CB ROUNDUP — DIGITAL CLOCKS — IC APPLICATIONS

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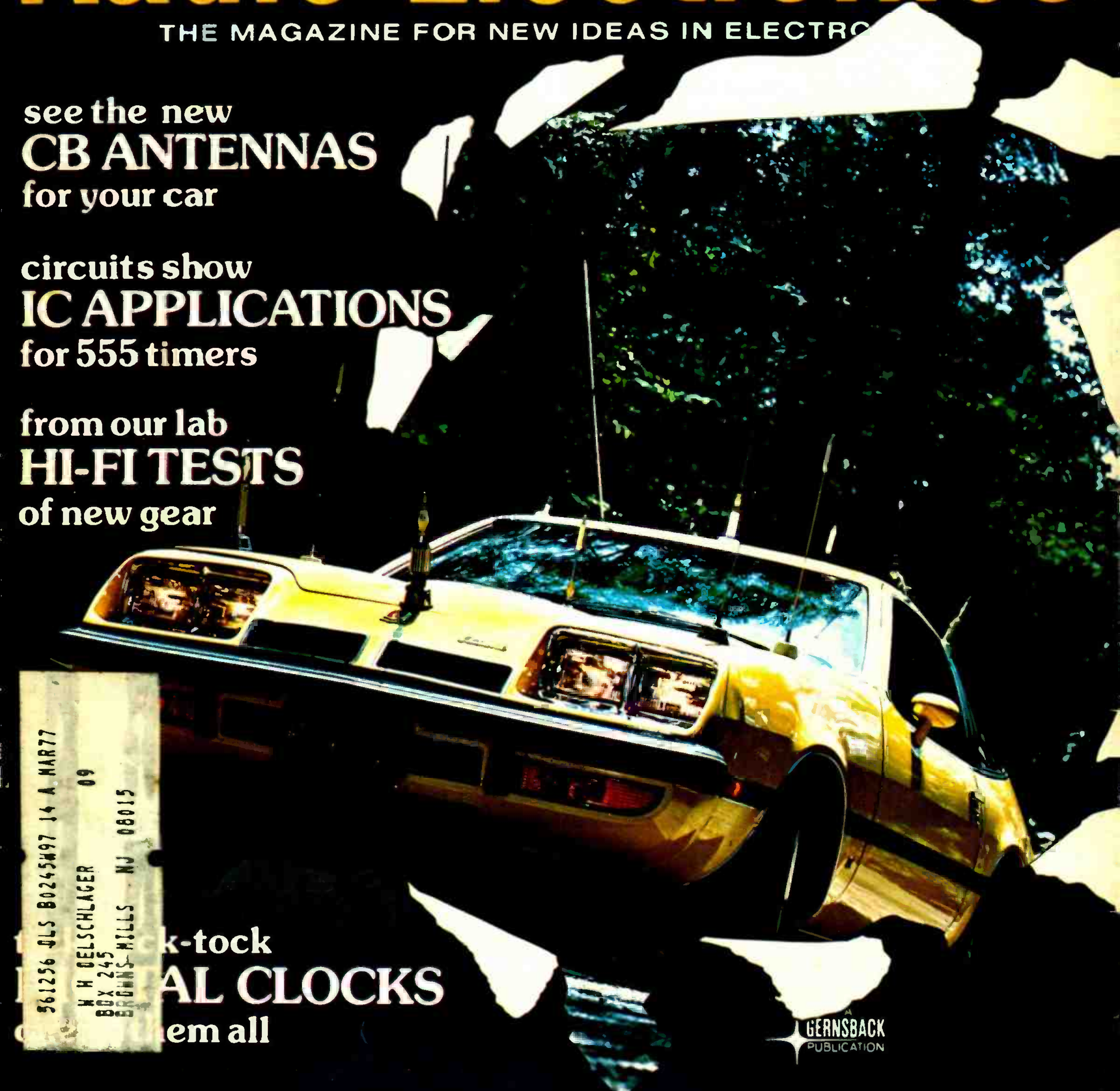
Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRO



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of new gear

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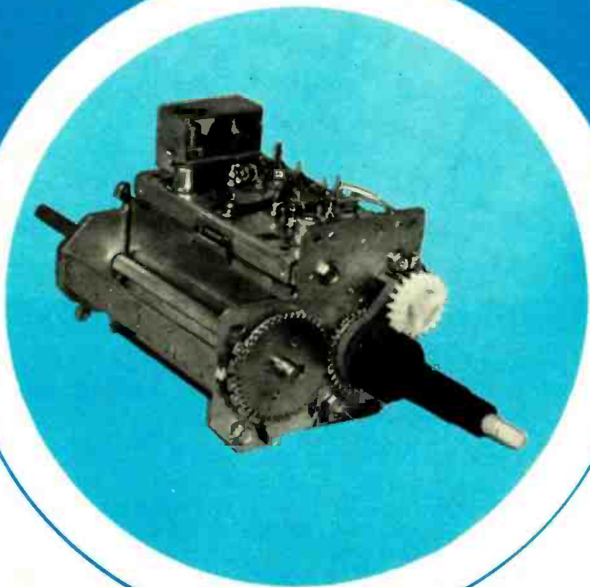
PLUS — Bucket Brigade Time Delay ★ Selecting & Installing TV Antennas ★ Mindpower: Alpha ★ State Of Solid State ★ Digital Countdown Timer ★ Step-By-Step Troubleshooting ★ Jack Darr's Service Clinic ★ Komputer Korner



Measuring just 11" wide x 11" deep x 5" high, and weighing a mere 7 pounds, the Altair ™ 680b is a complete, general-purpose computer.

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The Altair 680b can be programmed from front panel switches, or it can be interfaced to a video display terminal, or teletypewriter. Three additional circuit boards can be plugged inside the Altair 680b for further memory and interface expansion. The first of these boards is a 16K static RAM memory board.

Software already developed includes Altair 680 BASIC with all the features of the 8K BASIC previously developed for the Altair 8800. These include Boolean operators, the ability to read or write a byte from any I/O port or memory location, multiple statements per line, and the ability to interrupt program execution and then continue after the examination of variable values. This software takes only 6.8K bytes of memory space and a copy is **included free with the purchase of the Altair 680 16K memory board.**

Other software includes a resident two pass assembler (also free with 16K board) The Altair 680b is also compatible with Motorola 6800 software.

The Altair 680b is ideal for hobbyists who want a powerful computer system at an economic price. Altair 680b owners qualify for membership in the Altair Users Group, and like other Altair owners, they receive a complimentary subscription to **Computer Notes** and complete factory support.

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Altair 680b kit with complete, easy-to-understand assembly manual, operator's manual, and programming manual	$466
Assembled Altair 680b	$625
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"Quality, they satisfy my customers and reduce callbacks." William Stanek, Stanek Electronics Labs—Manchester, Conn.

"We have always been satisfied with Sylvania tubes." Mareck Bajana, Ken Crane's Magna City—Hawthorne, California.

"Good color contrast and brightness." Russell Treslor, Tele-Radio Service Co.—Birmingham, Alabama.

"Good quality makes the product easy to sell." Harry Murray, Murray's Television Service—King of Prussia, Pa.

"I have had good results and very few failures." Bobby Jones, Camilla TV Service—Camilla, Georgia.

"Have very few replacements when I use Sylvania—good quality." Robert Wayne, Accurate Television—Parma, Ohio.

"We use Sylvania picture tubes over all others regardless of price." Jesse Spain, Spain TV—Pasadena, Texas.

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We promise not to use any rough stuff.

GTE SYLVANIA

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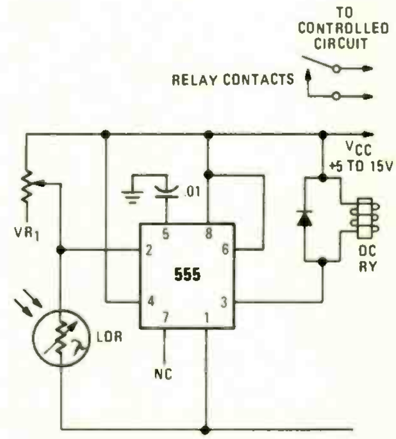
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

SEPTEMBER 1976 Vol. 47 No. 9

ON THE COVER

CB really explodes in Radio-Electronics this month. We've got a fast-breaking story on CB antennas for your car. It starts on page 40 and gives you a quick overlook of what's available now. And it's just the beginning of increased CB coverage that will bring you CB stories in every issue.



555 Circuit Applications that you'll want to try. A variety of interesting circuits that are fun to build and practical to use. The study starts on page 63.

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looking ahead

VTR of the month

Another home videocassette recorder is scheduled for introduction in the U.S. by the year's end. This one is from Quasar, a subsidiary of Matsushita Electric. The deck is scheduled to be priced at around $1,000, some $300 below competitive units offered by Sony and Sanyo. All three decks have different recording standards and so are mutually incompatible.

The Quasar VTR is a variation of *National Home Video*, now on the Japanese market at about $700. It accommodates a cartridge that contains ½-inch tape which can record or play for 100 minutes, as opposed to the Sony 60-minute capacity and Sanyo's two hours. The National cassette sells for $25 in Japan and is expected to be somewhat higher here.

Although neither of Matsushita's other two U.S. affiliates has commented on the subject, it wouldn't be surprising to see both Panasonic and JVC America marketing their own compatible versions of *National Home Video* here next year.

TV gamesmanship

The video game fad now has more than 50 entries by at least 30 companies. Many of the games are simple tennis types and most of them are awaiting the required FCC approval before going to the market. Nevertheless, game manufacturers are estimating that at least 2 million units will be sold this year, perhaps 5 million in 1977. More sophisticated microprocessor-based games are now beginning to show up. The most complex is from Fairchild—a programmable game. Special cartridges will be available containing read-only memories (ROM), each programming the unit for two to four games. In addition to the normal tennis-hockey-handball games, more sophisticated chase and target games will be offered, as well as multiple-choice quizzes, even on-screen color "doodling".

But all may not be clear sailing for TV games. FCC Chief Engineer Ray Spence says the Commission is already beginning to receive complaints about interference caused by the games, and if the market continues to grow as fast as it has so far, it may tighten the rules on certification of games or ban all RF devices that feed into a TV set's antenna terminals. If the Commission takes the latter move, games would have to be hard-wired to the video section of the receiver—and set manufacturers would be under pressure to offer receivers with video input jacks. Such a ruling would put a crimp in plans for home VTR's and videodisc players, which also feed RF. Ray Spence also said that the FCC would wait until the end of the Christmas selling season before deciding what to do.

One new game that doesn't have the RF problem is built into a new 19-inch Magnavox color set. The new set, to retail at about $500, contains a built-in Odyssey game that can play tennis, hockey and smash. A simple TV/game switch on the front changes the set from a TV receiver to a video game-board.

Videodisc recorder

Both Philips and RCA plan to introduce their videodisc players some time in 1977 as play-only devices. Now a professor at the University of Toronto says he's come up with a plastic disc material and low-powered laser which could make possible home recording on an optical videodisc. The laser requires only two milliwatts, just twice the power of the readout laser on the Philips player. Says inventor John Locke: "The startling reduction in laser power required for recording brings the thought of home videodisc recording, as well as playing, into the realm of economic possibility." He estimates a videodisc recorder/player could sell for $750 to $800, or about 50% more than Philips' target price of $500 for a playback-only unit.

New Sylvania tube

Zenith and Corning Glass have been urging other picture tube manufacturers to adopt a new and unusual type of tube designed for automatic production and precision construction (**R-E,** June 1976). Zenith's competitors in the picture tube business admire some features of the new tube, but unanimously reject the completely new design of the glass that they say would require heavy retooling and changes in production techniques.

Now Sylvania has taken what it feels are the best features of the Zenith tube and constructed a sample using conventional glass to offer to its set-making customers. Like the Zenith tube, the Sylvania version is a narrow-neck, self-converging, in-line slot-mask type, employing a tri-potential gun for smaller spot size and with a 100-degree deflection angle. This would bring the economic advantages of self-converging slot-mask design to large-screen tubes without impairing resolution. The Sylvania tube probably won't be ready for use until late 1977. Zenith is already producing the 19-inch version of its new 100-degree tube and will crank up the 25-inch edition in the first half of 1977.

Zenith hopes to sell its new tube to other set makers as well as use it in its own TV production. But some manufacturers have complained that the new tube's slightly larger dimensions make it too big for current cabinets. To meet these objections, Zenith is considering a version with the magnetic shielding built into the inside—eliminating the necessity of having an external metal shield and just about making up for the difference in bulk between the Zenith tube and conventional types. Zenith is digging in for a long and tough campaign to prove the superiority of its approach. Competitors, led by RCA and Sylvania, are just as determined to hang in there with the conventional tube.

More new TV's

Admiral, now a part of Rockwell International, has introduced three new TV chassis for 1977. The most interesting contains a chassis pan with no components at all—just connectors. Seven panels fit on the frame in a vertical position, five of them snapping into spring-loaded clips. The entire chassis may be assembled or disassembled in one minute. Admiral became the third American manufacturer to introduce keyboard-type digital tuning. And in its top-of-line 19- and 25-inch sets, it features consumer-installed optional remote control that can be added at the time of purchase or at any later time. To convert the set to remote control, the purchaser merely removes a one-inch square plug from the front of the set, slides in a two-inch deep receiver module and he's ready to punch in his channel number on the remote calculator keyboard.

Quasar also has new high-end chassis for 19- and 25-inch sets. This pioneer in modular television has developed an automatically produced chassis that concentrates 75% of the circuitry on a single Super-Module. IC's and the reduction in interconnections cuts the number of discrete components to 550 from 640 in last year's models and the amount of wiring to 125 from 250 feet. The Super-Module is designed for replacement by the service technician. Out of warranty, the module will cost $100, but a factory-rebuilt unit is only $30 on an exchange basis.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

new & timely

Optical video recording system for commercial TV

The system, demonstrated by RCA for the first time at the National Association of Broadcasters convention in Chicago last March, can store up to 10,000 high-quality still pictures in full color on a 12-inch disc. It records and transmits pictures directly from and through electronic equipment already available in the studio.

DEVELOPMENTAL VIDEO RECORDING SYSTEM is capable of storing 10,000 TV pictures on a 1-inch band of the disc. The disc is about to be loaded into the system by Lee Hedlund, RCA project engineer.

Lasers focused to a very fine spot are used for recording and playback. To record, a set spots 1-micron wide and 0.5-micron long are made in a single circular track. Separation between tracks is 2.5 microns. Each track contains one picture (two fields). The disc revolves at 1800 revolutions per minute.

At present, recording is limited to 10,000 tracks, covering one inch of the disc. RCA expects to increase that number to at least 20,000.

To play back, a laser beam is focused on the desired track. The reflected light strikes a photodiode detector, converting it to an electronic video signal that is processed in the usual way.

Selection of pictures is automatic. Each picture has an identifying number that appears on the record and in a computer memory. The operator types the title of the picture into the computer, which searches the memory and finds the identifying number. It then directs the playback laser beam to the approximate position of the track. A fine-search control unit, using a small mirror in the optical path, reads the numbers of the tracks and locates the correct one.

The operator can ask the computer to display up to 400 pictures in any desired sequence. Or, the pictures can be preprogrammed in groups and the operator need type in only the title of the group to have the slides presented in proper sequence.

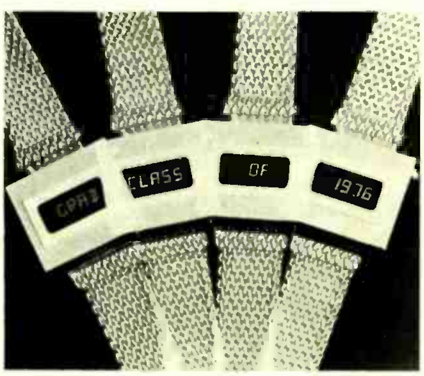
The equipment demonstrated covered only still pictures, but the technology can also record motion. RCA believes that "It is conceivable that some years in the future a TV station might broadcast an entire day's program from disc recordings."

Newest digital wristwatch will also carry a message

A new five-function digital electronic watch module introduced by Hughes will carry a pre-programmed message of up to four five-letter words, in addition to the usual readout of month, date, hour, minute and second. The fixed message is programmed onto the MOS chip that controls the watch readout in a separate masking stage during manufacture. Five 9-segment LED's provide an alphanumeric readout of up to five letters per word. The words are read out sequentially.

Fixed phrases to be offered include common messages of greeting, affection, etc., expected to be in demand (see photo). In addition, custom modules with special commercial, advertising, or political slogans will be offered to businesses. For orders of 1,000 or more, no extra charge will be levied for the special phrase. For smaller orders, a masking charge will be added to the price of the module.

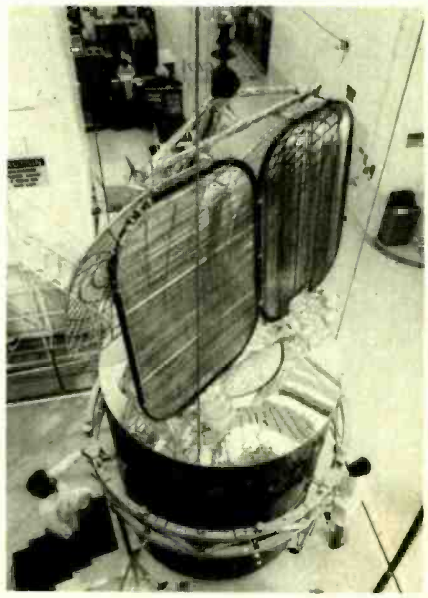
Although Hughes Aircraft Company's solid-state division does not market a watch to consumers under its own name, it is the leading supplier of the solid-state modules to name-brand and private-label watch companies.



NEWEST ELECTRONIC DIGITAL WATCH carries a greeting or message in addition to reading out time and date. Four words of five or fewer letters are spelled out sequentially.

Add another 44,600 miles to your next long-distance call!

Latest of the communications satellites to go into orbit, Comstar, was launched May 6. In synchronous orbit 22,300 miles above the earth, it is the first of four satellites in a domestic communications system built for Comsat General Corporation by Hughes Aircraft Co. at a total cost of $65.9 million. The system will consist of two primary satellites and a third to serve as backup. The fourth will be held on the ground as a spare. The satellites are expected to have a life of seven years.



COMSTAR SATELLITE, shown in final checking stage at Hughes Aircraft, will be used by AT&T and GTE Satellite Corp. to supply telephone service to all 50 states and Puerto Rico. The rectangular reflectors provide a technique for using the same frequency twice.

The system is designed to enable transmissions to and from all 50 states and Puerto Rico. It will be used jointly by AT&T (American Telephone & Telegraph Corp.) and GTE General Corp. The satellites will work from and to seven earth stations, four owned by AT&T and three by GTE Satellite Corp. Cost of the ground stations is about $77 million.

Dominant feature of the Comstar satellite is a pair of rectangular reflectors with filter screens for horizontal and vertical polarization of the microwave signals. Such polarization permits using the same frequency twice, thus doubling the effective capacity of the transmitting system while conserving the frequency spectrum.

continued on page 12

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1976 VACO catalog!

Circle 32 on reader service card

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new & timely continued from page 6

Audio via infrared helps hard-of-hearing children

Infrared transmission has been used by the entertainment industry to power remote loudspeakers in multiple-speaker systems. It is now being used by Siemens in a new type of speech-hearing training equipment for hard-of-hearing children.

In a new two-channel system now being tested, the audio signals are modulated on two separate carrier frequencies of 200 and 280 kHz. The transmitter is contained in the instructor's desk, from where the energy is transmitted by cable to four radiators in the corners of the room. These contain 12 infrared transmission diodes each. The energy is great enough to "illuminate" classrooms 30 feet square or larger. Transmitting power is 10 watts. Only about 5 percent of this, or 500 milliwatts, is delivered as optical output.

The children wear headphones and carry a receiving set that picks up the optical signals at any point in the room. Depending on the child's hearing deficiency, the right and left channels can be set individually. By throwing a switch, the receiver becomes a high-quality stereo hearing aid with which the children can communicate with each other in the classroom or schoolyard. The large frequency spacing of 80 kHz between channels allows high reproduction quality from 50 to 15,000 Hz.

The great advantage of this technique over magnetic induction wireless or other systems is that the infrared radiation is absorbed by walls and doors, and thus does not extend beyond the room in which the transmitter is situated. This makes it possible to use it in all the rooms of a large school, absolutely without interference. Each room has its own transmitter; the students carry their receivers from room to room throughout the building and can use them practically from primary school to matriculation.

NEW INFRARED TRANSMISSION SYSTEM for teaching hard-of-hearing children uses receivers almost identical in appearance to the ones used in older induction systems. The difference is that none of the infrared energy gets out of the room, making it possible to use similar systems in all the rooms of a large school.

Lasers could revolutionize internal combustion engines

A laser engine similar to an ordinary internal combustion engine (which could in fact be made from a piston-type gas engine by a few modifications) can operate at twice the efficiency of today's engines. This new engine was described in the May, 1976, issue of *Applied Optics* by Drs. Max Garbuny and Martin Pechersky of Westinghouse Research Laboratories. While the article describes techniques that are largely far in the future, practical work is being done on the project under a NASA-Ames contract, and at least one low-power laser engine has been tested.

The "fuel" in this system would be a simple laser beam, while the cylinders would contain a recyclable gas that is heated by the laser beam to expand and drive the pistons. The exhausted gas is discharged into a heat exchanger (what steam-engine people would call a "condenser") to cool, then returned via the intake valve to be used over again.

Most important modification of present engines is a window that is transparent to infrared light, to permit the laser beam to be focused in the cylinder. The gas would be a type similar to helium, to which a small quantity of gas that absorbs the laser discharge is added. An example would be carbon monoxide (CO) gas, working with a carbon monoxide laser. (Most of the experimental work to date has been with a CO_2 (carbon dioxide) laser and CO_2 gas.)

A laser beam focused through the window to a point near the center of the gas in the cylinder will excite the absorbing gas, raising temperature of the gas mixture at the focal point to nearly 10,000° C. This will cause the gas to expand more rapidly than is possible in a conventional internal combustion engine. Since the highest temperature would be at the center of the gas column in the cylinder and would drop off rapidly from that point, temperatures at the cylinder walls and piston face are in a range the metal could tolerate.

An interesting possibility arises from the fact that the beam-producing apparatus need not be connected to the rest of the equipment—the engine could be remotely powered. The only limiting factors are the necessity of directing the beam accurately through the cylinder window, and the absorption of the air through which the beam passes.

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letters

COMPUTER CLUB

A number of my associates in the computer industry and I are forming a Rhode Island computer hobbyist club. Several members are already building their own systems, including two Altairs and two micros based on the MCS-6502, and an assembler is being written in Fortran to assemble MCS-6502 machine language programs.

If any of your readers are interested in either joining our club or in exchanging programs and experience with the MCS-6502 they may contact me at the following address;

Rhode Island Computer Hobbyist Club
16 Grinnell Street
Jamestown, RI 02835

ROGER C. GARRETT
Jamestown, RI

TI MEMORY

I own a Texas Instruments SR-51 calculator, and I must rebut the claims made by Thomas S. Cox in the July "Letters" column regarding hidden memory capabilities in TI calculators.

It is true that if you press STO X, you can press RCL X and recall that data, but reader Cox failed to realize that the same data is also entered in two or three other registers. For example, if you store data in "memory 6" by pressing STO 6, you'll find that you can recall that data by pressing RCL 3, RCL 4, RCL 5, or RCL 6. Obviously, this is no good!

The table below shows the memory arrangement of the SR-51:

STO \ RCL	1	2	3	4	5	6	7	8	9	0
1	x						x		x	
2		x						x		x
3			x	x	x	x				
4			x	x	x	x				
5			x	x	x	x				
6			x	x	x	x				
7	x						x		x	
8		x						x		x
9	x						x		x	
0		x						x		x

Alas, TI did not let their "super" calculators get out of the shop with any greater memory capacity than advertised.

ERIC G. LEMMON
Vandenberg AFB, CA

VASCAR WARNING

In the June issue, the "New Products" section features a device called a Senturion, and says: "It detects and gives early warning of all modern traffic control radar systems, including the "Speed Gun" and VASCAR moving radar systems." This is flatly untrue, and your readers should be so advised.

The VASCAR system is not a radar device. It is a passive system and does not emit any signal to be detected. In operation, the operator enters the distance between any two points, either manually or by driving between them in his patrol car. He then activates the device when a suspect car passes (that is, is seen to pass) one of the points, and again when the suspect car is seen to pass the other point. The VASCAR device reads out the

continued on page 16

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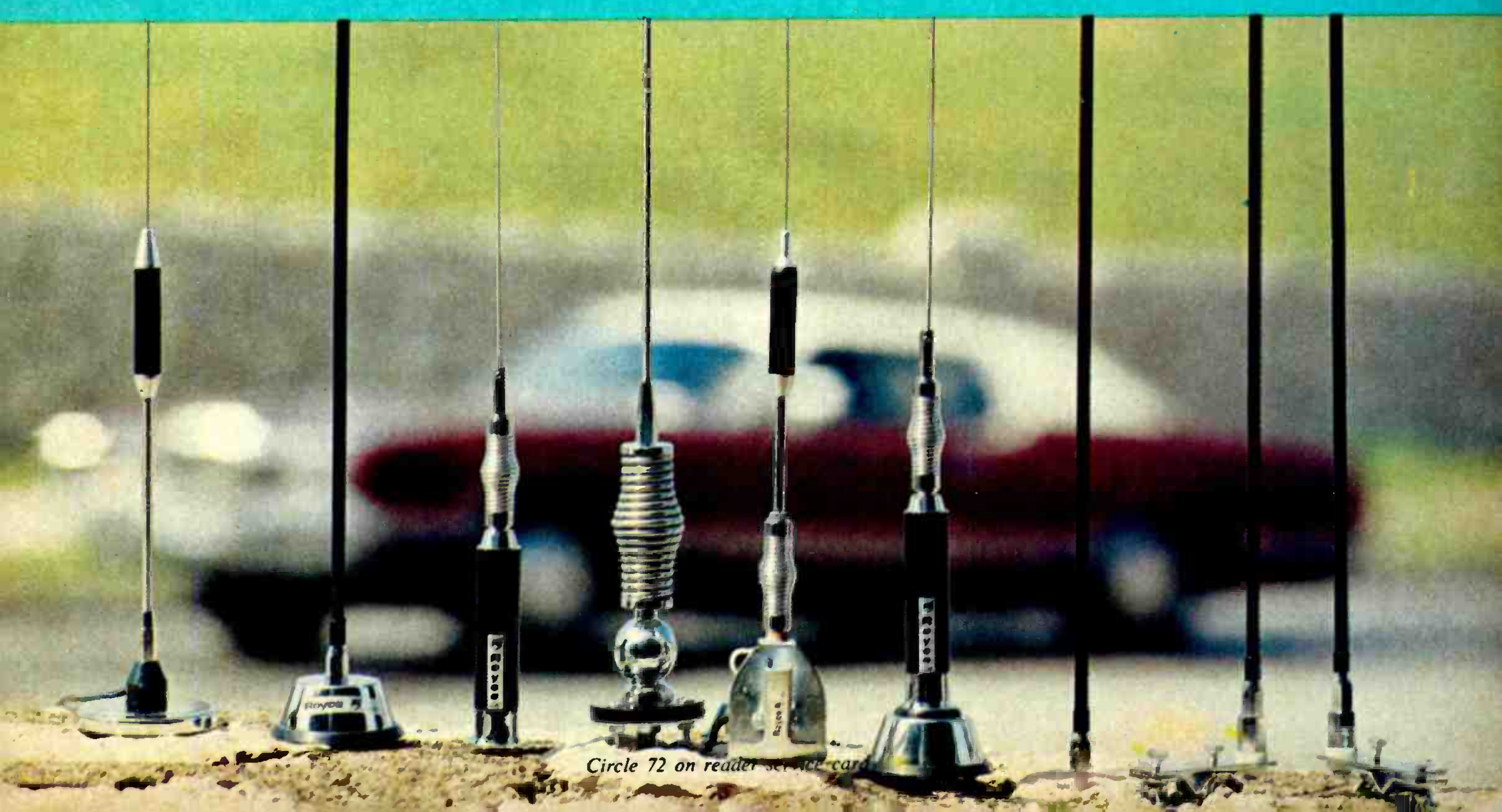


Circle 72 on reader

LETTERS

continued from page 14

average speed of the suspect car by a simple distance/time comparison.

If the false claim was made by the manufacturer, they would appear to be guilty of false advertising. In any event, one false claim tends to diminish the credibility of the others. Please advise your readers that neither Senturion, nor any other radar detector, will provide warning of a VASCAR device.

ROY B. SCHERER
Richmond, VA

1984?

I wrote you a letter a couple of years ago congratulating you upon your no-pussyfooting-around publication of construction projects for direct connection to telephone lines. We are all glad to see that your position is gradually being vindicated by the highest courts in the land. I congratulate you also on your boldness in going ahead with publication of direct-connection video construction projects, and I am confident that you will be vindicated in this also by relaxing or removal of present excessively restrictive regulations.

However, I was only recently made aware of an interesting by-product of such activities. The occasion resulted from my having subscribed to the magazine *Teletronics* (which had been advertised in the classified section of **Radio-Electronics**), the purpose of which was to reveal all the mysteries of how Ma Bell operated. I really did not have a very clear idea of what I was subscribing to, but as the issues finally did start arriving I was mildly interested and often amused at the material they carried, particularly by what I thought was their paranoid conviction that the Phone Co. was after them.

Two weeks ago I received this nasty threatening letter from the "Security Office" of the Pacific Telephone and Telegraph Company, and it appears that not only did PT&T succeed in putting *Teletronics* out of business, but that they were actually able to confiscate their mailing lists. Now it is *I* who am feeling paranoid—I'll bet PT&T sends copies of that subscriber list to every regional telephone company in America!

I am enclosing a copy of the PT&T missive. It would appear to me to be saying that dissemination or mere possession of information which COULD BE USED for disapproved purposes is a criminal offense—hence their urging that copies of *Teletronics* magazine be destroyed. I am committed to the position that CURIOSITY ALONE is sufficient "need to know," and that it is a fundamental freedom that criminality must be judged by what an individual DOES, not upon the knowledge which he has acquired or what he COULD do with it.

CHARLES D. GEILKER
Assoc. Prof. of Physics
William Jewell College
Liberty, MO

Dear Telephone User:

On March 25, 1976, the Superior Court of California, County of Los Angeles, entered an injunction in favor of The Pacific Telephone and Telegraph Company and against Teletronics Company of America, and others. Your name appeared on a list (provided under Court order) of subscribers, or potential subscribers, to material previously published and distributed by Teletronics Company of America. Accordingly, for your protection and benefit, you are hereby given the following notice:

IT IS A VIOLATION OF STATE AND FEDERAL LAW TO USE ANY INSTRUMENT, DEVICE OR SCHEME TO OBTAIN ANY TELEPHONE SERVICE WITHOUT PAYMENT OF THE LAWFUL CHARGES THEREFOR. IT IS ALSO A CRIME TO PROVIDE INFORMATION TO ANY PERSON WHICH IS USEFUL FOR SUCH PURPOSE. IN MANY STATES, THE POSSESSION OF OR DISSEMINATION OF PLANS OR INSTRUCTIONS FOR SUCH DEVICES IS A CRIMINAL OFFENSE.

VIOLATIONS OF THESE LAWS ARE VIGOROUSLY INVESTIGATED AND PROSECUTED. ACCORDINGLY, YOU ARE URGED TO DESTROY ANY AND ALL WRITTEN MATERIAL OR DEVICE YOU MAY HAVE WHICH MAY VIOLATE ANY OF THESE LAWS.

THIS STATEMENT IS BEING SENT TO YOU BY ORDER OF THE SUPERIOR COURT OF CALIFORNIA, COUNTY OF LOS ANGELES.

The Pacific Telephone
and Telegraph Company

I'm in a state of shock. For the first time in my life I don't know what to say, except to ask: Is 1984 8-years away?—Editor

KOMPUTER KORNER

Substituting microcomputer software for hardware

JOHN TITUS, PETER RONY, and DAVID LARSEN *

A READER WHO FOLLOWS THE CURRENT LITERATURE on microcomputers will frequently encounter phrases such as "hardware/software tradeoffs" or "substitution of software for hardware." These phrases are strongly indicative of anticipated applications for microcomputers in the near future and do much to explain why industry is so excited about them. In this month's column, we would like to discuss how it is possible to "substitute" microcomputer software for hardware.

Let us first recall the definitions for *software* and *hardware*:

hardware—The mechanical, magnetic, electronic, electromechanical, and electrical devices from which a system is fabricated.

software—The programs and routines used to extend the capabilities of computers, such as compilers, assemblers, narrators, routines and subroutines.[1]

In our specific case, software represents the machine-language program that is stored within the memory of a microcomputer, and hardware represents the specific devices that store, manipulate, receive or transmit digital information. The microcomputer itself is included in our definition of hardware. The purpose of this month's column can be simply stated as follows:

Through skillful programming it is possible to substitute machine-level routines and subroutines for specific hardware devices that store, manipulate, transmit, or receive digital information. This activity is called "the substitution of software for hardware."

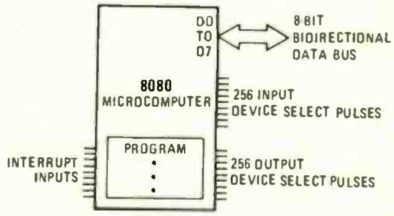
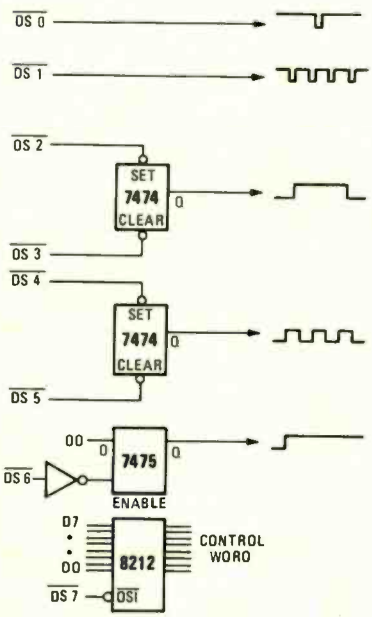


FIG. 1

TABLE 1—SUBSTITUTION OF HARDWARE BY SOFTWARE.

SUBSTITUTED HARDWARE FUNCTION	SOFTWARE EMPLOYED
1. PULSER, 500 ns MONOSTABLE	OUT 0
2. LOW DUTY-CYCLE CLOCK (500 ns PULSES)	OUT 1 : JMP — TIMING LOOP
3. DEBOUNCED PULSER, MONOSTABLE, LOGIC SWITCH	OUT 2 : TIMING LOOP : OUT 3
4. VARIABLE DUTY-CYCLE CLOCK	OUT 4 : TIMING LOOP OUT 5 : TIMING LOOP JMP
5. ONE BIT OF CONTROL INFORMATION FROM A MECHANICAL SWITCH	MVI A CTRL OUT 6
6. EIGHT BITS OF CONTROL INFORMATION FROM A SET OF EIGHT MECHANICAL SWITCHES	MVI A CTRL OUT 7

NEW HARDWARE CIRCUIT



* This article is reprinted courtesy of American Laboratories. *Dr. Rony, Department of Chemical Engineering, and Mr. Larsen, Department of Chemistry, are with the Virginia Polytechnic Institute & State University. Mr. Titus is president of Tychon, Inc., a microcomputer consulting firm in Blacksburg, Virginia.*

Typical Substitutions

Typical hardware that is replaced includes knobs, buttons, pulsers, switches, logic switches, clocks, and small memories as well as TTL integrated circuits that perform

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KOMPUTER KORNER
(continued from page 22)

digital functions such as debouncing, sequencing, shifting, adding, subtracting, comparing, and logic operations on multi-bit digital words. Hardware that is *not* usually replaced includes simple TTL IC's such as inverters, flip-flops, gates, latches, three-state buffers, and counters.

Tradeoffs

Figure 1 illustrates the basic "tools" that you would employ in the substitution of software for hardware, namely:

1. Programming.
2. The use of synchronized data appearing on the bidirectional 8-bit data bus, D0 through D7.
3. Input and output synchronizing pulses called *device select pulses*.
4. *Interrupts* to the microcomputer.

In an 8080-based microcomputer, you are able to generate 256 different input and 256 different output synchronizing-pulses. If you need more pulses, you can always employ memory I/O techniques. You therefore have an unlimited number of synchronizing pulses with which to coordinate the behavior of almost any type of digital electronic circuit. As you substitute software for hardware, your main tradeoff will be speed of operation. It is useful to remember the following rules when doing this:

In the substitution of software for hardware, the key tradeoff is speed of operation. The execution of any computer instruction takes time; the more instructions that are used, the longer it will take to execute them.

This tradeoff is not as serious as it may seem. Present 8-bit microcomputers are very fast, and future microcomputers will be at least ten times faster. The majority of existing electromechanical machines are slow by digital electronic standards. The human senses cannot participate in activities that require millisecond resolutions; i.e., in an input/output sense, we are very slow machines.

Practical examples

Table 1 summarizes some of the more commonly encountered situations where hardware such as debounced pulsers, switches, logic switches and clocks is replaced by simple wire connections, latches, flip-flops and inverters. We have provided abbreviated versions of the software required. The reader is referred to reference 2 for details on the generation of the OUT n pulses, where n is an octal number ranging between 000_8 and 377_8.

A "timing loop" is a short microcomputer subroutine that generates a precise time delay, typically greater than one hundred microseconds. As can be seen from the table, the replacement can be accomplished in most cases by the use of one or two different device-select pulses. A pair of OUT n instructions that bracket a timing loop are sufficient, when applied to an SN7474 flip-flop, to produce a monostable pulse of precise time duration. The addition of a second timing loop and a jump instruction changes the output of the flip-flop to that of a variable duty-cycle clock, the duty cycle being controlled by the relative time delays of the two timing loops.

Of particular interest is entry 6 in the table, in which an eight-position mechanical switch or eight individual mechanical switches are replaced by an 8-bit control word that is strobed into an 8212 IC from the accumulator with the aid of a device-select pulse. This control word is latched by such an action and can subsequently influence the behavior of a rather sophisticated digital circuit. The 8212 IC therefore functions as a *control register* for the circuit. We have directed your attention to this principle because it is now being widely used in an exciting new generation of *interface* chips that reduce the number of wire connections that need to be made between a microcomputer and an external device.

Table 1 provides only a few examples of how hardware can be replaced by simple software with the aid of device-select pulses. Omitted from the table are the more obvious hardware substitutions: arithmetic logic units (SN74181), digital comparators (SN7485), and shift registers (SN74194, SN74198, SN74199). Such IC's are replaced by microcomputer instructions that add, subtract, compare, and shift the 8-bit contents of the accumulator register. **R-E**

References

1. *Microprogramming Handbook* (Santa Ana, CA: Microdata Corp., 1971).
2. *Bugbook III* Derby, CT. E&L Instruments, Inc., 1975).

equipment reports

Sencore CB41 Automatic CB Performance Tester

Circle 102 on reader service card

MANY OF THE EARLIER CB ENTHUSIASTS WERE electronic hobbyists capable of installation and checkout of a CB installation. A substantial number of today's CB equipment buyers have no technical knowledge or ability and depend almost entirely on the dealer to provide installation, adjustment, and service where necessary. Fact is, on most Saturdays the average "auto radio/CB dealer" and service stations doing CB installations have waiting times running from three to five hours before their one or two "electronic technicians"—usually the kid who does the weekday lube jobs—can get to the basic mobile installation. Then, adjusting a short-whip antenna for minimum SWR can consume fifteen minutes to a half hour. And if the customer asks for proof the installation is *okay*, there goes another half hour as the technician connects test gear and then tries to explain what the readings indicate.

One of the ways to move CB installations along at a fast profit-making clip is to provide as much automation of the adjustments and checkouts as is possible. As far as the customer—the final user—is concerned, he can tell whether the receiver is working by how many stations he can hear. Few CB'ers ever question the receiver's performance; most CB'ers are primarily interested in RF power output, percent modulation and antenna system SWR—and it is these three performance characteristics that are most easily automated in an easy-to-understand manner for the non-technical CB'er.

Sencore Electronics, 3200 Sencore Drive, Sioux Falls, SD 57107, has come up with an answer. Full automation of the transmit and antenna characteristics is built into the new Sencore CB41 Automatic CB Performance Tester. This instrument measures RF watts in terms of average power for AM transmitters or peak envelope power for SSB transmitters, SWR (standing wave ratio) in both absolute values (such as 1.5:1) and in terms of *green* (good), *yellow* (acceptable) and *red* (poor) scale calibrations, and percent modulation of an AM transmitter to 100%.

The CB41 actually consists of two units: the meter itself which is powered by two 9-volt transistor radio type batteries or an external 9-VDC power source, and a power sensing head that connects via a connector/socket to the meter. (You can add extensions between the head and meter if desired). The sensing head is basically a reflectometer that provides forward and reverse power sensing for SWR measurements and an RF sample for the power and modulation readings. It also contains a 50 ohm non-inductive resistor (25 watts max.). The sensing head is normally connected between the transceiver or transmitter and the transmission line. A switch on the head determines whether the antenna or the internal dummy load is connected to the transmitter.

Now all this reads as routine as most other CB test sets, so what justifies a suggested retail price tag of $148? The difference is that readings are all automatic: there's no need to recalibrate the SWR meter for each antenna adjustment or calibrate the modulation meter to the transmitter's specific power output value.

The meter itself has three operating pushbutton switches in addition to the power and battery check switches. The SWR pushbutton provides a direct SWR reading without the need to calibrate for forward power—whatever the meter indicates as the SWR is the SWR regardless of the power output of the transmitter. If you are adjusting a mobile antenna, simply trim the antenna adjustment for the minimum SWR reading. You don't have to recalibrate the meter after each adjustment because that's done automatically by a built-in nulling circuit. Since you can track SWR continuously, a typical loaded antenna tuning for minimum SWR takes about 30 seconds; and the customer can see it all taking place without asking why you keep fiddling with the calibration knob.

Same procedure with the AM modulation measurements. Just press the % MOD switch and the meter automatically nulls the forward power calibration and the user can see the modulation reading directly, without questioning why you keep adjusting a calibration control. The percent modulation readings are calibrated for continuous tone, as can be provided by whistling into the microphone or by holding the mike in front of a small speaker connected to an audio generator. (The Sencore CB42 Automatic CB Analyzer contains the required generator and a special microphone coupling device. We'll do a report on the CB42 in a future issue.)

continued on page 28


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EQUIPMENT REPORTS
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Similarly, the peak envelope power output readings are calibrated for a two-tone generator.

You can, however, get meaningul measurements for a customer by just speaking into the microphone. For AM, the readings will be essentially the same as for tone. For SSB, the peak envelope power for voice will always indicate higher than 12 watts PEP (the legal limit) if all is okay. Note that regardless of claims by anyone, there is no general purpose meter-type test equipment that can indicate SSB PEP output using speech. For accurate measurements, a two-tone signal of 500 and 2400 Hz must be fed into the microphone (or microphone input).

The third CB41 function is power output. Pressing the RF WATTS pushbutton gives you the continuous AM (carrier) RF-output or the SSB PEP. By flipping the switch on the sensing head, the readings indicate the transmitter's output into the 50 ohm dummy load or into the antenna system.

While this might all sound easy, making the readings automatic is what makes it expensive, but also time saving—and time means more business to today's CB service center. Because of the CB41's forward power automatic nulling feature for the SWR and AM modulation readings, it is possible to test or checkout a new CB installation as fast as you can press three buttons; and you can adjust an antenna for minimum SWR in less time that it takes to calibrate the typical SWR meter for the first reading. Best of all, you can obtain your readings right at the antenna even though the sensing head is at the transmitter because you can easily connect a home-brew extension cable.

Obviously, the Sencore CB41 is a little too sophisticated and high priced for the typical CB hobbyist, but it's the answer to the Saturday jam-up in most CB service centers. **R-E**

Vector P180 Slit-N-Wrap Wiring Tool

Circle 103 on reader service card

AT FIRST GLANCE THE *P180* DOESN'T LOOK like much. But after a thorough examination and some on the job experience, your opinion moves to the high end of the scale. The tool is a 6-inch cylindrical tube with a wire spool at one end and a wire-wrapping bit at the other. A knurled finger-grip is provided for easy handling. It is made specifically for use with No. 28 AWG nylon polyurethane insulated wire on 0.025-inch square posts. However, it does work with other posts, wire and methods by giving up some of the conveniences. The tool is funneled making it easy to thread. A hold-down spring puts drag on the wire to maintain correct wrapping tension.

To use the *P180*, take a breadboard that has been prepared with a matrix of wire-wrap terminals, pull a small length of wire out of the end of the tool that can be held secure, and then put the bit over the terminal and turn the tool smoothly in a clockwise direction. There is no prestripping of insulation as with conventional wire-wrap methods. The wire used is the same used in Vector's *Model P173* solder-through wiring pencil. In this case, the insulation is scraped away when wrapping the terminal by a sharp edge where the wire leaves the wrap bit. If you look carefully at the dispensing end of the tool, there are actually two openings. The center round one is where the terminal fits. The second hole is a rectangular slot that is sharpened in one corner. Only when the wire is withdrawn at the proper angle by rotating the tool over the terminal in a clockwise direction does it contact the sharp edge scraping off the insulation. As long as the angle between the wire and tool is kept below 45 degrees there is no danger of damaging the insulation when dispensing wire between posts.

After the terminal has been wrapped with seven or so turns, the tool is simply lifted and an extra turn is looped around it to guard against shorts. The wire can then be routed to the next point. Seven turns gives 28 points of contact for high reliability. A second instrument, the *P183* chisel knife and forming tool is a nice complement for trimming and holding the wire ends during the wiring operation. One end of the companion tool looks like a screwdriver but is actually a sharp knife-like blade. By pressing the *P183* against the wire and the board, the wire is neatly severed precisely where you like. The other end is insulated and will hold the wire when starting the wrap action and when routing the wire between posts.

If you don't believe it works, take apart a wrapped connection or two and look at the wire with a magnifying glass. You'll see where the insulation has been scraped away and where it has contacted and indented by the terminal post edges. That is essentially what I did in addition to making some resistance measurements of the completed wraps.

All this may sound very exacting, but is a very simple operation. No appreciable force or particular skill is needed. Excessive force should be avoided as it may create problems by breaking the wire. The head of the tool can be replaced when the cutting edge becomes dull, but Vector estimates its life to be over 10,000 connections. The whole operation is very clean and not a chore as some supposedly labor-saving gadgets actually turn out to be.

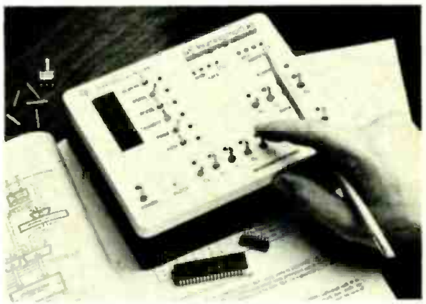
Round or rectangular terminals under 0.35 inch diameter will fit the center hole. If you really want to wrap other size or shape terminals such as round ones you can do it but you will have to solder the terminals to make reliable connections. Remember that you can still use the solder-through wire and won't have to strip it first. Generally, it takes more care to solder this wire and longer applications of heat than with normal soldering techniques. Large terminals can also be wrapped in pencil-like fashion but this is pretty far afield from the purpose behind the tool.

Give some thought to where all the wires are going when you lay out the circuit since there is limited room on each post and it is wise to daisy chain from one to the next. In other words, wire from one post to another and then continue on without cutting the wire.

The Vector *P180* sells for $24.50 with two 100-foot rolls of the No. 28 gauge wire. There is also a $69 *P160 Electro Wrapper* which is a cordless power tool that spins the P180. The *P183 Chisel Knife Tool* is a $1.95 option and $8 replacement *P180* bits are available. Bits for other wire sizes will be available in the future. Wire is purchased at $2.75 for a package of three 100-foot spools, and comes in green, clear, red, and blue. For further information, contact: Vector Electronic Company, Inc., 12460 Gladstone Avenue, Sylmar, CA 91342. **R-E**

Texas Instruments LCM-1001 Microprocessor Learning Module

THE LCM-1001 LEARNING MODULE USES THE TI SBP-0400 integrated circuit. Before looking at the microprogrammer, some introduction is necessary since this device is different than the majority of the microprocessors you have seen written up. Actually the SBP-0400 is not a μP but more correctly it is a 4-bit expandable parallel binary processor element. The I^2L (*I*ntegrated *I*njection *L*ogic) circuit is one step down in hierarchy from the mP. To expand it into a mP takes additional control logic and memory circuitry. Further expansion will convert the mP into a full microcomputer.



Circle 104 on reader service card

The instruction set can have as many operations as the combinations of the 9-bit input microinstruction code allows—a total of 2^9 or 512 instructions. The very flexible design of the processor element allows arithmetic and Boolean, logical shift, circulate, and register transfer operations, and combinations of these operations in a single clock cycle. To perform a single macroinstruction of a microprocessor, a series of microinstructions are carried out by the additional control circuitry and memory. A read-only-memory holds a microprogram or series of microinstructions that are executed for the specific higher level mP instructions.

The processor has a programmable logic array (PLA), an operation register (OR), an arithmetic logic unit (ALU), a relative position control, eight 4-bit register files (the 8th is the program counter), a working and extended register, and a number of multiplexers and busses.

The mask programmable PLA lets the user ultimately select the instruction code format he wants for specific operations. The standard factory PLA program has a very versatile set of 459 unique operations.

Two or more of the IC's may be chained to expand the computer word length in 4-bit increments starting from a single SBP-0400 4-bit machine. Two input-terminals control the way data shifts are handled through the interconnected devices. They are set hard-wired to a logic 0 or a logic 1 according to whether the particular package is the most, least, or an intermediate significant package in the element chain. These terminals also determine the input/output assignments.

The *LCM*-1001 is essentially a rechargeable battery powered SBP-0400 with a control panel. The panel has microinstruction and data inputs, six control switches, and a total of 29 LED indicators. There is also a 40-pin socket for carrying out the more complex exercises and for expansion into a mC if desired. Each pin on the socket corresponds one-to-one to the SBP-0400, except for pin-40 which connects to the power supply.

The *LCM*-1001 is designed to teach about the SBP-0400 by the time proven hands-on method. A pushbutton clock-pulse generator lets you step through instructions one at a time. In this form it is *strictly* a learning module and should not be confused with an automatically clocked microcomputer system.

The unit comes with a 150-page instruction manual. Most other systems sorely lack this type of documentation. One word of caution—the manual is not written for the beginner and reference is made to a text for the necessary background information.

You are warned by the manual that you cannot skip the important early part of the text and expect to get anything out of the *LCM-1001* by "playing" with the switches. And of course if this is what you attempt you've simply wasted the purchase price. After you read through the detailed descriptive material and have at least digested a portion of it, you can then move on to the module itself and begin to run some simple programs. You will find yourself going back to the previous material. It is during this phase that you will actually begin to understand what is going on. As you work the examples, you are encouraged to try some of the ideas that come into your head. For example, you might try to get the same results as a text program in some other way. You can also attempt to see how a microprocessor, such as the TMS8080, works by writing a series of microinstructions that carry out some of the operations in the 8080 instruction set.

There is a real need for this type of module that for $149.95 allows understanding of the computer at its most elemental microinstruction level. The learning module is a very neat plastic enclosed $6^3/_4 \times 5^1/_2 \times 2$-inch package. After the hobbyist, technician or engineer has mastered the basic concepts he can then go on to make his own controller and I/O interfaces. Three follow-on modules are planned for future release. They are a PROM controller, memory, and input/output modules.

Inquiries should be sent to Texas Instruments Incorporated, Inquiry Answering Service, P.O. Box 5012, Mail Station 84, Dallas, TX 75222. **R-E**

Hickok Model 217 Semiconductor Analyzer

Circle 105 on reader service card

INTEGRATED CIRCUITRY IS BECOMING MORE and more useful in service-type test equipment. The Hickok Electrical Instrument Co. has a line of automatic transistor analyzers that is a good example of this. Starting with the *Baby Bear*, the shirt-pocket size model

continued on page 32

Realistic is out front in cassette decks!

a giant step forward for your system:

the new front-loading SCT-11 with Dolby on tape and FM.

Most decks give you Dolby* noise reduction only on tape. But the Realistic® SCT-11 also brings improved fidelity to FM — by plugging into your receiver's tape monitor and decoding Dolbyized stereocasts. You can stack this deck or install it between shelves, because everything's out front. Lighted cassette compartment. Oversize VU meters. Bias selector for finest sound from standard or CrO_2 tape. LED function indicators. Dual concentric recording level knob. And you get full Auto-Stop, plus automatic recording in mono, on both channels, when only the left channel is plugged in. Ask for 14-849, pay only 229.95 at participating stores, get the out-front deck that leaves others behind. Walnut grain vinyl-over-metal case included.

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EQUIPMENT REPORTS

continued from page 30

215, it goes to a middle sized *(Mama Bear) model 217*, and then to *Papa Bear*, the larger *model 220*. The *model 215* has been previously reviewed, and now we come to the *model 217*. This uses the same automatic test circuitry. Well, almost completely automatic; you do have to hook up three test leads! After that, the internal circuitry does all the rest. These will test any transistor in-circuit or out-of-circuit–bipolars. JFET's. UJT's, diodes, Zeners, SCR's, Triacs, etc.

The three color-coded test leads have the EZ-Hook miniature clips and can be easily connected to any transistor. Even if there is only a little bit of lead showing. If there isn't, you can use a handy three-pin probe. This probe has very sharp tips and will penetrate any coating, insulation, etc. The three pins are adjustable. Then you push the switch on the *217* to TRANSISTOR and it does the rest. It scans all possible combinations of the three leads. When it comes to the right one, it files this away in its memory. At the end of the scan, the panel lights tell you whether the transistor is GOOD, BAD, NPN or PNP, and also which lead is the base (or the gate if it is an FET!). It will make in-circuit tests of any transistor that has more than 500 ohms of impedance shunted across it.

If the circuit has less than this, the *217* will read it as bad. The lights will keep on blinking and the BAD light comes on. However, the manual cautions you that any transistor reading BAD should be taken out of the circuit and retested. If it reads BAD now, then it is. I verified this. I checked out one of the little orphan radios that are so common now. The *217* picked out three bad transistors in the blink of an eye. (Should have said "Blink of an LED", for that's what all the indicator lights are.) There is one extra feature. If you hook the *217* to the output transistors of a radio, especially transformer-coupled types, you'll hear the "beep" of the scanning signal! Automatic test of speaker and output transformer for open circuits!

If the switch is turned on with the test leads open, all lights blink and the BAD light glows. This is the normal indication.

The *model 217* is very handy for testing transistors before you install them. I had a couple of odd-ball transistors that I was going to use in a radio. Testing these showed that the package marking was wrong! The base wasn't on the lead they showed. Things like this can save a whole lot of time.

When testing, the lights blink as soon as the switch is turned on. They will keep on for one second; this is all it takes to make a complete scan! If the transistor is good, it will then light the appropriate lights to indicate polarity, base location, etc., and hold this for 3 or 4 seconds. Then, the cycle starts over again. For diode testing, only leads 1 and 3 are used. Throwing the switch to DIODE, starts the test. The GOOD N or GOOD P light will come on if the diode is good. The panel markings show which test lead is on the anode and which one is on the cathode. This can be very handy for identifying the cathode on those diodes that are so small you can't even see 'em, let alone read any markings. A 3-pin transistor socket is mounted on the panel; lines from each pin go to the banana jacks for base identification.

The *217* has a very unusual panel meter. This is used for leakage and identification tests. These tests should be made out-of-circuit for valid results. To read leakage, hook up the transistor and wait till the circuitry has finished cycling, then push the TEST-HOLD button. The leakage can then be read directly on the meter. The meter is a little unusual. It is specially designed so that it can read leakages from 1.0 microamp up to 5.0 milliamps—all on a single scale. A range of 50,000 to 1! (Talk about nonlinear!) This test will read either I_{cbo} or Iebo of transistors, or I_{gss} of FET's.

For identifying the type of material, Ge or Si, push the TEST-HOLD switch and then push the LEAKAGE-IDENTIFY switch. The transistor will be identified by the meter reading. If the meter is in the orange scale, the device is Si. If the meter is in the blue scale, the device is Ge. Transistors with excessive leakage will throw this off. The allowable leakage for power or signal transistors, for each type, is shown by special scales on the meter.

The *model 217* can be powered from the AC line or from two 9-volt transistor batteries. These may be the stock types or rechargeable NiCad types. A built-in circuit may be hooked up for recharging. The BATTERY-AC selector switch is located in the handy compartment on the top, where the line cord and test leads are stowed. A handy bail-type handle is used to prop it up for the easiest use on the bench.

The manual gives you simple tests that can be made to make sure that it is working properly. This requires only a good silicon transistor, a meter able to read 1.0 mA and 5.0 mA, and a decade resistance box. The circuitry used is durable and normally trouble-free. A one-year warranty is given with provisions for one more year at a nominal charge.

