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THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

inside
TV GAMES
for '77

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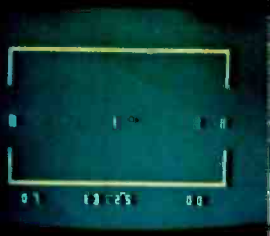
TV PROJECTION
systems



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THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

DECEMBER 1976 Vol. 47 No. 12

ON THE COVER

TV games are fun, frustrating, entertaining and educational. The Fairchild game shown on the cover is different from most in that it can have new games added to its repertoire. The cover photos were provided by Fairchild Camera and Instr See a full report on the latest games starting on page 39.

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looking ahead

From game to IVD

As many a lover has learned, what starts out as an innocent little game can end up as something very sophisticated—and serious. Now the "video game" industry is learning this lesson, and (to badly mix a metaphor) has discovered it has a tiger by the tail.

It's estimated that perhaps as many as 3,000,000 video games were sold in 1976—most of them of the innocent "paddle-and-ball" or tennis variety. These attach to the television set's antenna terminals, and they're fun—and after a while they tend to get monotonous. You could call them gadgets and they sell as low as $29.95 if you're a sharp shopper. But they've pried the lid off Pandora's box, and your home TV set may never be the same. (See our roundup of TV games in this issue of **Radio-Electronics**.)

The first of the "second-generation" video games are beginning to appear. These are home versions of coin-operated arcade games—tank games, space exploration games, race games, target games. But still games. The third generation, scheduled to appear shortly after New Year's Day, will have outgrown the "game" label. Nobody really knows what to call them, but "interactive video devices" or IVD will do until someone thinks up a catchy name.

These are the microprocessor-based devices, which will make possible an entirely new type of home electronic product. Programmed by cartridges containing ROM (read-only memory) IC's or audio cassettes, they'll convert the home TV set into a Professor Quiz with multiple-choice questions for students, a drawing-board for color sketches by the artistically inclined, an Answer Man for those with complex questions—in short, the TV set will become the display panel for a home minicomputer. These IVD's are expected to start in price below $150, with program cartridges running anywhere from about eight dollars to $20. The first cartridges will program the units for complex and sophisticated games, but later ones are expected to abandon the game approach completely for home problem-solving. And don't be surprised if you have an electronic typewriter keyboard in your home to let you ask your television set important questions—perhaps before the year is out.

Another interesting variation on the IVD theme may be in the works—cable TV "games." Warner Communications, one of America's biggest CATV operators, recently purchased a controlling interest in Atari, a major video game producer. Planners at Warner indicate they may eventually add "game" channels to the cable. These might permit home-to-home game competition with a two-way cable system, or eventually even such sophisticated pursuits as chess games with a central CATV computer, or access to a time-shared computer to solve a wide variety of problems, courtesy of your home IVD. At last you can talk back to your TV set.

Home VTR race

You can also interact with your TV—in a way—via a home video recorder. Four different (and mutually incompatible) home videocassette recorders are now on the market in Japan. Two of them—Sony Betamax and Sanyo's V-Cord II—are now available in at least some areas of the U.S. A third system is expected to be marketed soon by Quasar, a fourth by one of Japan Victor's subsidiaries in the United States. Sony's Betamax, the most widely distributed unit, plays or records for one hour per cassette. The Sanyo V-Cord has a cassette that operates for one hour in the conventional mode, or two hours by skipping every other field of the TV picture. The Quasar machine gets 100 minutes and JVC has two-hour playing time.

Why is playing time so important? Because these machines are being promoted as "time-shift" devices—equipped with timers, they can do your viewing for you, record programs while you're away from home, or while you're watching another show. Then you can view the program you missed at your convenience.

Is one hour enough? Sony says it usually is. Its competitors say no. Just in case, Sony has developed a new version of its Betamax machine which will get two hours' recording and playing time out of the same 492-foot reel of cassette tape which now gives only one hour. The seeming miracle was accomplished by cutting tape speed in half, reducing track width by half and using a new head and an associated change in electronic circuitry.

VTR tape economy

Because of the changed situation in videotape, I've revised the table that was first printed here in Aug. 1975, ranking the various home and industrial video recorders in order of economical tape usage. In the table below, the systems marked with an asterisk (*) are not in production.

System	Speed (ips)	Tape Width	Sq. ft./hour
* Betamax 2-hr.	0.79	1/2"	10.3
JVC	1.34	1/2"	16.5
V-Cord (skip)	1.45	1/2"	18.2
Betamax	1.57	1/2"	20.5
VX-2000	2.05	1/2"	26.2
* LVR	120.00	1/4"	26.8
* MagTape	1.53	3/4"	28.0
V-Cord	2.91	1/2"	36.5
* Cartrivision	3.80	1/2"	47.5
Akai	10.00	1/4"	62.5
Philips VCR	5.60	1/2"	70.0
Sony U-Matic	3.75	3/4"	70.3
EIA-J Type I	7.50	1/2"	93.8

The Betamax two-hour system is still developmental but could come this year. The LVR is a longitudinal 28-track system being developed in Germany and the U.S. by the German tape firm BASF. MagTape is the discarded RCA home videocassette system. Cartrivision shot briefly across the U.S. horizon before its backers went bankrupt; it's a skip-field system. V-Cord II is listed twice in the table, in the standard mode (one hour per cassette) and in the skip-field mode (two hours). EIA-J Type-I is the standard Japanese endless-loop cartridge recorder. Figures are approximate and are computed from manufacturers' specs.

Wired cities

Although most of the talk about the "wired city" of the future has been heard in the U.S., the Japanese seem to be doing more about it. The first Japanese wired city is now in experimental operation in a suburb of Tokyo, and the second—which will use fiber optics instead of coaxial cable—is scheduled for operation by 1979 or 1980.

The Tokyo-area system serves about 300 families in a 12,000-apartment project, Tama New Town. In addition to supplying off-the-air TV, it includes pay TV, a local studio in the project, facsimile newspapers, teletext on-screen information, a "request service" for still pictures and other information, a two-way educational channel which permits children to watch the instructor, ask and answer questions by voice line.

The second project, near Osaka, will be more elaborate, with 29 channels into homes, five in the other direction. Among its features will be a service whereby viewers can order videotapes transmitted into their homes; facsimile request service for documents from libraries; cashless shopping in which the subscriber inserts his credit card into a special machine in the apartment; reservation service for hotels, airlines, beauty parlors and clinics.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

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NESDA elects Pershing president

Over 200 delegates, representing more than 2,000 members of the National Electronic Service Dealers Association (NESDA), met at the Palacio del Rio in San Antonio, TX, last August 16, for the 1976 Annual Convention.

Everett Pershing, Burbank, CA, was elected President for the 1976-77 term. He is the owner of Pershing Radio & TV, a sales and service firm that has been in business since 1935.

Mr. Pershing was NESDA Senior Vice-President last year, and earlier was Vice President of the 9th Region of NESDA, which includes California, Nevada, Arizona and Hawaii. He was Chairman of the Electronics Hall of Fame in 1975-76, and has held every office in the California State Electronics Association, from local association president to two consecutive terms as President of the state association.

Other officers elected at the San Antonio convention are: Senior Vice President, Kurt Wertheim, Kurt's Furniture, San Antonio, TX; Secretary, John McPherson, Mac's TV, Yorktown, VA; Treasurer, Jack Kelley, Sage & Sand TV, Litchfield Park, AZ. Last year's president, Leroy Ragsdale of Ft. Smith, AR, will fill the Executive Committee position of Immediate Past President.

