thing. A manual iris control can also be closed a bit to compensate for the rarer case of a bright subject against a dark background.



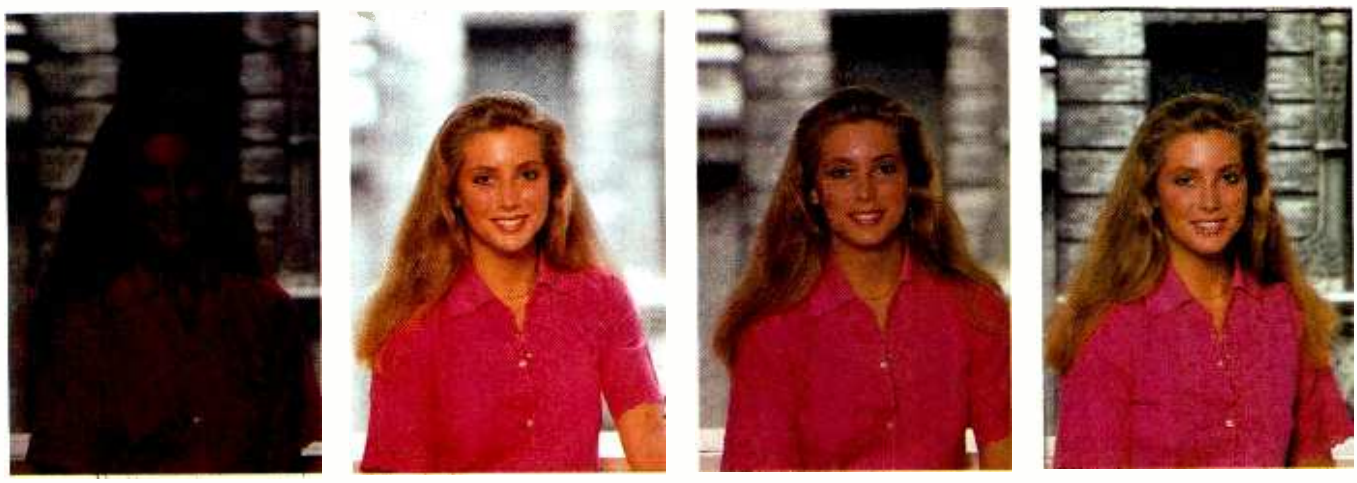
Shot at top was taken with lens with a 35-mm focal length. Since the pinwheels at right are closer to the camera, they are rendered much larger. Using an 180-mm (telephoto) lens, in the lower shot, distance between pinwheels is almost negligible compared to distance to camera so the objects appear to be about the same size and sense of depth is reduced.

If your camera has either a manual diaphragm and auto sensitivity control, or vice versa, you can also play tricks with depth of field—the depth of the in-focus zone at any distance setting. The sensitivity control varies the amount of light the tube needs or will accept. The more sensitive the setting, the more you can close down the iris and the greater the depth of field.

The sensitivity control's range isn't enough to let you vary depth of field much; but where you must either get foreground and background into focus at once or make your focus shallower to blur distracting backgrounds, that small difference may prove significant. Don't use the sensitivity control unless you have to, though. Raising the sensitivity makes the picture noisier and increases the camera tube's lagging or streaking when objects (especially bright ones) move.

If you keep the sensitivity constant, you can use a manual iris control to simulate night scenes by deliberately under-exposing. (You might also want to turn the camera's color control toward blue or use a filter.) Conversely, slight over-exposure gives the effect of a really bright desert or beach scene.

Many of the newer cameras have controls that automatically fade the image out to black at the end of a scene, then fade the next one back into full brightness. These are usually preset—nothing happens when you press the fade button, only when you start or stop the tape with the camera trigger. On many cameras, pushing the button at the wrong time will lead to such odd results as shots that start at full brightness, then immediately fade to black. To avoid such traps, read your camera's instructions carefully.



A B C D

The importance of exposure: (A) An automatic camera, reading strong light from background, closes the lens, underexposing the subject in foreground. (B) With the lens opened 7 f-stops further, the subject is exposed, but the background washes out. (C) A fill light on the camera partially offsets strong backlight. Lens is open 3 stops wide than at (A). (D) When lens is set at f/16, depth of field is greater; and subject and background are both in focus.

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VIDEO 81:

II. Lighting

WHAT YOU SEE on screen depends on what your camera sees—and that depends on how the scene is lit. Lighting for video or movies is harder than for still photography, because the camera and actors may move. Since you can't move the lights in midscene without attracting attention, you must light each scene in a way that will work for everything that goes on. It also pays to rehearse at least once with the lights and camera, to make sure the lighting works for the entire scene.

OUTDOOR LIGHTING. When we think of outdoor light, we think of the sun, but bright sun is not the easiest or best outdoor light to work with. It gives too much contrast—the camera can't show details in the shadows without letting the highlights wash out, or show highlight detail without having the shadows go to an undifferentiated black.

There are two ways to check contrast. If your camera has an electronic viewfinder, use it to judge how well the scene is registering. If not, use a photographic light meter (an incident type that measures the light falling on the subject rather than the light reflected from it is best), carrying it right up to the subject to check highlight and shadow areas separately. Video's contrast range is less than that of film; try to keep a ratio of about seven f-stops (and no more than 10) between the brightest and darkest areas where you want details. You may want some areas to go black or (less often) be washed out, depending on the dramatic effects desired. However, those must be unimportant areas.

If the sun's out, the contrast will be high, but there are ways to modify it. One is to shoot against the sun, so that the side of the subject that is facing you is the shadow. That shadow won't be deep, since it's still illuminated by the broad, bright sky. And the contrast on this shadow side will be low, because the sky is such a broad light source.

Since your camera usually sees a small, dark subject against a broad, bright background, it will be fooled into exposing for a bright subject. To correct this, use the camera's backlight control, or open up the iris about one stop more than the auto-iris control would.. Be aware, too, that the background will wash out when you do this—so either look for a dark background or one whose details are completely unimportant to you. A washed-out background usually spells "bright day" to an audience; be sure that's the effect you want to give.

Whatever you do, the sun itself must *never* be in the camera's field of view. That can ruin a camera tube, and is certain to cause at least temporary burn spots.

Another way to tame outdoor contrasts is to wait for a cloudy moment or a cloudy day. You'll need backlight compensation if the sky is the background—cloudy skies are brighter than they seem. Make sure the sun is not where it can pop out from behind the clouds and burn the camera tube.

Still another trick is to pick an area of open shade, where the sun doesn't shine but the scene is open to the sky. This frequently has the advantage of providing an equally well-shaded background, but it may also result in too low a contrast ratio. Covered shade (under a tree, for instance) may give an even lower contrast, making the picture look dull and flat.

But you can manipulate outdoor lighting contrasts with a little extra gear. If the contrast is too high, you can use large reflectors (large, white cardboard sheets or cardboards covered with crinkled aluminum foil) to fill in the shadows with extra light. If the contrast is too low, you can sometimes use the same reflectors to add extra illumination to the highlight areas. You'll have to find some way to aim these reflectors, and to keep them aimed should the wind blow. You can use light stands, but human assistants do a better job, especially when it's windy.

You can also use screens of thin or loosely woven white fabric to soften the light from the sun, creating a degree of artificial shade. These require less aiming than reflectors, but wind will still be a problem.

INDOOR LIGHT. There are at least three basic ways to light interior scenes: the studio approach, bounce lighting, and duplicating the room's existing light set-up. (A fourth way, putting a light weight movie light atop the camera, is simple, inexpensive, and looks terrible.)

The third way sounds odd. If the room is lit, why duplicate the lighting? Unfortunately, few rooms have enough illumination for good video or movie shooting. The minimum for good quality is about 200 foot-candles (enough to allow an exposure of 1/30 at f/4.0 on ASA-100 film, in case you want to check it with a light meter). If you replace the room's existing lights with brighter ones (one good way is to replace the existing light bulbs with floodlight bulbs, if the fuses will take it), you duplicate the original lighting effects, yet get enough light for good exposure. Another simulation technique is to leave the normal room lights up, but supplement them with bright lights coming from the same direction, set up outside the camera's field of view.

That may not always be enough, however. Important action may take place in portions of the room that are relatively unlit. Lights may cast distracting shadows on the walls, or there may be multiple shadows. These don't bother us when we just look at the room but they are terrible when seen through the camera's "eye."

Extra lights can cure the problem.

Washing the wall with light from a broad floodlight (preferably mounted very high, or, if that's impossible, quite low) will eliminate or soften shadows. Lights bounced from the ceiling will create an even, overall level of illumination between the pools of light cast by the main lamps.

Another alternative is to start out with bounce light, then add additional lights for accent. Plain bounce light isn't enough—the results are dull and flat, with soft but nonetheless unattractive shadows in people's eye sockets. Use enough bounce light to ensure that there will be at least 100 foot-candles everywhere that action

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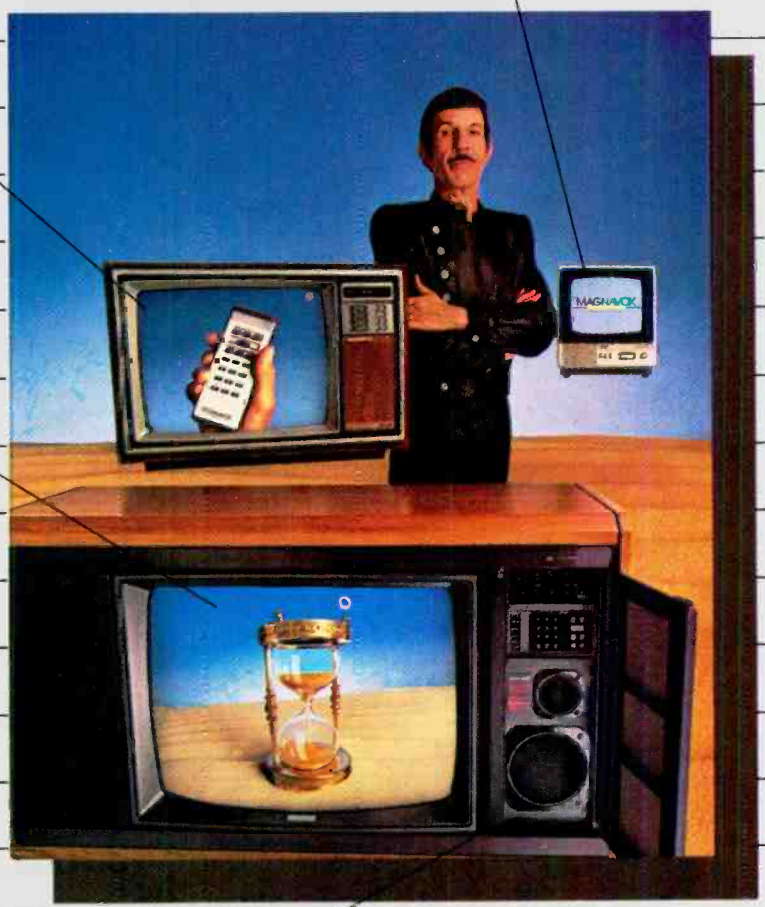

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TV pictures and wood-grain cabinets simulated. All models shown are Star Systems except model 4012.

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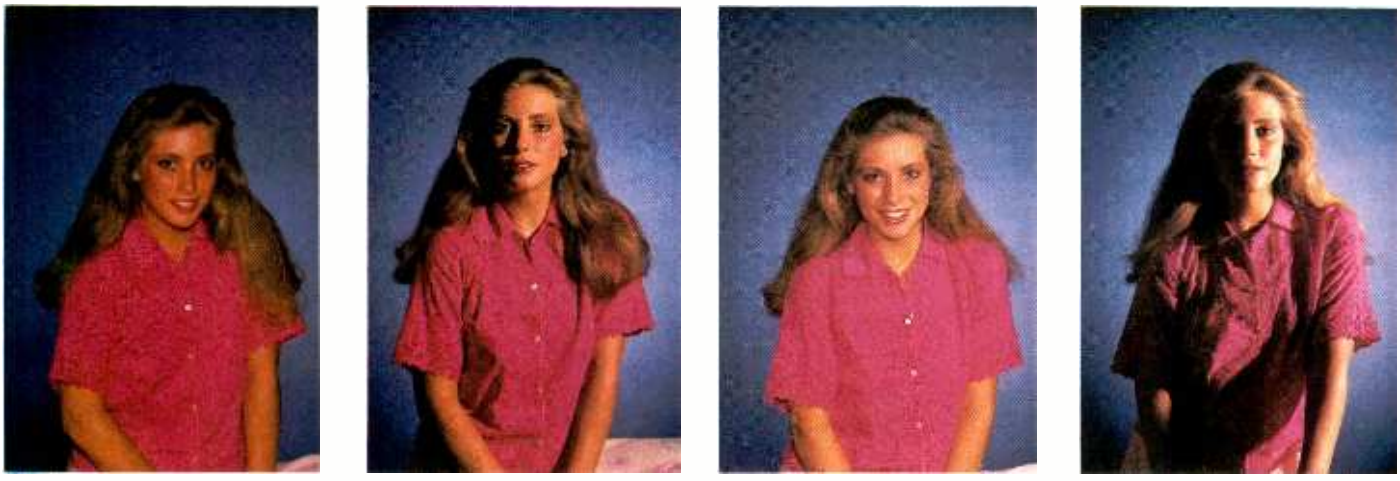
VIDEO 81:

must be visible, then use other lights to create a natural look.

The studio approach ignores "realism" and illuminates for good exposure and good modeling of facial and other shapes. The minimum requirement is a two-light set-up: a main light (mounted as high as possible, so its shadows will fall below the camera's view) at 45 degrees from the camera position, and a weaker light (with about



A B C D

What lighting does for your camera work: (A) With light attached to camera, the face is fine but details are minimized, giving an impression of flatness. (B) One light 45° to the right of the camera gives more of a three-dimensional effect, but shadows are harsh. (C) A low-intensity fill light added to the set-up in (B) gives better illumination to the face leaving sense of depth. A single light 90° to the right of the subject (D) divides the face with a harsh shadow. (E) Fill light on camera added to (D) removes shadows.

one-half to one-fourth the light output) on the other side of the camera (it can also be nearer to the camera position), to fill in and soften the shadows. Additonal lights could be used to wash the background or as "rim

E

lights"—high-mounted lights shining down from behind subjects' heads, to illuminate the hair and keep the subjects from merging into the background.

Even indoors, it's important that the camera not point directly at bright lights. You can include the room's lights in the picture if the actual illumination is coming from much brighter lights that the camera can't see. When the overall illumination is bright enough, the camera's iris closes down, reducing the light that reaches the camera tube from the visible lamps. Use this technique only for brief shots, though, and be sure your main lights come from the room lamps. Don't move the camera during such shots, or the lights may leave "comet-tail" streaks due to camera lag.

Two other things to watch out for indoors are glare and color casts. Shiny surfaces like windows, mirrors and glass-covered pictures (even unglazed pictures on slick paper) can reflect hot-spots or glare patches into the lens. If that happens, move the lights till the glare is reflected away from the camera position.

Color casts are another type of reflection problem. Light bouncing from walls and ceilings picks up their color. If that color isn't white, your picture will have an off-color cast.

Color balance can cause problems, too. Daylight, after all, is blue and tungsten light is red. At least, that's how the camera sees them. While almost all cameras have switches to match either type of light (the exceptions can use light-balancing filters), sometimes that's not enough.

The classic case is the daytime interior shot. The scene is lit in tungsten orange, but daylight blue pours in the window. If the camera needn't see the scene outside, you can shade off the window to replace the missing daylight. Another solution is to cover the window with a sheet of Rosco filter gel (available from professional movie suppliers), which converts the blue outdoor light to match the interior. Daylight-color floods are also available, as are daylight filter gels to mount over the lights. Gels can be used for special color effects too.

Fluorescent lighting can also cause trouble. Its greenish tint can be corrected by the color controls on some cameras (chiefly, those with fluorescent-light positions on their light-balance switches, or with separate red and blue controls), or with filters. But it's almost impossible to successfully mix fluorescent and other types of light in one scene. Once you've corrected for fluorescents, use them alone.

Even ordinary floodlights have pitfalls if they aren't matched. Not all floodlights put out exactly the same color of light, and all run somewhat bluer than ordinary room-light bulbs. You can match any given type of light, but a mixture of different bulb types will give you redder light in some parts of the shot than in others. You may want that effect sometimes, but probably seldom.

III. Sound Recording

THE EASIEST WAY to record sound for your video productions is to use your camera's built-in microphone, but unfortunately, this way is not the best. The built-in microphone can pick up noises from the power-zoom and auto-focus motors, the camera operator's breath, or hands rubbing on the camera body. And it can never get closer to the subject than the camera does—which is disastrous in long shots.

However, with an extension microphone plugged into your camera's MIC jack, new vistas will be opened. With a low-impedance microphone on a long cable or a wireless microphone and receiver, you can get close-up sound from distant subjects. With cardioid, shotgun, or parabolic microphones, you can get reasonably close sound from the camera position and exclude noise originating behind the microphone—and, to a lesser extent, toward its sides. Your add-on microphone may also improve the built-in mike's frequency response; just don't expect too much from that improvement, since the VCR's frequency response is usually as limited as the mike's.

If the sounds to be picked up become complex, or if you want to mix in other sounds (voice-over narration, sound effects, or music) as you tape, you can plug in a microphone mixer, too. While it's often more convenient to plug microphones into the camera (especially if the camera has an earphone jack for monitoring), mixers usually plug into the VCR's audio input jack, which is line level.

For drama and documentary, you usually want to keep your microphone out of the picture. You can do that with a microphone hung on a cord or boom over the action (beware of shadows) or mounted below camera level, with directional microphones outside the camera's view, or with microphones hidden in performers' clothing. But body microphones have two problems: they pick up the rustle of fabrics; and layers of cloth may muffle the pickup of performers' voices. One advantage, though, is reasonable freedom from wind noise. (For other microphone types—especially cardioids—use windscreens religiously, whenever you're outdoors.)

When you want microphones in the shot, as in musical performance numbers or man-on-the-street interviews, technical requirements are easier to fulfill. Just be sure all visible microphones are dull and nonreflective—chrome ones can create hot-spots.

If the sound accompanying the original action isn't up to snuff, it may be possible to do it over without reshooting the scene. That's what the audio dub switch on most VCRs is for. Of course it's far easier to get it right the first time than having to go back and redo things from scratch if overdubbing doesn't work.

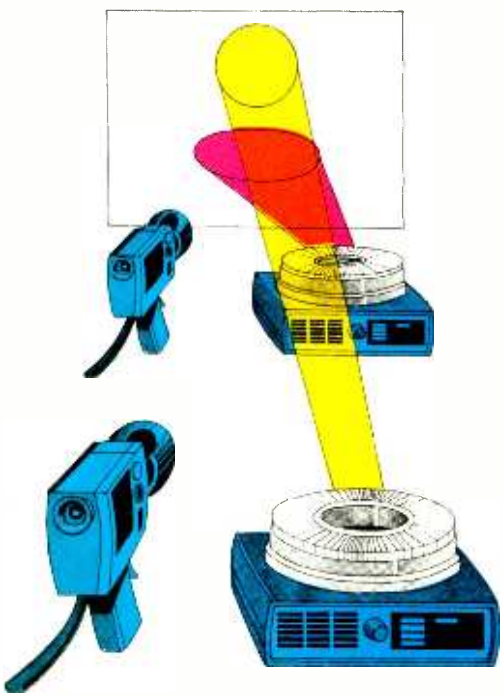
VIDEO 81:

IV. Accessories, Effects and Postproduction

PUTTING TOGETHER your production doesn't end when you stop shooting. There's a lot you can do with the tape in the camera and a bit you can do afterwards, too.

Take editing, for example. If you're shooting a straightforward sequence of events, or one you can put into sequence, it's usually easiest to edit in the camera. Shoot your shots in the proper order, recheck each with your electronic finder or a TV set (portables, for field work), and reshoot when necessary before going on to the next shot.

If working that way isn't possible and you're staging events that switch back and forth between two locations, it's far more convenient to shoot all scenes at one location first, then move to the other and edit them into sequence later. If you haven't the facilities or time to check your shots right after making them, you'll have to edit out the unsuccessful ones. In documenting real-life action, where you have no control, editing after you shoot will almost always be necessary.



In copying slides to video tape, keep the equipment as far as possible from the screen to avoid distortion

Editing video tape is not at all like editing audio tape or movie film. The latter are edited by cutting and splicing—something you should never do with video (sync loss at the joint will make the picture break up, and the splice is most likely to injure or gum up the video heads). Video editting is done by dubbing the original shots to another deck, in the desired order.

Sometimes, you may even want to "edit" a tape without changing its order or content. For example, you can permanently record onto the copy tape special effects (slow-or fast-motion, freeze-frame, frame-by-frame advance) which VCRs can only perform in playback. This ensures that you'll get the same effects, in exactly the same way, each time you play the copy.

All these editing techniques take at least two VCRs. (You might want to pool resources with a friend at editing time.) If the shots to be assembled are on two different cassettes, it may even pay to have three VCRs, dubbing alternately from each of the first two to the third one. Sometimes, you can even shoot with such a setup in mind. If you're cutting back and forth between scenes shot at two different locations, for example, you can use a different tape for each location.

The problem with using home equipment for this type of "assemble editing" is that you're liable to lose sync at each edit point. The key is to know your gear. Determine which of your two (or three) VCRs has the most glitch-free edits and whether it edits most cleanly when you enter record mode from STOP, PAUSE, or PLAY (which only some decks permit). Then always record onto the cleanest deck, using its cleanest mode. And always go directly from one deck's audio and video output jacks to the other's inputs—using the output and vhf antenna input degrades the signal needlessly.

In most major cities, you can rent special editing equipment. (Look in the Yellow Pages under "Recorders—Video" or "Video Recorders.") A typical, dedicated editing outfit might be a combination of two Sony SLO-383 Editing Betamax VCRs and RM-440 Editing Controller. The SLO-383 decks have special, automatic frame servo systems to ensure clean edits, rotary erase heads to erase old information field by field, and external sync inputs. The controller has a search dial for finding editing points easily, and a memory to help you relocate those points. It also lets you preview what an edit will look like.

SIGNAL PROCESSORS. Home VCR signals aren't great to begin with (signal-to-noise ratios for example, average between 35 and 45 dB), and dubbing only makes them worse. The problem can be minimized by using each deck's best performance speed (usually, but not always, its fastest one) at all times. You can reduce the degradation even more by dubbing through an enhancer, which can make the picture crisper and give you some color control.

Color processors and processing amps give you further color control, letting you adjust the color saturation, brightness, hue and flesh-tones.

Audio signal processors can also be used in video dubbing. Noise reduction can be used to clean up the original's output during dubbing and the final tape's sound in playback. Dolby or dbx can be used in making the final tape if you know decoders will be available for playback. Equalizers can also be used either to improve the sound or for special effects (such as narrowing the bandwidth for "telephone" response).

SPECIAL EFFECTS AND TITLING. Fade-ins, fade-outs, and color control aren't the only special effects available. A special-effects generator such as Sony's HVS-2000 lets you add a number of others to your creative arsenal. It has inputs for one color signal and one black-and-white one, which you can switch between or superimpose on one another. The black-and-white image can be colored, or reversed into a negative, for titling or other purposes. Panasonic has shown a prototype of a similar device, but with its own black-and-white camera built-in.

There are many other ways to title your productions. Sets of titling letters in many forms are available from home-movie equipment dealers, and press-on letters in a wide variety of sizes and type styles can be bought in art supply stores. Using a macro range, you can shoot the title and credits as they're being typed on a typewriter. (Better get a good typist for this, as you probably don't want to shoot mistakes being erased and retyped). You can even use the "random-note" technique of cutting and pasting letters from newspaper headlines, if that suits your production.

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VIDEO 81:

My favorite technique also requires a macro lens: put the title on a 35-mm slide, mount the slide as close to the lens as you can focus, then focus out through the slide into the distance. By the time the camera is focused across the room, the slide will be so out of focus as to disappear.

Several companies, such as Quasar and JVC, sell "telecine" kits—special, rear-projection screen systems for use in copying movie films or slides onto video tape. The film or slide is projected on the screen, then shot with the camera. Lower-priced rear-projection screens are also available from many photo stores.

Rear-projection screens are used so that the camera and projector can both face the image head-on. With front-projection screens, the camera would either have to be directly in front of or behind the projector for this. If all you have is a a front-projection screen, use the longest projection lens you have, and set the camera's zoom lens to its longest settings. Then the few inches the projector and camera must be offset to clear each other's field of view will cause minimal parallax error.

V. Scripting, Continuity and Acting

ANY PRODUCTION—documentary, drama, or simple how-to—must flow, dramatically and logically, or your audience will tune out. Generating that flow may or may not require a full-fledged script, but it will require deep and careful thought prior to shooting.

Consider first the purpose of your video production: What are you trying to say? Why are you saying it? Are you trying to instruct, inform, persuade?

Don't stop at generalities. *Romeo and Juliet* can be considered boy-meets-girl—but—boy-meets-girl isn't *Romeo and Juliet*. If it's romance, which boy? Which girl? And where? If it's engine repair, which section of which engine?

Then think in terms of a beginning, a middle, and an end. Beginnings aren't as simple as they sound. Do you start with how to change an alternator or how to tell if it needs to be changed? With the boy meeting the girl, or with background on both so you'll know what attractions and conflicts there will be between them? With the chicken or the egg?

Middles sometimes grow from beginnings, sometimes from ends. In nonfiction, the middle is usually straightforward; in fiction, you may have to invent complications to keep the beginning from launching you straight into the end—but those complications should grow naturally, since they're often the meat of the story.

Ends are sometimes preordained. In a how-to tape, for instance, the best end is usually a demonstration of the final result. If you've shown how to build a birdhouse, for

example, show the finished house in place, preferably with birds visibly endorsing it. But even surprise endings should seem preordained —in retrospect. Let the viewer see why your ending came out as it did, even if led to expect something else. And unless you're looking for an O. Henry effect (i.e., a surprise-ending), it's frequently best to put the big surprise just before the end, and give the viewers a chance to wind down from it.

There's room here only for generalities; but the airwaves are full of specifics. The best way to learn scripting is to tape a wide variety of programs of the type you want to make, then view and review the tapes till you understand how each one's script works. See what they have in common, how they differ, and why.

That last applies even to documentaries, where you have very limited control over what you shoot. Though you can sometimes stage a shot, you usually are stuck with what's there when your camera is ready. So find out as much as possible about what will be there. Are there regularly scheduled activities, and which ones do you think you'll want to tape? Are there people you know in advance you'll want to interview? (If so, have a list of questions ready beforehand, but be prepared to follow new trails their answers open up.) What kind of lighting will there be, and can you add more of your own? Are there good places to shoot from? How many hours' worth of tape and batteries will you need? (Bring more than you think you'll need.) Will you need any special permissions to shoot? Where and how do you get them?

Whether you're working from a script or not, be prepared to seize whatever picture opportunities arise. For example, a friend of mine, taping at a hospital, got the idea of shooting from a wheelchair, to show the world from that point of view. That meant shooting some scenes twice—once from the wheelchair and once from the normal, scripted viewpoint—but the results were worth it.

In some documentary situations, it may pay to start with film and convert to videotape after the editing is completed. Movie equipment is more portable (you carry just the camera, no shoulder-pack recorder, except with double-system sound). Movie film is easier to edit with precision, and there are many special effects available on film that aren't readily available on tape. Some of these, like cross-fading, can even be done in the camera. The drawback is that most film cameras only hold about 3½ minutes of film per load, and film and processing cost nearly as much per minute as video tape does per hour.

Whenever possible, there should be at least a short rehearsal beforehand, to make sure the action works and can be shot as planned. This will also let your cast concentrate on saying their lines with conviction, not worrying about whether they'll trip over the unfamiliar furniture or block one another from the camera's view. Don't overdo it, though—too much rehearsal loses spontaneity—and if you have an improvisational group, so much the better.

Be vigilant against continuity errors. If you don't shoot in strict sequence, make sure that a character who's supposed to have rushed from one scene to another hasn't mysteriously changed clothes between shots, and that any visible clocks show script time, not real time. Watch screen direction, too—if a character is traveling across the screen from right to left in one shot, he shouldn't go from left to right in the next unless you want to give the impression that he's headed back where he came from.

By Ivan Berger

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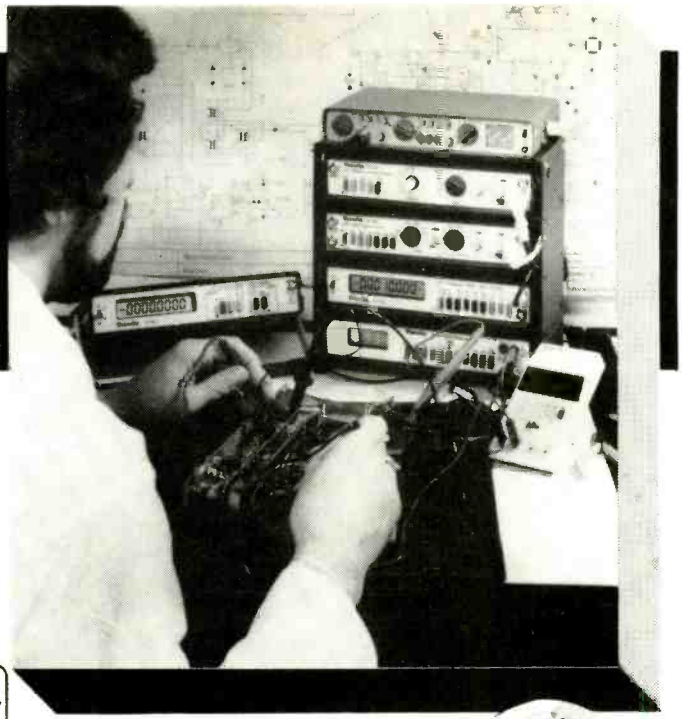

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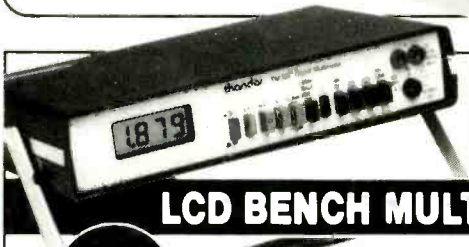

4000 hrs BATTERY LIFE

$199 inc.batts

TM351 3½ Digit

● DC and AC Volts : 100μV to 1000V (750V AC rms) ● DC and AC current : 100nA to 10A (20A for 10 secs) ● Resistance : 100mΩ to 20MΩ ● Diode check ● Basic accuracy : ± (0.1% of reading + 1 digit) ● Battery life : up to 4000 hours

TM353 3½ Digit

● DC and AC Volts : 100μV to 1000V (750V AC rms) ● DC and AC current : 100nA to 2A ● Resistance : 1Ω to 20MΩ ● Diode check ● Basic accuracy : ± (0.25% of reading + 1 digit) ● Battery life : Typically >3000 hours ● $159 (inc. batts).