A very handy instrument and one that meets the prime requirement for all commercial test equipment. Properly used it can pay for itself in time saved, in only a short time.

For more information contact: Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, OH 44108. **R-E**

Town Board orders Cablevision to cease repair of local TV's

As a result of representations made by the local Television and Electronics Service Association (TESA), the Oyster Bay (New York) Town Board ordered Cablevision of Jericho to "cease and desist" from offering TV repair contracts to the more than 30,000 cable customers in the town.

Neil Gaylor, president of the local TESA, appeared at the board meeting with a delegation from the Association. He stated that Cablevision was not only undercutting standard service contract rates—normally $125 per year—of the 400 service shops in the area, but that more than 1,000 persons would be out of work if the practice continued.

Cablevision's franchise prohibits the company from going into the repair business. The contention of Cablevision's attorney that the company was merely acting as an agent for Broadway Maintenance, which does the actual repair work, was brushed aside by town attorney Joseph Colbey. "Broadway Maintenance is an *alter ego* f Cablevision, subject to the same restrictions," he said. **R-E**

For a winning deck, pick a Sansui.

With the development of the Sansui cassette decks, the cassette can truly be called a high fidelity medium. Only with the technical accuracy and near perfection of these Sansui models can the musical recording and reproduction do full justice to the capabilities of the cassette being used.

The new Sansui vertical front-load series has achieved extremely low wow and flutter by isolating the capstan drive from the reel drive. This is accomplished by a slip-free drive belt coupled to a mirror finish, extra large flywheel. Our new decks incorporate the newest Dolby* IC chip technology to give you a full 10 dB improvement in signal-to-noise ratio. All mechanical controls are inter-locked so you can go directly from any mode to any other without going through stop, to prevent damaging valuable tape.

The SC-3000 and SC-3003, top-of-the-line models with 0.09% (WRMS) wow and flutter are stacked with attractive features: front-access tape compartment positioned right-side up, fully automatic stop-shut/off, a reliable and easy-to-read 3-digit tape index counter with a very useful Memory Rewind Section, highly accurate VU meters, peak level indicator, extremely hard Permalloy record/playback head for long life and outstanding performance.

All four models in this Sansui series, from under $290.00** to under $370.00,** share many of the same outstanding features for true high fidelity performance at attractive prices.

The Sansui SC-636[1] at under $280.00,** a leading all-around deck, delivers fine quality sound without costly frills. As with the higher priced models, the SC-636 offers fully automatic shut/off, illuminated VU meters, built-in Dolby* Type B Noise Reduction System, low wow and flutter and an excellent signal-to-noise ratio.

Sansui has stacked its decks. Stop in at your nearest franchised Sansui dealer today and buy one of these outstanding new Sansui series to stack yours.

* Dolby is a trademark of Dolby Laboratories Inc.
**The value shown is for informational purposes only. The actual resale price will be set by the individual Sansui dealer at his option.
[1] Simulated walnut grain

Sansui

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SANSUI ELECTRIC CO., LTD., Tokyo, Japan • SANSUI AUDIO EUROPE S.A., Antwerp, Belgium
In Canada: Electronic Distributors

Circle 91 on reader service card

New digital relay system uses frequency-shift keying

Increasing digitization of communications traffic, the need to use higher frequencies to meet future transmission capacity requirements, and economical aspects are among the reasons cited by Siemens for introducing a new microwave relay communications system, the PSK 120-240/15000. The equipment is now undergoing tests by the German postal administration.

THE SIEMENS PSK 120-240/15000

The system operates with phase-shift keying at 15 GHz. Information is contained in the phase shifts at 0, 90, 180 and 270 degrees. Transmission is at the rate of 8.448 megabits per second.

All transmission and reception equipment is contained in a weatherproof housing roughly 27 × 27 × 14½ inches, the front of which acts as the parabolic antenna. A total of eight transmitters and eight receivers can be used with one antenna. Four employ vertical and four horizontal polarization. Capacity is 1920 voice channels in two 120-MHz wide bands. Power is one-tenth or one-half watt, as desired.

Relay hop distances vary according to conditions; rainfall figures for Germany indicate spacings of about 14 to 18 miles between antennas.

Input unit for ELF transmitter helps submarine communications

An electronic device that enables a land-based transmitter of sufficient power to communicate with deep-cruising submarines almost anywhere in the world has been shipped by Sylvania to the Navy Test Facility in northern Wisconsin.

Known as an Input Message Processor Terminal, it includes a modulator, a teletype machine and a computer program. Under program control it encodes messages and modulates the ELF transmitter at the Wisconsin test facility.

The ELF band (30 to 300 hertz) is the only one useful for communicating with submarines deep in the water. Submarines can receive necessary messages on that band without rising to the surface, reducing the danger of detection and destruction. The Wisconsin test site has a buried antenna of fantastic size for such communications.

NESDA EVALUATES MAGNAVOX EQUIPMENT

NESDA SERVICEABILITY EVALUATION TEAM are evaluating the Magnavox T-995 and T-991 chassis at the company's Fort Wayne (IN) engineering laboratories. Left to right, standing are Dean Mock, Bob Schladetsch, Steve Carpenter, James Smith. Foreground, kneeling: Stu Leightner.

Automatic Frequency Counting and Display to 60MHz with 1Hz Resolution

B+K PRECISION MODEL 1801, $240

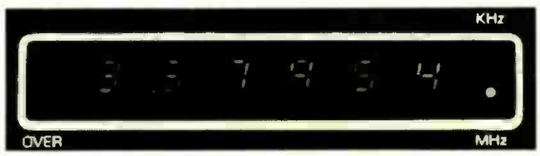
For laboratory, production line or maintenance applications, the Model 1801 will meet most requirements for sensitivity, ruggedness and dependability. With the Model 1801 you can *watch* oscillator adjustments, monitor RF and audio frequencies precisely, do fast production testing, check critical countdown chains, calibrate signal generators and check CB frequencies.

Automatic ranging 20Hz—40MHz is guaranteed. Ranging to 60MHz is typical. Reliable TTL circuitry updates the six-digit display five times per second. Resolution to 1Hz is obtained by switching to the 1SEC mode that suppresses the leading digits above 1MHz.

Specified accuracy better than 10PPM, 0-50° C. Maximum aging rate 10PPM/year.

The 1801 is compatible with prescalers that will extend its usability into the UHF range.

For detailed specifications and a no obligation, 10-day free trial, contact your local electronic distributor or B&K Precision.



MHz display of 3.579548 MHz input (AUTO mode)

KHz display of overflow of 3.579548 MHz input (1SEC mode)

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Circle 99 on reader service card

State of SOLID STATE

Microprocessors—assembling a system, software and system modules

KARL SAVON
SEMICONDUCTOR EDITOR

YOU'VE FINISHED READING THE MANUALS AND you have a working knowledge of the microprocessor instruction set. Waiting in front of you is a set of IC's to build your microcomputer. Suddenly you are hit with cold reality: How do you put this thing together and get it to run? And how do you get that program you've been working on into the memory?

Getting started

So I'll make a recommendation. Take a serious look at what's available in microcomputer kits. Assuming you've already decided on the microprocessor you want to work with, be it the Motorola M6800, the Intel 8080, the MOS Technology MCS6502 or the Fairchild F8, the field is narrowed and you can choose a microcomputer kit depending on the final goal and cost. You'll find relief in having all the busses and control wires connected for you as well as the input/output interfaces taken care of.

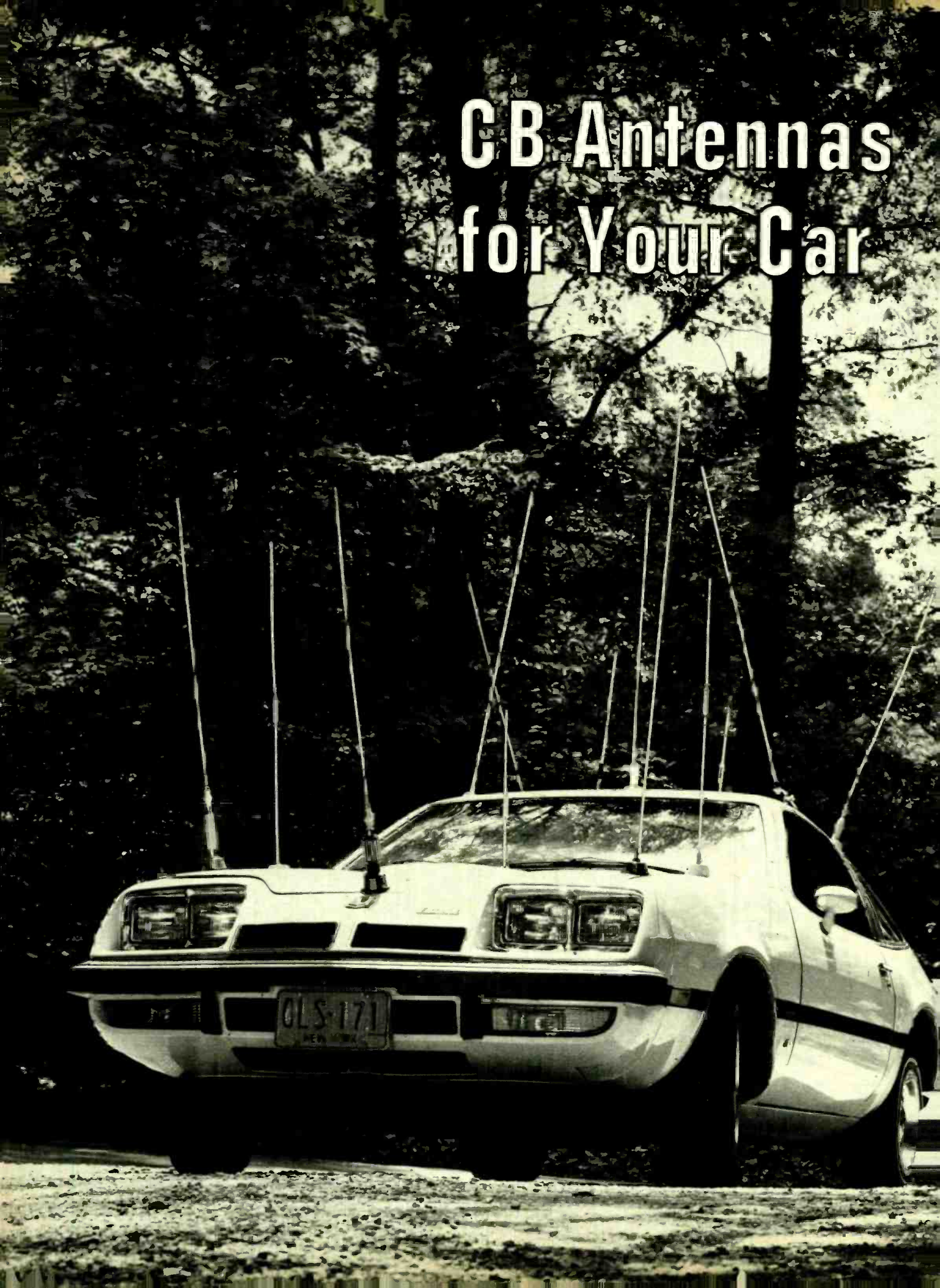
It's one thing if you're an experienced computer engineer and have a good idea where everything should go. But if you're a novice or even an experienced technician or engineer lacking in microcomputer savvy, the breadboarding kit route will save you lots of woes. No matter what you've heard, the microprocessor is not simple for the beginner to use. The manuals, diagrams, and software that are provided with the kit will be invaluable in getting your system working and in learning the less obvious details quickly.

If you are really determined to do your own thing and insist on making PC boards etc., then at least start with a system schematic provided by the microprocessor manufacturer.

The numerous breadboarding systems on the market—such as the MITS Altair 8800 and 680, the Microcomputer Associates JOLT kits, the Electronic Product Associates Micro-68, Control Logic's L and M series, Cramerkits, E & L Instruments MD-1 and the Sphere OCC—come with assortments of CPU's, power supplies, input/output interfaces, and programming and control methods. A bank of switches and indicators may be provided or there may be a more sophisticated teletype or video display interface. If you already own a TV typewriter, you are way ahead of the game. Front panel switches

(continued on page 112)

CB Antennas for Your Car



Mobile CB antennas are available in a variety of shapes, sizes and types. This combined with a wide choice of mounting locations and hardware makes finding the best possible combination difficult

HERB FRIEDMAN

IF YOU WALK DOWN TO YOUR LOCAL CB DEALER YOU MIGHT FIND A handful of antenna models from perhaps two, maybe three manufacturers. If you walk past to another dealer you'll find a completely different selection of antennas from a different group of manufacturers. And if you went to five different CB shops it's quite likely you would never see the same antenna or manufacturer twice. It seems that every week or so a new manufacturer joins the ranks of those providing antennas and in many instances they each offer something slightly different—and if not a different antenna, at least a different mount.

At one time selecting a CB antenna took about 30 seconds of thought. You had your choice of a full length 108" whip that was bumper or body mounted for mobile, and a ground plane or coaxial antenna for the base. About the only real choice you had was between manufacturers, most of whom were primarily concerned with the amateur/commercial market. And you could select between the antennas of maybe three or four brands, all virtually identical except for the brand name.

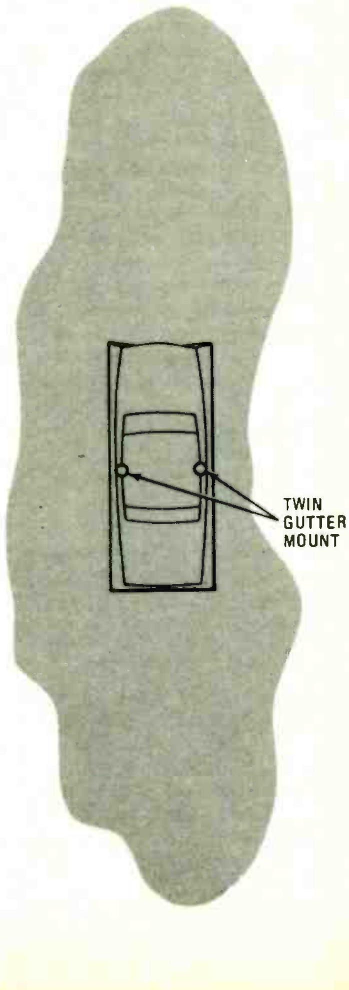
Today, the CB antenna is king of the hill. The demand is so great that most new brands simply avoid the amateur and commercial users, and many of the old-line manufacturers now have an extensive line of CB antennas with their other services relegated to a page or two in their catalog.

The duplication is, of course, enormous. You can find five or more models of the same type of mobile antenna within a short walk down any city's "electronics row". On the other hand, you will also find just about any oddball mount or design you or anyone else can dream up. No matter how far-out your particular mobile mounting problem might appear there's an odds-on bet someone has already thought of it and sells a specific mount (with or without antenna) virtually tailor-made for your particular mobile installation.

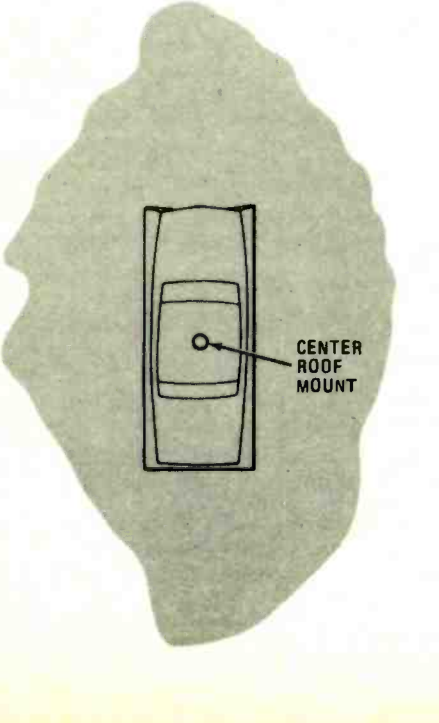
And when it comes to base station antennas . . . ho boy! You name it and someone makes it. Everything from an inexpensive ground plane that gets you into CB on a tight budget, to a virtual *RF cannon* that concentrates a transceiver's RF energy into one direction so the signal equals that of a transmitter with about 250 watts RF output.

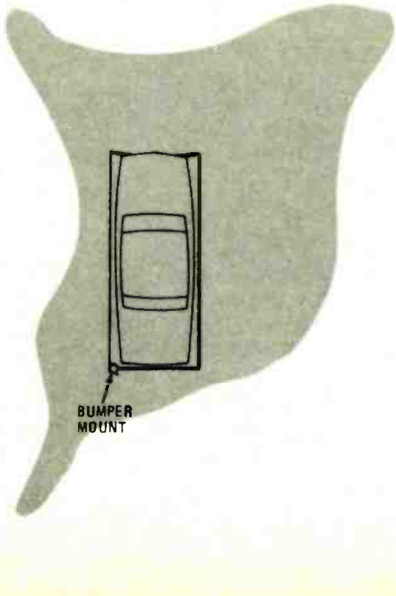
There are basically four types of mobile antennas, which through various specialized designs and mounting brackets finalize into some 50-odd different antennas. First, there are the 102-inch whips designed to be used with 6-inch shock-

THE TWIN-GUTTER MOUNT requires phasing harness and provides a directional response that points directly in front and behind car.



CENTER-ROOF MOUNT (left) provides the best omnidirectional response. This location requires a magnetic mount or a hole cut into the roof. BUMPER MOUNT (bottom) does not provide optimum directional response but antenna attaches directly to bumper.



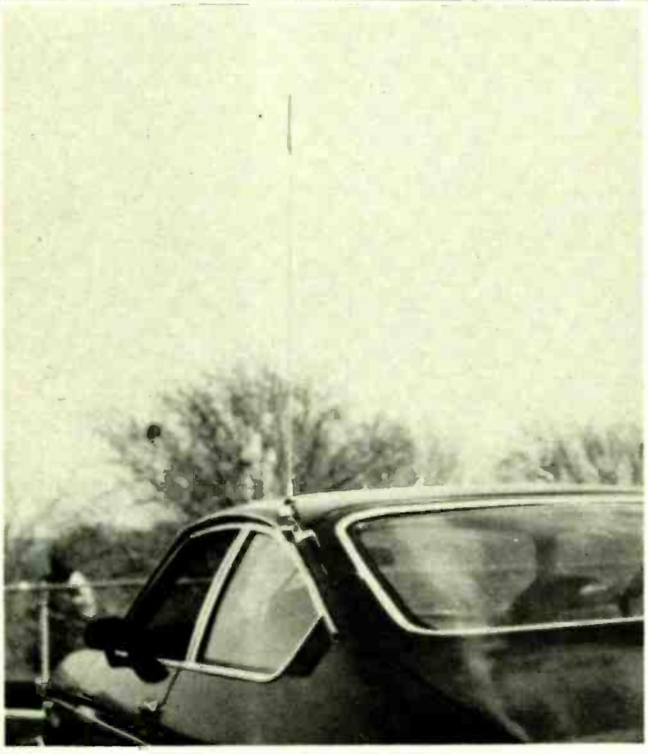


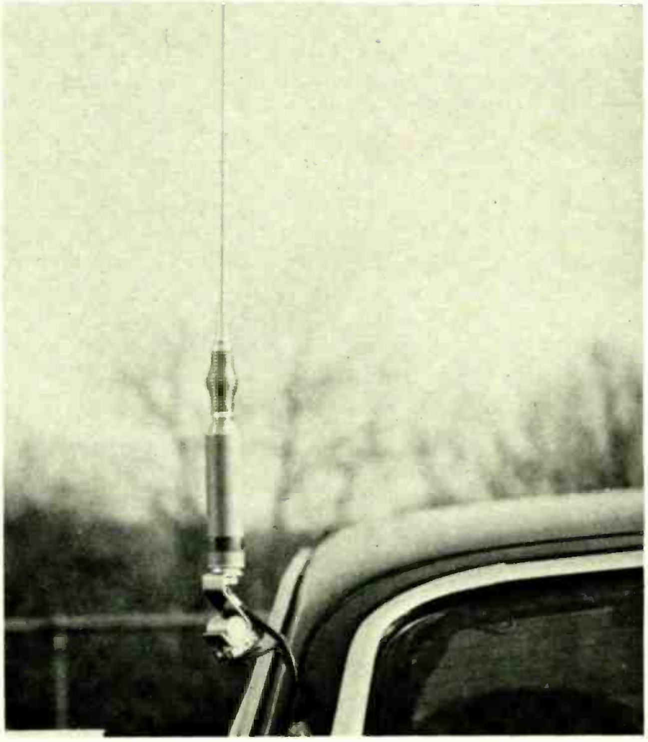
springs for a total length of 108-inches—the so-called ¼-*wavelength whip*. There are also some 108" whips that are meant to be used without shock-springs, if you're crazy enough to do it. Most 108-inch whips are stainless steel, a few models such as the Breaker 12-505, Shakespeare 10-3 and Cushcraft CB-9 are fiberglass, which is generally preferred around salt water. If you're interested in fiberglass whips don't be touted off by their 96-inch length. The fiberglass covering alters the velocity factor of the conductor so an electrical ¼-wavelength is attained with only 96 inches overall.

The second type of mobile antenna is the group consisting of fiberglass continuously loaded, or top loaded, whips. The overall length of these models is generally in the range of 36 to 48 inches, and they are usually non-adjustable. You screw them into the mount and the SWR is whatever it is. The advantage of the continuously loaded and top loaded whips is that they normally have a slightly greater "output" than center or base-loaded antennas of equivalent size. The reason for the greater output is that ¼-wavelength antennas radiate primarily from the high-current area which is near the base, minimal current is at the top of the antenna. If the antenna is top or continuously-loaded—the high-current area is undisturbed by the loading system. As the loading is moved downward through a center or base loading coil, the high-current area is compressed towards the base of the antenna, providing less high-current area for radiation.

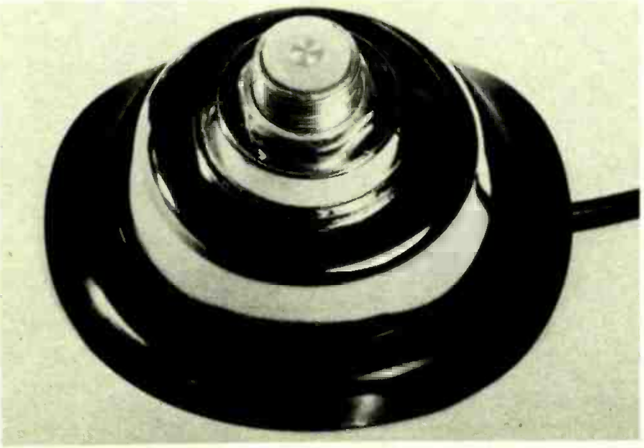
So why doesn't everyone use top or continuously loaded antennas? Because they are top-heavy, present high wind loading, and have a narrow bandwidth that presents tuning (high SWR) problems in certain installations. But when they can be used they have a definite advantage of greater radiation. Among the many manufacturers that provide top and continuously loaded antennas are Antenna Specialists, Mark, Shakespeare, Cushcraft, and Newtronics.

The real kings-of-the-road are the center and base-loaded mobile whips, for there are more of them on the road and in the CB showrooms than there are any other type of antenna. The reason for their popularity other than the fact they are cheap to manufacture and even cheaper to blister package is they are the easiest to adjust for individual mounting conditions. Connect an SWR meter in the transmission line, slide the top whip section up and down until you have lowest SWR, tighten a set-screw and the antenna is optimized to the car, truck, camper, etc. Maybe the radiation isn't as good as from a





TWO VIEWS OF A CB ANTENNA (above) with a unique hatchback mount that lets the user adjust the position of the antenna. The user can set the antenna so it stands straight up vertically on hatchback and fastback cars. In addition to the adjustment feature, the antenna doubles as a trunk-groove mount. It's made by Antenna Specialists. The new mount also makes it possible for the CBer to remove his antenna easily when he parks to protect against vandals and thieves.



A WATERPROOF ANTENNA MOUNT (left) also made by Antenna Specialists is worth noting. It provides complete protection against water shorting the antenna.

top-loaded or full-length whip, but a better "match" through an optimized tuning for a particular installation can result in a stronger signal at the receiving station.

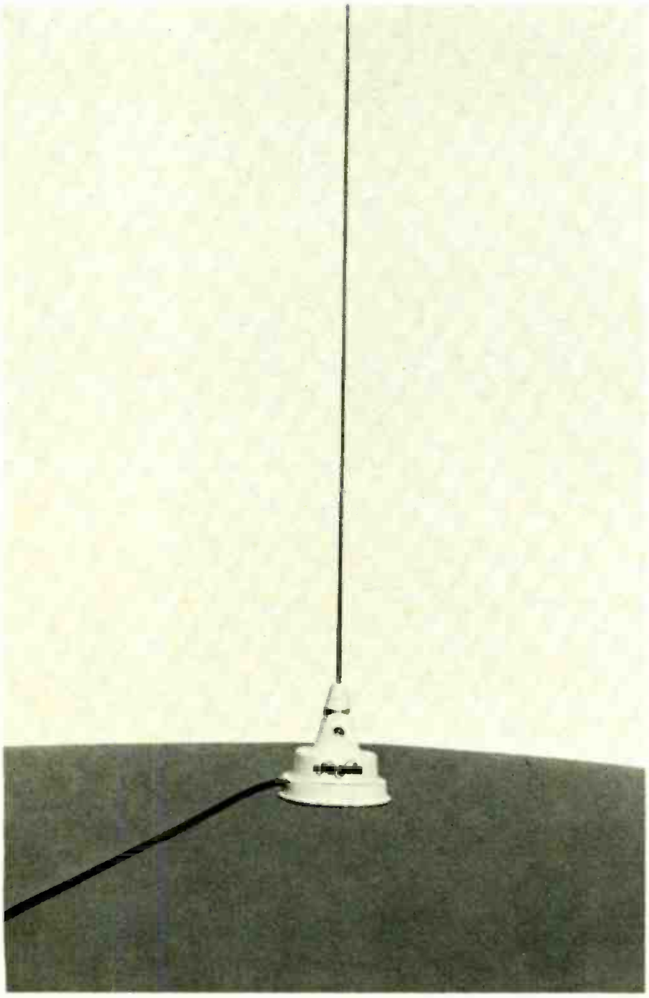
Center- and base-loaded antennas come in every size from about 18 inches up; and here the rule is firm—the longer the antenna the greater the radiation. You should use the longest model you can get away with, short of breaking the lights at the next toll booth.

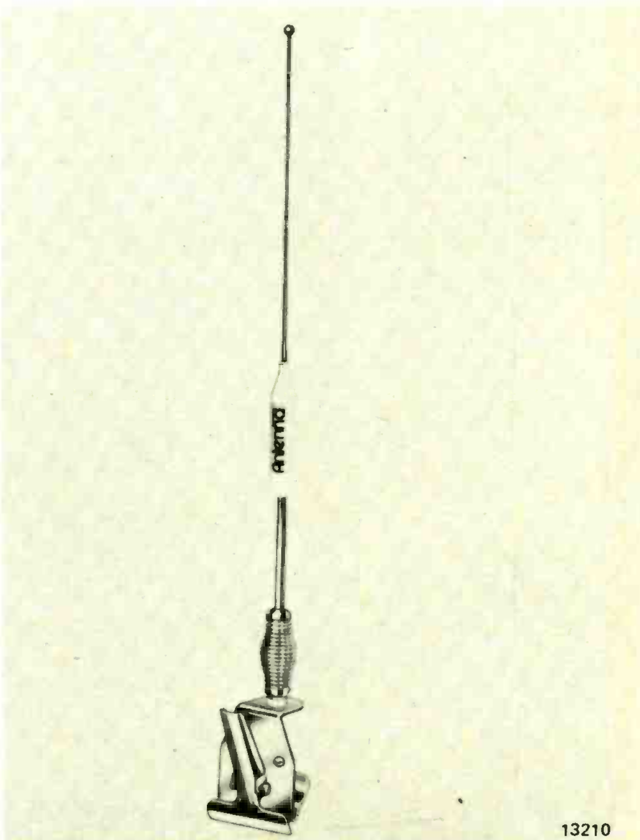
Every antenna line contains several different base and/or center-loaded mobile antennas, even the brands you might not of heard of yet, such as Shark, Antenna Inc. and Teaberry. (Keep in mind that yesterday's "unknown" brand is tomorrow's national brand when it comes to CB equipment.)

The only real difference between mobile antennas of similar design is the overall construction. Some models, such as the Avanti base-loaded models, will probably outlast five cars. Then there are the models from Antenna Specialists and Hy-Gain with loading coils that coast at 250 or 500 watts input, though this is somewhat more power than allowed by the FCC—like 246 and 496 watts too much.

The fourth and final type of mobile antenna is the *dual* antenna system sometimes termed *co-phased, twin*, or *Fazer*. The dual antenna system consists of two mobile antennas of any type connected through a phasing harness so the radiation pattern compensates for a poor mounting location. For example, if a whip were mounted on a truck's mirror bracket (the most common location), the radiation pattern would favor a diagonal line running through the truck. By mounting a whip on each side of the truck, connected by a common phasing harness (transmission line), the radiation pattern is shifted straight back and down the road. (Actually, the signal is made more omnidirectional, but since a greater part of the energy is forward and back it has become common to claim the dual antenna system concentrates the radiation "down the road.")

Within the four classifications of mobile types there are some six or seven basic designs—depending on what could be considered a different design. It is when we connect the pieces of mounting hardware that we get so many different antenna models. For example, put any type of antenna on a mirror bracket and it becomes a "West Coast Mirror" antenna. Use two West Coast Mirror antennas, add a phasing harness and you get a "trucker's antenna"—and just about everyone makes

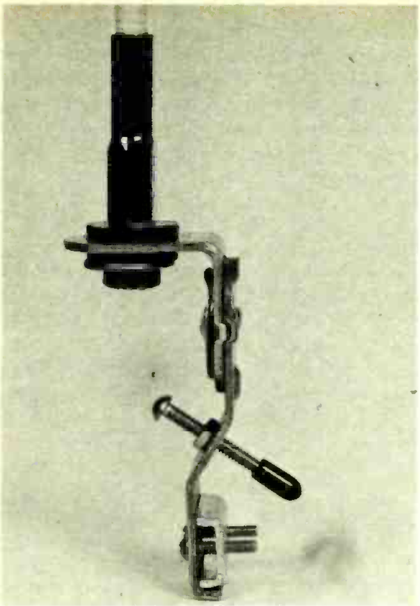


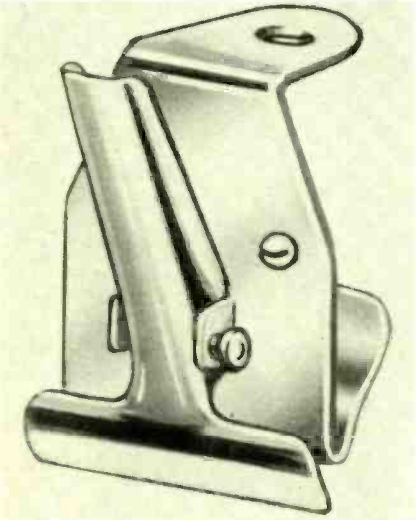


MAGNETIC ROOF MOUNT by Hy-Gain (above) is a cinch to install and remove. It has a 48-inch whip and the magnet is covered with a layer of clear plastic to protect the car roof against scratches.

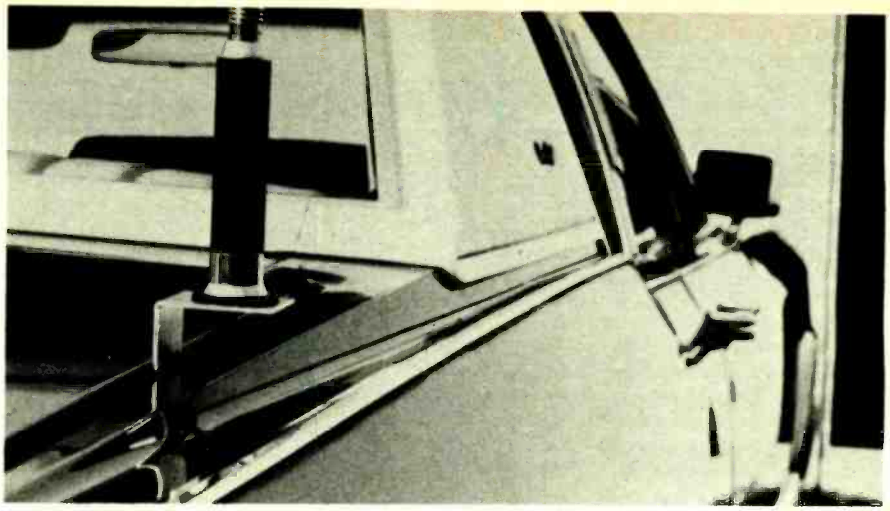
THE BUMPER MOUNTED CO-PHASED WHIP combo (top right) is made by Shakespeare. It features two half-wave center loaded antennas with a Diplexer wiring harness.

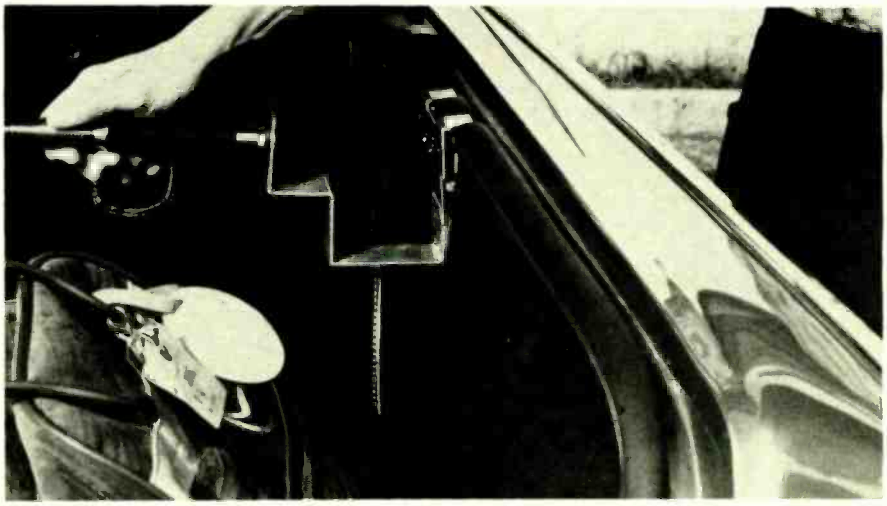
AT THE RIGHT IS Antenna Inc.'s spring clamp gutter mount antenna. It has a stainless-steel whip.





GUTTER-MOUNT ANTENNA (top) has a fold-over mount. It's made by Hy-Gain. THE SPRING CLAMP gutter mount (above) is made by Antenna, Inc. It adjusts to the car's rain gutter and needs no screws.





TUK-A-WAY ANTENNA MOUNT (top) is shown in use. Made of cold rolled steel and coated in zinc chromate it attaches to the trunk rim of most cars. It's made by Deep South Marketing Corp.

WHEN NOT IN USE (above) the Tuk-A-Way antenna mount folds into the trunk. When it is folded down, a stop keeps the antenna suspended and off the trunk floor while it is stored. Only the mount is supplied. The mount accepts antennas designed for either roof or trunk mounting.

one of those. Do you change trucks often, moving the rig each time? Then you can even get a set of vise-grip clamps with a built-on antenna mount you can quickly attach and remove it from any truck mirror assembly.

If you have just a typical mobile installation the choice of antennas and mounts is almost endless. There are mounts that go through the car (in a small hole), mounts that wrap around the edge of the trunk lip for a no-hole installation, mounts that fit the trunk-lip rain channel, mounts that fit on the bumper, mounts that clip to the rain gutter over the driver's window (either permanently with screws or temporarily with a clamp), even a magnetic mount that can hold a mobile whip in the center of the roof at high speeds. If there's some possible way to install a mobile antenna someone makes the right mount.

When we move from the concrete to the water, things get a bit more difficult as the antennas must be water and corrosion proof. While stainless steel will resist salt water corrosion, it depends on the type of stainless, and there are some stainless steels which virtually dissolve when out on the ocean. There's no way you can really be certain what you're getting. Fact is, the best marine material is usually fiberglass and that's what you'll find in the marine lines from the best known manufacturers such as Antenna Specialists, Hy-Gain, Francis, Mark and Shakespeare. These outfits have a lot of experience with marine equipment, and even those with stainless steel antennas use a formulation that's specially made for marine service. Each also provides special corrosion and waterproof marine mounts (such as a fold-down or lay-down bracket). Also, special marine antennas are available which do not require a ground plate connection, such as the A/S M-306, Francis CB-74, Mark HW-11-M6, and Shakespeare 176-1, among others. While the longer marine antennas such as the 8-foot Hy-Gain 433 are too tall for mounting on top of a camper, the shorter no-ground marine antennas can be used on non-metallic campers and other RV's. (Normally, a "standard" whip performs poorly on a non-metallic vehicle because there's no ground plane. No-ground marine antennas are specifically designed to work without a ground plane, whether on water or land. A standard mobile-type antenna would require a connection to a boat's ground-plate.)

Buying the right CB antenna isn't easy, but it can't be done casually either. We hope we've shown you the basics you need to make a wise choice. **R-E**

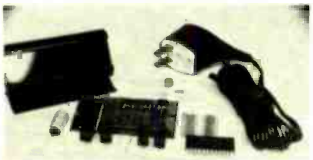
DIGITAL CLOCK KIT ROUNDUP

PART II. A comparison between the various digital clock kits that are currently available

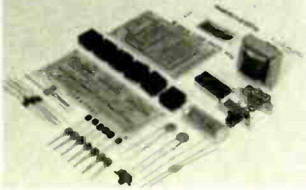
FRED BLECHMAN

ALTAJ 4-DIGIT ALARM CLOCK parts layout. Includes a case, not shown.

REAR VIEW, ALTAJ 4-DIGIT. Radio switch powers external radio for 45 minutes.



PARTS LAYOUT, Babylon Space Age clock.



SABTRONICS, parts layout.

BACK-PANEL VIEW OF THE DDC-1.

THE FIRST PART OF THIS ARTICLE DISCUSSED THE FEATURES AND PRESENTED a comparison chart of the clocks that are presently available. This second part of the article will take an in-depth look at each of the clock kits in alphabetical order.

Altaj Electronics

Both of the Altaj clock kits specify the use of "Molex pins", which they don't include. Molex pins substitute for IC sockets. They are spring-pins that are made in strips with the standard IC pin spacing of 0.1 inch. They are joined together at the top by a common flat metal section. You merely snip a length of strip that has the number of pins you want, with the connecting top section intact, insert them into the circuit board, and solder them to the foil. Now that the pins are secured by the solder joint, you bend the top connecting section back and forth with pliers until it breaks off, leaving the individual spring contacts all in a row, ready to accept the pins of the IC. Molex pins are somewhat hard to find, but suppliers heavy in the IC area have them. (James Electronics has them for $1 per strip of 100). Since clock IC's are subject to destruction in soldering and handling, Molex pins or IC sockets are used in most of the kits. Also, if you have a bad IC and want to unsolder it from the circuit board, you've got a real problem—some of the IC's have 40 pins to unsolder all at once!

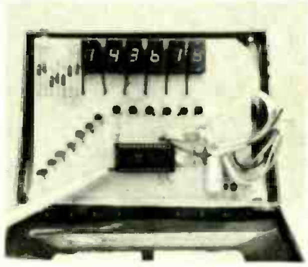
The direct-drive *4-Digit Alarm Clock* offers a sleep switch to shut off an external radio after 45 minutes. The digits for this clock can be ordered in either 0.25 or 0.5-inch heights.

The *King* is the most versatile of all the kits with respect to options. You can order 0.3-inch high red, yellow or green digits, or red digits 0.5 inch or 0.6 inch high. Extra modules are being offered to read temperature in four digits, to start an external appliance at a specified time, and to *chime* on the hour electronically! This clock is difficult to handle during final assembly, since the spacing and positioning of the display within the case involves connecting the control board and display board with 2-watt resistors that feed the display segments and double as structural members. The cases for both of these clocks are "first class"!

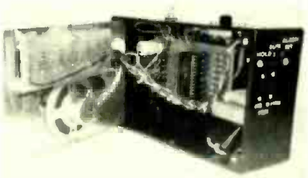
Babylon Electronics

The *Space Age Clock Kit* is the smallest and certainly the "cutest" of all the clocks reported in this article. It also got the most attention at a display of eight of these clocks at a recent Clock Society meeting. It somehow manages to use fewer parts than any other MM5314 clock, yet works beautifully. The kit is very complete, even including Molex pins and wire for the three "jumpers". Only solder was omitted.

To conserve case space, the transformer is a wall-plug type, and the switches for setting time are constructed and pre-assembled right on the printed circuit board. You simply apply pressure with a pencil point through the three holes in the back of the case for fast, slow and hold! The coded pulsing colon described earlier allows precise time setting to the second, even though only four digits are displayed. Soldering is somewhat difficult, since many of the circuit paths on the PC board are very close together, and the pin spacing of the FND-70

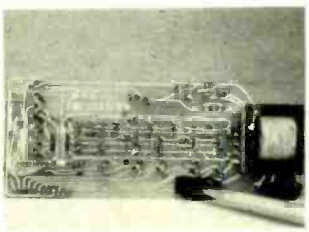


GODBOUT-SON-OF-A-CHEAP-CLOCK.

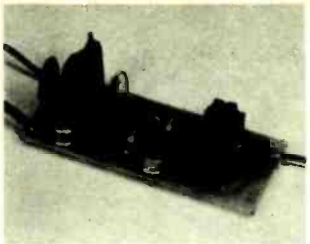


S.D. ALARM CLOCK. Display and alarm are on front panel and can be mounted remotely.

THE HEATHKIT MODEL GC-1092.

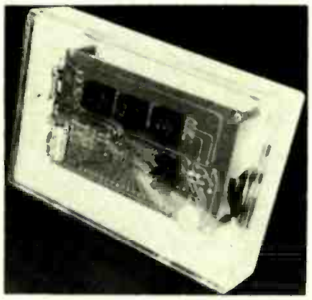


JE-700 TIMESETTING SWITCHES are prefabricated right on the board.

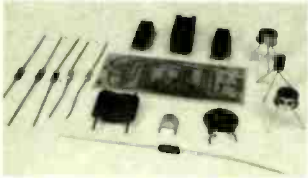


THE BILL GODBOUT TIME BASE.

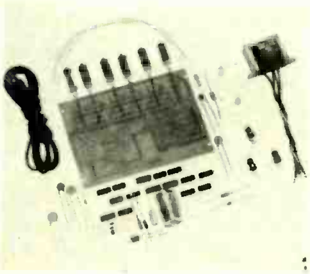
TWO MV-50 LED's between hour and minute displays form a pulsating colon that reads seconds in Space Age clock.



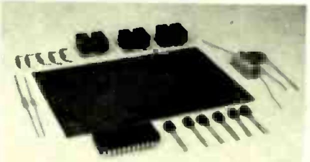
THE INTERNATIONAL CLOCK in a plastic box.



GODBOUT TIMEBASE PARTS LAYOUT

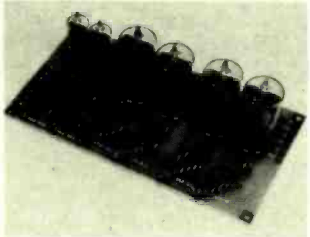


A PROFESSIONAL TYPE CLOCK, THE ESE ES-112K USES 15 separate IC'S instead of one clock IC, to achieve its results.

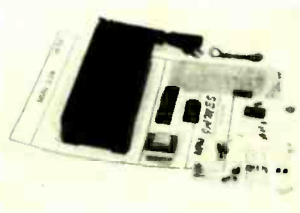


INTERNATIONAL ELECTRONICS CLOCK parts layout. Requires a 12-volt transformer.

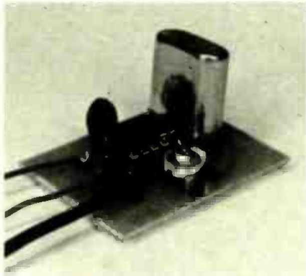
BLACK WATCH reads hours and minutes or date or seconds by pressing front panel.



THE CARINGELLA DDC-1 DISPLAY uses RCA Numitron tubes in sockets.



PARTS LAYOUT, JAMES JE-700.



S.D. SALES TIME BASE gives you the correct time from 12 volts DC.

S.D. timebase, parts layout

JAMES GIANT WALL CLOCK uses 31 separate LED's to light each digit.

displays are close. But, with care and a jeweler's loupe to inspect your work, you'll end up with a clock sure to get attention.

Bill Godbout Electronics

This is the only kit reported on that includes sockets for all the displays and the IC. You can make this clock with remote readouts, digit-blanking (display off to conserve power during battery use), 12 or 24-hour display, and battery or 50- or 60-Hz operation. Actually, any of the MM5314 clocks can do all these things, but the PC board and the instructions in this kit provide the method in detail. The PC board is designed so you can literally saw off the display portion and put it on your dashboard, for example, connected by a 13-wire ribbon cable to the clock control board under the dash. Specific instructions and sketches are provided to do this. Using a timebase described earlier, you can have a "Cheap Car Clock" (Godbout offers combination clock and timebase kit for $23.50).

Caringella

Beautifully packaged, and with clear, detailed instructions, these clocks would be rated "easy" in assembly, except for the large number of parts. No shortcuts have been taken, and these are top-quality clocks in appearance and performance. Great pains have obviously been taken to see that the builder has a no-hassle assembly job. Every wire needed in the assembly is color-coded by length, with the ends stripped of insulation and tinned for easy handling and soldering. If several wires follow a common path, they are furnished in pre-assembled tied cables, with each wire color-coded! This kit was really a delight to assemble, especially after some of the head-scratching required with other kits that offered not much more than a box of parts and a poorly reproduced schematic. Caringella kits show great attention to detail, in both the design of the kit and the clarity of instructions. The printed circuit boards were silk-screened on the component side to show the location of every part, making assembly almost foolproof.

Several Caringella clocks deserve special mention for unique design. The DDC-1 uses large digits for the hours and minutes, smaller ones for the seconds, making the display easier to interpret. This is also true with the DWC-1 and the MDC-1. The DWC-1 is a huge wall clock, with digits formed from individual LED's placed in lines to create digit segments. Furthermore, this clock and the MDC-1 have crystal-controlled built-in battery-powered timebases; this allows them to be unplugged, carried to another location, and when plugged in again with the displayed time being "right on". This also provides power failure immunity. The LDC-1, and smaller SDC-1, use only a single digit to read hours and minutes. The digit first reads tens-of-hours, then units-of-hours, then tens-of-minutes, then units-of-minutes—and then pauses before repeating! The LDC-1, in its 7-inch high hexagon wood case and single 3½ inch high digit, is a rare decorator conversation piece!

Fig. 2 shows the DDC-1 schematic—an MM5314 IC design with NO shortcuts!

Digital concepts

The EC-2000K takes less than a half hour to build, since there are very few parts. The display is a single large planar fluorescent display module that contains four large digits, colon, and AM and PM letters. Standard coloring is bright blue, but you can order other colors—they simply paint the front of the module the color you request, since the fluorescent output covers a broad spectrum of colors. All parts, including the transformer, mount directly on one printed circuit board. The only external wiring is the line cord and the wires to the time-setting switches. One switch selects unit-minutes and seconds display, instead of hours and minutes, and by proper operation of the switches this clock can be used as a 24-hour stop-clock that counts by the second! The case is unique in its clear tubular shape, with end-blocks in decorator wood. The end blocks have annular grooves that fit over the ends of the cylinder—no unsightly screws.

The CK-131 is a calendar clock—that is, it will read month and day alternately with time, if desired. With a clear Lucite front panel the display is orange and the circuit board parts show. With a colored panel, the display appears red, and the parts are not visible.

ESE

Instead of using a clock IC, this kit uses 15 individual IC's to perform the various functions of wave-shaping, dividing, decoding, encoding and driving the displays. This is a professional piece of equipment used extensively in the broadcasting industry, and is not really aimed at the hobby market. Assembly is straightforward, with very few parts beside the IC's. It comes in an attractive, rugged case and uses large, bright readouts with simple time-setting switches.

Formula International

The MM5314 clock is actually a simple kit to build, but the instructions are poorly planned and poorly reproduced, making a simple job confusing. With better instructions, this would be a very good "first clock kit" since the kit is very complete (only lacking solder and switch wiring). The circuit board is silk-screened to show component location and the only "tricky" part of the assembly is putting the eleven wire leads on each of the six fluorescent tube displays into the PC board. The case is modern and attractive, and the display a pleasant blue-green.

The OC130 and OC1032 are also very attractive when complete, but assembly of these two kits had best not be your first entry into the field. The OC1032 in particular is difficult to asemble, with the display sandwiched between two large circuit boards connected together with "strong copper wires". Although the OC1032 has only four digits, they are 1 inch high, and can be switched to read minutes and seconds. The digits are a bright yellow-orange, and the case is outstanding in appearance.

Heath

In the forefront of new design, these kits were produced before many of the other clocks shown, yet contain almost every imaginable feature—except simplicity! The designs are complex, with a maze of parts and cabling making them the most time-consuming clocks to build of all those in this article. The superb manuals would allow even a beginner to build one of these clocks given the time—a lot of time. However, if something goes wrong, it would take a competent technician to unravel it!

The GC1092A and GC1092D look alike—they use a similar case—but the "A" is an alarm version, and the "D" is a calendar clock. For power-failure operation, both use a battery-powered timebase oscillator whose output is calibrated by zero-beating against the line frequency as a time standard. The GC1093 is the only clock designed for car use, and uses a crystal-controlled timebase for accuracy. It also features switch-selection of elapsed time, repeating every 20 minutes. This would be a handy feature for sports car rallies.

International Electronics

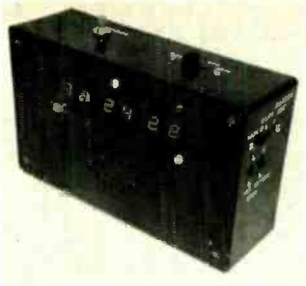
The two-sided printed circuit board, with plated-through holes, makes assembly of this kit a breeze. This is a "bare-bones" kit, containig all the necessary electronic parts, but without transformer, wire, switches, solder, case or sockets, so you'll have to do some additional shopping or junk-box raiding to end up with a usable clock. The PC board is designed with solder pads to connect wiring for remote readouts, and the instructions designate the outputs. For some unexplained reason, the PC board and remote connections will accommodate 9 digits, although only six are used. This is the least expensive kit on our list, even though it offers six digits at a lower price than some four-digit kits. With a two-buck transformer you probably have around (regular 12-volt type), three simple SPST or pushbutton switches and a plastic case, you're in business!

James Electronics

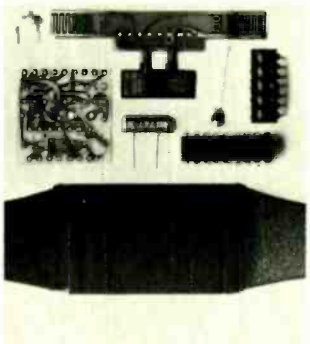
Appearing at first to be a very simple kit and containing everything you need but solder—even a neat wooden case and red plexiglass front panel—the JE-700 turns out to be a tedious assembly job because of 29 jumpers (wire connections) on the component side of the PC board. Assembly is not difficult—just slow. Time is set by pushing a pencil through holes in the back of the case to press on PC board switches (similar to Babylon). However, the HOLD switch is not provided to synchronize the seconds! This can be easily added by providing a switch to ground from pin 13 of the IC—but no mention of this appears in the instructions. Speaking of the instructions, they look nice enough but contain a number of errors sure to confuse a beginner.

The Wall Clock uses 0.6 inch high readouts for hours and minutes and 0.3 inch high readouts for seconds. Only three jumpers are used, so assembly is straightforward, if you can follow the instructions.

The most recent additions to the James clock-kits are the giant-digit wall clocks. Thirty-one separate LED's are used to form the seven segments of each digit, with additional LED's used to form colons between pairs of digits. Construction is not difficult, but takes time because of the large number of LED's used and because four jumpers are used with most of the digits. The 4 and 6-digit versons of this kit are identical for the first four digits with an add-on board containing the fifth and sixth digits. The assembly instructions are sparse, but a good pictorial makes them adequate. Time setting is simple using switches built-on to the PC board, just like the JE-700—except that a HOLD switch is included to stop the seconds count. The finished unit, complete in wooden case, is a sight to see!



S.D. ALARM CLOCK, mounted by the author in a standard plastic box.



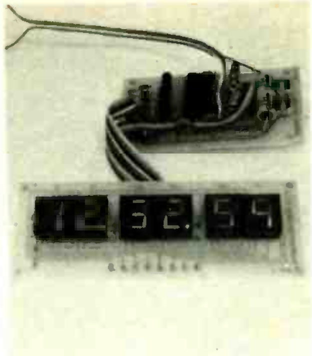
BLACK WATCH KIT, parts layout.

THE FLUORESCENT TUBE DISPLAY of the Formula International MM5314.

THE DIGITAL CONCEPTS CK-131. If a colored panel is used, the components are not visible.

JAMES JE-700 CLOCK

QUEST HAS LARGE DIGITS.

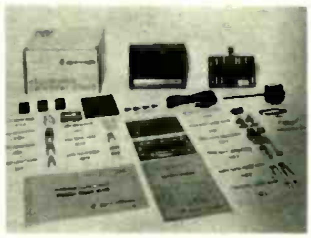


SABTRONICS uses decimal points for colons; connects sub-assemblies with ribbon cable.

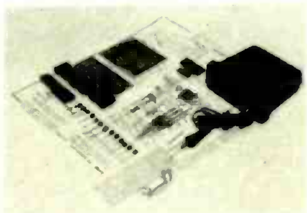
NOVUS CONTROL PANEL is concealed.

SINCLAIR KIT is beautifully packaged.

SINCLAIR BLACK WATCH is the first kit for a digital wrist watch.

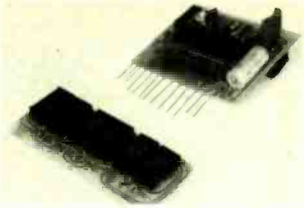


STEP-BY-STEP CONSTRUCTION of an electronic calendar clock. The Digital Concepts CK-131 is well shown in this layout-plus-demonstration.

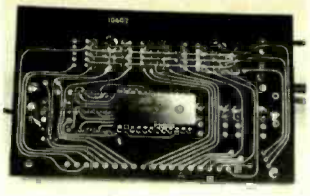


NEXUS CAR CLOCK, parts layout.

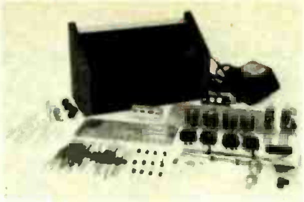
THE NEXUS OUT OF ITS CASE.



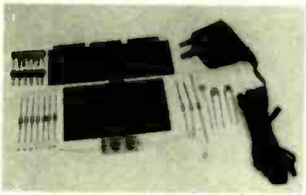
SUB-ASSEMBLIES for the Nexus car clock connect together with resistor leads.



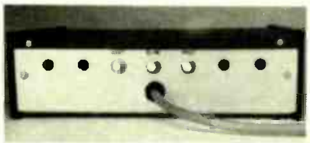
MM5314 IS ON ONE SIDE OF PC BOARD, clock display is mounted on the other.



PARTS LAYOUT FOR THE DDC-1.

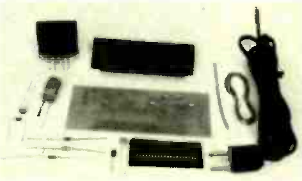


THE QUEST PARTS LAYOUT. The transformer is at the plug end of the line cord.



REAR VIEW OF THE ESE ES-112K. The three adjustments simplify time setting.

EC-2000K, ANOTHER REAR VIEW.



PARTS LAYOUT OF THE EC-2000K.

Meshna

The SP-169 clock kit is unusual in several respects: The PC board is 4 × 6 inches, rather large, but so designed that it is in four separate sections that can be cut apart. The case is a surplus extension TV speaker cabinet that includes a speaker and volume control, and a provision is made for either AC or battery operation. The four sections of the PC board, when cut apart, are the same size and are designed to allow stacking, like a club sandwich. All the necessary parts (except line cord) are provided for AC operation, but detailed instructions, PC board section and a parts list provide the timebase option with any crystal up to 6 MHz that can be divided down to 50 or 60 Hz evenly. The instructions are not elaborate, but include a good pictorial parts layout and schematic. Since the case was not made especially for this kit, final assembly required some cutting and drilling of holes.

The SP-284 *Cheapy Clock* is one of the easiest of all the kits to build, and the only kit reported on to use the National Semiconductor MM5316 Alarm Clock IC. This is a direct-drive IC, and no transistors or resistors are used to operate the display. The IC has the capability for alarm, snooze and "sleep switch" and the instructions show how they can be added to the basic kit. This is also true of the AM/PM indicators. The display consists of four bright blue-green fluorescent glass tubes with high visibility even in bright surroundings. One of the three switches supplied with the kit "shifts" the display to read unit-minutes and seconds for precise time-setting. With slide switches used in place of the pushbutton switches provided, this could be used as a 24-hour stopclock that counts by the second. Although no case is provided, the kit easily mounts in a flat plastic case with the switches and the four fluorescent tubes projecting through the top lid!