Regional Vice Presidents are: Region 1. Charles Yung, Jr., New Caanan, CN; 2. Warren Baker, CET, Albany, NY; 3. Walter Cooke, CET, Hampton, VA; 4. Herschel Lawhorn, CET, Perry, GA; 5. Dave Garwacki, CET, Toledo, OH; 6. George Simpson, Ft. Worth, TX; 7. Keith Knos, CET, Liberal, KS; 8. Tom Thomas, CET, Pueblo, CO; 9. Bill Lawler, Los Angeles, CA; 10. Bob Villont, CET, Tacoma, WA.

Direct vision and LED display combine in new aviator's helmet

A new helmet-mounted symbolic display makes it possible for a pilot to see symbolic information superimposed on his normal view while he looks in various directions. He can thus receive directives or advisory information without having to look straight ahead or down at instruments.

The unit includes a standard flying helmet with modified visor, a prismatic optical system, an LED array, a microelectronic assembly mounted inside the top of the helmet and a lightweight cord to connect to data and power sources in the cockpit.

The LED array contains 460 point elements, arranged in a 20 × 23 matrix. The elements are at 0.01 inch (0.3 mm) pitch, enabling a large variety of stationary and moving symbols to be generated and displayed.

The helmet manufactured by Marconi-Elliott Avionic Systems, Ltd., is being tested by the Navy at Point Mugu, CA.

A. Christ, J. Homay, R. Graham are Gernsback Award winners

Radio-Electronics makes an award annually to the most deserving student in each of eight leading home-study electronics schools. The Hugo Gernsback Memorial Award, named after the founder of this magazine who throughout his lifetime worked for the encouragement and development of electronic knowledge among the youth, is a check for $150.

Through the generosity of two test equipment manufacturers, it has been possible to add a second and third award. The second prize winner each month receives a B & K model 280 Digital Multimeter and the third winner on RCA WV-529 Service Special VOM.

Winner for this month is A. H. Christ. Originally from Syracuse, New York, he now works for General Electric in an area of Alaska so remote that he has an APO Seattle address. He reports that the nearest city is Anchorage, 1400 miles back on the mainland.

Christ, a veteran of four years in the Marine Corps during World War II, has been employed at General Electric for 25 years. In 1972 he started working on a new job in the Field Programs Department and has worked on his Alaskan island ever since. General Electric encourages its employees, through the G-E Individual Development program, to study an approved course to improve their job skills. As part of this program, Mr. Christ enrolled in Electronics Technical Institute.

A. H. CHRIST

Given his work location, he is well pleased with his home-study program in electronics. "ETI courses are ideal for anyone working at a remote site. I have found the courses fairly priced, interesting and comprehensive". He plans to continue his training. "One is never too many years too young to learn and I have derived enough knowledge from Digital Electronics and Advanced Electronics that I'm looking forward to Communications and practical information for on-the-job training."

Mr. Christ is a widower. His two daughters have families of their own and

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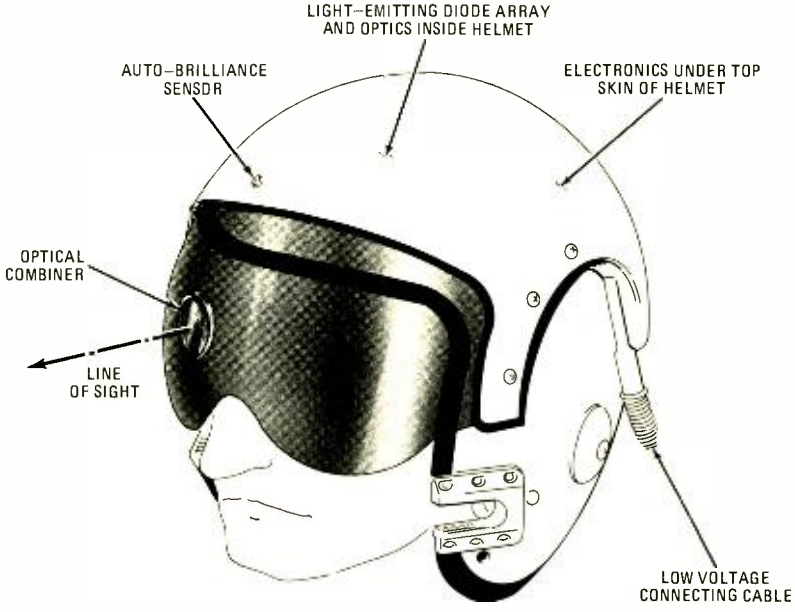

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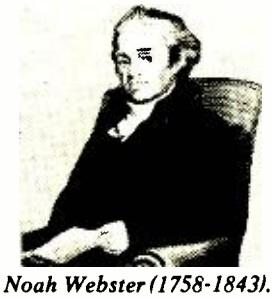

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new & timely

continued from page 6

he reports that his son Ronald, who will soon graduate from high school, spends a great deal of time on the air with his Citizens band rig.

Runner-up is Joseph E. Homay, of Easton, PA, who receives a B & K digital multimeter. After graduating from high school, he enrolled in the Warren County, NJ, Vocational and Technical School where he studied electronics technology. He completed the course in 1970.

He then decided to enlist in the U.S. Navy to take advantage of the excellent training programs available to servicemen. After boot camp he was assigned to the Basic Electricity and Electronics School, which was followed by Electrician's Mate School and Motion Picture Projector School. While on sea duty, Homay continued his training. He enrolled in the United States Armed Forces Institute and completed the Fundamentals of Radio and Radio Servicing course.

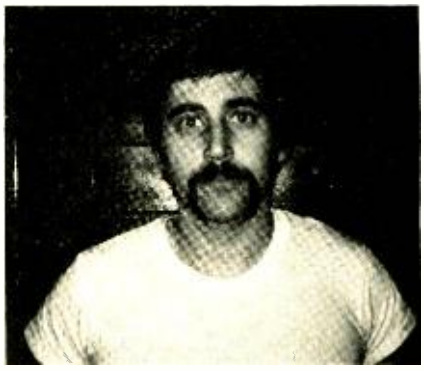
Homay is now employed as a maintenance technician for the American Can Company, which makes thermoformed plastics in its Easton plant. "Much of my work involves the installation and maintenance of solid-state equipment used to control production temperatures precisely", he says. "Exceedingly aware of the servicing problem we faced, I enrolled in Electronics Technical Institute's Advanced Solid-State Electronics course."

JOSEPH E. HOMAY

Homay reports, "This course was superb in relation to the actual working conditions of semiconductors in equipment and the configurations used to achieve ultimate system control. It has strengthened my trouble-shooting techniques and has exposed me to the finer points of testing and maintaining solid-state equipment. This course has been valuable to me in the position I hold with the company."

Mr. Homay feels that, with all the advances in electronics technology, he's got to keep learning. "I saw the chance and I took advantage of it. Thank you, ETI, for all your help—I'll be back!"

Third prize goes to Robert Graham, Jamaica, New York. He first became interested in electronics as a boy in Charlotte, NC. While still in high school, he enrolled in his first Radio and Television Servicing home-study course and began repairing radio and television receivers.



ROBERT GRAHAM

Soon after, he decided there was a better future in communications. "I made a survey of courses given in communications by several schools", he says, "and found the course offered by Electronics Technical Institute the best. I enrolled in the school and completed the FCC Communications course."

Organized service dealers Survey their own numbers

Service Shop magazine made a survey of the electronics service dealers who attended the 1976 National Electronic Service Dealers Association convention in San Antonio, TX, with the idea of determining the size and average value of their sales and service departments.

The survey indicates that the NESDA members in attendance had an annual service department volume (including parts sales) of $227,000 and that their products sales (CB's, TV's, radios and audio products) approximated $114,700 per dealer. Incidentals and other lines brought the average gross volume in 1975 to $373,296.