LED MULTIMETERS

$99.95

DM350 3½ Digit; 34 ranges; 0.1% basic accuracy;

DM235 3½ Digit; 21 ranges; 0.5% basic accuracy; $69.95

PDM35 3½ Digit; Hand held; 16 ranges; 1% basic accuracy; $39.95

PULSE & FUNCTION GENERATORS

$159

TG100 100kHz Function Generator

● Frequency range : 0.1Hz to 100kHz ● Functions : Sine, Square, Triangle and DC from variable 600Ω output ● Output range : 1mV-10V peak-peak ● DC offset range : ±5V ● TTL output ● External sweep : ≥300:1 linear range

STOP PRESS TG102 2MHz Function Generator $299

TG105 5MHz Pulse Generator

● Period : 200nsec to 200ms (5MHz to 5Hz) ● Pulse width : 100nsec to 100ms ● 50Ω output range : 0.1V-10V ● TTL output ● Sync. output ● Operating modes: run, external trigger, external gate, manual 1-shot or gate ● Complement and square wave ● $199

GOLD MEDAL WINNER

$259

SC110 SINGLE TRACE LOW POWER 2" OSCILLOSCOPE

This truly portable oscilloscope, the only British product to win a Gold Medal at the 1980 Brno Trade Fair, boasts the following specification: ● Bandwith : DC to 10MHz ● Sensitivity : 10mV/div to 50V/div ● Sweep Speeds : 0.1μsecs/div to 0.5 secs/div ● Power Requirements : 4 to 10V DC from 4 'C' cells or AC adaptor ● Size and weight : 255 × 150 × 40mm; 800gms excl. batteries

FREQUENCY METERS

$199 inc.batts

TF040 8-Digit LCD

● Frequency Range : 10Hz-40MHz (to 400MHz with TP600) ● Sensitivity : 40mV rms ● Timebase accuracy : better than 0.5 ppm ● Battery life : Typically 80 hours

TF200 8-Digit LCD

● Frequency Range : 10Hz-200MHz (to 600MHz with TP600) ● Sensitivity : 10mV rms 20Hz-100MHz, 30mV rms 10Hz-20Hz, 100MHz-200MHz ● Timebase accuracy : better than 0.3 ppm ● Battery life : Typically 200 hours ● $299 (inc. batts).

PFM200 8-Digit LED Hand Held Meter

● Frequency Range : 20Hz-200MHz (to 600MHz with TP600) ● Sensitivity : Typically 10mV ● Timebase accuracy : better than 2 ppm ● Battery life : Typically 10 hours ● $99.95

TP600 600MHz Prescaler

● Frequency Range : 40MHz to 600MHz ● Sensitivity : 10mV ● Output : Typically 500mV peak-peak ● $79

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Continuing education can help to advance your career

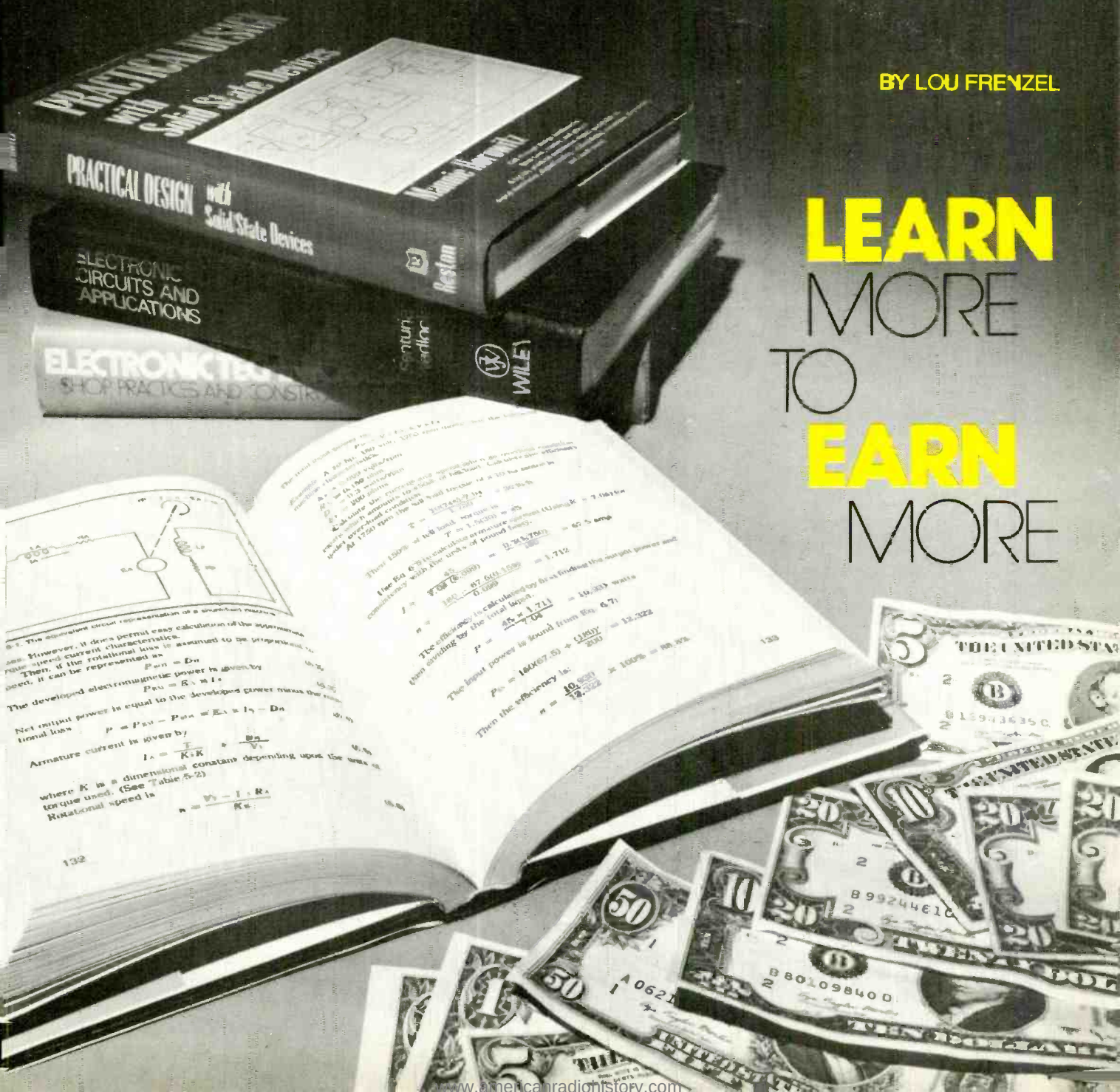
BY LOU FRENZEL

A SINGLE decision can help you to do a better job at work, get promoted to higher paying managerial or marketing positions, or even get more enjoyment out of your hobby. That is the decision to pursue continuing education, a name for studies that follow completion of regular formal education.

A recent study indicates that about 60 million people in the U.S. are participating in some kind of post-secondary education. Of these 14 million are enrolled in regular college, university or technical school programs. But 46 million are learning through other means.

Because of rapid changes in technology, electronics engineers and technicians risk becoming technically obsolete if their knowledge is not current. And technical obsolescence can make you less effective or even incompetent at your job. Besides keeping your training current, continuing education can provide new skills and knowledge in subjects like writing, speaking, supervision, management and marketing that are so important to career advancement. It may even help you prepare for a career change. Moreover there is often some hobby-related interest—as a major part of any hobby is learning more about it.

How to Get Started. Continuing education can take many forms. These include magazines and newspapers, books, self-study programs, resident



classes, home-study courses and even college degree programs. In addition, a good deal of learning comes from informal sources, such as manufacturers' literature and trade shows.

The particular strength of magazines is that they are usually published frequently, and can respond quickly to new technical developments.

Odd though it may seem, some of the most important sources of information in magazines are the ads. In electronics, some manufacturers on the leading edge of technology are particulary adroit at communicating and explaining it. And, in order to remain competitive, manufacturers are continually forced to adopt new technology. You can take advantage of this simply by reading their advertisements and obtaining their literature. Many companies supply volumes of data sheets, applications notes, catalogs, and newsletters. Most of these are free for the asking or available at a very modest price. Read the ads and write for manufacturers' literature that interests you; make liberal use of the "bingo" cards in the magazines.

Books are one of the most compact, efficient, and economical forms of education. They are an ideal complement to magazines since they provide greater length, depth, and breadth of coverage. Some electronics books may be too specialized for your local bookstores. But most electronics stores (Radio Shack, Heathkit Electronic Centers, etc.) also carry books.

An excellent and reasonably inexpensive way to get the books you want is through a book club. There are several aimed at those interested in electronics, computers and related subjects, and their regular announcements keep you informed as to what books are available. Table I lists some of them. Discounts range up to 15%.

You can also benefit from self-study courses, which are short, low-cost, formal learning programs covering a specific subject. These programs are designed for self-instruction and consist of printed text, audio cassettes, and often other media. Some also include experiments with various electronic components and circuits. Usually these courses sell from $50 to $700 and are available from a variety of sources. For example, Heath/Zenith Educational Systems, a division of Heath Company (Benton Harbor, MI 49022), specializes in courses in electronics, computers and related topics.

One of the oldest forms of continuing education is the correspondence course. There are a number of home-study schools providing college-level training for electronics technicians and engineers as well as complete career courses and shorter continuing education programs through these courses. Like self-study courses, home-study programs are designed for individual self-instruction. In contrast, though, the "student" works with a teacher through the mail. Lesson plans are sent and corrected; questions are posed and answered in this manner. Home-study courses are typically longer, more comprehensive and, of course, more expensive. Home study is a good way to review important fundamentals and gain new knowledge and skills. For additional information, contact the schools listed in Table II.

Many colleges and universities offer home study courses for college credit. You can complete up to one-half of the work toward a bachelor's degree this way. Contact the National University Continuing Education Association, Suite 360, One DuPont Circle, Washington, DC 20036, for more information on which colleges offer such programs.

Resident Seminars. There are workshops or short classroom courses that last anywhere from a day to a week. They usually concentrate on one specific topic and are often presented as a traditional classroom lecture (although some also include laboratory work). Many of these programs are conducted in the larger cities at local hotels where meeting facilities, meals and lodging are readily available. They cost from $50 to $700 (not including travel and lodging expenses).

Seminars are frequently conducted by manufacturers who wish to announce new components, circuits, equipment and techniques, and many of them are free. Some colleges and universities also offer resident seminars, and there are private companies specializing in various kinds of seminars. One such firm is Integrated Computer Systems (3304 Pico Blvd., Santa Monica, CA 90405) which offers courses in microprocessors, computer programming, speech synthesis and data communications. Professional organizations such as the Institute of Electrical and Electronic Engineers conduct them too.

Trade Shows and Conferences. Many people dismiss trade shows and conferences as a waste of time and money. Actually, they can be good sources of continuing education. You can learn a lot from the talks, papers, and exhibits covering the latest developments in components and equipment. You will also have an opportunity to check out the various competitive sources, exchange

TABLE I—BOOK CLUBS

Electronic and Control Engineer's Book Club
McGraw-Hill Book Company
1221 Avenue of the Americas
New York, NY 10020

Electronics Book Service
Box 42
West Nyack, NY 10995

Electronics Book Club
Blue Ridge Summit, PA 17214

The Library of Computer and Information Sciences
Riverside, NJ 08370

TABLE II—HOME STUDY SCHOOLS

Cleveland Institute of Electronics
1776 East 17th St.
Cleveland, OH 44114

International Correspondence Schools
Scranton, PA 18515

National Technical Schools
4000 South Figueroa
Los Angeles, CA 90037

NRI Schools
McGraw-Hill Continuing Education Center
3939 Wisconsin Ave., N.W.
Washington, DC 20016

TABLE III—SCHOOLS OFFERING NONTRADITIONAL DEGREE PROGRAMS

California Western University
Santa Ana, CA

Century University
9100 Wilshire Blvd.
Beverly Hills, CA 90212

Clayton University
Box 16150
St. Louis, MO 63105

Grantham College of Engineering
Box 35499
Los Angeles, CA 90035

Nova University
3301 College Ave.
Fort Lauderdale, FL 33314

University of Beverly Hills
Beverly Hills, CA

Upper Iowa University
107 Campbell Ave., S.W.
Roanoke, VA 24034

ideas and information, and pick up the latest manufacturers' literature. Trade shows give you a perspective that you just can't get elsewhere. They provide a great source of knowledge, information, and talent—and many products—in one place.

College. Regular college programs leading to a bachelor's, master's, or other advanced degree are not usually regarded as continuing education. However, they can serve this purpose for some individuals who lack a degree. Determining whether or not you should work toward a college degree depends upon your own situation. Does the job you seek require a degree? Is a degree necessary or desirable for advancement? Do you need a degree to change jobs or careers?

You might want a degree simply for the additional knowledge and prestige that it brings. Often, even when you do not actually need a degree to do a job, the degree will help you get it anyway. For many supervisory or managerial positions, a degree is mandatory.

If you are working full time, your best source of a degree is a local college or university with an evening degree program. Such programs can take anywhere from 4 to 10 years to complete, depending upon your pace of study, the availability of required courses, and your work schedule.

If you already have a technical bachelor's degree, you may have considered going back for a master's. While nice to have, a master's degree may not help to ward off obsolescence or foster promotion. And some of the things you study in a master's program may already be familiar to you from your bachelor's courses. In most cases, you would do better spending your time and money on other forms of more specific continuing education.

There are a number of schools that offer college degree programs through extension work or home study. They evaluate your previous education and experience, regardless of the source, and award you college credit for it. Other institutions test you on various subjects and give you appropriate credit if you pass. Many programs will transfer credit from home-study courses, seminars, military training, or employer courses. And you can actually obtain a college degree by completing certain home-study courses or written projects. The quality of such programs varies widely so you should investigate each school carefully before initiating a program. But your own motivation plays the major role in any success. Some of the schools that offer nontraditional programs are listed in Table IV. A good reference book and counseling service on this subject is offered by Dr. John Bear, Drawer H, Littleriver, CA 95456.

There are two specific programs that enable you to get credit without going to college. The first is sponsored by the American Council on Education (One DuPont Circle, Washington, DC 20036). ACE evaluates many kinds of noncollegiate courses—both resident and home-study—from sources such as industry, the military, and home-study schools. If the courses are college level and of sufficient depth and value, ACE will approve them and assign an appropriate amount of college credit. Such approved courses are then listed, in a quarterly directory. If you take or have taken any of the courses listed, you may receive college credit for them. Most colleges and universities are members of ACE and will consider giving credit for ACE-approved programs. But the ACE course must be the equivalent of a similar course at the college before credit is given. The decision is strictly up to the school and each case is considered individually.

Another college credit program is CLEP (College Level Examination Program). This is a testing program designed to help individuals get college credit for knowledge they have accumulated. To get college credit you sign up with CLEP for an appropriate exam, and if you pass, CLEP notifies the college or university of your choice. Most colleges and universities participate in the CLEP program and will automatically grant you college credit if you pass the exam. For more information, write to it directly at CLEP, Box 2815, Princeton, NJ 08540.

Accreditation. This is the process by which an independent agency investigates and evaluates the merit of a school and the quality of its programs. Accreditation indicates that the school meets certain minimum standards of quality and effectiveness. Basically, it is a guarantee that the institution is legitimate and that its courses will be of value to you. For the most part, continuing education programs are not accredited because they are offered from such a wide variety of sources. Usually, only schools are accredited. Organizations such as magazine and book publishers, seminar firms and manufacturers cannot be accredited. Therefore, when considering them, you must go by their reputation and the recommendations of others.

Home-study schools as well as colleges and universities do receive accreditation. They are accredited by the National Home Study Council to which you can write at 1601 18th Street N.W., Washington, DC 20009, for a list of accredited schools. The NUCEA mentioned earlier also accredits college home-study programs. The Accrediting Board for Engineering and Technology (ABET, formerly the Engineer's Council for Professional Development), an organization that accredits engineering and technology degree programs, is considering the accreditation of continuing education programs for engineers and technicians.

Recently, a new organization known as the Council for Non-Collegiate Continuing Education was formed in an attempt to approve and accredit all continuing education programs from nontraditional sources. Information and a list of its accredited organizations can be obtained by writing to it at 6 North Sixth St., Richmond, VA 23219.

The Continuing Education Unit (CEU). The CEU is a unit of measurement used by companies, institutions, and professional associations in recognizing the completion of some form of noncredit adult continuing education. One CEU is defined as ten contact hours in some kind of formal education activity. Many organizations award CEUs for self-study courses, resident seminars and other various forms of continuing education.

It is important to note that continuing education units are not college credit. The two are not related. CEUs are simply a means of recognizing, accumulating, and recording your participation in continuing education programs. For more information on the CEU, write to the Council for the Continuing Education Unit, 13000 Old Columbia Pike, Silver Spring, MD 20904.

Financing. Most individuals pay for continuing education themselves. But, there are a number of sources that will finance continuing education.

Your employer is the first source you should consider. In many cases, a company will pay for books, magazines, self-instruction materials, and resident seminars. Often, all you have to do is convince your employer that you need a particular course, that it is job related, and that it will benefit both of you. In addition, most employers offer some kind of tuition reimbursement plan for people working on a college degree or engaging in other forms of job-related education. In such plans, you pay for your college tuition and books, and upon completing and passing the course, the

learn more

company will reimburse you from 50% to 100%. Check with your supervisor or personnel department for information.

The Veterans Administration continues to provide educational benefits for those who served in the armed forces. The VA pays up to 90% of the tuition for regular college degree programs and many home-study courses. Check with the institutions in question to verify the applicability of VA funding.

One recent study shows that over $17 billion a year in educational funds is available from industry and government—most of it going unclaimed. And did you know that you can get a tax deduction for some kinds of continuing education? If you pay for this education yourself and it is used primarily to maintain your present job competence and skills, you may deduct the cost of such education and related expenses from your income tax. But continuing education that prepares you for an advancement or a new job is *not* eligible for the deduction. In any case, it is wise to check with the IRS.

What to Study. It is difficult to pinpoint which subjects you'll need, but we can make some suggestions that may be helpful. Today there is a revolution in the microprocessor and microcomputer fields, and sooner or later you can expect to encounter one of these versatile devices. For this reason, anything you learn about microprocessors, microcomputers and related topics will ultimately be helpful. Computer programming is another vital area. Programming in BASIC, FORTRAN or assembly language is a useful skill.

Keeping up-to-date on the latest components and circuits is also important. It is wise to keep your eye on new integrated circuit developments and applications. Some examples are op amps, active filters, phase-locked loops, dynamic and bubble memories, opto electronics, data conversion components such as A/D and D/A converters, and data communications devices like CODECS, modems and protocol controllers. Component advances such as CMOS, VMOS, VLSI and solid-state relays are important, as are developing technologies such as lasers, video discs, and fiber optics.

As an electronic engineer or technician you will probably find the technical courses of most value. But many non-electronics subjects are useful, too. For example, if you plan to move into management, you'll need to learn supervisory and management techniques, and people-handling skills. All of these can be helpful in broadening your professional skills and job opportunities. ◇

Popular Electronics Tests

THE Simpson 260 Model 7 Volt-Ohm-Milliammeter is an analog test instrument whose basic design has not changed in many years, but whose electrical and mechanical details have certainly been improved. The Model 7M is identical to the Model 7, except that a mirror has been added to the scale plate to eliminate parallax reading errors.

Old-timers will remember the Model 260 Series 1 through 6 that were the measurement instrument "workhorses" from the late thirties until the late seventies, when digital instruments were introduced. Yet, despite the popularity of digital instruments, the analog meter is still alive and the Model 7 proves it.

The Model 7, along with its companion instruments, fully meets the specifications of UL 1244 Safety Standard for Electrical and Electronic Measuring and Testing Equipment. (This standard spells out the physical construction and test performance requirements for protection from the likelihood of electrical shock, fire, and personal injury, and runs the gamut from internal circuit or

component failure to pc board damage and quality of the carrying handle. Copies of UL 1244 are available from the Underwriters Laboratories, Inc.)

The most obvious mechanical change in the 260 Model 7 is the use of recessed front-panel test-lead connectors, and the safety tips on the test leads to completely eliminate any chance of shock hazard to the user. A TRANSIT position on the polarity selector switch protects the meter from damage during transportation. The other change is the relocation of the fuse into the easy-to-open rear battery compartment.

The high-impact phenolic case is 5½" W × 7" H × 3⅛" D, and has heavy reinforced walls for maximum durability and circuit protection. The instrument weighs three pounds. Optional accessories include a temperature probe; 5-, 10-, and 40-kV probes; 5- and 10-kV ac probes; a low-power ohms probe; a series of test leads with various tips; a line splitter; and a series of carrying cases, including one with test-lead storage space. Suggested retail price for the basic Model 7 is $103. With all options taken, the price is $168.

General Description. The Series 7 is provided with eight deeply recessed test-lead connectors—COMMON (−), + OUTPUT, 1000V AC/DC, +10A, +50μA/250MV, +1V, AND −10A. There are three operating controls. One selects from AC, −DC, +DC, and OFF, which also provides the TRANSIT position. The second is a 12-position rotary selector switch which permits selection between 500V/1000V, 250V, 50V/μA, 10V, 2.5V/1V, 500MA, 100MA, 10MA/AMPS, 1MA, RX1, RX100, and RX10,000. The last control is the ZERO OHMS meter adjustment. The meter is provided with its own zero adjust screwdriver control. The taut-band meter is 4½" wide and contains five color-coded 4.2" scales. Meter protection is provided by a varistor circuit.

Each color-coded, 48" test lead has molded one-piece "elbows" for connection to the meter input terminals, and slip-proof barriers at the test probe end. Each test probe is threaded to accept screw-on, fully insulated, and color-coded alligator clips. Rubber bumpers on the underside of the meter eliminate sliding on the work surface, while the Adjust-A-View carrying handle doubles as a tilt stand.

The manufacturers specifications are shown in the Table.

Comments. The Model 260 Series 7 was checked by the Lockheed Electronics Instrumentation Measurement Laboratory (Plainfield, NJ) against standards traceable to the National Bureau

MANUFACTURERS SPECIFICATIONS

DC Volts
Ranges: 250 mV, 1, 2.5, 10, 50, 250, 500, 1000 volts
Accuracy: ±2% full scale
Sensitivity: 20,000 ohms/volt

AC Volts
Ranges: 2.5, 10, 50, 250, 500, 1000 volts
Accuracy: ±3% full scale
Sensitivity: 5000 ohms/volt
Freq. Response (3 dB): 2.5 / 10 volts = 100 kHz
50 volts = 60 kHz
250 volts = 20 kHz
500 volts = 6.5 kHz

Output
0.1-μF capacitor in series with all ac voltages through 250 volts. Limited to 350 volts dc.

DC Current
Ranges: 50 μA, 1, 10, 100, 500-mA, 10 amperes
Accuracy: 50 μA = ±1.5% full scale; 1 mA to 10A = ± 2% full scale
Voltage Drop: less than 500 mV (10-A range not fused)

AC Current:
Up to 250 A with optional Amp-Clamp Model 150

Resistance

	Rx1 (2 kΩ)	Rx100 (200 kΩ)	Rx10,000 (20 MΩ)
Ranges:			
Center:	12 Ω	1.2 kΩ	120 kΩ
Voltage:	1.5 V	1.5 V	9 V
Short Circuit Current:	125 mA	1.25 mA	75 μA
Accuracy:	±2.5° arc	±2° arc	±2° arc

Meter Scale
4.2 inches

Decibels
Range: −20 to +50 dB
Reference: 0 dB = 1 mW across 600 ohms

Size:
5½″ × 7″ × 3⅛″, weight 3 lb

Accessories
Furnished: 4′ test lead set with tip/alligator clip, batteries, fuses, manual
Optional: Deluxe case, vinyl case, drop front hard case, 5-10-kV ac probes, 5-10-40-kV dc probes, low power ohms probe, Amp-Clamp, line splitter.

of Standards. After the tests, the IML issued a certificate testifying that the Model 260 Series 7 met or exceeded the manufacturer's published specifications in all respects.

Having used a Model 260 for many years, we found the Series 7 to be an old friend. Like its well-known predecessors, it has the appearance of a rugged, long-lived instrument. Unlike them and some "modern" digital instruments, however, the Series 7 is safe with high voltages.

In actual use, the instrument performed very well. Its analog nature makes it excellent for tuning variable circuits, since trends can be rapidly spotted and pinpointed when aligning for dips or peaks. (This is somewhat hard to do with digital instruments.) The ranges are more than sufficient for just about every bench and field use.

One special value of the Model 260 came to light in the field when the battery in our portable DMM went down. True to Murphy's Law, we did not have a spare, and the local shops were closed. By luck, we had the Model 260 in the car. Realizing that it had no electronic elements, and even if its battery went down, all we would lose was the resistance function, we grabbed the "old-fashioned" analog meter and completed the job.

Despite the presence of several digital multimeters on our bench, the Model 260 saw a lot of service—at first out of curiosity, and then because it easily held its own. Reading the meter requires careful attention to the five color-coded scales, but you soon get used to it. This is one portable multimeter than can outlive the user, when given reasonable care.—*Les Solomon*

CIRCLE NO. 104 ON FREE INFORMATION CARD

BY RANDY CARLSTROM

DESIGNING WITH THE 8080 MICROPROCESSOR

Part 2: The CPU Module

A practical system and how to connect it to the outside world

IN Part 1 of this series, we discussed the basic features of a central processing system, using the 8080 as an example. Included were descriptions of how such features as the memory, input/output devices, and programming work. Now we will examine how to design a CPU module based on the 8080. The schematic of such a module is shown in Figs. 5 through 7.

In the design of this module, one of the objectives was to keep it as simple as possible while retaining versatility in interfacing and expansion. The module incorporates 1K bytes (1024) of RAM and 2K bytes of EPROM (erasable programmable read only memory) which should be ample memory for most control applications.

Most of the signals found in the CPU module are available at the Bus Interface of Fig. 7. The others, denoted by an asterisk, are for interfacing the CPU module to a Program Development board that is to be presented in Part 3 of the series. These signals will otherwise normally be of no concern and should be left open-circuited.

Circuit Description. The 8080 microprocessor, (*IC1* of Fig. 5) initiates and directs all operations between itself, the memory, and the I/O units. Crystal-controlled clock generator *IC3* provides two nonoverlapping clock phases ($\phi 1$ and $\phi 2$) derived from the 18-MHz crystal. The clock also generates a status strobe, $\overline{\text{STSTB}}$, at pin 7 for use in *IC2* to provide the control bus signals. Other functions of *IC3* include providing a synchronized RESET signal (pin 1) to *IC1* in response to an external asynchronous $\overline{\text{RESIN}}$ signal (pin 2) and a synchronized READY signal (pin 4) in response to an external RDYIN signal (pin 3). The network consisting of *R1* and *C1* provides a power-on-reset to *IC1* through *IC3* when the module is powered up. Program execution begins immediately at memory location zero after power-up (unless the RDYIN input is low, in which case the CPU remains idle after reset until it is brought high). The RUN status of the CPU is indicated by *LED1*. Besides generating the control bus signals, *IC2* buffers the bidirectional data bus. The need for a separate negative power supply is obviated by *IC4*, which generates −5 V from the +5-V supply.

The microprocessor operating program is stored in EPROM *IC5* of Fig. 6. Pin 8 of *IC10A* is low for all addresses between hexadecimal 0000 and 07FF, which "turns on" *IC5*. This corresponds to 2048 unique memory locations, which is exactly the number of bytes of memory in *IC5*. The eight outputs (constituting one byte) of *IC5* are logically connected to the data bus when the output enable, $\overline{\text{OE}}$, on pin 20 is driven low by the control bus signal $\overline{\text{MEMR}}$ from pin 24 of *IC2*. When asserted, this signal is the CPU's way of notifying the system that it is ready to accept a byte of information from memory. Inputs A0 through A10 of *IC5* determine which of the 2048 internal bytes will be presented at its outputs (when enabled).

System RAM is formed by *IC7* and *IC8* (Fig. 6) and its operation is similar to that of EPROM *IC5*. The RAM does not normally contain the CPU's program since, unlike an EPROM, it is volatile in nature. That is, the RAM powers up into a random logic state, which is of no value to the CPU. However, the RAM may be used as a temporary data "scratchpad" since CPU data may be readily stored in it and retrieved later. The Stack area for the CPU will exist somewhere in the RAM.

Pin 11 of *IC10C* is low for all memory read and write operations between addresses 0800 and 0BFF (1024 unique locations), which "turns on" the RAM, containing 1024 bytes of memory. The difference in operation between the EPROM and the RAM is in the write-enable, $\overline{\text{WE}}$, input at pins 10 of *IC7* and

IC8. The state of this input determines the mode of operation of the RAM (read or write) when it is being accessed by the CPU (that is, when pin 11 of *IC10C* is low). When the write-enable input is high, the I/O lines of *IC7* and *IC8* are in the output mode and operation is similar to that of the EPROM. When low, the I/O lines are in the input mode and data on the data bus is stored in the addressed memory location. Note that the control bus signal $\overline{\text{MEMW}}$ at pin 26 of *IC2* drives the write-enable input of *IC7* and *IC8*. (The assertion of $\overline{\text{MEMW}}$ tells the memory that the CPU is attempting to write data into it, from the data bus). Inputs A0 through A9 determine which of the 1024 internal memory bytes will be read from or written into. The high-order bits of the address bus, which control the selection of *IC5*, *IC7*, and *IC8*, are decoded by *IC9* and *IC10*.

Ins and Outs of the CPU Module. Now that we have the basic CPU module, how do we enable it to communicate with the outside world? Suppose we want to monitor temperatures from sensors installed in various rooms of a house. How would we go about connecting the temperature sensors to the CPU? Or, suppose we want an alarm to sound if a forced entry is detected in the house. How is the alarm told to sound when the system detects an intruder? These are examples of the type of problem we'll be investigating—how to interface a digital computer to an analog world. We will approach it in a generalized manner so that a neophyte can design interfaces for his applications.

Once we learn how to interface external devices to the CPU module and how to program the module, applications will be limited only by the experimenter's imagination. For instance, once we have temperature sensors interfaced to the module it is a simple matter to program it to detect if the temperature is rising or falling (and how fast), to sound an alarm (or take other appropriate action) if a temperature limit has been exceeded, to record maximum and minimum temperatures with their corresponding dates and times, etc. The CPU module could easily handle this task and at the same time act as watch dog over the premises. Want to play a game with the system or have it wake you up in the morning while it's finishing brewing a fresh pot of hot coffee? It's simply a matter of connecting the appropriate peripherals (coffee pot and alarm) and their interfaces to the CPU module and plugging an EPROM with an appropriate program into the module.

To complete the hardware, let's look at how we would go about designing a parallel output interface. In the following discussion, remember $\overline{\text{I/O W}}$ means that the CPU is "outputting" a data byte. However, this data byte is present on the data bus for only about one microsecond, too short a time for humans to even notice. One could bring the RDYIN line low during the output instruction's execution, which would prolong the time the output data byte was available. Since the CPU is stalled as long as RDYIN is held low, this would tend to make the CPU very inefficient. A better method would be to somehow "snatch" the byte from the data bus and store it externally for as long as we please, while allowing the CPU to hum along at full speed. Figure 8 shows how this can be implemented.