Nexus

These kits were designed specifically for automotive use, and are the same design except for case and display size. They contain a crystal-controlled timebase for operation from 12 volts. The displays are bright and clear, due to high current flowing through the LED's. The IC heats up, but is operated within limits. Time-setting is ingenious—a straight pin is inserted through a sandwich made up of the PC board, non-conducting sponge, and conducting foam pads to act as a switch. Although only fast and slow settings are provided, you can set these clocks almost to the second without the need of a third switch. Since the accuracy is inherently less than perfect (within 9 seconds per day in constant ambient temperature), second-setting is not necessary. The parts layout, case design and interboard wiring between control board and display board show good planning and execution. The *Car Clock* is the smallest 6-digit clock on our listing, and is easily located and installed in a car. The *Van Clock* is intended to be mounted in the wall of the living-quarters of the vehicle.

Quest

Step-by-step instructions, a complete schematic and a detailed pictorial view make this a simple clock to build. If not for the connections between the control and display board, construction would be listed as "Easy". The digits are large and bright, and the transformer is mounted in a wall-plus/line cord furnished as part of the kit. Switches are not included, to allow the user the flexibility of using his own type. Display blanking is described in the instructions if you should want to remote the display board. The PC boards in this kit are two-sided, with circuit wires spaced for easy soldering.

Sabtronics

Although very similar in appearance and circuitry to the Quest Digital Clock Kit, there are some definite differences. This clock kit includes three switches (two momentary, one on-off) and a separate transformer, but no line cord. The display can be wired to show a decimal point between pairs of digits, to simulate a colon, by adding only one resistor. The asembly is simple, but connections between control and display boards move it into the "Medium" assembly rating. The display is not very bright, since the 270-ohm segment resistors limit the LED current. Changing these to 100-ohm resistors yields a very bright display and does not overdrive the IC. A smaller display, using 0.25-inch high digits, is available for $5 less than the price shown for the 0.5-inch digits. Since the display board is completely separate from the control board, connected by 14 wires (13 for digits, 1 for decimal points), you can easily remote this board by using "ribbon cable". This cable, available from James Electronics, (26-gage, 20-conductor—59¢ per foot) is a flat ribbon of parallel adjacent wires, each in a different colored insulation; you simply fan out the ends to form individual wires, each a different color.

S.D. Sales

Patience and a good supply of stranded wire are needed to build this two-part clock kit. However, the result is a really nicely-operating 6-digit alarm clock, at the lowest price on our list. The display PC board is entirely separate from the control board, so it's a natural for a remote display. Fourteen wires join the display board to the control board—six for digit control, seven for segment control, and one to control the LED used as a PM indicator. Colons are not furnished, but the instructions cover their installation as an option. Four slide switches are used for setting time and alarm functions, with a pushbutton switch used for snooze. The Hewlett-Packard LED displays are bright and sharp. With the S.D. *Timebase* that sells for $5.95, this would make a good electronic alarm clock for a camper or trailer.

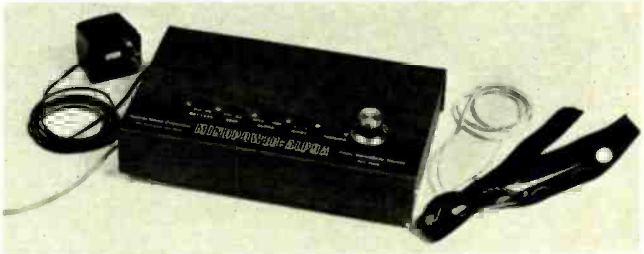
Sinclair

Although not a clock, but a four-function wristwatch, the *Black Watch* is an electronic timepiece in kit form, so it's included in this survey. Everything—even very fine diameter solder—is included, and the PC board has the very small IC already assembled to it. The actual assembly time is short, but varnish is used at two steps in the assembly procedure to protect the circuit from environmental attack—and it takes four hours for the varnish to dry! Also, calibration can take weeks if you're a fanatic, since it's a hit-and-miss proposition of comparing watch time to real time over a period of days and adjusting the crystal-oscillator trimmer to compensate for a fast or slow condition. There is very little soldering, and no watchmaker's tools are needed (though the jeweler's loupe is very handy to check those solder joints!). The result is a unique experience and a great conversation piece—after all, how many people do *you* know who've built their own electronic wristwatch? **R-E**

MINDPOWER: ALPHA

Part III. Build this biofeedback device that displays the presence of alpha waves on a TV screen. You can use it to learn and gain from the benefit of the relaxation that comes with it

> **NOTE**
>
> **Mindpower: Alpha is an intriguing device for entertainment and experimentation in video biofeedback. It is not a therapeutic instrument, neither is it suggested as a cure for individuals suffering from psychological or physiological disorders.**



THE POWERS OF THE HUMAN MIND RANK AT THE very top of the list of unknowns being studied by scientists throughout the world today. In no small way, this activity has resulted from the discovery that the powers and capabilities of the brain are chiefly limited by the amount and quality of information that reaches it through our senses. With the discovery of *biofeedback*, it has become possible for us to use an instrument to detect the brain's activity, and to feed this information back to the brain through the senses. This fascinating discovery has opened great new possibilities for expanding the powers of the mind through biofeedback training.

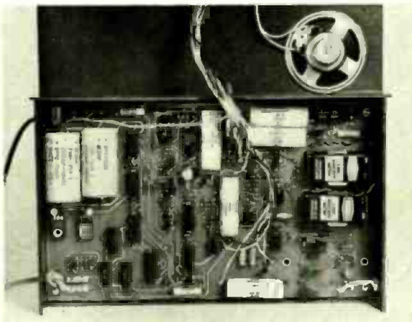
Mindpower: Alpha is an entirely new type of biofeedback instrument. It is designed to serve as a link between your *mind* and *a visible, controllable display on your television set's screen*. Its purpose is to aid you in training your mind to "downshift" from the high-tension state of anxiety and stress, to the state of relaxation in which the brain produces a dominant alphawave rhythm. This state, the subject of intense interest among meditators, yogis, mind control groups, and researchers, is believed to be both beneficial to the body and an important step in expanding the creative consciousness. Once you have achieved it, you will find it a fascinating state, in which you are free to experiment with the powers of your own mind!

In the July and August issues of **Radio-Electronics**, we described how Mindpower: Alpha works. This month we will discuss the assembly details.

Assembly

The two-sided printed-circuit board (see parts list) speeds up assembly and ensures freedom from poor joints and stray coupling. The foil patterns of the PC board is shown in Figs. 1 and 2.

Begin construction by installing IC sockets on the board. To save space, 16-pin sockets are used to hold pairs of closely related 8-pin IC's in several instances. Figure 3 shows the parts layout of the board.



MINDPOWER: ALPHA printed-circuit board mounted in metal case.

The IC sockets are inserted, pressed in, then sparingly soldered to the foil side of the board. (Use a 25-watt iron with a small, conical tip and do not dwell on a pad for more than a few seconds, otherwise you will cause foils to delaminate.) Next, install transistors Q1-Q15 being careful to orient them correctly. Diodes are installed next and the same care should be exercised.

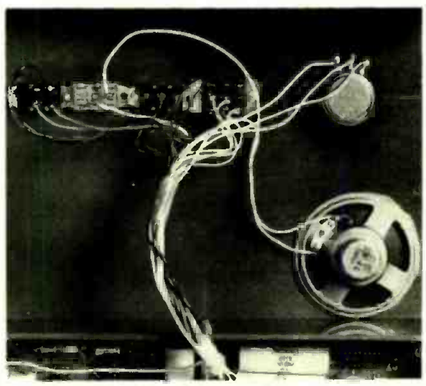
Resistors are installed next, and here it is worthwhile to remember that ¼-watt composition resistors are fairly fragile. Form their leads before inserting and don't be too vigorous in pressing them into place. A cracked resistor can be next to impossible to find by usual troubleshooting methods. There are 91 resistors to be installed on the board. Check values carefully against the parts list and Figure 3 before installing each resistor. Also, check again after all resistors have been installed. A wrong resistor value in a wrong location can be tedious to find later.

Next, install capacitors. Electrolytic capacitor polarity is indicated by a (+) mark on the board opposite the hole that accepts the positive lead of the capacitor. Disc and the non-polar tubular capacitors are installed, as shown, without regard for polarity. Note that 10 μF electrolytic capacitors C31 and C32 do not have pad holes on the board. These capacitors are soldered directly to the foils on the parts side of the board. The positive side of C31 connects to the +15 volt output of the regulated supply, and the negative side goes to the ground foil. Conversely, the minus side of C32 connects to the −15 volt output of the regulated supply, and the positive side goes to the ground foil. Capacitor C33 is soldered to the transformer wires that connect to points 23 and 24 after those wires are soldered to the board.

The +15 and −15 volt regulators, IC23 and IC24, are soldered to the board in the plated-through holes. The −15 volt regulator (an MC 7815) is installed with its brass-colored heat-sink up.

The two battery clips for installation of BATT1 and BATT2 are each secured to the board by short No. 4-40 screws and nuts. Screw heads are on the bracket side of the board and nuts are tightened from the foil side. When this stage of assembly has been reached, set the partially completed board aside and install parts on the case top.

Four slide switches S1-S4, control R92, and a miniature 8-ohm speaker are installed on the case top-half. The BATTERY switch S3 installs in the left-most punched rectangular hole in the case top. Next comes BEEP switch



REAR VIEW of the front panel

S4, followed by ALPHA test switch S2, and finally, MODE switch S1. THRESHOLD control R92 mounts in the round hole with its mounting hardware. The miniature speaker is glued to the inner vinyl surface of the case

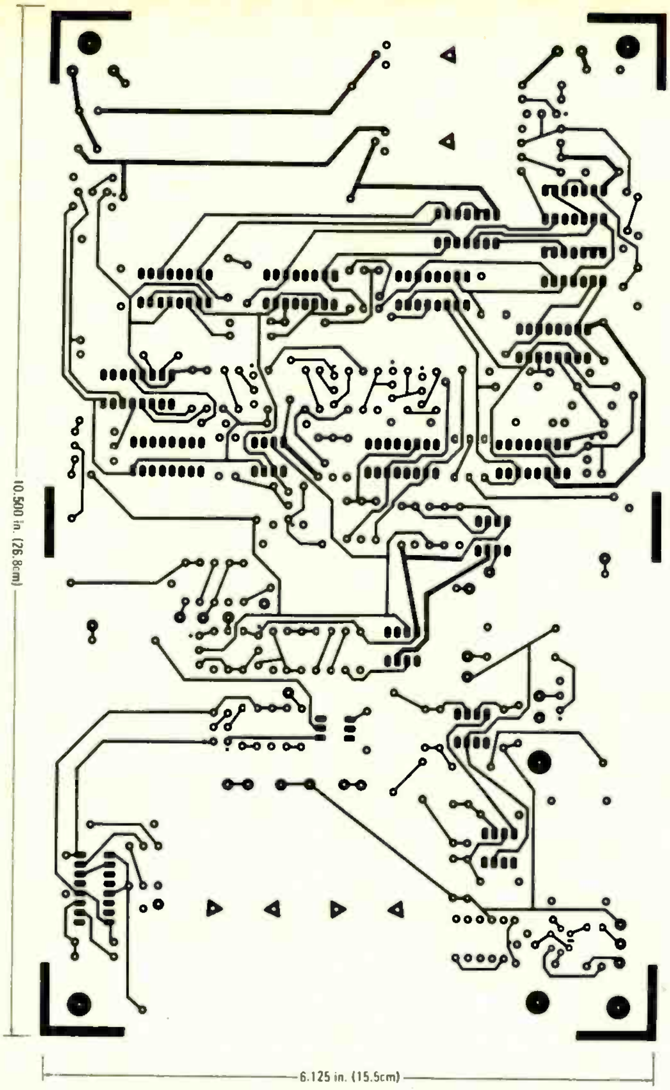


FIG. 1—MINDPOWER: ALPHA PRINTED-CIRCUIT BOARD foil pattern of the bottom of the double-sided board shown half-size.

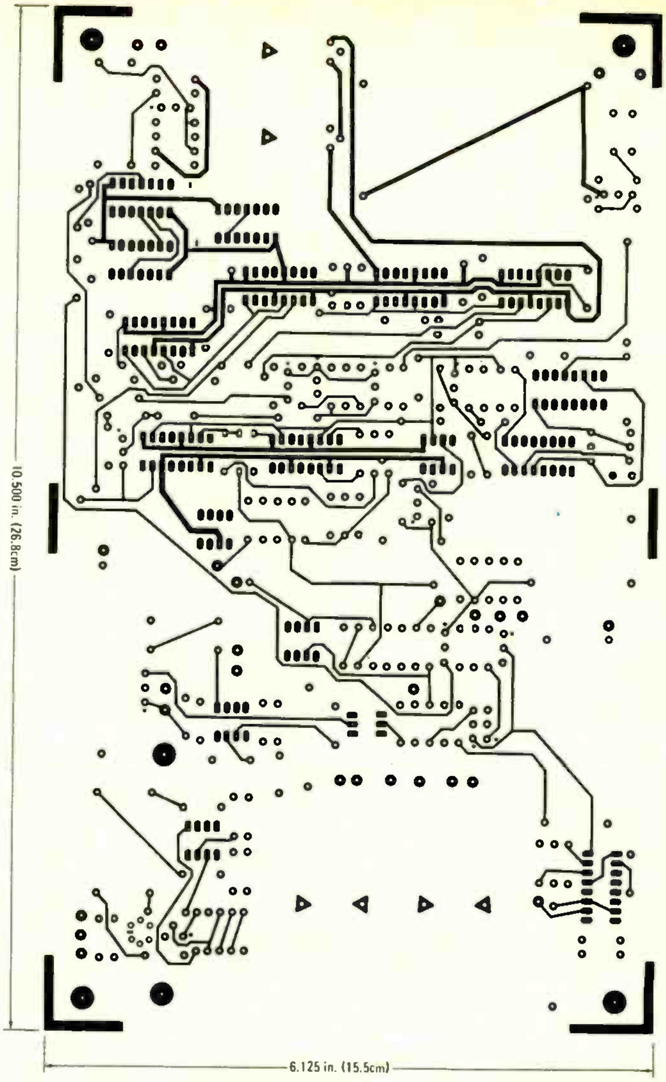


FIG. 2—PRINTED-CIRCUIT BOARD foil pattern of the component side of the double-sided board shown half-size.

top beneath the drilled speaker opening. Apply contact cement sparingly to the outer rim (not the paper cone) of the speaker and press into place. Allow to dry before proceeding.

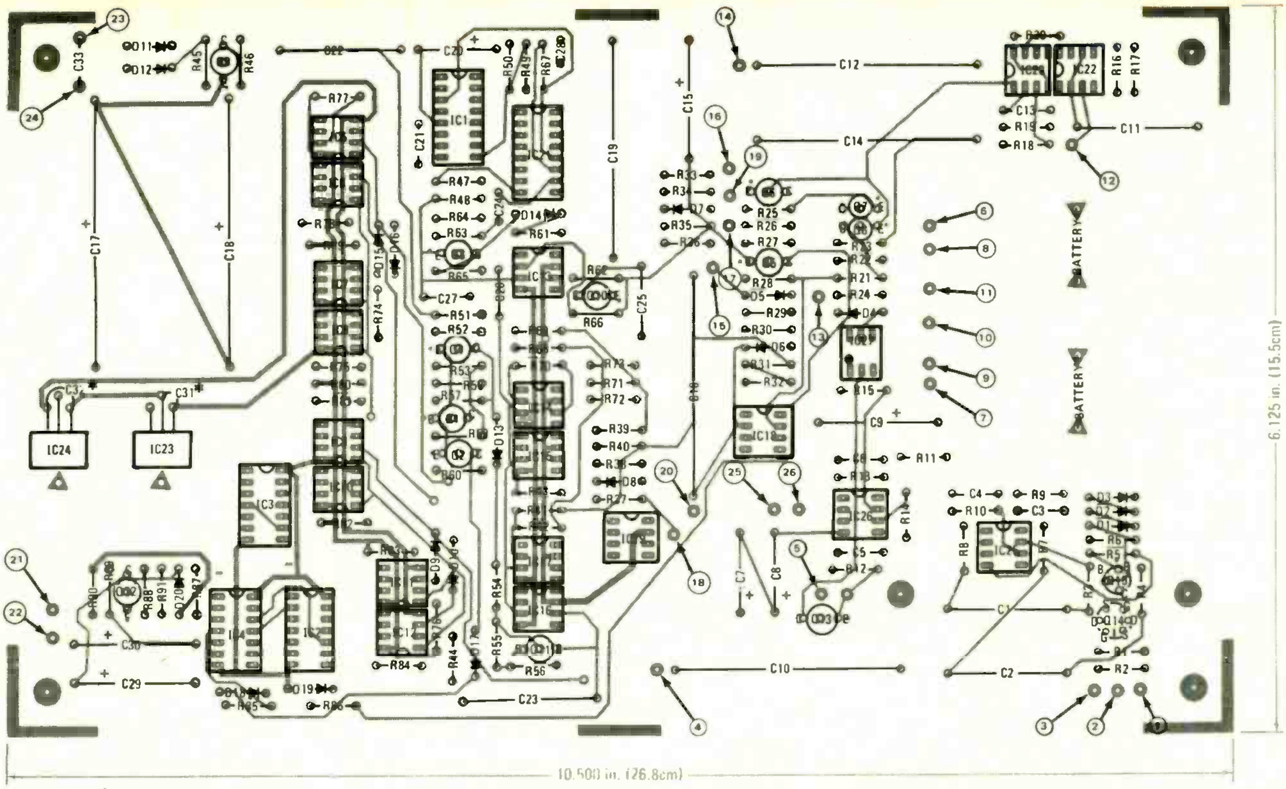
To interconnect the parts mounted on the case top, with the board, a simple wiring harness is needed. Each attachment point on the board bears a number (also shown on the schematic) and its destination is illustrated in Fig. 4. To ensure just the right wire length, lay the board next to the case top and lay out enough wire to reach from a numbered board point to the attachment point on the case-top. Now, add a few inches so that there's enough slack to bundle the wires at about the middle of the case top. You should be able to wire-up the parts, but still neatly gather and tape the wires into a harness bundle. Using this method, you'll be able to open up your unit without having wires in your way.

Attach battery terminal wires to the designated board points and dress the wires between the battery clips. Next, pass the wires of the external power transformer, the video output cable and the headband electrode cable, through the holes in the sides of the case bottom. Tie a knot in each entering cable for strain-relief. Leave about 2 inches of free wire end on each. Now, pull through the wires and cables, strip the wire ends and solder them to the proper points on the board, as shown in Figure 4. After connecting transformer secondary wires to points 23 and 24, be sure to solder bypass capacitor C33 across these two points. The finished, interconnected board can then be drawn back into the case by taking up the slack on the wires. To mount the board, push through screws from the outside of the case bottom, install ¼-inch spacers, and fasten with four nuts from the parts side of the board.

Finally, the IC's are installed. Great care is required in handling IC's, especially IC1–IC4, and IC21, all of which are CMOS types susceptible to damage from static discharges. The other IC's, though not as static-sensitive as the CMOS types, still require a gentle hand in inserting them into their respective sockets. Pay particular attention to correctly orienting the IC's when inserting them. (Note: In the accompanying photos, IC13 is shown as a TO-5 metal can package, with leads formed to fit the IC socket. In actuality, this IC is supplied in the parts kit as an 8-pin DIP, similar to the other IC's. For this reason, it is shown as a DIP in Fig. 3.

Upon completion, spend some time checking your work. Be critical and don't close your eyes to small defects like excessive rosin, solder flakes or loose foils. Every minute you

POWER comes from an external transformer.



* POSITIONED ON TOP OF BOARD. SOLDERED DIRECTLY TO FOIL.

FIG. 3—COMPONENT PLACEMENT diagram. Circled numbers are interconnect points to external components.

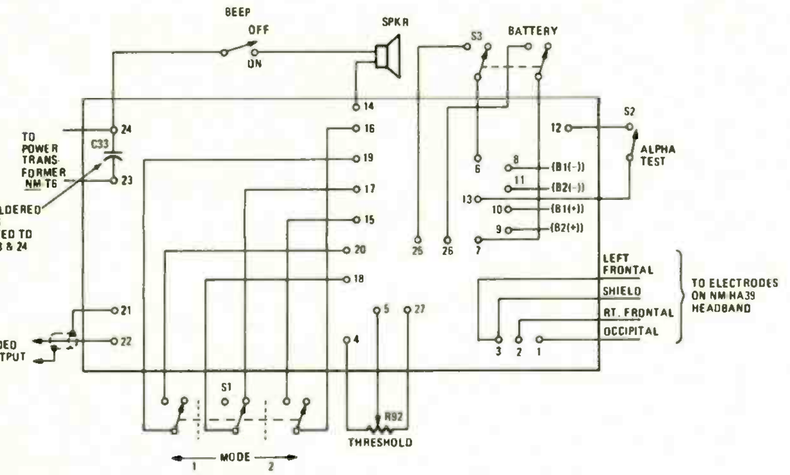


FIG. 4—INTERCONNECT DIAGRAM showing connection of external components to printed-circuit board.

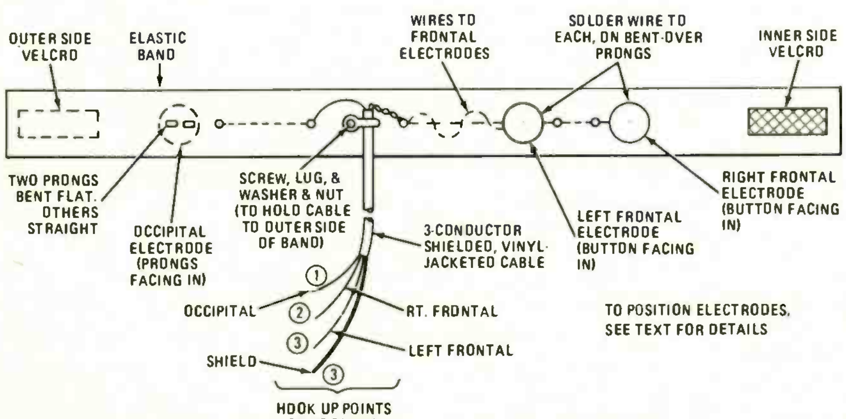


FIG. 5—HEADBAND ASSEMBLY details. View is from inside surface of headband.

invest in checking now could save you troubleshooting time later. Once you are satisfied that everything is correct, set aside the assembled unit and start fabricating the headband electrode assembly.

Headband assembly

The elastic headband assembly that holds the three EEG electrodes against the skin surface of your head is assembled from parts contained in the Headband Electrode Kit (NM-HA39) (see parts list). Assembly of these parts deserves care and attention, for it is through these electrodes that the tiny potentials of your brainwaves enter the Mindpower: Alpha circuitry.

Figure 5 is an assembly plan of the headband. The elastic band comes with pre-attached Velcro fasteners, located to permit snug attachment of the band to any size scalp. Four metal electrode buttons are provided, although only three of these will be used. Note that one of the four buttons has extra-long prongs. This is an occipital (back of the head) electrode, intended for use by people who have a substantial amount of hair covering the skin at the back of the head. The long prongs are intended to face inward and to comb-through the hair to touch the skin below at several points, thus providing a low-impedance contact. For those blessed with a lesser covering of hair at the back of the head, a better choice for the occipital electrode will be one of the buttons having shorter prongs. Plainly, where the hair is thin, there is less cushioning and the button with shorter prongs will be more comfortable in combing through a sparse hair covering.

To begin assembly of the headband, first mark the positions of the electrodes. Wrap the band about your head so that the closing ends overlap just above your right ear. Pull the band snugly, but comfortably tight, and

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mesh the Velcro ends. Now, standing before a mirror, place a mark on the band directly above the center of each eye using a piece of chalk. This will establish the positions of the right frontal lobe active electrode and the left

HEADBAND ASSEMBLY of Mindpower: Alpha.

frontal reference electrode. Now, place the base of your left hand's index finger against the top of your left ear, and extend your finger tip to the band at the back of the head. Place the chalk on the band against your finger tip, and you will establish the position for the occipital electrode.

Remove the band and lay it flat. Position it with the two frontal electrode marks to the right and facing down. Place the prongs of an electrode button on the band behind the rightmost mark and press the prongs through the band's fabric. Now, repeat the process to mount the left frontal electrode. Crimp all of the prongs over on the outside of the band to hold the two frontal button electrodes in place. (The smooth button side is the inside surface.)

Now, mount the occipital electrode, working from the outside *in*. Place the selected occipital electrode directly *over* the chalk mark and press its prongs through the fabric. Crimp *only two* of its prongs flat against the band leaving the remaining prongs protruding. This means that you will now have one electrode at the left, formed by prongs and two smooth button electrodes at the right of the band.

TABLE I—CHECK-OUT PROCEDURE

FROM	TO	USING	RESULT
IC23 out	Point 24 (gnd)	VOM	+15 VDC
IC24 out	Point 25 (gnd)	VOM	−15 VDC
Point 25	Point 10	VOM	−9 V (S3 ON)
Point 26	Point 11	VOM	+9 V (S3 ON)
IC1 (pin 9)	Point 24 (gnd)	Scope	Approx. 7V in-lock

Standing before the mirror again, fit the band to your head with the two frontal electrodes on the forehead above your eye centers. The prongs of the rear occipital electrode should now comb through your hair to contact the skin surface at the back left of your head.

Once the electrodes have been assembled to the band, you are ready to attach their lead wires. Begin by removing about 12 inches of the electrode cable's outer sheath and shield braid. This will reveal the three insulated wires of the cable. Crimp a solder lug around the outer sheath of the cable just below the point where the wires exit. This will be used as a strain-relief. Simply punch a tiny hole through the elastic band about 5" to the right of the occipital electrode. Now, insert a ¼" No. 4-40 screw (with washer on) through the band from the inside, slip on the lug from the outside, and secure in place with a No. 4-40 nut. Twist together the two insulated wires leading to points 2 and 3 on the PC board. Punch two small holes in the electrode band between the cable attachment point and the first electrode to the right. Thread the twisted wires through these holes. The first electrode is the left frontal (isolated ground) electrode. Cut to length the wire leading from PC board point 3, strip its end and solder it to the crimped prongs of that electrode. Punch two more holes in the band between the first and second electrodes and thread through the wire from PC board point 2. This wire should then be stripped and soldered to the crimped prongs of the right frontal electrode.

To complete assembly, punch two more tiny holes between the cable attachment point and thread the remaining wire leading from PC board point 1, through both, and solder it to one of the crimped-down prongs of the occipital electrode. This completes assembly.

Check-out

After a final check of all wiring and connections, you should make a few voltage checks to ensure that all is functioning correctly. Install 9-volt batteries BATT1 and BATT2, and insert the prongs of the power transformer assembly into an AC wall outlet. Table I lists the measurements that should be made during the check-out procedure.

When these checks have proven satisfactory, set the BEEP switch S4 to ON and move ALPHA switch S2 to the TEST position. You should hear a rapid succession of 1-kHz "beeps" from the speaker signifying that the alpha test oscillator is keying the speaker, as would amplified alpha. To check the input amplifier, run the THRESHOLD control up and down. At maximum, you will hear some 60-Hz modulation of the alpha test beeps. At minimum, the tones will be crisp and clean. (The 60 Hz modulation results from stray pickup by the "open" electrode circuit. When electrodes are placed on the head, the electrode circuit is "closed" and 60 Hz pickup is minimal because of the differential input circuit.)

When you have reached this stage, you are ready to connect your Mindpower: Alpha to the TV set for some fascinating experiments in video biofeedback.

HORIZONTAL SYNC

This one is beginning to get to me! Wards Airline GHI-4836. The problem is very bad horizontal sync. You can set it up and it works for a moment, then jumps out of sync. Moving the horizontal hold control will make it lock, then it goes out again. I've checked everything I can think of. I note that touching the horizontal oscillator plate with a scope probe makes it go out of sync. When I take the probe off, it comes back temporarily. Should I take this down to the creek and make a fish-trap out of it or what?—C.S., Vergennes, IL.

Probably wouldn't make a very good fish-trap; let's fix it. This sounds very much like a thermal. Something is changing in value as it warms up. Try heating and cooling various parts. The oscillator plate should *not* be that sensitive. Sounds very much like a resistor increasing in value to me. (Feedback: Right! 18K resistor across horizontal oscillator plate coil read anywhere from 100K to 200K, out of the circuit on the bench! Thanks!)

"ADD-ON" AUTOMATIC FREQUENCY CONTROL?

Is it possible to install an automatic frequency control in an old Zenith model FM radio? This is a model G-725.—O.B., Monett, MO.

Frankly, it would be pretty hairy to add something like this to an existing design, even in a tube chassis like this. Suggestion; if you are having oscillator drift problems in this chassis, check that little ceramic capacitor across the oscillator coil. This is a negative-temperature-coefficient type, and was used to correct drift. We replaced several of these when these sets were new! Aerovox part number for this capacitor is CN22JN080 and it's a 22-pF unit.

WHITE COMPRESSION

The picture looks odd on this Philco 7L40. It looks something like white compression. The brightness control has no effect. All of the DC voltages on the picture tube read about +300 volts! No; the cathode is about normal. The grid resistance to ground is too low. 1.0 megohm normal. What is this?—J.D., Mena, AR.

You have a shorted blanking coupling capacitor, C46, the .0022 μF from the vertical output transformer to the picture tube grid.

WIDTH COIL

I have an old Capehart CT-125 TV that I'm working over. I need a width coil for it. It works fine but I have no AGC and sync.—V.M., Mission, TX.

Tight! This is one of the old dual-winding types—you get the AGC and sync keying pulses from the secondary of the width coil. You can get a Triad WLC-29 that is listed as a replacement for the original part number that I'm not going to copy since it's so long! Thordarson WC-26 is also a sub.

FIG. 1—DEMONSTRATION of the Digital Time Delay System. Robert Berkovitz, research director of Acoustic Research, sets up demonstration as David McIntosh, circuit designer, looks on.

Digital Time Delay System For Concert-Hall Sound

A prototype system used in audio research that can create a concert hall of any size and shape in any typical listening room

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

IN THE EARLY DAYS OF HIGH FIDELITY, IT was fashionable to describe the end goal of all hi-fi as being the "ability to recreate the concert hall in your living room." As time went on (and as audiophiles became more sophisticated and knowledgeable), the industry soon came to realize that such a goal was, at best, highly elusive. A home living room has neither the cubic volume nor the acoustic properties of a large concert hall and no amount of "wishing" would make them the same. Furthermore, it has long been conceded that part of what gives listeners the "feeling" of attending a live concert is psychological or psychoacoustic in nature. We sense the fact that we *are* in a large hall because of visual clues as well as aural ones -The audience around us, the plush seats, the brightly lit stage upon which the musicians perform—all these things contribute to our sense of the "live performance".

During the brief but short-lived heyday of quadriphonic sound, many proponents of 4-channel audio maintained that this multi-channel reproduction technique could bring us a step closer to "concert hall sound" in our homes. The fact is, though, that much of what was passed off as "concert hall ambience" in 4-channel records and tapes was, in reality, nothing more than a form of "surround sound" that was deemed most unnatural by many listeners who resented being bombarded by vocalists and instruments located behind their backs. Until recently, it appeared that the only way to make a hi-fi music system sound like it was reproducing a concert hall performance was to transport speakers, amplifiers and program source into an actual concert hall. The hall would then provide the required acoustic qualities that are missing in any home version of the performance. Much of the success of some of the early "live versus recorded" concerts that were a popular audio sport in the earliest days of component hi-fi are now attributed to the fact that *both* the live performance and the electronically reproduced equivalent were, in fact, taking place in a large and acoustically identical auditorium or concert hall.

Still, with the aid of modern computers it should be possible to study the exact nature of all the sounds—primary and reflected, phase shifted and attenuated, coherent and incoherent—that reach a listener's ears when he or she attends a live concert. And if all these elements of sound can be programmed electronically and reproduced from a sufficient number of directions or points of origin, it should be possible to "fool" a listener into believing that he or she is, in fact, attending a live concert when all the while that listener may be sitting in a darkened room no larger than the proverbial "typical home listening room". At least that is how Bob Berkovitz of Acoustic Research and his engineering team headed by David McIntoch reasoned some time ago when they first began a project that lead to the Digital Time Delay system described here. Much of what follows was learned during a brief but fascinating trip up to AR's plant a few months ago, and the author is indebted to the people at Acoustic Research for letting us in on this exciting research project, and for supplying some of the photos appearing in this article.

Background

A listener at a concert hall hears at least three effects of concert hall acoustics. One of these is the arrival of sound from a number of directions in rapid succession; first from the stage (called the "direct" sound) and then from various reflecting surfaces inside the hall. A second effect is the incoherence of high (treble) frequencies that makes it difficult for a listener to localize the sound source and at the same time gives an open, airy quality to concert hall sounds. The third effect is the familiar gradual decay of sound after it has stopped originating from the stage. This last effect is often successfully simulated during recording, so that there seems no need to recreate it during the playback process.

The first two effects, however, cannot be conveyed by conventional sound reproduction techniques, according to AR. The failure of conventional high-fidelity equipment to reproduce the two missing effects is probably one of the main reasons for the artificial quality of the reproduction of orchestral music in the home, even when the components used are accurate insofar as frequency response and negligible harmonic and IM distortion are concerned.

The premise upon which AR's research was based is that "concert hall acoustics" can be electronically simulated and added to the reproduction of ordinary stereophonic records and broadcasts. Two phases of study and research were involved, both of which were carried on simultaneously.

First, it was necessary to define the acoustical properties of large halls in order to understand the patterns of reflections and the type of sound distribution that takes place in such halls or enclosed spaces. Mathematical models of halls were used in this study, since the objective of the study was to understand the acoustics of an ideal hall rather than how to build one in a true architectural sense. The program that was used to characterize different halls utilizes such data as hall dimensions, sound source and listener location (specified in three dimensions), absorption coefficients for each of the interior surfaces of the hall, absorption coefficients for areas of special absorption on any of the interior surfaces, the dimensions of those special areas, and the specific time period that the user of the program wishes to examine closely.

A number of studies indicate that the subjective effect of early reflections of a large hall is different from that of later reverberation. These studies further indicate that the time period in which the acoustical "character" of a hall is sensed by the listener is approximately 100 milliseconds (one tenth of a second). In this time, following the attack transient that represents the start of the musical sound, our ears and brain form an idea of the size and diffusion of the sound source and of the setting in which the source and listener are located. Mathematical modelling of simplified rooms, implemented with computers, provides a highly precise way of determining the basic image locations in time and space. This, in turn, allows the user of the program to look for patterns that correspond to different subjective effects. The data from the output of the computer can be used to set the operating characteristics of an appropriate simulator and the subjective effects of different "halls" can then be compared and analyzed electronically.

Reproduction simulator

A sixteen-channel delay system was developed by Acoustic Research that converts the computer generated information into equivalent acoustical properties in a listening room. In the tests we heard, sixteen AR-7 loudspeakers, mounted in two tiers of 8, reproduced delayed sounds. A pair of AR-11 loudspeakers were used for reproducing the regular, undelayed stereo channels. Figure 1 shows Robert Berkovitz, research director of AR, as he enters computer generated data into a prototype of the Digital Time Delay System during the recently held Audio Engineering Society Convention in Zurich.

Figure 2 is a closeup view of the control panel of the Digital Time Delay System. Each knob is used to set up the

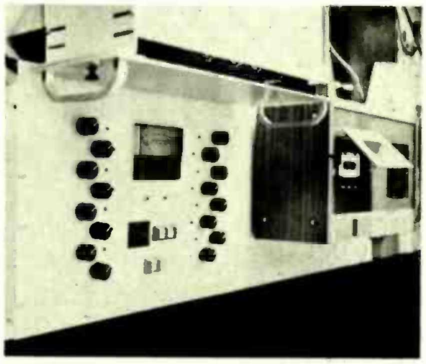


FIG. 2—FRONT-PANEL of the Digital Time Delay System. Sixteen knobs control the time delay of the 16 channels.

proper time delay for one of the sixteen reproducing channels used in the system. Sixteen channels were chosen simply because the number 16 works out well in terms of available digital IC specifications. The sixteen-channel delay system is actually a special purpose computer designed and built at AR. It operates by sampling the incoming music signal at approximately 30,000 times per second, converting the level of each sample to a number that is then stored in the correct location of a digital memory. This memory contains the last quarter-second of program material fed to it.

The component side of a memory

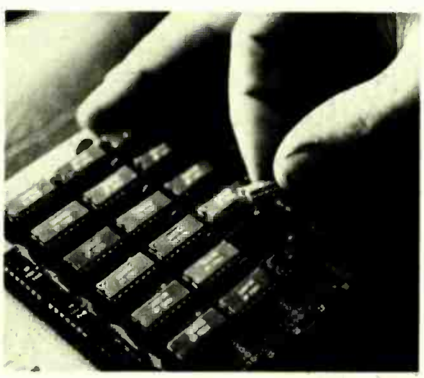


FIG. 3—MEMORY BOARD contains 96 memory IC's for a total storage of 98,000 bits.

board in the Digital Time Delay system is shown in Fig. 3. Each memory IC (a monolithic circuit with the equivalent of 7000 transistors) has a storage capability of 1024 bits of information. In this application, the "bits" are music signals encoded in digital form. The total system contains 96 memory IC's, for a total storage of 98,000 bits, which corresponds to the required maximum time delay of one-quarter second. The Digital Time Delay system could be expanded to provide longer delays if required and, because the music is digitally encoded before storage, its quality is unaffected by the length of time that it is delayed.

The wiring side of a memory card used in the Digital Time Delay system is pictured in Fig. 4. The wire-wrap technique used allows rapid construction and modification of circuits while providing high reliability. There are over 1500 connections on this 4 × 10 in. wiring surface!

After the value of each sample has been stored, and before the next one is taken, a memory recall circuit reads sixteen samples from as many memory locations and sends each sample to one of the sixteen output channels. Each channel drives a loudspeaker system placed to cover one-sixteenth of the space above and around the listener. When the system is operating (reproducing musical program material), reproduced sound comes first from the

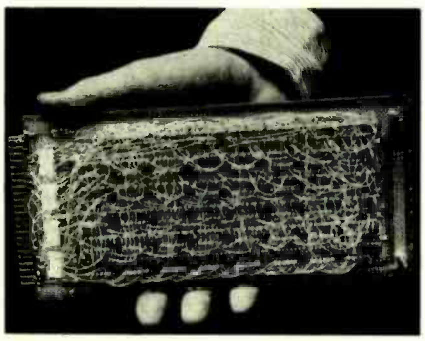


FIG. 4—MEMORY BOARD measures 4 × 10 inches and contains over 1500 connections.

two conventional stereo loudspeakers located in front of the listener. Then, after delays of fractions of a second (determined by the particular program used), the same information is successively reproduced from each of the sixteen delay channels. The audible sensation to a listener sitting "inside" the system is that of listening to music in a hall whose size, shape and acoustical character depend upon how the system controls are set.

Listening tests

In our own listening tests, the illusion of being in a large concert hall was tremendously enhanced when the lights in the demonstration room were extinguished, which confirms what we said earlier about the psychological aspects of concert hall attendance. But, with that reservation aside, the overall sonic effect of the experiments was uncannily real. Not only were we able to sense the spaciousness of a large concert auditorium, but as Mr. Berkovitz altered the parameters of our simulated concert halls, we were even able to sense the direction in which the "dimensions" of the hall had been changed.

A most unnerving experience occurred when the controls were altered so as to "build" a concert hall that could not be realized architecturally. (As I recall, one wall was "turned around on itself" or "stretched" beyond physical reality while in another instance unrealistic side alcoves were "implanted" in our make-believe hall). When these architectural abberations were imposed, our lifetime of listening experience immediately rejected the audible results as being "unnatural"—or just plain weird!

A consumer product?

Readers of **R-E** will recall that just a few months ago we reported about a Digital Time Delay System developed by Audio Pulse that was ready for consumer use. Obviously, the more complex and elaborate sixteen-channel simulator now developed by Acoustic Research is not quite ready for consumer packaging (nor could any consumer of our acquaintance afford it if it were). According to Robert Berkovitz, the entire project was initiated without a specific end-product in mind—as purely a research tool to investigate those remaining unknown factors in human hearing that are greatly in need of further study. The system will be used, no doubt, by acousticians and architects and could well serve ac an important tool for such craftsmen who must design the concert halls of the future. Theoretically, new shapes and materials could be "tried" using the simulator before thousands or even millions of dollars were expended on new architectural realities that might or might not prove acoustically satisfying after the money has been spent.

In our auditioning of different stereo records, we noted that the techniques brought to bear in the original recording by the recording engineer had some effect upon the way in which the "hall" was simulated acoustically, but not nearly so much as we would have imagined. In other words, the simulated acoustics created by the sixteen-channel digital time delay system played a much larger role in this listener's subjective evaluation of the "space" in which the music was being reproduced than did any artificial reverberation or decay time introduced into the original stereo discs that we listened to. The "hall" sensations were there (and similar) whether we listened to a so-called "live" stereo disc (one recorded from master tapes originally made at a live performance) or to a studio-type multi-channel recording more typical of today's recording techniques used for modern or "pop" music.

In summarizing the work done at Acoustic Research Bob Berkovitz did not firmly rule out the possibility that such multi-channel digital time delay systems would someday be economically and technically feasible for a home product. Based upon the rapid strides we have seen in recent years in large-scale integration and miniaturization, we suspect that a product for home use will be here sooner than ever. As for the question of where we will put those extra sixteen speakers, take comfort in the fact that they need not be as large in size or high in quality as the two primary stereo channel speakers that must still supply the "direct" sound even in the home concert hall of the future. **R-E**

SPECIAL POWER TRANSFORMER

I've been trying to locate a power transformer for a Scott 299 for some time. I would appreciate any help I could get; no one seems to have an exact replacement. The specs are as follows: high voltage, 390 VCT. Filament, 5 V at 3A, 6.3 V at 4.2A. Bias, 50 volts at 150 mA. Do you have any ideas?—R.Z., Buffalo, NY.

I'm full of ideas! Now let's see if any of them are worth a darn. Sams 445-13 shows that this is a stock transformer, except for that bias winding. Why such a high current rating on that one? 150 mA. Oh, oh. Now I see. They are also using this as a DC source for the heaters of the preamplifier tubes! *That's* why the 150 mA.

I have a listing of a Thordarson 22R123 transformer that is fine except for the current rating of the bias tap. Everything else matches. Hey! This transformer also has a 12-volt heater winding rated at 5.0 A! Do this: put a diode in series with this, with a filter capacitor, and use the resulting DC to feed the preamp heaters. Then the bias tap will have plenty of voltage!

RASTER WITH VIDEO AMPLIFIER OUT?

I've got all sorts of problems in this Zenith 20X1C38. If I pull the 12HL7 video output tube, I can get a raster of sorts. With the tube in, the high-voltage jumps up and down and then goes out. What does the crystal ball say?—F.L., North Bergen, NJ.

You've got one dandy "reverse symptom" here. When you pull the video output tube of a normal TV set, the raster should *go out*. Reason; the video output tube plate is supplied from +400 volts. With no load, this plate voltage (normal +330 V) should jump to +400, and the picture tube cathodes with it. This rise in *cathode* voltage makes the picture tube grids far more negative by comparison, and the tube should cut off.

I believe you'll find that someone has cranked all three of the picture-tube screen controls wide open. This will let the tube light a little even with such a bias upset. Run a grey-scale adjustment, and then find out why the plate voltage of the 12HL7 is so far off. Bad resistor, open peaking coil, etc.

LOW BRIGHTNESS

I can't find out why the brightness is so low on this Sears black-and-white TV. The DC voltages on the picture tube seem to be close; the cathode reads +225 V and the grid +178. If I touch pin 7 (cathode) with the voltmeter, the brightness jumps up right away. If I leave it there, it tries to get too bright. The tester seems to be bleeding off some of the excess voltage. I'm lost.—L.H., Buckley, WA.

No, you're not; you're in the right place. Your picture tube cathode is far too much positive. This makes the grid too far negative and cuts down the brightness. Normal should be; cathode, +188 volts; Grid, +139-volts for a net bias of -49 volts. You must be using a low-impedance DC voltmeter, to cause such a drop.

The DC voltage comes from the +174-volt source on the flyback, through a "spot-killer" diode, to the picture tube cathode through a 150K resistor. Check this diode; it could be shorted which would raise the cathode voltage.

NEW FORMULA FOR REMOVING "TAR SMELL"

I saw your note on tar smell from burnt-out transformers. I have another way; ran across the same problem some years ago. Tried several things and finally came up with this one.

Soak an old cotton rag in pure *vanilla extract*, and wash the affected area vigorously. Do not rinse off. If the user doesn't like vanilla, try cherry, almond or other flavors!—R.L. Ward, A-V Technician, E. Lansing, MI.

MISSING TUBE

I just got hold of a model 546 Supreme scope. Got nothing but a dot on the screen. One of the tubes is missing. This is a 5-pin type. Tried several, but none of them worked. What tube is this?—P.P., Astoria, NY.

This is a 885 gas triode (sometimes called a thyratron). It's the horizontal sweep generator; sort of a relaxation oscillator kind of thing. The tube is obsolete, but you might be able to dig one up from ads in the Classified section in the back pages of **R-E**. Several companies advertise old tube types. **R-E**

Selecting and Installing TV Antennas

BOOSTER MOUNTS ON MAST and connects between lead in and transmission coax. In typical installations the antenna should be mounted further above the chimney.

There's a lot of things to consider when undertaking this task. Here we look at the most important ones and see what it takes to get the best possible reception

JAMES E. KLUGE*

AN ANTENNA INTERCEPTS THE TRANSMITTED ELECTROMAGNETIC energy traveling through space and converts it into a voltage that the TV set can process into a visible picture. Ideally the antenna voltage should be an exact replica of what is transmitted by the broadcaster. A number of things can prevent that from happening. Some of them are:

- Impedance mismatch to downlead.
- Inadequate bandwidth.
- Broken or missing elements.
- Damaged, loose or misaligned elements.
- Loose signal connections.
- Unstable supports.
- Improper phasing or element spacing.
- Relative motion of elements in wind.
- Corrosion at joints and connections.
- Proximity to metal objects.
- Lightning damage.
- Strong reflections or signals from other sources.
- Disoriented or tipped antenna.

Each one of the above causes for poor pictures can be avoided either at the time you purchase an antenna or install it. Of the thirteen mentioned above, the last four can be avoided by proper installation. The others can be avoided by selecting the right antenna. Taking them one at a time, let's discuss how problems can be avoided.

Transmission lines

In most residential applications the delivery system consists simply of a length of 75-ohm coaxial cable or 300-ohm twinlead connecting the antenna to the TV set. In some installations where more than one TV set is connected to the antenna there may be splitters, set couplers or line-drop taps distributing the signals throughout the residence. This would be considered a simple master-antenna television (MATV) system. Except where amplifiers are involved and where connections are bad, there is little chance for trouble. Where 300-ohm unshielded twinlead is used, keep it at least 6 inches from metal objects and *do not coil* it. Now, let's take a close look at antennas.

Impedance

Most TV antennas are nominally either 75-ohm or 300-ohm balanced. It's usually impossible to look at an antenna and determine its impedance. The manufacturer will usually specify it. You then match this impedance to the impedance of the downlead or, where not included with the antenna, install an impedance-matching transformer to convert from 75 to 300 ohms or vice versa. Mismatched impedances not only waste signal power but cause standing waves that result in smeared pictures.

Bandwidth

Again, there is no way to look at an antenna to tell what its bandwidth is. It can be observed only with sophisticated engineering instruments. You have to rely on a reputable manufacturer who has the measurement facilities and has specified the bandwidth of his product.

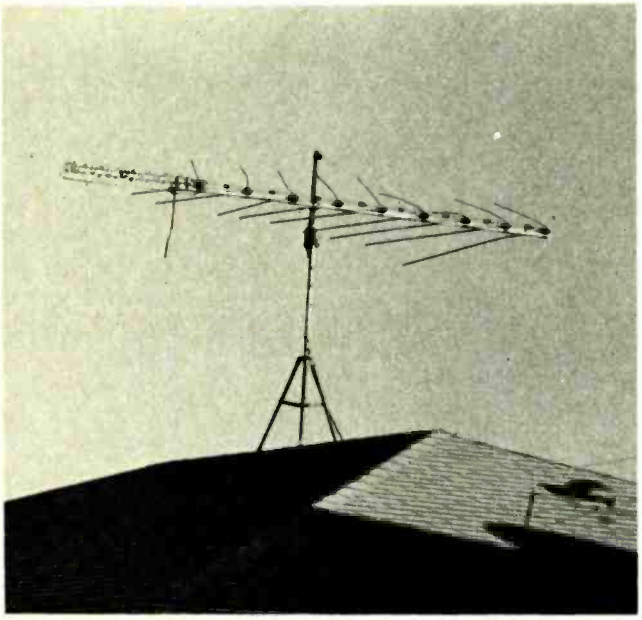
An antenna is like a tuned circuit. It will respond to frequencies within the bandwidth to which it is tuned and is

* Technical Editor, Winegard Co.

virtually unresponsive to frequencies outside that bandwidth.

Ideally, the antenna's response curve should be flat, with steep skirts at the cutoff frequencies. If it cuts off the edge of a channel too soon or too sharply it will attenuate either the picture, sound or color carrier. This will degrade picture quality on that channel. On the other hand, an antenna that does not cut off sharply outside the passband will make the antenna responsive to frequencies other than the TV signals, such as land-mobile radio, aircraft and FM broadcast.

Any of these can cause interference patterns in the picture. They represent extraneous signals not part of the original TV signal. Choose a manufacturer who has antenna design and measurement facilities plus an established reputation.



GOOD RECEPTION? NOT A CHANCE! Bent and twisted elements improperly aligned with each other and dangling (disconnected?) twinlead guarantee poor pictures at the set.

Antenna construction

Some antennas may look well constructed but after they're installed and severe weather gets to them, they show their weaknesses. Elements bend or break under stresses caused by heavy winds or ice loads. Element spacing and alignment are critical to phasing and affect the frequency response, impedance matching, gain uniformity and directivity.

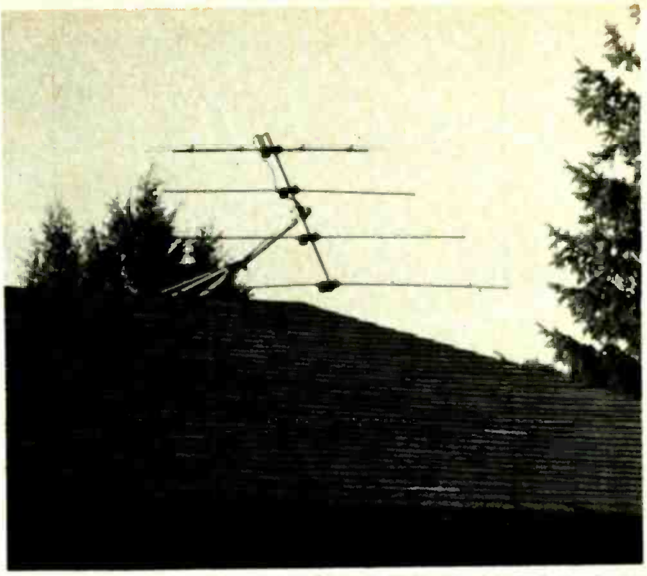
Look for heavy-duty construction and reinforcing supports at points of maximum stress. Look for strength in mountings and fabricated parts—particularly for 7/16-inch diameter aluminum tubing used for long elements. Look for bracing and heavy-gauge materials where strong forces will be applied as a result of high winds and ice.

Where elements rotate into position and plastic or aluminum parts hold them captive for proper alignment, test the captive positioning device for rigidity and strength by subjecting the elements to bending and twisting forces.

Downlead connections, impedance-matching components and preamplifiers should be enclosed and protected from the weather. Typically they are enclosed in plastic housings to keep out dirt, rain and snow.

Well designed antennas are not only mechanically strong and electrically sound, but assemble quickly and easily. Fold-out elements that are self-locking and secure, involving a minimum of assembly time is the general rule.

People who earn a living putting up TV antennas must be able to do it quickly. An antenna installer's time is valuable as well as costly from the customer's point of view. Ease of assembly and speed of installation is as important as the cost of the antenna itself. It would be better that the installer do a



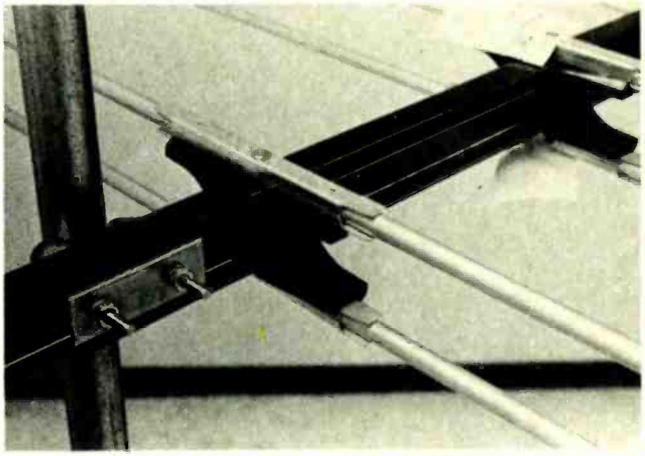
READY FOR SATELLITE BROADCASTS! With its skyward slant, this antenna will do better on signals from outer space than those from the nearby television transmitters.

signal survey on the roof to insure a good reliable signal than to spend that time assembling bolts, nuts and antenna parts on the ground. Avoiding costly callbacks is another good reason for selling and installing a line of good sturdy antennas made by an established and reputable antenna manufacturer.

The mast clamp, since it supports the entire antenna array, should receive careful scrutiny. A simple clamp with heavy bolts is not enough—the antenna load with all its twisting and bending motions must be transferred from the boom to the mast through that mast clamp. The boom and the mast must be strong enough to withstand these forces while the clamp locks them together rigidly.

Installation

Up to now much of our discussion has dealt with the antenna itself. As most of us know, the installation can make



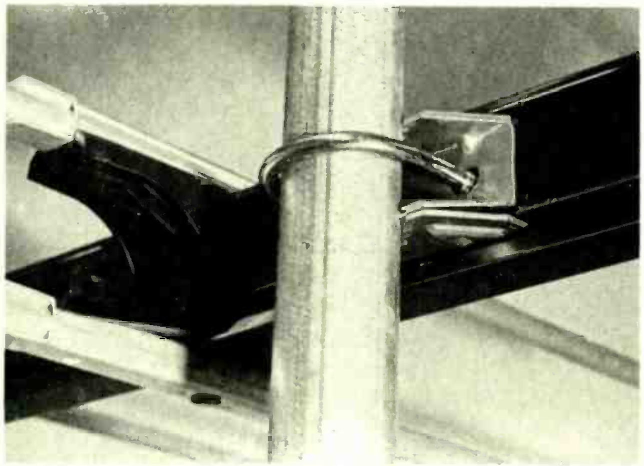
HEAVY 1-PIECE TUBULAR ELEMENTS locked to the boom by aluminum clamps and tough plastic supports will stand up.

or break the performance of a good quality antenna. How many people do you know who have condemned a tried and proven antenna simply because it was installed improperly? Good pictures depend on a good antenna that is properly installed to transform the airborne signal into a faithfully reproduced voltage applied to the TV set.

To begin with, the set needs at least 1000 μV (0 dBmV) at the antenna terminals. The AGC circuits in most TV sets can usually handle up to a few hundred thousand microvolts, except perhaps the small portables that prefer something well under 100.000 μV (+60 dBmV). To measure these levels, a good signal-level meter (SLM) is necessary. If you can't buy one now, try to borrow or rent one until you feel you can justify the cost of buying one. When you do buy one, let me caution you on one thing.

When buying an instrument like an SLM, it doesn't pay to try to save a few dollars. Like good antennas, a high-quality SLM will pay you back many times over. One other thing, if you plan to get into MATV work some day, buy the more expensive but more accurate and useful MATV meter now—not later. Here's a good case where you get what you pay for.

If you can't justify buying or renting a high-quality SLM,

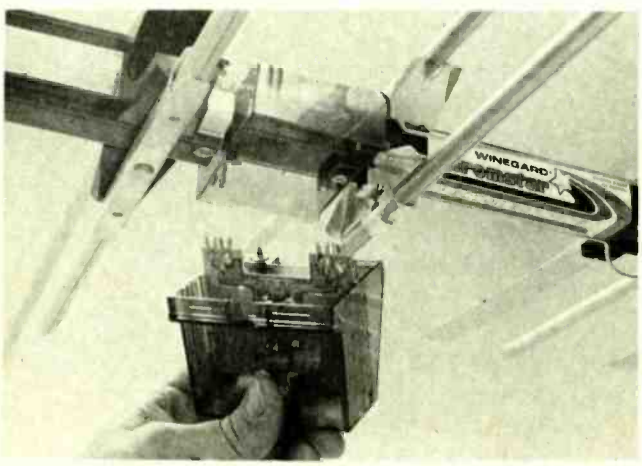


THE STRONG 3-PIECE MAST CLAMP transfers wind or other forces on the boom to the vertical mast. Clamp design prevents turning, avoids compression damage to boom.