The survey also discovered that service shops operated by NESDA members are larger than the national average. The service dealers surveyed employed just under seven technicians per shop—two and one-half times the national average of 2.8. The dealers sampled also employed an average of 4.3 sales and clerical people per shop.

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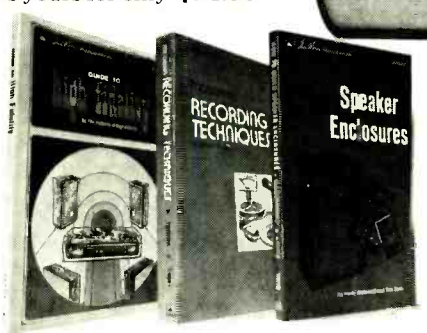

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Introductory prices for the Altair 8800b are $840 for a kit with complete assembly instructions, and $1100 for an assembled unit. Complete documentation, membership into the Altair Users Club, subscription to "Computer Notes," access to the Altair Software Library, and a copy of Charles J. Sippl's Microcomputer Dictionary are included. BankAmericard or Master Charge accepted for mail order sales. Include $8 for postage and handling.

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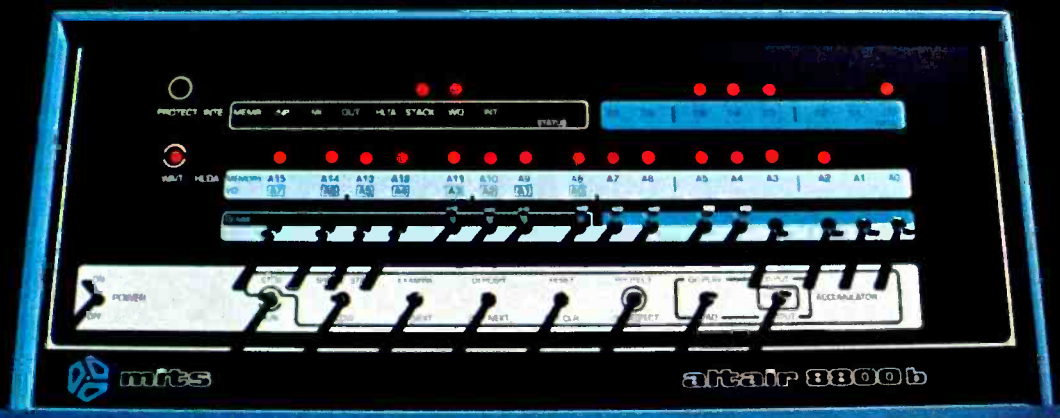

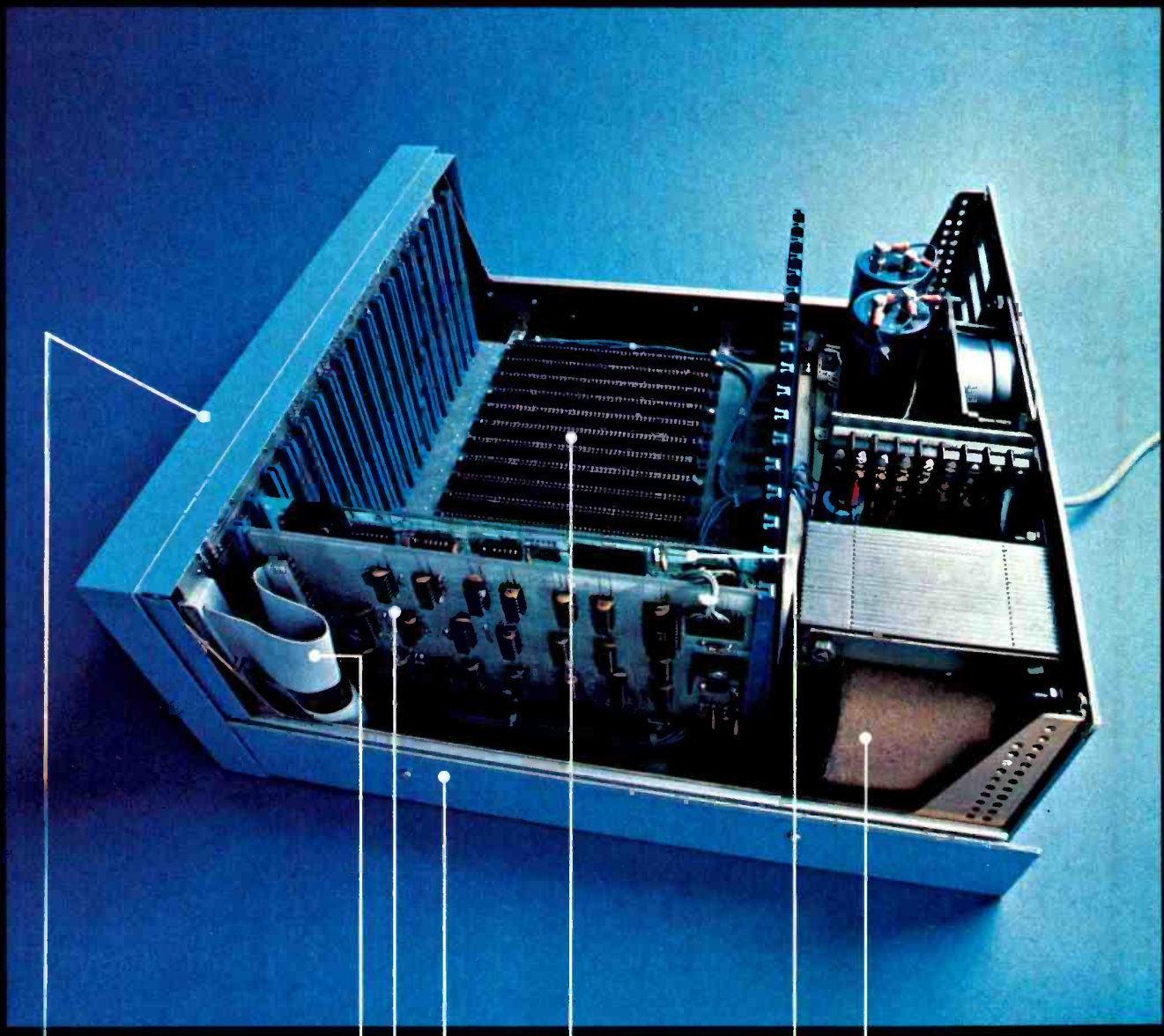

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CIRCLE 30 ON FREE INFORMATION CARD

letters

GREAT TV GAME

I enjoyed your article "Build This Great TV Game" in the June, July and August 1976 issues of **Radio-Electronics.** I used the author's ideas to build a similar unit. There are some errors in the schematic that other readers may be interested in. Also, I came up with some modifications that can easily be made to the circuit.

The schematic appeared on pages 36 and 37 of the June issue. The errors are as follows: IC5-b pin-4 also connects to IC13-a pin-3. The output of IC5-d (pin 13) is listed as being connected to, among others, IC18 pin 3. This is incorrect. Change IC18 pin-3 to IC13 pin-13. Another error is in the output connection of IC14; pin 8 is listed as being connected to IC18 pin-9. This should be changed to IC18 pin-10. The collector of Q1 should also connect to IC4 pin-8. The output of IC13-b is pin 9. The 510-ohm resistor on the output of IC13 pin-7 is R37.

As far as the modifications are concerned, there are three. First, to automatically enable the paddle only after the ball crosses the center line or after it hits the bumper, rather than having control of the paddle during the entire duration of ball travel across the screen, do the following: Delete the connection between IC10 pin-9 and IC12 pin-5. Also delete the connection between IC10 pin-12 and IC12 pin-13. Add two 7400 IC's and wire as shown in Fig. 1.