Since the 8080 is capable of handling 256 output ports, the interface must have some means of determining if it is the one to receive the data byte. The Output Port Select in Fig. 8 accomplishes this by giving a true output for one unique address out of the 256 possible I/O port addresses. This circuit may consist of an 8-input NAND gate, an 8-bit comparator, or a decoder (1-of-8 or 1-of-16) chip as shown in Fig. 9. The selection device used is connected to

PARTS LIST

C1,C2,C3—10-μF, 10-V tantalum capacitor
C4,C5—2.2-μF, 15-V tantalum capacitor
D1—Germanium diode (1N270 or similar)
IC1—8080A microprocessor
IC2—8228 system controller
IC3—8224 clock generator and driver
IC4—ICL7660 voltage inverter
IC5—2716 EPROM
IC6—74LS368 hex inverting tri-state bus driver
IC7,IC8—2114L 1024x4 RAM
IC9—74LS33 quad 2-input NOR buffer
IC10—74LS00 quad 2-input NAND
IC11,IC12—74LS244 noninverting tri-state buffer
LED1—Red light emitting diode
P1,P2,P3—16-pin DIP socket
Q1—2N2907 or 2N3906 transistor
R1—10-kΩ, 1/4-W 10% resistor
R2—330-Ω, 1/4-W, 10% resistor
R3—20-kΩ, 1/4-W, 10% resistor
R4,R5,R6,R11—3.3-Ω, 1/4-W, 10% resistor
R7—1-kΩ, 1/4-W, 10% resistor
R8,R9,R10—39-kΩ, 1/4-W, 10% resistor
XTAL—18.000-MHz quartz crystal (Cystek CY19A or similar)
Misc.—Sockets for ICs (must be provided for IC5), perf or pc board, 0.01-μF disc ceramic bypass capacitors distributed near ICs, +5-V, 500-mA and 12-V, 60-mA power supplies, wire-wrap wire or solder, etc.

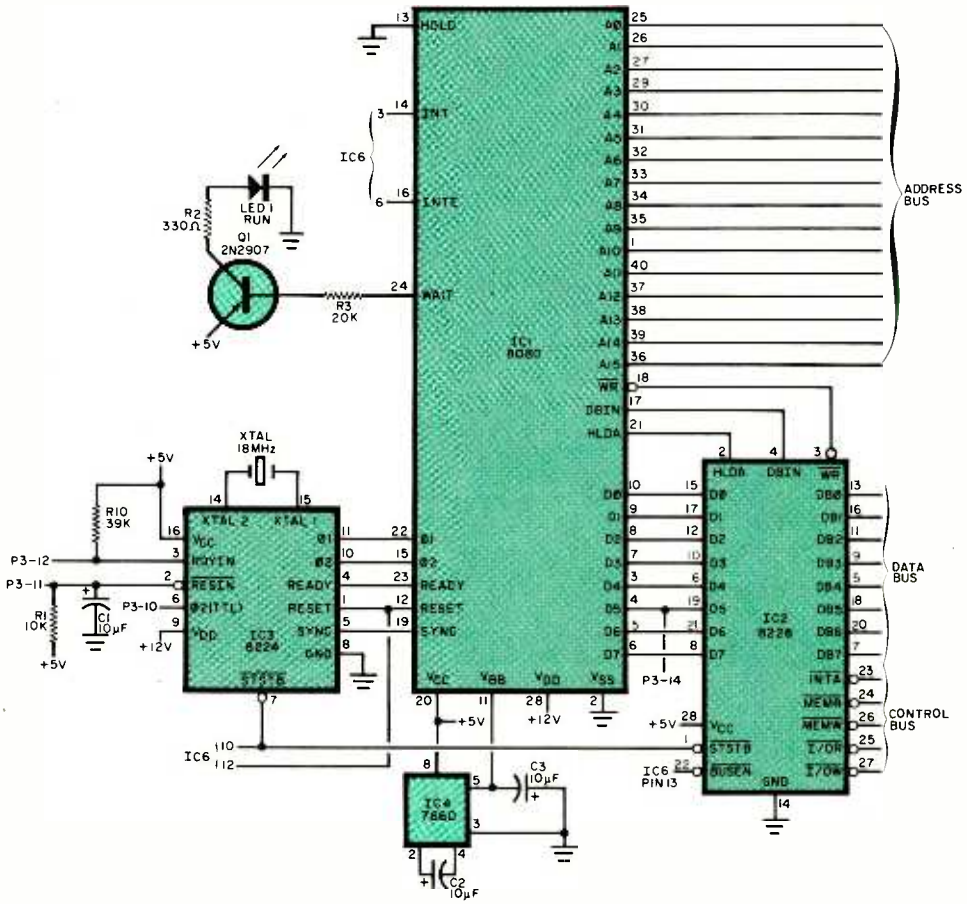


Fig. 5. Schematic of the microprocessor, clock generator (IC3) and control signal generator (IC2).

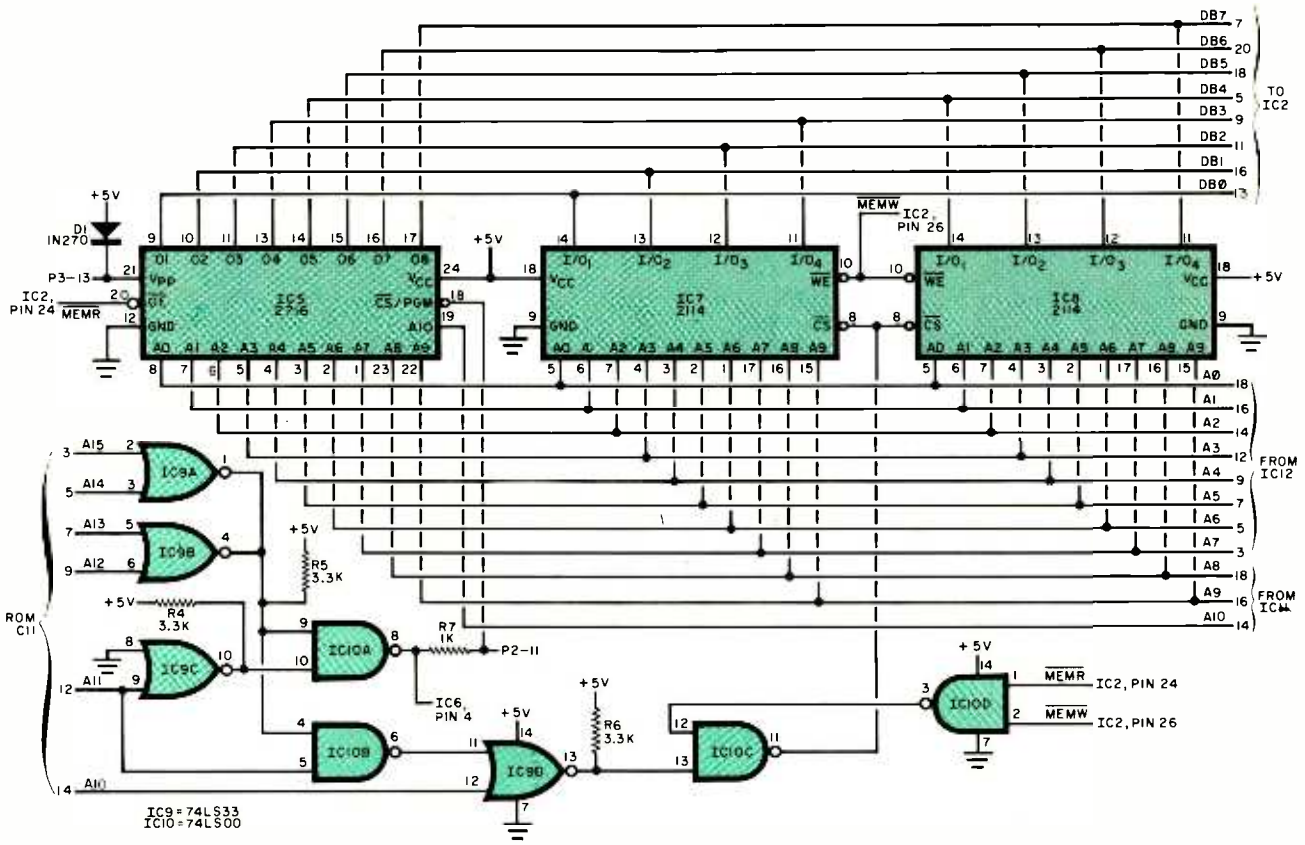


Fig. 6. Memory circuits contain the EPROM (IC5) and RAM composed of IC7 and IC8. Control logic is in IC9 and IC10.

either the high- or low-order byte of the address bus (both of which carry the I/O port address). We will use the high-order byte in the examples.

In Fig. 9A, the NAND gate approach, inverters can be used to create the desired port address. Here the port address is E8. The 1-of-8 decoder approach is shown in Fig. 8B. This method is particularly attractive when more than one output port is needed. A 1-of-16 decoder can be used when working with more address lines. The comparator approach, Fig. 8C, uses exclusive-NOR gates whose output goes high only when the same logic signal is applied to both inputs. By using open-collector gates as shown here, the outputs may be hard-wired together (wire ANDed) so as to produce a high output only when all the gate outputs are high. Using jumpers, port addresses are easily changed.

We now know how to determine *who* the CPU is communicating with, but now how do we actually "store" the output data byte? It just so happens (by no coincidence) that $\overline{I/O\ W}$ goes true (low) shortly after the output data has had time to stabilize on the data bus, and goes false (high) just before the data byte disappears. This translates to a low-going pulse on the order of half a microsecond in length, which is suitable for most digital IC's. By using this pulse to clock a latch (a temporary storage register), we will have succeeded in snatching and storing this data byte.

The AND gate in Fig. 8 tells the output latch to latch the contents of the data bus (which contains the data byte) at the proper time *only* when the CPU is making reference (outputting) to that particular latch (output port number). The eight outputs of the latch hold the data byte, which may be used for driving LED's, a printer, or turning on the coffee pot. One of the outputs may be connected to a relay or SCR to turn on the coffee pot, another output may drive an alarm, while yet another may turn on an air conditioner (via a relay, or SCR of course). It is evident from these examples that one output port can control a variety of peripherals by selectively setting and clearing the appropriate control bits at the latch output. This is easily done in the computer's program, which will be discussed in Part 3.

A parallel input interface is almost identical to a parallel output interface. The only difference is the direction of flow on the data bus. During the execution of an "input" instruction a "window" of only about half a microsecond exists in which input data can be placed on the data bus. This cannot be done at any other time or conflict may occur, resulting in a system "crash."

It is therefore essential that the input data be gated onto the data bus at the proper time. Fortunately, this strict timing requirement can be easily satisfied by use of the CPU generated $\overline{I/O\ R}$ signal. As the CPU executes an input instruction, it generates $\overline{I/O\ R}$ to inform external logic that input data can be placed on the data bus. This signal is usually AND'ed with an "Input Port Select" signal which is then connected to the enable input of three-state buffers as shown in Fig. 10. Note the similarity to the parallel output interface (Fig. 8). During the final execution phase of an input instruction (when $\overline{I/O\ R}$ is active), the input data is "latched" inside the CPU (transferred to the accumulator); therefore an external latch is not required as in the output interface.

In the I/O port decoder examples of Fig. 9 , the address bus (A8-A15) in itself does not tell us whether we are referencing a memory location, an input port, or an output port. Consequently , the Port Select signal will be true whenever the high-order byte of the address bus contains E8 (E8 through EF in Fig. 9B), regardless of the type of reference being made. This "ambiguity" may be put to advantage because it then makes it possible to use an Output Port Select signal also as an Input Port Select signal. In other words, the Port Selects for

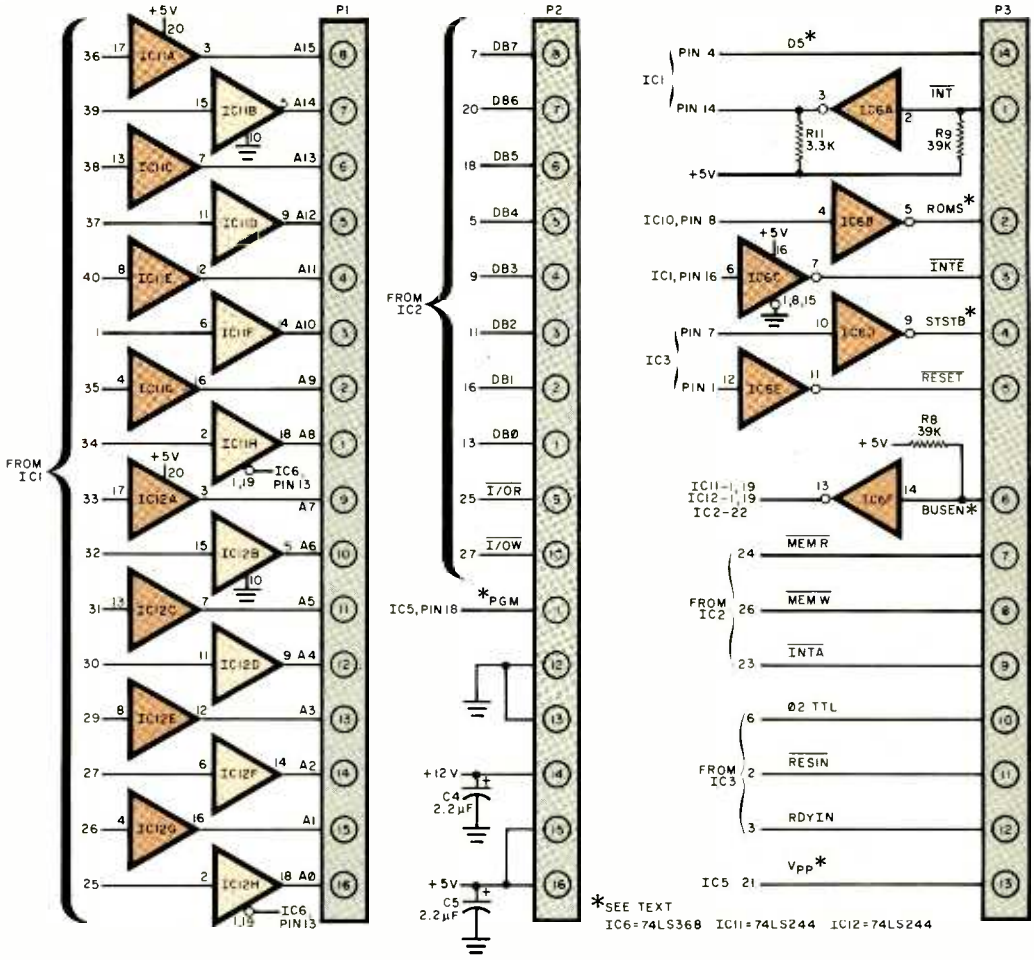


Fig. 7. Bus Interface for the CPU module shows connections to the outside world. Signals marked with an asterisk are for interfacing the CPU module to a Program Development-Debugging board to be described in Part 3.

Fig. 8 and Fig. 10 may share the same Port Select circuit. (The control bus resolves this ambiguity by specifying the type of reference the address bus is making.) If the input and output port numbers are not equal, then two separate Port Select circuits will be required. The conrol bus signals $\overline{I/O\,R}$ and $\overline{I/O\,W}$ differentiate the input and output operations, as may be observed by comparing Figs. 8 and 10.

Figure 11A shows an output latch. The CPU data bus is connected to an octal latch which is clocked by the coincidence of Port Select and I/O Write signals. The latch outputs can be used to drive relays, LEDs, a printer, D/A converter, etc. The latch is cleared when the CPU is reset. In the typical parallel input interface circuit shown in Fig. 11B, data is buffered via the three-state

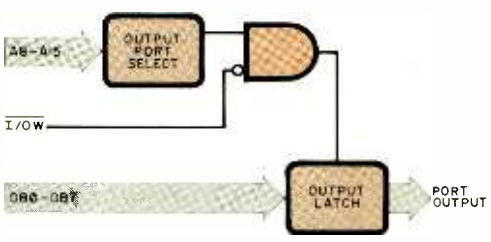


Fig. 8. Parallel output interface block diagram.

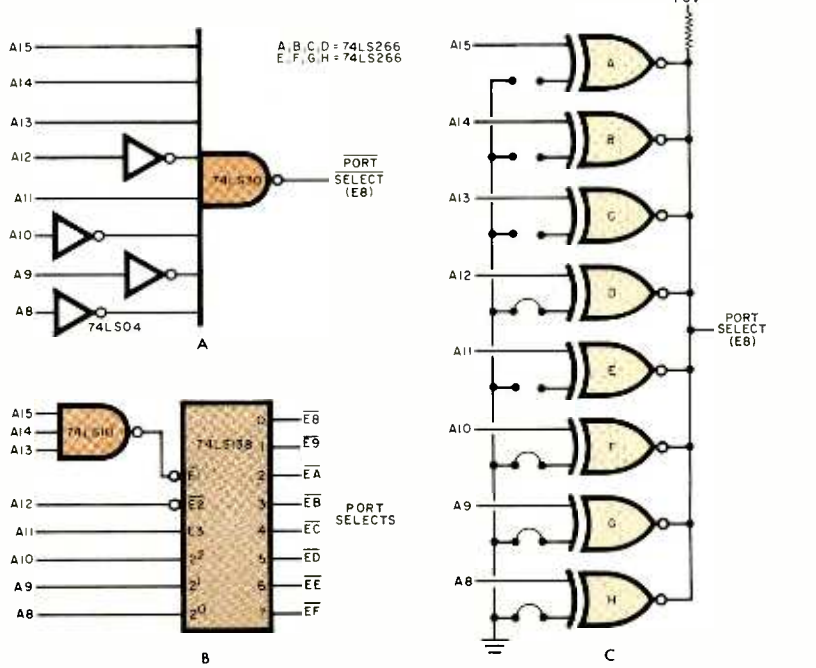


Fig. 9. Three ways to generate the port select signal: (A) with a NAND gate; (B) with a 1-of-8 decoder; and (C) with a comparator.

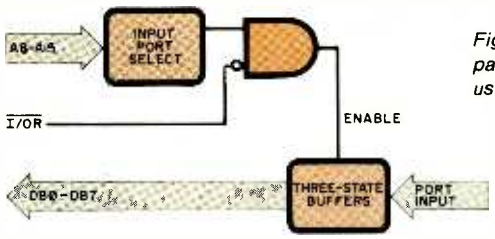


Fig. 10. Block diagram of parallel input interface using three-state buffers.

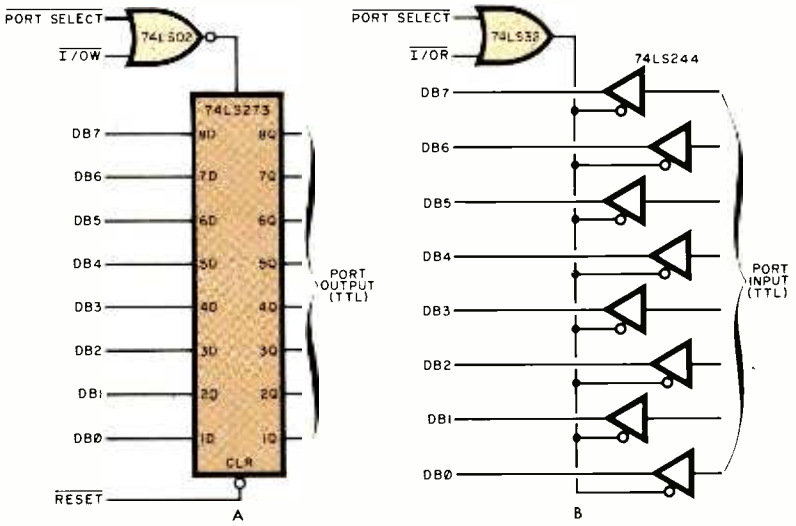


Fig. 11. At (A) is an output latch: (B) is a parallel input interface circuit.

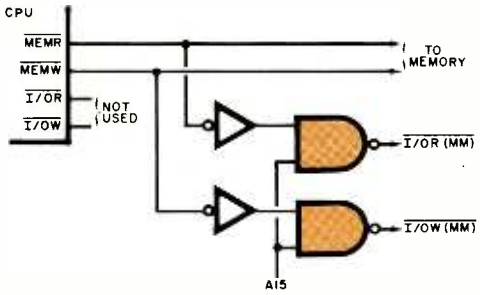


Fig. 12. Circuit for implementing memory-mapped input/output.

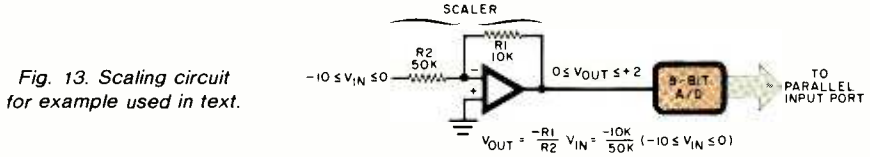


Fig. 13. Scaling circuit for example used in text.

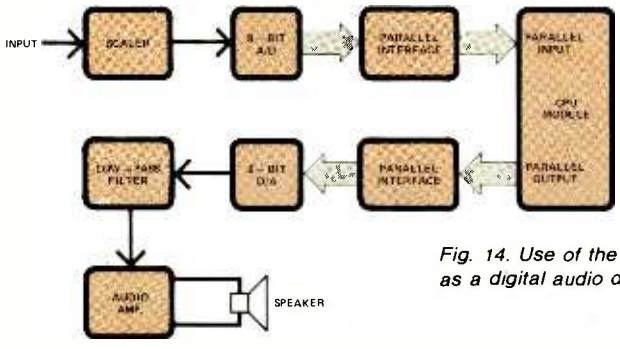


Fig. 14. Use of the CPU module as a digital audio delay line.

device to allow the data to be gated onto the data bus at the proper time. The Port Select signal can be derived from any of the previously discussed Port Select circuits. The input and output interfaces can share the same Port Select circuit if their port numbers are equal.

Note the similarity between $\overline{\text{MEMR}}$ and $\overline{\text{I/O R}}$ and also $\overline{\text{MEMW}}$ and $\overline{\text{I/O W}}$. In fact, the only reason the CPU generates $\overline{\text{I/O R}}$ and $\overline{\text{I/O W}}$ for input and output is to islolate memory from the I/O ports (by using the 8080 input and output instructions). Since the I/O structure may be viewed as an array of 256 single-byte memory locations (and therefore read and written), there is really no reason why $\overline{\text{MEMR}}$ and $\overline{\text{MEMW}}$ cannot also be used for I/O. An I/O of this type is called *memory-mapped I/O* (as compared to *isolated I/O* where the input and output instructions are exclusively used for input and output). If the full 8080 address space (64K bytes) is not used by memory, then memory-mapped I/O can be implementd.

Let's assume, for example, that we will never use any memory locations above hexadecimal address 7FFF. If we gate address bus bit A15 (which goes high for all address locations above 7FFF) with the $\overline{\text{MEMR}}$ and $\overline{\text{MEMW}}$ signals (Fig. 12), we may address up to 32,768 (2^{15}) input and 32,768 output devices! These new I/O control signals—$\overline{\text{I/O R (MM)}}$ (mm=memory mapped) and $\overline{\text{I/O W (MM)}}$—connect in exactly the same manner as the isolated control signals $\overline{\text{I/O R}}$ and $\overline{\text{I/O W}}$. The address bus now activates *memory* if A15 is a logic 0 and activates *I/O* if A15 is a logic 1. The I/O devices are still considered addressed ports, but instead of the accumulator being the only transfer medium, any of the 8080 registers can be used. All of the 8080 instructions that operate on memory locations can also be used in memory-mapped I/O. So by allocating an area of memory address space as I/O, we can create many new I/O "instructions" in the 8080 instruction set.

Some Applications. Note that data to be input in Fig. 11B must be in digital form. However, very few things in our world are digital in nature; they usually appear in analog form (voltages, currents, temperatures, sound waves, etc.). It is therefore inevitable that more circuitry will be required to complete the input interface. Before we discuss some typical examples, let's introduce the key element to be used—the analog-to-digital (A/D) converter.

The A/D converter is a versatile device widely used in computer applications. Its function is just what its name implies: to convert an analog (real-world) signal into digital form. A typical 8-bit A/D might accept an analog input voltage between 0 and +2 volts and represent this voltage by an 8-bit number at its output. In this case, an input voltage of +2 V would be represented by 255 (hexadecimal FF) at the output, 0 V by 0, +1 V by 127 (hexadecimal 7F), etc. The process of converting an analog signal to a digital number is called *quanti-*

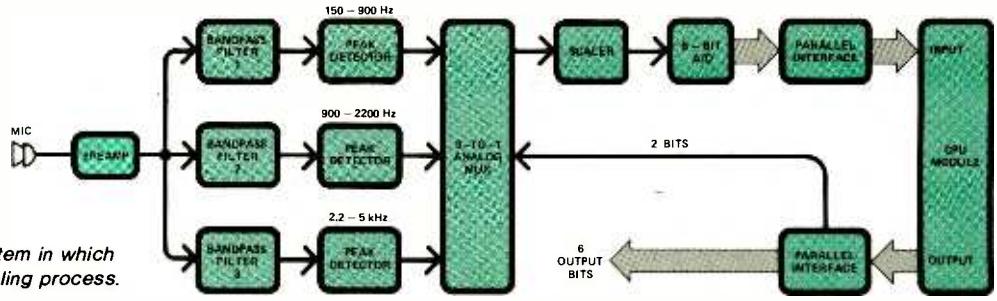


Fig. 15. A speech recognition system in which A/D conversion is used in a sampling process.

zation, and a variety of devices is available to perform this operation.

Since a typical A/D converter generally operates only over a small range of input voltages, what if we want to quantize a signal that varies from −10 V to 0 V, and the A/D can only convert voltages in the range of 0 to +2 volts? Figure 13 illustrates one possible solution. In this circuit, an input of −10 V will produce 255 (hex FF) at the A/D converter output. The process of conditioning an analog signal in order that it may be presented to an A/D in its operating range is called *scaling*. Note that if we built a variety of scaling circuits (to handle a wide range of input voltages) we would have the makings of a digital voltmeter. If we also converted currents and resistances into voltages within the range of the A/D, we might make our CPU function as a DMM, simply by connecting the A/D converter output to a parallel input port and writing a suitable program.

By connecting a digital-to-analog converter (D/A) to a parallel output port, we provide many more applications of the CPU module. For example, the module can be used as a digital audio delay line (Fig. 14) by "shifting" the quantized signal through the CPU's RAM. By varying the amount of delayed signal that is recombined with the original undelayed signal (either externally or in the CPU), and by varying the delay time, the CPU can create the effects of flanging, echo, phase shifting, compression (sustain), vibrato, harmonizing, etc. The delay time is easily controlled in the CPU's program by varying the rate at which the quantized music samples are shifted through the CPU's RAM. All of the signal characteristics—amplitude, frequency, and phase—can be easily manipulated once the quantized signal is in the CPU's memory. The real beauty of this approach is that all of the effects can be implemented with the same piece of hardware. Each special effect can be represented by a program routine in the CPU's EPROM memory, which is individually "called into action" via switches from an input port (or other means).

Another application of the A/D converter is in speech recognition. As shown in Fig. 15, bandpass filters are connected between a microphone and the A/D converter, a suitable speech-recognition program can be written to control various output devices (lights, locks, heaters, etc.) upon receipt of specific verbal commands. The peak detectors at the bandpass filter outputs have a sufficiently long time constant to act as "time-averagers." The dc voltage at the peak detector outputs are proportional to the amount of energy present in the speech waveform within the passband of the respective bandpass filters. By periodically sampling the peak detectors, the CPU can identify ("recognize") words and phrases in any language by way of comparison methods. The A/D converts the detector voltages into digital form for the CPU via an analog multiplexer. The output port of the CPU determines which peak detector is sampled. The six unused bits can be used to control external devices in response to verbal commands.

Let us look at one last way in which our CPU module can be put to use. Suppose we desire to build a digital thermometer using an A/D and the CPU module. How do we convert temperature to a suitable voltage? There are a wide variety of temperature transducers available, the price of which seems to be proportional to the precision desired. But by taking advantage of the CPU's ability to manipulate data, we may employ a very inexpensive device as the transducer.

A very basic temperature transducer circuit is shown in Fig. 16A. The transducing element is an inexpensive thermistor that is by no means the most accurate or linear temperature transducer. But, by taking a sufficient number of calibration points (the number depending upon the linearity of the thermistor used), a high degree of accuracy can be obtained. Figure 16B illustrates the ideal output voltage/temperature transfer curve, which is a straight line. A real physical thermistor however will produce a curve that may be very irregular in shape, instead of a straight line. If calibration points are taken at regular intervals along the thermistor's curve, that is, if output voltages are measured for various known temperatures, a "calibration correction table" can be created for the thermistor. Stored in the CPU's memory, this table can be used to measure other temperatures accurately by methods of approximation. As shown in Fig. 16C, consider point x between two calibration points a and b. The unknown temperature Tx may be approximated by $Tx = Ta + \Delta T$ where $\Delta T \approx m\Delta V$, with m being the slope of the line intersecting points a and b. Then $Tx \approx Ta + m\Delta V = Ta + [(Tb - Ta)/(Vb - Va)]\Delta V$. Assume calibration points have been taken every 0.1 V along the horizontal axis. Then $Vb - Va = 0.1$ V. Thus, $Tx = Ta + [10(Tb - Ta)](Vx - Va)$, where the parameters Ta, Tb, and Va were determined during the calibration process. With the above formula and calibration parameters in the CPU's memory, Tx can be calculated for any Vx from the transducer. Note that the more calibration points taken, the more accurate is the approximation.

We have now covered the important aspects of interfacing and some applications. Part 3 of this series will introduce us to programming the CPU module in its machine language. Also included will be the details of building and using the Program Development board. ◇

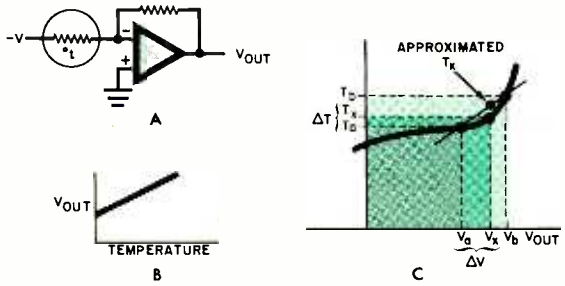


Fig. 16. A simple temperature transducer circuit (A); an ideal thermistor output characteristic (B); and how an actual curve is sampled to make a calibration curve to be stored in the CPU.