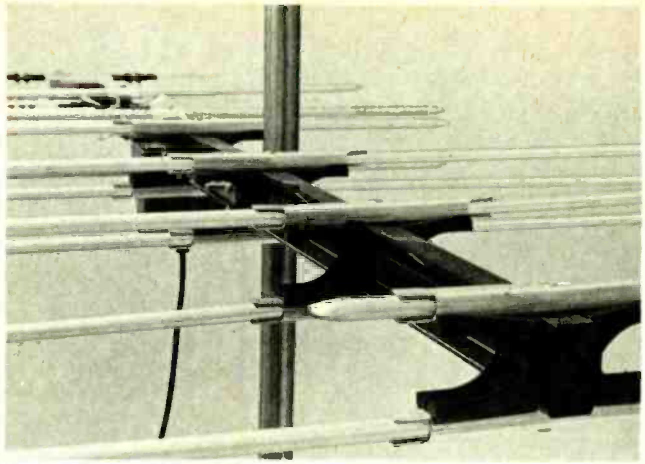
then at least get yourself a good portable color TV so you can see what kind of a picture you're getting. Remember, the objective behind all this effort is *good pictures* on the tube. Because of AGC, a TV set will not provide an indication of relative signal strength.

Make a signal survey

Now that you have chosen the best antenna for the job at hand and are outfitted with the necessary tools to install it properly, do a signal survey. Don't look up and down the street to see how all the neighbors have installed their antennas and then follow suit. The first installer may have goofed. Subsequent installations, being the same, would produce the same poor pictures. Logical conclusion—this is a poor signal area. Don't believe it! Show the neighborhood that TV pictures can be good with a good antenna properly installed.



PLASTIC HOUSING PROTECTS BOARDS used for impedance matching or combining UHF and VHF signals from weather or dirt.



REAR VIEW OF WINEGARD CH-7078 shows heavy metal parts and tough plastic insulators designed to transfer wind and ice loads on 7/16-inch tubing to the 1-inch square boom. All elements rotate into position and lock into place to make a rigid assembly requiring minimum installation and labor time.

After you've unpacked and assembled the antenna, mount it on a short section of mast. Now, walk it around the roof while your helper or partner observes the picture on the portable TV and the SLM if you have one. It's not unusual to clean up a marginal-quality picture by moving the antenna one or two feet in any direction. Remember to check the *picture*—the SLM may indicate adequate signal but the picture may be full of interference patterns or ghosts. Be sure to check all channels, too—particularly the weakest ones.

Now that you've located the antenna, rotate the mast to orient it for the *best picture*—one free of ghosts and interference. If you can't eliminate them, you may have to stack antennas for greater directivity. According to theory, when stacking antennas on the same mast, there should be at least ½-wavelength or more spacing between the antennas—about the distance of the longest antenna elements. In actual practice, however, this is seldom done. With a spacing of 2 or 3 feet, three antennas can fit on a single 10-foot mast.

Don't just point the antenna toward the transmitter. You may get a better signal (picture) reflected off a water tower, high-rise building or mountain. This is why a good portable color TV is so important. And be sure it has a picture tube large enough to show up minor picture deficiencies!

Now that you've oriented the antenna properly, make sure it *stays that way*. Use plenty of guy wire to anchor the mast securely. Be sure the mast is prevented from turning, even in high winds. A large, well-designed antenna is highly directional. Even a few degrees of antenna disorientation can spoil good pictures.

Once the antenna is in place and secure, you have—in addition to a source of good TV signals—an excellent lightning rod. It needs to be grounded. Everything but the driven elements are connected to the boom and the mast. The mast then must be grounded through a tower or with heavy wire, either AWG No. 6 aluminum or AWG No. 8 copper. Grounding means a ⅝-inch metal stake 8 feet in the ground or a metal cold-water-pipe system. Since pipes enter buildings, the metal stake is usually preferred. Make good solid electrical connections to the mast and the stake or you will defeat your purpose. Also keep the antenna 6 to 12 inches below the top of the mast.

Your customers can now enjoy good color TV for years to come. However, they should be prepared for guests. Their friends and neighbors will probably enjoy watching your customer's TV more than their own. Although there could be, there just aren't that many good antenna installations around. Also, for those who don't install antennas, if you're so inclined, here's an opportunity to get into the business, turn over a handsome profit and make people feel they're getting something for their money. **R-E**

555 IC TIMER CIRCUITS

The versatile 555 IC timer has many applications. Here are some interesting ones including pulse-width and pulse-position modulators

ROBERT F. SCOTT
TECHNICAL EDITOR

THIS IS THE THIRD IN A SERIES OF ARTICLES describing various applications of the 555 timer IC. In the article 555 Timer Applications (February 1976 issue), we saw how the device is used in the monostable mode as a time-delay generator and as a one-shot pulse generator. In March, we covered operation in the astable mode as a free-running oscillator generating pulses and squarewaves. We also threw in a few practical applications.

Monostable applications

Let's take another look at the basic monostable circuit (Fig. 1) and see how it can be

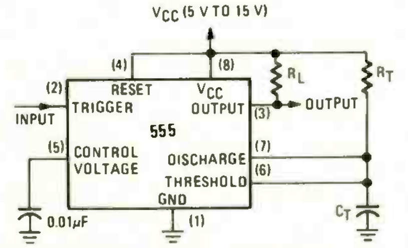


FIG. 1—THE 555 TIMER connected for monostable mode. Negative-going input pulse drives output high for interval equal to R_TC_T.

used for such applications as a heartbeat monitor, frequency divider, pulsewidth modulator and pulse-position modulator.

Recapping monostable operation: The output pulse is independent of the input waveform and is controlled by the time constant of R_1C_T. At the onset, C_T is held discharged by an internal transistor connected to the threshold control terminal. A negative-going pulse on the trigger terminal drives the output high and C_1 begins to charge. When the voltage across C_T reaches the threshold level (in a time interval determined by R_1C_1), the output immediately returns to the "low" state.

Missing-pulse detector

When the 555 is connected as shown in Fig. 2-a, it can detect a missing pulse or an abnormally long period between two consecutive pulses in a train. Thus, it can be used to detect intermittent firing of a sparkplug in an internal combustion engine or to monitor the heartbeat of a sick patient.

When connected as shown and fed with a continuous train of pulses, the timing interval of the monostable is continuously being reset by each pulse in the evenly spaced chain as long as the pulse spacing is less than the timing interval. A decrease in pulse frequency or a missing pulse permits completion of the time-interval so the output level goes high—triggering an alarm or other device connected to the output terminal. Figure 2-b shows the waveform when the timer is used as a heartbeat monitor or missing-pulse detector.

A shaper must be inserted between the pickup transducer and the input to convert the heartbeat or sparkplug signal into a series of negative-going pulses.

TYPICAL APPLICATION DATA

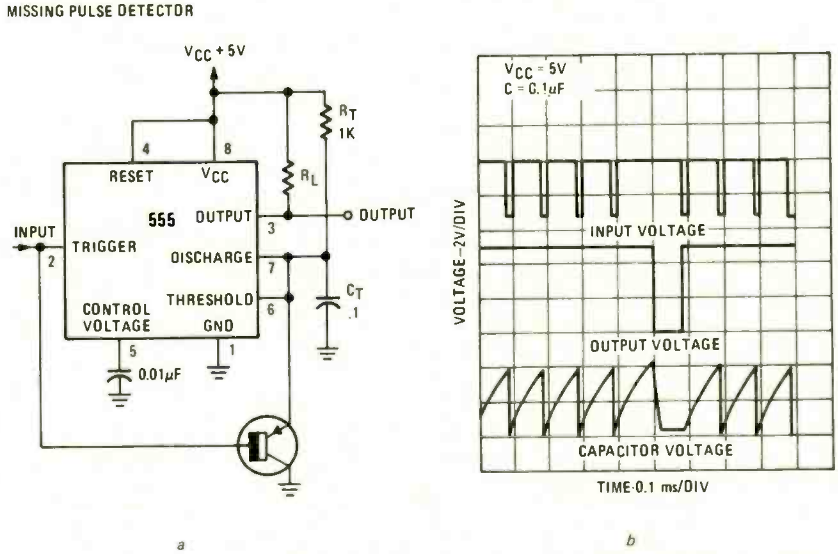


FIG. 2—MISSING-PULSE DETECTOR is shown at *a*. Waveforms at *b* shows how output goes low when there is a break in the input pulse chain.

Frequency divider

If the frequency of a pulse chain is known, it can be divided down as required by feeding it into a basic monostable circuit (Fig. 1) and adjusting the length of its timing interval. When the timing interval ($T = 1.1R_1C_T$) is longer than the *period* of the input trigger pulses, only those pulses that are more than $1.1R_1C_1$ apart will produce an output pulse. The operation of the divider is based on the fact that retriggering cannot occur during the timing cycle.

The output frequency f_o of the divider equals f_{in}/N, where N is the division factor. Figure 3 shows the circuit waveforms for a divide-by-five operation of the timer. The timing period of the circuit is set to approximately 4.5 times the period of the input pulse chain.

A second timer, or the second section of a dual device, can be used as a pulse shaper to adjust the duty cycle of the output waveform. Figure 4, from the Exar XR-2556 and Teledyne D555 data sheets, shows the device connected as a frequency divider and pulse shaper. The output of timer 1 is fed to timer 2 whose frequency is set to that of the output of timer 1. The duty cycle of the output waveform can be varied from 1% to 99% by varying R_{12}. Figure 5 shows the input and output waveforms associated with the frequency divider and pulse shaper shown in Fig. 4.

Pulse-width modulation

When the monostable-connected timer (Fig. 1) is triggered by a continuous pulse chain, the charge time of capacitor C_T, and thus the duration of the output pulse, can be changed by varying the voltage on the control terminal. The waveforms in Fig. 6 show the operation of the pulse-width modulator.

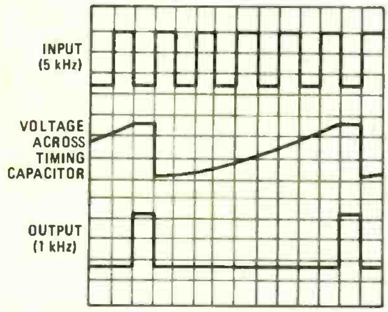


FIG. 3—PREQUENCY-DIVIDER WAVEFORMS from 555 set up to divide by five with 5-kHz input.

Pulse-position modulation

When the timer is operated in the astable mode, the instantaneous period or repetition rate of the output pulse can be varied by applying a modulation voltage to the control terminal. Figure 8 the timer as a pulse-position modulator and Fig. 9 shows the related waveforms. In this example, the timer operates as an oscillator whose output is modulated by a triangular signal. Note, however, that the modulating signal can have any desired shape and may be derived from another signal generator or from a pressure, temperature or humidity sensor.

Linear ramp generator

When the timer is operated so the timing capacitor C_1 charges through a resistor, the voltage across it increases logarithmically. If we need a voltage that increases linearly with time, we can replace timing resistor R_T with a constant-current source and take the linearly increasing voltage from across C_T. In Fig. 10, a 2N2450, 2N4403 or similar transistor is connected as the constant-current source. Figure 11 shows the related waveforms.

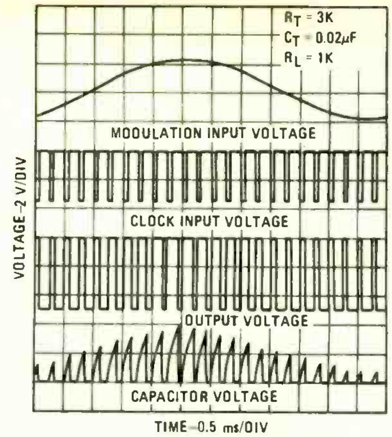


FIG. 6—OUTPUT PULSE WIDTH is determined by voltage on control terminal. Waveforms show circuit preformance with sinewave control.

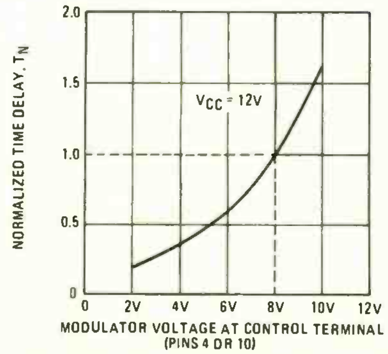


FIG. 7—HOW OUTPUT PULSE WIDTH or time delay varies with modulation voltage on control terminal.

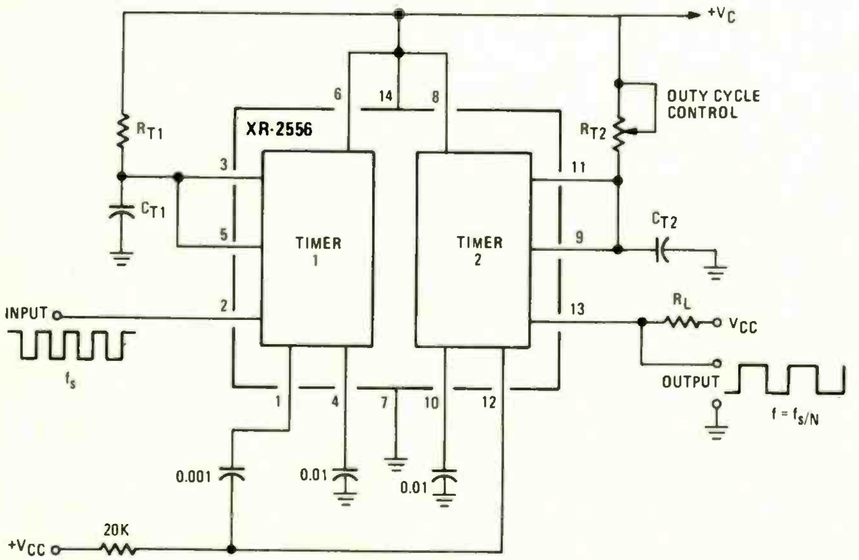


FIG. 4—FREQUENCY DIVIDER AND PULSE SHAPER. Timer 1 is frequency divider controlled by R_{T1} and C_{T1}. Timer 2 is a pulse shaper. The output duty cycle is set by R_{T2} and C_{T2}.

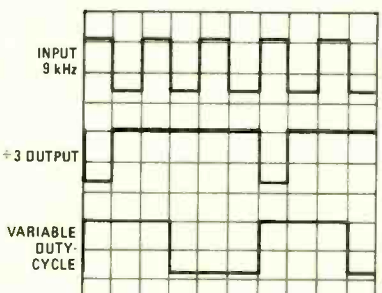


FIG. 5—WAVEFORMS associated with the divider and pulse shaper in Fig. 4.

(Note that in this application, the 0.010-μF decoupling capacitor must be disconnected from the control terminal. The modulation voltage can be direct coupled or fed through a suitable capacitor. Figure 7 shows how the voltage applied to the control terminal affects the pulse width or time delay of the signal developed at the output of the timer.

Another long-time timer

The last time around, we showed three timers connected in cascade to provide a time delay much longer than is practical with a single device. The overall delay is the sum of the delays in the three timers. Another method of achieving long delays is to use the scheme (Fig. 12) described in application notes supplied by most timer manufacturers. In this case, the two halves of a dual timer are connected in cascade with a type 8281 binary counter between them. The first timer is connected as an oscillator with a period of $1/f_o$. The 8281 counter provides selectable outputs (at times equal to 2, 4, 8 and 16 times the input) that are used to trigger the second half of the dual timer. The RC constants in the second timer are selected to give the desired output pulse length.

For your car

Figure 13 is a simple electronic tachometer described in Texas Instruments timer application note. It is operated by pulses generated as the car's distributor points open and

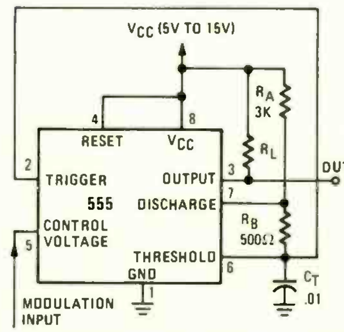


FIG. 8—ASTABLE OPERATION provides for pulse-position modulation when modulating signal voltage is applied to control terminal.

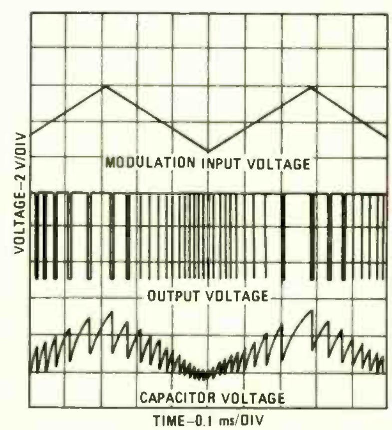


FIG. 9—PPM (PULSE-POSITION MODULATION) waveforms. Modulation voltage need not be symmetrical.

close. These pulses are shaped and clamped by the 1K input resistor and the 5-volt Zener diode. The processed pulses are then fed to the trigger input of the timer. The pulses on the trigger terminal cause the timer output to go "high" for a period equal to $1.1R_1C_1$. During this time, the 1N457 diode is back-biased and a current, determined by the setting of the 200K CALIBRATION control, flows through the meter. At the end of the delay period, the output terminal goes "low" (drops to around ground potential) and removes the blocking bias from the diode. The 1N457 now conducts, forming a low-impedance shunt around the meter.

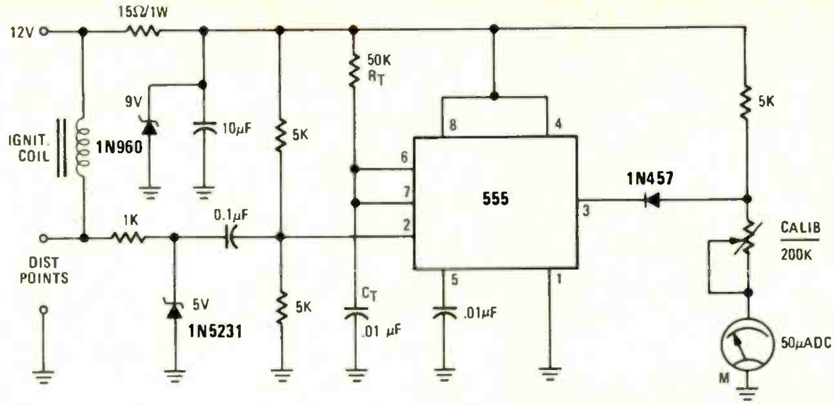


FIG. 13—ELECTRONIC TACHOMETER. Timer processes ignition pulses and controls current flowing through the meter movement.

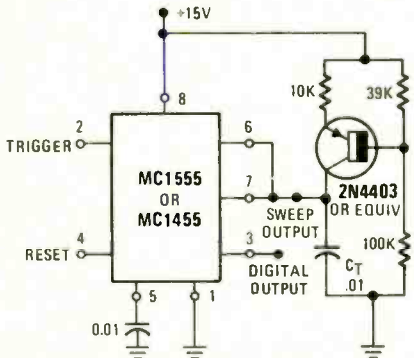


FIG. 10—LINEAR RAMP developed when timing capacitor charges through constant-current source.

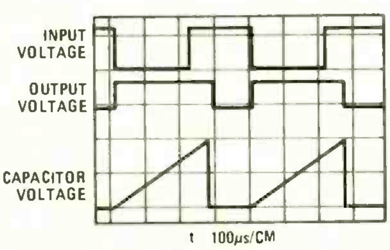


FIG. 11—WAVEFORMS developed in linear-ramp generator.

Non-timer applications

In previously described applications, the timer was used in both the monostable and astable modes for time delay or pulse generations. Another popular application is as a controlled flip-flop. All we need to do is to arrange for the voltage on the trigger terminal to swing from below one-third V_{cc} to a point above two-thirds V_{cc} under some varying outside influence as light, pressure, humidity or temperature. A control relay can be connected from the output terminal to ground or to V_{cc}, depending on the application.

Figure 14 shows how a 555-type timer and an LDR such as a CdS photocell can be used as a photosensitive relay in an intruder alarm or for switching on a light at sunset and off at sunrise. Under normal conditions, the light falling on the photoresistive (or photoconductive) cell causes its resistance to drop to a low value. The voltage on the trigger terminal is equal to one-third V_{cc}, or lower, keeping the relay de-energized. As daylight fades, or the light on the photocell is interrupted by an intruder, the photocell resistance rises and the relay is energized to actuate the alarm or

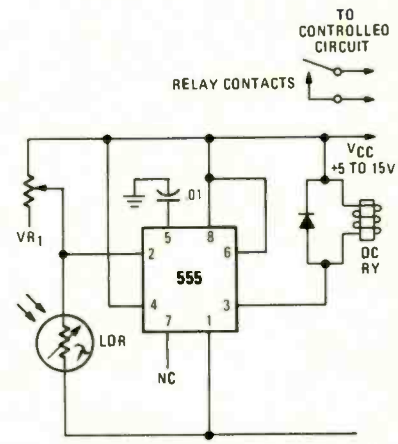


FIG. 14—TIMER CONTROLS RELAY in photo-electric applications. Circuit can be used to control lighting or detect intruders.

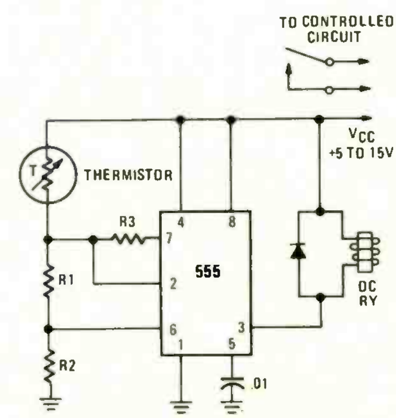


FIG. 15—ELECTRONIC THERMOSTAT can be based on this circuit. Performance depends on thermistor characteristics and on the resistive voltage divider.

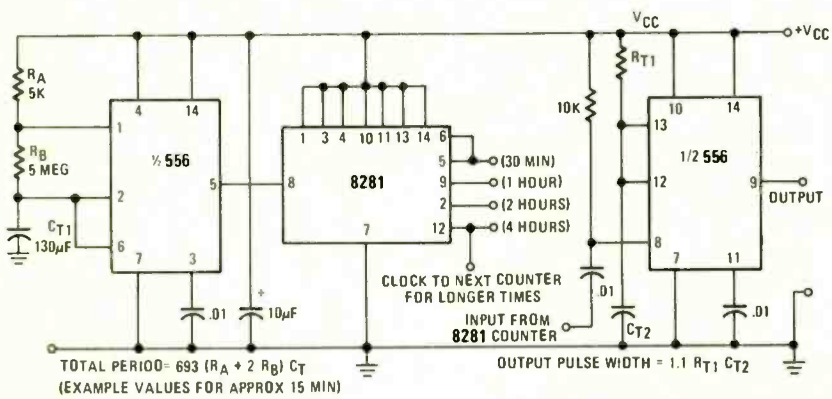


FIG. 12—DUAL TIMER and 8281 presettable binary counter teamed up for long time delays. The delay can be as much as sixteen times that set by the time-constant of the first timer.

From this, we see that the meter is fed a train of current pulses. The meter interprets the ratio of the time that current flows through it to the time that it is removed as revolutions per minute. The best way to calibrate the tachometer is against another of known accuracy. Your local garage will probably have a portable tach or will have one built into their engine analyzer.

turn on a lamp. The variable resistor is a SENSITIVITY control.

Another non-timer use of the 555 is as a thermostat or an interface between a thermistor and a power relay. An application of this type is shown in Fig. 15.

For example, it can be used to turn on a cooling or ventilator fan when the temperature reaches a certain level and turn it off when the temperature has dropped to a preset low level. Similarly, the circuit might be used to control a heater or oven or, with a lot of refinements, to control the temperature of photo processing chemicals and baths.

The on and off states of the controlled device are determined by the values of R1, R2 and R3 and on the resistance and temperature coefficients of the thermistor. **R-E**

Radio-Electronics Tests JVC S-300 Stereo Receiver


1

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

YOU HAVE TO TAKE A HARD SECOND LOOK AT JVC's new S-300 to realize that it is, in fact, an integrated receiver. All of JVC's new receivers for 1976–77 have been totally restyled and, in general, resemble the mid-priced unit we tested for this report. As shown in the photo of Fig. 1, the front panel of the S-300 has not a single rotary control on it (unless one counts the edge-mounted thumb-wheel tuning control that resembles a similar tuning treatment popularized by Marantz and still used on that company's tuner and receiver products). The tuning control, isolated on a light colored section of the panel, separates the two main areas of the front panel. The rear sloped AM and FM frequency dials and pointer are highly visible and put an end to having to crouch down to read station frequencies. FM frequencies are linearly spaced, with calibration marks at every half megahertz. Above the dial area, at the left, are twin signal-strength and center-of-channel tuning meters, while at the right are another pair of meters that are actually calibrated to read power output delivered to a pair of 8-ohm speakers. These meters can be used for monitoring output level to insure that speaker power ratings are not being exceeded and to balance the channels. It is most unusual to find a pair of output meters on an all-in-one receiver, since such extras are confined to separate basic power amplifiers—and expensive ones at that.

Eleven rectangular pushbuttons are neatly arranged in a single row below the dial area. These take care of power turn on, speaker system selection, program source selection, tape monitoring or dubbing (via the two tape monitor circuits included), FM mute/mono selection and loudness circuit activation. A headphone jack is located along the lower edge of the panel, while a stereo indicator light is centered between the two pairs of meters previously described. The right section of the panel is devoted to what JVC calls its S.E.A. Graphic-Equalizer tone control system. Instead of having bass, treble or even a mid-range tone control, the five slide controls of the graphic equalizer divide the audio spectrum into five sections.

Each control alters response by ±12 dB at a particular center frequency (see Manufacturer's Specifications) providing a much greater degree of control than is possible with conventional bass or treble controls. Graphic equalizers have become quite popular as separate add-on devices with more sophisticated hi-fi systems but this is, as far as we know, the only all-in-one receiver to incorporate such an elaborate and flexible tone control system. Each lever moves in click-stop increments so that preferred settings of each control are easily duplicated. Above the five graphic equalizer knobs are a pair of horizontal slide controls that take care of master volume adjustment and channel balance.

The rear panel of the JVC S-300 is shown in Fig. 2. Spring-loaded speaker terminals are provided for each of two possible speaker system pairs, as are switched and unswitched convenience AC receptacles. In addition to the usual phono-jacks for inputs and tape outputs, there is a multi-contact DIN connector (in parallel with the TAPE 2 IN and OUT jacks), an FM DETECTOR output jack (for possible future use with an FM 4-channel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adaptor) and PREAMP-OUT and MAIN AMP IN jacks equipped with wire jumpers that can be removed for separate access to the preamplifier section outputs and the main (power) amplifier inputs. Screw terminals are provided for connection of the AM and FM external antennas, with 75-ohm or 300-ohm options for FM. Before connecting an FM external antenna it is necessary to disconnect a so-called "built in" FM antenna lead from one of the 300-ohm terminals. A ferrite-bar antenna, pivotable away from the chassis, completes the rear-panel layout. The diagram of Fig. 3 illustrates the variety of associated components that can be connected to and used with the S-300 receiver.

The owner's manual of the S-300 does not include a schematic diagram of its circuitry, but careful examination of the internal construction of the receiver (Fig. 4) plus a reading of the company's descriptive literature enabled us to summarize features and construction as follows:

The amplifier section has in input differential stage followed by a Class-A pre-driver. The output stage is a Darlington-connected parallel push-pull fully complementary circuit. The phono preamp section uses a two-stage direct coupled NPN-PNP circuit that is powered by a dual-polarity supply. Protection circuitry includes a speaker circuit relay, DC voltage detector and a speaker safety circuit covered by two U.S. patents. A new four-resonator type single-unit ceramic filter is used in the IF section, along with a

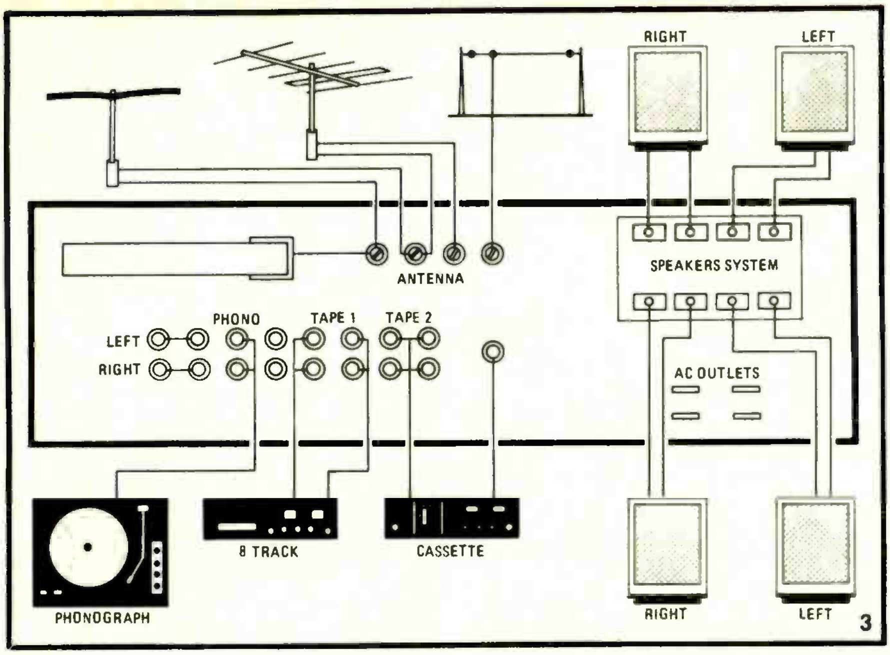
MANUFACTURER'S PUBLISHED SPECIFICATIONS

FM TUNER SECTION:
IHF Usable Sensitivity: 1.9 μV (10.96 dBf). **50 dB Quieting Sensitivity:** mono, 3.5 μV (16.3 dBf); stereo, 40 μV (37.4 dBf). **Harmonic Distortion** 1 kHz: mono, 0.2%; stereo, 0.4%. **Signal-to-Noise Ratio:** mono, 70 dB; stereo, 60 dB. **Selectivity:** 60 dB. **Capture Ratio:** 1.2 dB. **Image Rejection:** 70 dB. **AM Suppression:** 50 dB. Stereo Separation: 1 kHz, 45 dB; 10 kHz, 30 dB.

AM TUNER SECTION:
Sensitivity: internal antenna, 300 μV/M; external antenna, 30 μV. **Signal-to-Noise Ratio:** 55 dB. **Selectivity:** 30 dB. **Image Rejection:** 45 dB. IF Rejection: 50 dB.

AMPLIFIER AND PREAMPLIFIER SECTION:
Power Output: 50 watts/channel continuous into 8-ohm loads, 20 Hz to 20 kHz at no more than 0.3% total harmonic distortion. **IM Distortion:** 0.3% at rated output. **Damping Factor:** 50 at 8 ohms. **Input Sensitivity:** phono, 2.5 mV; high level, 180 mV **Signal-to-Noise Ratio** (A Weighted): phono, 70 dB; aux and tape, 95 dB. **Phono Overload:** 200 mV. **Phono Frequency Response:** RIAA ±0.5 dB. **Tone Control Center Frequencies:** 40 Hz, 250 Hz, 1 kHz, 5 kHz, 15 kHz. **Control Range:** ±12 dB.

GENERAL SPECIFICATIONS:
Dimensions: 19-11/16" wide × 6-5/16" high × 13-3/16" deep (50W. × 16H. × 33.5D. cm.) **Net Weight:** 22.9 pounds (10.39 Kg). **Suggested Retail Price:** $400.00



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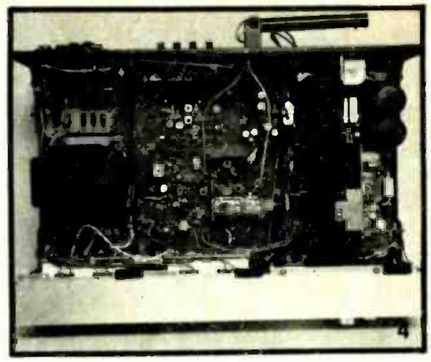


quadrature FM detector circuit and a phase-locked-loop multiplex section. The entire AM circuitry is contained in a single multi-purpose IC. The FM front-end of the S-300 uses a 3-gang capacitor and a dual-gate MOSFET RF amplifier stage. High-voltage (output stage) supplies (negative and positive) are filtered by means of a pair of 10,000 μF capacitors.

FM tuner measurements

Laboratory measurements of the tuner section of the S-300 are summarized in Table I. Sensitivity readings in mono and stereo are typical for a three-section tuning arrangement in the front end, though 50 dB quieting in mono is better than we would have expected, at 2.5 μV (13.4 dBf). Maximum S/N ratios in both mono and stereo were outstandingly good and, in each case, considerably better than claimed by the manufacturer. We suspect that JVC may have "counted in" the residual sub-carrier product output in specifying only 60 dB of quieting in the stereo mode, when, in fact, the new IHF measurement specs permit the use of a low-pass filter (with cut-off set at 15 kHz) when making S/N measurements. While both mono and stereo THD figures were lower than claimed (at 1 kHz), we were surprised to note that the THD in stereo was actually lower than that measured in mono. This is contrary to what usually happens when we measure THD in both FM reception modes and can only be explained as some sort of distortion cancelling that occurs in two circuit regions which result in a single lower overall figure when measured at the output of the multiplex section. Frequency response follows the required de-emphasis quite closely out to beyond 10 kHz, but dips a bit too quickly (in an effort to minimize sub-carrier output products, no doubt) so that response at 15 kHz (the end of the useful audio spectrum in FM) response is attenuated some 1.5 dB more than it should be.

Secondary specifications such as selectivity, image and IF rejection were not as high as on some more expensive sets but were certainly adequate for most listening situations. Stereo separation, while not quite as high at mid-frequencies as the 45 dB claimed by JVC, manages to remain above 30 dB all the way out to 10 kHz and is a more than sufficient 41 dB at 1 kHz. Stereo switching takes place at an input signal strength of 10 μV (25.4 dBf), by which time distortion is down below 1.0% and noise is better than –40 dB. Muting threshold is set to almost the same point (9 μV, or 24.5 dBf), but it should be noted that when listening to stereo it is impossible to defeat the muting circuitry. JVC probably reasoned that weaker signals would not be listenable in stereo anyway, so they combined the mono/stereo FM mode switch with the mute defeat switch on one pushbutton. Measured 19 kHz and 38 kHz rejection (with no filter connected at the output) was 60 dB. All in all, JVC engineers have managed to squeeze quite a bit of FM performance out of an economical circuit that is designed into this receiver.

TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **JVC** | Model: **S-300**

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	**R-E Measurement**	**R-E Evaluation**
IHF sensitivity, mono: (μV) (dBf)	2.1 (11.8)	Good
Sensitivity, stereo (μV) (dBf)	10.0 (25.4)	Good
50 dB quieting signal, mono (μV)	2.5 (13.4)	Excellent
50 dB quieting signal, stereo (μV)	40.0 (37.4)	Average
Maximum S/N ratio, mono (dB)	74.0	Excellent
Maximum S/N ratio, stereo (dB)	71.0	Excellent
Capture ratio (dB)	1.2	Very good
AM supression (dB)	53.0	Good
Image rejection (dB)	73.0	Average
IF rejection (dB)	75.0	Average
Spurious rejection (dB)	88.0	Good
Alternate channel selectivity (dB)	60.0	Good
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz ($\pm$dB)	1.5 dB	Average
Harmonic distortion, 1 kHz, mono (%)	0.14	Very good
Harmonic distortion, 1 kHz, stereo (%)	0.08	Superb
Harmonic distortion, 100 Hz, mono (%)	0.17	Very good
Harmonic distortion, 100 Hz, stereo (%)	0.08	Superb
Harmonic distortion, 6 kHz, mono (%)	0.17	Very good
Harmonic distortion, 6 kHz, stereo (%)	0.18	Excellent
Distortion at 50 dB quieting, mono (%)	1.0	Average
Distortion at 50 dB quieting, stereo (%)	0.3	Excellent
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV) dBf)	10.0 (25.4)	Good
Separation, 1 kHz (dB)	41.0	Very good
Separation, 100 Hz (dB)	35.0	Good
Separation, 10 kHz (dB)	30.0	Very good
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV) (dBf)	9.0 (24.5)	Fair
Dial calibration accuracy ($\pm$kHz @ MHz)	100	Excellent
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION		
Control layout		Excellent
Ease of tuning		Fair
Accuracy of meters or other tuning aids		Very good
Usefulness of other controls		Excellent
Construction and internal layout		Very good
Ease of servicing		Very good
Evaluation of extra features, if any		Excellent
OVERALL FM PERFORMANCE RATING		Very good

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **JVC** Model: **S-300**

OVERALL PRODUCT ANALYSIS

Retail price	**$400.00**
Price category	**Medium**
Price/performance ratio	**Excellent**
Styling and appearance	**Very good**
Sound quality	**Very good**
Mechanical performance	**Excellent**

Comments: The truism which suggests that the high-fidelity component of today offers greater dollar value than ever before certainly applies to this totally redesigned receiver from JVC. The graphic-equalizer section of this receiver, if bought as a separate component, would be worth fully half the asking price of the entire S-300, and its incorporation in this relatively low-priced integrated receiver is an outstanding accomplishment. From a cosmetic standpoint, we suspect that shoppers will either love the new JVC look instantly or will be completely turned off by it. The inveterate knob twirler will find the knob-less front panel a bit difficult to get used to. The only rotating control to be found on the S-300, the edge mounted tuning knob, is a rather crude imitation of the edge-tuned thumbwheel long featured in Marantz tuners and amplifiers and is not nearly as easy to use as its progenitor. Incorporation of direct-reading power meters on a unit in this price class is also most unusual and welcome.

While the amplifier section "measures" a bit better, overall, than the tuner section, actual listening tests posed no problems either with FM, stereo FM or phono disc and tape reproduction. For all the pushbuttons provided, we would have thought it possible to separate the mute function from the mono/stereo FM switch, since, in its present configuration, it is not possible to listen to stereo FM without engaging the muting function—a combination which may frustrate some FM DX'ers who want to scan the dial for everything they can pick up regardless of its noise content.

50 watts of audio per channel, conservatively rated as in the JVC S-300 receiver, is enough power for most hi-fi system applications wherein the user does not expect to produce ear-shattering loudness levels from inefficient speaker systems, and the $400.00 price tag of this well executed receiver places it within the budget of a great number of first and second-system owners who want a receiver that offers tonal compensation facilities not ordinarily found in an all-in-one unit.

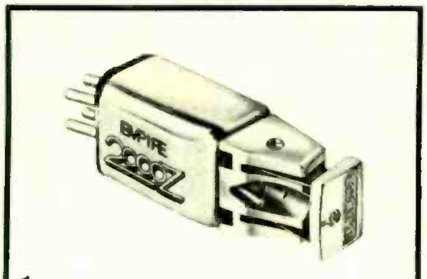
Amplifier and preamplifier measurements

Table III shows results of measurements made of the preamplifier and power amplifier sections of the JVC S-300 receiver. From the consistently high power output obtained even at the low-frequency extreme (54 watts at 20 Hz, compared with a mid-frequency output of 58 watts for rated 0.3% THD). one can judge that the power supply arrangement in the receiver is well regulated and conservatively designed. At its rated output of 50 watts per channel (into 8 ohms) at mid-frequencies. THD measured a low 0.065%. IM, though not quite as low at 0.18%, was well below it's rated 0.3% figure. There is absolutely no indication of notch or crossover distortion with this receiver and distortion continues to get lower with decreasing power outputs until it becomes too difficult to read because of noise content that begins to represent appreciable contribution to the single reading when measuring THD for low power output levels.

Phono input sensitivity measured close to the 2.5 mV claimed, and based upon that input sensitivity, signal-to-noise in phono (unweighted) was in impressive 71 dB. Since JVC quotes S/N figures on the basis of an "A" weighting curve, we repeated the S/N measurements with such weighting applied and obtained readings of 78 dB in phono, 97 dB for the high level inputs and 102 dB for residual noise (with volume control at minimum)—all excellent results for a receiver at any price. Overload capability of the phono section was 220 millivolts.

(continued on page 120)

Empire 2000Z Cartridge



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EMPIRE SCIENTIFIC CORPORATION'S NEW MODEL 2000Z cartridge, shown in Fig. 1, is that company's highest quality pickup in their popular 2000 series which includes cartridges ranging in price from around $30.00 (for the model 2002) to $100.00 for the 2000Z. The new cartridge boasts tighter frequency response specs and better tracking capability and separation than their previous top model, the 2000EIII. In physical format, it differs slightly from the other models in the 2000 series in that its removable stylus assembly (the entire forward part of the cartridge) is equipped with a pivotable stylus guard that can be rotated downward to cover the exposed stylus tip. In this regard, it more closely resembles the 4000 series cartridges offered by Empire.

Cartridge construction

Not shown in Fig. 1 is the simple mounting bracket with which all Empire cartridges are secured in place and properly positioned in a pickup arm of a turntable system. The bracket has two projecting lips that slip under the metal shield of the cartridge at the rear and a projecting dimple at the front that pops neatly into place. This provides the correct downward angle for the entire cartridge housing as referenced to the horizontal plane of the holder. The bracket has the advantage of permitting to user to mount it (by means of screws provided) into a pickup arm headshell while the cartridge body itself is safely off to the side away from possible accidental damage by screwdrivers or nervous fingers.

Few audio enthusiasts realize just how complex a quality phono cartridge really is, and what precise tolerances are required in its manufacture. Twenty seven precision parts are pictured in a blow-up diagram of a typical phono cartridge made by Empire in their excellently illustrated product brochure. The 2000Z uses four coils, pairs of which are wound in opposite directions to cancel induced hum voltages. Three separate magnets are used. The rear magnet (located behind the coils) generates the primary magnetic field while the two front magnets help to equalize magnetic flow when the sylus is motionless thereby preventing microphonics. Four precision poles serve to guide and concentrate the magnetic flow in the gap in which the light-mass hollow iron armature varies magnetic flow as it is moved by the stylus affixed at the other end of the cantilever tube. A compliant elastomer suspension

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Frequency Response: 20 Hz to 20,000 Hz, ±1 dB. **Tracking Force Range:** 0.75 to 1.25 grams. **Separation:** 20 dB from 20 Hz to 500 Hz; 30 dB from 500 Hz to 15 kHz; 25 dB from 15 kHz to 20 kHz. **IM Distortion:** Less than 0.08%, 2 kHz to 20 kHz @ 3.54 cm/sec stylus velocity. **Stylus:** 0.2 × 0.7 mil diamond. **Effective Tip Mass:** 0.2 milligrams. **Compliance:** Lateral: 30 × 10^{-6} cm/dyne; Vertical: 30 × 10^{-6} cm/dyne. **Tracking Ability:** 0.9 grams for 38 cm/sec at 1 kHz; 0.8 grams for 30 cm/sec @ 400 Hz. **Channel Balance:** within 0.75 dB @ 1 kHz. **Tracking Angle:** 20°. **Recommended Load:** 47,000 ohms. **Required System Capacitance:** 300 pF. **Output Level:** 3.0 mV at 3.54 cm/sec. **DC Resistance:** 1100 ohms. **Inductance:** 675 mH. **Type Of Cartridge:** moving iron. **Suggested Retail Price:** $100.00

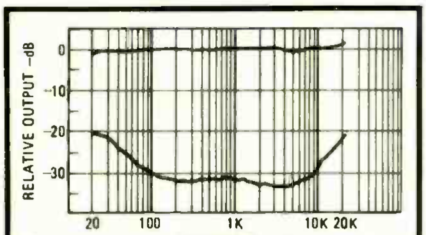
element is used for accurate positioning of the stylus.

Laboratory measurements

Empire's published frequency response is based upon measurements made using a CBS 100 test record. Since that test record was introduced to the industry several years ago, a newer and more accurate set of test records has been developed by CBS and, in our tests, we used an STR-130 test record by CBS which was recorded using precise RIAA equalization. Our results, shown in Fig. 2, are almost identical with those published in Empire's literature and, if anything, show somewhat less of a rise in amplitude as one approaches the 20-kHz frequency extreme. So good was the response to 20 kHz, in fact, that we decided to use a JVC-TRS-1005 test record that has test frequencies recorded out to 50,000 Hz (and is intended for checking out CD-4 type phono pickups). Although the 2000Z was never intended to be used as a discrete CD-4 playback cartridge, we were surprised to find that at 30 kHz, response was down only 4 dB (relative to 1000 Hz response) and at 40 kHz response was down some 13 dB. Whatever resonance there was (and it amounted to less than 2 dB) showed up at a frequency of 25 kHz.

Using the CBS STR-112 tracking-ability test record we determined that compliance (both lateral and vertical) equalled 30×10^{-6} cm/dyne, exactly as claimed. Velocities of 38 cm/sec were tracked with minimal distortion with a downward tracking force of one gram. This velocity is probably higher than any you are likely to encounter in playing commercially recorded musical records.

Output level for a 3.54 cm/sec velocity was 3.0 mV for one channel, 3.2 mV for the other, indicating extremely good balance between channels. Separation (also plotted in Fig. 2)



2

measured over 30 dB at mid frequencies and remained well over 25 dB at 10 kHz.

Summary listings of our laboratory measurements for the Empire 2000Z are given in Table I. It should be noted that all tests were conducted with a carefully measured loading capacitance of 320 pF (a bit higher than the nominal recommended 300 pF value listed by Empire). We cannot stress the importance of correct capacitive loading of a cartridge enough, especially when dealing with a cartridge that has the potential performance of this one. The capacitance consists of the audio cable capacitance plus the lower capacitance of the tiny wires within the pickup arm of the turntable system, plus the input capacitance of the phono preamplifier circuit. With insufficient capacitance applied in parallel with the cartridge output, a rising characteristic will be obtained. With too much capacitance, high frequency response will be attenuated noticeably.

TABLE I

RADIO-ELECTRONICS PRODUCT TES

Manufacturer: **Empire Scientific Corp.**

PHONOGRAPH CARTRIDGE MEAS

FREQUENCY RESPONSE		
(Hz-kHz, ±dB)		
STEREO SEPARATION		
Separation, 1 kHz (dB)	32	
Separation, 10 kHz (dB)	28	**Ve.,**
CHANNEL BALANCE		
1 kHz (dB)	0.2	**Excellent**
TRACKABILITY MEASUREMENTS		
Stylus velocity at 1 kHz (cm/sec)	38	**Excellent**
Lateral compliance (cm/dyne)	30×10^{-6}	**Excellent**
COMPONENT MATCHING CHARACTERISTICS		
Output level, 1 kHz, 3.54 cm/sec (mV)	3.1	
Optimum load impedance (ohms)	47,000	
Tracking force range (to grams)	0.75-1.25	
OVERALL PHONO CARTRIDGE RATING		**Excellent**

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Empire Scientific Corp.** Model: **2000Z**

OVERALL PRODUCT ANALYSIS

Retail Price	**$100.00**
Price Category	**High**
Price/performance ratio	**Excellent**
Sound Quality	**Excellent**
Mechanical performance	**Very good**

Comments: Like a loudspeaker system, the phono cartridge is a transducer. Instead of converting electrical energy into mechanical energy, it does just the reverse. Transducers are that special category of hi-fi components that have traditionally been presented to the buying public shrouded in vague and often meaningless accompanying performance specifications. To a large degree, this is because there has been little agreement as to how to measure and report performance—particularly in the case of speakers. While the situation is not nearly as bad when it comes to phono cartridges, few manufacturers have bothered to clearly spell out specifications that aid the consumer in making the right selection. Happily, Empire now seems to have changed all that. Their new format of specification listing tells us all we want and need to know about a phono pickup. More importantly, our tests confirmed that the specs are honestly and conservatively reported and our ears confirmed the correlation between good specs and good sound. The Empire 2000Z offers extremely smooth response in the audible range and, even at the light tracking force (1.0 grams) at which our listening tests were conducted, never failed to track the grooves of even our most dynamically recorded musical test passages. Highs were silky smooth, never "edgy" or raspy and there was not even a hint of "peakiness" in the important 12,000 to 16,000 Hz range where so many other pickups often add distinct and easily identifiable coloration. We found that mounting of this cartridge is easily accomplished, thanks to the separate bracket that can be affixed to the pickup arm separately, after which the cartridge body is simply snapped into place. Hum level was noticeably lower for this cartridge than that heard with cartridges lacking Empire's hum-bucking coil construction and extensive shielding. In short, the new Empire 2000Z is a top-of-the-line pickup that should appeal to audio enthusiasts who seek extreme accuracy of reproduction, low tracking force and excellent tracking characteristics.

All of our tests were conducted using Empire's newly developed model 698 turntable system. The pickup arm of this turntable has a vertical and horizontal bearing friction of less than .001 grams. To realize the full potential of a cartridge such as the Empire 2000Z, it is important that the pickup be used in conjunction with a high-quality turntable system that can accommodate such low tracking-force cartridges and is also equipped with an accurate and stable anti-skating force adjustment.

Our overall comments regarding the Empire 2000Z, along with a summary product evaluation will be found in Table II. With the introduction of the 2000Z, Empire Scientific Corporation has taken an important step forward in the often difficult realm of transducer development. For the audiophile, this cartridge is worth its price. **R-E**

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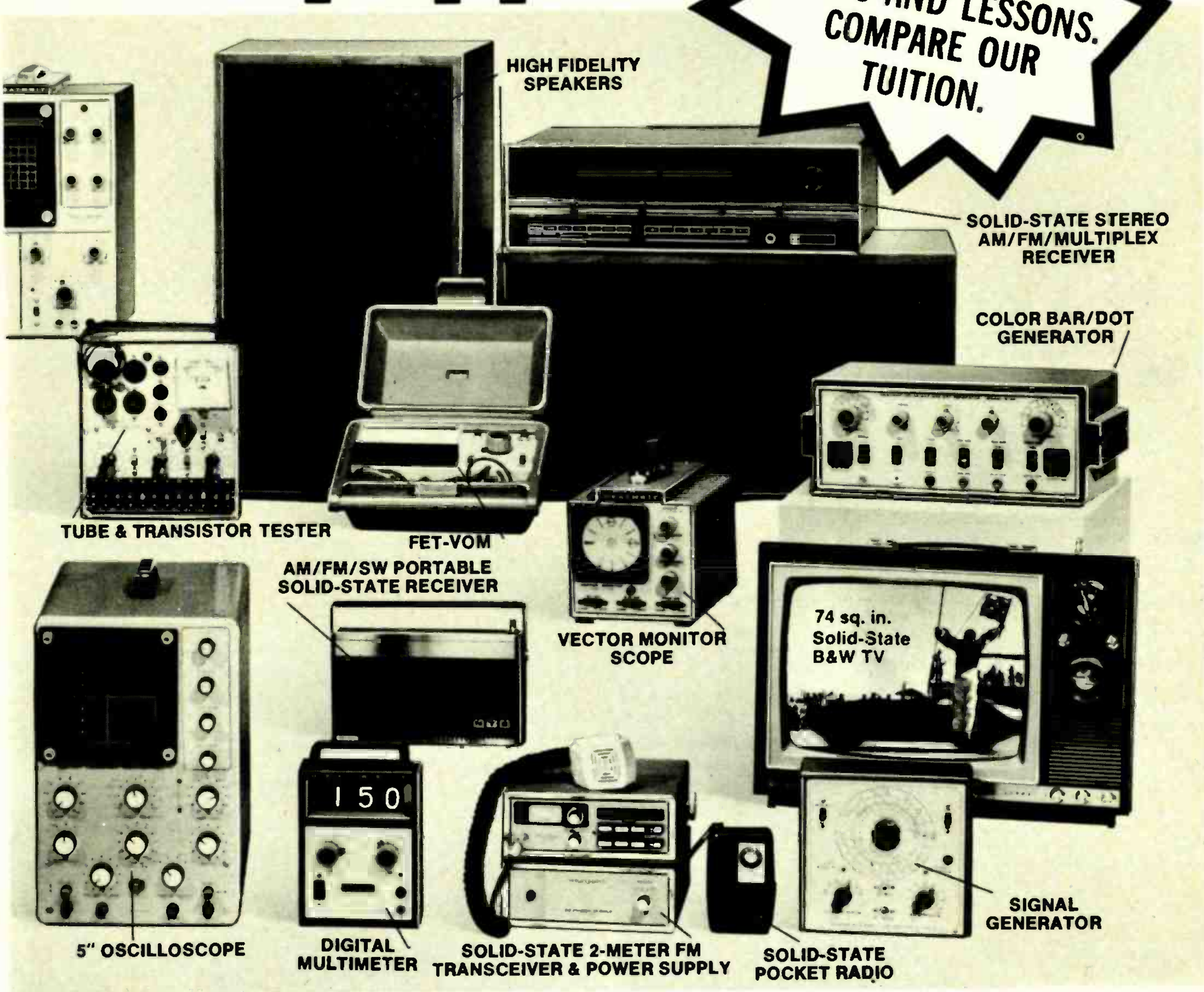

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Calibrating with

New frequency calibration method that is of Standards involves the use of an ordinary

FREQUENCY CALIBRATION WITH GREATER accuracy than most people need is now possible using a system developed by the National Bureau of Standards. The system is based on the characteristics of network color television broadcasts and yields more accurate and quicker results than those obtainable using the NBS radio stations—WWV, WWVH or WWVB.

To accurately measure the frequency of an oscillator or to set it to a predetermined frequency, some means of comparison is required. This is not unlike measuring a distance or constructing your own ruler or micrometer. For the ruler to be very accurate, some means of comparing it to the national standard of length is needed.

Taking the ruler to the standard is usually difficult and taking the standard to the ruler is usually impossible. Some means of transferring a measured length, directly comparable to the standard length, is required. This transfer standard can be a precision "ruler" that is characterized and calibrated by the NBS. This hypothetical ruler comes with data describing how its length changes with temperature and other environmental influences and with data indicating how accurately it was calibrated. From this information, the accuracy of this transfer standard ruler can be calculated.

Frequency measurement usually involves some kind of a transfer standard. The international units for time and frequency (the second and the hertz) are defined in terms of atomic phenomena (see box). The oscillator used to generate the standard is shown in Fig. 1. It is difficult to compare an oscillator to the NBS Cesium standard (not the least difficulty being the long drive for most people to Boulder, Colorado). Many schemes have been devised that make it possible to compare an oscillator to transfer standards that are themselves carefully compared to the NBS standard. Three of these schemes are the flying clock, the NBS radio broadcasts and the new television subcarrier transfer system.

Transfer standards

The flying clock is a portable version of the Cesium atomic standard that can be carried aboard an aircraft to any location in the world. This is the most accurate system yet devised and is used to compare the national standards of different countries to each other. Since few people need this accuracy or can afford the cost (the portable standard has a price tag of close to $20,000), other methods are used for mass distribution.

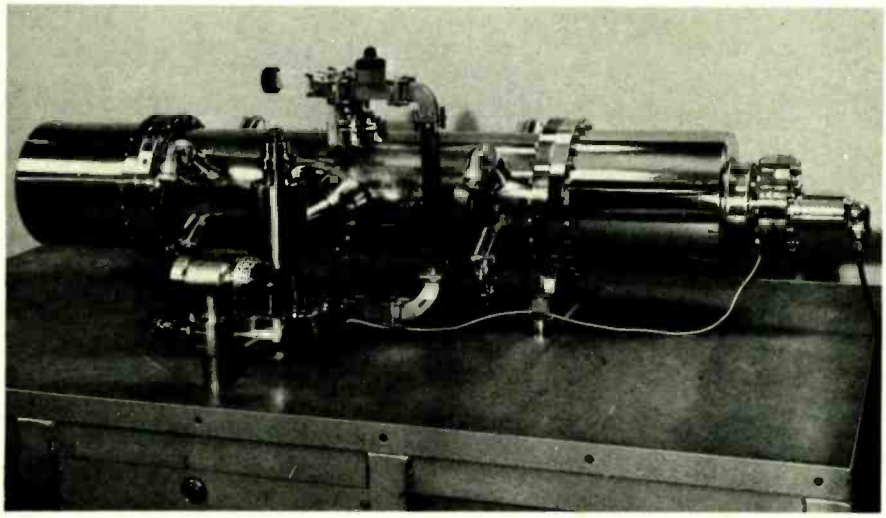


FIG. 1—CESIUM BEAM ATOMIC FREQUENCY STANDARD at the National Bureau of Standards.

Standard-frequency radio broadcasts are the most popular of the transfer standards. The NBS radio stations are located near Fort Collins, Colorado (WWV and WWVB) and Kekaha, Kauai, Hawaii (WWVH). The information and services provided by the broadcasts include standard time and frequency, standard audio tones, seconds broadcasted as ticks, BCD time-code and voice announcements for time, storm information, radio propagation forecasts and geophysical alerts. WWV and WWVH broadcast on 2.5, 5, 10, 15 and 20 MHz. WWV also broadcasts on 25 MHz. WWVB broadcasts on 60 kHz and transmits only a time code. Its VLF (*V*ery *L*ow *F*requency) carrier is affected much less by propagation factors than the HF (*H*igh *F*requency) carriers of WWV and WWVH.