The bumper can be made smaller by grounding pin 5 of IC24 and parallel R68 with a 100K resistor (or change R68 to 80K.) The bumper can also be made randomly transparent to the ball, but always visible on the screen, by removing the +5 volts from pin 4 of IC25 and wiring the unused half of IC10 as shown in Fig. 2.

J. E. ROHEN
Apalachin, NY

MORE ON TV GAMES

Many readers of the June, July, and August 1976 issues, who followed the Great TV Game story, might be interested to know of two recent changes: joystick paddle controllers are now included as standard items (replacing the rotary potentiometers), and the price has been reduced to $129.50 including the custom case and power supply.

A new low-priced version called Econ-O-Kit is also available at $57.50. It's based on the same design and identical PC board as the one featured in the construction article.

Readers can obtain more information by sending $1.00 (refundable with purchase) for an information packet to Visulex Corporation, Box 4204, Mountain View, CA 94040.

DAN PICHULO
Visulex
Mountain View, CA

PHOTO PROJECTS

I commend you and the publishers of **Radio-Electronics** for the formidable efforts presented month after month with do-it-yourself projects that can perform outstanding feats of wizardry. With all this outstanding talent, I would like to see a few projects that would assist thousands of persons like myself who are interested in photography.

The first is an enlarging analyzer/calculator for color printing. Many are on the market for $100 and up but I am sure something could be built for much less that would be as (if not more) accurate than commercial units.

The second project I would like to see is a reasonably priced voltage stabilizer (150-200 watts) for printers and enlargers. Another would be some method of checking shutter speed and strobe light outputs.

The photography business is becom-

continued on page 20

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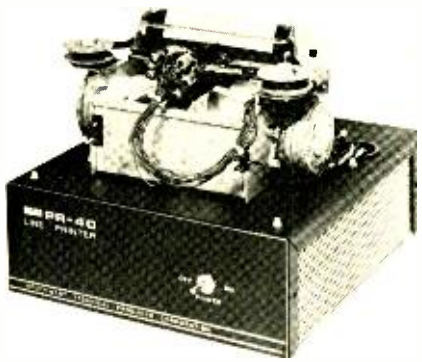

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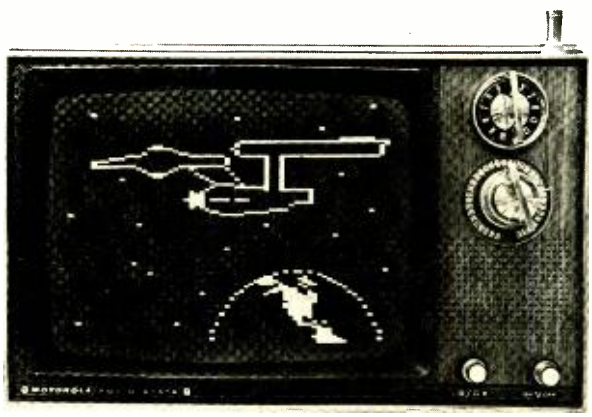

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With its optional Programmer, this Computer TV system allows you to program your set for an entire evening's viewing. The top bank of 8 keys [1] accesses the static NMOS RAM and turns the on-screen clock display into a computer CRT readout which allows you to see your "program" as you enter it through the bank of 12 keys below the programmer panel. The selected time appears in the first four digits of the clock display, the channel number appears in the last two. First, enter the time at which you want the set to change channels. Next, enter the channel number you want. Then the memory takes over. While you sit back and relax, the Programmer automatically changes to the right channel at the right time. You can program up to 32 channel changes within two 12/24-hour periods!

Those two programming periods add extra versatility. Program the first for your daytime viewing schedule, the second for evening shows. Or, program the first for week nights, the second for weekends. You can even preselect the programs young children can watch — once the programmer is engaged, the manual keyboard is disconnected and can only be reactivated by the remote control or by pressing the correct button on the programming panel.

You can even program the set to return to manual operation at a preselected time, then resume automatic operation at another time. When the last program you want to see is over, the set can be programmed to switch to an empty channel. This will cause the screen to go blank and the on-screen readout to flash on and off indicating that it is time to turn the system off with the front panel pushbutton or optional remote control.

Convenient Remote Control

The optional wireless remote control [2] lets you adjust volume, turn the set on or off, adjust tint, activate the digital readout, scan up or down through the preselected channels, and turn the optional programmer on and off — all at the touch of a button. This wireless remote control has improved circuitry for greater range and reliability and is the best we've ever offered.

Random Access Tuning

The 3 x 4 keyboard [3] lets you instantly choose any of up to 16 preselected stations — up to 24 with the optional eight channel accessory. Switch from VHF to UHF, up or down, in any sequence, and be tuned in instantly without switching through empty channels. Up and down buttons on the keyboard also let you scan all the preselected stations.

Automatic Antenna Rotor Control

A Heathkit exclusive! With the optional antenna rotor control [4], you can program the GR-2001 to automatically rotate your outdoor antenna system as it changes from one channel to another, for optimum reception on every channel. No special knobs to turn, no buttons to push. You can select up to eight separate antenna headings with up to three stations per heading. It's perfect for areas where stations are in widely separated locations.

Superb Color and Sound

The TV set itself contains dozens of circuit refinements and improvements designed to give you the best picture and performance you've ever seen. The Automatic Gain Control circuit, for example, has been significantly improved to better resist airplane flutter. And since you build it yourself, you can be assured of a set that is free of mass production "glitches" that show up all too often in other sets now on the market. Other improvements are listed below.

Separate Audio IF Stage

The audio circuitry is probably the finest on any commercial set in the world. The sound signal has its own separate IF stage [5] to dramatically reduce the "buzz" caused by the picture carrier modulating the sound. You can hear the difference — especially if you use the output jack to connect the GR-2001 to your stereo system. The built-in wide-range speaker offers excellent fidelity as well. It's one of the first sets ever to give you real hi-fi sound from a TV!

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New phase-locked-loop horizontal and vertical oscillators [6] "lock-in" on any channel for a picture that's rock-steady and stable. There are no conventional vertical and horizontal hold controls because you never need them! There are no alignment problems either, so you get consistently excellent pictures year after year.

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The GR-2001's 25" (diagonal) ultra-rectangular picture tube [7] provides one of the brightest, sharpest pictures in the world. The tube is fully shielded to maintain outstanding color purity by eliminating stray magnetic fields.

Easy To Assemble

Though the GR-2001 is one of our more complex kits, the average person shouldn't have any difficulty in assembling it. A step-by-step illustrated manual will lead you through assembly right up to troubleshooting and testing. And if you do happen to need assistance, help is only a phone call away. A complete staff of Technical Consultants will answer all your questions. We won't let you down.