AN AUDIO LEVEL METER

BY JOSEPH M. GORIN

USEFUL IN:

- *tape recording*
- *checking broadcast modulation*
- *balancing channels*
- *monitoring power amplifiers*

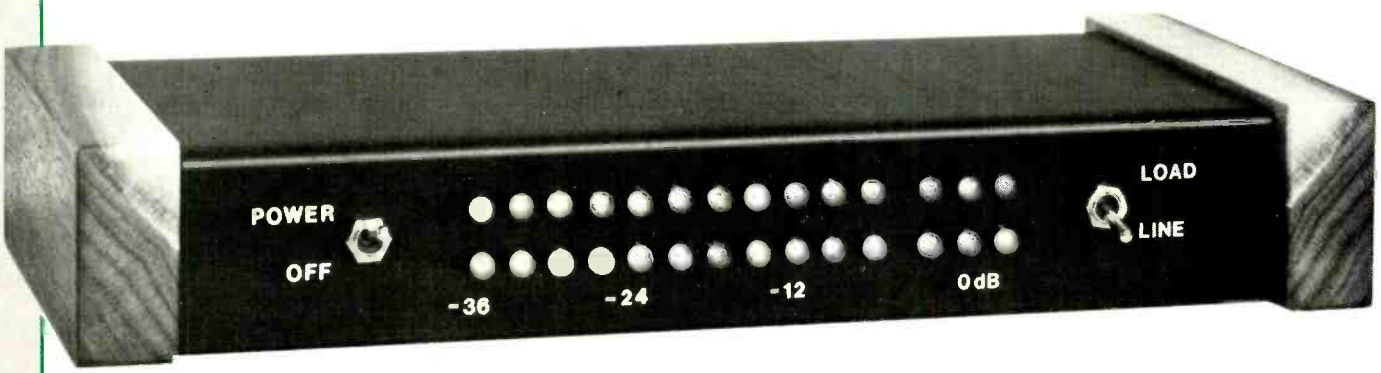
KNOWING the signal levels at which a piece of audio equipment is operating, is often necessary to avoid distortion. In tape recording, for example, the third-harmonic distortion increases quite rapidly above a certain threshold; and when tape saturation is reached, increasing input levels can cause decreasing output levels. At the same time, the recording should be made at as high a level as possible to keep the signal well above the inherent tape noise.

In power amplifiers, significant distortion is created when the output is driven beyond its maximum level. A process called "clipping" takes place, which flattens the top of the waveform. Although clipping usually is induced by low-frequency fundamental tones, the waveform contains appreciable high-frequency energy that is potentially dangerous to tweeters.

In either of these cases, a level meter would be of great help. Since the distortion is predominantly due to the largest signals encountered (because of the rapidly rising characteristic of the distortion VS level relationship), a peak-responding characteristic is desirable in a meter. Mechanical meters, due to the inertia of the pointer, do not respond rapidly enough to track peak levels, unless they have electronic circuits that hold the peaks. An unassisted mechanical meter is termed "average-responding" because its deflection shows the average of the absolute value of the signal. If all music had similar properties, this would be acceptable; but, in fact, the peak-to-average ratio can be anything from a few dB (as in compressed radio broadcasts) to around 20 dB in some live situations.

Once the peak is captured and held, we must decide how rapidly to let it decay. If decay is rapid, the advantages are having a lot of visual motion in the display, rapid feedback in level setting, and a good measure of how much the signal is above the noise floor at all times. If the decay is slow, we can look at it within a short time of hearing a high-level transient and still tell how close it was to maximum without having to keep our eyes glued to the meter. The meter described here can read out both short-term (rapid decay) and long-term (slow decay) peaks on the same display.

Having a dual-speed readout, the meter can also be used as a modulation analyzer for broadcast signals, especially FM multiplex. The long-term peak LED will remain constant on all stations that employ heavy limiting (which is most stations). If the long-term peak LED is *always* significantly lower on a given station than most of the other stations, that station is under-modulating. Looking at both channels simultaneously lets you see how well balanced they are. Observing the spacing between the long-term



and short-term peaks for different stations playing the same kind of music, and for records and tapes, lets you see the relative amount of compression being used by the stations.

Circuit Operation. Since both channels are the same, only the right channel is shown in the schematic in Fig. 1. Parts numbers for the left channel are the same but in the 100 series–that is, *R1* in the right channel becomes *R101* in the left channel.

Switch *S1* (common to both channels), selects either the speaker level signal (LOAD IN), attenuated by *R15* and *R17*, or the LINE IN signal, applied to *J1*. Resistor *R17* is selected in accordance with the Parts List. Resistor *R16* prevents undesired ground loops that can produce oscillation in some amplifiers. The *HI* side of the load input should be connected to the "hot" output of the amplifier being used, and the *LO* to ground.

In LINE operation, *IC1* amplifies the input signal level and provides a low driving impedance for the following peak detectors. The line input can be obtained from the Tape Record or Tape Out terminals of an amplifier. From *S1*, the input is fed to the fast peak detectors *IC2A* (negative) and *IC2B* (positive).

When a positive peak occurs, it is coupled via *R4* to *IC2B*. This causes the *IC2B* output (pin 4) to go high, turning on *Q1*, and rapidly charging *C3* until its voltage equals the input voltage to *IC2B*.

For negative peaks, *IC2A* operates *Q2* to charge *C3* until the output is the opposite of the applied input voltage (actually until $V_{out} = -V_{in} \times R8/R7$). When this signal is lower than recent peaks, *C3* is discharged through *R9*. Buffer *IC2D* has a gain of +1, a high input impedance to prevent loading of *C3*, and a low output impedance.

Op amp *IC2C* and its associated circuit forms a slow-release peak detector charging *C5*. On the positive peaks, (negative peaks have been made positive by the fast detector), *C5* is charged via *D5*, while resistor *R12* provides a slow discharge path.

Before we discuss the LED drivers as shown in Fig. 2, let us take a look at the power supply shown in Fig. 3. Transformer *T1* is a wall-socket mounted source that connects via POWER switch *S2* to the bridge rectifier formed by *D201* through *D204*. Using *C202* as a filter, this supply delivers about 9 volts. Diodes *D205*

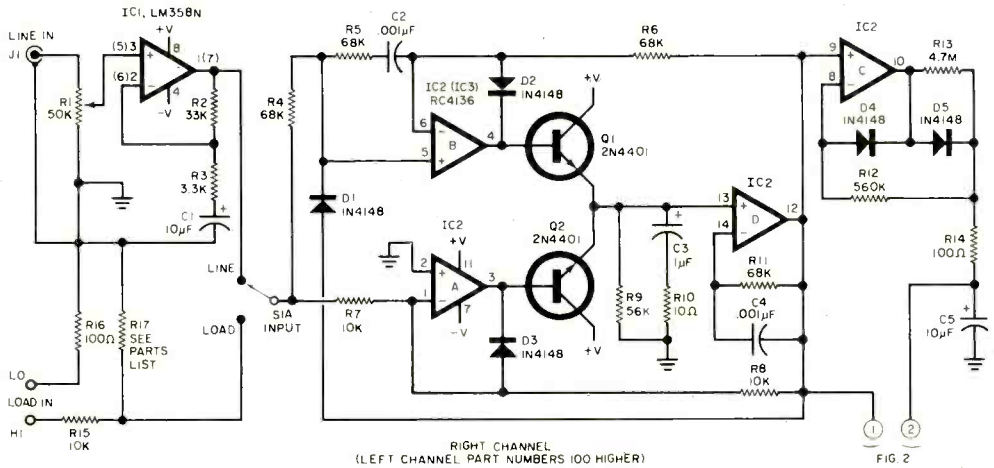


Fig. 1. Schematic diagram of one channel of the level meter.

PARTS LIST

C1, C101, C5, C105—10-µF, 25-V aluminum electrolytic
C2, C102, C4, C104, C205, C206, C207, C208—0.001-µF polyester film capacitor
C3, C103—1-µF, 16-V tantalum electrolytic
C201, C211—0.1-µF ceramic disc capacitor
C202, C203, C204,—220-µF, 16-V aluminum electrolytic
C209, C210—3.3-µF aluminum electrolytic
D1, D101, D2, D102, D3, D103, D4, D104, D5, D105, D209—1N4148 switching diode
D201 through D208—1N4001 rectifier
IC1—LM358N dual op amp
IC2, IC3—RC4136 quad op amp
IC4—CD4052 analog multiplexer
IC5, IC6—LM3915 LED bar-graph IC
J1,J101—phono jack
LED201 through LED228—Red T-1¾ light emitting diode (high efficiency)
Q1, Q101, Q2, Q102, Q201—2N4401 or 2N2222 npn transistor
R1, R101—50-kΩ potentiometer
R2, R102—33-kΩ, ¼-W, 5% resistor
R3, R103, R202—3.3-kΩ, ¼-W, 5% resistor
R4, R5, R6, R104, R105, R106, R11, R111, R201, R203, R204, R205,—68-kΩ, ¼-W, 5% resistor
R7, R107, R8, R108, R15, R115—10-kΩ, ⅛-W, 1% resistor
R9, R109—56-kΩ, ¼-W, 5% resistor
R10, R110—10-Ω, ¼-W, 5% resistor
R12, R112—560-kΩ, ¼-W, 5% resistor
R13, R113—4.7-MΩ, ¼-W, 5% resistor
R14, R114, R16, R116—100-Ω, ¼-W, 5% resistor
R17, R117—For 50 W at 8Ω, 1.27-kΩ, 1%; for 100 W at 8Ω, 845-Ω, 1%; for 200 W at 8Ω, 562-Ω, 1% resistor
R206, R207, R208—4.7-kΩ, ¼-W, 5% resistor
R209—120-Ω, ¼-W, 5% resistor
R210, R213, R214—560-Ω, ¼-W, 5% resistor
R211, R212—300-Ω, ¼-W, 5% resistor
S1, S2—Dpdt miniature toggle switch
S3, S4—Sp3t slide switch
T1—7.2-V, 200-mA wall-plug transformer (Dormeyer PS14206 or similar)
Misc.—Terminal blocks, mounting hardware, wire, solder, etc.

Note: Except for switches, ICs, and transformer, items in 1-100 series are for right channel, 100-200 are for left channel, 200-up are for both. **The following is available from Symmetric Sound Systems, 912 Knobcone Pl., Loveland, CO 80537: complete kit with cabinet with unfinished walnut end panels, Model #PLM-2, at $75.00. Also available from the same source; pc boards and all board-mounted parts, #PLM-2B, at $45.00; pc boards #PLM-2PC, at $10 (not available after 6/30/82). All prices include shipping on prepaid orders in U.S. Canadians, please add $5 shipping and handling (except PLM-2PC). Add $1.00, plus shipping, for charge-card orders. Colorado residents, add 3% sales tax.**

and *D206*, in conjunction with *C203* and *C204*, form a voltage doubler to generate the −8 V for the op amps.

On the ac power-line half cycles when the anode of *D208* is positive, this diode is forward-biased to power the left-channel LED bank formed by *LED215* through *LED228*. The right channel LEDs are off. On the other half cycle, the right-channel LED bank formed by *LED201* through *LED214* is powered via *D207*, while the left channel LEDs are off. During this half cycle, transistor *Q201* is turned on (via *R202*) producing a high-to-low transition at its collector. This 60-Hz pulse is applied to *IC4* as shown in Fig. 2. This switching action alternates the LEDs at a rate fast enough to make both banks appear to light up at the same time. This approach allows use of the same LED switching circuitry, saving components and money.

Since *IC5* and *IC6* have their associated LEDs switched at a 60-Hz rate, the inputs to these ICs should also be switched at 60 Hz. Dual-analog switch *IC4* is a two-pole, four-position electronic switch with the "rotors" at pins 3 and 13. The signal at pin 9 determines whether a slow or fast input is selected, while the input at pin 10 determines right or left LED selection. Since pin 10 is hardwired to the collector of *Q201* (switched at 60 Hz), the internal switches of *IC4* are operating at 60 Hz.

When *S3* (DISPLAY SPEED), is placed in the FAST position, pin 9 of *IC4* is high and selects only the "right fast" and "left fast" inputs. When S3 is at SLOW, pin 9 is placed low, and the slow inputs are selected. If *S3* is set to BOTH, the output signal at pin 13 drives the pin-9 input via the phase shifter composed of *R203* through *R205* and *C205* through *C207*. This causes the circuit to oscillate, therefore in this position of *S3*, the input to the LED drivers oscillates between fast and slow at a few kHz, while also oscillating between right and left at 60 Hz via pin 10.

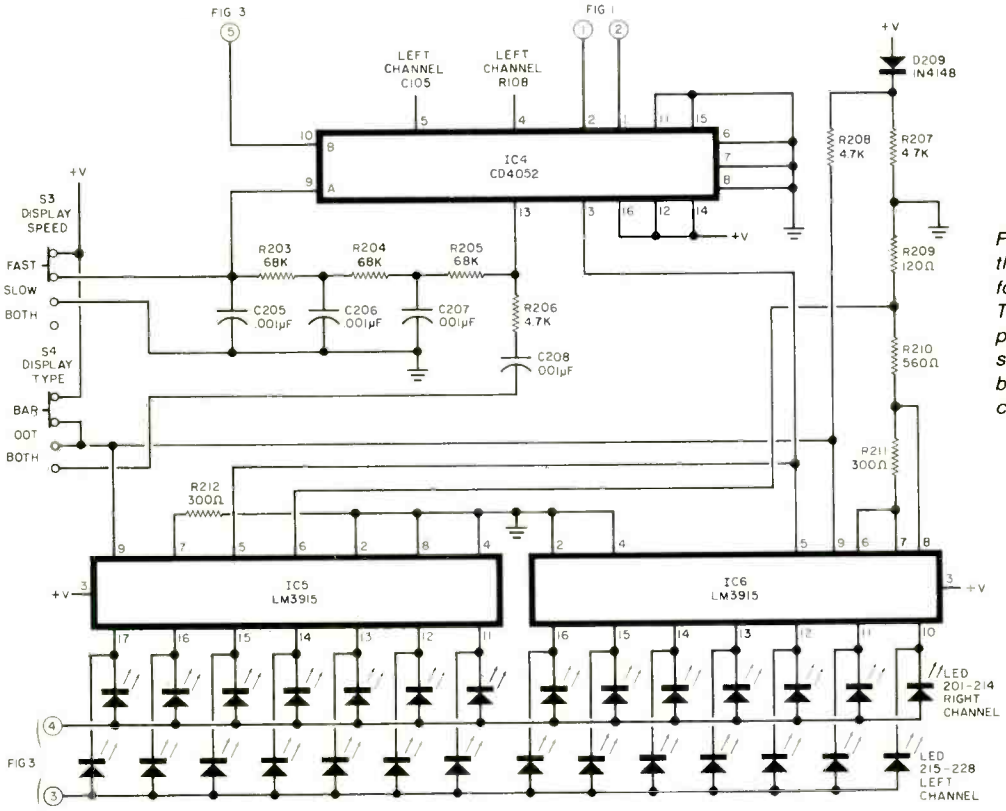


Fig. 2. Schematic of the display circuit for the level meter. The switching scheme permits use of the same circuit for both left and right channels of LEDs.

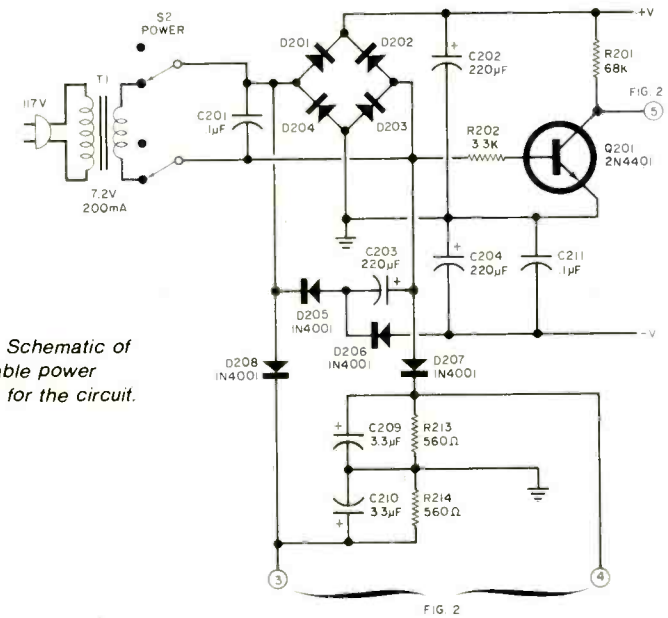


Fig. 3. Schematic of a suitable power supply for the circuit.

Switch *S4* determines the DISPLAY TYPE. In the BAR mode, it connects pin 9 of *IC5* and *IC6* to the positive supply to cause the drivers to display a bar graph. When *S4* is in the DOT position, diode *D209* and *R207/R208* keep pin 9 about 0.6 volt below the positive supply, forcing *IC5* and *IC6* to display a single LED at a time in a moving-dot display. When *S4* and *S3* are both in the BOTH position, an interesting display results. Pin 13 of *IC4* will have a square wave of a few kHz on it, and on the rising edge of this waveform, when the input to *IC5* and *IC6* is changing from the fast to slow peak detector, the positive pulse is coupled to pin 9 of both *IC5* and *IC6* via *R206* and *C208*. This places the LED drivers in the BAR mode; and, when *C208* charges, the voltage at pin 9 places the drivers in the DOT mode. The visible result is a bright dot in the position of the fast input and another for the slow input. There will be a dim bar from the left end of the display to the slow LED. A bright dot makes it easier to watch the fast-decay signal; but in a dimly lit room, only the motion is visible, not its absolute position. The dim bar of the BOTH mode provides an excellent display with high readability.

Construction. Although the pc board shown in Fig. 4 simplifies construction, point-to-point wiring can be used. If you elect to go this route, keep the leads to the LEDs short.

Note that two pc boards are shown in Fig. 4, one for the control circuit, and the other for the LEDs. There is a space between the top three LEDs and the others to make the display better for distance reading when it is indicating near the peak levels.

After selecting a suitable enclosure, mount the main pc board on spacers, and the LED board as desired on the front panel. The various off-board components (*J1*, *R1*, the LOAD IN connector, *R15*, *R16*, *R17*, and *S1*, power on/off switch *S2*, and *S3* and *S4*) are mounted as desired on the front and rear panel. Drill a hole, and use a grommet to allow the power cord from wall-mounted *T1* to enter the enclosure. Use suitable markings to identify each front-panel item.

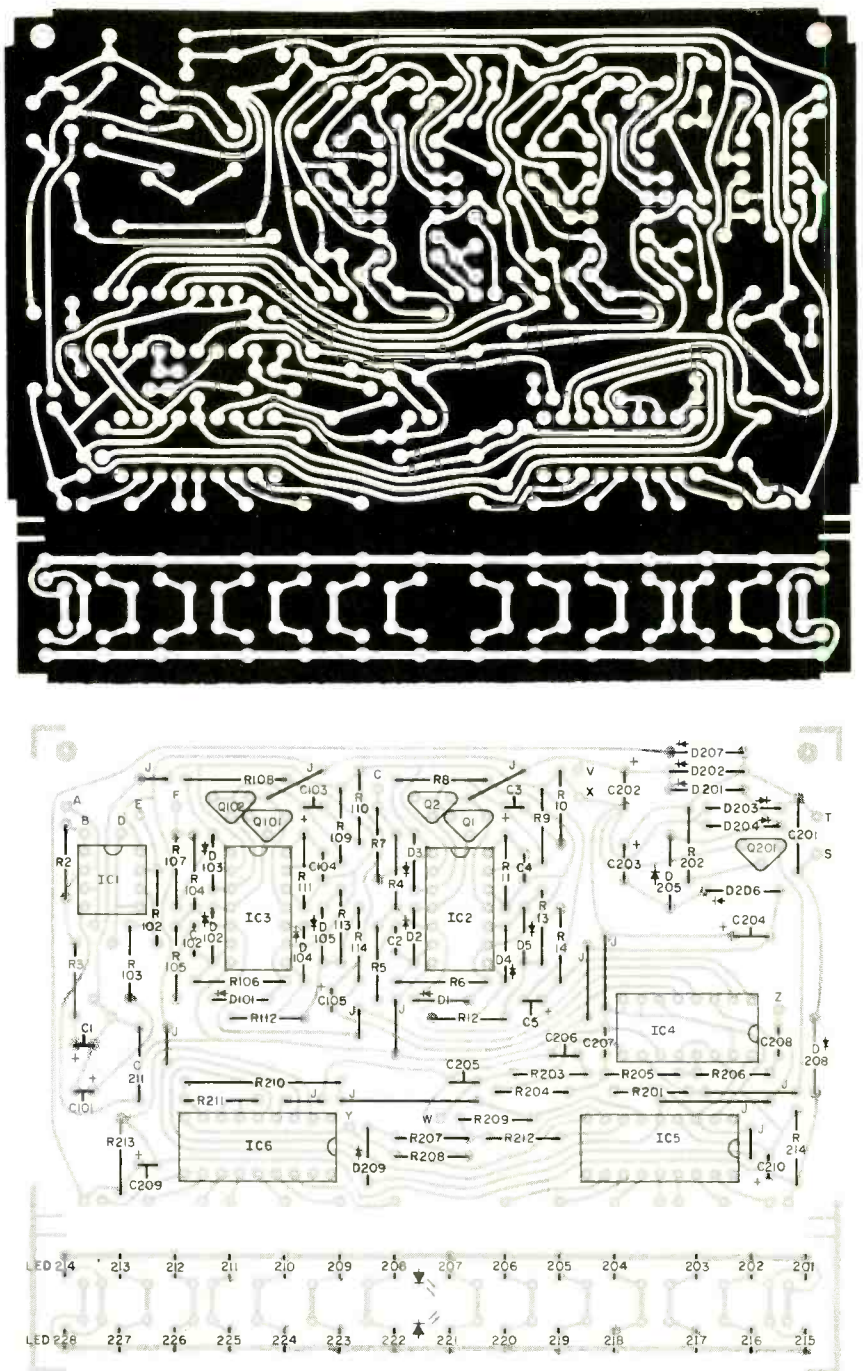
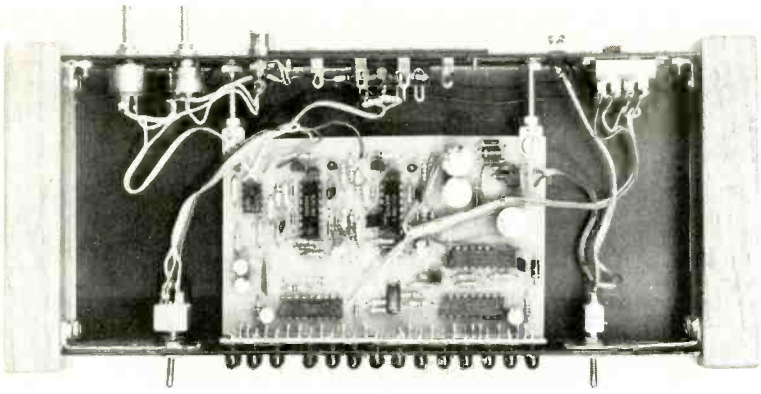


Fig. 4. Foil pattern (top) and component layout for the pc board, which is in two parts for control circuit and display.

Calibration. The LOAD IN terminals are for speaker-level signals. Select *R17* and *R117* in accordance with the Parts List. For example, if you are using a 50-watt amplifier, *R17* will be 1.27 kΩ. This will allow a peak signal as large as a sine wave that will put 50 watts into an 8-ohm load to light the 0-dB LED. In this case, the +3-dB LED will be the equivalent of 100 watts, and the −3-dB LED will equal 25 watts, etc.

For power levels not in the Parts List, $R17 = 5\ k\Omega \times (X/1\text{-}X)$ where X = 4.083 volts divided by the square root of the power in watts times the impedance in ohms. Typical error from this form of calibration is ±0.3 dB, but it can be as high as ±1.5 dB.

There are several ways to calibrate the input circuit. If *R1* and *R101* are set to the center of their ranges, 0 dB will correspond to the peak level of a 0.775-volt sine wave. This latter is 0 dBm into 600 ohms, or 1 mW at 600 ohms impedance. An input of 400 mV or more can be used to light the 0-dB LED by adjustment of the calibration potentiometer.



Internal view of the author's prototype level meter.

Use. To use the line-level section to help with tape recording, there are many different techniques with different accuracies and instrumentation requirements. First, the Audio Level Meter should be connected *after* the record level controls of your tape deck. This connection can be at an internal point, or at the output jacks. We will describe techniques that assume the latter point; note that, if you have the level adjustments that affect the outputs, the system will be calibrated only for the setting you use then, so mark that setting.

One technique is to find the signal level of a 400-Hz tone that results in 3% total harmonic distortion and let that be the 0 dB to which you set your meter. If you only rarely exceed this peak level during recording, average distortion will be very low.

Another technique would be to play FM interstation noise into your tape deck and adjust the level control to read −6 dB on the deck's meters—if they are of the typical average-responding type (or 0 dB if they are peak-responding). Calibrate the Audio Level Meter to 0 dB. The reason for the 6-dB difference is that noise has a peak-to-average ratio of about twice the peak-to-average ratio of sine waves, for which average-responding meters are calibrated.

A final technique would be to play a Dolby reference-level tape and adjust your meter so that a signal recorded at a similar level causes the meter to read −3 dB. With good quality tape, optimum record level will then be a setting that allows the 0-dB LED to light occasionally, and the +3 dB LED will indicate more than 3% distortion. With metal particle tape, the +3-dB light may be allowed to light occasionally, as metal tape has a little more headroom with typical musical signals (and a lot more with treble-intensive signals that are found in live music). With poorer quality tapes, try to have the 0-dB LED light rarely. A Dolby reference level tape may be purchased from Integrex, Box 747, Havertown, PA 19083, for $9.00 ppd. (specify reel or cassette).

The Audio Level Meter, with its simultaneous display of short-term and long-term true peak levels, will allow you to set your record levels more accurately, for the optimum trade-off between distortion and noise. It also helps you prevent amplifier clipping and makes for a pretty visual show! ◇

REJUVENATE DEFUNCT AUTOMOBILE CLOCKS

Simple timer/driver circuit replaces troublesome switch contacts

BY ARTHUR V. CLARK

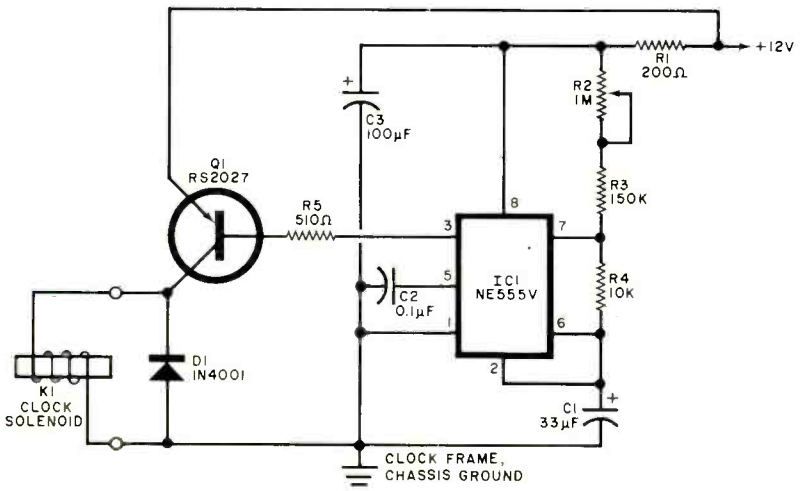
MOST automobile clocks are conventional analog types that use a mainspring, a gear train, and a balance-wheel escapement. Their one ususual feature is that the mainspring is wound by means of a solenoid. Energizing the solenoid rewinds the spring sufficiently to run the clock for 60 to 90 seconds. As the mainspring relaxes, a contact affixed to the winding-mechanism shaft moves and eventually touches a stationary contact on the clock frame. This completes the circuit and starts the cycle over again.

Most often, these clocks stop working because the solenoid-energizing contacts have failed. The circuit shown here allows you to rejuvenate such a clock. It takes over the function of the failed contacts by having an IC timer and a driver transistor periodically energize the solenoid.

About the Circuit. Timer *IC1* operates as an astable multivibrator. The period of the timer's square-wave output is determined by the time constant of the RC network formed by potentiometer *R2*, resistors *R3* and *R4*, and tantalum capacitor *C1*. The square-wave's duty cycle is determined by the ratio $(R_A + R_B)/(R_A + 2R_B)$, where R_A is the total effective resistance between pins 7 and 8 of *IC1*, and R_B is the value of *R4*.

Capacitor *C1* charges through *R1*, *R2*, *R3*, and *R4* to a voltage that triggers a comparator inside *IC1*. During the charging interval, pin 3 is high and transistor *Q1* is cut off. When the comparator is triggered, *C1* discharges through *R4* until the voltage across it decreases to a value that triggers a second comparator in *IC1*. During the discharge interval, pin 3 is low and base current flows in *Q1*. While *Q1* conducts, the clock's rewind solenoid is energized and the clock's mainspring is rewound. At the end of the discharging interval, pin 3 goes high again, *Q1* cuts off, and the process repeats itself. The period of the output waveform is adjusted via potentiometer *R2* to equal that needed to maintain proper winding of the clock's mainspring.

Resistor *R1* and capacitor *C3* form a filter that prevents any noise voltage riding on the vehicle's positive supply line from affecting the operation of *IC1*. Resistor *R3* prevents the timer IC from latching when the wiper of *R2* is set to the extremity of its travel. Such a condition could cause transistor *Q1* to overheat. The transistor is protected from the inductive spikes that appear across the clock's rewinding solenoid (*K1*) by diode *D1*.



Schematic diagram of the Car-Clock Rejuvenator. Transistor Q1 periodically energizes the solenoid that rewinds the car clock's mainspring.

PARTS LIST

C1—33-µF, 25-V tantalum capacitor
C2—0.1-µF, 25-V disc ceramic capacitor
C3—100-µF, 25-V aluminum electrolytic
D1—1N4001 rectifier
IC1—NE555V timer
K1—Car-clock rewinding solenoid
Q1—Pnp silicon power transistor (Radio Shack RS2027 or similar)
R1—200-Ω, ½-W, 10% resistor
R2—1-MΩ, linear-taper potentiometer
R3—150-kΩ, ¼-W, 10% resistor
R4—10-kΩ, ¼-W, 10% resistor
R5—510-Ω, ½-W, 10% resistor
Misc.—Pc or perf board, IC and transistor sockets, mica insulator, silicone thermal compound, heat sink (can be case of car clock).

Construction. The circuit can be assembled on a small pc or perforated board. If it is made compact, it will likely fit into the clock case. The original solenoid-energizing contacts can be cut off and discarded. One end of the solenoid coil should be grounded to the clock's frame, and the other end connected to the collector of *Q1* by a suitable length of hookup wire. The clock's original battery terminal provides a convenient tie-point for this latter connection.

Sockets should be used for *IC1* and *Q1*. Also, the transistor should be heat-sinked. The case of the clock can serve as the sink, but the transistor case must be electrically isolated from it. A preformed mica insulator and shoulder washers can provide the required isolation. Be sure to use silicone thermal compound to improve the bond between the transistor case, the mica insulator, and the heat sink or clock case.

Potentiometer *R2* can be either a pc-mount trimmer or a compact, screwdriver-adjust type. If a trimmer is used, the circuit board should be mounted in such a way that the potentiometer can be readily adjusted. If a screwdriver-adjust potentiometer is used, it can be mounted on the clock case so that the adjustment screw faces outward. In either case, the circuit and the clock should be tested on a workbench before adjustment and installation. When it has been verified that the circuit is operating correctly, *R2* should be adjusted so that the solenoid is energized at the rate needed to keep the clock mechanism running smoothly and accurately.