All time-signals, tones and carrier frequencies of the three stations are controlled by Cesium atomic oscillators that are regularly compared to the national standard (see Fig. 2). This precision at the transmitter, however, does not guarantee equivalent precision at the receiver. Effects due to the changes in the propagation medium cause fluctuations in the received frequencies .While transmitted frequencies are held to better than 2 parts in 10^{11} (0.0002 Hz at 10 MHz), the received frequency stability of WWV is no better than 1 part in 10^{7} (1 Hz at 10 MHz) when averaged for 10 minutes. The VLF signals of WWVB are good to 1 part in 10^{10} (0.00001 Hz) when averaged for 2 to 8 hours. This really isn't too bad for experimenters and amateur radio operators; after all, most common quartz crystals are only calibrated to 0.01% (1 part in 10^{4}). However, when measuring frequencies in the UHF or microwave regions or setting clock oscillators, more accuracy is often required.

The new television subcarrier transfer system offers this increased accuracy and,

Frequency your TV

directly traceable to the National Bureau
television receiver and an external device

MICHAEL S. ROBBINS

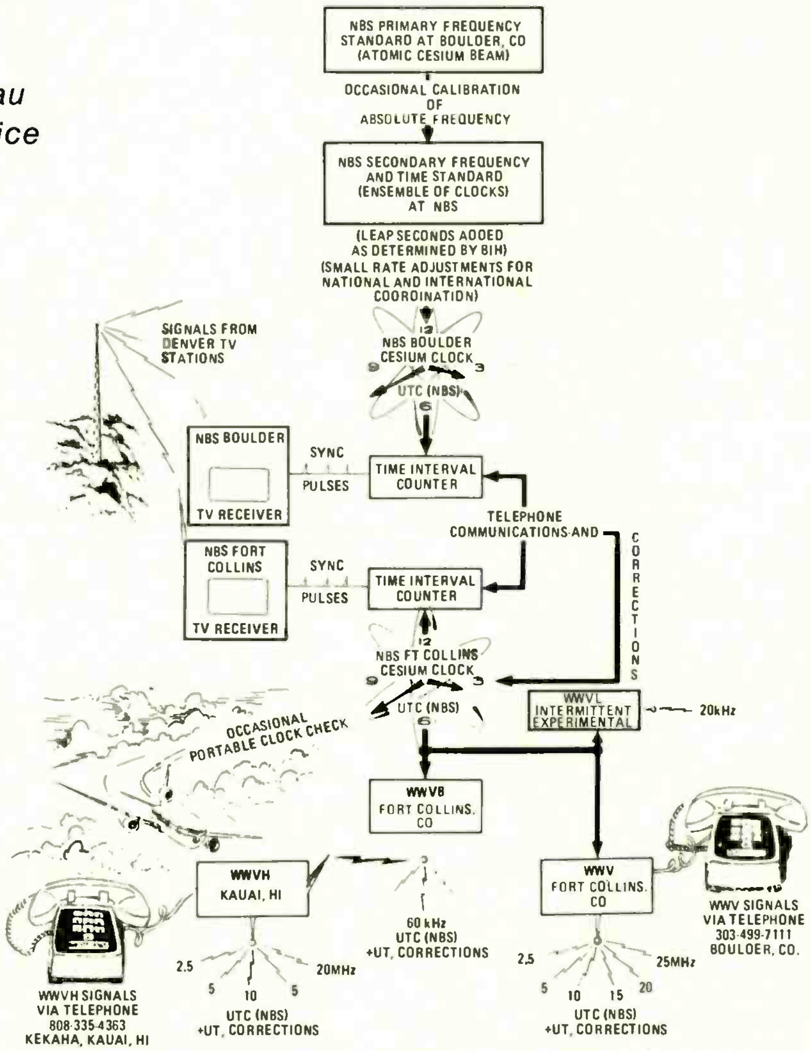


FIG. 2—FREQUENCY AND TIME FACILITIES of the National Bureau of Standards.

as a bonus, costs less and is quicker to use than most other systems. The transfer standard in this system is the Rubidium atomic oscillator used by the networks to generate the 3.58-Mz color subcarrier. These Rubidium oscillators are in use by the three commercial networks in both New York and Los Angeles and by PBS in New York. If you're not in New York or Los Angeles, don't stop reading! Almost every network show, including those on tape, with the exception of live sports events, has a color subcarrier generated by a Rubidium oscillator. Every program, whether it comes to you via satellite, microwave relay or coaxial cable contains this same color subcarrier practically undistorted by its travels through the bowels of the telephone company and the void of outer space. And, most importantly, every 3.58 crystal oscillator in every television receiver tuned to one of these network shows, in New York, Los Angeles or at the end of CATV cable system in a mountain village, is phase locked to that network Rubidium oscillator! This system is also applicable to those parts of Canada and Mexico that receive U.S. network programs.

Think of it! Every color television set, even that old clunker that you're about to throw out, has an oscillator good to 1 part in 10^{11} (0.00001 Hz) when averaged for only 15 minutes.

TV transfer system

Figure 3 shows how the 3.58 MHz and the vertical and horizontal synchronization pulses are derived from the 5 MHz Rubidium oscillators. A similar scheme can be used to generate a 3.58 MHz signal from a 5 MHz oscillator in any shop or lab which can then be compared to the 3.58 MHz oscillator in the TV set. Figure 4 shows how this might be done.

There is a quirk in the system that can be both a help and a hindrance. The network Rubidium oscillators are not exactly at 5 MHz. This is not to say that they are varying all over the place; far from it! International definitions and standards have changed since the networks purchased their equipment and it is now offset from the NBS standard by about 300 parts in 10^{10} low (written -300×10^{-10}). The exact value of this offset including any drift produced by other effects is measured daily by the NBS and published in its free monthly services bulletin. The offset itself facilitates the use of the subcarrier in this measurement system, while the

THE SECOND REDEFINED

A joint experiment between NPL (England) and the U.S. Naval Observatory from 1955-58 determined the cesium transition frequency in terms of the second. "The duration of 9,192,631,770 periods of the radiation corresponding to the transition between two hyperfine levels of the ground state of the cesium 133 atom" defined the second. This definition, replacing the astronomical definition of a second, has been used by the NBS since 1960, and was internationally adopted in 1967 by the 13th General Conference on Weights and Measures. Since 1967, the world's unit of time interval, the second, has therefore been defined by using atomic devices and not by astronomical observatories.

NBS measurements and their publication make your results traceable to NBS.

It is a requirement in every measurement system to have some degree of traceability if a given measurement is to have any validity when compared to measurements made at other times or in other places. Traceability to NBS is a requirement for measurements made to FCC specifications. This system offers traceability to NBS and measurement precision greater than that available using most other methods.

Three different types of equipment have been devised to make use of the technique. All three compare the phase of the received color subcarrier to the oscillator being measured.

The most elegant of the three is the NBS *System 358 Frequency Measurement Computer* shown in Figure 5. This unit automatically computes the difference between the networks rubidium oscillator (5 MHz minus offset) and your oscillator and displays it digitally on its TV screen. When your oscillator is exactly at 5 MHz, the number on the screen will be equal to the published offset. After ten readings are displayed in the left-hand column, their average will be displayed in the right-hand column. A total of ten averages can be displayed for a total of 100 measurements. Any reading that falls outside preset limits (the "window") is rejected and therefore does not skew the average. These rejected values may result from interference or program changes.

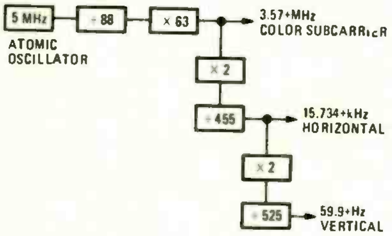


FIG. 3—COLOR TV SYSTEM FREQUENCIES are derived from an atomic oscillator by using a combination of frequency multipliers and dividers.

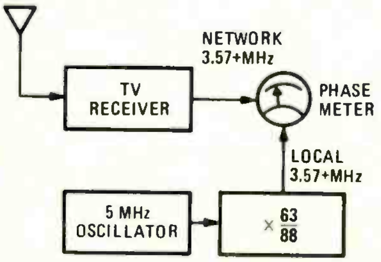


FIG. 4—PHASE COMPARISON permits calibration of oscillator to network color subcarrier.

FIG. 5—NBS SYSTEM 358 COMPUTER displays frequency difference between network's Rubidium oscillator and local signal.

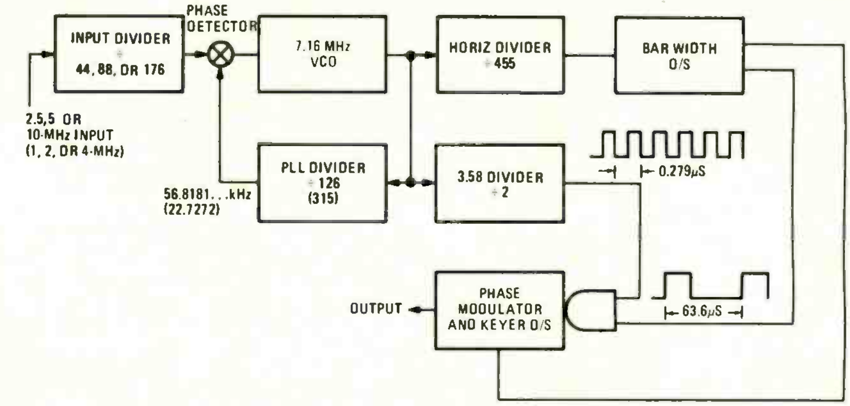


FIG. 6—COLOR-BAR frequency comparator system.

The *System 358 Frequency Measurement Computer* can also be used to compare two oscillators to each other. This is often valuable, especially in the absence of network programs. The unit is available in wired or kit form from Astro Engineering. Complete circiut details are available from the NBS.

Another unit is the *Model 1011 Frequency Comparator* manufactured by Arbiter Systems. It contains its own television front-end, IF and chroma demodulator circuits. Offsets from the NBS bulletin are entered on thumbwheel switches and measured results are displayed on digital readouts. The unit sells for about $3000.00.

FIG. 7—DYNATRON MODEL 175 frequency comparator displays color-bar on the screen of an ordinary receiver.

Color-bar comparator

The most economical, though slightly less precise, method involves the use of a color-bar frequency comparator and an ordinary color television receiver. The comparator synthesizes a 3.58 MHz signal from the signal fed into it. A horizontal pulse rate is derived from the 3.58 MHz and used to gate the 3.58 MHz to the output. This pulsed 3.58 MHz is fed into the TV set's chroma circuit and is displayed on the TV screen as a vertical color bar. A block diagram is shown in Fig. 6.

If the oscillator being calibrated is at the precise frequency of the network oscillator, the bar will be stationary and its color will not change. This, however, is not the desired situation as the network oscillators are offset from the NBS standard by approximately 300 parts in 10^{10} low (written -300×10^{-10}). To compensate for this offset, the oscillator being calibrated should be adjusted so that the rainbow appears to move from right to left through a complete color cycle in

(continued on page 108)

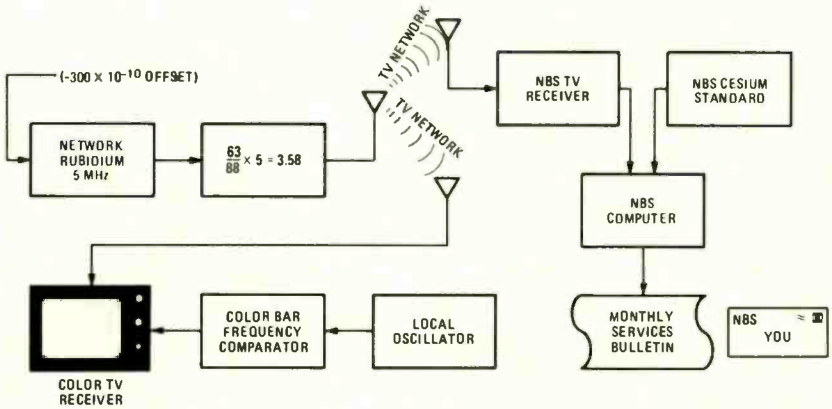


FIG. 8—CALIBRATION SYSTEM using the color-bar frequency comparator.

Step-by-step TV Troubleshooters Guide

Vertical sweep circuits are basically simple, but their problems may not be. Here's how to troubleshoot them

JACK DARR
SERVICE EDITOR

THE VERTICAL SWEEP CIRCUITS OF A tube-type color TV look very simple. Basically they are, but there can be problems. Let's see how this circuit works; it is very well adapted to step by step troubleshooting methods.

One circuit has almost become a standard in tube-type color sets. It's the multivibrator oscillator. Figure 1 shows a typical circuit. For identification purposes, let's call the left hand tube the "input" and the right one the "output". Most sets, especially later models, use a tube designed for this circuit. The input half is a voltage amplifier triode and the right half a power amplifier pentode.

If you'll look closely at Figure 1, you'll see that this is actually a two-stage R-C coupled audio amplifier. It could be the driver and power output stage of a hi-fi amplifier. We take the signal from the plate of the output tube and feed it back to the input through a dropping and shaping network of resistors and capacitors. It arrives at the input in just the right phase to make the circuit oscillate. With this kind of feedback, the circuit has to oscillate *if all the parts are good*. This is one of the key points in the troubleshooting procedure. If the circuit refuses to oscillate, you've still got a bad part in there somewhere.

The circuit is free-wheeling—it does not depend on the presence of sync pulses to work. Sync pulses are fed into the input stage, at various points. You can feed a positive-going pulse to the grid of the input tube, a negative-going pulse to the grid of the output tube, etc. The sync is often fed to the plate of the input tube through the coupling capacitor. This pulse is amplified by the output tube and fed back to the input grid.

The time-constant that determines the frequency of oscillation depends on the values of the coupling capacitor between input and output, and the grid resistor of the output stage or the grid resistor of the input stage. So, we can control the frequency by making part of this grid resistance variable.

The operation of this circuit depends on the charging of the grid capacitor. This takes place when the DC voltage is applied to the plate of the input tube. When this capacitor has charged up to the desired voltage, it is discharged by the input tube being driven into conduction. This action is triggered by the sync pulse. Note the gradually rising waveform on the input grid. If the HOLD control is rotated so that the picture rolls slowly downward, you'll see the vertical sync on this waveform. It will be a tiny pip on the curved part. You will be able to see the picture lock-in momentarily when the sync-pip gets to the top of the waveform. This fires the input tube, discharges the capacitor and develop a sawtooth voltage on the output tube grid.

The output stage amplifies and shapes this pulse, and feeds a more or less rectangular pulse to the output transformer. This pulse is fed to the vertical windings of the deflection yoke via the output transformer. The inductance of the yoke converts the rectangular pulse into a sawtooth wave of *current*. The sawtooth wave is required to obtain a linear vertical sweep.

There are three controls—the vertical HOLD control varies the grid resistance of the input stage, the vertical SIZE or HEIGHT control varies the plate voltage of the input stage, and the vertical LINEARITY control varies the grid voltage of the output stage. These are adjusted to make the raster full and linear. There are some pitfalls here; we'll go over them in a minute.

In the "old original" circuit as used in black-and-white TV, the cathode of the output tube was bypassed with an electrolytic capacitor. The cathode resistor was a low-resistance variable, the ends were connected to cathode and ground so that the resistance remained the same. The bypass capacitor was connected to the slider—this changed the amount of the cathode resistor that was bypassed. The *gain* of the output stage was varied by changing the amount of cathode degeneration. With the capacitor at the cathode end, the stage has maximum gain; at the ground end, minimum gain. This was used as the vertical LINEARITY control. Remember this "effect." We're going to see it used in a slightly different way but with the same basic principle.

Troubles

There are several kinds of different problems that show up in this circuit. One, of course, is a loss of vertical sweep. The symptom is a bright horizontal line on the screen. The appearance of this line will give you a clue to location of the trouble. If it's very thin, only one or two scanning lines high, the cause is usually something in the output stage—an open winding in the vertical deflection yoke or vertical output transformer, dead output tube, loss of supply voltage to the output stage, or a bad connection between the vertical output transformer secondary and the yoke.

If the horizontal line is thicker, say about an inch high or so, the cause of the trouble is more apt to be something in the input stage. What little deflection you see is due to some stray 60-Hz pickup on the open grid of the output section. Loss of the DC supply voltage to input stage, open coupling capacitor between input and output, open plate load resistor of the input stage, open vertical SIZE control, bad tube and similar things. If the feedback loop is completely open, the symptom will be much the same.

Another problem that can develop is sweep distortion. If the raster is short, or the linearity is bad, you'll see that the scanning lines are either too far apart or crowded together. This shows up at the top of the picture in most cases. The top of the picture may even be folded over so that you can see some of it upside down and backwards. Problems like this are mostly caused by something in the output stage. Incorrect bias, open cathode bypass capacitor or leakage in the coupling capacitor between input and output. This allows too much positive voltage to get through to the output grid and causes foldover and non-linearity.

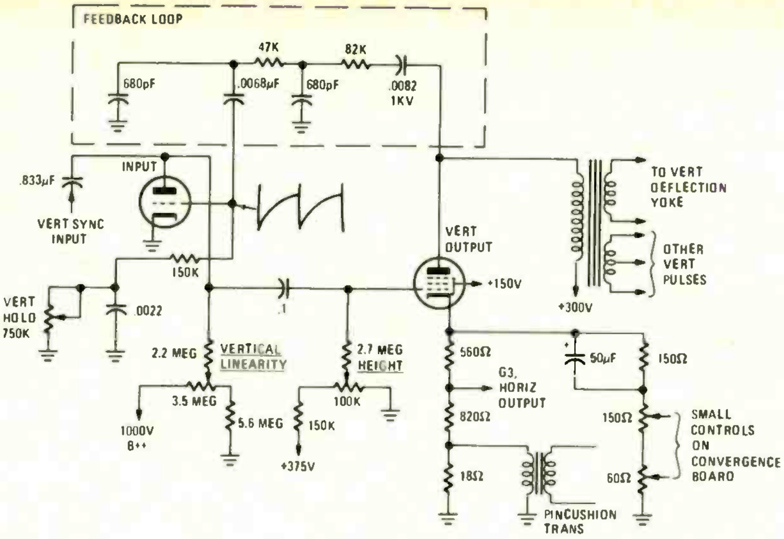


FIG. 1.—TYPICAL CIRCUIT of vertical output and oscillator stage. Tube will probably be special triode-pentode.

Misadjustment of the vertical SIZE and LINEARITY controls can *cause* nonlinearity, short sweep and even foldover if they're far enough off. The correct method of adjustment is to turn both SIZE and LINEARITY controls until you shrink the raster by about an inch both top and bottom. Adjust both of these controls until the raster is linear. (You'll find that they can affect the vertical hold and the picture will roll. This is normal. Stop the picture by setting the vertical hold control and continue the adjustment.)

A crosshatch generator is very handy for easy checking of linearity. You can also do it by looking at the scanning lines; get them evenly spaced all the way up. To finish up, move both controls until the raster covers the screen, and is overscanned top and bottom by not more than half an inch. This is important; if the raster is stretched too far at the top, this will affect the grid waveform shape and it will actually show up as a case of vertical sync trouble! The waveform distortion makes it hard for the sync to trigger the oscillator at the proper time.

One or two more things. If the raster isn't centered in the first step, adjust the vertical centering control until it is. Also, note that in Fig. 1 the control in the plate of the input half is marked LINEARITY and the control in the output half grid is HEIGHT (or SIZE, interchangeable). In quite a few sets, you'll find the same controls with the *names reversed*! Actually, this doesn't make much difference. They do the same things and both must be adjusted to set the raster up properly. Finally, the vertical adjustments *must* be made *before* any dynamic convergence is attempted. Reason: these adjustments change the shape of the vertical pulses used in the convergence circuitry. Adjust these after convergence and you'll have to do the convergence over!

Stretching or compression of the scanning lines near the center of the screen (not at the top) is generally due to a few shorted turns in the primary or secondary of the vertical output transformer. Shorted turns in one half of the vertical windings of the deflection yoke will make the raster "keystone." The small end of the keystone will point to the shorted half of the yoke.

Vertical sync problems

If you have a linear raster that fills the entire screen and the vertical HOLD control will make it roll up or down, holding the raster somewhere near the center of rotation of the HOLD control, this is *not* due to a problem in the vertical oscillator or output stages! You have lost too much amplitude in the vertical sync. To check this move the HOLD control until the picture is rolling slowly down. Watch the blanking bar between the pictures. When this reaches a point about two inches or more from the bottom of the screen, it should suddenly snap in and hold temporarily. Check this action on a working TV set; it's a key clue to the presence or absence of vertical sync.

There is a peculiarity in the action of the vertical HOLD control. Its normal action is like this; turning it one way (usually clockwise) should make the picture roll slowly downward with the "snap" at the bottom. Turning it the opposite way should leave the picture stationary for quite a while, then it will break out of sync very suddenly and move upward rapidly. For identification, we say that a picture moving down is "rolling" and moving up is "flipping." This type of action is due to the shape of the grid waveform on the input stage and the timing of the sync pulse.

A good check is turning the HOLD control to the flipping side and checking the reaction. If you find that you can move the picture slowly *upward*, you have no vertical sync at all! Don't waste time checking the vertical oscillator or vertical output stages, go to the sync-separator stage. Vertical sync works on amplitude, horizontal sync on phase. So if there is a problem in the sync separator, the vertical sync is always the first one that shows up.

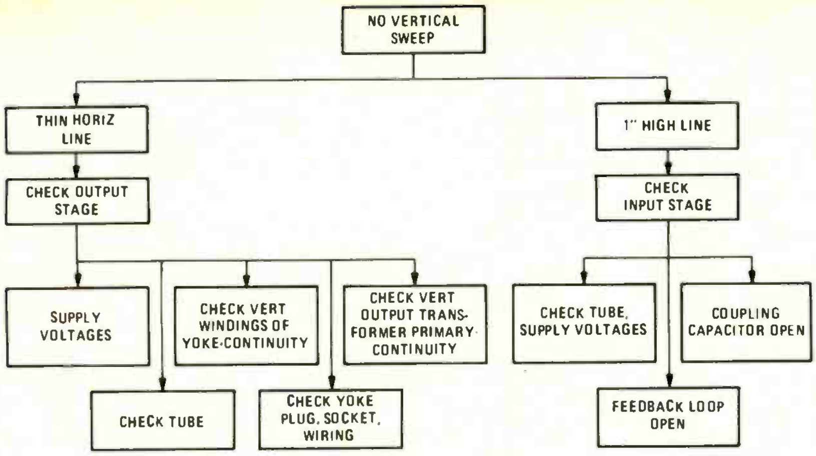
There is another somewhat similar problem but with a different cause. This is the one where the vertical HOLD control will stop the picture but it's all the way to one end or the other of its rotation. You may not be able to make it flip or roll though it will hold fairly well. Normally you should be able to stop the picture with the hold control somewhere near the center of its rotation. This is generally due to a drift in the value of the fixed resistor in series with the vertical HOLD control, the 150K in Fig. 1.

You can check to see which way it went. If your vertical HOLD control is set at maximum resistance, this resistor is now too small. Change it to 180K and see if this will let your HOLD control center again. If the hold control is at minimum resistance, the fixed resistor is too large—try using a smaller one, say 120K. This will not have too much affect on the circuit operation but will give you better centering of the HOLD control. In very rare cases, this can be caused by a minute leakage in the capacitors in the grid circuit. If the resistor won't stop it, check them by replacement.

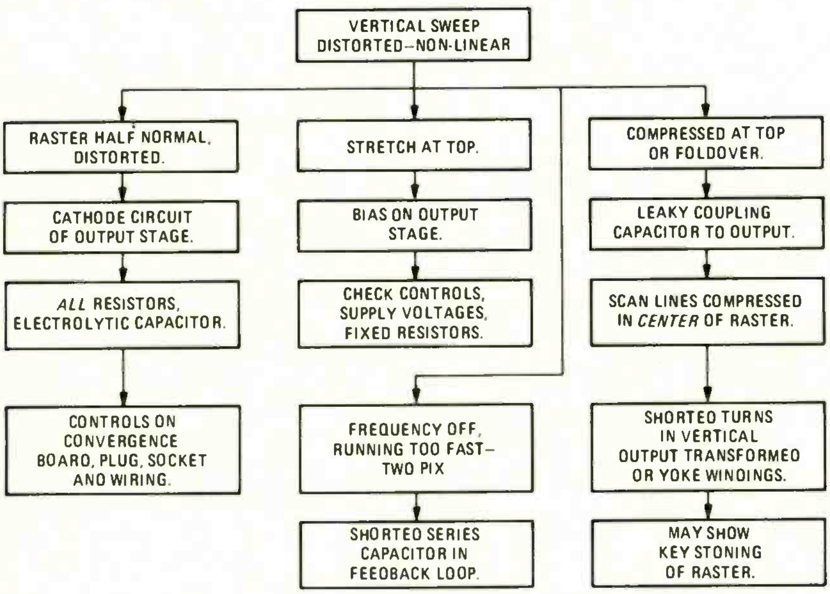
As we said in the beginning, this circuit can be broken down into two major sections—the two-stage audio amplifier and the feedback loop. In most cases, trouble in the amplifier stages will upset the height, linearity etc. while troubles in the feedback loop will upset the frequency but leave the raster comparatively linear.

One good test for this is to open the feedback loop. Disconnect the .0068-μF capacitor from the input grid. Now feed a test signal into the grid of the output stage. This can be any low voltage at 60 Hz; the heater voltage of the tube itself if this isn't a series-string type set. If you see that this does cause some vertical deflection, usually about half of a full raster, with a decided "barrel shape" (due to the sine-wave signal instead of the sawtooth), the output stage is working. Now go to the grid of the input stage and feed in the same signal. Due to the greater gain, you should obtain much more deflection. If you do, the amplifier stages are working and you have pinned the cause of the trouble down to something in the feedback loop. Check all resistors and capacitors in there.

When you boil it down, this is a very



TROUBLESHOOTING CHART—No vertical sweep.



TROUBLESHOOTING CHART—Distorted vertical sweep.

simple circuit. It uses only a few resistors and capacitors! However, they are all critical. Any drift in the resistors or leakage in the capacitors is going to upset circuit operation. Check capacitors for leakage by disconnecting them. Now hook your VTVM or FETVM, set to DC volts, to one end and touch the other end of the capacitor to a high DC voltage. You will see a kick reading. Due to the very high impedance of the voltmeter, this may stay up for some time. You can discharge the capacitor by touching the probe and chassis with a fingertip. The reading should fall to zero. If it climbs back up again, even to only one volt DC, this indicates too much leakage! Try this on a known good capacitor and you'll see how it works. When replacing capacitors, always use the best you can get, with at least a 600 working-voltage rating. Also, never substitute a different size capacitor! Use exactly the same value used in the original.

The "do not measure" point

Note that the plate of the output tube is always marked "Do Not Measure" on schematics. This is due to the presence of a very high transient voltage during normal operation. This is big enough to break down scope probes and unprotected DC voltmeters, it averages around 1400 volts peak. To read the plate voltage of this tube, take your reading at the bottom of the primary winding on the B+. Then, turn the set off and read the resistance of the primary winding. If both of these are normal, you do have plate voltage on the tube and you can go on to other tests. If you're careful, you can check for the spike voltage by holding the scope probe close to, but *not* touching, the plate connection or transformer lead. You will get enough capacitive pickup to see it.

Another way is to check the waveform on the vertical output transformer *secondary*, on the hot lead to the vertical windings of the yoke. This will be a spike waveform, but only about 25 to 30 volts P-P.

Additions to basic circuit

The circuit shown in Fig. 1 is a representative sample of what you'll see in practically all tube and hybrid color TV sets. There will be quite a few variations, but the basic reactions will still be there. You'll find different part values, tubes, voltages, and so on. In some sets you'll even find added parts. Some of these will be little R-C networks to ground, these are called "sawformers" and aid in shaping the waveforms properly. Check these if you have distortion problems.

Unusual troubles

The vertical output stage in color TV sets isn't as simple as the one mentioned earlier. This is especially true of the vertical output *cathode* circuit. In the black-and-white TV, this consisted of one variable resistor and a big capacitor. The one used in color sets is quite a bag of worms! This can cause problems in troubleshooting simply because we don't think of the cathode circuit as a possible cause! Trace out this circuit in Fig. 1. Leaving the cathode, we go through a small resistor then through a couple more to ground. This is one branch. On the cathode, an R-C circuit is connected to the convergence circuitry through two controls. You may find additional components in more complex circuits.

The purpose of all this is to provide vertical frequency pulses for use in the convergence circuits, or for vertical blanking, etc. The tap between the 560 ohm and 820 ohm resistors, though, is used to provide a small DC voltage. This is applied to the suppressor grid of the *horizontal* output tube to suppress snivets. However, a shorted horizontal output tube can damage the lower two resistors, and thus make trouble in the *vertical* circuits! The last tap is used to feed a pulse to the pincussion transformer. Here again, trouble in the pincushion transformer can upset the vertical circuits.

The problem here is that when the other circuits are defective, they upset the *bias* on the vertical output stage. So, check out *all* of the different branches and make sure that they're not affecting the vertical output. One way to check is to measure the cathode voltage. This should be somewhere around 35-40 volts. Another way is to check the cathode waveform. This should be something of a parabola with fairly sharp spikes, about 35-40 volts P-P.

One common cause of "freak" symptoms is that little electrolytic capacitor in the cathode circuit. This will run from 50 to 100 μF at about

(continued on page 110)

build a digital countdown timer

PART II

A versatile countdown timer with keyboard programming that can control various external devices. The time interval can be programmed in increments of one second from one second to approx. 11,000 years

GEORGE R. BAUMGRAS

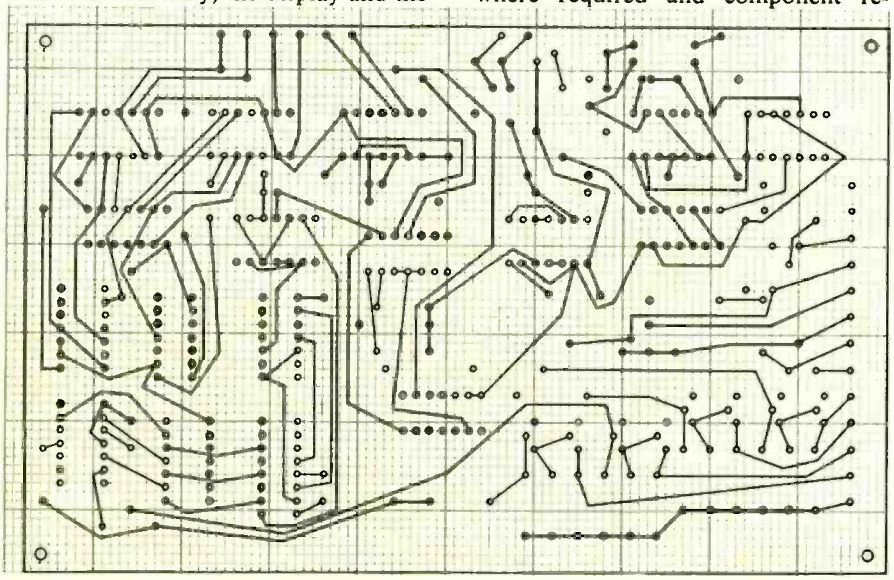
THE FIRST PART OF THIS ARTICLE (AUgust, 1976) presented the schematic diagram and a description of the digital countdown timer.

This second and concluding part of the article presents the board layouts and the construction details.

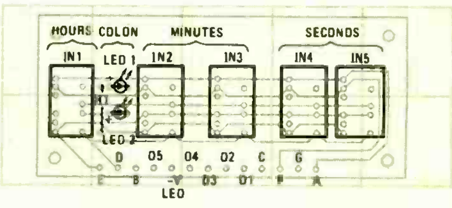
Construction

All of the circuitry, the display and the keyboard were mounted on 6 printed-circuit boards and assembled in a custom-made cabinet measuring 5″ high × 8½″ wide × 6″ deep, affording plenty of room for wiring, switches, the relay and the transformer. Wire-wrap sockets were used for the displays and the TTL IC's so that connections could be soldered on both sides of the board where required and component replacement would be easy. All connections between boards were made with No. 22 stranded and color-coded wire, and No. 12 was used between the relay and the AC outlet. The line cord connects directly to the relay common-terminals and should be rated at 10 amps minimum.

The only components that require selective purchase are the discrete transistors, other than Q3. Both the silicon NPN and PNP types are rated at 40V (B_{VCE}), 600 mA (I_C), should have a current gain (β) of at least 80 and a



CONTROL BOARD, view of bottom side of double-sided board. Grid is 10 lines per inch.



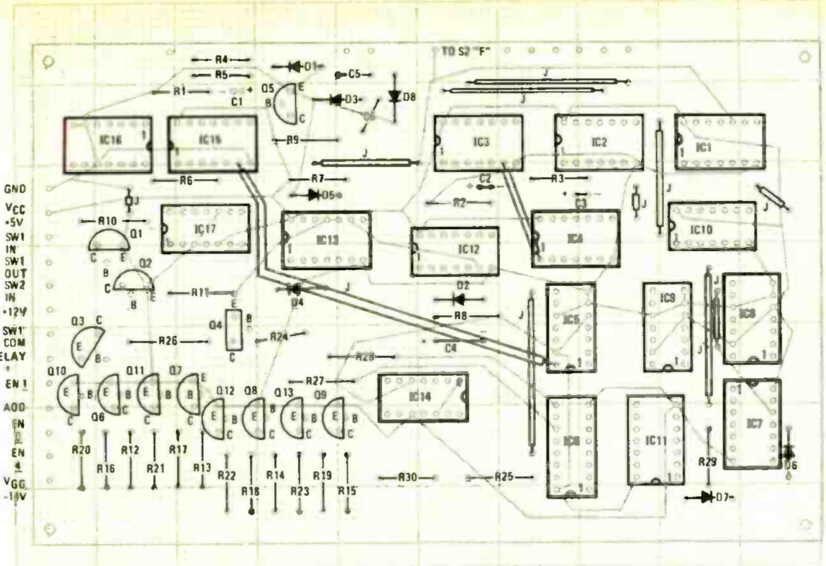
NOTES:
1. ALL PARTS LOCATED ON COMPONENT SIDE
2. WIRE WRAP SOCKETS EXTENDING .2″ ABOVE BOARD REQUIRED TO PERMIT SOLDERING
3. CUT OFF SOCKET PINS 4, 9, 12 AND 14.

DISPLAY BOARD, view of component side of board with components shown. Layout may be used to generate PC board or perforated board. Grid is 10 lines to the inch. Actual board size is 4″ × 17.″ (10.2 cm × 4.3 cm).

CONTROL BOARD (top left), view of component side of double-sided board with component placement. Layout may be used to make printed-circuit board of perforated board. Actual board size is 4" × 6.4" (10.2 cm × 16.3 cm). Grid is 10 lines-per-inch.

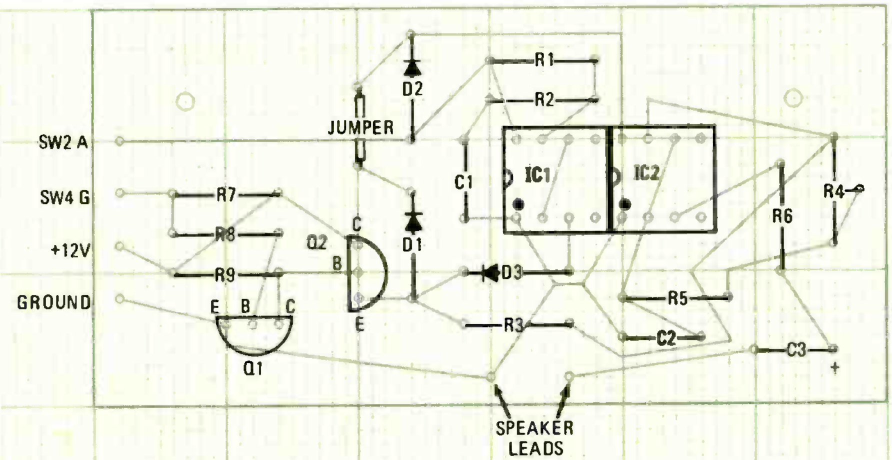
ALARM BOARD (middle left), view of component side of board with components shown. Layout may be used to generate PC board or perforated board. Grid is 10 lines to the inch. Actual board size is 3" × 1.5" (7.6 cm × 3.8 cm).

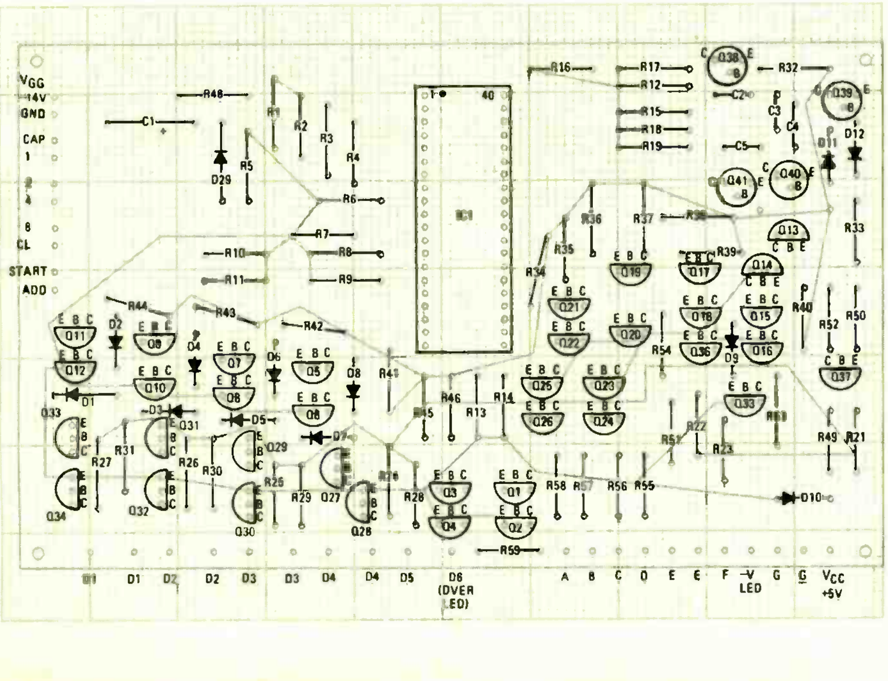
CALCULATOR BOARD (bottom left), view of component side of double-sided board with component placement. Grid is 10 lines per inch. Layout may be used to generate printed-circuit board or perforated board. Actual board size is 4" × 6.4" (10.2 cm × 16.3 cm).

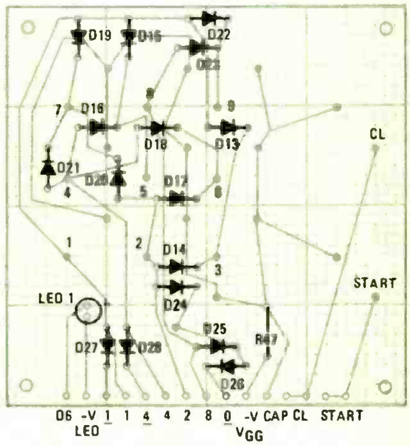


NOTE:
1. ALL PARTS THIS SIDE
2. WIRE-WRAP SOCKETS EXTENDING .2" ABOVE BOARD REQUIRED TO PERMIT SOLDERING BOTH SIDES.
3. INSTALL JUMPERS AS SHOWN-INSULATE AS REQUIRED. PIN-TO-PIN JUMPERS SHOULD BE ON OTHER SIDE.

This mode of construction lets you lay out and make your own circuit boards. *Note:* Our artist goofed on some boards and drew some IC pins too far apart. Just make sure that the IC terminal pins fall exactly on consecutive one-tenth inch line intersections and all else will work out OK.





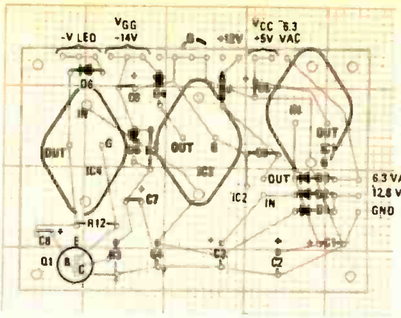


NOTE:
1. HOLES MARKED ● CONNECT TO AND LOCATE BODY OF OAK #415 SWITCHES.
2. UNDERLINED NUMBERS CONNECT TO CONTROL CIRCUIT BOARD. "OVER" LED CONNECTIONS ARE TO BE LOCATED PER SWITCH BODY PATTERN, REPLACING DECIMAL POINT KEY NORMALLY USED.
3. RESISTOR AND DIODES LOCATED ON BOTTOM SIDE—SWITCH BODIES ARE MOUNTED ON COMPONENT SIDE OF BOARD.

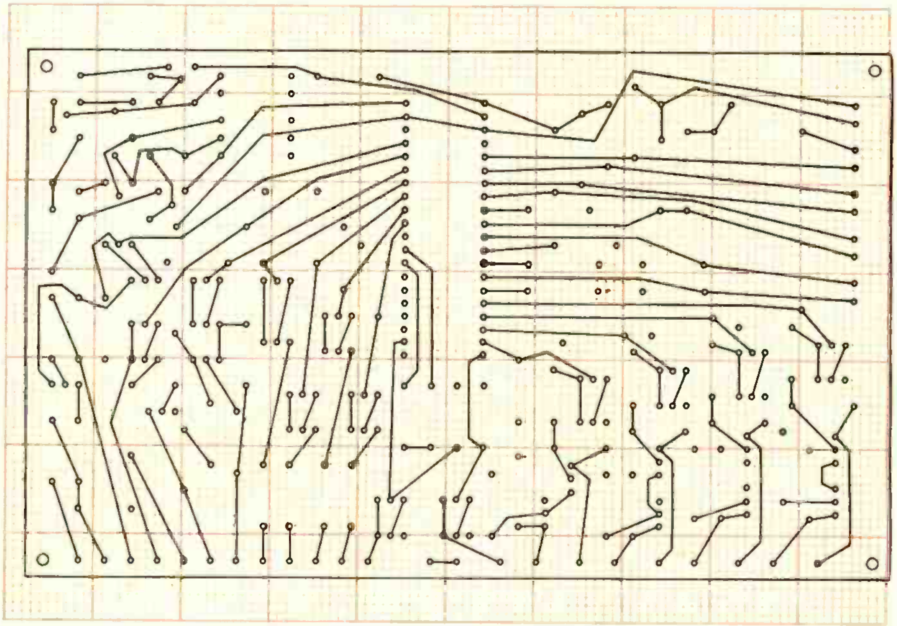
KEYBOARD, view of component side of board with components shown. Layout may be used to generate PC board or perforated board. Grid is 10 lines to the inch. Actual board size is 4" × 4" (10.2 cm × 10.2 cm).

TO-92 case. Those used in the prototype appear to be house numbered, the NPN type being marked M311 and similar to a 2N3904 or 2N2222. The PNP's were marked M236 and similar to MPS6563 or HEP716. Suitable equivalents should be available from surplus outlets for around 20¢ each. These two transistor-types are used throughout the design and each was tested before use. Two of the NPN units that appeared to be matched were selected during testing and used as Q39 and Q40 in the calculator clock circuit shown in Fig. 2. All of the IC's, diodes and resistors were also checked and although not a single bad part was found, the effort was considered worthwhile since a malfunction would be difficult to track down once the total package is put together.

Where a more complex timing function is demanded, several additional modes are possible. For example, the terminals of switch S2, instead of operating an alarm, can be rewired to provide +12 volts at 30 mA to two receptacles on the rear panel; thus initiating either of two external functions. A third receptacle interfaced with the START input will permit remote, sequential, or automatically controlled triggering of the countdown process. A similar input to the CLEAR function can be used for remote or emergency turnoff, and the normally-closed contacts of the relay could also be brought out to the rear panel. In a darkroom application, the normally-closed relay contacts can be used to control the safelight while the enlarger is controlled by the normally-open relay contacts. Thus the safelights will be switched off when the enlarger is on, and vice versa. Probably many other adaptations of the basic scheme will become obvious. **R-E**



POWER SUPPLY BOARD, view of top of single-sided board. Actual board size is 4.25" × 3" (10.8 cm × 7.6 cm.) Grid is 10 lines to the inch. Layout can be used to generate PC board.



CALCULATOR BOARD, view of bottom side of double-sided board. Grid is 10 lines per inch.

BRIGHTNESS CONTROL HAS NO EFFECT

Turning the brightness control on this Philco 22QT79 has no effect. I'd welcome any help.—S.E., Norfolk, VA.

Look in the cathode circuit of the 12GN7 video-output tube. (A little crowded in there, isn't it? There are *three* different controls all in the circuit!) First is the PICTURE-PEAKING, next the CONTRAST, and finally the BRIGHTNESS. The BRIGHTNESS control finally returns to the +20 volt source. See diagram.

The brightness control has one end tied to the slider. Moving this varies the voltage on the 12GN7 cathode, and so changes the bias that in turn changes the brightness. I'd say that it was quite possible that the slider contact on the control was either open or shorted to one end of the control.

Alternate possibility is that the +20-volt supply is not correct. Be sure that it's present on the low end of this control and then check to make sure that the control does vary the voltage.

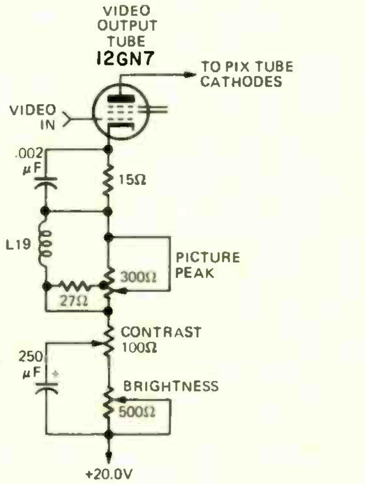


FIG. 1—HICKOK model 350.

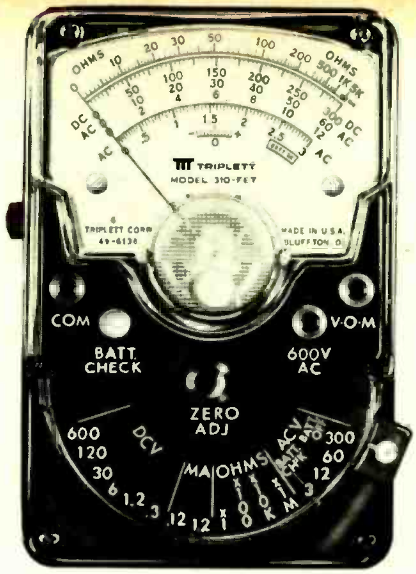


FIG. 2—TRIPLETT model 310-FET.

FIG. 3—B&K model 177 VTVM.

Industrial

A roundup of FETVOM's, amplified VOM's and FETMM's that are

JACK DARR
SERVICE EDITOR

IN THE NOVEMBER 1975 ISSUE OF **R-E** we covered quite a few of the tests you'll need to make in industrial electronics and electrical work, and the instruments used in doing the testing. Because of space limitations, we were able to cover only the VOM's. Now, as advertised, let's take a look at the "Amplified VOM's"—FETVOM's and FETMM's.

These cover the same basic ranges and functions as the VOM's, and are used for the same kind of testing. Almost all use FET transistor amplifiers; this gives the instruments a very high sensitivity. Typical input impedance runs 10-15 megohms, so they can be used in high-impedance circuits with practically no loading effect. Several of them use IC's, op-amps, etc. which gives them versatility. They can make some measurements that the VOM won't.

The circuits are very low-drain. The instruments are mainly powered by built-in batteries; dry cells or rechargeable NiCad types. Many have built-in recharging circuits. This gives them portability; while they're in use on the bench, the batteries are kept up so that they can be taken to field jobs. The current drain is so small that one maker says his instrument can be left on at all times, and still get the normal shelf-life from the batteries!

The types designed for industrial work are ruggedized. Cases are made of high-impact plastic, controls are recessed, and test leads are very well insulated. They come in all sizes, like the VOM's. Some can be slipped into your shirt pocket; others are the "standard" size, and some have large meters for bench work with better readability. Accuracy of these types is very good.

Electrically, all of these are well-protected against accidental overload. Fuses and "instantaneous" circuit-breakers prevent damage to the instrument; all have the protective meter-diodes to save the movement.

Digital readouts are beginning to show up here, too. The "DMM's" have the same basic ranges and functions, and the same protection against overload. Their accuracy is very good, giving good results in solid-state circuits where we need readings of very low voltages. They are also handy for working in dark places, with the lighted readout!

You'll see all of these as we go along. Once again, we'll start with the "little fellers," in physical size though not in performance:

The Hickok *model 350* is a handy midget. It has a tough plastic case with

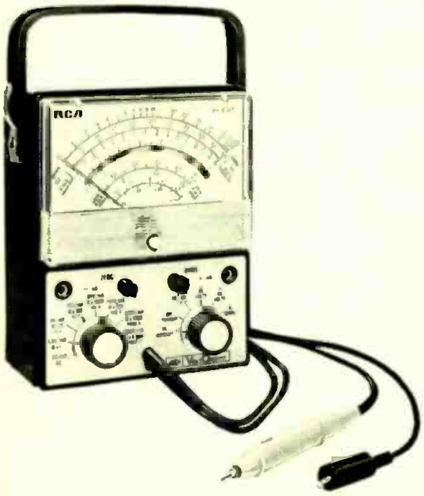


FIG. 7—RCA WV-500B Voltohmyst. The RCA line of test instruments has been sold to VIZ and are now being manufactured under the VIZ name.

FIG. 4—B&K model 277.

FIG. 5—B&K model 290.

FIG. 6—HICKOK model 370.

Voltmeters

used in industrial electronics and electrical servicing

a protective cover. A full set of AC, DC voltage and resistance ranges are provided, Polarity indication is automatic. The ohms ranges have high-low voltage, for in-circuit transistor tests. It uses an op-amp, with FET input. The meter sees only the op-amp output, for protection. See Fig. 1.

The other "teeny-weeny" may look familiar. It ought to. The Triplett *model 310* has been around for a long time. This is a new one. Even though it looks as if there's no room, they have added a FET amplifier circuit inside the case! So, this one now becomes a *"310-FET."* Same ranges as the original, with a battery-check light. A handy polarity-reversal switch is on the left side of the case, right where you normally hold it. A flip of the thumb changes the polarity, for fast transistor-testing, etc. See Fig. 2.

In the medium-size and bench models, here's the B&K *model 177* VTVM: See Fig. 3. An AC-powered unit with a large meter, for bench testing and regular maintenance work. Its counterpart in a solid-state version is the *model 277* seen in Fig. 4. Ranges are provided for all standard tests, including AC current. A ruggedized case makes it useful for field work. The *model 290* is a larger-scale model with a meter suitable for bench tests. Both of these have mirror-scale meters for greater accuracy. See Fig. 5.

Hickok's larger unit is the *model 370* in Fig. 6. This is a FET Multimeter, with auto-polarity indication on the panel. All controls are push-button, for range and function selection. This one will read AC and DC voltages AC and DC current, and has the high-low ohms feature. It will also read capacitance from .005 up to 10,000 μF at 60 Hz. A set of decibel calibrations are included; handy for audio work since it will read AC voltage accurately up to 20 kHz.

VIZ has two entries in this field. Both of them are VoltOhmysts. The *model WV-500B* is a standard size case, a FETVOM with the regular ranges. For solid-state work, the lowest DC voltage range is only 0.5 volt full-scale. Top is 1,500 volts. The AC voltage ranges can read RMS or P-P voltages. See Fig. 7.

Another "familiar face" is the *model WV-510A*, a Master VoltOhmyst in a solid-state version. It has the large mirror-scale meter and can be used for bench work or field testing. The same basic ranges as in previous VoltOmyst models are used. See Fig. 8.

Sencore's entry here is a proven model. The *FE-23* "Little Henry" Multimeter is built into a ruggedized plastic case with a carrying handle. All controls are pushbutton, well-

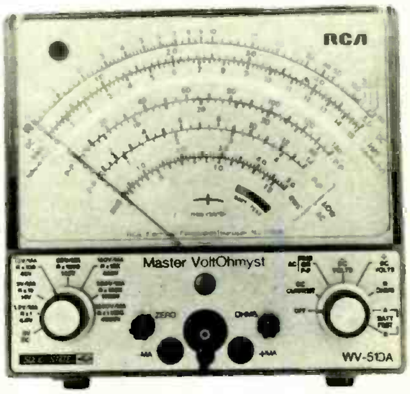


FIG. 8—RCA model WV-510A. The RCA line of test instruments has been sold to VIZ and are now being manufactured under the VIZ name.

FIG. 9—SENCORE FE-23, *Little Henry*.

spaced for easy use. Li'l Henry has wide range, making it useful for all kinds of industrial-electronics work. The DC voltage ranges go up to 6,000 volts. The AC voltage ranges go to 1,000 volts. There are several "handies" in this instrument. The test leads and jacks are inside a compartment just below the switches. This is not only a handy storage space, but it is used for other things; when you close the lid, a switch automatically turns the power off! For icing on the cake, a special battery is used to provide light for the meter scale. This can be turned on or off by a switch inside the test-lead compartment. A BATTERY-TEST switch is also in there. See Fig. 9.

"Big Henry" has a very similar set of ranges to little brother, and all the same features. This is the *model FE27* of Fig. 10. He has a lower range, only 0.3 volt full-scale for both AC and DC, for solid-state work. On the AC voltage ranges, a special circuit is used to enable reading the "square-wave" AC voltages of TV voltage-regulating power transformers. It gives you the true RMS voltage of such waveforms.

Triplett has a FETVOM, their *model 603*, called the "Micro-Power VOM." This instrument has a resting current drain of only 10 microamperes; they claim that it will give almost shelf life even if left on all the time. The 603 has AC and DC voltage ranges of 0.3 volt to 1,000 volts, and low-power ohms ranges for transistor work. It will read AC or DC currents from 1.0 mA up to 1,000 mA full-scale. All controls are pushbutton except the range switch; you can get automatic polarity by pushing both + and − buttons at the same time. The meter reads up-scale on either polarity of DC. The + and − buttons can also be used to reverse the polarity of the ohmmeter for quick transistor checks in-circuit. See Fig. 11.

The digital meters

The FET voltmeters, like many other things, are going digital. A couple of representative instruments are shown; one is the B&K *282 DMM* in Fig. 12. A 3½-digit display gives bright readings. Ranges and functions are standard. High input impedance is standard. Very high accuracy is possible, to 0.5% on the DC voltage ranges. A smaller version (not shown) is the *model 280*, which has practically the same features, but in the "standard size VOM" case.

Sencore's new *DVM-32* is a ruggedized instrument; very compact, in a tough plastic case. A 3½-digit LED display reads AC and DC voltages up to 1,000. Accuracy of 0.5% on DC gives reliable readings of low DC voltages. High and low ohms scales, and both AC and DC current ranges from 2.0 mA up to 2.0 A make it handy to

FIG. 12—B&K model 282 DMM.

use for any kind of work. The *DVM-32* is powered by self-contained batteries, or by rechargeable batteries with an AC charger. A novel feature for battery operation is the "Auto" Display. With the switch in this position, the instrument is "on and ready" but the display is not lit up. When you get any reading above an indicated "10" on the

FIG. 13—SENCORE model DVM-32.

scale, the display lights up. This saves 85 percent of the battery drain. The *DVM-32* is protected against overload by fuses and diode clamps. This is only the first of a series: Sencore promises several new developments in digitals in the not-too-distant future.

FIG. 10—SENCORE FE-27, *Big Henry*.

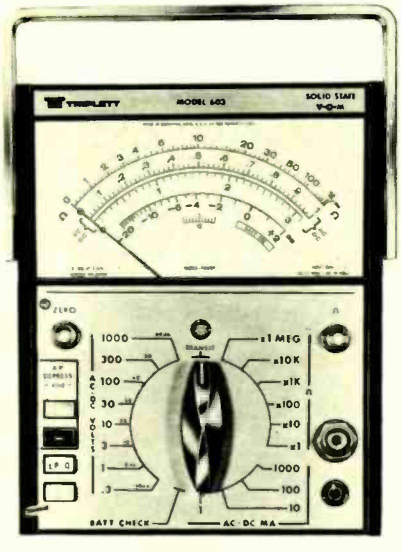


FIG. 11—TRIPLETT model 603.

"I think I can clear up your TV from out here. Do you have a pair of scissors?"

R-E's Service Clinic

The challenge

Troubleshooting with no service data

JACK DARR
SERVICE EDITOR

I FIRMLY BELIEVE THAT MOST OF YOU ARE in this bewildering business for the same reason that I am. You like it! You like to fix things. It's always a challenge to our skill to take something that's dead and make it work again. (You're nuts; you know that, don't you?) We solve puzzles that would drive an ordinary human up the wall, every day. This has to be the reason; we're certainly not in it to get rich!