GR-2001 Specifications

Deflection: Magnetic 90°.
Focus: Electrostatic.
Convergence: Magnetic.
Antenna Input Impedance: VHF: 300Ω balanced or 75Ω unbalanced. UHF: 300Ω balanced.
Picture IF Carrier: 45.74 MHz.
Sound IF Carrier: 41.25 MHz.
Color IF Subcarrier: 42.17 MHz.
Sound IF Frequency: 4.5 MHz.
Video IF Bandwidth: 4.08 MHz at 6 dB down.
Hi-Fi Output: Frequency Response: ±1 dB, 50 Hz to 15 kHz.
Output Voltage: Greater than 1.0 V RMS.
Audio Output: 4Ω or 8Ω, 2 Watts.
Power Requirement: 110 to 130 Volts AC, 60 Hz, 200 Watts.
Kit Net Weight: 146 lbs.
GR-2001 TV kit alone (chassis, picture tube and one speaker): 699.95

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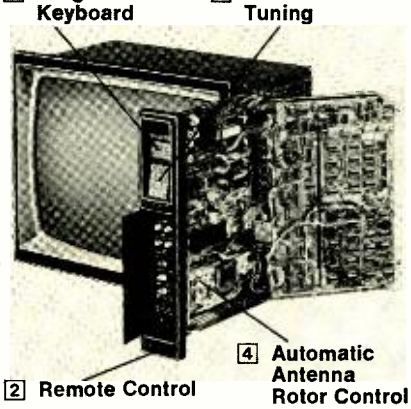

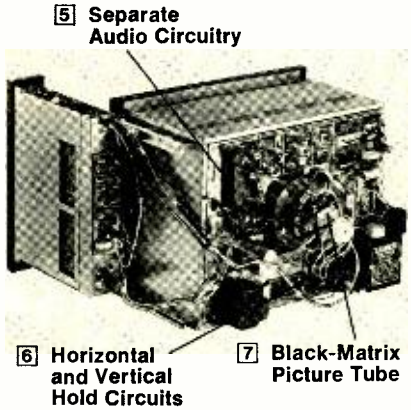

the world's only computerized TV system.

FREE INFORMATION CARD

LETTERS

continued from page 16

ming more and more dependent on electronics and I feel that **Radio-Electronics** and its contributors would assist readers greatly if these and other photography projects were published.

How about it? Would some of you out there in your basement/garage laboratories design some of these projects and submit it to **Radio-Electronics.** Lots of us out here would appreciate it. Thanks.

DANIEL A. MARCEK, SR.
Nashua, NH

CLASS G

I have just read the article on Class-G amplification that appeared in the August 1976 issue. I thought it was not only interesting, but well written and informative.

Regarding the possible confusion between Classes A, B, C, D, E, F, and S. Class G seems a satisfactory name, since the multivoltage mode of operation does differ from other modes or classes. However, I hope that various manufacturers will use some restraint and not start naming their amplifiers Class H, Class Z, etc., when they have only minor circuit differences from others. I hope also that they will not try to make class definitions their own trademarks. Either of these will only add confusion to the field.

FREDERICK H. RAAB
Burlington, VT

CLASS-G REPLY

Thank you for your letter. As a matter of fact, Hitachi, wisely or not, has decided to call their circuit a "Series E" circuit rather than Class G, which they had at first proposed when I discussed this new, efficient circuit with them some months ago. Mr. Sampei, who originated the practical circuits used, was evidently aware of the conflict between Class E and his own circuit innovation, but the sales department of Hitachi prevailed, and Series E it will be. This change was made too late for inclusion in my article in **Radio-Electronics.**

You are quite right in saying that classes of amplification should not be assigned with utter abandon.

LEN FELDMAN
Contributing Hi-Fi Editor

LONG DISTANCE TV

I need help in selecting a TV booster. The area that I live in (Melbourne) is 60 miles to the nearest TV station with additional stations located in Miami and Tampa some 150 miles away. Standard TV boosters amplify too much noise and adjacent channel interference, so I think that I need a "tuned" or switched type of booster. Has any reader of **Radio-Electronics** found any method of getting in such long distant stations with reasonably good picture quality? Does anyone know of a manufacturer that makes a switchable TV booster?

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TIM BARRY

WE PREVIOUSLY DISCUSSED THE DATA TRANSfer and arithmetic/logic instructions that can be performed by the 8080. This month we conclude this presentation with a discussion of the transfer of control and processor control instruction groups. (You may wish to refer to the two previous columns for an explanation of some of the features mentioned and the notations used to represent various register groups, data types, and data transfers.)

Transfer of control instructions

Any instruction that is used to transfer the execution of the program from where it is currently executing to another place in memory is considered to be a member of this group. Transfers of control can be considered to be either *returning* or *non-returning*: A non-returning transfer, once executed, has no way of knowing the memory address that it was transferred from because it does not save the address of the next instruction to be executed prior to executing the transfer. A returning transfer, on the other hand, saves the address of the next instruction where the program is executing before the transfer is executed. This saved address can be used later in the program to return control to the place in the program where the transfer occurred. A non-returning transfer is usually called a *program jump* or a *program branch*. A returning transfer is usually called a *subroutine call*. The transfer of control back to a returning transfer is usually called a *subroutine return*.

Transfers of control—whether jumps, calls or returns—can be considered to be either *conditional* or *unconditional*. Unconditional transfers are executed whenever they are encountered, regardless of the state of the processor flags. Conditional transfers are executed based upon the state of internal processor flags. If the specified condition is met, the transfer takes place. If the condition is not met, the instruction is ignored and execution continues on (i.e. Jump if zero, call if no carry, etc.). Different processors have different flags, and hence different conditional instructions. However, all computers will have some conditional instructions, because this is the feature that allows the processor to respond to the results of tests and operations performed by the arithmetic/logic unit.

The 8080 offers both returned and unreturned transfers of control. The unreturned transfers are called *jump* instructions, the returned transfers are called *call* instructions, and the returns to the addresses saved by returned transfers are called *return* instructions. These transfers are all available in both conditional and unconditional forms. In addition, there is one indirect unconditional transfer instruction (PCHL) and a group of special truncated unconditional subroutine calls (RST).

The returning transfer-of-control instructions executed by the 8080 save the return address in the area of memory addressed by the stack pointer. Before the transfer is executed, the program-counter address where execution is to return is pushed into the top two locations of the stack. When a return is executed, the contents of the top two locations of the stack are popped into the program counter, thereby transferring control to that location.

This is a very convenient way to handle subroutine return addresses, but it requires us to pay careful attention to the stack operations performed by the rest of the program. We have other program operations that can *push* and *pop* data using the stack. If these operations don't match properly, the stack pointer may not be pointing to the correct return address when a subroutine return is executed. When this happens, something other than the intended return address is placed into the program counter. This results in the execution of a "return to random address" instruction, usually followed immediately by a dramatic change in program execution. To avoid this problem, you must always make sure that data is taken out of the stack in the reverse order that it is put into it. It also means that the last subroutine called

continued on page 24

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must be the first one returned. The number of unreturned subroutine calls that have been executed prior to the first return being executed is called *subroutine nesting*. When you hear a programmer say that his program is "nested four deep" at some point, he means that four subroutines have been called and none have executed returns. Keeping track of subroutine nesting and data transfers with the stack is called *balancing the stack*, and it is essential to correct program operation.

In addition to balancing the stack, you must be sure that no program operations inadvertently modify the contents of the stack. This can happen when the stack nesting causes it to overlap with other assigned program storage. It can also happen when some routine that transfers data into memory gets out of control and overruns into the stack area. To avoid these problems, it is best to locate the stack in an area of memory that is not used by any other portion of the program. If this is not possible, you must compute stack usage based on nesting and stack use and allocate an area among the rest of your program storage for stack use. The stack is a very powerful feature, but it must be used with care to avoid problems.

Unconditional transfers of control

This group of 8080 instructions is executed whenever they are encountered during program execution.

JMP Addr (3)
Operation Performed: $Addr_{0-15} \longrightarrow PC_{0-15}$
The 16-bit address included with the instruction is loaded into the program counter.

CALL Addr (3)
Operation Performed: $(PC_{8-15}) \longrightarrow [SP-1]$
$(PC_{0-7}) \longrightarrow [SP-2]$
$Addr_{0-15} \longrightarrow PC_{0-15}$
$(SP) + 2 \longrightarrow SP$
The address of the next instruction to be executed after the subroutine returns is pushed onto the stack. Then the 16-bit address included with the instruction is loaded into the program counter.