This circuit was originally designed to rejuvenate the nonreplaceable clock of a classic automobile. It is inexpensive enough, however, that it can be used to put back in working order a car clock that does not have such great intrinsic value. ◇

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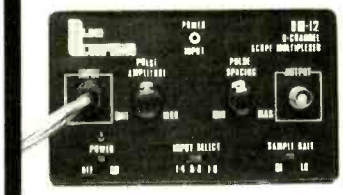

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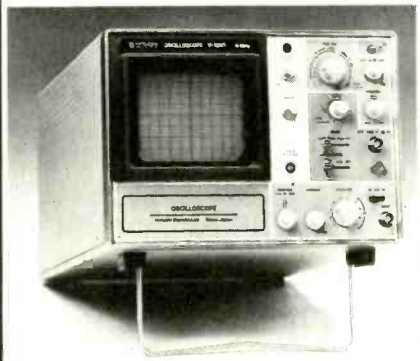

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• Horizontal deflection	
Sweep mode	Auto, NORM, TV (+), TV (−)
TV synchronization	TV sync-separator circuit
Internal	Over 1 div (V sync-signal)
External	Over 1 Vp-p (V sync-signal)

Trigger sensitivity

Frequency	Internal	External
20Hz—2MHz	0.5div	200mV
2—15MHz	1.5div	800mV

Trigger slope	±
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Sweep-time magnifier	10 times (±7%)
Max. sweep rate	100ns/div
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Voltage	0.5V ±3%
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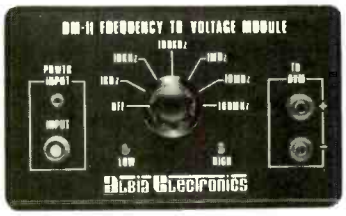

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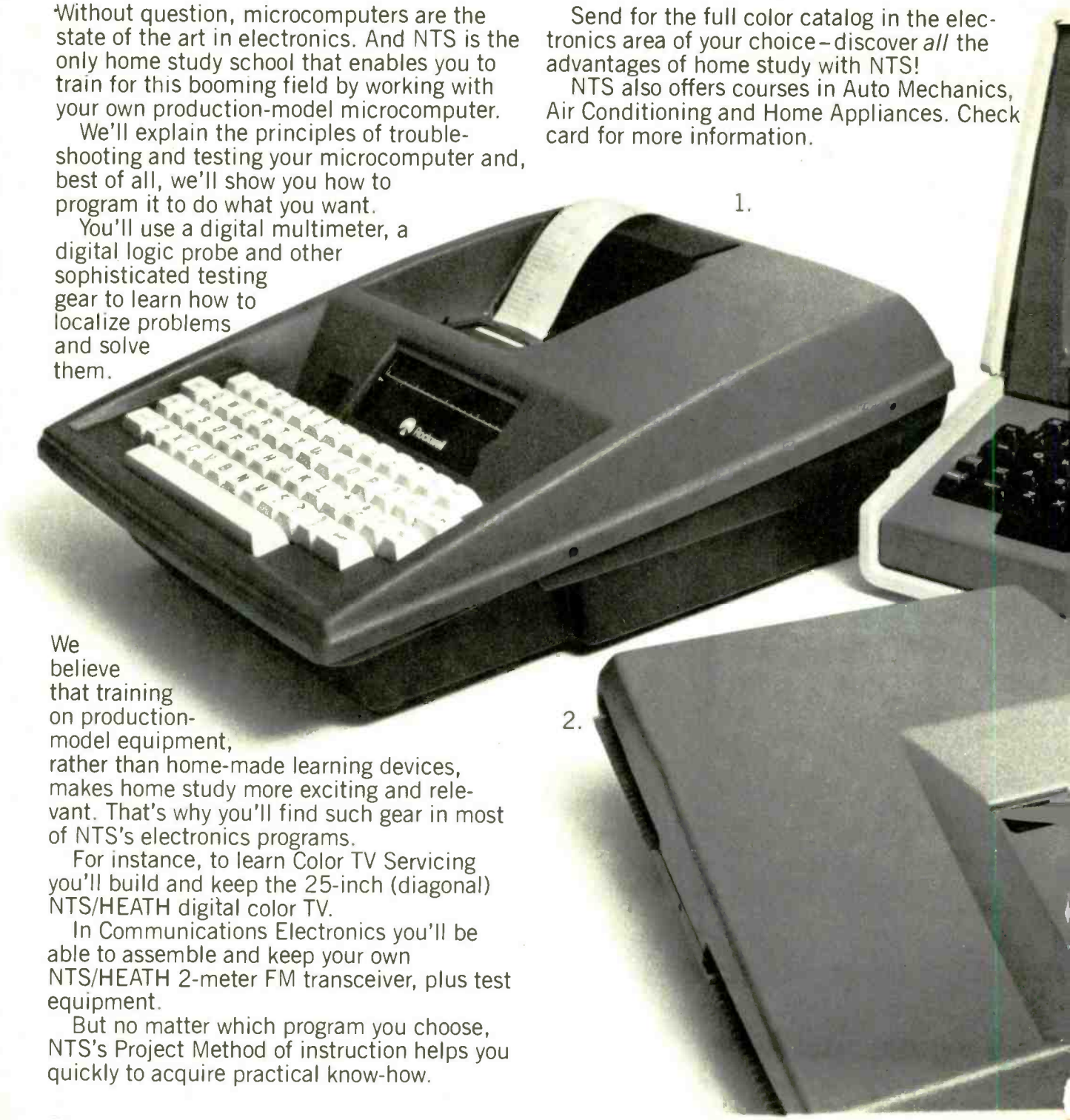

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HOBBY SCENE

By Leslie Solomon
Senior Technical Editor

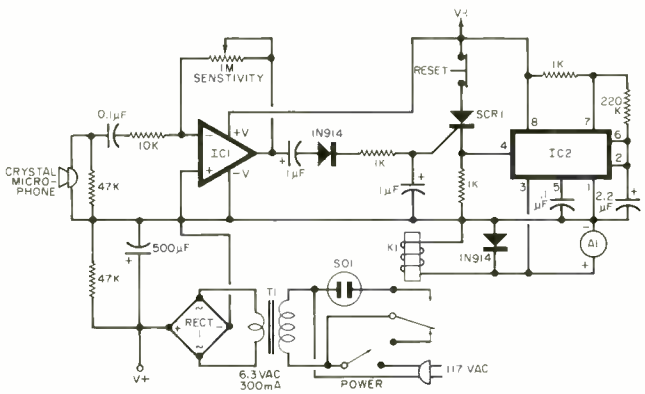
Cry Alert

Q. ***I hope you can help me with a problem. I am a prospective father who is deaf. Can you provide me with a circuit that will flash a light when it senses the cry of a baby?—Pete Bigotta, Rochester, NY***

A. The circuit shown will activate both an audible alert and a lamp which is plugged into ac power socket *S01*. The baby's cry is sensed by the crystal microphone (Radio Shack 270-095 or similar) and transduced into a voltage which is amplified by operational amplifier *IC1*. (Just about any op amp—μA741C, TL074CN, etc.—will do.) The gain of the op amp is determined by the setting of the linear-taper SENSITIVITY control. Output signals from the op amp are capacitively coupled, rectified, and filtered into a dc level. This dc voltage turns on *SCR1* (HEP R1001 or similar), which in turn actuates the astable multivibrator comprising *IC2*.

Both relay *K1* (Radio Shack 275-004 or similar) and plezoelectric buzzer *A1* (Radio Shack 273-060) will be strobed approximately twice each second by the output of the 555 timer. The diode protects the chip's output stage from inductive spikes. Opening the RESET switch will deactivate the multivibrator.

The buzzer can be omitted, but is included as a back-up alerting device for someone with unimpaired hearing who is within earshot. Plug a 60- or 75-watt incandescent lamp into *S01*.The entire circuit is powered by a simple line-operated supply rectifier with ratings of 1 ampere and 50 PIV.



SOLID-STATE DEVELOPMENTS

By Forrest M. Mims

The Electrostatic Discharge Problem

EVERYONE has experienced the static discharge that occurs when one touches a metal object after walking across a carpet on a dry winter day. But few people are aware that high static voltages are accumulated by many common objects.

Things made from plastic are notorious generators and accumulators of very high static charges. Styrofoam cups, cigarette and candy wrappers, parts trays and some kinds of solder removal tools are all potential high-voltage generators. These, and many other plastic objects, are commonly found on or near electronic work benches. It's surprisingly easy to demonstrate the accumulation of a static charge on plastic objects. For example, rub a piece of plastic packing snow between two sheets of dry paper, and the plastic will adhere to a surface having an opposite charge. Or rub a balloon on a flannel shirt and it will stick to a ceiling.

A neon glow lamp makes a handy visual indicator of static electricity. Walk across a rug while wearing leather-soled shoes to accumulate a charge and touch one lead of a neon lamp to a metal object while holding the other lead between a thumb and forefinger. The lamp will flash when the discharge occurs.

It's very important to isolate MOS, CMOS and other components that are vulnerable to electrostatic discharge (ESD) from objects that can generate a static charge. Ideally, all static-generating objects should be removed from the vicinity of vulnerable components. Soldering irons should be grounded (or battery powered) as should workers who handle components.

In the June 1981 installment of this column, I noted that manufacturers often ship components and circuit boards that are vulnerable to ESD in antistatic polyethylene bags known as "pink poly." These special-purpose bags do not develop a high potential like ordinary polyethylene bags when rubbed or flexed.

I also mentioned a new antistatic bag made by 3M Static Control Systems (P.O. Box 33050, 3M Center, St. Paul, MN 55101). The 3M bag, which is more expensive than pink poly, consists of an inner layer of antistatic polyethylene and a polyester strength layer coated with a 10-micron thick film of nickel.

Dan C. Anderson of the Richmond Division of Dixico, Inc. (Box 1129, Redlands, CA 92373) responded to this item with a thick package of literature about his firm's antistatic products. He also sent along some samples of Richmond's pink poly as well as some special-purpose RCAS (TM) 3600 antistatic bags that give both r-f and EMI shielding.

Being a long-time static electricity experimenter, I was particularly attracted to Dan's method of demonstrating the static electricity produced when transparent adhesive tape is unrolled. He says to place a neon lamp, whose leads have been spread apart, near a spool of tape. The lamp will glow as the tape is unrolled. I tried this demonstration and it worked even on a very rainy day. (For best results, dim the lights and pull the tape rapidly.)

The primary purpose of Dan's package, however, was to explain the merits of pink poly. According to Richmond's literature, its RCAS 1200 was the first pink poly. Prior to its development, the

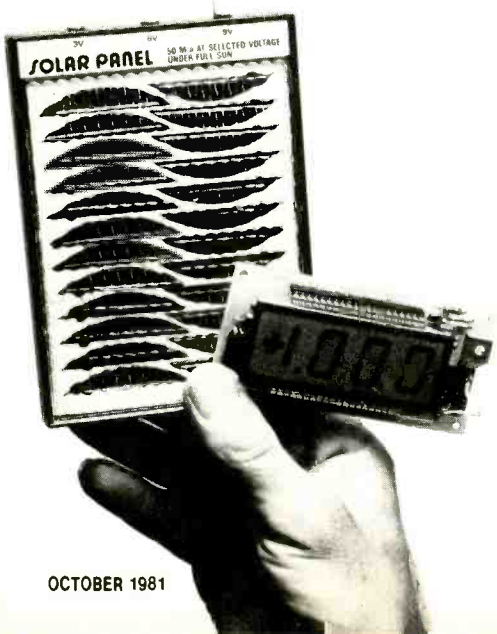


Fig. 1. Data-Intersil's low-level LCD panel meter is powered by a solar cell.

chief antistatic wrap was Velostat (TM), a product of Custom Materials, a company since acquired by 3M. Velostat is made by mixing finely ground carbon particles with polyethylene or a similar resin. It is used to protect electronic components, printed circuit boards and explosives from ESD. Unlike Velstat, pink poly is transparent. The pink hue is added to distinguish the material from ordinary plastics.

According to Richmond, the development of its pink poly was stimulated by a 1964 tragedy at Cape Canaveral in which three men were killed by the accidental ignition of a solid propellant rocket motor inside a hangar. The rocket ignited, apparently, when a static discharge generated by its polyethylene dust cover caused a spark to jump across the ignition squib.

Fig. 2. A new ultra-fast operational amplifier from Optical Electronics, Inc.

Pink poly is made by impregnating ordinary polyethylene resin with an antistatic liquid. According to Richmond, the antistatic liquid ". . . forms a self-renewing, noncorrosive 'sweat layer' on all its exposed surfaces by combining with the moisture found in normal air." If the old one is removed by a solvent or abrasion, a new layer of antistatic compound is eventually formed.

Apparently there is a good deal of healthy competition between 3M, Richmond, and other companies over the relative merits of their respective antistatic products. Richmond, for instance, is quick to point out that categorical criticism of pink poly is unfair since the product is "widely and poorly imitated." They also note that their RCAS 1200 meets the requirements of military standard MIL-B-81705, Type II, "and is still the only material meeting this as determined by the government's Qualified Products List."

On the other hand, 3M observes: "No one product . . . no one technology . . . can offer full protection from static," and then boasts: "Only 3M has the products and the trained static analysts to give you total control of the static in your business."

Rather than enter this fray myself, I urge readers who have an interest in ESD protection to contact Richmond, 3M, and other companies *directly*. They can provide you with considerably more information on the topic than can be squeezed into this column.

If recent reports in various technical journals and trade magazines are a reliable indicator, protection against component damage due to ESD is becoming a matter of major concern and importance. For example, at a forum on ESD sponsored last year by *Electronic Products* magazine, several conferees noted that though ESD damage to components and assembled circuit boards is a serious problem, many companies don't have the technical expertise necessary to trace their rejects and failures to ESD. Some are unwilling to invest the funds necessary to equip and maintain a static-free work environment.

You can learn more about the *Electronic Products* forum in that magazine's June 1980 issue (pp. 31-38). If you're involved in the manufacture of circuit boards or systems which use components vulnerable to ESD damage, the Department of Defense has published a detailed standard on the subject. It's designated 1686 and is entitled "Electro Static Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment." You can request a copy of the standard by writing the Navy Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

In the meantime, pay particular attention to antistatic procedures to protect vulnerable components, especially MOS and CMOS chips, from ESD. Richmond has formulated a set of antistatic rules you may wish to follow. They're called "The S-I-G-H of Relief from ESD" and here they are:

1. *S*urround . . . the device or assembly with antistatic materials (bag, lidded box, or other shaped container) except when it is being worked on.

2. *I*mpound . . . all plain plastics and textiles, foams and cushionings from being near to the items. Replace with approved antistatic types or treat with topical antistats.

3. *G*round . . . the skin of all item-handling personnel with safely resistive wrist straps. Where this is not possible, use conductive floor mats and appropriate footwear.

4. *H*ound . . . personnel and management to see that the above rules are observed, for without breaking one of them it is virtually impossible to cause electrostatic damage.

Richmond's Dan Anderson acknowledges Fred Mykkanen of Honeywell

solid-state developments

Defense Systems for originating the "S-I-G-H of Relief" idea. Mr. Mykkanen is an authority in the ESD field.

Don't let this discussion of the importance of protecting sensitive components from ESD damage frighten you away from MOS and CMOS chips and transistors! In my opinion, CMOS is the best way to go. It's very flexible, simple to use, and consumes little power.

My CMOS chips are inserted in aluminum foil-covered styrofoam salvaged from the grocery store's meat counter. The foam plastic is cut to fit inside ordinary plastic parts trays. While the contact between the foil and the IC leads may cause some reaction to occur, thus far none of my CMOS chips has been damaged by ESD . . . to the best of my knowledge. I have, however, zapped a few chips or individual gates by foolish or accidental circuit errors. I always touch a grounded object before handling CMOS chips and, if possible, use a battery powered soldering iron. Finally, loose chips are laid on a sheet of aluminum foil until used in a circuit or placed back in their foil-covered carrier.

A Micropower Digital Panel Meter. Liquid-crystal displays have replaced LED displays in most digital watches and calculators. Now they are moving into new territory, and Fig. 1 shows one reason why: liquid crystal displays consume much less power than their LED counterparts. As you can see, the LCD display in Fig. 1 is being powered by a small solar cell array.

The product in Fig. 1 is a 3½-digit panel meter with 0.75-inch figures. The circuit uses CMOS technology to achieve a total power consumption of only 17.5 milliwatts (3.5 milliamperes at +5 volts). This permits the meter to operate *continuously* for several months on a single set of 4 AA alkaline penlight cells.

The new meter is designated the DM-LX3. It sells for $57.50 in single quantities. For additional information, write its manufacturer, Datel-Intersil (11 Cabot Boulevard, Mansfield, MA 02048).

An Ultra-Fast Op Amp. Most op amps are not very fast. An important exception is the Model 9918 shown in Fig. 2. This new opamp features a minimum unity-gain frequency of 200 MHz and a propagation delay of only 5 nanoseconds. The ±1% settling time is 20 nanoseconds.

The Model 9918 is made by Optical Electronics, Inc. (P.O. Box 11140, Tucson, AZ 85734) and is functionally equivalent to the Teledyne-Philbrick 1435. It sells for $31.25 in 100 unit quantities.

For what applications are ultrafast op amps suited? An important area is the amplification of video frequency signals. Fast bandwidth lightwave communications is another. Still another important application is very fast digital-to-analog conversion. ◇

EXPERIMENTER'S CORNER

By Forrest M. Mims

Experimenting with High-Speed Logic

HOW WOULD you like a flip-flop that can switch states 500-*million* times in a single second? Flip-flops this fast actually exist and are used in ultrafast computers, communication interfaces for computers, high-speed phase-locked loops, and high-performance controllers.

Ultrafast flip-flops are representative of a family of logic circuits characterized by nanosecond switching speeds. The family is called *emitter-coupled logic* or simply ECL.

I first became interested in ECL while pondering the possibility of measuring the time light takes to travel from a miniaturized laser transmitter to a nearby reflective surface and back. Dividing the elapsed time in half and multiplying the quotient by the speed of light gives the distance from the laser to the surface.

In one second, light travels 299,800,000 meters, or 984,000,000 feet, or 186,280 miles. Put another way, light travels about one foot in one nanosecond (0.000000001 second). Since I wished to measure the distance to objects a few feet, or few tens of feet, distant, nanosecond resolution would be required for successful use of the time-of-flight method.

In a typical time-of-flight optical radar, the transmitter emits a fast-rising, very short light pulse while simultaneously enabling a high-speed counter. Reflected light from the target illuminated by the transmitted pulse is returned to a photodetector, then shaped and amplified. The resultant signal stops the counter. Half the elapsed time stored in the counter provides the time-of-flight from transmitter to target.

The fastest ECL gates change states in a nanosecond; thus ECL is suitable for making the high-speed gate and counter of a time-of-flight optical radar. Though I have not yet designed a practical short-range time-of-flight system, I have experimented with a number of ECL circuits designed around a quad NOR gate. Before having a look at how they work, let's find out more about ECL.

A Typical ECL Gate. The circuit and logic symbol of a typical three-input ECL OR/NOR gate is shown in Fig. 1. Depending upon your point of view, you can think of the circuit as an OR gate with a complementary (NOR) output or a NOR gate with a complementary (OR) output.

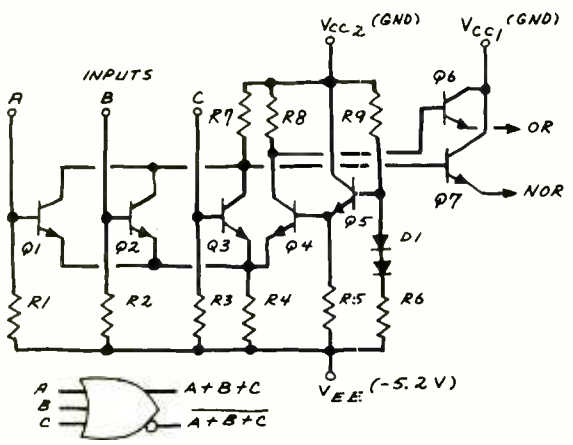


Fig. 1. An emitter-coupled logic (ECL) 3-input OR-NOR gate.

In the instance of the OR gate, the complementary NOR output eliminates the necessity for an external inverter and avoids propagation delays that such an external inverter would add. In either case, the complementary outputs make possible a number of interesting design shortcuts which can reduce circuit complexity and gate count.

In operation, input transistors *Q1-Q3*, together with *Q4*, form a differential amplifier. The bias network composed of *Q5, R5, R6, R9, D1*, and *D2* sets the switching threshold for the differential input amplifier.

If the base voltages at *Q1, Q2* and *Q3* coincide with the voltage at the base of *Q4*, then the current flow between V_{CC} and V_{EE} will divide between the transistors. If, however, the voltage at input A (*Q1*) is increased about half a volt above the reference voltage at the base of *Q4*, then *Q3* will turn on and the current flow will be diverted away from *Q4* and flow through *Q3*. The same applies to inputs B (*Q2*) and C (*Q3*).

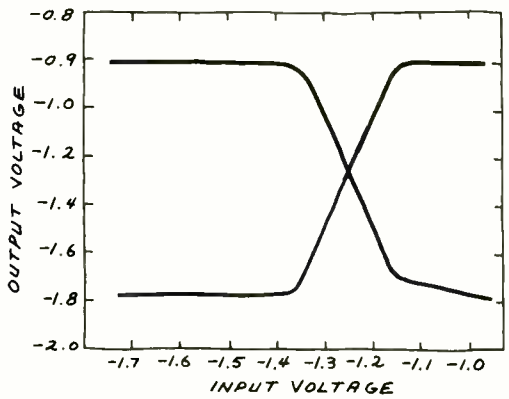


Fig. 2. Transfer curves of a typical ECL gate. The difference between a high and a low is only about 0.85 volt.

Output transistors *Q6* and *Q7* form a complementary pair that monitors each half of the differential amplifier. Should *Q1, Q2* or *Q3* receive an input signal of sufficient amplitude, *Q7* will be turned on. Otherwise, *Q6* is turned on. Since only one side of the differential amplifier can be on at any time, when *Q6* is on, *Q7* is off, and vice versa.

The *transfer curves* for a typical ECL gate are given in Fig. 2. These curves show both the switching thresholds and the high and low logic levels. Note that the difference between an EDL low (−1.75 volts) and high (−0.9 volt) is only 0.85 volt. This means a conventional ECL gate cannot be interfaced directly with TTL logic (where a low is less than 0.8 volt and a high is more than 2 volts). Instead, special ECL circuits called *TTL translators* must be used to interface ECL with TTL.

Note that the ECL logic levels in Fig. 2 are *negative* voltages. This is in accordance with the ECL convention in which

V_{CC} is at ground potential and V_{EE} is -5.2 volts. This convention can be reversed so that V_{EE} is at ground potential and V_{CC} is $+5.2$ volts. However, maintaining V_{CC} at ground potential provides much better noise immunity since any V_{EE} power supply noise becomes a common-mode signal that is cancelled by the differential input amplifier.

ECL Advantages. The principle advantage of ECL is its speed, but it offers other benefits also. One is the very desirable combination of high input impedance and low output impedance. This means a single ECL gate output can drive many ECL inputs. In other words, ECL has a large *fanout* capability.

Another important advantage of ECL is its ability to drive transmission lines and twisted pairs *directly*. This is a result of the open emitter output at an ECL gate (see Fig. 1).

Still another ECL advantage is that unused inputs need not be connected to V_{CC} or V_{EE}. This is because each input is connected internally to V_{EE} via a 50,000-ohm resistor (*R1-R3* in Fig. 1).

Finally, ECL chips have a nearly constant power-supply drain. This greatly simplifies power-supply design and reduces the possibility of noise transients on the supply lines during switching transitions.

Advantages and Drawbacks. ECL circuits have the potential of providing one-nonosecond switching times and propagations delays. Motorola, for example, makes a family of ECL chips called MECL III, having ultrafast operating speeds.

These ultrafast ECL chips require very careful design techniques to avoid uncontrolled oscillation, excessive ringing, and other problems associated with very fast pulses. Wrapped wire interconnections are *not* recommended, and the maximum length of an interconnection should be under one inch.

The 10,000-series ECL made by Fairchild, Motorola, and other companies avoids some of the problems associated with

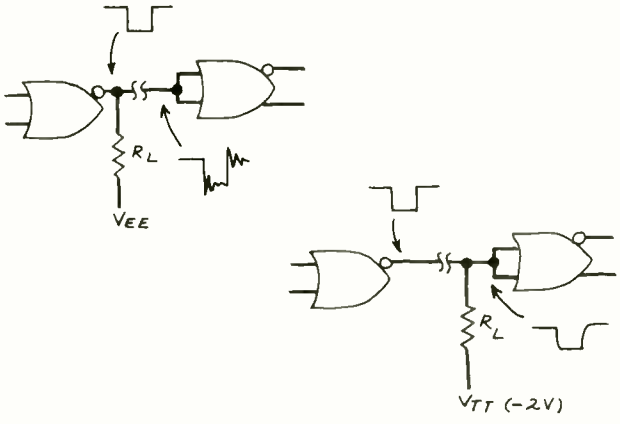


Fig. 3. The effects of an improper (left) and proper termination on a transmission line are evident in the noise on the output signal.

ultrafast ECL by purposely slowing switching times to several nanoseconds and stretching propagation delays to about two nanoseconds. These modifications allow 10,000-series ECL to far exceed the speed of any other logic family while relaxing interconnection requirements. For example, wrapping wire can be used to interconnect 10,000-series ECL chips so long as connections are less than eight inches in length.

Though 10,000-series ECL is much easier to use than ultrafast MECL III, attention must still be given to interconnections. Each foot of interconnection inserts a delay of about two nanoseconds. This is approximately equivalent to the propagation delay of an ECL gate.

Transmission lines such as coaxial cables and twisted pairs are ideal for interconnecting 10,000-series ECL over dis-

tances of up to 1,000 feet. But if the line is not properly terminated, transmitted pulses will be distorted by considerable leading and trailing edge ringing. Since an ECL output is an uncommitted open emitter, an external resistor to V_{EE} must be added. In a properly terminated transmission line, this resistor is inserted at the *receiving* end rather than the transmitting end. Figure 3 shows the effects on a transmitted pulse under both configurations.

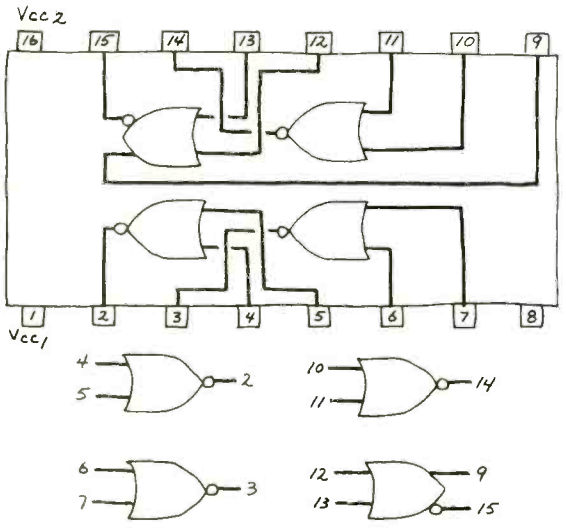


Fig. 4. Pin layout and internal schematic diagrams of the 10102 ECL quad NOR gate.

Experimenting with an ECL Quad NOR Gate. A good way to learn about ECL firsthand is to experiment with the 10102 quad 2-input NOR gate. The pin outline for the DIP version of this gate is shown in Fig. 4. As in TTL gate packages, pins 8 and 16 are reserved as power-supply terminals. Pin 1 is also used as a power-supply terminal.

The pin connections to the individual gates are unlike those of any comparable CMOS or TTL gate package. Note in particular how the outputs from two gates cross over the inputs of the two adjacent gates.

Finally, note that one of the 10102 gates has complementary outputs. This will give you an opportunity to experiment with this unique feature of ECL gates should you wish to go beyond the simple circuits that follow.

A 78-MHz Oscillator. A straight-forward ECL ring oscillator patterned after similar TTL versions is shown in Fig. 5. The only significant difference is the addition of the required pull-down resistors *(R1-R3)* at each ECL output.

I assembled this simple circuit on a standard solderless breadboard using short lengths of point-to-point connection wire. Power was supplied by a standard TTL power supply.

The output from this oscillator is a 1.6-volt sine wave riding on a 2.6-volt dc level. This means that, while the circuit will easily drive an LED, compensation for the dc level must be provided or the LED will be saturated.

An Ultrafast Schmitt Trigger. The Schmitt trigger is a bistable (two-state) logic circuit with a host of useful applications. Typical uses include threshold detection, signal conditioning, and sine-to-square-wave conversion. Figure 6 shows a Schmitt trigger designed after a standard two-inverter TTL version. The chief difference is that the ECL version in Fig. 6 switches on in about 10 nanoseconds.

When the signal at the input of the Schmitt trigger is below the circuit's switching threshold, the output is a dc level of 3.0 volts. When the input signal exceeds the circuit's switching threshold of about 3.6 volts, a very fast rising pulse with an amplitude of 0.85 volt is superimposed over the dc output.

Like the oscillator in Fig. 5, the Schmitt trigger was assembled on a standard solderless breadboard using short point-to-point connections. Figure 7 shows the response of the

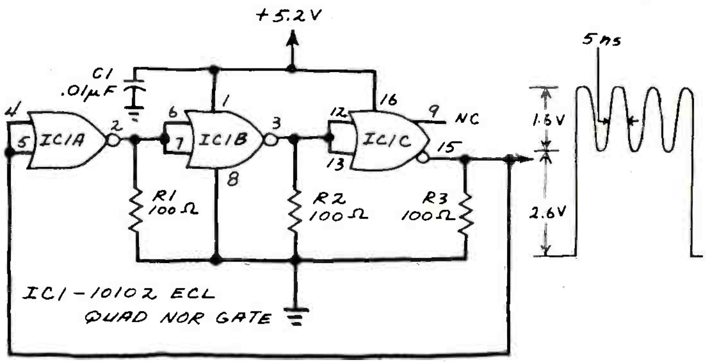


Fig. 5. Schematic of a 78-MHz ring oscillator using ECL. A pull-down resistor is required at each ECL output.