So, here's a real challenge. Find out just what kind of a hot-shot technician you are. Try this. It must be classified as recreation—play—you are definitely not going to make any money out of it. It will be darn good practice, though. It's fun, and that's the reason I did it. I'll guarantee you that it will sharpen up your diagnostic skills, which is always helpful.

Here's the idea. Find a small transistor radio, of an unknown make. This is the easy part. Get one with a board big enough to see—clock radio, table model, etc. All that is necessary is that it be dead and that you have absolutely *no service data* on it. Sit down, cold-turkey, and *fix it*. To get the most benefit out of this, get a clip-board with plenty of blank paper. Make detailed notes of every test, the reasons for making it, and the results. Take your time and don't leave anything out. That is what I did. I wound up with four and a half pages of notes. Note the start and stop time on each session. I did this. Wound up with four and a half hours of elapsed time. Figure this at your regular rates and you'll see why it isn't a money-maker! After you fix it, you can go back over the notes and recheck your methods. This is valuable data; read it.

OK, here we go. There are test methods we can use for this kind of problem. Open it up and look for the parts that are unmistakable—speaker, volume control, power supply and so on. These are our starting points. Look for any broken wires, burnt resistors or obviously damaged parts. (If you find that the trouble was just a broken wire, that doesn't count! Solder it back and get another set. That's not enough of a workout!)

Troubleshooting

The first step, of course, is to check the DC power supply. You'll usually find a little power transformer; follow the leads to the rectifier(s) and then find the filter capacitors. You can find the DC output voltage by checking the voltage rating of the filter capacitor. Most of these will be something like 6, 9 or 12 volts DC. Verify this by turning it on and reading the AC voltage across the rectifiers.

Now check the DC voltage output. If this is well *below* the AC voltage, the chances are that you have either a short or a heavy leakage. If you find a burnt resistor, lift one end to open the circuit and recheck the DC power supply. You can open the circuit and put a DC milliammeter in series. (Start on a high scale, 1,000 mA at least! Mine was drawing about 250 mA, which is far too much for this type of set. Typical current drain will be about 15 mA with no volume, and about 35–40 mA full volume.)

High current and no sound except for a little hum (which is what I had) usually means trouble in the output stage. You can locate this by following the voice coil leads back from the speaker. If they go to a big electrolytic, you have an OTL output stage. If they go to a transformer, it is a transformer coupled stage. You can check from the transformer and find the output transistors. Check these with an ohmmeter. This will find any with a dead short.

If the problem is high leakage, you'll have to take them out for a definite test. A curve-tracer or one of the new transistor testers that identifies the base pin on any unknown transistor is a big help! Find the base, and then you can find the emitter by checking to see which pin has a small resistor to ground. (In push-pull Class-A transformer stages.)

With the output transistors removed, check the power supply. If the voltage jumps back up and the current drops, scope the base terminal and see if there is audio there. If so, the problem is in the output stage.

One thing you must find is the common or return of the DC power supply. In mine, it was the center-tap lead from the power transformer secondary that was switched. A full-wave rectifier circuit was used. This lead went to a glob of solder on the frame of the output transformer. Here's a pitfall that I fell into. In older sets, the cans of the

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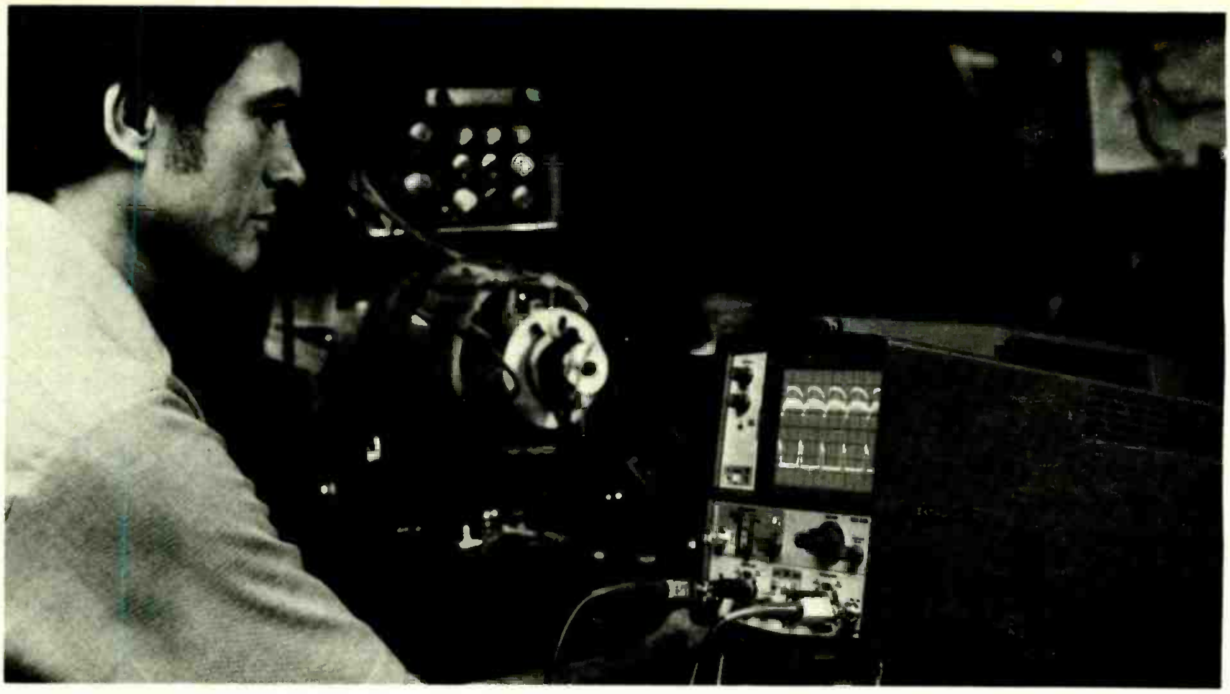

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Circle 101 on reader service card

(continued from page 88)

electrolytic capacitors were all common. They're NOT in these little monsters! Also, on the front of the chassis was a metal bracket that wasn't common either, but floating! I finally found a pad of solder along one edge of the board where I could hook the return lead of my voltmeter. In this case, the output transistors were 2SB77's, which are PNP. So, my DC power supply was negative. If the switch lead is like this one, this is a handy place to connect the milliammeter.

From initial tests, I decided that one of the output transistors was bad. So, I pulled it. I looked up a replacement, and tacked it in. Now, I could receive a local station, with very bad distortion. Current drain was still 200 mA. The new transistor got hot enough to burn your finger! I turned it off again to check the transformers, etc. These seemed to be fine. However, I noticed that although the bases of the output transistors were fed from the ends of a center-tapped secondary, they showed different voltages! One was almost double the other. So, what did I do? I checked the preamplifier stage, the driver, and so on. (This is one of the mistakes that you see when you re-read your notes!)

Other things testing good, I went back to that output stage. There was a strange extra transistor close to the outputs. This turned out, after much tracing, to be a DC voltage regulator! It was bad. There was a diode in the base circuit (transistor with collector lead cut off) that was also bad. Replaced these. Still no help. (This took a lot longer to do than it does to write!)

That base voltage unbalance still puzzled me. So, I pulled both transistors and rechecked them (The other original had not been pulled, remember?) My new one was good, but the *other* one was bad. Terrific leakage. So; back to the transistor guide and hunt up a substitute. Get a pair out of stock (and check them both on the curve-tracer. I was learning. Slowly, but learning.) They match. So, tack them in and turn the set on (which isn't easy to do with your fingers crossed.) Oh, wow. Current drops to about 25 mA. Volume good, tone clear, everything working. NOW the base voltages of the output transistors are the same.

So, there it was. I believe that in most of these sets, the trouble will turn out to be in the DC power supply or output stage or both. If you do have the audio output working and the trouble seems to be in the RF or IF stages, you can pin it down by loosely coupling a signal into the mixer, which will be close to the tuning capacitor.

(turn page)

You can identify the intermediate frequency used by tuning the signal generator back and forth. Most of these have sealed IF transformers, which is good! Also, the alignment adjustments on the tuning capacitor are so small that most people don't even know they're there.

You'll note that there are no illustrations in this article! You're supposed to have the circuits in your head! However, if you want to be sneaky (which I was!), you can take a peek at a few typical transistor circuits in Sams TSM manuals, and get a good refresher course in what you're apt to find.

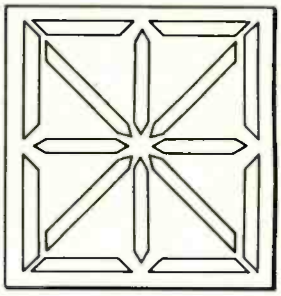
As I said in the beginning, you didn't make any money. It was very good practice though, wasn't it? Builds up your self-confidence. It takes two things to solve a problem like this. One is a very good knowledge of electronic circuits and tests, and the other is good clear rational THINKING. **R-E**

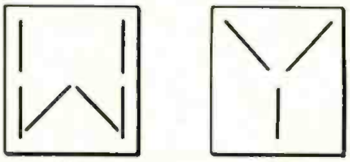
reader questions

ALPHANUMERIC DISPLAY UNIT

I'm looking for a device that displays letters instead of numbers. I've searched in vain. What would this look like and who makes them?—L.E., Suffield, CT.

It would look something like the diagram. This one is a liquid-crystal device





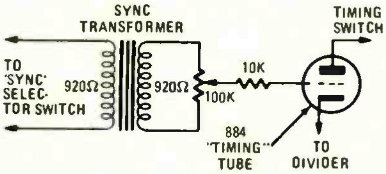
"W" "Y"

made by Hamlin Electronics, Lake & Grove Streets, Lake Mills, WI 53551. Litronix, 19000 Homestead Road, Vallco Park, Cupertino, CA 95014, makes a similar device with "dot" LED's.

SYNC TRANSFORMER

I can't find a replacement for the synchronizing transformer on an RCA 155B oscilloscope. Can I modify the circuit to work without it?—K.H., Pacific, MO.

I don't think you'll have to. This seems to be just a plain audio transformer with a 1:1 ratio. It would be an



interstage type. Try a Triad T-33X using only one half of each winding. This ought to be very close to the original. If you can locate any other type with about the same resistance, it ought to do.

WHAT'S THE 'K' FOR?

Would you please explain the following resistor nomenclature? The nomenclature in question is: 2K2, 2K7, 6K8, etc. I'm really at a loss and so are all of the people I've asked so far!—C.S., Springfield, VA.

This I can do. I ran across this in *Wireless World* (published in London) some time ago. The British use this and I think several other European countries do as well. It's a very good system, and I like it!

The K stands for kilohms and is used in place of the decimal point. So, a 2.2K resistor would be written as 2K2, 4.7K as 4K7, etc. Even values, such as 25K, are written as 25K. For larger resistors, a 3M9 is a 3.9 megohm resistor. This does away with the possibility of confusion due to a missing decimal point, or a lightly printed one.

SOUND, NO VIDEO

I have sound but no video in this RCA CTC-30. This began as an intermittent, and finally the picture went out and stayed out. Tubes are all good, voltages OK. Can you suggest something?—L.H., Milford, MI.

Yep. If you have sound but no video, the signal must be getting as far as the video detector. Woops; plate of 3rd IF tube is sound takeoff in this one! So, this leaves us with a couple of things.

One is the video detector diode, which is unlikely—seldom intermittent. The other is some problem in the 1st/2nd video amplifier tube, the 6LF8. Now *this* can be intermittent. For one thing, check to be sure that this tube is *lit!* (Feedback: Reader says "That was it. Bad connection to heater of 6LF8! How did you do it?" (Easy; I've been finding the same thing in my own set off and on for quite a while! Hi!)

NO CONTROL OF BRIGHTNESS

I can't control the brightness on this Zenith 12A12C52. All of my DC voltage supplies are OK. The voltages on the 3rd video amplifier transistor are all low. On the 2nd video amplifier transistor, I get +2.6 volts on the emitter, +3.1 volts on the base, and +2.6 volts on the collector. The set was hit by lightning.—R.K., Davenport, IA.

Look again at those DC voltages on the 2nd video transistor! Note that the emitter and collector are exactly *the same.* Normal voltages are +13.6 volts on collector and +5.14 volts on emitter. This is pointing to the very good chance of a collector-to-emitter short. The collector voltage of the 2nd stage is directly coupled to the base of the 3rd video stage. So, this would upset that stage as well. Check this transistor with the ohmmeter. When lightning has been around, you're apt to find such things anywhere in the set.

POWER SUPPLY TOO LOW

I've got an old 6–12-volt bench power-supply. Works very well on most things. I have problems on cassette recorders, etc., in getting the thing to eject. Apparently I don't have enough current to make it work right. Do you have any ideas as to how I could raise the current rating?—A.R., Unity, SK.

There are a couple of things you might try. One is a bit wild and I have not tried it, but it might do. Add a *big* filter capacitor right across the DC output; you can get monstrous big ones from some of the ads in the back pages of **R-E**. All you really need is a short *pulse* of high current to make the eject solenoid work, and the charge in the capacitor could provide that. Big capacitor acts as a reservoir. *(turn page)*

Second thing would be to check your rectifiers. If these are selenium, they may have dropped off in output. You can also get high-current low-voltage rectifiers from those same ads. They're making silicon types now with plenty of current rating. All you'd need would be something like a 50-volt rating for this.

FUNNY SHAPED RASTER

The raster on this 20Y1C48 Zenith has an odd shape. With a crosshatch pattern, the vertical lines on each side pull in at the bottom. I've checked a lot of things with no luck.—G.S., Warren, MI.

There is one "funny" that can cause a "fake keystone" raster in some Zeniths. This is the 30-μF electrolytic capacitor on the screen of the vertical output transformer (the red wire). This is a "waveshaping" capacitor that actually works in the pincushion corrector circuitry. It is not the screen bypass that is directly on the screen terminal with a resistor between it and this one. Try a new capacitor here and see.

CB PROBLEM

I liked your article on CB testing. Now I have a problem! This CB transmitter will tune up fine on a dummy load with an in-line wattmeter. Modulation causes reading to go up, as you said. But! When I hook up the vehicle antenna and modulate it, the reading goes down. Using a field-strength meter at the same time, its reading goes down too. There is an antenna-matcher unit in the line. I don't get it.—C.E., Great Neck, NY.

When you can tune up a transmitter on a properly matched dummy load and get normal output and modulation, that transmitter is working. The only thing you're changing when you go to the vehicle is the *antenna!* I've tuned up many a two-way radio on a dummy load, then moved it into the vehicle and never had to move a tuning adjustment. So; go thou and see what is the matter with the *vehicle antenna!* For a crystal ball hint, the transmission line may not be grounded at the antenna base, or something. That was one of my favorite goofs!

FIX FOR HOT TRANSISTORS

Your "Quick and Dirty" fix for overheating transformer, output transistors and so on, works! You said to add a small resistor in series with the collector supply of each transistor to act as a current limiter. I did. Worked like a charm! Currents much lower, output still OK, and customer happy. Thanks!—C.K., Ft. Gibson, MS.

Glad to hear it! I was a little ashamed to use this, but not long ago I saw a modification hint from one of the better-known hi-fi amplifier makers, and that's what *they* were doing. So, I feel better.

WHAT SIZE RESISTOR?

I have an old DuMont amplifier. The tubes used are 6C4, 12AX7 and two 50C5S. The cathode resistor from pin 8 of the 12AX7 is burnt up and I can't find a schematic. Can you help?—W.W., Calumet City, IL.

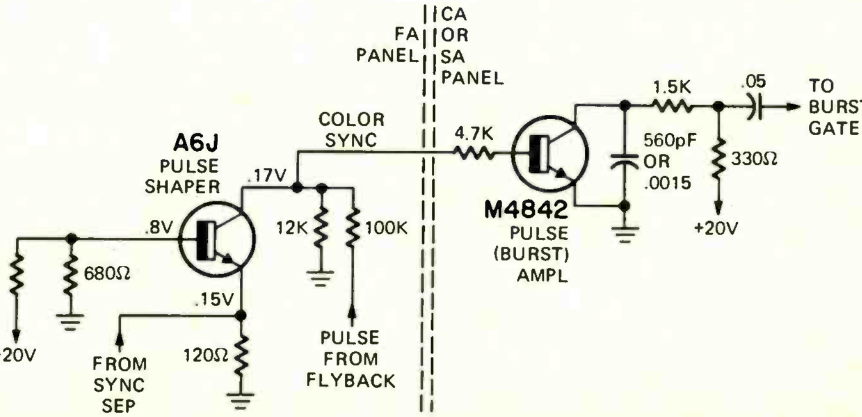
Can't identify this chassis, but I can give you a crystal-ball guess on the resistor. The 12AX7 will be one of two things, or both. Probably used as audio driver and a phase-inverter to drive the 50C5's. If it's the audio driver [check for coupling capacitor from pin-6 (plate) to pin-2 (grid)], the cathode resistor will be about 330-ohms bypassed by something like a 0.1 μF capacitor.

If the triode (pins 6, 7 and 8 of the 12AX7) is the phase inverter, it'll probably be a "split-load" type. In this circuit, the resistors in the plate and cathode will be the same size (about 270K), and there will be a coupling capacitor from both the plate (pin 6) and cathode (pin 8) to the grids of the 50C5's.

NO COLOR

The black-and-white picture is good in this Motorola TS-929 chassis, but I have no color at all. If I put a small positive bias on the base of the ACC amplifier, I can get rainbows. I've changed the pulse amplifier, burst gate and burst amplifier transistors, and the crystal. No luck.

The burst amplifier doesn't seem to be working. I get a 1.0 V P-P pulse on the



base and only 4 V P-P on the collector. This should be 30 volts P-P. Any ideas as to where to look now?—W.K., E. Sparta, OH.

I believe I'd go "downhill", on the schematic, that is. Your burst-amplifier stage seems to have normal voltage gain. Note that you read 1 volt in and 4 volts out. The schematic shows 8 volts in and 30 volts out, (P-P) which is a gain of *four*. Your input pulse is only 25% of normal.

This comes from the pulse shaping stage (which the Motorola diagram calls Pulse Former). In the Sams schematic, 1207-2, this is Q1 on the FA panel. There is nothing between this stage's collector and the burst amplifier's base except a 4700-ohm resistor.

It is often possible for a transistor to open a junction, yet you will see a certain amount of signal getting through. This is due to the *very* close spacing of the elements. Combined vertical and horizontal sync pulses are fed to the emitter of this stage. Check it for amplification.

THE FLUTTERING PICTURE

The picture on this Sylvania B10 fluttered. I never saw so many things at once. It was: 1. shrinking about an inch top and bottom; 2. pulling in at both sides, about the same amount; 3. bending slightly on the edges; 4. brightness went up and down; 5. rolling about every 3-4 seconds. All of this happened at the same time, at a rate of about 1 or 2 per second.

This was due to an open output filter capacitor, C500B, 100 μF. The ripple on this line read about 125 volts P-P.

Thanks to: Leon Caldwell, Caldwell's TV, Mena, AR.

REPEAT PROBLEMS

I wrote you about a jail-bar symptom in a Sears 562-10421 quite a while ago. You recommended checking the 50-μF AGC bypass capacitor. I'd replaced this last November! When I went back to this set, I rechecked that. Sure enough; the one I had put in was defective! This is the third time in as many months that we've had problems with defective or mis-marked new parts!—E.B., Largo, FL.

I know what you mean. I've been there!

RECTIFIER CAP ARCING

I've got a problem with arcing from the high-voltage rectifier plate cap in a Nivico 7208. I can't find a replacement for the flyback in any of the Guides.—M.B., LaCrosse, WI.

I can't find a substitute for the flyback either! However, you might try using one of the very well insulated plate cap units. For instance, Oneida Electronics A-177, which has a long skirt and high-voltage wire.

new products

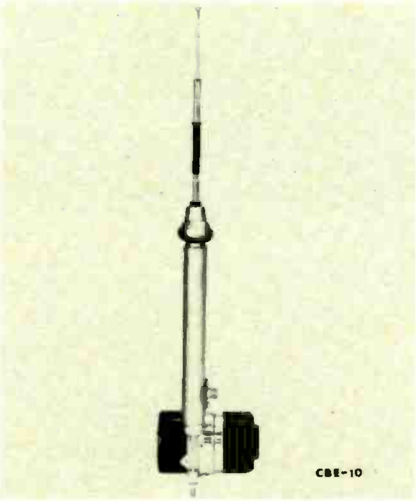
More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card inside the back cover.

TWO-SPEED TURNTABLE, *model SR-222,* is a belt-drive turntable with one-touch control. The motor is a four-pole synchronous type with wow-and-flutter kept down to 0.07%. Signal-to-

noise ratio is 54 dB and rumble is 60 dB. The tonearm is an S-shaped, static-balance type, and the balance weight is continuously adjustable. The turntable is equipped with an anti-skating adjustment and is protected by a hinged dustcover. Suggested retail price is $115.00.—**Sansui Electronics Corporation,** 55-11 Queens Boulevard, Woodside, NY 11377.

Circle 106 on reader service card

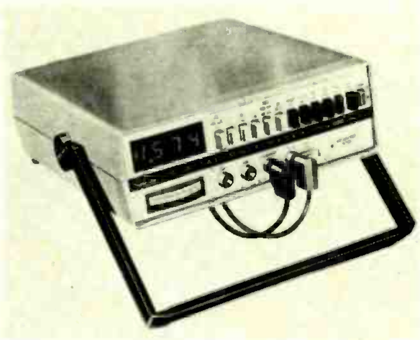
POWERED CB ANTENNA, *model CBE-10,* is motor driven and can be mounted in the rear deck or fender of any automobile. The unit is made of chrome-plated tubular brass. It weighs seven pounds. With a flick of a switch, the disappearing electric antenna extends to its full



length for its top performance and turns on the CB transceiver automatically. Another flick of the same switch and the antenna with its skinny center-loading coil disappears turning the radio off.—**Tenna Corporation,** 16201 Parkway, Cleveland, OH 44128.

Circle 107 on reader service card

PORTABLE DIGITAL MULTIMETER, *model 460-3,* features pushbutton selection of 32 overload-protected ranges and functions. A custom-designed MOS-LSI chip provides 0.1% accuracy of reading +1 digit on all DC voltage ranges, plus reliability and low power drain. Includes a calibrated analog meter for nulling, peaking and scanning trends. Digital readout is 0.43" LEDS. 32 ranges include 5 DCV ranges to 1000V, 5 ACV ranges to 600V, 5 low-power ohms ranges to 2 Meg, 5 standard ohms ranges to 20 Meg, 6 DC and 6 AC current ranges to 10 amps. The *model 460-3A* is $285, and operates on line voltages of 120/220/240 VAC (50-400 Hz). The *460-3D* has a built-in rechargeable battery circuit to permit completely portable operation



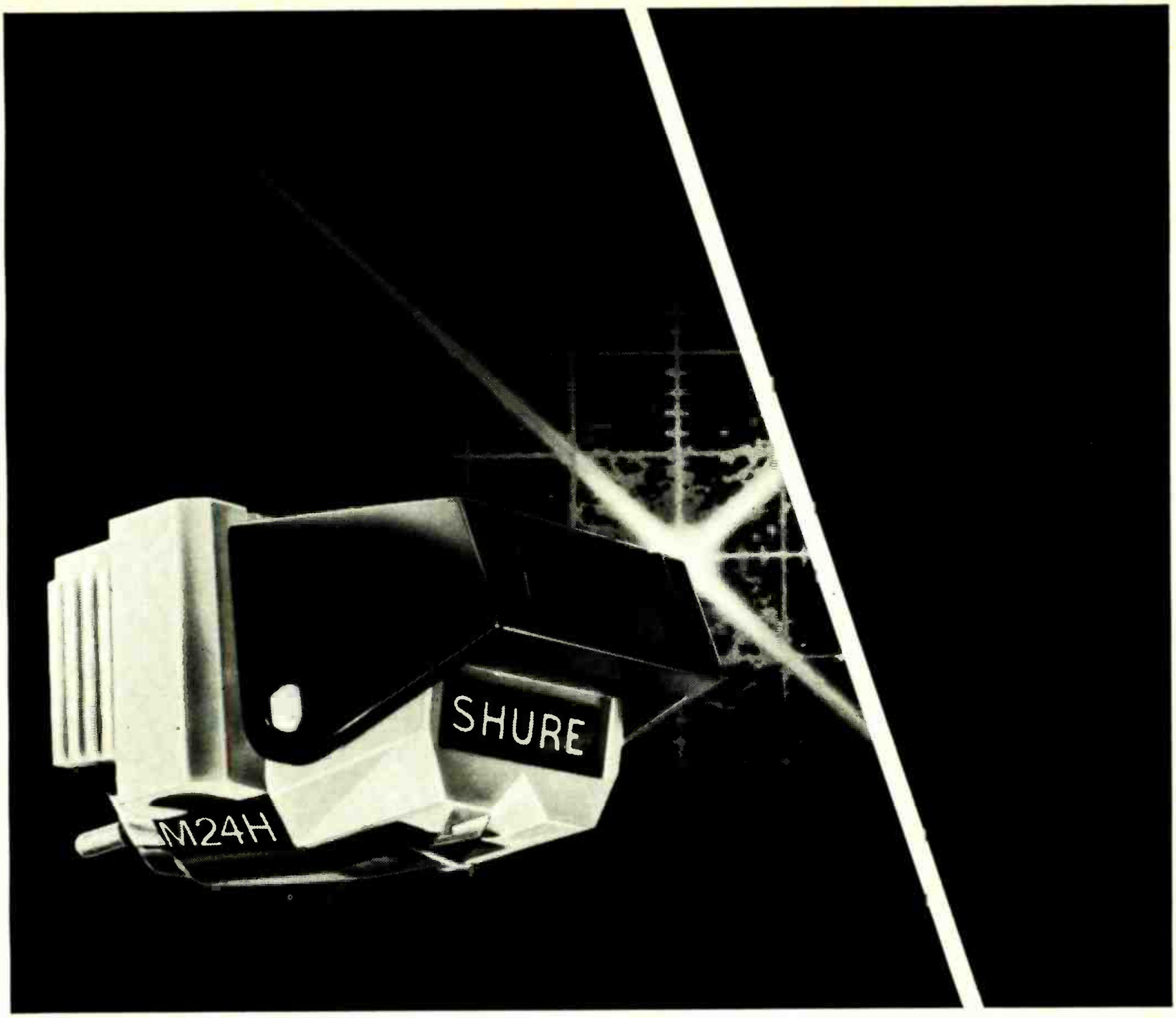
in addition to AC line operation. Its price is $322, batteries not included.—**Simpson Electric Company,** 853 Dundee Avenue, Elgin, IL 60120.

Circle 108 on reader service card

CB REPAIR KITS. *Kit K-936* consists of 37 semiconductors and 16 different types. *Kit K-*

937 consists of 36 semiconductors and 16

(continued on page 98)



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NEW PRODUCTS

(continued from page 96)

different types. Both kits come in a 24-drawer storage cabinet with pull-out drawers. Among the popular CB brands that can be repaired with the G-E Kits are: Air Castle, Allied, Browning, Channel Master, Claricon, Cobra, Courier, Electronic, Fannon, Fieldmaster, Hy-Gain, J.C. Penney, Johnson, Kris, Lafayette, Mark, Midland, PCE, Palomar, Pierce-Simpson, Ray Jefferson, Raytheon, Realistic, Regency, Robyn, SBE, Sharp, Siltronix, Teaberry, Tram and Trutone.—**General Electric,** Suite 301, 2100 Gardiner Lane, Louisville, KY 40205.

Circle 109 on reader service card

MOBILE AM/CB TRANSCEIVER, *model XL-25,* has bright LED readout, talkback intercom circuitry, 0.5 microvolt receiver sensitivity, adjacent-channel rejection better than 60 dB, 95% modulation capability, and 4 watts RF output. Other features include four-position noise-limiter switch, public address, internal/external

speaker switching, delta tuning, RF gain control, squelch control and illuminated S/RF meter. Comes complete with connectors and mounting bracket, plug-in microphone and installation instructions. $219.95.—**Kris, Inc.,** Pioneer Road, Cedarburg, WI 53012.

Circle 110 on reader service card

CB CARRYING CASES, *Models CB-1 and CB-2,* are rugged, lightweight, molded cases for CB equipment and accessories. Protects CB equipment when it's taken in and out of a vehicle. Made of high-density polyethylene with a double wall. Interior is shock absorbent polyfoam. Two

sizes are available, each with a 5-year guarantee. The 12 × $8\frac{1}{2}$ × $4\frac{1}{4}$" case is $14.95. The $13\frac{1}{2}$ × 10 × 4" case is $19.95.—**Platt Luggage, Inc.,** 2301 South Prairie Avenue, Chicago, IL 60616.

Circle 111 on reader service card

CB TRANSCEIVER/ANTENNA, *model CB-800* transceiver and *CA-11* mobile antenna. The transceiver includes LED digital channel-indicator and a pulsing red light for emergency Channel-9. Also features phase-locked-loop circuitry. The *CA-11* is a trunk-lip mount type antenna with a three-step telescopic rod that opens to a minimum of 26 inches, to a maximum

of 60 inches. The combination *CB-PAK-2* is $169.95.—**Sharp Electronics Corp.,** 10 Keystone Place, Paramus, NJ 07652.

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MULTIPROCESSING SYSTEM, developed for IMSAI 8080 computer, can handle a variety of complex applications, such as high-speed telemetry-data acquisition and reformating, and time sharing with simultaneous batch-processing. Using this technique, as many as six processors can be connected to a single shared memory block (or several noncontiguous memory blocks). Each processor can operate either independently or on a shared basis with one or more I/O peripheral devices. The processors access the shared memory on a priority basis. When two or more processors access the shared memory simultaneously, they are automatically sequenced according to a preprogrammed priority status. The hardware

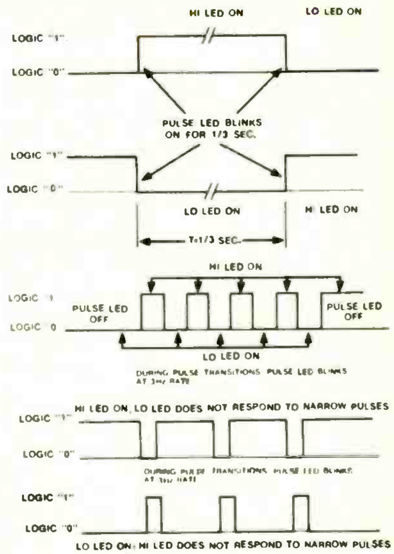
(continued on page 100)

Logic Probe 1 is a compact, enormously versatile design, test and trouble-shooting tool for all types of digital applications. By simply connecting the clip leads to the circuit's power supply, setting a switch to the proper logic family and touching the probe tip to the node under test, you get an instant picture of circuit conditions.

LP-1's unique circuitry—which combines the functions of level detector, pulse detector, pulse stretcher and memory—makes one-shot, low-rep-rate, narrow pulses—nearly impossible to see, even with a fast scope—easily detectable and visible. HI LED indicates logic "1", LO LED, logic "0", and all pulse transitions—positive *and* negative as narrow as 50 nanoseconds—are stretched to ⅓ second and displayed on the PULSE LED. By setting the PULSE/MEMORY switch to MEMORY, single-shot events as well as low- rep-rate events can be stored indefinitely.

While high-frequency (5-10MHz) signals cause the "pulse" LED to blink at a 3Hz rate, there is an additional indication with unsymmetrical pulses: with duty cycles of less than 30%, the LO LED will light, while duty cycles over 70% will light the HI LED.

In all modes, high input impedance (100K) virtually eliminates loading problems, and impedance is constant for all states. LP-1 also features over-voltage and reverse-polarity protection. Housed in a rugged, high-impact plastic case with strain-relieved power cables, it's built to provide reliable day-in, day-out service for years to come.



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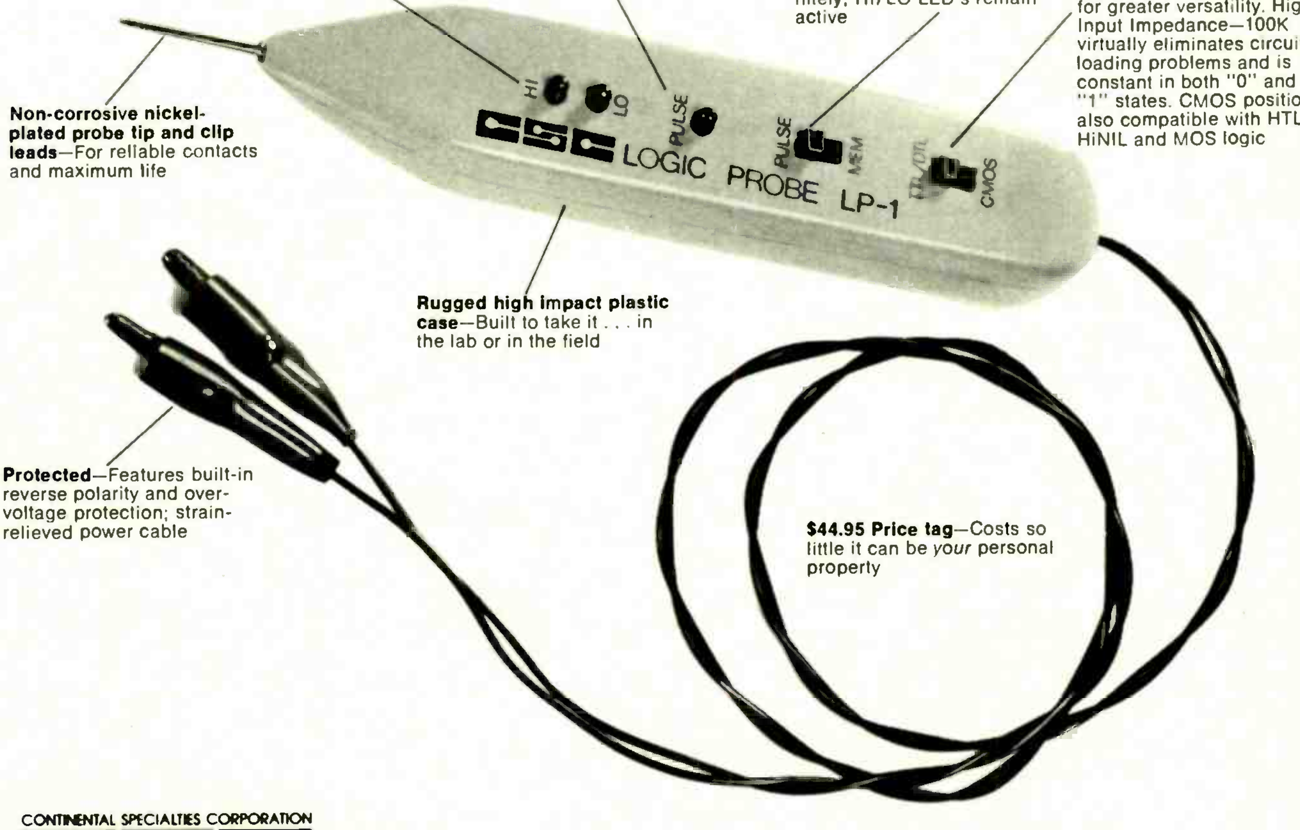

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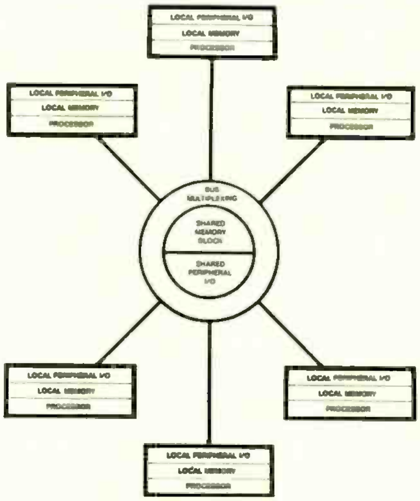
Circle 83 on reader service card

NEW PRODUCTS

(continued from page 98)

required for the multiprocessor logic consists of a bus multiplexing board ($399 assembled, $325



IMSAI 8080 MULTIPROCESSING COMPUTER SYSTEM

unassembled), a timing and control board ($305 assembled, $225 unassembled), and, for each processor, a bus extension board ($65).—**IMS Associates, Inc.**, 14860 Wicks Boulevard, San Leandro, CA 94577.

Circle 113 on reader service card

NEW SOLDER, *Savbit*, developed to prevent fine-gauge copper wires and thin copper foils forming the conductive patterns of flexible circuits and printed-circuit boards from dissolving during the soldering operation. This dissolving action, a result of the well known tin-copper

migration phenomena, has frequently caused a wire or thin foil to weaken during soldering, and subsequently break during field use. It is also ideal for applications where copper soldering tips are used because it prevents rapid pitting and wear. Approximately $3.00 per pound, depending on gauge quantity and world metals prices.—**Multicore Solders,** Westbury, NY 11590.

Circle 114 on reader service card

MOBILE CB-TRANSCEIVER, *model CB 2600*, incorporates a sensitive and responsive automatic noise-limiter circuit with time constants so rapid that there is no perceptible time-delay before the circuit counteracts or suppresses noise. Equipped with Delta tuning, backlighted

(continued on page 102)

NEW PRODUCTS

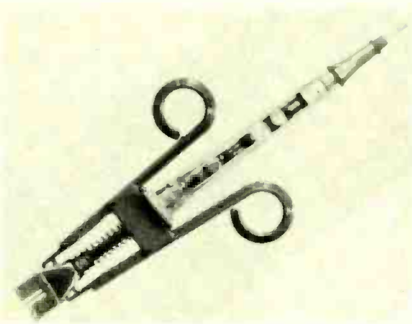
(continued from page 100)

channel selector, on-air indicator lamp, dual-purpose RF output-power and signal-strength meter, and external speaker jack. Can be used

in any mobile installation with positive or negative ground electrical systems. Price: $159.00.—**Surveyor Manufacturing Corp.,** 7 Electronics Court, Madison Heights, MI 48071.

Circle 115 on reader service card

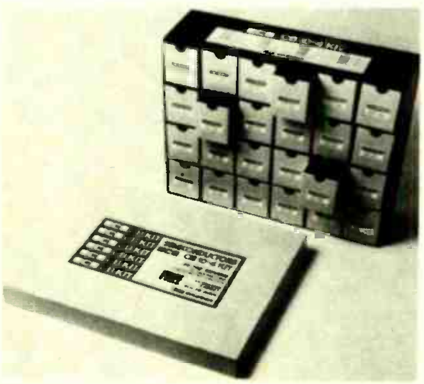
DIP EXTRACTOR, *model DE180-1,* offers a simplified way to remove 14- and 16-pin DIP IC's from printed-circuit boards. It features a precision width, high-mass heating head for maximum pin-contact and heat transfer. All pins are heated uniformly so the IC can be quickly removed when the solder becomes molten. The key to removing the IC is an integral gripping device shaped much like a surgical forceps. The forceps device is spring loaded vertically and



free to rotate 360 degrees about the axis of the heating head.—**Edsyn, Inc.,** 15954 Arminta, Van Nuys, CA 91406.

Circle 116 on reader service card

CB REPLACEMENT-SEMICONDUCTOR KIT, *model ECG CB10-4,* provides replacements for those solid-state devices most frequently subject to failure in Citizen band (CB) transceivers.



Kit *ECG CB10-4* includes 23 transistors and 3 IC's for replacing drivers, modulators, RF output and other semiconductors. Included with the kit is a *CB Replacement Guide* (Bulletin *ECG 212F-2*). It cross-references more than 3,600 industry part numbers for 44 brands of CB radios in a 20-page booklet.—**GTE Sylvania, Inc.,** One Stamford Forum, Stamford, CT 06904. **R-E**

Circle 117 on reader service card

CIE has a terrific idea for a few people who know what they want.

If you want success in electronics . . . if you want the skills people are glad to pay for . . . find out about CIE training. It's a terrific idea that can get you on your way to success in electronics troubleshooting.

Let's face it, learning valuable new skills isn't something you just breeze through. Especially in a modern technological field like electronics troubleshooting. You've got to really *want* success if you're going to build your skills properly.

But, oh boy, the rewards when you do! In today's world, the ones who really *know* electronics troubleshooting find that people . . . even industries . . . look for their help.

What about you? How much do you want the thrill of success . . . of being in demand? Enough to roll up your sleeves and work for it?

Why it pays to build troubleshooting skills.

Suppose the automated production controls on an assembly line break down. Imagine how much money the manufacturer can lose when help doesn't come *fast!* And it takes a skilled electronics troubleshooter to move in . . . locate the problem . . . solve it . . . and get the lines moving again.

Or take a TV station. Breakdowns are costly in broadcasting where time is money. Viewers won't sit forever waiting for sound or the picture to come back. Before they change channels, the station needs to get back on the air again – with the help of a skilled troubleshooter.

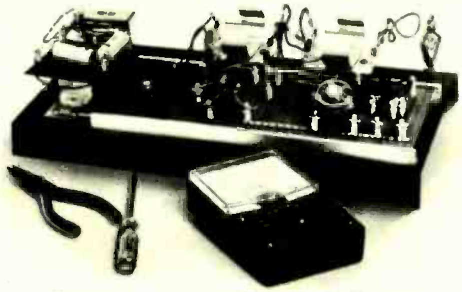
No question about it. Building new skills in electronics troubleshooting is an investment in your future. It's well worth the effort.

Why you should get CIE to help you do it.

Troubleshooting starts with *ideas* . . . principles. CIE's Auto-Programmed® Lessons help you get the idea – at your own most comfortable pace. Step by step at home, you explore each principle – each theory – until you understand it thoroughly and completely. Then you start to use it.

How CIE helps you turn ideas into reality.

If you're a beginner, you start with CIE's Experimental Electronics Laboratory. You actually perform over 200 experiments to help you grasp the basics. Plus you use a 3-in-1 Precision Multimeter to get your first taste of the testing, checking, analyzing steps you take in troubleshooting!



How 3 practical steps help you build troubleshooting skills.

You'll take your first practical step in professional troubleshooting when you build your own 5MHz triggered-sweep, solid-state oscilloscope.

As a trained troubleshooter, you'll use your oscilloscope the way a doctor uses his X-ray machine. As a student, you learn how to "read" waveform patterns on a big, 8cm. x 10cm. screen . . . how to "lock them in" for closer study . . . how to understand and interpret what they tell you.

Your second practical, skill-building step begins when you get your Zenith 19-inch diagonal, solid-state color TV – featuring nine removable modules! Now's your chance to apply the new skills you learned with your oscilloscope!

With CIE's guidance, you perform actual service operations – the kind you'd handle on the job as a trained troubleshooter! Using the TV, you learn to trace signal flow . . . detect and locate malfunctions . . . restore perfect operating standards . . . just as you would with any sophisticated electronics equipment.

Finally, step three rounds out your experience as you work with a completely solid-state color bar generator – actually a TV signal transmitter that produces ten different display patterns on your TV screen!

You study a gated color bar rainbow . . . crosshatch lines . . . dot patterns. You explore digital logic circuits . . . observe the action of a crystal-controlled oscillator!

This practical, "hands on" training takes concentration and effort. But it's enjoyable and rewarding. And it's a great way to prepare for a troubleshooting career!

Why it's important to get your FCC License.

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

Almost 4 out of 5 CIE graduates who take the exam get their Licenses. More than half of CIE's courses can prepare you for it . . . and the broadest range of career opportunities!

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CIE Cleveland Institute of Electronics, Inc.

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Check box for G. I. Bill information: ☐ Veteran ☐ Active Duty

RE-84

Mail today!

NBS FREQUENCY STANDARD
(continued from page 76)

about ten seconds. The exact time may be calculated using the following formula and the information published in the NBS services bulletin:

$$T = \frac{279.36 \times 10^{-9}}{\text{NBS Published Offset}}$$

This determination should be made for each network signal available to increase the confidence in the calibration. As an example, the information published by the NBS for the five days of December 30, 1974 through January 3, 1975 is as follows:

Network	Offset
NBC	-301.30×10^{-10}
CBS	-296.04×10^{-10}
ABC	-300.50×10^{-10}

The resulting values for the calculated period of a rainbow color cycle using the equation above are as follows:

Network	Period
NBC	9.27 seconds
CBS	9.44 seconds
ABC	9.30 seconds

A commercial version of the color bar frequency comparator from the Dynatron Company is shown in Fig. 7. It sells for about $100.00 and can be used with any color TV. The overall system using the color bar comparator is shown in Fig. 8.

This new system has the potential of exceeding the requirements of most users at a lower cost in time and money. It will be turning up where accurate frequency and time measurements are made **R-E**

FOR MORE INFORMATION CONTACT:

Arbiter Systems
1402 Norman Firestone Road
Goleta, CA 93017

Astro Engineering
2655 Pearl
Boulder, CO 80302

The Dynatron Company
P.O. Box 48822
Los Angeles, CA 90048

U.S. Department of Commerce
National Bureau of Standards
Time and Frequency Division
Boulder, CO 80302

STEP-BY-STEP
(continued from page 79)

50 volts. If this opens, it changes the cathode degeneration drastically. If it develops a high power-factor or leakage, here we go again. The best way of checking this is to lift one end of the capacitor and try a new one. Bridging another one across it may not clear up the trouble.

Follow the cathode circuit and note that it goes to ground *through* the two little controls on the convergence board. So, if one of these is open, one half of the cathode circuit is too. This will change the bias on the vertical output tube, and away we go. If you have just finished fixing a set only to find that now you have a raster only half normal height with distortion, you have probably forgotten to plug in the convergence yoke! A bad socket contact or broken wiring on the convergence yoke plug, socket or board can do the same thing. Incidentally, if you don't see the little 50-μF electrolytic capacitor on the chassis, keep looking. In quite a few sets you'll find it on the convergence board!

One other problem that is often thought to be in the vertical circuits, but is not, is a light horizontal bar about an inch high. This bar floats slowly up through the picture which is otherwise normal. The root cause of this *is* in the vertical circuit; it's the good sized pulse of current drawn by the vertical output tube once each field. This is normal. However, if the DC power supply *filter capacitors* are not good enough to take it out, the pulse will get into the video stages and cause the floating bar.

The best test for this is to scope the ripple on the DC power supply. Your pattern should stand still, and not be of a higher P-P voltage than the value shown on the schematic—about 1.5 volts maximum. If this ripple waveform shows a distinct "writhing" or movement, varying when you turn the vertical HOLD control, look out. You have a filter capacitor that isn't doing its job. In well-designed sets, one of the capacitors will be below normal in capacitance. In some of the cheaper sets, the orignal design may be marginal. In both of these cases, you will have to add more capacitance to get rid of the bar. I have had to add as much as 100 μF of extra capacitance to get rid of it. **R-E**

STATE OF SOLID STATE

(continued from page 36)

are useful—they are a viable way to get going—but you're going to find programming with them eventually a tiring and unproductive procedure.

Incidentally, a control panel switch register is not as easy to implement with micro as it is with minis. The various registers are not discrete as in the mini and can not be reached by wiring directly to them. Programs must be written and stored that fetch and display data or alter register contents.

Breadboarding and evaluation packages are available in different orders of sophistication and price. Money-making projects with a commercial product as a goal may justify spending 2 to 10 thousand dollars on an evaluation and design system. These finely polished systems include RCA's Microkit, Motorola's EXORciser, and National's PACE microcomputer.

If on the other hand you are working on a low production item or simply are in the learning or hobby phase (along with most of us), you will probably want to spend a minimum. You can use evaluation modules that the larger manufacturers use as the basis for their breadboarding systems, or you can go to one of the smaller producers and get started for around $200.

Software

Don't forget to consider software. It may be available with the breadboarding kit, from the microprocessor manufacturer or from an independent organization. Software may be free or have a moderate price tag. Software comes as a simple program listing on paper, or on magnetic or paper tape that is loaded directly with a peripheral input device.

You must have software to do an effective job. It should be considered an equal partner with hardware in a microcomputer system. Hundreds of hours of experienced effort are consumed in its development, so it is not wise to try to duplicate the effort. Later on you may be able to make additions or modifications to the software package on your own. And I certainly encourage dissecting the software and learning what makes it tick. Figure 1 (top right) shows the elements of software packages. Very few systems include all the pieces shown.

One way to write a program is directly in machine language. Keeping the instruction list nearby, take a piece of paper or a programming pad, figure out what you want to do and list the machine code line by line. This can be a listing in octal or hexidecimal, but the program will be entered into the machine, in binary. The only exception to this is when hardware or resident software does a number conversion.

At the other end of the scale are the most sophisticated operating systems. These systems, upon cue of terminal commands, automatically load processors or programs into memory from peripherals such as cassette tape. There are also stand-alone operating systems with a monitor that keeps all the programs in memory simultaneously and selectively starts the one of interest. Operating systems used in microcomputers are generally simple because of the tendency for limited memory space. They still do a powerful, nontrivial job.

(text continues on page 114)

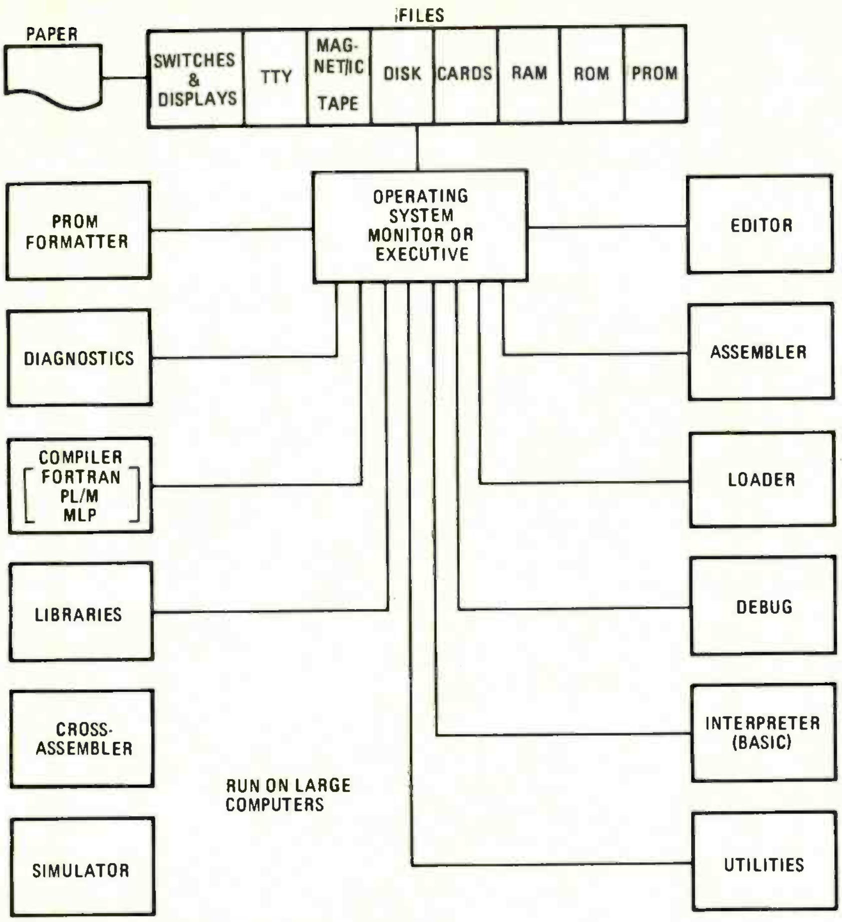


FIG. 1—**SOFTWARE** operating system components.

STATE OF SOLID STATE
(continued from page 112)

Programming is also done on large time-shared or dedicated computers. The completed program is then simulated on the same large machine. A large computer speeds the job but there are some serious shortcomings to the approach. A large computer cannot completely simulate the final microcomputer system. Timing and I/O interfaces are peculiar to the specific micro and cannot be simulated. Time-shared computer time and dedicated computer overhead is also expensive. Before any program is indelibly written onto a ROM mask, it must be checked by running on its eventual host machine.

Operating system modules

First you need some kind of file system. You will need to store the components of the software package and the programs you are developing. In the most elemental systems, the program is entered via front-panel switches so that the switch positions can then be read and transferred to paper—a file system of sorts. Punched paper tape is a much better long-term storage medium. File storage is also necessary for saving the programs at various stages of editing and assembly. Random-access memory in sufficient quantity is ideal for intermediate storage because of the high speed with which the programs can be shuffled back and forth. Let's look at some file handling examples:

Processor Technology sells a software operating system package designated package No. 1 for the 8080. They assume you have a microcomputer system running with facilities for entering their program. An executive routine carries out commands typed into the terminal. It costs only $3 as a program listing—looks like a bargain. 6,000 bytes of memory are required for its routines plus the additional space needed to store the source and object user programs.

Assume that the four programs are already stored in RAM. Maximum capacity of the system is six files. These files should not be limiting since this is short-term RAM storage. To find out how the four are cataloged, type the FILES command. The software directs the printer to list the names and their memory locations.

Motorola's EXORciser development system is built around their M6800 evaluation module. EXbug, the resident control program is stored in 1,000 bytes of ROM. Directed from a teletype or RS-232C terminal, EXbug can load programs or search a tape for a specific one. The LOAD command starts the program entry sequence.

Programs stored in ROM or PROM are called firmware—they are nonalterable software. They are less expensive than hardware implementation of the same function since the only thing they require is allocated memory space and the ROM itself. Firmware is also less expensive than software because, in quantity, ROM is cheaper than RAM. And there is no need to worry about destroying the firmware program during execution of a defective program.

The JOLT system built around MOS Technology's MCS6502 also uses firmware. To read in from a high-speed tape reader, simply type LH for load hexidecimal. The monitor does the conversion into binary.

Now that the program has been loaded from a storage medium or has been typed in

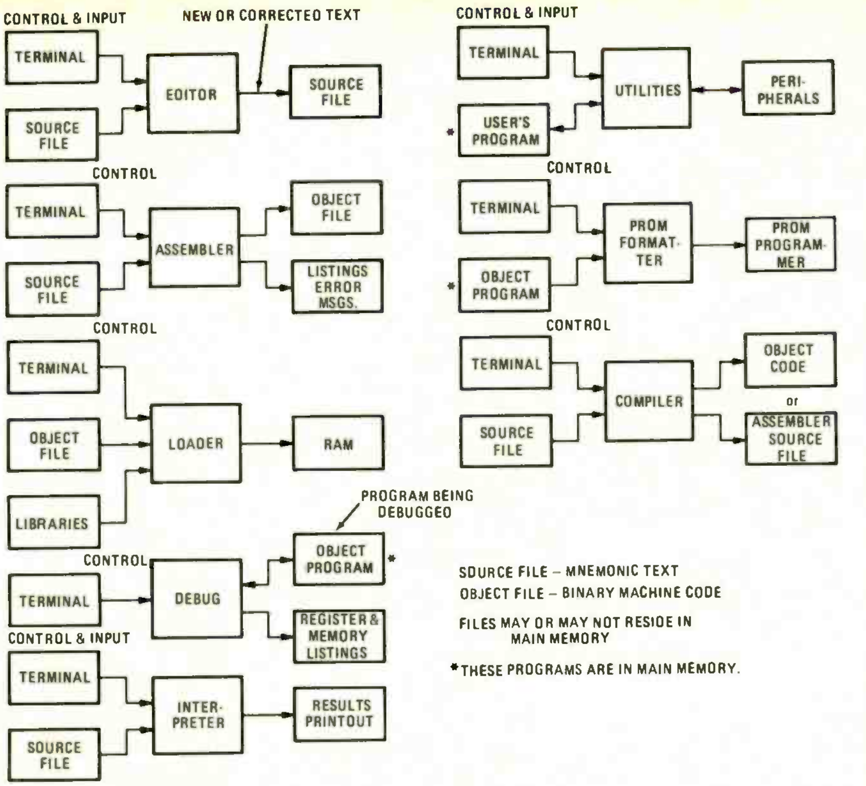


FIG. 2—INPUTS AND OUTPUTS of the main operating system components during program development.

at the keyboard, there will usually be editing necessary. The editor processor is loaded into memory or the resident program is started up with the proper terminal command or switch sequence. The keyboard becomes a very *(turn page)*

fancy typewriter—much like automatic correcting office typewriters.

A common operation is to delete lines. Sometimes the program is modified so a smaller number of lines replace an original larger group. One or more lines have to come out. All the lines after the deleted lines are moved up displacing the old characters. Overwriting is the normal computer operation rather than erasing. Pointers keep track of where everything is. File deletions are sometimes done by just erasing the listing. As memory space becomes short because of deleted files, a pack command then crams the active programs together overwriting the dropped files.

Processor Technology uses the DELT (delete) command followed by the line numbers. Each line is prefixed with a line number by the user. To change a single line, simply rewrite that line number along with the updated text. Separating line numbers by 5 or 10 when you enter text initially allows you to go back and make insertions by using intermediate line numbers.

Motorola's Exbug has an I command for insertion of text. It also has a string-search feature to find a sequence of characters anywhere in the workspace buffer.

The contents of the editor buffer is called TEXT since the editor is an English text handling program. Whether you are writing machine code or a trip report doesn't make any difference to it. You may be writing in binary, hexidecimal, assembly language, or a high-level language depending on what the next step of program development is. Figure 2 shows the inputs and outputs of the main operating system components.