RET (1)
Operation Performed: $[SP] \longrightarrow PC_{0-7}$
$[SP + 1] \longrightarrow PC_{8-15}$
$(SP) + 2 \longrightarrow SP$
The contents of memory addressed by the stack pointer are popped into the program counter, transferring control to that location.

PCHL (1)
Operation Performed: $(HL) \longrightarrow PC$
The contents of the HL register are transferred into the program counter. (This instruction was also included as a data-transfer instruction.)

RST L (1)
where L is an integer in the range 0-7.
Operation Performed: $(PC_{8-15}) \longrightarrow [SP-1]$
$(PC_{0-7}) \longrightarrow [SP-2]$
$8*L \longrightarrow PC_{0-15}$
$(SP) + 2 \longrightarrow SP$
The RST instruction is actually a call instruction which is hardware defined to call a fixed block of memory locations. Upon execution, a RST instruction behaves exactly as a subroutine call to the location 8*L. Thus the instruction RST 1 would be equivalent to CALL 8. A transfer initiated by a RST instruction is returned using a return instruction, exactly like any other subroutine call. The RST instructions are provided so that an external device can interrupt the 8080 and provide a single-byte instruction to transfer to a device-service routine.

Conditional transfers of control

The 8080 provides a wide selection of conditional transfer instructions. The state of the four ALU flags (carry, zero, sign, and parity) can be used to determine the execution of jumps, calls or returns. The condition code symbols used to represent these various flag conditions are as follows:

Symbol	Condition Tested
Z	Transfer if zero
NZ	Transfer if not zero
C	Transfer if carry
NC	Transfer if no carry
P	Transfer if sign flag is plus
M	Transfer if sign flag is minus
PE	Transfer if parity flag is even
PO	Transfer if parity flag is odd

A conditional transfer is formed by adding the appropriate character prefix (J for jump, C for call, or R for return) to the condition symbol. Jump if parity even would thus be

continued on page 30

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continued from page 24

JPE. call if sign is minus would be CM, and so on.

J(COND) Addr (3)
Operation Performed: If (COND) is true, then $Addr_{0-15} \longrightarrow PC_{0-15}$, otherwise $(PC) + 3 \longrightarrow PC$

If the condition code specified is true, transfer to the location specified by the 16-bit address included with the instruction. Otherwise, continue execution with the next instruction.

C(COND) Addr (3)
Operation Performed: If (COND) is true, then
$(PC_{8-15}) \longrightarrow [SP-1]$
$(PC_{0-7}) \longrightarrow [SP-2]$
$Addr_{0-15} \longrightarrow PC_{0-15}$
$(SP) - 2 \longrightarrow SP$,
otherwise
$(PC) + 3 \longrightarrow PC$

If the condition code specified is true, the address of the next instruction to be executed upon return is pushed onto the stack and control is transferred to the location specified by the 16-bit address included with the instruction. Otherwise, continue execution with the next instruction.

R(COND) (1)
Operation Performed: If (COND) is true, then $[SP] \longrightarrow PC_{0-7}$
$[SP + 1] \longrightarrow PC_{8-15}$
$(SP) + 2 \longrightarrow SP$,
otherwise
$(PC) + 1 \longrightarrow PC$

If the condition code specified is true, the top elements of memory as addressed by the stack pointer are popped into the program counter, transferring program execution to that location. Otherwise, continue execution with the next instruction.

Processor control instructions

Computers provide a small group of instructions that can be used to control the operation of the actual CPU hardware. These instructions are concerned with enabling and disabling the computer's interrupt facility, setting up I/O device priority, halting and resetting the processor and so on. These instructions are not used often, but it is important to understand their operation for those times when you will need them and want to use them.

The 8080 has four processor-control instructions. These instructions include an instruction that does nothing (often needed, believe it or not), a computer-halt instruction, and instructions to enable and disable the processor's response to interrupts.

NOP (1)

The NOP operation does nothing. It is present in the instruction set to allow you to delete operations when debugging, leave space for program additions and provide a fixed execution time interval for use in program timing loops.

HLT (1)

The HLT operation causes the processor to halt execution. Halting the processor should be done with care, since once halted it can only be restarted by a hardware reset or an interrupt. If the processor interrupt structure is disabled and you halt it, you lose. Generally, the processor should never be halted. If you can't find something useful for it to do, turn the computer off and save the energy.

EI (1)

The EI instruction is used to enable the 8080 to accept interrupts from external devices. It is important to remember that one of the 8080's hardware characteristics is that it disables the interrupt facility when it acknowledges an interrupt. You must therefore include an EI instruction somewhere in your device-service routine if you want to be able to process further interrupts.

DI (1)

The DI instruction is used to disable the acceptance of interrupts from external devices. It is used primarily to lock-out interrupts during time sensitive sections of code. In this case, the time required to service the interrupting device could introduce errors into the program. This type of condition is seldom encountered, and you should use the DI instruction with caution. Anytime you have the interrupts disabled there is the possibility that data will be lost when a device interrupt request is denied.

This article concludes a presentation of the 8080's instruction set. We have now studied the 8080 from both a hardware and a software standpoint. We can now start to examine actual programming techniques and digital systems using the 8080. **R-E**

Illegal New Jersey CB gear confiscated by authorities

More than $10,000 worth of illegally used CB radio equipment was seized last July 22 in a crack-down on illegal Citizens band operators in the northern New Jersey area. The United States Attorney for the District of New Jersey, John L. Goldstein. United States marshalls, accompanied by agents of the FCC from Maryland, Pennsylvania and New York, simultaneously executed seven search warrants in Waye, Parsippany, Troy Hills, Upper Saddle River, Wayne, Patterson and Whippany, seized the equipment and closed down the stations.

Among the violations with which the operators were charged were transmission on unauthorized frequencies, which, Goldstein said, jeopardized police, fire, rescue and aircraft communications, as well as interfering with legitimate CB users, government radio use, public and special industries radio services and even AM/FM and television reception.

Federal law provides penalties up to $500 per day, per offense, for violation of FCC Rules and Regulations, and one year's imprisonment and a $10,000 fine for unlicensed use. **R-E**

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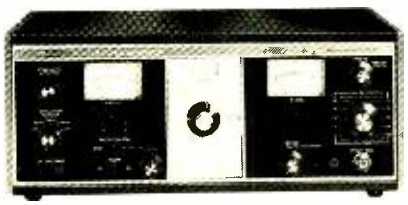

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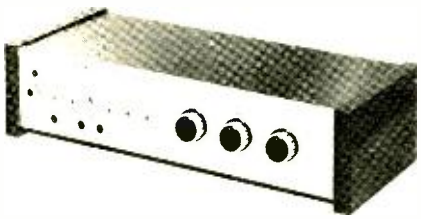

IN A SOUND SYSTEM, A GOOD AUDIO PREAMP should minimally distort and add negligible noise to the amplified signal. The preamp must also be versatile since it is the switching center between the input sources, power amplifier and tape recorder inputs. Heath's AP-1615 meets these requirements nicely in an attractive low-cost package.

Except for the power transformer and related parts, connectors and switches, all components mount on a single printed-circuit board. Kit assembly is easy and after some soldering practice, a beginner should be able to do a reasonable job.

The AP-1615 is divided into three distinct sections: the phono input stage, a high-level preamp stage and the headphone filter/amplifier. Input signals from the turntable are boosted by a low-noise µA739 integrated circuit operational amplifier stage. The frequency and noise performance of the phono preamp is determined primarily by the input stage. Noise and hum are specified at 65 dB with respect to rated output. The µA739 IC is used only for the two phono-input positions on the front-panel SELECTOR switch. For other signal sources, the input to this stage is grounded.