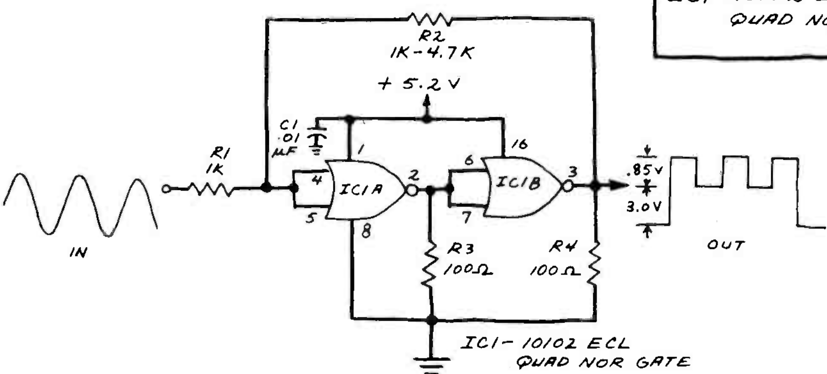


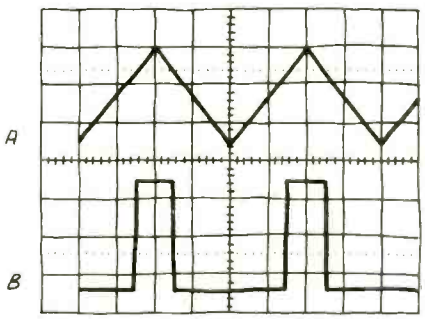
Fig. 6. A Schmitt trigger using ECL is similar to a standard two-inverter TTL version except that it switches on in about 10 ns.

experimenter's corner

Schmitt trigger to a triangular waveform while Fig. 8 is an expanded view of the Schmitt trigger's output showing a rise and fall time of about 10 nanoseconds at the 10%-90% points.

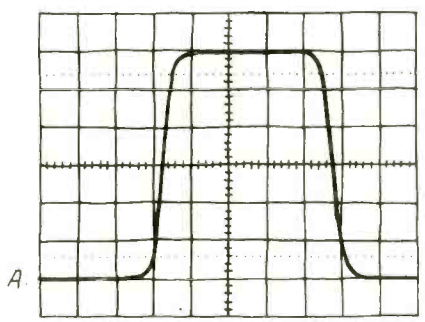
Other ECL Chips. If you would like to try some more sophisticated ECL circuit designs, a wide variety of standard ECL chips is available. The 10,000 series, for example, includes many different gate packages, flip-flops, decoders, encoders, memories, and other functions.

In the past, some of the parts suppliers who advertise in this magazine have carried some ECL chips. Recently, however, I haven't noticed any ECL chips in their ads. If you have trouble locating a supplier for ECL chips, try manufacturer's representatives.



VOLTS/DIV:
A. 2.0
B. 0.1
TIME/DIV: 1 ms

Fig. 7. Response of circuit in Fig. 6 shows fast rise and fall times.



VOLTS/DIV:
A 0.2
B —
TIME/DIV: 20 ns

Fig. 8. Expanded view of the output of Fig. 6 with 10-ns rise and fall times.

resentatives. Most big cities have a number of such representatives who can order chips for you. They may even be in stock. Signetics, Motorola, Fairchild, and other companies make ECL chips.

Summing Up ECL. This column provides only a very elementary introduction to ECL. For more information, visit any technical library and review books on digital logic which cover ECL. Even better, get a copy of Fairchild's *The ECL Handbook*. Another excellent manufacturer's handbook is Motorola's *MECL High-Speed Integrated Circuits*. A wide range of ECL application notes is also available from the various ECL manufacturers. If you have technical questions about ECL circuit design, be sure to contact the manufacturers or their representatives directly. Because of the volume of mail this column receives, I am unable to provide custom designs. ◇

English Broadcasts Audible in No. America

by Glenn Hauser

4:00-4:15 a.m.	0900-0915	BBC	A	15070, 11955, 11750, 9640, 9510, 6195
4:00-4:15 a.m.	0900-0915	R. Japan[4]	B	15195, 9505
4:00-4:30 a.m.	0900-0930	UN Radio	B	15250, 9565, 9350-SSB (Tue.-Sat.)
4:00-5:30 a.m.	0900-1030	R. Australia	B	15115
4:00-5:00 a.m.	0900-1000	AFRTS, Los Angeles	A	9590, 9530, 6030
4:15-6:00 a.m.	0915-1100	BBC	C	17790, 17695, 15070, (21660 Sat. & Sun. and daily from 1030)
4:30-5:30 a.m.	0930-1030	R. Japan	C	15235, 11840†
4:30-5:30 a.m.	0930-1030	V. of Germany	C	17780, 11850
5:00-5:15 a.m.	1000-1015	UN Radio	A	15250, 11090-LSB†, 9565 (Sat.)
5:00-5:15 a.m.	1000-1015	R. Japan	B	9505
5:00-5:30 a.m.	1000-1030	V. of Vietnam	C	12036, 10080
5:00-6:00 a.m.	1000-1100	R. Korea	C	15575, 11725, 9870, 9570
5:00-6:00 a.m.	1000-1100	All India Radio	C	17875
5:00-6:00 a.m.	1000-1100	AFRTS, Los Angeles	A	11805, 9700, 9590, 9530, 6030
5:00-fade out	1000-	R. Australia	B	6045, 5995
5:00-8:00 a.m.	1000-1300	R. Moscow (via Cuba)	B	9600, 600
5:00-11:02 a.m.	1000-1602	ABC, Perth	B	9610, 6140
5:10-12:00 a.m.	1010-1700	V. of Nigeria	C	15120
5:15-5:55 a.m.	1015-1055	UAE Radio, Dubai	C	21700, 21640, 21625
5:20-5:30 a.m.	1020-1030	V. of Guatemala	B	6180, 640 (time varies widely)
5:28-8:00 a.m.	1028-1300	CBC Northern Service	B-C	9625, 6065 (not all Eng.)
5:30-6:30 a.m.	1030-1130	Sri Lanka Br. Corp.	C	17850, 15120, 11800, (not all Eng.)
6:00-6:15 a.m.	1100-1115	R. Japan	B	9505
6:00-6:30 a.m.	1100-1130	V. of Vietnam	C	12036, 10080
6:00-6:30 a.m.	1100-1130	R. Mogadishu	D	9585
6:00-6:56 a.m.	1100-1156	R. RSA	C	25790, 21535
6:00-7:00 a.m.	1100-1200	V. of Asia, Taiwan	C	5980 (Sun. 1030-1040)
6:00-7:00 a.m.	1100-1200	AFRTS, Los Angeles	A	6030
6:00-7:30 a.m.	1100-1230	TWR-Bonaire	A	11815 (Sat. & Sun. 1100-1330)
6:00-7:50 a.m.	1100-1250	R. Pyongyang	C	9977
6:00-8:00 a.m.	1100-1300	R. Australia	A	9580, 17795
6:00-8:30 a.m.	1100-1330	BBC	A B	25650, 21710, 21660, 21550, 11775, 11750, 9740, 9510, 6195
6:00-9:00 a.m.	1100-1400	4VEH, Haiti	C	11835, 9770
6:00-10:00 a.m.	1100-1500	VOA	B	11715, 9565
6:00-12:00 a.m.	1100-1700	AFRTS, Los Angeles	A	15430, 15330, 11805, 9700
6:15-6:30 a.m.	1115-1130	Vatican R.	C	21485, 17840 (not Sun.)
6:30-6:55 a.m.	1130-1155	R. Nacional, Angola	D	11955, 9535 (Mon.-Fri.) (irreg.)
6:30-7:30 a.m.	1130-1230	R. Thailand	C	11905, 9655
7:00-7:15 a.m.	1200-1215	V. of Kampuchean People	C	11938, 9694 (vary)
7:00-7:20 a.m.	1200-1220	Vatican R.	B	21485, 17840 (not Sun.)
7:00-7:20 a.m.	1200-1220	R. Canada International	A	17820, 15440, 11955, 9650 (Mon.-Fri.)
7:00-7:30 a.m.	1200-1230	Kol Israel	C	25640, 21675, 21600, 17612.5
7:00-7:30 a.m.	1200-1230	R. Finland	B	15400, 17800 (one hour later from Sept. 27)
7:00-7:30 a.m.	1200-1230	R. Norway	C	25730, 21730, 25615 (Sun.)
7:00-7:30 a.m.	1200-1230	R. Tashkent	C	15460, 11785, 9750, 9715, 5950
7:00-7:30 a.m.	1200-1230	R. Japan	B	9505
7:00-7:30 a.m.	1200-1230	HCJB, Ecuador	A	26020, 15115, 11740
7:00-7:45 a.m.	1200-1245	V. of Germany	B	21600, 17875, 17765, 15410
7:00-7:55 a.m.	1200-1255	R. Peking	B	15520
7:00-8:00 a.m.	1200-1300	V. of Turkey	D	9560†
7:00-9:00 a.m.	1200-1400	R. Moscow World Service	B	1740, 15150, 15135, 12030, 11720, 9750, 9580
7:20-7:50 a.m.	1220-1250	R. Ulan Bator, Mongolia	C	12070 or 11825, 6383 or 4850 or 7235† (not Sun.)
7:30-7:55 a.m.	1230-1255	R. Tirana	D	11960, 9515
7:30-7:57 a.m.	1230-1257	Austrian R.	B	21655†
7:30-8:00 a.m.	1230-1300	R. Sweden	C	21690, 21635
7:30-8:00 a.m.	1230-1300	BBC (English by radio)	C	21695
7:30-8:00 a.m.	1230-1300	R. Bangladesh	D	21670, 15285
7:30-8:25 a.m.	1230-1325	R. Finland	B	17800, 15400 (Sun.) (one hour later from Sept. 27)
7:30-8:30 a.m.	1230-1330	R. Korea	C	11830, 9570
7:30-8:30 a.m.	1230-1330	R. Maldives	D	4754
7:30-9:30 a.m.	1230-1430	HCJB, Ecuador	A	26020, 17890, 15115, 11740
7:30-9:30 a.m.	1230-1430	SLBC, Sri Lanka	C	15425, 9720
7:30-10:51 a.m.	1230-1551	WYFR, Family Radio	A	21545, 17785 (Sun. only)
7:35-7:45 a.m.	1235-1245	V. of Greece	C	21455, 17830, 11730 (Mon.-Fri.)
8:00-8:15 a.m.	1300-1315	R. Japan	B	9505
8:00-8:30 a.m.	1300-1330	R. Bucharest	C	17850, 15250, 11940
8:00-8:45 a.m.	1300-1345	R. Berlin International	C.	21540, 21465, 17700 (one hour later from Sept. 27)
8:00-9:00 a.m.	1300-1400	R. Australia	C	11705, 9770, 6080
8:00-10:57 a.m.	1300-1557	R. RSA	B	25790, 21535, 15220
8:00-11:00 a.m.	1300-1600	CBC Southern Service	A	17820, 11955 (Sun.)
8:00-12:00 a.m.	1300-1700	WYFR, Family Radio	A	9535 or 11830 (15365 from 1500)
8:00 a.m.-6:00 p.m.	1300-2300	CBC Northern Service	B-C	11720, 9625 (not all Eng.)
8:15-8:45 a.m.	1315-1345	Swiss R. International	B	21570, 21520, 17850, 17830
8:30-9:00 a.m.	1330-1400	R. Finland	B	21475, 15400 (one hour later from Sept. 27)

8:30-9:00 a.m.	1330-1400	BRT, Belgium	B	21810, 21525 (Mon.-Fri.)
8:30-9:00 a.m.	1330-1400	NYAB, Bhutan	D	4692 (Wed. & Fri.)
8:30-9:20 a.m.	1330-1420	R. Nederland	C	17605
8:30-9:30 a.m.	1330-1430	V. of Turkey	C	15125
8:30-9:30 a.m.	1330-1430	V. of Vietnam	C	12036, 10080
8:30-10:00 a.m.	1330-1500	All India R.	C	15335, 11810
8:30-11:00 a.m.	1330-1600	BBC	B-C	25650, 21710, 21660, 21550, 21470, 15400 (from 1430), 15070
8:30-11:00 a.m.	1330-1600	R. Malaysia Sabah	C	5980, 4970
8:30 a.m.-fade	1330-	R. Australia	C	6060
8:30 a.m.-5:00 p.m.	1330-2200	R. Moscow World Service (via Cuba)	B	11840 or 11860
8:57-11:55 a.m.	1357-1655	V. of Philippines	D	9578 (Sun.-1555) (not all English)
9:00-9:15 a.m.	1400-1415	R. Japan	B	9505
9:00-9:30 a.m.	1400-1430	R. Sweden	B	21615
9:00-9:30 a.m.	1400-1430	R. Norway	B	25730, 21730, 17795 (Sun. only)
9:00-9:30 a.m.	1400-1430	V. Rev. Party, N. Korea	D	4557, 4109
9:00-9:30 a.m.	1400-1430	R. Tashkent	C	15460, 11785, 9750, 9715, 5950
9:00-10:00 a.m.	1400-1500	R. Moscow World Service	B	15150, 15135, 12030, 11900, 11720, 9750, 9580
9:00-10:00 a.m.	1400-1500	R. Malaysia Sarawak	C	7160, 4950
9:00-10:00 a.m.	1400-1500	V. of Indonesia	C	15200 or 15150, 11790
9:00-12:30 a.m.	1400-1730	R. Australia	C	17795, 9770, 9710
9:30-10:00 a.m.	1430-1500	KTWR, Guam	B	11945
9:30-10:25 a.m.	1430-1525	R. Nederland	B	21480, 15560, 11740
9:30-11:00 a.m.	1430-1600	HCJB, Ecuador	A	26020, 17890, 15115
9:30-11:00 a.m.	1430-1600	Burma Br. Ser.	D	5985, 5040
9:30 a.m.-5:00 p.m.	1430-2200	UN Radio	A	21670, 15410 (when in session)
9:35-10:20 a.m.	1435-1520	R. Nepal	D	3425 or 7105 or 9589
10:00-10:15 a.m.	1500-1515	R. Japan	C	9505
10:00-10:30 a.m.	1500-1530	V. of Asia, Taiwan	D	5980 (not Sun.)
10:00-11:00 a.m.	1500-1600	V. of Rev. Ethiopia	D	9560
10:00-11:00 a.m.	1500-1600	V. of Nigeria	C	11770 (varies)
10:00-11:00 a.m.	1500-1600	BBC	B	17830, 15260 (Sat, Sun)
10:00-11:00 a.m.	1500-1600	R. Moscow World Service	B	12010, 24020, 12050, 11900, 11720, 9580
10:00-12:30 a.m.	1500-1730	BSHKJ, Jordan	D	9560
10:30-11:00 a.m.	1530-1600	R. Afghanistan	D	4775 or 6230
10:30-11:00 a.m.	1530-1600	R. Yugoslavia	C	15300, 15240
10:30-11:00 a.m.	1530-1600	Swiss R. International	B	21570, 17830, 15125
10:30-11:30 a.m.	1530-1630	V. of Vietnam	C	11840, 10040
10:35-10:45 a.m.	1535-1545	V. of Greece	C	21455, 17830, 11730 (Mon.-Fri.)
10:45-11:00 a.m.	1545-1600	R. Canada International	A	21695, (17820 Mon.-Sat.), 15325
11:00-11:15 a.m.	1600-1615	R. Japan	C	9505
11:00-11:15 a.m.	1600-1615	Vatican R.	C	17730
11:00-11:15 a.m.	1600-1615	R. Pakistan	C	21757, 21605, 21486, 17910, 17660†
11:00-11:30 a.m.	1600-1630	R. Norway	B	25730, 25615, 17795 (Sun. only)
11:00-11:30 a.m.	1600-1630	R. Portugal	C	21530 or 21475 (not Sun.)
11:00-12:00 a.m.	1600-1700	R. Korea	C	11830, 9720
11:00-12:00 a.m.	1600-1700	R. Moscow World Service	B	24020, 15240, 15150, 12050, 12030, 11900, 11720
11:00 a.m.-12:09 p.m.	1600-1709	BBC	B	21710, 17830, 15260
11:00 a.m.-6:00 p.m.	1600-2300	VOA	A	26040, 21660, 21485, 17870, (15250 from 1900) 15445, (15410 to 2200)
11:05-11:55 a.m.	1605-1655	R. France International	B	25820, 21620, 21580, 21515, 17860 (one hour later from Sept. 27)
11:10-11:55 a.m.	1610-1655	BRT, Belgium	C	21810 (one hour later from Sept. 27)
-11:30 a.m.	-1630	R. Singapore	C	11940, 5052, 5010 (fade-in time varies)
11:15-12:00 a.m.	1615-1700	UAE Radio, Dubai	B	21700, 21655, 21625
11:45-12:00 a.m.	1645-1700	R. Canada International	A	21695, 17820, 15325
11:45-12:45 p.m.	1645-1745	R. Pakistan	C	15500, 11672†
12:00-12:15 p.m.	1700-1715	R. Japan	C	9505
12:00-12:30 p.m.	1700-1730	HCJB, Ecuador	B	26020, 21480, 17790
12:00-12:45 p.m.	1700-1745	BBC	C	17695
12:00-1:00 p.m.	1700-1800	R. Moscow World Service	A	15455, 15425, 15240, 15150, 12050, 12030, 11960, 11900
12:00-1:00 p.m.	1700-1800	AFRTS, Los Angeles	A	17765, 15430, 15345, 15330, 11805
12:00-1:00 p.m.	1700-1800	WYFR, Family Radio	A	21615, 21465, 17845, 15440, 15365, 11830
12:00-3:00 p.m.	1700-2000	4VEH, Haiti	C	11835, 9770 (Sun.)
12:00-4:00 p.m.	1700-2100	BSK, Saudi Arabia	C	11856 (varies)
12:00-5:00 p.m.	1700-2200	VOA	B	17785, 15205, 11760, 9760, (15140 from 1830)
12:09-12:45 p.m.	1709-1745	BBC	B	17830, 15260 (Sat. & Sun.)
12:15-1:05 p.m.	1715-1805	V. of Germany	C	21600
12:45-3:00 p.m.	1745-2000	BBC	C	(21710 to 1830), 15400, 15070, 12095
12:45-5:30 p.m.	1745-2230	All India R.	C	11620
1:00-1:15 p.m.	1800-1815	R. Japan	C	9505
1:00-1:30 p.m.	1800-1830	R. Canada International	A	17820, 15260 (Sat. & Sun. - 1900)
1:00-1:30 p.m.	1800-1830	R. Norway	C	25730, 21655, 17875 (Sun. only)
1:00-2:00 p.m.	1800-1900	V. of Vietnam	C	10040, 15010
1:00-2:00 p.m.	1800-1900	R. Moscow World Service	A	17700, 15455, 15425, 15240, 15150, 12050, 11960, 11900, 11700
1:00-2:00 p.m.	1800-1900	WYFR, Family Radio	A	21615, 15440, 15365, 11830
1:00-2:00 p.m.	1800-1900	V. of Nigeria	C	15120, 17800
1:00-3:00 p.m.	1800-2000	R. Australia	C	17795
1:00-4:00 p.m.	1800-2100	R. Kuwait	C	11650
1:00-5:00 p.m.	1800-2200	AFRTS, Los Angeles	A	21570, 17765, 15430, 15345, 15330

1:15-1:45 p.m.	1815-1845	Swiss R. International	C	21570 or 21520, 17850, 17830, 15415 or 15305
1:15-2:15 p.m.	1815-1915	R. Bangladesh	D	15285, 11765 (both vary)†
1:30-1:35 p.m.	1830-1835	UN Radio	A	21670, 18782.5-SSB, 17740 (Mon.-Fri.)
1:30-1:57 p.m.	1830-1857	Austrian Radio	C	15560 (Sun. from 1805)
1:30-2:00 p.m.	1830-1900	V. of Revolution, Guinea	C	15309 (varies) 9650 (Mon. Wed. and Fri.) (irregular)
1:30-4:00 p.m.	1830-2100	WRNO, New Orleans	A	15175
2:00-2:30 p.m.	1900-1930	R. Japan	B	17755
2:00-2:30 p.m.	1900-1930	R. Canada International	A	21695, 17875, 15325 (Sat. & Sun. -2000)
			A	17820, 15260 (Mon.-Fri.)
2:00-2:30 p.m.	1900-1930	R. Afghanistan	C	15079 (varies) or 17742†, 9665
2:00-2:45 p.m.	1900-1945	UN Radio	A	21670, 15300 (Mon.-Fri.)
2:00-3:00 p.m.	1900-2000	HCJB, Ecuador	C	26020, 21480, 17790†
2:00-3:00 p.m.	1900-2000	WYFR, Family Radio	A	21615, 17845, 11830
2:00-3:00 p.m.	1900-2000	R. Nacional, Brazil	C	17810, 15125
2:00-3:00 p.m.	1900-2000	R. Moscow World Service	A	17700, 15455, 15150, 12050, 11960
2:30-3:30 p.m.	1930-2030	V. of Iran	D	9022
2:35-5:00 p.m.	1935-2200	TIFC, Costa Rica	C	9645 (Sun.)
2:45-4:15 p.m.	1945-2115	R. Free Grenada	C	15104 (time varies and irregular)
3:00-3:15 p.m.	2000-2015	R. Japan	B	17755
3:00-3:30 p.m.	2000-2030	R. Norway	C	25730, 25615, 21730 (Sun.)
3:00-3:30 p.m.	2000-2030	R. Algiers	C	Some of: 25700, 25680, 21725, 21635, 17745, 15365, 15307, 11810
3:00-3:30 p.m.	2000-2030	R. Canada International	A	21630, 17875, 17820, 15325 (Mon.-Fri.)
3:00-3:30 p.m.	2000-2030	Kol Israel	C	21675, 21495, 17685, 17645, 15582.6
3:00-4:00 p.m.	2000-2100	R. Moscow World Service	A	17700, 15425, 15150, 15100, 12050, 11960, 7390
3:00-4:00 p.m.	2000-2100	WYFR, Family Radio	A	21615, 21525, 15440, 15365, 11830
3:00-4:15 p.m.	2000-2115	BBC	B	21560, 15260, 15070, 11750
3:00-7:00 p.m.	2000-2400	R. Moscow (via Cuba)	C	600
3:10-4:40 p.m.	2010-2140	R. Habana Cuba	A	15155 or 11920
3:15-3:30 p.m.	2015-2030	Sri Lanka Br. Corp.	C	15120, 15115, 11800
3:30-4:15 p.m.	2030-2115	Int. Christ. Radio, Malta	C	9510
3:30-4:20 p.m.	2030-2120	R. Nederland	B	21685, 17695, 17605, 15220, 9715
3:30-4:30 p.m.	2030-2130	V. of Vietnam	C	15010, 10040
3:30-4:30 p.m.	2030-2130	V. Turkey	C	9615 or 9725
3:50-4:00 p.m.	2050-2100	R. Free Europe	C	21720, 17835, 15255, 15420 or 15290, 11825, 9725, 9565 (Fri.)
3:50-4:40 p.m.	2050-2140	R. Habana Cuba	C	17750, 11725
4:00-4:15 p.m.	2100-2115	R. Japan	B	17755
4:00-4:50 p.m.	2100-2150	R. RSA	B	17780, 15155, 11900, 9585
4:00-5:00 p.m.	2100-2200	V. of Nigeria	C	15120, 17800
4:00-5:00 p.m.	2100-2200	R. Moscow World Service	C	17700, 15425, 15240, 15100, 12050, 11960, 11750, 11700, 9700
4:00-5:00 p.m.	2100-2200	WYFR, Family Radio	A	21615, 21525, 15440, 15365, 9535
4:00-6:00 p.m.	2100-2300	WRNO, New Orleans	A	11890
4:00-6:00 p.m.	2100-2300	CBC Radio	A	17875, 15325 (Mon.-Fri.)
4:15-5:00 p.m.	2115-2200	BBC	A	21690, 15260, 15070, 9510, 6175
4:15-5:45 p.m.	2115-2245	R. Cairo	C	19610, 9805 (time may shift one hour later)
4:15-7:30 p.m.	2115-2430	R. Free Grenada	B	15045 (time varies)
4:30-5:00 p.m.	2130-2200	R. Canada International	A	17820, 15150, 11945 (17875, 15325 Sat. & Sun.)
4:30-5:00 p.m.	2130-2200	KGEI, San Francisco	C	15280
4:30-5:00 p.m.	2130-2200	HCJB Ecuador	C	26020, 21480, 17790†, 15305†
4:30-5:00 p.m.	2130-2200	R. Sofia	B	15135, 11750, 11720
4:30-5:30 p.m.	2130-2230	R. Baghdad	C	9745
4:40-5:40 p.m.	2140-2240	V. of Free China	C	17890, 15270, or 15210, 11825
4:45-5:15 p.m.	2145-2215	Swiss R. International	C	21585, 21520 or 17830, 17850, 15305
4:55 p.m.-1:30 a.m.	2155-0630	R. New Zealand	C	17860
5:00-5:15 p.m.	2200-2215	R. Japan	B	17755, (via Portugal 15425†)
5:00-5:30 p.m.	2200-2230	R. Argentina	D	11710 (Mon.-Sat.)
5:00-5:30 p.m.	2200-2230	R. Norway	C	17795, 15135, 15345 (Sun. only)
5:00-5:30 p.m.	2200-2230	R. Vilnius	B	17870, 17845, 15100, 12060, 11735 (one hour later from Oct. 1)
5:00-6:00 p.m.	2200-2300	WYFR, Family Radio	A	21525, 15440, 15365, 11875, 9535
5:00-6:00 p.m.	2200-2300	R. Moscow	A	21560, 17760, 17700, 15425, 12050, 11850, 11770, 11750, 11720, 11700, 9760, 9720, 9685, 9665, 9610 (until Oct. 1)
5:00-6:00 p.m.	2200-2300	V. of Turkey	B	9725, 7215†
5:00-6:00 p.m.	2200-2300	R. Clarin, Dom. Rep.	B	11700 (Sat. & Sun.; irregular)
5:00-6:00 p.m.	2200-2300	BBC	A	21690, 15420, 15260, 15070, 11750, 9590, 9510, 6175, 6120
5:00-7:00 p.m.	2200-2400	CBC Southern Service	A	9755, 5960 (Sat. 2200-2230; Sun. 2200-2300)
5:00-7:00 p.m.	2200-2400	AFRTS, Los Angeles	A	25615, 21570, 15430, 15345, 15330
5:00-11:30 p.m.	2200-0430	VOA	A	21460, 17740, (26000 – 2400), (17820 -0100)
5:15-5:30 p.m.	2215-2230	UN Radio	A	15240, 11830 or 11920 (Mon.-Fri.)
5:15-5:30 p.m.	2215-2230	R. Yugoslavia	C	9620
5:30-6:00 p.m.	2230-2300	Kol Israel	A	21710, 15583, 11638, 9815
5:30-6:00 p.m.	2230-2300	R. Nacional, Angola	O	11955, 9535 (Mon.-Fri.) (Irreg.)
5:30-6:25 p.m.	2230-2325	R. Mexico	B	15430 (Sun.; time varies)
5:30-6:30 p.m.	2230-2330	R. Sofia	B	15330, 15110
5:45-6:30 p.m.	2245-2330	SODRE, Uruguay	C	11885 (time varies)
6:00-6:30 p.m.	2300-2330	R. Japan	C	17755
6:00-6:30 p.m.	2300-2330	R. Sweden	B	11705, 9695

6:00-7:00 p.m.	2300-2400	4VEH, Haiti	B	11835, 9770
6:00-7:00 p.m.	2300-2400	WYFR, Family Radio	A	21525, 15365, 9535
6:00-7:00 p.m.	2300-2400	R. Mexico	B	15430 (Thurs.; time varies)
6:00-7:30 p.m.	2300-2430	BBC	A	15420, 15260, 15070, 11910, 9600, 9590, 9410, 7325, 6175, 6120, 5975
6:00-7:50 p.m.	2300-2450	R. Pyongyang	C	9977
6:00-8:00 p.m.	2300-0100	R. Moscow	A	21560, 17760, 17700, 15425, 12050, 11770, 11750, 11720, 11710, 11700, 9760, 9720, 9685, (9665 to 2400)
6:00-9:00 p.m.	2300-0200	WRNO, New Orleans	A	11965
6:00-12:07 p.m.	2300-0507	CBC Northern Service	B-C	9625, 6195 (not all English)
6:30-7:00 p.m.	2330-2400	HCJB, Ecuador	B	26020, 15180†
6:30-7:00 p.m.	2330-2400	R. Kiev	B	17870, 17845, 15100, 12060, 11735, 9800 (one hour later from Oct. 1)
6:30-7:00 p.m.	2330-2400	V. of Vietnam	C	12036, 10080
6:45-7:45 p.m.	2345-2445	R. Japan	C	17825, 15430
7:00-7:15 p.m.	0000-0015	R. Japan	C	17755
7:00-7:25 p.m.	0000-0025	R. Tirana	B	9750, 7065
7:00-7:30 p.m.	0000-0030	R. Mexico	C	17765, 15430, 11770 (Sat.)
7:00-7:30 p.m.	0000-0030	R. Canada International	A	9755, 5960
7:00-7:30 p.m.	0000-0030	Kol Israel	A	15583, 11638, 9815
7:00-7:30 p.m.	0000-0030	R. Norway	C	17840, 15345, 11870 (Mon. only)
7:00-7:45 p.m.	0000-0045	R. Berlin International	C	11975, 9730, 9560 (one hour later from Sept. 27)
7:00-7:55 p.m.	0000-0055	R. Peking	B	17855, 17680, 15520, 15120
7:00-8:00 p.m.	0000-0100	WYFR, Family Radio	A	15365, 9715, 5985
7:00-8:00 p.m.	0000-0100	R. Sofia	B	15330, 15110
7:00-8:00 p.m.	0000-0100	AFRTS, Los Angeles	A	25615, 21570, 15430, 15330, 11790
7:00-9:00 p.m.	0000-0200	R. Luxembourg	C	6090 (Time varies)
7:00-9:00 p.m.	0000-0200	VOA	A	17860 and/or 17730, 15205, 11740, 9650, 6130, 5995, 1580
7:00-12:00 p.m.	0000-0500	R. Moscow (via Cuba)	A	9600, 600
7:00 p.m.-4:00 a.m.	0000-0900	UN Radio	A	6055 (when in session)
7:05-8:55 p.m.	0005-0155	Spanish Foreign R.	B	11880, 9630
7:15-8:00 p.m.	0015-0100	BRT, Belgium	C	15365, 15175
7:15-8:00 p.m.	0015-0100	SODRE, Uruguay	C	11885 (time varies)
7:30-8:00 p.m.	0030-0100	R. Prague	C	6055
7:30-8:00 p.m.	0030-0100	R. Budapest	B	17710, 15220, 11910, 9835, 9585 (Wed. and Fri.) (one hour later from Sept. 27)
7:30-8:00 p.m.	0030-0100	La Cruz del Sur, Bolivia	D	4875 (Mon. only)
7:30-9:00 p.m.	0030-0200	HCJB, Ecuador	A	15155
7:30-9:30 p.m.	0030-0230	SLBC, Sri Lanka	C	15425
7:30-9:30 p.m.	0030-0230	BBC	A	15260, 15070, 11835, 11750, 9410, 7325, 6175, 6120, 5975
7:35-9:30 p.m.	0035-0230	HCJB, Ecuador	B	17875, 15360, 9745
7:55-8:35 p.m.	0055-0135	TWR-Bonaire	B	11755
8:00-8:15 p.m.	0100-0115	R. Japan	C	17755
8:00-8:15 p.m.	0100-0115	Vatican R.	B	11845, 9605, 6015
8:00-8:20 p.m.	0100-0120	RAI, Italy	B	11800, 9575
8:00-8:25 p.m.	0100-0125	Kol Israel	A	15583, 11638, 9815
8:00-8:30 p.m.	0100-0130	R. Argentina	C	11710 (not Mon.)
8:00-8:30 p.m.	0100-0130	La Voz de la Mosquitia, Honduras	C	4910
8:00-8:30 p.m.	0100-0130	R. Budapest	B	17710, 15220, 11910, 9835, 9585, 6025 (not Mon.) (one hour later from Sept. 27)
8:00-8:30 p.m.	0100-0130	R. Canada International	A	17820, 9755, 5960
8:00-8:54 p.m.	0100-0154	V. of Germany	A	15105, 11865, 9590, 9565, 9545, 6145, 6085, 6040
8:00-8:55 p.m.	0100-0155	R. Prague	B	11990, 9740, 9540, 7345, 5930
8:00-8:55 p.m.	0100-0155	R. Peking	B	17855, 17680, 15520, 15120
8:00-9:00 p.m.	0100-0200	V. of Free China	C	17890, 15345, 11825
8:00-9:00 p.m.	0100-0200	R. Moscow	A	21560, 17760, 17700, 15425, 12050, 11770, 11750, 11720, 11710, 9760, (9700 from 0130), 9685, 9610, 7150
8:00-9:00 p.m.	0100-0200	AFRTS, Los Angeles	A	25615, 21570, 15430, 15330, 11790
8:00-9:00 p.m.	0100-0200	WYFR, Family Radio	B	15365, 9715, 5985
8:00-10:30 p.m.	0100-0330	R. Australia	B	21740, 17795
8:00-11:50 p.m.	0100-0450	R. Habana Cuba	B	11930, 11725
8:20 p.m.-12:10 a.m.	0120-0510	R. Belize	C	3285, 834
8:30-8:45 p.m.	0130-0145	V. of Greece	B	11730, 9655, 9515 (not Sun.)
8:30-8:57 p.m.	0130-0157	Austrian Radio	B	9770, 5945
8:30-8:55 p.m.	0130-0155	R. Tirana	B	9750, 7120
8:30-9:15 p.m.	0130-0215	R. Berlin International	C	11975, 9730, 9560 (one hour later from Sept. 27)
8:30-9:30 p.m.	0130-0230	R. Japan	C	21640, 17825, 17725, 15235
8:45-9:15 p.m.	0145-0215	Swiss R. International	A	15305, 11715, 9725, 6135
9:00-9:15 p.m.	0200-0215	R. Japan	C	17755
9:00-9:25 p.m.	0200-0225	Kol Israel	A	15583, 11638, 9815
9:00-9:30 p.m.	0200-0230	R. Canada International	A	11940, 9755, 5960
9:00-9:30 p.m.	0200-0230	R. Norway	B	11895, 11870, 9590, (Mon. only)
9:00-9:30 p.m.	0200-0230	R. Kiev	B	17870, 15100, 12060, 11735, 9800 (one hour later from Oct. 1)
9:00-9:30 p.m.	0200-0230	R. Budapest	B	17710, 15220, 11910, 9835, 9585, 6025 (one hour later from Sept. 27)
9:00-9:40 p.m.	0200-0240	R. Polonia	B	15120, 11815, 9525, 7270, 7145, 6135, 6095 (length varies)