If an assembler is part of your package, program writing using the editor will be done in shorthand mnemonics. Things become much simpler. Instead of committing the machine code to memory including all the variations of addressing, you use more easily remembered mnemonics like ADC for add with carry.

The next step is assembly. The assembler is loaded and the editor mnemonic text output fed through it. Each assembly language statement has a number of fields. The label field holds the symbolic statement name if any, the operation field contains the instruction mnemonic or assembler directive, the argument field holds operands and the comment field is used for documentation. A good programmer includes nonexecutable comments to help himself and others recall what was done.

In one or more passes over the mnemonics, the assembler produces binary object code ready for loading into the computer for execution. A listing of the program is typed out matching the machine code to the mnemonics. More sophisticated assembly programs run on the larger computers will produce cross-references and symbol tables. During editing, program steps are given names such as BEGIN or NEXT. Alphabetical table listings printed by the assembler tell you where the tagged statements are located in memory. The cross-references give the locations of all instructions that refer to labeled statements. Assembly listing make life a lot easier when troubleshooting or analyzing programs.

Most assemblers produce error diagnostics—messages that call out common mistakes. It is easy for an assembler to know that you typed ADB instead of ADC if ADB is not a valid instruction mnemonic and is not in the assembler's internal instruction list.

Assembled programs are put into memory with a loader. Absolute loaders take a program and store it in the specific memory addresses assigned by the programmer. Many programs must be able to run in different segments of memory. Relocatable loaders are called into play. You must realize that programs contain specific addresses in their instructions. If an instruction says JUMP NEXT and NEXT is located at address 4200, the actual instruction will be the machine code equivalent of JUMP 4200. The relocatable loader not only puts the instruction into memory step by step, but first modifies the code so that it will run where it is loaded.

The loader will often start the program. Otherwise, the CPU program counter is changed to the address of the first instruction and the computer is started manually or through the terminal monitor software.

Debugging procedures are now used to find out why the program does not do what it is supposed to or why it doesn't run at all. Firmware or software debuggers set traps or breakpoints by replacing instructions with halt commands. The program runs until it reaches the suspected trouble spot where the breakpoint has been inserted. Registers and memory are then examined to see what went wrong. Corrections are made by returning to the editor and assembler. Without an assembler, if an instruction has to be added, each statement would have to be moved up a slot throughout the entire

(continued on page 119)

WEIRD PROBLEM

I've got a really weird problem in an RCA CTC-52. The horizontal and vertical sync are very jittery, and I get small bright wormy lines in the center of the screen. The edges of the raster seem to pull in where the lines are, but the picture is jumping around so fast I can't be sure. Wow! Checked filters, etc.; no help.—E.G., Umpire, AR.

You *have* got a problem. Try this: this is a "dual-feed" horizontal oscillator supply circuit. The oscillator is started by a connection to B+ but *runs* on a DC voltage coming from boost. Check the two resistors going from the oscillator plate back to boost. These should be 270K and 120K, and you will probably find that both of them have gone away down in value. The loss of load impedance is actually making the oscillator "drop out" so that you lose horizontal sweep, then start up again. This makes the "wormy lines" in the middle of the screen. A lot like "Christmas-Tree" in the older sets.

REPEATED CAPACITOR FAILURE

This Admiral 3C3591 came in with C111, 300 pF, on the damper cathode burnt up. I replaced it. Worked fine. Sent it home and it came back in three weeks with the same capacitor burnt up, and no other problems! I need a permanent fix!—C.G., Albuquerque, NM.

Apparently this has happened to others. I have an *Admiral Service Note* saying that this capacitor must be replaced with an *exact duplicate*, with the right temperature coefficient and voltage rating. The Admiral part number of this is 65A10-457—300 pF ceramic disc, 10%, with a 6 kV rating.

RCA LISTING OF RCA TYPES!

I have a solid-state RCA TV. The audio output transistor, X10, is given as "2444", and this is what was in the set. However, I can't find a substitute listed in any of the transistor guides, even RCA's! What the heck?—J.L., Bridgeport, OH.

The "2444" is a "device number". You'll find all of the transistors in this set listed in the RCA SK replacement guide. Look for them under the RCA *stock number*. In this case, this would be 116075. An RCA SK-3021 will replace this; case and everything match.

TV SOUND IN RADIO

Give me a good idea on how I can pick up TV sound on a radio. I like to listen to some programs without watching them—L.S., Miami, FL.

I know what you mean. I have a couple of programs like that, too! There are several ways. I think the easiest and cheapest would be to use one of the little "wireless mike" modules fed from the top of the TV volume control, etc. You can get these for AM or FM. The FM might be better because the AM unit might pick up harmonics from the TV sweep. See any of the "little ads in the back of the book" in any issue of R-E, or look at radio-TV supply houses for the modules.

REPEATED FAILURE

I got a Sears 562.10523 color set. When it came in, the 30KD6 and 23JS6 tubes were bad. Replaced them, and it ran about a month. Came back with the 23JS6 high-voltage regulator bad. Replaced it again, and it was back in two weeks! Same thing. The high-voltage, cathode current, etc., are all in spec. I don't get it.—P.C., Salem, WV.

Neither did I, the first few times I heard of this. Thanks to Monty Huckle of Lake Tahoe, CA, we found the reason! The 23JS6 tubes used in these are a special EIAJ (Electronics Industries Association of Japan) type, with a much higher heater-cathode breakdown voltage than the EIA (U.S.) 23JS6 type! So, a perfectly good American 23JS6 won't stand up. You'll have to get the Japanese type replacement from the factory. We covered this in a Reader Question some time ago, but it seems to need a "re-run". Watch out for this. **R-E**

next month

OCTOBER 1976

- **CB Technical Feature**

  Synthesizers—what they are and how they work.

- **SWR Made Easy**

  How it affects your CB operations and how to make the best of it.

- **AM Stereo**

  It's new and may be all over the US soon. Here's a preview of this new kind of sound.

- **Build Digicolororgan**

  A really special kind of color organ that turns sound into color in your music room.

- **Elcaset**

  New jumbo cassette takes ¼-inch tape, runs at a higher speed and permits the use of multiple tape heads.

- **PLUS**

  Mystery Of The Tweeters
  Overspeed Circuits For Your Car
  Mindpower: Alpha
  Lab Tested Hi-Fi Reports
  Delayed Sweep—How To Use It
  Step-By-Step Troubleshooting
  State Of Solid State
  Komputer Korner
  Jack Darr's Service Clinic

STATE OF SOLID STATE

(continued from page 116)

program. Then there is the problem of correcting addresses and off-page references. For a program of larger than about 100 statements, you will be pretty unhappy.

When the program is finished, you will either file it away or produce an output to program a ROM or PROM. Small volume applications, those under 100 systems where the mask charges for ROM are too high, will probably use PROM in the final product.

Some programmable read-only-memory can be programmed only once. Microcomputer systems usually use the reprogrammable type. They are erased by exposure to ultraviolet light. To change a single bit, the entire PROM is erased and is totally reprogrammed including the modified bit. Operating systems may include PROM formatters to produce output tapes that will control external programming machines. Typical program flow during program generation is illustrated in Fig. 3.

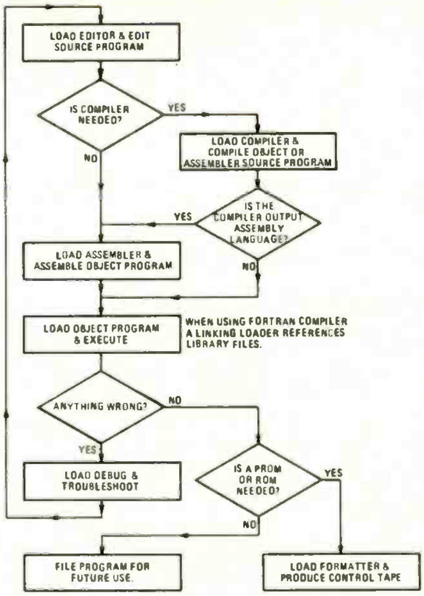


FIG. 3—PROGRAM FLOW during program generation.

Micro notes

Electronic Product Associates compact microcomputer, the Micro-68, comes with a keyboard, LED display, 512 words of PROM, 128 words of RAM and a power supply. The 512 word John-Bug PROM lets you load programs, inspect and edit them, and insert breakpoints. It sells for $430. 8K-byte static-memory boards for the 8-bit machine are $270. Built around the Motorola M6800 it has a $28.50 MIK-BUG ROM option.

An assembler, 64K memory board, PROM programmer, television adapter and cassette tape recorder are in the works. Electronic Product Associates ,Inc., 1157 Vega Street, San Diego, CA 92110.

Motorola and Hitachi have announced that Hitachi will join AMI in second sourcing the M6800 NMOS MPU family including software, firmware, and the EXORcisers.

National Semiconductor is delivering production quantities of the 16-bit PACE microprocessor for Hamilton-Avnet's PACER desk-top microcomputer.

The build-it-yourself machine sells for $685 in kit form. It features a new type keyboard to enter programs directly into memory and two 4-digit alphanumeric displays to analyze data and programs.

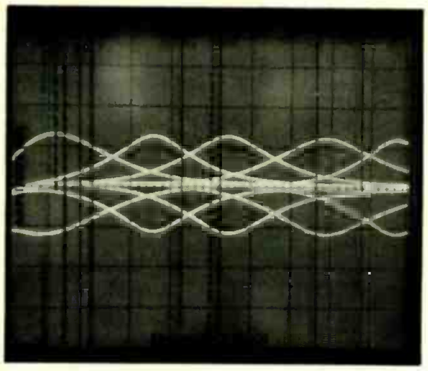
Vector Electronics 4350 plugboard will supply up to two voltages to a wide variety of microprocessors and interface circuits. The 7 × 9.6" (178 × 244 mm) board holds 14-, 16-, 24- and 40-pin DIP's. The 4350 was originally developed for TI's 980 series of computers. Vector Electronic Company, Inc., 12460 Gladstone Avenue, Sylmar, CA 91342.

MITS Computer Notes is a publication of the Altair Users Group. Software and operating notes and a Q & A column on the Altair 8800 and 680 lines are featured. New products and information on the 8080 BASIC interpreter are presented. 4K, 8K, and Extended BASIC is available for $150, $200 and $350, respectively. 4K, 8K, or 12K Altair 8800's with an I/O board lowers the prices to $60, $75, or $150. MITS, 6328 Linn NE, Albuquerque, NM 87108. **R-E**

R-E TESTS JVC S-300

(continued from page 68)

Using our spectrum analyzer for successive frequency sweeps, it becomes a simple matter to visually illustrate the capabilities of the S.E.A. (graphic equalizer) circuits of the JVC S-300 receiver (see Fig. 5) but the true flexibility and usefulness of those five slide controls can only be appreciated by using them during actual listening and use tests. Figure 5 illustrates only the extreme settings



of each of the five controls, but of course an almost limitless variety of response curves can be set up with the equalizer controls to suit any listening requirement and to compensate for just about any kind of acoustic or equipment limitations that are present, within reason.

One minor criticism of JVC's brochure is in order. In it, they imply that the end controls (those that govern boost or attenuation of 40 Hz and 15 kHz) may be considered to be low and high cut filters, as well as tone controls. Certainly, when placed in their most downward positions these levers will attenuate the region of frequencies around the nominal center points named, but as can be clearly observed from the scope traces in Fig. 5, output tends to be restored beyond the range of these controls. Thus, the 15-kHz level provides maximum attenuation at 15 kHz, but output rises again beyond 15 kHz—hardly the action expected of a low-pass high cut filter.

The same is true of the 40 Hz lever. Below 40 Hz, output increases even if that lever is pushed down to its greatest attenuating position. This is perhaps a minor point, and one not worthy of serious criticism, but we get the feeling that JVC felt guilty at not having been able to include separate low and high cut filters at this price and so they elected to assign "double duty" (at least verbally) to

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **JVC** Model: **S-300**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	58.0	Very good
RMS power/channel, 8-ohms, 20 Hz (watts)	54.0	Excellent
RMS power/channel, 8-ohms, 20 kHz (watts)	56.0	Very good
RMS power/channel, 4-ohms, 1 kHz (watts)	70.0	Good
RMS power/channel, 4-ohms, 20 Hz (watts)	N/A	—
RMS power/channel, 4-ohms, 20 kHz (watts)	N/A	—
Frequency limits for rated output (Hz-kHz)	14-43	Excellent
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.065	Excellent
Intermodulation distortion, rated output (%)	0.18)	Very good
Harmonic distortion at 1 watt output, 1 kHz (%)	0.027	Superb
Intermodulation distortion at 1 watt output (%)	0.026	Excellent
DAMPING FACTOR, AT 8 OHMS	53	Very good
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ± __ dB)	–0.4, +0.5	Good
Maximum input before overload (mV)	220	Very good
Hum/noise referred to full output (dB) (at rated input sensitivity)	71 (78 wtd)	Excellent

those end sliders on the graphic-equalizer arrangement.

Listening tests

Our overall product analysis as well as our reactions during listening tests of the S-300 will be found in Table II.

Our view is that JVC has managed to cram a great many circuit features and flexible switching and program source selection into a medium-priced receiver that offers excellent value for its price.

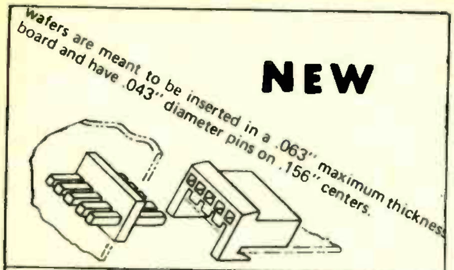
TABLE III

HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ± __ dB)	15-53, 1.0	**Very good**
Hum/noise referred to full output (dB)	85 (97 wtd)	**Excellent**
Residual hum/noise (min. volume) (dB)	90 (102 wtd)	**Excellent**
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	see Fig.	**Not applicable**
Action of secondary tone controls	see Fig. 5	**Superb**
Action of low frequency filter(s)	see Fig.	**Not applicable**
Action of high frequency filter(s)	see Fig.	**Not applicable**
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.7/	
Input sensitivity, auxiliary input(s) (mV)	190	
Input sensitivity, tape input(s) (mV)	190	
Output level, tape output(s)	190	
Output level, headphone jack(s) (V or mW)	N/A	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		**Very good**
Adequacy of input facilities		**Very good**
Arrangement of controls (panel layout)		**Excellent**
Action of controls and switches		**Excellent**
Design and construction		**Very good**
Ease of servicing		**Good**
OVERALL AMPLIFIER PERFORMANCE RATING		**Excellent**

Latest hand-held calculator computes common fractions

The AL-8, recently introduced by Casio, is the world's first calculator that can compute with ordinary fractions. It has a number of other extraordinary features, two of the most striking being the ability to calculate in circular measure units (degrees, minutes and seconds) and computing standard deviations.

The 8-digit calculator handles the four basic functions, has a percent key and a full 4-key independent memory (allowing addition, subtraction, recall and clearing of the memory). But in addition, it has two slide switches with special functions. The one at the left under the display in the photograph cuts off or rounds decimals to two places. The longer one, at the right in the photo, has six positions marked with special codes: The first position (left to right) computes the square root. The next position, GT (Grand Total) is used with the memory to compute horizontal and vertical totals. The REM (Remainder) position enables the user to divide one number by another, determine the integer number of times that the first number can be divided by the second, and by pressing a key display the remainder. The fraction position enables the user to add, subtract, multiply and divide fractions. The next position is for sexagesimal calculations, those dealing with degrees, minutes and seconds. It can also be used for measuring time intervals expressed in hours, minutes and seconds. The last position is for calculating the standard deviation.



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13-0003	9 pos. rt. angle connector	.60	.50

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1-10	11-100
.35	.29

MINIATURE FILM CAPACITORS

VALUE (uF)	PRICE TABLE 1-14	15-50	51-100
001	10	10	.06
0047	10	10	.06
01	10	10	.06
05	19	17	.15
1	20	18	16
22	25	23	21

These units are made by Internation Components Corp. All units 100 V

FIXED POWER SUPPLY KITS

Specifications	F0510	F1210	F1510
Input Voltage (50-500Hz)	105-125v	105-125v	110-125v
Output Voltage	5v ± 5%	12v ± 5%	15v ± 5%
Output Current (T_A = 25° C)	1.5A Max.	1.5A Max.	1.1A Max.
PRICE	$14.00	$14.50	$14.50

INDEFINITE SHORT CIRCUIT PROTECTION. Price includes Pre-drilled G-10 Board, All Parts and Transformer.

DISPLAY BEZELS

CATALOG NUMBER	FILTER COLOR	PRICE 1-24	DIMENSION C
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£ 910-60	Red	2.80	2.00
£ 915-60	Red	2.90	3.00
920-60	Red	2.95	4.00
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24	.40	.35
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2N5133	N	.05	TO-18	.25
2N5494	N	7.00	TO-220	1.05
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2N4403	P	.60	TO-92	.30
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VALUES OHMS
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25K 250K 50K 100K
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30	29	27

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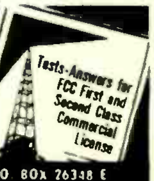

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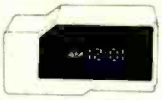

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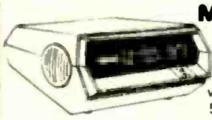

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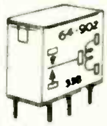

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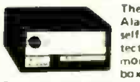

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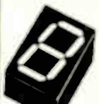

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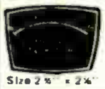

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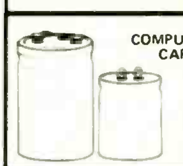

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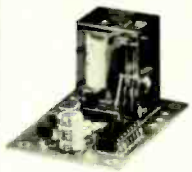

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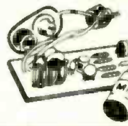

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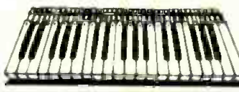

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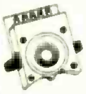

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Input Frequency	60 HZ	X	X		X	X
	50 HZ			X		
Time Display	12 Hour	X	X		X	
	24 Hour			X		X
Duplicate Register	Alarm Counter	X	X			
	Date Counter			X		
	Minute Timer				X	
	Second Timer					X
Alarm Signal	Tone	X	X			X
	DC Level			X	X	
Alarm Output	Modulated @ 2 0Hz	X	X		X	X
	Not Modulated			X		
Alarm at Power Failure	ON	X	X			
	OFF			X	X	X
Segment Output Polarity	Vss for Display		X		X	
	Vdd for Display	X		X		X
AM or PM Indication	Off during time display	X	X			
	Displayed at all times			X	X	X

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Circle 10 on reader service card

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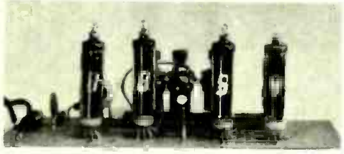
Circle 19 on reader service card



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7409	.21	7489	2.19	74188	3.50	4013	.40	4516	1.23
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7411	.21	7491	.70	74190	1.23	4015	.96	4520	1.14
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7413	.25	7493	.44	74192	.88	4017	1.05	4528	.88
7414	.89	7494	.70	74193	.88	4018	1.05	4585	1.23
7416	.25	7495	.70	74194	.88	4019	.23	LM309K	1.80
7417	.25	7496	.70	74195	.88	4020	1.14	LM324N	1.28
7420	.21	74100	1.28	74196	.88	4021	1.14	LM340T-5	1.25
7421	.25	74107	.30	74197	.88	4022	.96	LM340T-6	1.25
7423	.35	74109	.33	74198	1.49	4023	.23	LM340T-8	1.25
7425	.35	74121	.35	74199	1.49	4024	.84	LM340T-12	1.25
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7427	.33	74123	.61	74279	.58	4026	1.68	LM340T-18	1.25
7428	.28	74125	.40	74365	.67	4027	.40	LM340T-24	1.25
7430	.21	74126	.40	74366	.67	4028	.89	LM3900N	.88
7432	.25	74132	.70	74367	.67	4029	1.14	NE536T	3.24
7433	.30	74141	.88	74368	.67	4030	.23	NE540L	2.04
7437	.25	74145	.70	75150	1.31	4033	1.51	NE555V	.48
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7441	.88	74150	1.16	75452	.61	4040	1.14	NE561B	3.83
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7443	.63	74153	.65	75454	.61	4042	.79	NE565A	1.25
7444	.63	74154	1.03	75491	.81	4043	.70	NE566V	1.28
7445	.70	74155	.70	75492	.84	4044	.70	NE567V	1.36
7446	.70	74156	.70	75493	1.09	4046	1.86	uA709CV	.44
7447	.70	74157	.70	75494	1.19	4049	.40	uA710CA	.44
7448	.70	74160	.88	8093	.40	4050	.40	uA711CA	.53
7450	.21	74161	.88	8094	.40	4051	1.26	uA723CA	.60
7453	.21	74162	.88	8095	.67	4052	1.26	uA741CV	.44
7454	.21	74163	.88	8096	.67	4053	.72	uA747CA	.70
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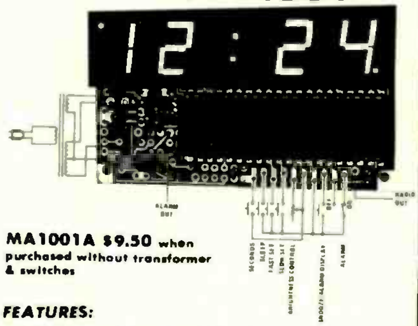

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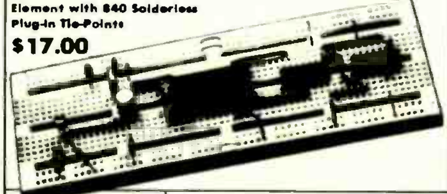

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7407	.28	7472	.30	74161	.97
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7409	.19	7474	.28	74163	1.09
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7414	.65	7485	.88	74170	2.10
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7425	.27	7493	.48	74180	.90
7426	.26	7494	.78	74181	2.45
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7430	.20	7496	.79	74184	1.90
7432	.23	74100	.98	74185	2.20
7437	.25	74105	.44	74187	5.75
7438	.25	74107	.37	74190	1.15
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7441	.89	74122	.38	74192	.95
7442	.59	74123	.65	74193	.85
7443	.73	74125	.54	74194	1.25
7444	.73	74126	.58	74195	.74
7445	.73	74132	.89	74916	1.25
7446	.81	74141	1.04	74197	.73
7447	.79	74145	1.04	74198	1.73
7448	.79	74150	.97	74199	1.69
7450	.17	74151	.79	74200	5.45

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74L06	.29	74L73	.56	74L98	2.25
74L10	.29	74L74	.56	74L164	2.25
74L20	.29	74L78	.75	74L165	2.30
74L30	.29	74L85	1.09		
74L42	1.39	74L86	.65		

LOW POWER SCHOTTKY

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74LS04	.36	74LS42	1.40	74LS164	2.20
74LS08	.38	74LS74	.59	74LS193	2.20
74LS10	.36	74LS90	1.30	74LS197	2.20
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74H01	.25	74H30	.25	74H62	.25
74H04	.25	74H40	.25	74H74	.39
74H08	.25	74H50	.25	74H101	.58
74H10	.25	74H52	.25	74H102	.58
74H11	.25	74H53	.25	74H103	.60
74H20	.25	74H55	.25	74H106	.72
74H21	.25	74H60	.25	74H108	.72

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74S00	.38	74S08	.52	74S22	.38
74S02	.45	74S10	.38	74S32	.52
74S03	.38	74S20	.38	74S74	.38
74S04	.45				

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8121	.80	8520	1.16	8830	2.19
8123	1.43	8552	2.19	8831	2.19
8200	2.33	8563	.62	8836	.29
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9000

9002	.40	9309	.79	9601	.61
9301	1.03	9312	.79	9602	.79

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930	.15	937	.15	949	.15
932	.15	944	.15	962	.15
936	.15	946	.15	963	.15

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Calc. Kit. & Adapter	$9.95
Batteries (alkaline, disp.)	2.00

Data included with order on request.
Add $.30 ea. if item is priced below $1.00

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Solder Tail - low profile

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16 pin	.22	40 pin	.69
18 pin	.29		

WIRE WRAP - gold plate
14 pin .49

CMOS

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4001A	.25	4020A	1.72	4068A	.44
4002A	.25	4021A	1.18	4069A	.44
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4007A	.26	4023A	.25	4072A	.35
4008A	1.52	4024A	.89	4073A	.39
4009A	.57	4025A	.25	4075A	.39
4010A	.54	4027A	.59	4078A	.39
4011A	.29	4028A	.98	4082A	.35
4012A	.25	4030A	.44	4518A	1.56
4013A	.45	4035A	1.27	4528A	1.56
4014A	1.27	4040A	1.39	4585A	2.10
4015A	1.27	4042A	1.47		
4016A	.48	4049A	.59		
4017A	1.01	4050A	.59		
74C00	.19	74C74	1.04	74C162	2.49
74C02	.26	74C76	1.34	74C163	2.66
74C04	.44	74C107	1.13	74C164	2.66
74C08	.68	74C151	2.62	74C173	2.22
74C10	.35	74C154	3.15	74C195	2.26
74C20	.35	74C157	1.76	80C95	1.15
74C42	1.61	74C160	2.48	80C97	.96
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MAN1	1.39
NSN71L	1.19
NSN74	1.19
MAN8	1.39

CALCULATOR CHIPS

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5005	1.29
5738	1.95

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2102
1K STATIC RAM
COMPUTER QUALITY $1.69

TTL

7432	$ .19
7437	.20
7438	.18
7446	.69
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74164	.85
74165	.85
74193	.73

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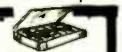

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5203	8.95
5260	.95
5261	.95
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2102	1024 bit RAM static 16 pin	1.95
5203	2048 bit PROM static electrically programmable UV erasable 24 pin	10.95
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5261	1024 bit RAM MOS dynamic 16 pin	1.95
7489	64 bit ROM TTL 16 pin	2.25
82S23	256 PROM-SCHOTTKY 16 pin	3.69
F93410	256 bit RAM bi-polar 16 pin	1.95
74187	1024 bit ROM TTL 16 pin	5.75
74200	256 bit RAM tri-state 16 pin	5.45

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MM5316	4 digit, 12-24 Hr, 50-60 Hz, alarm 40 pin	4.95
537AA	4-6 digit, 12 hour, 60 Hz snooze alarm brightness control capability, alarm tone output — 24 pin	4.95
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CT5005	12 digit, 4 function plus memory, fixed decimal — 20 pin	2.49
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MM5739	9 digit, 4 function, 9V battery operation — 22 pin	3.95

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MM5016	500/512 bit dyn. 8 pin	1.59
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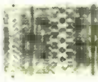

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MAN7	1.49
MAN8	2.25
MAN66	2.25
DL10A	2.19
FND500	1.09
NS71L	1.39

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MV50	.12
NSL100	.12
NSL101	.12
NSL102	.15
MV5020	
RED	.15
GREEN	.15
AMBER	.15
CLEAR	.15

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HP5082-7405	5 digit .11 red LED	3.49
HP5082-7414	4 digit .11 red LED	3.25
SP-425-09	9 digit .25 gas disch.	1.79

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301	Hi Perf Op Amp mDIP TO-5	.29
302	Volt follower TO-5	.53
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305	Pos V Reg TO-5	.71
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308	Micro Pwr Op Amp mDIP TO-5	.89
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320T	Neg Reg 5, 12, TO-220	1.39
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380	2w Audio Amp DIP	1.30
380-8	.6w Audio Amp mDIP	1.25
381	Lo Noise Dual preamp DIP	1.75
382	Lo Noise Dual preamp DIP	1.75
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555	Timer mDIP	.45
556A	Dual 555 Timer DIP	1.19
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562	Phase Locked Loop DIP	3.39
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710	Hi Speed Volt Comp DIP	.35
711	Dual Difference Compar DIP	.26
723	V Reg DIP	.62
733	Diff. video AMPL TO-5	1.02
739	Dual Hi Perf Op Amp DIP	1.07
741	Comp Op Amp mDIP TO-5	.32
747	741 Dual Op Amp DIP or TO-5	.71
748	Freq Adj 741 mDIP	.35
1304	FM Mulpx Stereo Demod DIP	1.07
1307	FM Mulpx Stereo Demod DIP	.74
1456	Op Amp mDIP	1.83
1458	Dual Comp Op Amp mDIP	.62
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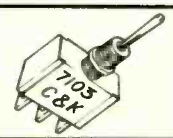

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74S04 – 44c	7438 – 39c	7485 – 95c	74161 – 95c
7404 – 19c	7440 – 19c	7486 – 45c	74164 – 1.10
7406 – 29c	7447 – 85c	7490 – 65c	74165 – 1.10
7408 – 19c	7448 – 85c	7492 – 75c	74174 – 95c
7410 – 19c	7451 – 19c	7495 – 75c	74181 – 2.50
7411 – 29c	7453 – 19c	7496 – 89c	74191 – 1.25
7413 – 50c	7473 – 39c	74121 – 38c	74192 – 1.25
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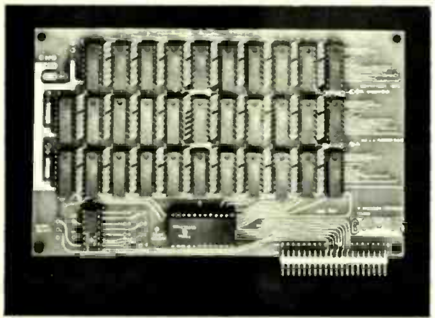

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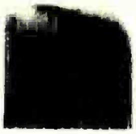

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SN7402N	.17	SN74LS20N	34
SN7404N	19	SN74LS28N	.41
SN7410N	17	SN74LS30N	34
SN7414N	.63	SN74LS38N	39
SN7416N	34	SN74LS74N	59
SN7417N	39	SN74LS75N	75
SN7420N	17	SN74LS90N	1 10
SN7430N	20	SN74LS93N	1 10
SN7438N	25	SN74LS95N	1 89
SN7439N	25	SN74LS107N	52
SN7440N	17	SN74LS132N	1 50
SN7447N	60	SN74LS151N	1 28
SN7450N	.17	SN74LS157N	1 40
SN7473N	36	SN74LS163N	2 05
SN7474N	32	SN74LS194N	2 00
SN7475N	.49	SN74LS258N	2 20
SN7476N	32	**LINEAR**	
SN7483N	.70	CA3082	1 90
SN7486N	39	CA3089	2 75
SN7489N	2 00	LM301AN	35
SN7490N	.45	LM301AH	35
SN7492N	45	LM307N	35
SN7493N	49	LM308N	89
SN7496N	75	LM309K	95
SN74100N	90	LM311H	.90
SN74107N	39	LM318	1 35
SN74121N	39	LM324N	1.10
SN74123N	59	LM339N	1 55
SN74126N	55	LM340K-5	1 60
SN74145N	.89	LM343H	4 25
SN74150N	95	LM358N	2 40
SN74151N	75	LM380N	1 00
SN74154N	1.10	LM710N	65
SN74155N	96	LM723N	44
SN74157N	95	LM733N	89
SN74161N	95	LM741CH	35
SN74166N	1.35	LM741N	.25
SN74170N	1.95	LM1303N	82
SN74174N	1 19	LM1812	7.50
SN74175N	90	LM3900N	55
SN74191N	1 25	LM3909	1 10
SN74193N	85	MC1458V	59
SN74298N	1 65	NE540L	5 00
SN75494	3 00	NE550N	65
		NE555V	43
		NE556A	1 00
74LS00 TTL		NE565A	1 00
SN74LS00N	34	NE566V	1 85
SN74LS02N	34	NE567V	1 25
SN74LS04N	39	SN75451CN	39
SN74LS08N	39	SN75452CN	39

CMOS	
CD34001	.42
CD4001	25
CD4002	25
CD4011	25
CD4012	25
CD4013	40
CD4016	50
CD4017	1 25
CD4020	1 35
CD4024	1 20
CD4027	.62
CD4030	.55
CD4049	.62
CD4050	62
CD4071	.40
CD4072	.40
CD4082	.45
CD4511	2 20
CD40192	3 00
74C00	.28
74C04	.33
74C74	.75
74C160	2 00
74C192	2.40
74C221	2.75
INTERFACE	
N8T25V	2 20
N8T26V	2 00
N8T28B	2.75
N8T97B	2 75
N8T98	2.75
MOS/MEMORY RAM	
2102	1 80
2102-1	2 20
2107B	8 00
2112-2	7 90
2513B	10 00
MM5262	.90
MM5058	2 20
PROM	
1702A	13 00
N82S23	3 25
N82S123	4.00
N82S126	4 65

DISPLAY LEDS			
MAN1	CA	270	2 90
MAN3	CC	125	39
DL704	CC	300	1 25
DL707	CA	300	1 50
DL727	CA	500	2 55
DL747	CA	600	2 25
FND359	CC	357	95
FND503	CC	500	1 35
FND510	CA	.500	1 35
FND800	CC	800	2.75
FND807	CA	800	2.75
6640 Dual	CC	500	3 50
MV5022			.69
MV5082			89
5082-7414			1.40

CRYSTALS	
1 MHz	4.50
2 MHz	4 50
4 MHz	4 25
5 MHz	4 25
10 MHz	4 25
18 MHz	3.90
20 MHz	3 90
32 MHz	3 90
32768 Hz	4 00
A to D CONVERTER	
8700CN	16 00
D to A CONVERTER	
MDAC100	12 00

IC SOCKETS
Solder Tin Low Profile

PIN	1 UP	PIN	1 UP
8	15	24	38
14	18	28	43
16	20	36	58
18	.27	40	61
22	35		

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MM5311	3 60
MM5312	4 80
MM5313	3 60
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MM5316	6 35
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3314	8 50

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Complete capacitor list .50

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(Specify car make and year)	
CMOS Rate Multipliers	$19.95
2- .50 in Displays	$ 2.50

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PC Board not included.

Circle 77 on reader service card

CB SPECIALS–R.F. DRIVERS–R.F. POWER OUTPUTS–FETS

2SC481	1.85	2SC767	15.75	2SC866	5.85	2SC1449-1	1.60	40081	1.50
2SC482	1.75	2SC773	.85	2SC1013	1.50	2SC1475	1.50	40082	3.00
2SC495	1.10	2SC774	1.75	2SC1014	1.50	2SC1678	5.50	2SC608	4.85
2SC502	3.75	2SC775	2.75	2SC1017	1.50	2SC1679	4.75	SK3046	2.15
2SC517	4.75	2SC776	3.00	2SC1018	1.50	2SC1728	2.15	SK3047	3.75
2SC614	3.80	2SC777	4.75	2SC1173	1.25	2SC1760	2.15	SJ2095	3.50
2SC615	3.90	2SC778	3.25	2SC1226A	1.25	2SC1816	5.50	SK3048	3.25
2SC616	4.15	2SC797	2.50	2SC1237	4.50	2SC1908	.70	SK3054	1.25
2SC617	4.25	2SC798	3.10	2SC1239	3.50	2SC1957	1.50		
2SC699	4.75	2SC781	3.00	2SC1243	1.50	2SF8	3.00	2SK19	1.75
2SC710	.70	2SC789	1.00	2SC1306	4.75	HEP-S 3001	3.25	2SK30	1.00
2SC711	.70	2SC796	3.15	2SC1306-1	4.90	2SD235	1.00	2SK33	1.20
2SC735	.70	2SC799	4.25	2SC1307	5.75	MRF8004	3.00		
2SC756	3.00	2SC802	3.75	2SC1307-1	6.00	4004	3.00	3SK40	2.75
2SC765	9.50	2SC803	4.00	2SC1377	5.50	4005	3.00	3SK45	2.75
2SC766	10.15	2SC839	.85	2SC1449	1.30	40080	1.25	3SK49	2.75

JAPANESE TRANSISTORS

2SA52	.60	2SB187	.60	2SC458	.70	2SC815	.75	2SC1569	1.25
2SA316	.75	2SB235	1.75	2SC460	.70	2SC828	.75	2SC1756	1.25
2SA473	.75	2SB303	.65	2SC478	.80	2SC829	.75		
2SA483	1.95	2SB324	1.00	2SC491	2.50	2SC830	1.60	2SD30	.95
2SA489	.80	2SB337	2.10	2SC497	1.60	2SC839	.85	2SD45	2.00
2SA490	.70	2SB367	1.60	2SC515	.80	2SC945	.65	2SD65	.75
2SA505	.70	2SB370	.65	2SC535	.75	2SC1010	.80	2SD68	.90
2SA564	.50	2SB405	.85	2SC536	.65	2SC1012	.80	2SD72	1.00
2SA628	.65	2SB407	1.65	2SC537	.70	2SC1051	2.50	2SD88	1.50
2SA643	.85	2SB415	.85	2SC563	2.50	2SC1061	1.65	2SD151	2.25
2SA647	2.75	2SB461	1.25	2SC605	1.00	2SC1079	3.75	2SD170	2.00
2SA673	.85	2SB463	1.65	2SC620	.80	2SC1096	1.20	2SD180	2.75
2SA679	3.75	2SB471	1.75	2SC627	1.75	2SC1098	1.15	2SD201	1.95
2SA682	.85	2SB474	1.50	2SC642	3.50	2SC1115	2.75	2SD218	4.75
2SA699	1.30	2SB476	1.25	2SC643	3.75	2SC1166	.70	2SD300	2.50
2SA699A	1.75	2SB481	2.10	2SC644	.70	2SC1170	4.00	2SD313	1.10
2SA705	.55	2SB492	1.25	2SC681	2.50	2SC1172B	4.25	2SD315	.75
2SA815	.85	2SB495	.95	2SC684	2.10	2SC1209	.55	2SD318	.95
2SA816	.85	2SB507	.90	2SC687	2.50	2SC1213	.75	2SD341	.95
		2SB511	.70	2SC696	2.35	2SC1226	1.25	2SD350	3.25
2SB22	.65			2SC712	.70	2SC1243	1.50	2SD352	.80
2SB54	.70	2SC206	1.00	2SC713	.70	2SC1293	.85	2SD380	5.70
2SB56	.70	2SC240	1.10	2SC732	.70	2SC1308	4.75	2SD389	.90
2SB77	.70	2SC261	.65	2SC733	.70	2SC1347	.80	2SD-390	.75
2SB128	2.25	2SC291	.65	2SC739	.70	2SC1383	.75	2SD437	5.50
2SB135	.95	2SC320	2.00	2SC715	1.75	2SC1409	1.25		
2SB152	4.50	2SC352	.75	2SC762	1.90	2SC1410	1.25	MPS-U31	4.00
2SB173	.55	2SC353	.75	2SC783	1.00	2SC1447	1.25	MPS8000	1.25
2SB175	.55	2SC371	.70	2SC784	.70	2SC1448	1.25		
2SB178	1.00	2SC372	.70	2SC785	1.00	2SC1507	1.25		
2SB186	.60	2SC394	.70	2SC793	2.50	2SC1509	1.25		

POWER-TRANSISTORS HIGH-VOLT. TV. TYPE

BU204	1300V	3.90	BU207	1300V	5.40	2SC1172B	1100V	4.25
BU205	1500V	4.70	BU208	1500V	6.25	2SC1308	1100V	4.95
BU206	1700V	5.90	2SC1170	1100V	4.00	2SC1325	1100V	4.95

OEM SPECIALS

1N270	.10	2N960	.55	2N2219A	.30	2N2913	.75	2N3740	1.00	2N4401	.20
1N914	.10	2N962	.40	2N2221	.25	2N2914	1.20	2N3771	1.75	2N4402	.20
		2N967	.50	2N2221A	.30	2N2916A	3.65	2N3772	1.90	2N4403	.20
2N173	1.75	2N1136	1.35	2N2222	.25	2N3019	.50	2N3773	3.00	2N4409	.20
2N178	.90	2N1142	2.25	2N2222A	.30	2N3053	.30	2N3819	.32	2N4410	.25
2N327A	1.15	2N1302	.25	2N2270	.40	2N3054	.70	2N3823	.70	2N4416	.75
2N334	1.20	2N1305	.30	2N2322	1.00	2N3055	.75	2N3856	.20	2N4441	.85
2N336	.90	2N1377	.75	2N2323	1.00	2N3227	1.00	2N3866	.85	2N4442	.90
2N338A	1.05	2N1420	.20	2N2324	1.35	2N3247	3.40	2N3903	.20	2N4443	1.20
2N398B	.90	2N1483	.95	2N2325	2.00	2N3250	.50	2N3904	.20	2N4852	.55
2N404	.30	2N1540	.90	2N2326	2.85	2N3375	6.50	2N3905	.20	2N5061	.30
2N443	1.75	2N1543	2.70	2N2327	3.80	2N3393	.20	2N3906	.25	2N5064	.50
2N456	1.10	2N1544	.80	2N2328	4.20	2N3394	.17	2N3925	3.75	2N5130	.20
2N501A	3.00	2N1549	1.25	2N2329	4.75	2N3414	.17	2N3954	3.50	2N5133	.15
2N508A	.45	2N1551	2.50	2N2368	.25	2N3415	.18	2N3954A	3.75	2N5138	.15
2N555	.45	2N1552	3.25	2N2369	.25	2N3416	.19	2N3955	2.45	2N5198	3.75
2N652A	.85	2N1554	1.25	2N2484	.32	2N3417	.20	2N3957	1.25	2N5294	.50
2N677C	6.00	2N1557	1.15	2N2712	.18	2N3442	1.85	2N3958	1.20	2N5296	.50
2N706	.25	2N1560	2.80	2N2894	.40	2N3553	1.50	2N4037	.60	2N5306	.20
2N706B	.40	2N1605	.35	2N2903	3.30	2N3563	.20	2N4093	.85	2N5354	.20
2N711	.50	2N1613	.30	2N2904	.25	2N3565	.20	2N4124	.20	2N5369	.20
2N711B	.60	2N1711	.30	2N2904A	.30	2N3638	.20	2N4126	.20	2N5400	.40
2N718	.25	2N1907	4.10	2N2905	.25	2N3642	.20	2N4141	.20	2N5401	.50
2N718A	.30	2N2060	1.85	2N2905A	.30	2N3643	.15	2N4142	.20	2N5457	.35
2N720A	.50	2N2102	.40	2N2906	.25	2N3645	.15	2N4143	.20	2N5458	.30
2N918	.35	2N2218	.25	2N2906A	.30	2N3646	.14	2N4220A	.45	C103y	.25
2N930	.25	2N2218A	.30	2N2907	.25	2N3730	1.50	2N4234	.95	C103d	.40
2N956	.30	2N2219	.25	2N2907A	.30	2N3731	2.75	2N4400	.20	C106b1	.50
										C106di	.75

SILICON UNIJUNCTIONS

2N2646	.50	2N4871	.50
2N2647	.60	2N4891	.50
2N6027	.55	2N4892	.50
2N6028	.70	2N4893	.50
D5E37	.25	2N4894	.50
2N2160	.65	MU10	.40
2N4870	.50		

INTEGRATED CIRC.

UA703C	.40
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741C OP. AMP.	.25
7400	.15
TA7061P	3.50
TA7205P	8.00
UPC1001h2	6.00
Ne555	1.25

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IN4002	.70	6.00
IN4003	.80	7.00
IN4004	.90	8.00
IN4005	1.00	9.00
IN4006	1.10	10.00
IN4007	1.20	11.00

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SN7400N*	.16	SN7453N	.27	SN74150N	1.00
SN7401N	.16	SN7454N	.20	SN74151N	.79
SN7402N	.21	SN7459A	.25	SN74153N	.89
SN7403N	.16	SN7460N	.22	SN74154N*	1.25
SN7404N*	.18	SN7470N	.45	SN74155N	.99
SN7405N	.24	SN7471N*	.69	SN74156N	.99
SN7406N	.20	SN7472N	.39	SN74157N	.99
SN7407N	.29	SN7473N*	.37	SN74160N	1.25
SN7408N	.25	SN7474N*	.32	SN74161N	.99
SN7409N	.25	SN7475N*	.50	SN74163N*	.99
SN7410N*	.18	SN7476N*	.32	SN74164N	1.10
SN7411N	.30	SN7479N*	5.00	SN74165N	1.10
SN7412N	.33	SN7480N	.50	SN74166N	1.25
SN7413N	.45	SN7482N	.98	SN74167N	5.50
SN7414N	.70	SN7483N	.70	SN74170N	2.10
SN7416N	.35	SN7485N	.89	SN74172N	18.00
SN7417N	.35	SN7486N	.39	SN74173N	1.50
SN7420N	.21	SN7488N	3.50	SN74174N	1.25
SN7421N	.33	SN7489N	2.25	SN74175N	.99
SN7422N*	.49	SN7490N*	.45	SN74176N	.90
SN7423N	.37	SN7491N	.75	SN74177N	.90
SN7425N	.29	SN7492N	.49	SN74180N	.99
SN7426N	.29	SN7493N*	.49	SN74181N	2.49
SN7427N	.37	SN7494N	.79	SN74182N	.95
SN7429N	.42	SN7495N	.79	SN74184N	1.95
SN7430N	.26	SN7496N	.89	SN74185N	2.20
SN7432N	.31	SN7497N*	4.00	SN74186N*	5.00
SN7437N	.27	SN74100N*	1.00	SN74187N	6.00
SN7438N	.27	SN74107N	.39	SN74190N	1.19
SN7439N	.25	SN74121N*	.39	SN74191N	1.25
SN7440N	.15	SN74122N	.39	SN74192N*	.89
SN7441N	.89	SN74123N*	.70	SN74193N*	.89
SN7442N	.59	SN74125N	.60	SN74194N	1.25
SN7443N	.75	SN74126N	.60	SN74195N	.75
SN7444N	.75	SN74132N	1.09	SN74196N	1.25
SN7445N	.75	SN74136N	.95	SN74197N	.75
SN7446N	.81	SN74141N	1.15	SN74198N	1.75
SN7447N*	.69	SN74142N*	4.00	SN74199N	1.75
SN7448N	.79	SN74143N*	4.50	SN74200N	5.59
SN7450N	.26	SN74144N*	4.50	SN74279N*	.90
SN7451N	.27	SN74145N	1.15	SN74251N	1.79
		SN74147N	2.35	SN74284N	6.00
		SN74148N	2.00	SN74285N	6.00

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.125" dia.		.185" dia.		.190" dia.	
XC209R	5/$1	XC526R	5/$1	XC111R	5/$1
XC209G	4/$1	XC526G	4/$1	XC111G	4/$1
XC209Y	4/$1	XC526Y	4/$1	XC111Y	4/$1
XC2090	4/$1	XC5260	4/$1	XC1110	4/$1

.200" dia.		.200" dia.		.085" dia.	
XC22R	5/$1	XC556R	5/$1	MV50	
XC22G	4/$1	XC556G	4/$1	.085" dia. Micro	
XC22Y	4/$1	XC556Y	4/$1	red led	
XC220	4/$1	XC5560	4/$1		6/$1

DISPLAY LEDS

TYPE	POLARITY	HT		TYPE	POLARITY	HT	
MAN 1	COMMON ANODE	.270	$3.25	MAN 74	COMMON CATHODE	.300	$1.50
MAN 2	5 x 7 DOT MATRIX	.300	4.95	DL707	COMMON ANODE	.300	$1.50
MAN 3	COMMON CATHODE	.125	.39	DL747	COMMON ANODE	.600	2.25
MAN 4	COMMON CATHODE	.187	1.95	DL750	COMMON CATHODE	.600	2.49
MAN 7	COMMON ANODE	.300	1.50	DL338	COMMON CATHODE	.110	1.25
MAN 7G	COMMON ANODE-GREEN	.300	1.95	FND70	COMMON CATHODE	.250	.50
MAN 7Y	COMMON ANODE-YELLOW	.300	1.95	FND503	COMMON CATHODE	.500	1.75
MAN 72	COMMON ANODE	.300	1.50	FND507	COMMON ANODE	.500	1.75

CMOS

CD4000	.25	CD4035	1.65	74C04N	.75
CD4001	.25	CD4040	2.45	74C10N	.65
CD4002	.25	CD4042	1.90	74C20N	.65
CD4006	2.50	CD4044	1.50	74C30N	.65
CD4007	.25	CD4046	2.51	74C42N	2.15
CD4009	.59	CD4047	2.75	74C73N	1.50
CD4010	.59	CD4049	.79	74C74	1.15
CD4011	.25	CD4050	.79	74C90N	3.00
CD4012	.25	CD4051	2.95	74C95N	2.00
CD4013	.47	CD4053	2.95	74C107N	1.25
CD4016	.56	CD4060	3.25	74C151	2.90
CD4017	1.35	CD4066	1.75	74C154	3.00
CD4019	.55	CD4069	.45	74C157	2.15
CD4020	1.49	CD4071	.45	74C160	3.25
CD4022	1.25	CD4072*	.45	74C161	3.25
CD4023	.25	CD4081	.45	74C163	3.00
CD4024	1.50	CD4511	2.50	74C164	3.25
CD4025	.25	CD4518	2.50	74C173	2.60
CD4027	.69	74C00N	.39	74C193	2.75
CD4028	1.65	74C02N	.55	74C195	2.75
CD4029	2.90			MC4044*	4.50
CD4030	.65			MC14016*	.56

LINEAR

LM300H	.80	LM377N	4.00	LM1351N	1.65
LM301H	.35	LM380N	1.39	LM1414N	1.75
LM301CN	.35	LM380CN	1.05	LM1458C	.65
LM302H	.75	LM381N	1.79	LM1496N	.95
LM304H	1.00	LM382N	1.79	LM1556V	1.85
LM305H	.95	NE501K	8.00	LM2111N	1.95
LM307CN	.35	NE510A	6.00	LM2901N	2.95
LM308H	1.00	NE531H	3.00	LM3065N	.69
LM308CN	1.00	NE536T	6.00	LM3900N	.55
LM309H	1.10	NE540L	6.00	LM3905N	.60
LM309K	.99	NE550N	.79	LM3909*	1.25
LM310CN	1.15	NE553	2.50	LM5556N	1.85
LM311H	.90	NE555V*	.45	MC5558V	1.00
LM311N	.90	NE560B*	5.00	LM7525N	.90
LM318CN	1.50	NE561B*	5.00	LM7535N	1.25
LM319N	1.30	NE562B*	5.00	80388*	4.95
LM3190	9.00	NE565H*	.99	LM75450	.49
LM320K-5	1.35	NE565N*	1.25	75451CN	.39
LM320K-5.2	1.35	NE566CN*	1.95	75452CN	.39
LM320K-12	1.35	NE567H*	1.25	75453CN	.39
LM320K-15	1.35	NE567V*	1.50	75454CN	.39
LM320T-5*	1.75	LM703CN	.45	75491CN	.79
LM320T-8*	1.75	LM709H	.29	75492CN	.89
LM320T-12*	1.75	LM709N	.29	75494CN	.89
LM320T-18*	1.75	LM710N	.79	**RCA LINEAR**	
LM323K-5*	9.95	LM711N	.39	CA3013	2.15
LM324N	1.80	LM723H	.55	CA3023	2.56
LM339N	1.70	LM723N	.55	CA3035	2.48
LM340K-5	1.95	LM733N	1.00	CA3039	1.35
LM340K-12	1.95	LM739N	1.29	CA3046	1.30
LM340K-15	1.95	LM741CH	.35	CA3059	3.25
LM340K-24	1.95	LM741CN	.35	CA3060	3.25
LM340T-5	1.75	LM741 14N	.39	CA3080	.85
LM340T-6	1.75	LM747H	.79	CA3081	2.00
LM340T-8*	1.75	LM747N	.79	CA3082	2.00
LM340T-18*	1.75	LM748H	.39	CA3083	1.60
LM340T-12	1.75	LM748N	.39	CA3086	.85
LM340T-15	1.75	LM1303N	.90	CA3089	3.75
LM340T-24	1.75	LM1304N	1.19	CA3091	10.20
LM350N	1.00	LM1305N	1.40	CA3123	2.15
LM351CN	.65	LM1307N	.85	CA3130	1.39
LM370N	1.15	LM1310N	2.95	CA3600	1.75
LM370H	1.15			RC4194	5.95
LM373N	3.25			RC4195	3.25

KITS EXAR ICS

XR-2206KA — SPECIAL $17.95
Includes monolithic function generator IC, PC board, and assembly instruction manual.

XR-2206KB — SPECIAL $27.95
Same as XR 2206KA above and includes external components for PC board.

TIMERS		STEREO DECODERS	
XR-555CP	$.69	XR-1310P	$3.20
XR-320P	1.55	XR-1310EP	3.20
XR-556CP	1.85	XR1800P	3.20
XR-2556CP	3.20		
XR-2240CP	3.25	**WAVEFORM GENERATORS**	
		XR-205	8.40
PHASE LOCKED LOOPS		XR-2206CP	4.49
XR-210	5.20	XR-2207CP	3.85
XR-215	6.60	**MISCELLANEOUS**	
XR-567CP	1.95	XR-2211CP	6.70
XR-2567CP	2.99	XR4136	2.00

100 PER STRIP MOLEX PINS

Intended for use as an inexpensive substitute for IC sockets. Also perfect for use as board connectors and in subassemblies.
SPECIAL — 100/1.49 — 1000/12.00

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

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

SOLDERTAIL STANDARD (TIN)

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

SOLDERTAIL STANDARD (GOLD)

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

WIRE WRAP SOCKETS (GOLD) LEVEL #3

10 pin	$.45	.41	.37	24 pin	$1.05	.95	.85
14 pin	.39	.38	.37	28 pin	1.40	1.25	1.10
16 pin	.43	.42	.41	36 pin	1.59	1.45	1.30
18 pin	.75	.68	.62	40 pin	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.25 PER ASST.

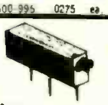
ASST. 1	5 ea.	10 OHM 27 OHM	12 OHM 33 OHM	15 OHM 39 OHM	18 OHM 47 OHM	22 OHM 56 OHM	1/4 WATT 5% = 50 PCS.
ASST. 2	5 ea.	68 OHM 180 OHM	82 OHM 220 OHM	100 OHM 270 OHM	120 OHM 330 OHM	150 OHM 390 OHM	1/4 WATT 5% = 50 PCS.
ASST. 3	5 ea.	470 OHM 1.2K	560 OHM 1.5K	680 OHM 1.8K	820 OHM 2.2K	1K 2.7K	1/4 WATT 5% = 50 PCS.
ASST. 4	5 ea.	3.3K 8.2K	3.9K 10K	4.7K 12K	5.6K 15K	6.8K 18K	1/4 WATT 5% = 50 PCS.
ASST. 5	5 ea.	22K 56K	27K 68K	33K 82K	39K 100K	47K 120K	1/4 WATT 5% = 50 PCS.
ASST. 6	5 ea.	150K 390K	180K 470K	220K 560K	270K 680K	330K 820K	1/4 WATT 5% = 50 PCS.
ASST. 7	5 ea.	1M 2.7M	1.2M 3.3M	1.5M 3.9M	1.8M 4.7M	2.2M 5.6M	1/4 WATT 5% = 50 PCS.

ALL OTHER RESISTORS FROM 2.2 OHMS 5.6M AVAILABLE IN MULTIPLES OF 5 ea
5-25 PCS .05 ea. 30-95 PCS .04 ea 100-495 PCS .03 ea 500-995 .0275 ea.

14 PCS. POTENTIOMETER ASSORTMENTS

ASST. A 2 ea: 10 OHM-20 OHM-50 OHM-100 OHM-200 OHM-250 OHM-500 OHM
ASST. B 2 ea: 1K, 2K, 5K, 10K, 20K, 20K, 50K
ASST. C 2 ea: 50K, 100K, 200K, 250K, 500K, 1M, 2M

$9.95 Per Asst.



Each assortment contains 14 pcs of 10 turn pots. All pots are available in single unit quantities. $.99 ea.