Stabilization and frequency characteristics of the phono preamp are controlled by the feedback components. The feedback network shapes the frequency response to within ±0.5 dB of the RIAA equalization characteristic from 30 Hz to 15 kHz. Sensitivity is 2 millivolts for rated 1.5 volt (RMS) output. The input impedance is comprised of 65 pF of capacitance and 47,000 ohms resistance.

Second in the signal chain is the high-level

continued on page 37

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preamp that gets its input from the phono preamp, or TAPE MON. AUX. TUNER or TAPE DUB connectors. The signal passes through the BALANCE and VOLUME controls on the way to the base of the first transistor. Complementary NPN-PNP output transistors are used in a heavily degenerated configuration known for its low noise and distortion. Three series diodes form the bias network across the two base-emitter junctions of the output transistors. The inherent no signal DC idling current of this arrangement minimizes crossover distortion.

The stage has a sensitivity of 180 millivolts and has a voltage gain of 9.2 set by the ratio of two feedback resistors. This accounts for the amplification needed to produce the 1.5-volt rated output.

Next is the headphone filter/amplifier, similar in design to the intermediate stage. This stage uses a current sink for the collector load at the input of its complementary output transistors for high open-loop gain. Both the preamp output connector and the headphone front-panel connector are driven through current-limiting resistor networks.

The headphone filter/amplifier uses an RC network in its feedback path to create an active filter when selected by the front-panel switches. Filter characteristics are maximally flat Butterworth responses. The high-cut (low pass) filter is 3-dB down at 7 kHz and reduces disc scratch, tape hiss, and FM background noise. Rumble, record warp, and room vibrations are attenuated by the low-cut filter with a 3-dB corner at 15 Hz.

continued on page 80

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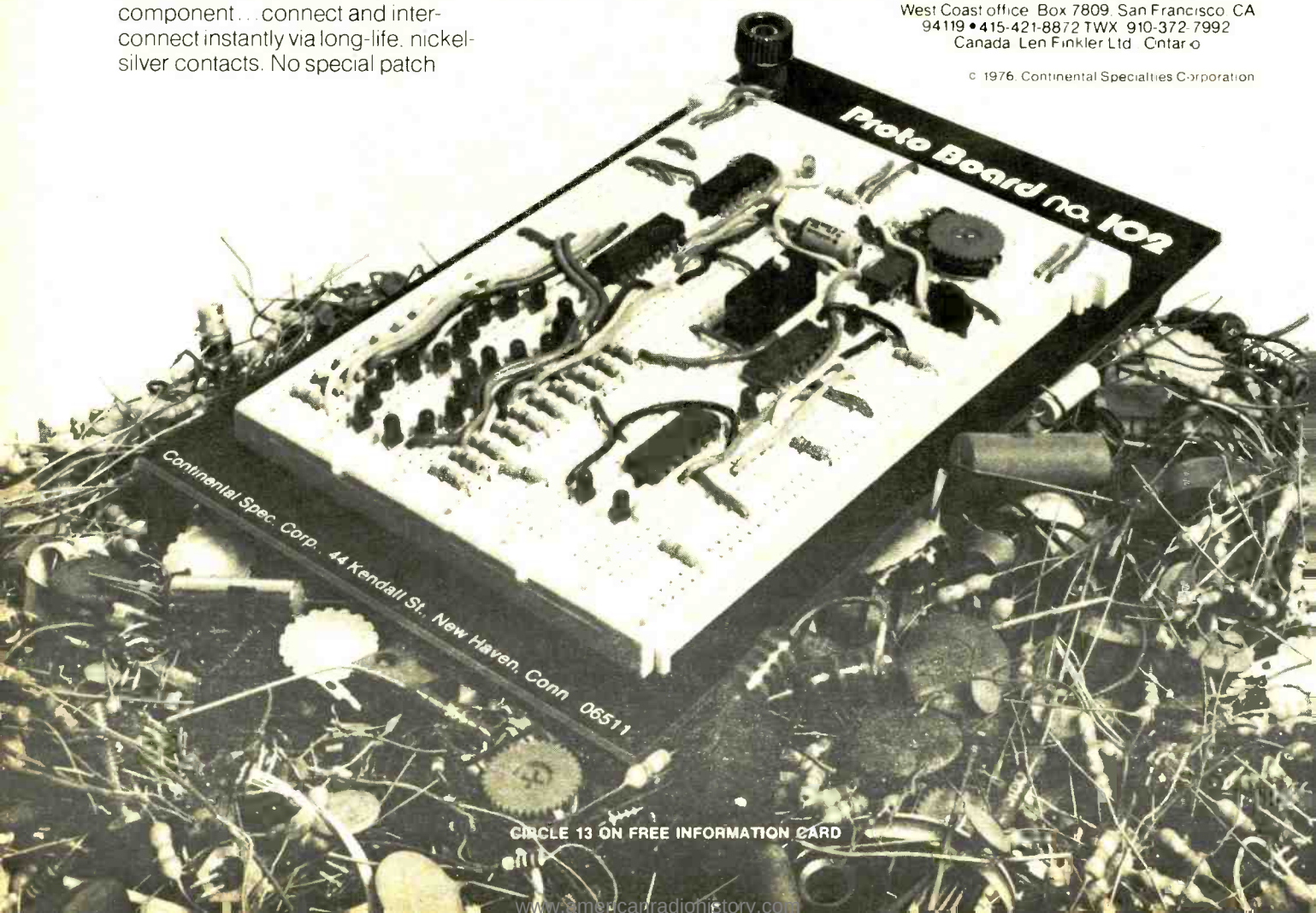

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ROUNDUP

TV Games

New competition for prime time viewing adds a new dimension to an old medium

FRED BLECHMAN

DURING 1975, THE MARKET FOR ELECTRONIC TOYS, GAMES AND amusements expanded abruptly into one of the most exciting and potentially profitable segments of the consumer electronics industry. This was due largely to the success of the home video-game, introduced by Magnavox in 1972 under the *Odyssey* name. Atari, a leader in the coin-operated video game field, introduced *Pong* through Sears and Roebuck stores in 1974.

Now video games are hitting the home market in a big way, with some industry officials estimating sales of 12 million units annually by 1980! It's no wonder that over 40 firms are manufacturing completely ready-to-operate home video-games for use with television receivers, and several others are offering kits or plans to build your own.

FCC regulations

A black cloud hovering over this potentially lucrative market, however, is the Federal Communications Commission. Home TV games are essentially miniature television transmitters whose video output ideally should be connected directly into the video input circuitry of the receiver being used to display the game. Unfortunately, most TV sets don't have a video input jack, and adding one requires a qualified technician. (See **Radio-Electronics**, August 1976 issue, page 57, for how this can be done). For this reason, ready-made TV games designed for home use contain a low-powered video modulated RF transmitter, usually operating on Channels 2 through 6 of the VHF TV-band. This TV signal is fed to the antenna terminals of the TV receiver through a switch that disconnects the regular TV antenna during game play. The FCC requires that these games—considered a Class-I TV Device under Part II, Paragraph 15, Subpart H, of the FCC *Rules and Regulations*—not emit more than 15 microvolts-per-meter of RF energy. Many of the designs submitted for approval under these regulations radiated between 40 and 80 microvolts-per-meter! Furthermore, the Regulations have no provision for approval of a separate video-modulated oscillator—the entire game must be submitted and approved as a unit. Even the antenna switch must satisfy FCC isolation requirements (at least 60-dB attenuation) to prevent the game signal from "leaking" out the TV antenna and being broadcast all over the neighborhood!