9:00-9:50 p.m.	0200-0250	R. RSA	B	11900, 9615, 9585, 5980
9:00-9:55 p.m.	0200-0255	R. Bucharest	C	15380, 11940, 11840, 11725 9570, 5990
9:00-9:55 p.m.	0200-0255	R. Peking	B	17855, 17680, 15520, 15120
9:00-10:00 p.m.	0200-0300	R. National, Brazil	A	17830, 15290
9:00-10:00 p.m.	0200-0300	WYFR, Family Radio	A	11740, 9715
9:00-10:00 p.m.	0200-0300	R. Moscow	A	17760, 17700, 15425, 15405, 12050, 11770, 11750, 11720, 11710, 9760, 9720, 9700, 9685, 9610, 7150
9:00-10:30 p.m.	0200-0330	R. Cairo	B	12000, 9475
9:00-11:00 p.m.	0200-0400	VOA	A	17860, and/or 17730, 15205, 9650, 5995, 1580
9:00-11:30 p.m.	0200-0430	AFRTS, Los Angeles	A	21570, 17765, 11790, 6030
9:00 p.m.-3:00 a.m.	0200-0700	WRNO, New Orleans	A	6155
9:30-9:45 p.m.	0230-0245	R. Pakistan	C	21590, 17835, 21755
9:30-9:45 p.m.	0230-0245	UN Radio	A	15240, 6035, 15685-SSB 13869-SSB (Tue.-Sat.)
9:30-9:55 p.m.	0230-0255	R. Tirana	B	9750, 7120
9:30-10:00 p.m.	0230-0300	R. Lebanon	C	17715† (time varies)
9:30-10:00 p.m.	0230-0300	R. Finland	B	11755, 15400 (one hour later from Sept. 27)
9:30-10:00 p.m.	0230-0300	R. Sweden	B	11705, 9695
9:30-10:15 p.m.	0230-0315	R. Berlin International	B	11975, 11890, 11840, 9560 (one hour later from Sept. 27)
9:30-10:25 p.m.	0230-0325	R. Nederland	A	9590, 6165
9:30-10:30 p.m.	0230-0330	R. Korea	C	15575, 11810
9:30-10:30 p.m.	0230-0330	BBC	A	11750, 9510, 9410, 7325, 6175, 6120, 5975
9:30-12:00 p.m.	0230-0500	HCJB, Ecuador	A	15360, 9745
9:51-9:58 p.m.	0351-0358	V. of Yerevan	C	17870, 17845, 15100 (one hour earlier until Oct. 1)
10:00-10:15 p.m.	0300-0315	R. Japan	C	17755
10:00-10:15 p.m.	0300-0315	R. Budapest	B	17710, 15220, 11910, 9835, 9585, 6025 (Wed. & Fri.; Mon. -0330) (one hour later from Sept. 27)
10:00-10:25 p.m.	0300-0325	R. Polonia	B	15120, 11815, 9525, 7270, 7145, 6135, 6095 (length varies)
10:00-10:30 p.m.	0300-0330	R. Canada International	A	11940, 11845, 9755, 9535, 5960
10:00-10:30 p.m.	0300-0330	R. Portugal	B	11925, 6155
10:00-10:30 p.m.	0300-0330	R. Australia	C	15260 (Fri.)
10:00-10:50 p.m.	0300-0350	V. of Free China	C	17890 or 17830, 15345,15270, 11825
10:00-10:55 p.m.	0300-0355	R. Prague	B	11990, 9740, 9540, 7345, 5930
10:00-10:55 p.m.	0300-0355	R. Peking	B	17680, 15520, 15120
10:00-11:00 p.m.	0300-0400	R. Moscow World Service	A	11920, 11720, 9665 (North American Service from Oct.1)
10:00-11:00 p.m.	0300-0400	TIFC Costa Rica	C	9645, 5055, (Mon. 0235 0435)
10:00-11:00 p.m.	0300-0400	R. Moscow	A	17760, 17700, 15405, 15180, 12050, 9580
10:00-11:00 p.m.	0300-0400	R. Baghdad	C	21585, 15400, 11935,
10:00-11:15 p.m.	0300-0415	R. Uganda	B	15325 (irregular)
10:00-11:26 p.m.	0300-0426	R. RSA	B	11900, 9585, 7270, 5980
10:00-11:30 p.m.	0300-0430	R. Cultural, Guatemala	B	3300 (Mon. 0030--)
10:00-12:00 p.m.	0300-0500	HRVC, Honduras	B	4820
10:00-12:00 p.m.	0300-0500	WYFR, Family Radio	A	9715, 9675, 5985
10:00-12:00 p.m.	0300-0500	AWR Guatemala	C	5980
10:00 p.m.-2:30 a.m.	0300-0730	VOA	A	15240, 9670, 6040, 6035, 5995
10:25 p.m.-fade	0325-	R. One, Zimbabwe	C	3396 (exc. Sun.)
10:30-10:55 p.m.	0330-0355	R. Tirana	B	7300, 6200
10:30-11:23 p.m.	0330-0423	U.A.E. Radio, Dubai	B	15320, 17775 (length varies)
10:30-10:57 p.m.	0330-0357	Austrian Radio	C	9770, 5945
10:30-11:00 p.m.	0330-0400	R. Australia	B	21680, 17890, 17870, 17795, 17725
10:30-11:45 p.m.	0330-0445	BBC	A	15070, 9410, 6175, 5975
10:30 p.m.-1:00 a.m.	0330-0600	R. Habana Cuba	A	11760, 11725
10:40-10:47 p.m.	0340-0347	V. of Greece	B	11730, 9650, 9515 (not Sun.)
10:50-11:10 p.m.	0350-0410	RAI, Italy	C	17795, 15330
11:00-11:15 p.m.	0400-0415	R. Japan	C	17755
11:00-11:30 p.m.	0400-0430	R. Bucharest	C	15380, 11940, 11725, 9570, 5990
11:00-11:30 p.m.	0400-0430	R. Canada International	A	11845, 9755, 9535, 5960
11:00-11:30 p.m.	0400-0430	R. Norway	C	15135,9590 (Mon. only)
11:00-11:30 p.m.	0400-0430	R. Mozambique	C	4855, 3265
11:00-11:55 p.m.	0400-0455	R. Peking	B	17680, 15520, 15120
11:00-12:00 p.m.	0400-0500	R. Sofia	C	11750†
11:00-12:00 p.m.	0400-0500	R. Australia	B	21680, 21650, 21525, 17890, 17870, 17795, 17755, 17725, 15320, 15240, 15160
11:00-12:00 p.m.	0400-0500	R. Moscow World Service	A	15505, 11920, 11720, 9665
11:00 p.m.-1:00 a.m.	0400-0600	TWR, Bonaire	A	9700
11:00 p.m.-2:00 a.m.	0400-0700	R. Moscow	A	(15405 to 0600), 12050, (11870 and 11750 from 0500), 11710, 9580
11:05-11:50 p.m.	0405-0450	FEBA, Seychelles	C	11810†
11:30-11:57 p.m.	0430-0457	Austrian R.	B	12015
11:30-12:00 p.m.	0430-0500	Swiss R. International	B	11715, 9725
11:30 p.m.-1:00 a.m.	0430-0600	AFRTS, Los Angeles	A	17765, 11790, 15330, 9755, 6030
11:45-12:00 p.m.	0445-0500	Vatican Radio	C	6210 or 6190 (one hour later from Sept. 27)
11:45 p.m.-12:45 a.m.	0445-0545	BBC	A	15070, 9510, 9410, 6175, 5975
11:55 p.m.-1:00 a.m.	0455-0600	V. of Nigeria	C	7255

12:00-12:15 a.m.	0500-0515	Kol Israel	B	21710, 21600, 11655, 11637
12:00-12:15 a.m.	0500-0515	R. Japan	C	15325
12:00-12:54 a.m.	0500-0554	V. of Germany	A	11905, 9650, 9545, 6100, 5960
12:00-1:00 a.m.	0500-0600	R. Australia	C	21680, 17890, 17870, 17725, 15240, 15160
12:00-1:00 a.m.	0500-0600	WYFR, Family Radio	A	9705, 9675, 5985
12:00-1:00 a.m.	0500-0600	R. Moscow World Service	C	17880, 12010, 11735, 9530
12:00-2:00 a.m.	0500-0700	HCJB, Ecuador	B	11915, 9745, 6095
12:00-3:00 a.m.	0500-0800	R. Kuwait	C	15345
2:00-3:00 a.m.	0500-0800	R. Nigeria, Kaduna	B	4770 (not all Eng.)
12:00-5:00 a.m.	0500-1000	V. of Cuba	C	550 and/or 720
12:10-12:45 a.m.	0510-0545	UAE Radio, Dubai	C	21700, 17810, 17775
12:30-12:40 p.m.	0530-0540	R. Garoua, Cameroon	C	5010
12:30-1:00 a.m.	0530-0600	R. Portugal	A	9575, 6155
12:30-fade	0530-	R. Ghana	C	3366, 4915
12:30-1:25 a.m.	0530-0625	R. Nederland	A	9715, 6165
12:30-1:30 a.m.	0530-0630	Spanish Foreign R.	B	11880, 9630
12:35-1:30 a.m.	0530-0630	R. Korea	C	15575, 11810, 9870
12:45-1:30 a.m.	0545-0630	R. Berlin Int.	B	17700, 15100 (one hour later from Sept. 27)
12:45-2:30 a.m.	0545-0730	BBC	B	15070, 11955, 11860, 9640, 9510, 9410, 7150, 6175
1:00-1:15 a.m.	0600-0615	R. Japan	C	15325
1:00-1:30 a.m.	0600-0630	V. of Germany	C	17875, 15275, 11905, 11765, 9700
1:00-1:30 a.m.	0600-0630	R. Norway	C	15135 (Mon. only)
1:00-1:30 a.m.	0600-0630	R. Australia	C	21680, 21525, 17870, 17795, 17755, 17725, 15240, 15160
1:00-2:00 a.m.	0600-0700	AFRTS, Los Angeles	B	11790, 9755, 6030
1:00-2:30 a.m.	0600-0730	R. Kiribati	C	16433-SSB (not all English)
1:00-2:00 a.m.	0600-0730	HCJB, Ecuador	C	11835, 15225
1:00-3:00 a.m.	0600-0800	V. of Nigeria	C	15120, 17800
1:00-4:00 a.m.	0600-0900	R. Cook Islands	C	11760 or 9695 or 5045† (not all English)
1:15-1:30 a.m.	0615-0630	R. Canada International	B	17860, 15265, 11960, 11825, 11775, 9760, 9590, 7155, 6140, 6045 (Mon-Fri)
1:25-3:00 a.m.	0625-0800	TWR, Monte Carlo	B	9495† (Sun. to 1000)
1:25-3:55 a.m.	0625-0855	V. of Malaysia	C	15295, 12350, 9750
1:30-2:00 a.m.	0630-0700	R. Australia	B	21680, 17870, 17725, 15240, 15115
1:30-2:00 a.m.	0630-0700	Radio Polonia	B	9675, 7270
1:30-2:30 a.m.	0630-0730	R. RSA	B	21535. 17780, 15220
1:30-3:00 a.m.	0630-0800	R. Habana Cuba	A	9525
1:40-7:25 a.m.	0640-1225	R. New Zealand	C	15485, 11945
1:45-2:00 a.m.	0645-0700	R. Canada International	B	17860, 15265, 11960, 11825, 11775, 9760, 9590, 7155, 6140, 6045 (Mon-Fri)
1:45-2:00 a.m.	0645-0700	UN Radio	A	15120, 11735 (Tue.-Sat.)
1:57-4:55 a.m.	0657-0955	V. of Philippines	C	9578 (not all English)
2:00-2:15 a.m.	0700-0715	R. Japan	C	15325, (15235† via Portugal)
2:00-2:20 a.m.	0700-0720	R. Nederland	C	25650, 21480, 17605. 11720, 9895
2:00-2:30 a.m.	0700-0730	Swiss Radio Int.	C	21520, 15305, 9560, 9535
2:00-3:00 a.m.	0700-0800	Xandir Malta	C	9670 (Sat.) (irregular)
2:00-3:00 a.m.	0700-0800	ELWA, Liberia	C	11830
2:00-3:00 a.m.	0700-0800	V. of Vietnam	C	7512, 9840, 6383
2:00-4:00 a.m.	0700-0900	R. Australia	B	21680, 17725, 15115, 11740, 9570
2:00-5:30 a.m.	0700-1030	HCJB, Ecuador	C	11900, 9745, 6130
2:07-2:15 a.m.	0707-0715	UN Radio	A	15120, 11735 (Tues. to Sat.)
2:30-3:25 a.m.	0730-0825	R. Nederland	8	9770, 9715
2:30-4:00 a.m.	0730-0900	BBC	B	15070, 11955, 9640, 9510
2:30-6:30 a.m.	0730-1130	Solomon Isl. Broadcasting	C	9545 or 5020 (not all Eng.)
2:30-9:00 a.m.	0730-1400	NBC, Papua New Guinea	C	4890, 3925 (not all Eng.)
2:30-9:02 a.m.	0730-1402	ABC Melbourne	C	9680
2:37-2:45 a.m.	0737-0745	UN Radio	A	17815, 15195 15120, 11735 (Tue.-Sat.)
2:45-4:30 a.m.	0745-0930	KTWR, Guam	B	11840
2:55 a.m.-fade	0755-	Action Radio, Guyana	C	5950
2:55-3:05 a.m.	0755-0805	V. of Guatemala	B	6180, 640 (time varies)
3:00-3:15 a.m.	0800-0815	R. Japan	B	9505
3:00-3:30 a.m.	0800-0830	R. Norway	C	17795, 11850 (Sun.)
3:00-315 a.m.	0800-0815	UN Radio	A	17860, 15235, 15125, 11735 (Tues. to Sat.)
3:30-3:45 a.m.	0830-0845	R. Vanuatu	D	7260, 3945
3:30-4:25 a.m.	0830-0925	R. Nederland	B	9715
3:30-5:00 a.m.	0830-1000	FEBC, Philippines	C	11890 or 11765
24 Hours	24 Hours	CFRX, Toronto	C	6070

Explanatory Notes.

1. Times in first column are EST/CDT. For ADT add 2 hours; EDT add 1 hour; MDT, subtract 1 hour, MST/PDT, subtract 2 hours. Days of week are in GMT.
2. Quality.A–strong signal and very reliable reception. B–regular reception. C–occasional reception under favorable conditions. D–rarely audible. These ratings are for locations in the central USA. European and African stations are in general, more reliably received in eastern North America. Asian and Pacific stations are more reliably received in western North America. North American stations are received well except in areas too close to the transmitter site.
3. The information in this listing is correct to press time. However, frequencies and schedules are constantly changing. Listen to "DX Digest" on R. Canada International for late changes, Saturday at 2130; Sunday at 1930; GMT Mondays at 0100 and 0400.
4. R.–Radio; V.–Voice

† = frequent changes

NEW LITERATURE

Oscilloscope Probe Guide

Greenpar Connectors has a new guide to nine different oscilloscope probe kits that are said to fit any scope on the market. Featured are four fixed-attenuation models with bandwidths from 15 to 250 MHz, two switched-attenuation models (100 to 250 MHz), a demodulator model (100 kHz to 500 MHz), and two detector models (100 kHz to 600 MHz). Complete specifications are given on attenuation, bandwidth, cable length, capacitance, rise time, working voltage, dc offset, etc. Special optional accessories are also described. **Address:** Greenpar Connectors, 14128 Lemoli Ave., Hawthorne, CA 90250.

CBASIC Software Support

"CBASIC: The Key to Business Software Development" is the title of a brochure which describes the computer language and its features such as 14-digit decimal arithmetic, random and sequential disk accessing, complete string processing facilities, and enhanced source code maintenance. Also covered are service and support capabilities. CBASIC is available on all microcomputers running under CP/M, MP/M, CP/NET, CP/M-86, TRSDOS, and UNIX. **Address:** Compiler Systems, Inc., 37 N. Auburn Ave., Box 145, Sierra Madre, CA 91024.

VHF/UHF/Oscar Ham Catalog

A 40-page catalog covers all types of equipment for the vhf/uhf/Oscar ham enthusiast and two-way shops. Featured are a new 5-channel, 10-watt vhf FM transceiver, COR and CWID modules for repeater builders, and new accessories such as r-f-tight enclosures for repeaters and power supplies. New ranges of transmitting and receiving converters have been added, as well as a series of receiving converters to extend frequency coverage. The Cushcraft and Larsen lines of antennas are also included. **Address:** Hamtronics, Inc., 65F Moul Rd., Hilton, NY 14468. For foreign mailing, add $2.00 or 5 IRCs.

Wiring Products Catalog

Catalog E-CC6 contains, in 24 pages, an update of the Panduit line of wiring products. Included are: cable ties, clamps, and markers; wire mounting devices; harness board accessories; cable tie installation tools; plastic wiring duct; spiral wrapping; terminals; and installation tools. **Address:** Panduit Corp., 17301 Ridgeland Ave., Tinley Park, IL 60477.

3M Products Brochure

Nearly 150 products from 3M, grouped by major segments of the communications industry, are described in a new brochure. Products ranging from abrasives to videotape recorders are catalogued for the voice, video and data communications market: original equipment manufacturing; cable and splicing systems; data processing materials; and transmission, storage, and retrieval systems. **Address:** Dept. 1599/3M, Box 4039, St. Paul, MN 55133.

Metal-Film Resistors

A new brochure from Stackpole describes its complete metal-film resistor line, including new low-value units from 1 to 9.9 ohms. Bulletin 82/89-103 details physical and environmental performance specifications for precision, commercial, and general-purpose resistor's ranging in values from 1 ohm to 5 megohms and 1/8 watt to 2 watts. **Address:** Stackpole Components Co., Box 24466, Raleigh, NC 27620.

Line-Power Conditioner

Eight products intended to reduce "electrical pollution" coming through power lines to solid-state electronic equipment are described in a 20-page catalog from SGL Waber Electric. The products, containing varistors, are said to reduce or eliminate power surges, transient spikes, RFI, EMI and electromagnetic pulses. The equipment varies from simple wall plug-in units to console or rack-mounted units. **Address:** SGL Waber Electric, 300 Harvard Ave., Westville, NJ 08093.

Humidity Instrumentation Catalog

A new 16-page short-form catalog covers General Eastern's line of humidity instruments for measurement of dew points, relative humidity, parts-per-million, grains per pound, and dry-wet bulb. Systems provide digital displays, BCD, alarms, and linear voltage and current outputs. Accessories listed include sampling systems, calibration kits, aspirators, pressure bosses, ambient temperature probes, etc. **Address:** General Eastern Instruments Corp., 50 Hunt St., Watertown, MA 02172.

Soldering Products

A new manual (Form 325) contains detailed photographs and descriptions of the Edsyn line of soldering equipment including portable and vacuum-powered desoldering tools, tool holders, special-purpose hand tools, professional kits, etc. **Address:** Edsyn Inc., 15958 Arminta St., Van Nuys, CA 91406.

Digital Switch Guide

A six-page product guide lists ten basic types of thumbwheel digital switches. Brochure No. 1-0074D contains dimension and performance specifications for more than 60 units of various configurations. **Address:** The Digitran Co., 855 S. Arroyo Pkwy., Pasadena, CA 91105.

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.)

Communications Power Inc., CP300 CB radio. Need schematic. Vernon C. Gagnon, Box 162, Clallam Bay, WA 98326.

Sonar Aristocrat 95 radiotelephone. Need schematic and service manual. Don Galloway, 109 Luther Dr., Lakehurst, NJ 08733.

Conar Instruments Model 600 color TV. Need schematic and construction manual. George Gimarelli, 8048 S.E. Main, Portland, OR 97215.

Akai Model X2000SD tape recorder. Need schematic and manual. Tom Poleet, 159 Boylston St., Jamaica Plain, MA 02130

Gemini computer game. Schematic diagram or any information available. Phil Plimmer, Box 701, Alpine, TX 79830

Ford Models 69MF, 76MF, 86MF, 95MF pushbuttons. Want to buy complete unit. D. Smith, Box 113, Trenton MI 48183.

Military receivers BC 348 Q and BC 348R. Need schematics and modifications. **Akai** CR81D 8-track recorder. Need schematic. David Vardy, 24781 Upland Hill Dr., Nevi, MI 48050.

RCA Model CR88A receiver and **Nems Clarke** Model 1302 vhf receiver and REU200, REU100 uhf converters. Need schematics and service manuals. Barry Bakos, RR2 Courtland, Ontario, Canada NOJ1E0.

Hallicrafter Model SR10A radio. Need schematic. **Opti-Cal III** calculator. Need IC chip #MCS521-0024273. Fred Cerne, 2809 So. Austin Blvd., Cicero, IL 60650.

Lloyd's Electronics Int'l., Model JJ-6152, Series 280A radio. Need schematic. Martin Pientkervic, 204 River Road, Vulcan, MI 49892.

Motorola Model 52B1U ac/dc battery portable radio. Need schematic and service data. Don F. Lehman, 378 Fairway Drive, Columbus, OH 43214.

Knight Model KG-686 generator. Need owners manual and schematic. John Schneider, 1501 W. Jean Circle, Lincoln, NB 68522.

Canadian Marconi Co., Model 208 receiver. Need technical manual or schematic. John Allan, USCG Station, Chatham, MA 02633

Metz Model 309 multi-band radio. Need schematic and technical manual. **Valvo** vacumm tubes. Need information on current source. John Sinsabaugh, Box 3, FPO Seattle, WA 98767.

Broan Model 372 home intercom AM/FM radio and phonograph system. Need service manual, operating instructions and schematic. Robert Hatchett, Box 193, Aurora, IN 47001.

Gold Model TI-8000 CB station power supply. Need American replacement numbers for Japanese V/R transistors TA78012P and B595. Also need schematic and parts list. E.V. Schwartz, 4277 Motor Ave., Culver City, CA.

Farnsworth U.S. Army Signal Corp BC-242N receiver. Need any information available. Richard Picott, Box 86, South Berwick, ME 03908.

Kenwood Model TK-666 receiver. Need tuning dial glass. Damon Collins, 1221 William St., Key West, FL 33040.

Metro Electronics metrodyne single dial radio. Need schematic or any information available. H.A. Flatjurd, 719 Gateway St., Cedar Rapids, IA 52402.

RCA WP-703A dc power supply. Need schematic diagram. Richard Slover, 2700 Waverly St., #4, Knoxville, TN 37-21.

Dumont type 201-A oscillograph. Need operation manual and schematic. Robert L. Kitzberger, 7668 Saratoga Rd., Cleveland, OH 44130.

Motorola MH-70 communications receiver. Need schematic and parts list. Yehuda Habot, 6 Rashy, Petach-Ticva 49463 Israel.

Seco Model 520-A antenna tester. Need wiring diagram. R.J. Seyler, 312-186 Edinburgh Rd., Guelph, Ontario N1G 2H9.

Webcor Model ER2101-1 recorder, Serial #757666. Need operation and service manuals. Roy V. Kelly, Box 165, Sheridan, OR 97378.

Hallicrafters Model S-107 receiver. Need alignment data. Don Wagner, 308 Parkdale Avenue, East Aurora, NY 14052.

Digital Systems Model DSC-2 microprocessor. Need operations and maintenance manuals. N.C. Helmkay, Box 446, Milliken, Ontario LOH1K0, Canada.

Friden Model FIO programatic flexowriter, **Monroe** EPIC 3000 calculator and **Tektronix** Model 519 oscilloscope. Need wiring diagram, schematics and operations manuals. Arnold R. Allen, 423 So. Highland, Ada, OK 74820.

Bendix Radio Corp., Type RA-1B radio receiver. Need schematic and alignment data. Andy Anderson, 2250 Cable Avenue, Beaumont, TX 77703.

Pioneer Model SX-700T receiver. Need schematic. Van S. Vangor, Box 346C, Island Falls, ME 04747.

Advance Electronics Ltd., Model OS1000 dual trace oscilloscope. Need schematic and service manual. K. Heinonen, Rte. 4, Box 238, Foley MN 56329.

California Instrument Corp., Model 500 oscilloscope. Need theory and calibrating instructions. William G. Hendricks, 616 W. Lincoln Rd., Stockton, CA 95207.

Eico Model ST40 integrated amplifier. Need tube diagram, schematic and owner's manual. Tim Bovard, 282 W. Dayton St., Gatesburg, IL 61401.

EMS Model S440 power amplifier. Need schematic. Peter Martin, Box 312, Greenhurst, NY 14742.

Admiral Model 12P206 TV. Need schematic. **Tektronix** Type 551 dual beam oscilloscope. Need schematic and operating manual. F. Mayfield, Rt. 3, Box 185, Brighton, TN 58011.

Sears Model 570-74108-0330, Serial 315-20815 AM/FM stereo receiver. Need service and operation manuals. Alvin R. Manlick, Box 431, Waupun, WI 53963.

Lavoie Labs OS-62B/USM military surplus oscilloscope. Need schematic and manual. Peter Cole, Box 1120, Altona, Manitoba, Canada RO60B0.

Echophone Model EC-1B receiver. Need schematic. Howard Webb, 1616 E. Bantam Rd., Tucson, AZ 85706.

Lafayette clock radio, stock #17-01135W. Need schematic diagram and service information. Scott Forgues, 37 Bay St., Fairhaven, MA 02719.

U.S. Navy Type CME-50063 preselector and **Sencore** 43A7 color bar generator. Schematics, service information and manuals needed. Warren Ready, 136 Pine Circle, Cairo, GA 31728.

Dumont Model 322-A oscillograph. Need replacement parts. Jim Pfeiffer, 6232 Tony Ave., Woodland Hills, CA 91367.

Hallicrafters S27 receiver. Need schematic and any information available. J.M. Vetter, 3657 Tantalus Dr., Honolulu, HI 96822.

PROJECT OF THE MONTH

By Forrest M. Mims

Audible Pulse Indicator

HOW MANY times have you wondered if the clock section of a circuit was functioning properly? Finding out can sometimes be a difficult job, particularly if you don't have access to an oscilloscope.

An excellent way to detect pulses when a scope isn't available is to use a logic probe. But, as with a scope, you must keep an eye on the test instrument to determine whether or not pulses are present.

Shown here is a circuit that provides both visual *and* audible indication of the presence of pulses. The circuit is designed around three timers, two of which are integrated onto a single chip.

Timers 1 and 2 are monostable multivibrators, each having a timing period of about 1/3 of a second. The pulse source is connected to the trigger input of Timer 1 through attenuator *R1*. If a pulse occurs, Timer 1's timing cycle is begun. Subsequent pulses which occur *during* the timing are ignored.

Ordinarily, after its timing cycle is complete, Timer 1 would be retriggered by the next incoming pulse. This is acceptable for slow-repetition rate signals. If the time between pulses is very brief, however, it would not always be possible to visually or audibly recognize the presence of pulses since one stretched pulse would be immediately followed by another. In other words, a train of closely spaced pulses would appear continous to the relatively slow eye or ear.

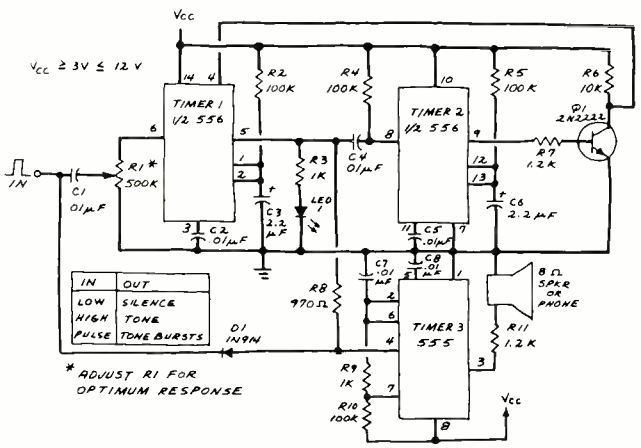
Timer 2 solves this problem by disabling Timer 1 by means of *Q1* for about 1/3 second immediately after each of Timer 1's timing cycles. Timer 1, therefore, responds to an incoming train of fast pulses by switching on and off at 1/3-second intervals.