Astrisk Denotes Items On Special For This Month
Satisfaction Guaranteed. $5.00 Min. Order. U.S. Funds.
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JAMES

1021 HOWARD AVE., SAN CARLOS, CA. 94070
PHONE ORDERS — (415) 592-8097

74LS00 TTL

74LS00	.39	74LS55	.39	74LS151	1.55
74LS02	.39	74LS73	.65	74LS153	1.89
74LS03	.39	74LS74	.65	74LS157	1.55
74LS04	.45	74LS75	.79	74LS162	2.25
74LS05	.45	74LS76	.65	74LS163	2.25
74LS08	.39	74LS83	2.19	74LS164	2.25
74LS10	.39	74LS86	.65	74LS181	3.69
74LS13	.79	74LS90	1.25	74LS190	2.85
74LS14	2.19	74LS92	1.25	74LS191	2.85
74LS20	.39	74LS93	1.25	74LS192	2.85
74LS26	.49	74LS95	2.19	74LS193	2.85
74LS27	.45	74LS96	1.89	74LS194	2.25
74LS28	.49	74LS107	.65	74LS195	2.25
74LS30	.39	74LS112	.65	74LS257	1.89
74LS32	.49	74LS132	1.55	74LS260	.55
74LS40	.49	74LS136	.65	74LS279	.79
74LS51	.39	74LS138	1.89	74LS670	5.95

DATA HANDBOOKS

7400 Pin-out & Description of 5400/7400 ICS $2.95
CMOS Pin-out & Description of 4000 Series ICS $2.95
Linear Pin-out & Functional Description $2.95
ALL THREE HANDBOOKS $6.95

MINIATURE TOGGLE

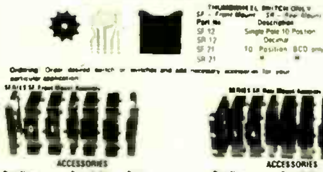
SPDT					1	2-9	[illegible]	[illegible]
	ON	OFF	ON	221	2.95	2.56	1.87	1.70
	ON	NONE	ON	223	2.95	2.15	1.58	1.43
	ON	OFF	ON	121	2.30	1.98	1.43	1.30
	ON	NONE	ON	123	2.00	1.86	1.21	1.10

PUSH BUTTON

Model Number	1 Each	2-9	10-29	30-99
PB-123	$2.35	$1.95	$1.47	$1.30
PB-126	$2.35	$1.95	$1.47	$1.30

5 AMP RATINGS

THUMBWHEEL SWITCHES



Part No	Description	Price	Part No	Description	Price
SF EP	End Plate (Pair)	$.50	SR EP	End Plates (pair)	$.50
SF DP	Divider Plate (each)	.40	SR DP	Divider Plate (each)	.40
SF BB	Blank Body (each)	.40	SR BB	Blank Body (each)	.40
SF HB	Half Body (each)	.40	SR HB	Half Body (each)	.40

8 POSITION ROTARY SWITCH

2 FOR $1.00

These switches are a 7 position, one position open rotary switch enclosed in a TO-5 can. They have a standard 8 pin configuration and will mount perfectly on printed circuit board.

ZENERS—DIODES—RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4005*	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006*	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007*	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N965B	15	400m	4/1.00	1N4154	35	10m	12/1.00
1N5232	5.6	500m	.28	1N4734	5.6	1w	.28
1N5234	6.2	500m	.28	1N4735	6.2	1w	.28
1N5235	6.8	500m	.28	1N4736	6.8	1w	.28
1N5236	7.5	500m	.28	1N4738	8.2	1w	.28
1N456	25	40m	6/1.00	1N4742	12	1w	.28
1N458	150	7m	6/1.00	1N4744	15	1w	.28
1N485A	180	10m	5/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4003	200 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00
1N4004	400 PIV	1 AMP	12/1.00				

TRANSISTORS

MPS A05	5/$1.00	PN3567	3/$1.00	PN4249	4/$1.00
MPS A06	5/$1.00	PN3568	4/$1.00	PN4250	4/$1.00
2N2219A	3/$1.00	PN3569	4/$1.00	2N4400	4/$1.00
2N2221	4/$1.00	2N3704	5/$1.00	2N4401	4/$1.00
2N2222A	5/$1.00	2N3705	5/$1.00	2N4402	4/$1.00
2N2369	5/$1.00	2N3706	5/$1.00	2N4403	4/$1.00
2N2369A	4/$1.00	2N3707	5/$1.00	2N4409	5/$1.00
FN2415	5/$1.00	2N3711	5/$1.00	2N5086	4/$1.00
2N2484	4/$1.00	2N3724	$.65	2N5087	4/$1.00
2N2906A	4/$1.00	2N3725	$1.00	2N5088	4/$1.00
2N2907A	5/$1.00	2N3903	5/$1.00	2N5089	4/$1.00
2N2925	5/$1.00	2N3904	4/$1.00	2N5129	5/$1.00
2N3053	2/$1.00	2N3905	4/$1.00	2N5138	5/$1.00
2N3055	$.89	2N3906	4/$1.00	2N5139	5/$1.00
MJE3055	$1.00	2N4013	3/$1.00	2N5209	5/$1.00
MJE2955	$1.25	2N4014	3/$1.00	2N5951	5/$1.00
2N3392	5/$1.00			C106B1SCR	2/$1.00
2N3398	5/$1.00			2N5432	$2.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+ 20% DIPPED TANTALUMS (SOLID) CAPACITORS

.1 35V	.28	.23	.17	1.5 35V	.30	.26	.21
.15 35V	.28	.23	.17	2.2 25V	.31	.27	.22
.22 35V	.28	.23	.17	3.3 25V	.31	.27	.22
.33 35V	.28	.23	.17	4.7 25V	.32	.28	.23
.47 35V	.28	.23	.17	6.8 25V	.36	.31	.25
.68 35V	.28	.23	.17	10 25V	.40	.35	.29
1.0 35V	.28	.23	.17	15 25V	.63	.50	.40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47 50V	.15	.13	.10	.47 25V	.15	.13	.10
1.0 50V	.16	.14	.11	.47 50V	.16	.14	.11
3.3 50V	.15	.13	.10	1.0 16V	.15	.13	.10
4.7 25V	.16	.14	.12	1.0 25V	.16	.14	.11
10 25V	.15	.13	.10	1.0 50V	.16	.14	.11
10 50V	.16	.14	.12	4.7 16V	.15	.13	.10
22 25V	.17	.15	.12	4.7 25V	.15	.13	.10
22 50V	.24	.20	.18	4.7 50V	.16	.14	.11
47 25V	.19	.17	.15	10 16V	.14	.12	.09
47 50V	.25	.21	.19	10 25V	.15	.13	.10
100 25V	.24	.20	.18	10 50V	.16	.14	.12
100 50V	.35	.30	.28	47 50V	.24	.21	.19
220 25V	.32	.28	.25	100 16V	.19	.15	.14
220 50V	.45	.41	.38	100 25V	.24	.20	.18
470 25V	.33	.29	.27	100 50V	.35	.30	.28
1000 16V	.55	.50	.45	220 16V	.23	.17	.16
2200 16V	.70	.62	.55	470 25V	.31	.28	.26

CRYSTALS
THESE FREQUENCIES ONLY

Part #	Frequency	Case/Style	Price
CY1A	1.000 MHz	HC33/U	$4.95
CY2A	2.000 MHz	HC33/U	$4.95
CY3A	4.000 MHz	HC18/U	$4.95
CY7A	5.000 MHz	HC18/U	$4.95
CY12A	10.000 MHz	HC18/U	$4.95
CY14A	14.31818 MHz	HC18U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

CLOCK CHIPS — CALCULATOR CHIPS

MM5309	6 Digit, BCD Outputs, Reset PIN.	$5.95
MM5311	6 Digit, BCD Outputs, 12 or 24 Hour	4.95
MM5312	4 Digit, BCD Outputs, 1 PPS Output	4.95
MM5313	6 Digit, BCD Outputs, 1PPS Output	4.95
MM5314	6 Digit, 12 or 24 Hour, 50 or 60 Hz	4.95
MM5316	4 Digit, Alarm, 1PPS Output	6.95
MM5318	Video Clock Chip, For Use With MM5841	9.95
CT7001	6 Digit, Calander, Alarm, 12 or 24 Hour	6.95

CALCULATOR CHIPS

MM5725	6 Digit, Four Function, Less Decimal	$2.95
MM5738	8 Digit, 5 Function, +, −, ×, ÷, %	2.95
MM5739	8 Digit, 4 Function, Floating Decimal	2.95
CT5001	12 Digit, 4 Function	3.95
CT5005	12 Digit, 4 Function with Memory	5.95
CT5030	12 Digit, 4 Function and %	7.95

MISC. MOS

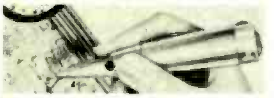
MM5320	TV Camera Sync. Generator	$19.95
MM5330	4½ Digit DVM Chip	9.95
MM5369	60 Hz Timebase Circuit From 3.58 MHz	5.00
MM5841	Video Generator For MM5318	18.00
MC1408-L7	7 Bit Digital to Analog Converter	9.95
MK5007	4 Decade Counter with Latches	10.95
LD110/LD111	3½ Digit DVM Chip Set	25.00
95H90	100 MHz ÷ 10 Counter For Prescalers	13.95

THE NEW RCA CA3140
MOST USEFUL OP AMP SINCE THE 741
CA3140 vs. 741 at a glance

	CA3140T,S	CA741CT,S
Input Resistance R_I (MΩ)	1,500,000	2
Input Current I_I (pA)	10	80,000
Slew Rate, SR (closed loop) (V/μs)	9	0.5
Gain-Bandwidth Product, f_T (MHz)	4.5	1.0

$1.25

VECTOR WIRING PENCIL

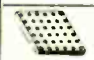


Vector Wiring Pencil P173 consists of a hand held featherweight (under one ounce) tool which is used to guide and wrap insulated wire, fed off a self-contained replaceable bobbin, onto component leads or terminals installed on pre-punched "P" Pattern Vectorbord®. Connections between the wrapped wire and component leads, pads or terminals are made by soldering. Complete with 250 FT of red wire. **$9.50**

REPLACEMENT WIRE — BOBBINS FOR WIRING PENCIL

W36-3-A-Pkg. 3	250 ft. 36 AWG GREEN	$2.40
W36-3-B-Pkg. 3	250 ft. 36 AWG RED	$2.40
W36-3-C-Pkg. 3	250 ft. 36 AWG CLEAR	$2.40
W36-3-D-Pkg. 3	250 ft. 36 AWG BLUE	$2.40

1/16 VECTOR BOARD



0.1" Hole Spacing

	Part No	P-Pattern L	W	Price 1-19	20-49
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 02XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44 062	4.50	6.50	2.07	1.86
	84P44 062	4.50	8.50	2.56	2.31
	169P44 062	4.50	17.00	5.04	4.53
	169P84 062	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062C1	4.50	17.00	6.80	6.12

VECTOR TERMINALS

Series	Part No. Finish Gold	Tinned	Post Size	25 pcs Gold	Tin	50 pcs Gold	Tin
T44	T44-1	T44	.025 sq	1.50 lot	1.00 lot	2.75 lot	1.75 lot
T46	T46-1	T46	.028 sq	1.75 lot	1.25 lot	3.00 lot	2.25 lot
T49	T49A	T49	.025 sq	1.75 lot	1.25 lot	3.10 lot	2.25 lot
T42-1	PKG. 100	Terminals	$3.50 C	$13.00M			

DIP SWITCH

These switches feature seven SPST slide switches in a molded dip. They are ideally suited for microprocessor applications. **$1.95**

SCR AND FW BRIDGE RECTIFIERS

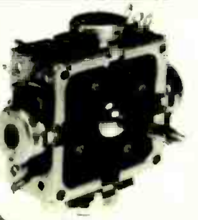
C36D	15A @ 400V	SCR	$1.95
C38M	35A @ 200V	SCR	1.95
2N2328	1.6A @ 200V	SCR	.50
MDA 980-1	25A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	25A@ 200V	FW BRIDGE REC.	1.95

64 KEY KEYBOARD

This keyboard features 64 unencoded SPST keys, unattached to any kind of P.C.B. A very solid molded plastic 13" × 4" base suits most applications. **$19.95**

HD0165 16 LINE TO FOUR BIT PARALLEL KEYBOARD ENCODER $7.95

JOYSTICK



These joysticks feature four 100K potentiometers, that vary resistance proportional to the angle of the stick. Sturdy metal construction with plastics components only at the movable joint. Perfect for electronic games and instrumentation.

$9.95 ea.

MICROPROCESSOR COMPONENTS

8080 SUPPORT DEVICES

8080A $37.95

8212	8 BIT INPUT/OUTPUT PORT FOR 8080	$ 5.95
8224	CLOCK GENERATOR AND DRIVER FOR 8080	12.95
8228	SYSTEM CONTROLLER AND BUS DRIVER FOR 8080	12.95

8080 $24.95

CPU'S

8008	8 BIT CPU	$19.95
8080	Super 8008	24.95
8080A	Super 8008	37.95

SR'S

2504	1024 Dynamic	$ 9.00
2518	Hex 32 BIT	7.00
2519	Hex 40 BIT	4.00
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2525	1024 Dynamic	6.00
2527	Dual 256 BIT	3.95
2529	Dual 512 BIT	4.00
2532	Quad 80 BIT	3.95
2533	1024 Static	7.95
3341	Fifo	6.95
74LS670	16 × 4 Reg	3.95

UART'S

AY-5-1013	30K Baud	$ 6.95

ROM'S

2513	Char. Gen.	$11.00
2516	Char. Gen.	13.00
74S387	1024-Bit Programmable	1.95

RAM'S

1101	256 × 1	Static	$ 2.25
1103	102 × 1	Dynamic	2.95
2101	256 × 1	Static	6.95
2102	1024 × 1	Static	1.95
2107	4096 × 1	Dynamic	19.95
2111	256 × 4	Static	7.95
7010	1024 × 1	MNOS	29.95
7489	16 × 4	Static	2.49
8101	256 × 4	Static	7.95
8111	256 × 4	Static	7.95
8599	16 × 4	Static	3.49
91L02	1024 × 1	Static	2.49
74200	256 × 1	Static	6.95
93410	256 × 1	Static	1.75

PROMS

1702A	2048	Famos	$15.95
5203	2048	Famos	14.95
82S23	32 × 8	Open C.	5.00
82S123	32 × 8	Tristate	5.00
74S287	1024	Static	7.95
3601	256 × 4	Fast	5.00

2K RAM SPECIAL

MM5262 Fully decoded 2Kx1 dynamic RAM. All inputs except clocks are TTL compatible. Provides a 635 ns minimum access time, and requires a +5, +8.5, and −15V power supply. Low power provides non volatile memory using battery back up.

$0.99 ea. (0.05 cents per bit)

Special Requested Items

RC4194	Dual Track V Reg	$ 5.95	N8T97	$ 2.00	MK5007	$10.95	MC4044	$ 4.50
RC4195	±15V Track Reg	3.25	4024P	2.25	8263	5.95	LM3909	1.25
F9368	Decoder	3.95	DM8130	3.25	8267	2.75	MM5320	19.95
LD110/111	DVM Chip Set	25.00	CD4520	$2.50	8288	1.15	4072AE	.45
CA3130	Super CMOS Op Amp	1.39	MC14016	.56	8826	3.00	7422	1.50
MC1408L7	D/A	9.95	2525	6.00	8880	.80	7497	4.00
F3341	FIFO	6.95	2527	3.95	4511AE	2.50	74186	5.00
MM5841	Character Gen.	18.00	CD4518	2.50	XR4136	2.00	74279	.90
AY5-9100	Push Button Dialer	17.50	MM5309	5.95	4566AE	3.00	82S90	4.00
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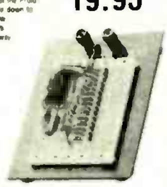
For the economy-minded experimenter . . .

NEW

Proto Board 100

19.95

Here's a low cost, big 10 IC capacity breadboard kit with all the quality of QT Sockets and the best of the Proto Board series . . . complete down to the last nut, bolt and screw. Includes 2 QT 35S Sockets, 1 QT 35B Bus Strip, 2 5-way binding posts, 4 rubber feet, screws, nuts, bolts and easy assembly instructions.



Proto Board 104: Huge 3,060 solderless tie points, (4) 5-way binding posts, 32 14 pin DIP capacity. **79.95**

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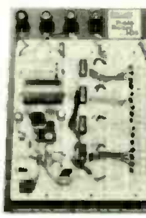
Proto Board 101: Compact, inexpensive, 10-14 pin DIP capacity. **29.95**

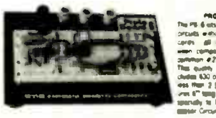
Proto Board 102: Compact 12 14 pin DIP capacity. **39.95**

Proto Board 103: 2,250 solderless tie points, (4) 5-way binding posts, 24-14 pin DIP capacity. **59.95**



DESIGN MATE 1

CIRCUIT DESIGNER: You asked for it. HERE IT IS! CSC's basic circuit designer to help you build and test ANY electronic circuit. Send #22 AWG wire interconnects any discrete component without solder. Resistors, Transistors, Linear Digital ICs in TO-5 DIP packages (from 8-40 pins). And more. Components fit directly into Sockets and Bus strips instantly and easily. Plus DESIGN MATE ONE's (DM-1) variable regulated power supply gives 5-15VDC up to 600ma (9 watts). Now that's design flexibility for you! You can even monitor the DM-1's internal power supply or external circuits thanks to the built-in 0-15V voltmeter. If you're into electronics, DM-1 is a must for your laboratory. It comes to you completely wired, tested and ready to use for only $49.95



PROTO BOARD 6

The PB-6 lets the user test and build circuits without soldering or patch cords. All interconnections between components are made with common #22 AWG hook up wire. This quality breadboarding kit includes 630 component tie points at less than 2 ½ cents each. It measures 6" long by 4" wide. Designed specially to Breadboard Microprocessor Circuits. $15.95

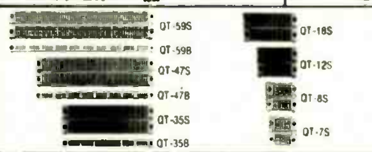
Now trace signals or troubleshoot fast. Inject signals or view unused circuits into existing boards. Scope probes, test leads lock onto Dytagrip ... Plastic construction — no springs or pivots. Thousands of ... Narrow thread for high density PC boards.

PC 14	14 pin Proto Clip	$3.00
PC 16	16 pin Proto Clip	$3.00
PC 24	24 pin Proto Clip	$6.00

SPECIAL!

LOGIC MONITOR

Simultaneously displays static and dynamic logic states of DTL, TTL, HTL or CMOS DIP ICs. Pocket size. $84.95



QT Proto Strips

QT type	# holes	price
QT-59S	590	12.50
QT-59B	bus strip	2.50
QT-47S	470	10.00
QT-47B	bus strip	2.25
QT-35S	350	8.50
QT-35B	bus strip	2.00
QT-18S	180	4.75
QT-12S	120	3.75
QT-8S	80	3.25
QT-7S	70	3.00

DIGITAL CLOCK KIT — 3½ INCH DIGITS

This clock features big 3½" high digits for viewing in offices, auditoriums, etc. Each digit is formed by 31 bright 0.2" LED's. The clock operates from 117 VAC, has either 12 or 24 hr. operation. The 6 digit version is 27" × 3½" × 1½", and the 4 digit is 18" × 3½" × 1½". Kits come complete with all components, case and transformer. Specify 12 Or 24 Hr. When Ordering.

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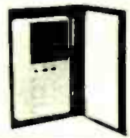
$8.95

FEATURES:
- 8 Digit Display
- 5 Functions consists of addition, subtraction, multiplication, division, percentage; with constant on all functions, with full floating decimal point.
- Power source is 1 piece 9V DC Battery 006P, jack for AC adapter
- Black superfine grained finish plastic cabinet

5 FUNCTION ELECTRONIC CALCULATOR WITH WALLET-NOTEBOOK AND POCKET CHECKBOOK RADOFIN MODEL 1710

$19.95



FEATURES:
- 8 Digit Display
- 5 Functions consists of addition, subtraction, multiplication, division, percentage; with constant on all functions, with full floating decimal point
- Power source is 6 AAA cells 9 V DC
- Wallet is 2 tone texon, cabinet is black plastic

IMC 3½ DIGIT DVM KIT

This 0-2 VDC .05 per cent digital voltmeter features the Motorola 3½ digit DVM chip set. It has a .4" LED display and operates from a single +5V power supply. The unit is provided complete with an injection molded black plastic case complete with Bezel. An optional power supply is available which fits into the same case as the 0-2V DVM allowing 117 VAC operation.

A. 0-2V DVM with Case	$49.95
B. 5V Power Supply	$14.95

JE700 CLOCK

12 or 24 Hour

115 VAC

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

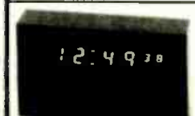
$17.95

Liquid Crystal Temperature Display

Six Digit Light Emitting Diode Display

DL 33 Display

This clock makes an attractive addition to any desk. It has an extruded, black anodized aluminum case. It displays hours, minutes, and seconds with .11 inch displays, and comes complete with a liquid crystal thermometer. It operates off 115 VAC at 50 or 60 Hz. **$24.95**



This large digit clock (.6" hours & minutes, .3" seconds) features the MM5314 clock chip. It operates from 117 VAC, and will operate in either a 12 or 24 hour mode. The clock is complete with a walnut grain case, and has fast set, slow set, and hold time set features.

KIT - ALL COMPONENTS & CASE $34.95
WIRED & ASSEMBLED $39.95

JE803 PROBE

The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test, drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols: (HI) - 1 (LOW) - 0 (PULSE) - P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.

$9.95 Per Kit
printed circuit board

T²L 5V 1A Supply

This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only **$9.95 Per Kit**

exelar

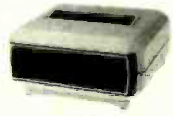
This watch is manufactured by National Semiconductor. It provides 5 functions; hours, minutes, seconds, date, A.M. indicator dot. Accuracy is assured to 5 seconds per month by precision quartz crystal. If something should go wrong with the watch, repair is assured within 48 hours after it is received. Complete with steel black leather band.

ES4-YS
3 MICRON GOLD PLATE BEZEL
$29.95

DIGITAL ALARM CLOCK

Novus

This 4 digit Novus Alarm Clock is a very reliable and smartly styled unit. It provides such features as an alarm settable to any minute of the day, a 7 minutes snooze alarm, a power failure indicator, and even an A.M., P.M. indicator.



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All pacs are first quality (no fallout), tested and guaranteed.

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Regulators — 4 LM723 DIP variable regulators, 2-40V, with data $1.98

TTL Gates — 15 assorted DIP's 7400 series-7420, 7430, 7440, etc...All prime, marked parts, with data $1.98

LED pac — 10 assorted discrete LED's-green, red, and infra-red, with data. $1.98

Comparator pac — 5 assorted DIP's--LM311, 710, 711, with data $1.98

UNTESTED PACS

CMOS pac — 30 Untested CMOS ICs. All factory marked-- $1.98

Stud Rectifiers — 20 5 amp stud rectifiers. Untested, mostly 100V+. $1.98

Resistors — 100 5% resistors of any single standard value from 2.7 ohm to 1M ohm. Not an ass't. $1.98

Transistors — 40 assorted GE power tab series--NPN, PNP and some Darlington. Untested, pin connections supplied. $1.98

IC Assortment — 100 Untested ICs, all DIP, mostly TTL--some marked, housemarked, or unmarked. $1.98

Switches — 8 SPST momentary contact push button N.O. Red button fits in approx. ¼" panel, with lock washer and mounting nut. $1.98

Diodes — 100 Germanium computer signal diodes with leads trimmed for PCB mounting. $1.98

739 pac — 5 Linears--dual low noise stereo amplifier 739. With data. $1.98

Buy 5 pacs for $9.90 and pic-a-pac for 10¢

Capacitors — PCB vertical mount dipped tantalum capacitors--all brand new marked parts. Values: 10mfd 25V; 6.8mfd 6V; 33mfd 10V; 4.7mfd 16V. **25¢ each**

NPN TO3 POWER TRANSISTORS — 2N3055 PD-115W, VCE-60V, hFE-50; fT-30W. Each $ .90 10 for $6.95. 410 (RCA) 200V-10A; 2N3772 70V-30A. Each $1.75 10 for $15.00

FULL WAVE BRIDGE RECTIFIERS — 10A, 100V 1⅛"x1⅛"x⅝" Similar to Motorola MDA990. Each $1.00 10 for $9.00

SPACE AGE CLOCK KIT — Instructions & parts - 12 or 24 hour format. Four digit clock kit includes all parts for complete clock: 3½"x 2": -FND 70 readouts -MM5314 clock chip & all transistors, etc. -extruded aluminum case -cord with transformer plug $16.95

POTTER BRUMFIELD Type KHP Relay 4 PDT 3A Contacts. 24V DC ... $1.50 (650 coil) 120V AC ... $1.75 (10.5 MA coil)

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ACOUSTIC COUPLER

This coupler was manufactured by Novation, Inc. Tarzana, California for use in Texas Instrument's model 725 Electronic Data Terminal. It is compatible with Bell 103 and 113 data sets or equivalent. The coupler operates asynchronously to a maximum speed of 450 baud in the full-or-half-duplex mode coupled to a standard telephone handset. Transmit freq. is 1270hz for mark and 1070hz for space. Receive frequency is 2225hz for mark and 2025hz for space. Unit requires ± 12 VOLTS and + 5 VOLTS for operation. Complete with schematic & all pertinent information, fully reconditioned, calibrated, and guaranteed $47.50

ASCII COMPUTER KEYBOARDS

These keyboards were manufactured for use on Texas Instrument's line of Silent 700 series data terminals. They are fully encoded with TTL large scale integrated circuits (T.I. TMS-5000 in 28 pin socket). Additional IC's provide a parallel 7 bit, without parity, code plus a strobe signal indicating "valid" data and six other independent outputs for those special keys which are not encoded. Internal circuitry provides for two key rollover and de-bounce. Output is on standard 10 pin double readout connector for data and power input. And 8 pin double readout connector for six special switch functions.

KB-6 · Clare/Pander 720627-1 New · tested $39.95
T.I. Part number 959327-1 Used · tested $29.95
A 56 key ASCII encoded Alphanumeric keyboard with six extra switch closures to ground marked HERE IS, PAPER ADV., BREAK, REPEAT, TAPE→ TAPE←

TMS 5000 ASCII keyboard encoder with data $14.95 ASR33 Teletype Code

SWITCHCRAFT Micro-Jax TR-2A

10	$ 2.95
100	25.00
1000	199.50
10M	1250.00

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PRINTED CIRCUIT BOARD G-10 · 1/16" thick, unetched copper clad 1 oz. 2 sides

Size	1	10	100
3x6"	.50	2.50	19.95
4x12"	1.00	5.00	39.95
8x8"	1.50	9.95	59.75

TMS 4030 JL, 4096-BIT DYNAMIC RAM Low Power 400 mW with data and 22 Pin SOCKET removed from sockets. Tested and guaranteed $9.95 8 FOR $64.95

NE-2 NEON
100 — 9.95
1000 — 49.95
10M — $350.00

BAUDOT KEYBOARD KB-5

ELECTRICAL REQUIREMENTS — The keyboard requires +5volts. All outputs are capable of driving a minimum of one standard TTL load. Logic level "1" is defined as a voltage between +2.4 and +5.25 volts. Logic level "0" is defined as a voltage between +6 volts and 0.0 volts.

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AC adapter $3.00 ea. INPUT 115 Volts, 50-60 Hertz OUTPUT 8 VAC 100 Ma. 10 for $25.00

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Kit No. 70250 1Y (Yellow readouts)
Kit No. 70250 2R (DL727 readouts) $28.50
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All kits include components, PC Boards, Transformer, case, and construction manual

THE KING'S HAREM

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Features 4 digit temperature display, farenheit or centigrade, complete C-Mos application: uses 7002 4- digit counter.

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(Example) Set your alarm for 7: a.m., set timer for 15 min. At exactly 7: a.m., the appliance will start, at 7:15 your clock alarm will wake you.

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ADDITIONAL FEATURES:
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DL727 One of our best readouts .5 in. high, 20mA per segment. Common anode. $3.75

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LEDS
Mini red .12
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DL33 If you like an array of displays, we have it. Common cathode. $1.45

TTL BOARDS

MEMOREX computer boards with TTL's Diodes and Transistors, etc

*5 Boards containing 150-250 IC's $4.50

GE TRANSISTOR ASSORTMENT
T098 cased Darling., SCRs, NPN,PNP, ect.
50 for $1.50
100 for $2.50
300 for $6.00

LSI INTEGRATION

MM5316	4-6 digit alarm clock 40 pin dip w/spec.	$ 4.25
7002	4 digit counter/latch decoder; 7 segment and BCD outputs. 28 pin dip w/spec.	$12.50
7005	4 digit counter/latch decoder, 7 segment output only. 24 pin dip w/spec.	$ 8.50
7007	4 digit counter/latch decoder with BCD output only. 16 pin dip w/spec	$ 7.00
70250	4-6 digit alarm clock 28 pin dip w/spec.	$ 5.50
PC Board for 70250		$ 4.75
70380	4 digit non multiplexed radio alarm clock featuring direct drive display output 40 pin dip w/spec	$4.50
PC Board for 70380		$ 3.75
8008	8 bit parallel CPU	$19.50
2102	1K static RAM for 8008	$ 2.25
MM5203	2K UV eraseable PROM	$12.25
75491	segment driver	$ 0.35
75492	digit driver	$ 0.45
7020	6 function calculator chip with direct segment drive 8 digit	$ 2.25

TTL

7400	.21	7448	.94	74151	.80
7402	.21	7453	.21	74153	.94
7404	.21	7473	.42	74154	1.00
7406	.29	7474	.42	74161	1.04
7408	.21	7475	.70	74163	1.24
7410	.21	7476	.44	74164	1.94
7413	.54	7483	.90	74165	1.54
7420	.21	7489	2.50	74174	1.34
7427	.29	7490	.74	74175	1.44
7430	.21	7492	.80	74181	2.80
7437	.44	7493	.80	74192	1.30
7438	.39	7495	.80	74193	1.30
7440	.21	7496	.80	74195	.84
7442	.74	74121	.43		
7447	.94	74123	.80		

CMOS

4000	.24	4018	1.49	4037	4.50
4001	.24	4019	.59	4040	1.59
4002	.24	4020	1.59	4041	.89
4006	1.49	4021	1.49	4042	.79
4007	.24	4022	1.19	4043	.80
4008	1.15	4023	.24	4044	.59
4009	.59	4024	.99	4047	.59
4010	.55	4025	.24	4049	.59
4011	.24	4027	.59	4050	.59
4012	.24	4028	.99	4066	.99
4013	.59	4029	1.39	74C02	.29
4014	1.49	4030	.49	74C04	.29
4015	1.19	4034	3.25	74C07	1.29
4016	.59	4035	1.39		
4017	1.29				

4 & 6 DIGIT PC BOAROS

PC Board for 4 digit display FND 800 or 807	$2.75
PC Board for 6 digit display FND 800 or 807	$3.50
PC Board for 4 digit display MAN series or DL707	$1.75
PC Board for 6 digit display MAN series or DL707	$2.75
PC Board for 4 digit display FND503	$2.00
PC Board for 6 digit display FND503	$3.00
PC Board for 4 digit display DL747	$2.50
PC Board for 6 digit display DL747	$3.00
PC Board for 4 digit display DL727	$2.75
PC Board for 6 digit display DL727	$3.00
PC Board for 4 digit display FND70	$1.75

All PC display boards are multiplexed for adding additional digits

MSI

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Now you can build some of the most advanced digital electronic instruments with our new series of low-cost modular scientific kits. These kits will expand the range of your electronic applications enormously, and all at a surprisingly low cost.

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A Digital Voltmeter (DVM) ... Kit 012 • Kit 030 • Kit 017
Frequency Counter ... Kit 012 • Kit 030 • Kit 016 • Time Base
RPM Counter ... Kit 012 • Kit 030 • Kit 020 • Kit 018

4-DIGIT DECADE COUNTER KIT $19.95 KIT 012

One chip 4 digit decade counter kit, with both 7 segment and BCD output.

1. Chip features internal oscillator for scanning speed.
2. Overflow and count extent outputs.
3. Transfer, reset, count, blanking and true compliment control inputs.
4. PC Boards can be cascaded to 8 12 16, etc. digits
5. Kit includes counter chip, drive circuit for 4 cathode type displays and PC Board. (For readout board see FND70 FND503)

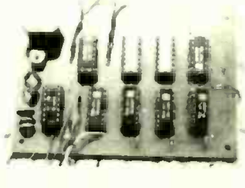
KIT 016 FREQ. COUNTER

Features FET input front end with trigger circuit for measuring complex waveforms. Measures from 0.1Hz to 10MHz when used with Kit 015 or 019. Measures from .01Hz to 35MHz when used with Kit 013 and 014. $24.50

KIT 030 POWER SUPPLY

*Input voltage 25V max. *Output current 1 amp max. *Load regulation 50mV. *Output voltage 5V *Line regulation .01%. (requires 8-20V transformer) $4.55

(Contains all parts except transformer)



KIT 017 DVM

1.999V as basic, with polarity indication 1 M ohm input impedance and accuracy to 1% if properly adjusted $16.50

TIME BASES

1 Mhz crystal chain time base divider. Outputs. 1Mhz-100Khz-10Khz-1Khz-100Hz-10Hz-1Hz 0.1Hz. Accuracy better than .005% with proper adjustment.

Kit 013 complete CMos with PC board $15.75
Buffer Circuit for TTL Interfacing

Kit 014 Same as Kit 013, but with TTL $13.75

Kit 015 50Hz or 60Hz chain time base using line frequence as reference. Accuracy 0.1-0.05%. Outputs 10Hz-1Hz 0.1Hz. Complete with CMos shaping circuit and PC Board $9.75

Kit 019 Same as Kit 015, but with TTL and 60Hz only $7.75

Kit 018 60Hz chain time base using line frequence for Kit 020 RPM counter.

*Outputs: .6 sec. = 100th of RPM
6 sec = 10th of RPM
60 sec = full revolution $9.75

KIT 020 RPM COUNTER

Counts from 1 to 100,000 RPM. RPM counter kit contains components and PC board. $8.95

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Send for your membership card to the Modular Scientific Instrumentation Club and receive a big 10% off on future purchases of M.S.I. kits. Send $3.00 with your name and address. We will promptly send your very own registered membership card. Don't miss out on the savings. Write now.

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$$$ SAVE! 4-DIGIT ALARM CLOCK

KIT NO.1 $13.95 (with PC Board)

FEATURES:

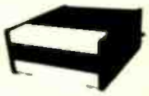
Direct drive display outputs. * Current control regulation on chip. * Low power brightness control on chip. * RFI eliminating slowup circuitry. * Sleep Radio feature. * 24 hr. snooze alarm. * Independent digit setting. * Non multiplexed output circuitry. 12V AC CT 1.2 amp transformer for Kit No. 1 $2.00

*KIT NO. 2

Complete kit with components, PC Board, Transformer, wood grain case and filter for display window. Includes .25 in. readouts. $21.50

KIT NO. 3

Complete kit with components, PC Board, Transformer, wood grain case and filter for display window. Includes .5 inch readouts. $22.50



* Components for Kit No. 2 or Kit No. 3 sleep radio feature, add $.95

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Completely self contained unit with 120 volt power cord included

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RCA 3043 FM If. Aud Preamp.	1.20
565 Phase Lock Loop	1.95
567V Tone Decoder	1.50
LM723 Pos. Volt. Reg	0.55
LM309 5v. Lamp Reg'	1.10
LM380 2w. Audio Amp. 8 pin dip	1.00
LM741 Operational Amp	0.25

TRANSISTORS-DIODES

RCA200V 115W T05 NPN		1.25
GE D40C1 NPN Darl		0.25
2N4443SCR 400\8A T0220		0.65
2N2222 NPN Gen Ampl		0.20
2N3904 NPN Driver		0.15
2N3906 PNP Compl. 2N3904		0.15
2N4400 NPN Low level noise		0.20
2N5401 PNP Nixie driver		0.25
1N4004 400PIV	15 for	1.00
1N4007 4000PIV	10 for	1.00
1N746 3.3 Zen	4 for	1.00
1N4148 Switch	20 for	1.00

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BARREL KIT #145 MINI TRANSFORMER 15 for $1.98. Miniature transformer back again. Asst. outputs, inter-stage and audio. Only 1" sq. Wt. 2 lbs. 9R3294

BARREL KIT #147 OVER-FLO FLUORESCENT NIXIES 5 for $1.98. Used originally in table top calculators. Brand new. Gas discharge type, color: Blue. Cat. No. 9R3288

BARREL KIT #151 INCANDESCENT 15 for $1.98. Importer sez, "Name your price". Hard to find 7-seg. 5V readouts. How good, asst sizes, we don't know. Can't test 'em. 9R3306

BARREL KIT #154 CLOCK CHIPS 20 for $1.98. We gathered an assortment of clock chip, alarm, calendar, beepers, who knows, all mixed. At these prices? Cat. No. 9R3308

BARREL KIT #155 MOLDED CAPACITORS 75 for $1.98. Asst. size voltages, red, green, yellow, blue plastic cases, axial leads. No. 9R3311

BARREL KIT #159 MODULAR SWITCHES 24 for $1.98. Centralab "push-ON" switches. TV-makers ex-cess. Dpdt, 6pdt, etc. Brand new. Cat. No. 9R3150

BARREL KIT #1 SN7400 DIP IC'S 75 for $1.98. Marked 14 and/or with 16 pin dips, may include gates, registers, flip flops, counters. Who knows! GUARANTEED SATISFACTION! Cat.No 9R2415 Untested.

BARREL KIT #2 LINEAR OP AMPS, DIPS 75 for $1.98. Untested. May include 709's, 741's, 703's, 560 series, 555 includes marked and unmarked. Cat.No. 9R2416

BARREL KIT #3 1N4148/914 SWITCHING DIODES 100 for $1.98. You never saw this before. Imagine famous switching diodes at these prices! Cat.No. 9R2418 Untested.

BARREL KIT #4 "4000" RECTIFIERS 100 for $1.98. Untested. These are the famous micro miniature rectifiers of the 1N4000 series. May include 25, 50, 100, 200, 400, 600, 800 and 1000 volters. Cat.No. 9R2417

BARREL KIT #5 SCRS, TRIACS, QUADRACS 40 for $1.98. All the famous plastic power tab type. Raw factory stock! All the 10 amp types. Cat.No. 9R2419 Untested.

BARREL KIT #160 V. REGULATORS 15 for $1.98. LM309KC TO-3 V.R.'s barreled. Bot by the pound, but who wants to ck em? Your gain. No. 9R3330

BARREL KIT #161 'POP' PLASTIC TRANSISTORS 25 for $1.98. Calculator maker dumps 2N3904's with some 2N3906's of 100% material. TO-92. Preformed. Cat. No. 9R3343

BARREL KIT #7 VOLUME CONTROL BONANZA! 40 for $1.98. 100% good. Singles, duals, variety of values, styles, big ones — small ones. Cat.No. 9R2421

BARREL KIT #8 SUBMINIATURE IF TRANSFORMERS 100% good. 100 for $1.98. Amazing, includes 455kcs, osc, antenna, who knows? From transistor radio manufacturers. Cat.No. 9R2422

BARREL KIT #10 ROMS-REGISTERS 50 for $1.98. Untested. 28 to 40 pin devices, marked, internal factory numbers, etc. Cat.No. 9R2424

BARREL KIT #12 POWER TAB TRANSISTORS 40 for $1.98. PNP, plastic TO220 type. Assorted 2N numbers. Cat.No. 9R2426 Untested.

BARREL KIT #13 RESISTOR NETWORKS 60 for $1.98. Untested. By Corning Glass, in 14-pin dip paks. Cat.No. 9R2427

BARREL KIT #14 PRECISION RESISTORS 200 for $1.98. Marked and unmarked ¼, ½, 2 watts. No. 9R2428

BARREL KIT #15 MOSFET TRANSISTORS 60 for $1.98. All 4 leaders TO-18 case. Includes UHF transistors too! Cat.No. 9R2429

BARREL KIT #17 LINEAR & 7400 DIPS Untested. 100 for $1.98. Marked and unmarked, internal numbers of raw factory stock. Cat.No. 9R2431

BARREL KIT #19 DIPPED MYLARS 60 for $1.98. Finest capacitors made, shiny finish. Imagine factory dumping 'em in barrels. Cat.No. 9R2597 100% good.

BARREL KIT #20 LONG LEAD DISCS 150 for $1.98. Factory distributor stock "auction sale". Prime, marked only. Long leads. Cat.No. 9R2598 100% good.

BARREL KIT #25 METAL CAN TRANSISTORS 100 for $1.98. Untested. Includes TO-5, TO-1, TO-18, etc., assorted 2N numbers, unmarked etc. Cat.No. 9R2603

BARREL KIT #26 PLASTIC TRANSISTORS 100 for $1.98. Untested. Type TO-92 (TO-18), all manufacturers, variety of 2N's. Cat.No. 9R2604

BARREL KIT #30 PREFORMED RESISTORS 250 for $1.98. We got barrels of ¼ and ½" watters for pc use. You'll get even amount. 100: ¼, 100 ½" watters. Cat.No. 9R2608 100% good.

BARREL KIT #31 METALLIC RESISTORS 100 for $1.98. Made mostly by Corning, the finest resistor made. Mostly ½ watters, 1% to 5% tol. & a barrel of values. Cat. No. 9R2609

BARREL KIT #32 TRANSISTORS WITH A HOLE IN IT 50 for $1.98. Cat.No. 9R2610 Untested. Can't name factory but we bought barrels of 25 watt-ers with mtg. hole in middle. PNP'S and NPN'S.

BARREL KIT #35 NEON LAMPS 30 for $1.98. 100% good. Famous NE-2's. All prime, but factory made millions and barrel'ed 'em. Your advantage. Cat.No. 9R2613

BARREL KIT #36 GERMANIUM DIODES 200 for $1.98. Untested. Famous maker, popular item. Never grows old. But this is the way the RE-TESTERS buy 'em from the factories. Cat.No. 9R2614

BARREL KIT #37 1 AMP "BULLETT" RECTIFIERS Untested. 100 for $1.98. Famous style, asstd. voltages, silicon, axial includes all types of voltages to 1KV. Cat.No. 9R2615

BARREL KIT #39 2N3055 HOBBY TRANSISTORS 15 for $1.98. 100% good. From factory to you, these fallouts of the famous 2N3055. We have 10 barrels. Cat.No. 9R2617

BARREL KIT #40 PNP HIGH-POWER TRANSISTORS 20 for $1.98. Popular germanium TO-3 case units, now available at "good ole barrel" prices. Cat.No. 9R2618 100% good.

BARREL KIT #46 G.E. 3.5 WATT AMPLIFIERS 25 for $1.98. Untested. Hobby type, factory fallouts, we purchased them in barrels. These are unknowns. Cat.No. 9R2624

BARREL KIT #50 SIGNAL SILICON DIODES 200 for $1.98. Includes many, many types of switching, signal silicon types, all axial leads. Some may be zeners. Cat.No. 9R2628 Untested.

BARREL KIT #53 JUMBO RESISTOR PAK 100-pc. $1.98. Cat.No. 9R2721. Assortm metal films, precisions, carbons, metal oxide powers, from ⅛ watt to 7 watts. Color coded & 100% good. Worth $10.

BARREL KIT #54 8 DIGIT READOUTS 7 for $1.98. Bargain of a lifetime! All we got was 1 barrel — the "bisdor digit" types. Multi-plexed. Cat. No. 9R2722

BARREL KIT #58 SLIDE SWITCHES 30 for $1.98. All shapes, sizes, spst, dpdt, momentaries, etc. Tremendous shop pak for 100's of switching projects. Cat.No. 9R2726 100% good.

BARREL KIT #59 POWER TRANSISTORS 40 for $1.98. 15 watt Bendix B-5000 pellet transistors, npn, all good, purchased from a pretester, have millions of. 100% good Cat.No. 9R2727

BARREL KIT #61 POLYSTYRENE CAPS 100 for $1.98. Finest caps made. As a gamble we bought 10 barrels from factory, mixed values; all good. Cat.No. 9R2729

BARREL KIT #65 MIXED READOUTS 15 for $1.98. Factory returns — such numbers as MAN-4's, MAN-7's, MAN-3's, 11 barrels & no time to separate. Cat.No. 9R2733 Untested.

BARREL KIT #68 2 WATTERS 100 for $1.98. 100% good. Nobody seems to want 'em! So many suppliers don't count, but throw 'em in the barrel. It's a li'l gold mine. All marked. Cat.No. 9R2735

BARREL KIT #71 CAPACITOR SPECIAL 100 pcs. $1.98. Emptied stockrooms into barrels of mylars, poly's, micas, moldeds, plastics, ceramics, discs, etc. Nifty 100% good. Cat. No. 9R2738

BARREL KIT #73 TRANSISTOR ELECTROS 50 for $1.98. It "bugs" us why the factories dump 'em in barrels. We don't wish to separate wide asst voltages & values up to 300 mf. Cat. 9R2747

BARREL KIT #75 400MW ZENERS 150 for $1.98. Factory out of biz! Amazing offer: 6, 8, 10, 12 to 16V. You test. Hermetically sealed glass pak. Double plug. Cat.No. 9R2740

BARREL KIT #76 1-WATT ZENERS 100 for $1.98. Untested. Factory same as 400-mw's. Never-to-see-again offer. 6, 8, 10, 12, 15V. under glass. Double plug. Cat.No. 9R2741

BARREL KIT #77 "BROWN" BODY TRANSISTORS 40 for $1.98. G-E D-40 series: has hi-voltage, Darlingtons, hi-current, npn's. Factory line discontinued. Power tabs. Cat.No. 9R2742 Untested.

BARREL KIT #81 SUBMINI RESISTORS 200 for $1.98. 100% good. PC, upright type, color coded, ⅛ watt. Asst values. Came to us in a barrel. Cat.No 9R2746

BARREL KIT #83 LM-340T VOLTAGE REGULATORS 15 for $1.98. Untested. Factory rejected them for length of leads. May include 5, 6, 8, 12, 15, 18, 24 volts. Power tab Cat.No. 9R2635

BARREL KIT #86 HOBBY LEDS 40 for $1.98. Untested. Wow! A Litronics dump of all kinds of mixed discrete LEDS, shapes, colors, good, poor, etc. 9R2859

BARREL KIT #87 NATIONAL IC BONANZA 100 for $1.98. Factory dumps into barrels. Types 8000, 7400 series, DTLs, ROMs, registers, clock & calc. chips, linears, etc. Cat.No. 9R2860 Untested.

BARREL KIT #88 LITRONICS LED READOUTS 10 for $1.98. 747's, 727's, singles, triples, etc. .33 to 0.6. Bot from factory, all mixed; have fun! No. 9R2861

BARREL KIT #91 SILVER MICAS 100 for $1.98. Cat.No. 9R3018. For the first time silver micas so low in price! Axial, red case, variety of physical sizes & values. Big savings from distributor prices. Wt. 1 lb.

BARREL KIT #93 HALF WATTERS 200 for $1.98. Untested. Resistor factory tried to fool us by mixing 100% color-coded resistors in barrel. But value is there. 4 oz. Cat. No. 9R3046

BARREL KIT #99 PHOTO ELECTRIC CELLS 10 for $1.98. Asst. GE types, CDS types. Mixed by factory. Big job for us to separate. 100% good. Cat.No. 9R3052

BARREL KIT #101 RESISTOR SPECIAL 200 for $1.98. Includes: ⅛, ¼, ½, 1, 2-watters, carbon. 8 oz. 100% good. 9R3054

BARREL KIT #104 SLIDE VOLUME CONTROLS 10 for $1.98. Cat.No. 9R3057. Used in hi-fi, volume control maker unloads. Asst. values, what a buy. Worth $1 ea. We've got barrels of 100% material.

BARREL KIT #108 MINI VOLUME CONTROLS 25 for $1.98. 1-Million pcs of 100%, 50K mini pots, ceramic case, long shaft. Eqpt maker unloads. 9R3058

BARREL KIT #108 TO-5 PLASTIC TRANSISTORS Cat.No. 9R3101. 40 for $1.98. Includes PNP, NPN, 2N-3638, 2N3641, 2N5000 series, etc. Untested, but guaranteed to a 60% yield.

BARREL KIT #109 TERMINAL STRIPS 150 for $1.98. Wide asst. of terminal strip connectors, from 1 contact up. Strip manufacturers barrel dump is your gain. Wt. 1 lb. Cat.No 9R3136

BARREL KIT #112 MICRO MINI LEDS 40 for $1.98. All the tiny leds, axial, upright of Monsanto, Litronix, variety of colors. Yield 50% or better. Cat.No. 9R3139

BARREL KIT #115 MOLEX SOCKETS 200 for $1.98. 100% good. Calculator maker dump! We got a zillion of 'em. Used for IC sockets, etc. Cat.No. 9R3144

BARREL KIT #116 BUTTONS 'N FEEDTHRU'S 100 for $1.98. 100% good. Truthfully worth a small fortune. Wide asst. of button-feedthru caps! HAMS TAKE NOTE! RF, UHF, etc. Wt. 1 lb. Cat.No. 9R3141

BARREL KIT #118 MINI SCRS 50 for $1.98. UNBELIEVABLE! TO-92 plastic SCRS in barrels . . . rite from factory. Includes all voltages up thru 200 prv. 9R3136

BARREL KIT #119 PRECISION RESISTORS 100% good. 2 ozs. 100 for $1.98. PREFORMED! Designed for printed circuit work. ¼, ½ w. Marked values, 1 and 2% values. 9R3205

BARREL KIT #126 UPRIGHT ELECTROS 40 for $1.98. Wide asst. of values from 1mf to 300mf in mixture of voltages. 100% marked 'n good. Why barreled? U-got-a-buy! Cat. No. 9R3226

BARREL KIT #127 AXIAL ELECTROS 40 for $1.98. Truthfully the factories (by mixing 'em in barrels) do all of us a favor. WUT A BUY! Asst. capacities and voltages. Cat. No. 9R3227

BARREL KIT #128 MINI DIP ICS 75 for $1.98. Large mfgr dumped 100's of lbs into barrels. Includes 741s, LM-380-8, 703, 567, 555, 558—but who knows? Factory to you. All mixed, you test. Wt. 1 lb. Cat. No. 9R3245

BARREL KIT #130 CRYSTALS! 12 for $1.98. 2 ozs. Large U.S. maker dumped frequency marked H/6U crystals in barrels. Some worth $5. Precision. Many in 8 mc. areas. 9R3250

BARREL KIT #131 TANTALUM ELECTROS 30 for $1.98. Mixed, marked prime, top grade asst. values, voltages. GE, Centralab, etc. Cat. No. 9R3255

BARREL KIT #133 C-MOS IC'S 60 for $1.98. Deliberately thrown in barrels, so we can't test 'em! The famous CD4000 series. How good? Who knows? Who cares? It's only 3c ea. Cat. No. 9R3257

BARREL KIT #134 CALCULATOR CHIPS 15 for $1.98. National type. Can be MM5736, 38, etc. They have discontinued these chips. FIND A USE. Untested. Cat. No. 9R3258

BARREL KIT #136 KLIP IN DIODES 50 for $1.98. 2 ozs. 100% good. Snaps into fuse type clip holder, 1N82 diodes. Metal ferrule type. No. 9R3261

BARREL KIT #137 OPTO SPECIAL 25 for $1.98. Untested. "Skinny C-Thru's". New, Monsanto, infra-red led, photo darlingtons, photo transistors. 9R3262

BARREL KIT #138 PANEL SWITCHES 30 for $1.98. Did you hear of OAK? Another eqpt maker barrelled all types of rotaries, electric, slides, etc. 9R3268

BARREL KIT #142 DARLINGTON TRANSISTORS 40 for $1.98. TO-92, a Motorola dump, unknown numbers, but high yield to good darlingtons. Retesters don't get 'em! You will. 3285

BARREL KIT #143 75-PC TRANSISTORS $1.98. 100% material, TO-92, factory discontinued lines, pnp's mixed with npns, 2N4400-1-2-3-4. Wut do you care, it's gud stuff. Cat. No. 9R3290

BARREL KIT #144 RCA PHONO PLUGS 40 for $1.98. 1,000,000 RCA phono plugs for this one. You hi-fi-ers know wut they are . . . 100% material. Look at the price. 9R3293

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311SM56 10A 125V Micro 2/1.50

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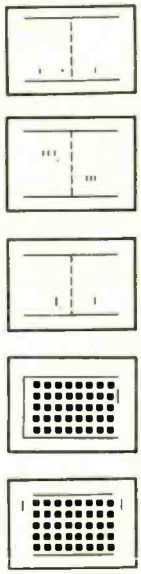

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6. Sound.
7. Basic TTL circuitry except for VK-6 proms.
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VK-1	PC Board Only Includes parts list & wiring Diagram requires VK-6	25.00
VK-2	PC Board with parts Includes PC Board, 78 IC's (those necessary are pre-programed) resistors & capacitors to stuff the board.	125.00
VK-3	Hardware Kit Controls, switches, wire Does not include Housing.	17.50
VK-4	RF Module Kit To convert video signal to TV receiver signal. Eliminates internal "wire in" on TV set.	22.50
VK-4-A	Antenna-Game Switch Allows outside antenna to remain connected while game is in use.	9.50
VK-5	Power Supply Kit For VK-1 or VK-2 PC Board ONLY.	12.50
VK-6	PROM Set 3 Programmed DM8574N with 2 DM8130N for VK-1 (If you have plenty of TTL).	50.00

LINEAR CIRCUITS

Package Codes
H-TO5 K-TO3 M-8 PinMin N-14 PinDip T-TO220

304H	Neg Reg	1.00	566H	V Cont OSC	1.50
305H	V Reg	1.00	566N(8)	V Cont OSC	1.50
306H	V Comp	2.25	567N(8)	Tone Decoder	1.50
307H	OpAmp	3/1.00	702H		1.00
307N(8)	OpAmp	3/1.00	703H	RF/IF Amp	2/1.00
308H	OpAmp	1.00	709H(14)	OpAmp	3/1.00
308N(8)	OpAmp	1.00	710H	V Comp	2/1.25
309H		1.10	710N(14)	V Comp	2/1.25
309K	5V Reg	1.25	711H	Dual Comp	2/1.00
310H	V Fol	1.15	711N(14)	Dual Comp	2/1.00
310N(8)	V Fol	1.15	723H	V Reg	2/1.00
311H	V Comp	1.00	723N(14)	V Reg	2/1.10
311N(14)	V Comp	1.00	725H	Instr OpAmp	2.00
318H	HiPerOpAmp	2.00	733H	Dif Vid Amp	1.00
318N(8)	HiPerOpAmp	1.50	733N(14)	Dif Vid Amp	1.00
320T-5V	Neg Reg	1.75	739N(14)	Dual Aud PreAmp	1.00
320T-6V	Neg Reg	1.75	740H	FET OpAmp	7.00
320T-8V	Neg Reg	1.75	741H	OpAmp	3/1.00
320T-12V	Neg Reg	1.75	741H(8)	OpAmp	3/1.00
320T-15V	Neg Reg	1.75	741N(14)	OpAmp	3/1.00
320T-18V	Neg Reg	1.75	747H	Dual OpAmp	2/1.50
323K-5V	Reg	6.00	747N(14)	Dual OpAmp	2/1.50
339N(14)	LoV Quad Comp	1.80	748H	OpAmp	3/1.25
340K-5	Pos Reg	1.95	748N(14)	OpAmp	3/1.25
340T-5V	Pos Reg	1.75	749N(14)	OpAmp	1.50
340T-8V	Pos Reg	1.75	760N(14)	Dif Vol Comp	4.25
340T-12V	Pos Reg	1.75	1303N(14)	Dl Ster PreAmp	1.00
340T-15V	Pos Reg	1.75	1414N(14)	Dual Dif Comp	1.75
340T-18V	Pos Reg	1.75	1458N(8)	Dual OpAmp	2/1.00
370H	AGC/SgAmp	1.15	1488N(14)	Quad MDTL Dr	2.00
370N(14)	AGC/SgAmp	1.15	1489N(14)	Quad MDTL Dr	2.00
373N(14)	AM/FM IF Det	3.25	1496N(14)	Mod-DeMod	1.00
380N(8)	Audio Amp	1.00	2900N(14)	Quad Amp	1.00
380N(14)	Audio Amp	1.25	3065N(14)	TV Snd Sys	2/1.50
381N(14)	Dual PreAmp	1.50	3900N(14)	Quad Amp	2/1.25
531H	OpAmp	3.00	3905N(14)	Prec Timer	2/1.25
550N(14)	Prec V Reg	1.00	3909N(14)		1.25
555N(8)	Timer	2/1.00	4136N(14)	Quad 741	1.75
556N(14)	Dual Timer	1.35	4558N(14)	Dual 741	2/1.00
565N(14)	Ph Lock Loop	2.00			

C MOS

34001	FSC	1.00
4000		4/1.00
4001		4/1.00
4002		4/1.00
4006		1.50
4007		4/1.00
4008		1.00
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4010		2/1.25
4011		3/1.00
4012		3/1.00
4013		2/1.00
4014		1.25
4015		1.50
4016		2/1.25
4017		1.25
4018		1.25
4019		2/1.25
4020		1.25
4021		1.50
4022		1.25
4023		3/1.00
4024		1.00
4025		3/1.00
4027		2/1.25
4028		1.25
4029		1.35
4030		2/1.25
4032		2/1.00
4033		2.00
4035		1.85
4040		2.45
4041		1.25
4042		1.25
4043		1.25
4044		1.25
4049		2/1.35
4050		2/1.35
4051		1.50
4052		1.50
4053		1.50
4060		3.00
4066		1.25
4069		3/1.00
4070		1.35
4071		2/1.00
4077		1.00
4081		2/1.50
4511		1.75
4512		1.75
4518		1.50
4520		1.65
4528		1.50

IC SOCKETS

	LoPro	Standard	Wire Wrap
8	5/1.00	—	—
10	—	4/1.00	—
14	4/1.00	4/1.25	3/1.00
16	4/1.25	3/1.00	3/1.25
18	4/1.25	—	—
24	3/1.00	3/1.25	2/1.50
28	—	3/1.12	2/1.50

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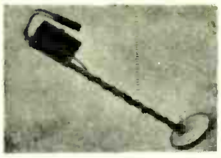

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