Indicator *LED1* provides a visual response to the presence of incoming pulses. It stays on during Timer 1's timing cycle.

An astable audio-frequency oscillator provides the circuit's audible output. When Timer 1 has not been triggered, its output is low. Since Timer 1's output is connected to Timer 3's reset input through *R8*, Timer 3 is disabled when no pulse is present at Timer 1's input. When a pulse occurs, Timer 1 is triggered, which, in turn, enables the audio oscillator formed by Timer 3. Note that Timer 3, like Timer 1, is disabled for 1/3 second following the completion of Timer 1's timing cycle. Therefore, a very fast train of pulses is indicated by a slow series of tones spaced 1/3 second apart.

This circuit may need modification for some applications. For example, a high input impedance section can be added to prevent the circuit from loading down the clock being checked. Similarly, an input amplifier can be added to beef up weak pulses. The circuit can even be added to existing circuits so that it becomes an integral audible/visual pulse indicator.

In its present form, the circuit responds to pulses having an amplitude of from a few volts to V_{CC}. Though I used a 556 and a 555 for the three timers, you can use three 555's or a pair of 556's. If you choose the latter approach, you'll have an extra timer section for use in possible circuit modifications. ◇



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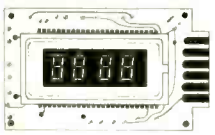

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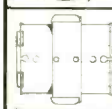

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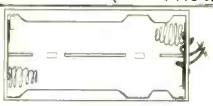

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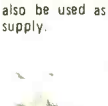

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MM510H	Dual 64-Bit Accumulator	.50
MM1402N	256-Bit Dynamic	2.95
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2111 (8111)	256x4 Static	3.95
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4116N-4 (TMS4416)	16K Dynamic 250ns (MM5290N-4)	7.95
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M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

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JE608 PROGRAMMER
2704/2708 EPROM PROGRAMMER

GENERAL APPLICATIONS:
- To program EPROMS 2704 and 2708.
- Developmental system for microcomputer circuits
- To read the contents of a pre-programmed EPROM
- To compare EPROM(s) for content differences
- To emulate a programmed EPROM
- To store program in RAMS for alterations
- Three separate Display Registers: 8 LED's for Hex Key entries, 10 LED's (2⁴-2⁹) for Address Register and 8 LED's for Data Memory Register. The Data Memory Register displays the content of the RAMs from the EPROM Chip. Development of microprocessor systems by means of a ribbon cable from the programmer panel test socket to the EPROM socket on the microprocessor board. Rapid checking verification of programmed data changes. User may move data from a master to RAM's or write into RAM's with keyboard entries. Allows manual stepping manipulation (up and down) at any address location. Stand-alone EPROM Programmer consisting of: A 19-key Hexadecimal Keyboard assembly, Programmer Board assembly with 4 power supplies snd a LED/Test Socket Panel Board assembly. The Test Socket is zero force insertion type. Power requirements: 115VAC, 60Hz, 6W. Compact desk-top enclosure: Color-coordinated designer's case with light tan panels and molded end pieces in mocha brown. Size: 3¼"H x 11"W x 8¾"D. Weight: 5 lbs.

The JE608 EPROM Programmer is a completely self contained unit which is independent of computer control and requires no additional systems for its operations. The EPROM can be programmed from the Hexadecimal Keyboard or from a pre-programmed EPROM. The JE608 Programmer can emulate a programmed EPROM by the use of its internal RAM circuits. This will allow the user to test or pretest a program for a system, prior to programming a chip. Any changes in the program can be entered directly into the memory circuits with the Hexadecimal Keyboard so that rewriting the entire program will not be necessary. The JE608 Programmer contains a Programmer/Board w/25 IC's & includes power supplies of: -5V, +5V, +12V and +26V. The Hexadecimal Keyboard and LED/Test Socket Panel board are separate assemblies within the system.

JE608K Kit $399.95
JE608A Assembled and Tested $499.95

JE608-16K ADAPTER BOARD
FOR 2716/2758 EPROMS

GENERAL DESCRIPTION:
The JE608 16K Adapter Board allows the JE608 Programmer to be modified for the additional programming of the 2716 and 2758 EPROMS. The adapter provides for adding an address switch for the 2¹⁰ bit and also for selecting the proper power and timing pulses to be applied to the EPROM. Programming and emulating the 2716 (16K) EPROM is done separately to each half (1024x8) of the EPROM because of the existing 8K RAM capacity in the JE608 Programmer.

JE608-16K	Adapter Board Kit	$29.95
JE608-Upgrade	(Send assembled JE608 to factory for adapter installation of the JE608-16K Adapter Board Kit)	$99.95
JE608A-16K Mod.	Assembled JE608 w/Adapter (JE608-16K) Installed	$599.95

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30004	National Series 80 – Board Level Computer (224 pages)	$4.95
30006	National TTL Logic Data Book (624 pages) 7400, LS, LH, S, and DM8000 Series	$6.95
30008S	Buy above (5) 30001,2,3,4,5 as a set.	$24.95/lot
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AC1700	117V/60Hz	9 VAC 1.7 amp	$3.95
DV 9200	117V/60Hz	9 VDC 200mA	$3.25
DC 900	120V/60Hz	9 VDC 500mA	$3.95

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DB51226	Cover for DB25P/S	$1.75
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Expand your 4K TRS-80 System to 16K.

Kit comes complete with:
- ★ 8 ea. MM5290 (UPD416/4116) 16K Dyn. Rams (*NS)
- ★ Documentation for Conversion

TRS-16K2	*150NS	$29.95
TRS-16K3	*200NS	$24.95
TRS-16K4	*250NS	$19.95

JE610 ASCII Encoded Keyboard Kit

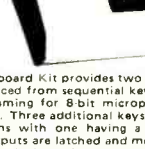
The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and –12V @ 10 mA for operation. Features: 60 keys generate the 126 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector. Size: 3½"H x 14½"W x 8¾"D

JE610/DTE-AK (After assembled as pictured above) **. . . $124.95**

JE610 Kit	62-Key Keyboard, PC Board, & Components (no case).	$ 79.95
K62	62-Key Keyboard (Keyboard only)	$ 34.95
DTE-AK	(case only – 3¼"Hx11"Wx8¾"D)	$ 49.95

NEW! JE212 – Negative 12VDC Adapter Board Kit for JE610 ASCII KEYBOARD KIT
Provides -12VDC from incoming $VDC . . . $9.95

JE600 Hexadecimal Encoder Kit



FULL 8-BIT LATCHED OUTPUT
19-KEY KEYBOARD

The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¼"W x 8¾"D

JE600/DTE-HK (After assembled as pictured above) **. . . $99.95**

JE600 Kit	19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case)	$59.95
K19	19-Key Keyboard (Keyboard only)	$14.95
DTE-HK	(case only – 3½"Hx8¼"Wx8¾"D)	$44.95

7400

SN7400N	.20	SN7472N	.29	SN74156N	.79
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74S

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74S04	.55	74S135	1.19	74S253	1.45
74S05	.55	74S136	1.75	74S257	1.35
74S08	.50	74S138	1.35	74S258	1.35
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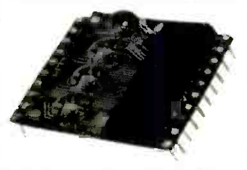
CD4010	.49	CD4048	1.35	CD4512	1.49
CD4011	.39	CD4049	.49	CD4514	3.95
CD4012	.25	CD4050	.69	CD4515	2.95
CD4013	.49	CD4051	1.19	CD4516	1.49
CD4014	1.39	CD4052	1.19	CD4518	1.79
CD4015	1.19	CD4053	1.19	CD4519	.89
CD4016	.59	CD4056	2.95	CD4520	1.29
CD4017	1.19	CD4059	9.95	CD4526	1.79
CD4018	.99	CD4060	1.49	CD4528	1.79
CD4019	.49	CD4066	.79	CD4529	1.95
CD4020	1.19	CD4068	.39	CD4543	2.79
CD4021	1.39	CD4069	.45	CD4562	11.95
CD4022	1.19	CD4070	.55	CD4566	2.79
CD4023	.29	CD4071	.49	CD4583	2.49
CD4024	.79	CD4072	.49	CD4584	.75
CD4025	.23	CD4073	.39	CD4723	1.95
CD4026	2.95	CD4075	.39	CD4724	1.95
CD4027	.69	CD4076	1.39	MC14409	17.95
CD4028	.89	CD4078	.55	MC14410	18.95
CD4029	1.49	CD4081	.39	MC14411	15.95
CD4030	.49	CD4082	.39	MC14412	15.95
CD4034	3.49	CD4093	.99	MC14419	7.95
CD4035	.99			MC14433	15.95
CD4040	1.49			MC14538	2.49
				MC14541	1.95

4-Digit 16 Segment Alphanumeric Intelligent Display with Memory, Recorder, Driver

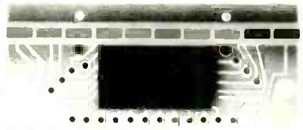


End stackable, 4-character package. High contrast, 160mil high, magnified monolithic characters. 64-Character ASCII format. Built-in memory, decoder, multiplexer and drivers. Direct access to each digit independently and asynchronously. Five volt logic. TTL compatible. Five volt power supply only. Independent cursor function. Size: 1"L x 1-3/16"H x .225"D.

DL-1416 Alphanumeric Display $19.95 ea.

10-Segment Bargraph Displays

(with On-Board Driver IC-Chip)



Size: 2"L x 7/8"H x 3/16"D

Bar or dot display mode externally selectable by user. Packages are end-stackable for expanded displays. Can be cascaded to 10 arrays (100 bargraph elements). LED current programmable from 2mA to 30mA. Stable internal voltage reference for full scale analog inputs from 1.2 to 12V. Each LED output of driver IC with external access. Size: 2"x7/8"x3/16".

NSM3914	Linear Function (10 bars red)	$5.95
NSM39146	Linear Function (6 bars green/4 red)	6.95
NSM3915	Logarithmic Function (10 bars red)	5.95
NSM39158	Logarithmic Func. (6 grn./2 yell./2 rd.)	6.95
NSM3916	VU-Meter Function (10 bars red)	5.95
NSM39168	VU-Meter Func. (6 grn./2 yell./2 rd.)	6.95

DISCRETE LEDS

XC556R	.200"	red	5/$1	MV50	.085"	red	6/$1
XC556G	.200"	green	4/$1	XC209R	.125"	red	5/$1
XC556Y	.200"	yellow	4/$1	XC209G	.125"	green	4/$1
XC556C	.200"	clear	4/$1	XC209Y	.125"	yellow	4/$1
XC22R	.200"	red	5/$1	XC526R	.185"	red	5/$1
XC22G	.200"	green	4/$1	XC526G	.185"	green	4/$1
XC22Y	.200"	yellow	4/$1	XC526Y	.185"	yellow	4/$1
MV10B	.170"	red	4/$1	XC526C	.185"	clear	4/$1

.200(T1¾) Red/Green

Diffused Bi-Color LED

Part No.	1-99	100+
XC5491	.79	.69

XC556 RED LED, METAL MTG. HDW. 2-6" LEADS

RL-2 . . $.39 ea. or 3/$1.00

DISPLAY LEDS

C.A. — Common Anode
D.D. — Double Digit
C.C. — Common Cathode
RHD — Right Hand Decimal

Type	Polarity	Ht	Price	Type	Polarity	Ht	Price
MAN 1	C.A.—red	.270	2.95	DLG507	C.A.—green	.500	1.25
MAN 2	5x7 D.M.—red	.300	4.95	DL704	C.C.—red	.300	1.25
MAN 3	C.C.—red	.125	.25	DL707	C.A.—red	.300	1.25
MAN 52	C.A.—green	.300	.99	DL728	C.C.—red	.500	1.49
MAN 54	C.C.—green	.300	.99	DL741	C.A.—red	.600	1.25
MAN 71	C.A.—red	.300	.75	DL747	C.A.—red	.600	1.49
MAN 72	C.A.—red	.300	.75	DL750	C.C.—red	.600	1.49
MAN 74	C.C.—red	.300	1.25	DLO847	C.A.—orange	.800	1.49
MAN 82	C.A.—yellow	.300	.49	DLO850	C.C.—orange	.800	1.49
MAN 84	C.C.—yellow	.300	.99	DL33B	C.C.—red	.110	.35
MAN 3620	C.A.—orange	.300	.49	FND358	C.C. ± 1	.357	.99
MAN 3630	C.A.—orange ± 1	.300	.99	FND357	C.C.	.357	.75
MAN 3640	C.C.—orange	.300	.99	FND500	C.C. (FND503)	.500	.99
MAN 4610	C.A.—orange	.400	.99	FND507	C.A. (FND510)	.500	.99
MAN 6610	C.A.—orange—DD	.560	.99	HDSP-3401	C.A.—red	.800	1.50
MAN 6630	C.A.—orange ± 1	.560	.99	HDSP-3403	C.C.—red	.800	1.50
MAN 6640	C.C.—orange—DD	.560	.99	HDSP-3406	C.C. red ± 1	.800	1.50
MAN 6650	C.C.—orange ± 1	.560	.99	5082-7751	C.A., R.H.D.—red	.430	1.25
MAN 6660	C.A.—orange	.560	.99	5082-7760	C.C., R.H.D.—red	.430	1.25
MAN 6710	C.A.—red—DD	.560	.99	5082-7300	4x7 Numeric (RHD)	.600	22.00
MAN 6740	C.C.—red—DD	.560	.99	5082-7302	4x7 Numeric (LHD)	.600	22.00
MAN 6750	C.C.—red ± 1	.560	.99	5082-7340	4x7 Hxdcl. (0-9/A-F)	.600	22.50
DLO304	C.C.—orange	.300	1.25	4N28	Photo Xsistor Opto-Isol.		.69
DLO307	C.A.—orange	.300	1.25	LIT-1	Photo Xsistor Opto-Isol.		.69
DLG500	C.C.—green	.500	1.25	MOC3010	Optically Isol. Triac Driver		1.25

SOCKETS — RECEPTACLES

Test TEXTOOL Sockets

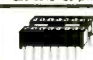
ZERO INSERTION FORCE

- Nickel Boron Plating
- G.F. PSF Plastic Body
- For testing IC's

- Nickel Boron Plating
- G.F. PSF Plastic Body
- Wire Wrap Contacts

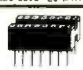
Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
214-3339	14 pin	5.95	222-3343	22 pin	9.95	214-3592	14 pin	9.75	222-3596	22 pin	12.95
216-3340	16 pin	6.49	224-3344	24 pin	9.75	216-3593	16 pin	9.95	224-3597	24 pin	12.75
218-3341	18 pin	7.95	228-3345	28 pin	11.95	218-3594	18 pin	10.95	228-3598	28 pin	13.95
220-3342	20 pin	8.95	240-3346	40 pin	12.95	220-3595	20 pin	11.95	240-3599	40 pin	15.95

LOW PROFILE (TIN) SOCKETS



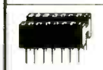
	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)



	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD



	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea.	10 Ohm 12 Ohm 15 Ohm 18 Ohm 22 Ohm 27 Ohm 33 Ohm 39 Ohm 47 Ohm 56 Ohm	50 pcs.	$1.95
ASST. 2	5 ea.	68 Ohm 82 Ohm 100 Ohm 120 Ohm 150 Ohm 180 Ohm 220 Ohm 270 Ohm 330 Ohm 390 Ohm	50 pcs.	$1.95
ASST. 3	5 ea.	470 Ohm 560 Ohm 680 Ohm 820 Ohm 1K 1.2K 1.5K 1.8K 2.2K 2.7K	50 pcs.	$1.95
ASST. 4	5 ea.	3.3K 3.9K 4.7K 5.6K 6.8K 8.2K 10K 12K 15K 18K	50 pcs.	$1.95
ASST. 5	5 ea.	22K 27K 33K 39K 47K 56K 68K 82K 100K 120K	50 pcs.	$1.95
ASST. 6	5 ea.	150K 180K 220K 270K 330K 390K 470K 560K 680K 820K	50 pcs.	$1.95
ASST. 7	5 ea.	1M 1.2M 1.5M 1.8M 2.2M 2.7M 3.3M 3.9M 4.7M 5.6M	50 pcs.	$1.95
ASST. 8R		Includes Resistor Assts. 1-7 (350 pcs.)		$10.95 ea.

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INTERSIL

Part No.	Function	Price
7045IPI	CMOS Precision Timer	14.95
7045EV/Kit*	Stopwatch Chip, XTL	24.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	29.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	13.95
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter	12.95
7218CIJI	8-Digit Univ. LED Drive	10.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8038CCPD	Waveform Generator	4.95
8048CCPE	Monolithic Logarithmic Amp	21.60
8069CCQ	50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.95
8212CPA	Volt Ref/Indicator	2.95

74C

74C00	.39	74C95	1.59	74C221	1.95
74C02	.39	74C107	1.89	74C240	2.25
74C04	.39	74C151	2.95	74C244	2.25
74C08	.39	74C154	3.95	74C373	2.49
74C10	.39	74C157	2.25	74C374	2.59
74C14	.75	74C160	1.69	74C901	.69
74C20	.39	74C161	1.60	74C903	.69
74C30	.39	74C162	1.49	74C911	10.95
74C42	1.39	74C163	1.69	74C912	10.95
74C48	1.95	74C164	1.59	74C915	1.69
74C73	.79	74C173	1.39	74C917	10.95
74C74	.79	74C174	1.39	74C922	5.49
74C85	1.95	74C175	1.19	74C923	5.75
74C86	.99	74C192	1.69	74C925	7.50
74C89	6.95	74C193	1.69	74C926	7.50
74C90	1.29	74C195	1.59	80C95	.79
74C93	1.29			80C97	.79

LINEAR

LH0002CN	6.85	LM340T-5	1.25	LM702H	.79
LM10CLH	4.50	LM340T-12	1.25	LM703CN	.89
LM11CLH	4.75	LM340T-15	1.25	LM709N	.29
LH0070-OH	4.95	LM341P-5	.75	LM710N	.79
TL071CP	.79	LM341P-12	.75	LM711N	.79
TL072CP	1.39	LM341P-15	.75	LM723N	.69
TL074CN	2.49	LM342P-5	.69	LM733N	1.00
LH0082CD	35.80	LM342P-12	.69	LM739N	1.19
TL082CP	1.19	LM342P-15	.69	LM741CN	.35
TL084CN	2.19	LM348N	1.25	MC1741SCG	3.00
LH0094CD	36.80	LM350K	5.75	LM747N	.79
LM300H	.99	LF351N	.60	LM748N	.59
LM301CN	.35	LF353N	1.00	LM1014N	2.75
LM302H	1.95	LF355N	1.10	LM1310N	1.95
LM304H	1.95	LF356N	1.10	LM1458CN	.59
LM305H	.99	LM358N	1.00	LM1488N	1.25
LM307CN	.45	LM359N	1.79	LM1489N	1.25
LM308CN	1.00	LM370N	4.49	LM1496N	1.95
LM309H	1.95	LM373N	3.25	LM1556V	1.75
LM309K	1.25	LM377N	2.95	LM1800N	2.95
LM310CN	1.75	LM380N	1.25	LM1871N	5.49
LM311/CN	.90	LM381N	1.95	LM1872N	5.49
LM312H	2.49	LM382N	1.79	LM1877N-9	3.25
LM317MP	1.15	LM384N	1.95	LM1889N	3.20
LM317T	1.75	LM386N-3	1.29	LM1896N	1.75
LM317K	3.95	LM387N	1.45	LM2002T	1.49
LM318CN	1.95	LM389N	1.35	LM2877P	2.05
LM319N	1.95	LM392N	.69	LM2878P	2.25
LM320K-5	1.35	LF398N	4.00	LM2896P-1	2.25
LM320K-12	1.35	LM399H	5.00	LM3189N	2.95
LM320K-15	1.35	TL494CN	4.49	LM3900N	.69
LM320T-5	1.25	TL496CP	1.75	LM3905CN	1.25
LM320T-12	1.25	NE510A	6.00	LM3909N	1.15
LM320T-15	1.25	NE529A	4.95	LM3914N	3.95
LM323K	5.95	NE531H	3.95	LM3915N	3.95
LM324N	.99	NE536H	6.00	LM3916N	3.95
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LM336Z	1.75	LM556N	.99	LM4500A	3.25
LM337T	1.95	NE564N	3.95	ICL8038B	4.95
LM337MP	1.15	LM565N	1.25	LM13080N	1.29
LM338K	6.95	LM566CN	1.95	LM13600N	1.49
LM339N	.99	LM567V	1.25	75138N	1.95
LM340K-5	1.35	NE570N	4.95	75450N	.89
LM340K-12	1.35			75451CN	.39
LM340K-15	1.35			75492	.89

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

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.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/35V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

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Axial	1-99	100-499	500+	Radial	1-99	100-499	500+
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

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Introduction to the Computer

by Jeffrey Frates & William Moldrup

This text is an overview of the science of computing. Not written to provide instruction in actual programming, the thrust is on the structure and capabilities of computers in general, with focus on the various types of computers available for business, scientific and personal use. There is a section on the history of computing as well as on the social and economic impact of computers. The book is broad in scope and could prove informative to those who have had little direct contact with computers, but have wanted general information about them, including cursory examinations of teleprocessing, data-base systems, popular programming languages, and so on.

Published by Prentice-Hall, Englewood Cliffs, NJ. Hard cover. 449 pages. $17.95

101 Easy Test Instrument Projects

by Robert M. Brown & Tom Kneitel

Most of the test instruments described in this book can be built in one evening for less than five dollars. A parts list is provided at the beginning of each project along with schematics and some basic construction instructions. Among the projects are: an impedance checker, line voltage booster, sound-level meter, audio oscillator, diode r-f probe, and transistor checker.

Published by TAB Books Inc., Blue Ridge Summit, PA 17214. Soft cover. 210 pages. $7.95.

BASIC Computer Programs in Science and Engineering

by Jules H. Gilder

This is a collection of 114 ready-to-run BASIC programs. Written for the hobbyist or the engineer, programs cover statistical operations (standard deviations, curve fitting, and interpolation) and design applications (mostly circuits). Each program is presented in flow-chart form and includes a sample as it would appear on the computer. Written for an Apple II micro, the author states they can be used for almost any personal computer with no or little modification.

Published by Hayden Book Co., Rochelle Park, NJ. Soft cover. 256 pages. $8.95.

Microcomputers for External Control Devices

by James A. Gupton, Jr.

This book deals with two distinct topics, although there is no official division. The first part is about microcomputers in general; i.e., terminology, an overview of digital circuits, D/A converters, etc. The second is the substance of the book. It covers the various possibilities for using microprocessors to control devices in the home and in business; e.g., ac and dc motors, vacuum pumps, TV monitor displays, etc.

Published by dilithium Press, 30 NW 23rd Place, Portland, OR 97210. Soft cover. 279 pages. $13.95.

How to Buy and Install Your Hi-Fi Stereo System

by Derek Cameron

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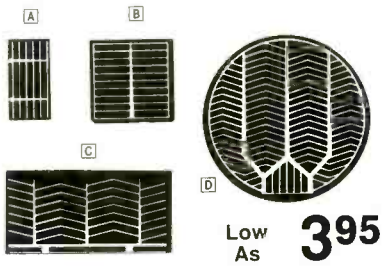

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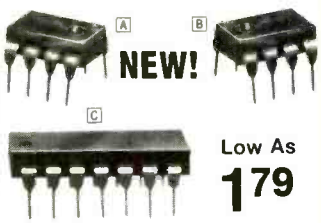

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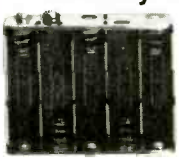

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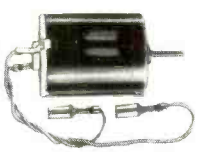

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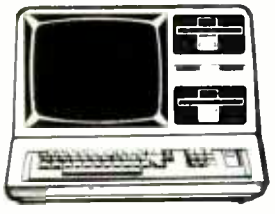

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Popular Electronics

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Personal Electronics News

DEREGULATION OF VITS (vertical interval test signals) is strongly supported by the National Association of Broadcasters. Commenting on a Federal Communications Commission proposal to eliminate VITS requirements for remotely controlled television operations, the NAB noted that "with the advent of new video technologies, such as closed captioning for the hearing impaired, teletext, videotext . . . the vertical interval has become a very valuable spectrum resource." In addition, the association said that it had endorsed ABC's 1977 proposal to modify VITS requirements and congratulated the commission for a proposal that goes beyond the original request.

EXIT SIGNS THAT TALK are being produced by Exit-Us of Easton, Conn. Built around microprocessors programmed to detect emergency conditions, the signs deliver appropriate "spoken" messages according to a preplanned system of priorities. For example, a "fire . . . exit this way" message takes priority over a "power failure" message, and a "danger . . . this exit unsafe" message would take priority over both. Speech synthesis techniques are used to produce the messages, but the audio portion of the signs can also be connected into a public address system.

SOLAR POWER FOR SAILING VESSELS is available from AEG-Telefunken Corp., Systems Technology Division (Rte. 22-Orr Drive, Somerville, N.J. 08876). Capable of providing electric power for recreational sailing boats even when the auxiliary engine and generator are seldom used, the system consists of solar generator modules (designed to withstand the effects of salt water), a charge regulator, and mounting hardware. The modules are rated to charge a 12-volt battery, and the smallest one delivers a maximum of 10 watts in full sunlight. For larger energy demands, several of the modules can be connected in parallel.

"THE BOOK" FROM ATARI, a guide to servicing and operating the company's coin-operated video games, is now available. Pegged at a U.S. price of $39.00, the book can be ordered from Atari's authorized distributors or the customer service department. In addition to an eight-page glossary of electronic terms, the 186-page illustrated guide contains information on general troubleshooting, display monitor repair, and printed-circuit components.

THREE-DIMENSIONAL TV is being transmitted experimentally by Visions and Multivisions, the HBO affiliate in Alaska. Existing three-dimensional films are transferred to video tape using a process developed by 3D Video Corp. of North Hollywood, CA. Viewers watching on a color set and wearing special glasses (distributed in the Anchorage area by Carrs-Pay Less Stores) will see a three-dimensional picture. The initial transmission, which took place early last summer, was expected to reach more than 12,000 households. Home Box Office is reportedly observing this experiment carefully, with an eye to expanding the service if there is sufficient viewer demand.

VIDEO IN-FLIGHT "MAGAZINES" are featured on selected wide-body flights of American Airlines. In an arrangement that started early last summer with CBS News, American will offer two 30-minute news magazines, "Eye on Science" with Charles Kuralt and "Magazine of the Air" with Douglas Edwards. The former will focus on health, technology, and the world of nature, while the latter will include feature stories concerning people and events that are rarely in the headlines.

COLLEGE INFORMATION BY COMPUTER is now a reality, as The College Board, an association of over 2,500 secondary schools, colleges, and educational associations, is providing service via the CompuServe Information Service. With access to a personal computer and terminal (plus a modem and telephone line), one can receive information on choosing a college, availability of financial assistance, and preparation for the Scholastic Aptitude Test. Cost of the service is $5 per hour weekdays. Weekday daytime access is also possible.

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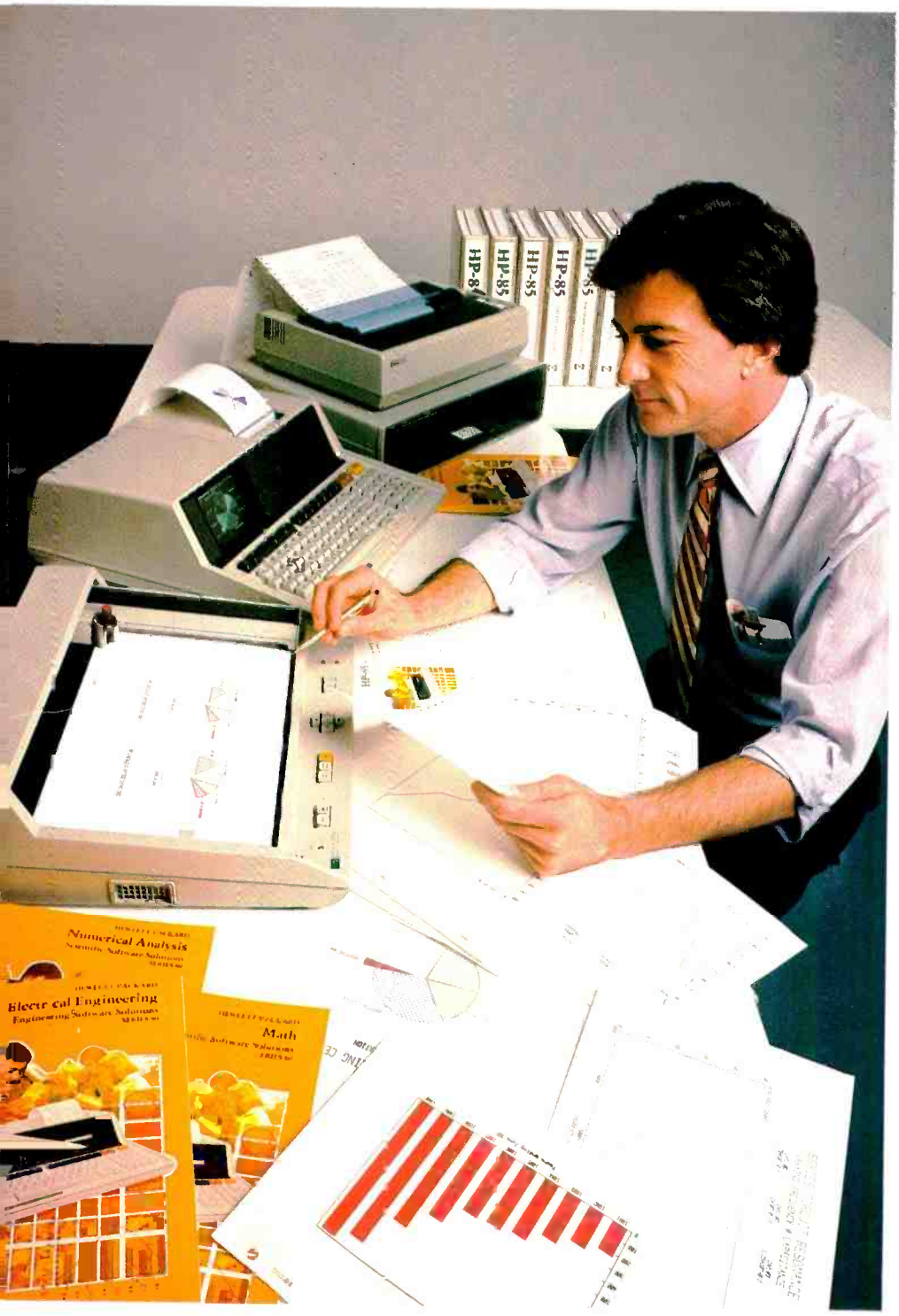

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