With game interference complaints on the increase, the FCC is taking an even harder look at their approval specifications, and may soon tighten them further. It doesn't take much imagination to see the threat this places on the manufacturers. At this time, many units still have not received FCC approval and they may not legally be announced, advertised or sold before such approval. Violators are being aggressively dealt with by the FCC. Doing any of the following may cause interference to nearby television sets and is against FCC regulations: using longer-than-supplied twin lead wires from

Comparison chart on pages 40 & 41
text continues on page 42

COMPARISON CHART – VIDEO GAMES AND KITS

MANUFACTURER OR DISTRIBUTOR	GAME NAME OR MODEL	GAME	KIT	PLANS	NUMBER OF GAMES	NUMBER OF PLAYERS	COLOR DISPLAY	PADDLES/PLAYERS: SIZE VARIABLE	MOVE VERTICAL	MOVE HORIZONTAL	KNOB	LEVER	JOYSTICK	REMOTE CONTROLS	BALL: DEFLECTION VARIABLE	SPEED VARIABLE	SCORING: ON-SCREEN DIGITAL	ON-SCREEN MARK	MANUAL	SERVE: AUTOMATIC	MANUAL	AUTOMATIC PLAY	SOUND	MONITOR BUILT-IN	POWER: BATTERIES	AC	AC ADAPTOR	IC USED	FCC APPROVED	PRICE ($)	NOTES & REMARKS
ADVANCED ELECTRONICS P.O. BOX 133 CORVALLIS, OR 97330	PONG			●	7	4		●	●	●			①		●	●	●			●			●			●			⑧	5	①②③④⑤⑦
	ANTI-AIRCRAFT 1 & 2			●	2	2			●	●	⑤						●				●		●			●			⑧	8	①②③④⑤⑦
	JAWS-2 & SPACE RACE			●	2	2			●	●			●				●				●		●			●			⑧	8	①②③④⑤⑦
ADVANCED MICROCOMPUTER PRODUCTS P.O. BOX 17329 IRVINE, CA 92713	6 TV GAMES ON ONE CHIP			●																									1	②
			●		6	2		●	●				①		●	●	●			●	●	●	⑨			⑩		GI	⑧	70	
ALLIED LEISURE INDUST., INC. 245 W. 7th PLACE HIALEAH, FL 33014	THE NAME OF THE GAME #I	●			6	4	●	●	●		●			●		●	●			●		●	●		?			⑪		98	
	THE NAME OF THE GAME #II	●			4	2	●		●		●			●			●			●		●	●		?			⑪		78	
AMCOR, LOS ANGELES, CA (ADDRESS UNKNOWN)	TABLE MODEL	●			1	4																						⑧	495	
	BAR MODEL	●			1	4																						⑧	495	
APF ELECTRONICS, INC. 444 MADISON AVE. NEW YORK, NY 10022	TV FUN® (MODEL 401)	●			4	2		●	●		●				●	●	●			●		●	⑨			●		GI	●	89	
ARS SYSTEMS P.O. BOX 1922 SUNNYVALE, CA 94088	BASIC TV PING-PONG			●	1	2			●	●			①						●	●								⑤	⑧	⑫	⑦⑩
ATARI, INC. CONSUMER DIV 1195 BORREGAS DR. SUNNYVALE, CA 94086	C-100 PONG™	●			1	2	●		●		●					●	●			●		●	●		●		●	AMI		80	
	C-140 SUPER PONG™	●			4	2	●		●		●					●	●			●		●	●		●		●			90	
	C-160 PONG DOUBLES	●			1	2	●		●		●					●	●			●		●	●		●		●	EI		80	
BROADMOOR (OLYMPIC INT'L) 26 GENERAL PLACE JERICHO, N.Y. 11753	FOUR-PLAY	●			2	4											●							●					⑧	199	
CAL KIT, INC. P.O. BOX 877 SEBASTOPOL, CA 95472	PING-PONGTRONICS		●		4	2				●	●				●	●		⑫		⑫	●	●	⑫			●		⑤	⑧	55	②⑦
CHANNEL MASTER ELLENVILLE, N.Y. 12428	CHALLENGER	●			4	2			●								●						●					GI		80	DID NOT REPLY TO INQUIRY
COLECO INDUSTRIES, INC. 945 ASYLUM AVE. HARTFORD, CT 06105	6040 TELSTAR™	●			3	2		●	●		●					●	●			●		●			●		●	GI	●	60	⑨
	TELSTAR™ CLASSIC	●			3	2		●	●		●					●	●			●		●			●		●	GI	●	70	⑨
CONTINENTAL MICROSYSTEMS, INC. 11347 VANOWEN ST. NORTH HOLLYWOOD, CA 91609	V44B BANG	●			4	2		●	●			●		●	●	●	●			●	●	●	●				●		GI		70	⑨
	V44C BANG	●			4	2	●	●	●			●		●	●	●	●			●	●	●	●				●		GI		90	⑨
	V44C5 BANG	●			6	4	●	●	●			●		●	●	●	●			●	●	●	●				●		MOS		110	⑨
DYN 3095 NW 77th AVE MIAMI, FL 33122	PADDLE-FOUR	●			4	2								●			●												GI	●	79	
	PADDLE-SIX	●			6	2								●			●														124	
ENTERPREX INTERNATIONAL CORP. 1231 NORTH BROADWAY LOS ANGELES, CA 90012	APOLLO 2001	●			4	2		●	●			●			●	●	●			●	●		●		●		●	GI	●	90	⑨
ENTEX 1016 E. BURGROVE CARSON, CA 90746	TELE-PONG	●			3	2			●	●	●					●			●	●		●	●		●				●	85	
EXECUTIVE GAMES, INC. DORCHESTER, MA 02124	TV TENNIS	●			3	2								●											●		●		●	69	DID NOT REPLY TO INQUIRY
	FACE-OFF	●			2	2		●	●	●			●																	90	
FAIRCHILD CAMERA & INST. CORP. CONSUMER PRODUCTS GROUP 4001 MIRANDA AVE. PALO ALTO, CA 94303	VIDEO ENTER-TAINMENT SYSTEM	●			26	2	●							●			●						●						F8		under 150	⑬ ⑭
FANTASIA 1098 RANDOLPH AVE. RAHWAY, N.J. 07063	FANTASIA 101	●			4	2										●	●												GI		59	DID NOT REPLY TO INQUIRY
FIRST DIMENSION CORP. 708 BERRY RD. NASHVILLE, TN 37204	VIDEO SPORTS™ 76	●			4	2		●	●		●				●	●	●												GI		69	⑨
	VIDEO SPORTS™ 76C	●			4	2	●	●	●		●				●	●	●														79	⑨
	VIDEO SPORTS™ MARK IV	●			3	2	●	●	●			●				●	●						●		●		●	NS		79	
	MODEL FO 3000W	●			6	4										●		●				●	●		●		●			129	⑮
FRIED TRADING CO. 167 CLYMER ST. BROOKLYN, N.Y. 11211	GRANADA	●			4	2																							GI		79	DID NOT REPLY TO INQUIRY
GLOBAL VIDEO INDUST., LTD. 1818 WESTLAKE AV. NORTH, SEATTLE, WA 98109	CHALLENGE	●			1	4																		●					⑧		50" DIAGONAL SCREEN
HEATH COMPANY BENTON HARBOR, MI 49022	GO-1380 SPORTSCREEN™		●		6	2		●	●			●		●	●	●	●			●	●	●	●			⑱		GI	⑧	50	⑯ ⑰ ⑨
I.E.A. DOWNSVIEW ONTARIO, CANADA	TELETAINMENT II	●			7	2			●		●						●				●				●		●					
INTERFAB 27963 CABOT RD LAGUNA NIGUEL, CA 92677	TV TENNIS		●		4	2		●	●	●	●		⑫	●		●	●			●		●	●			●		⑤	⑧	⑲	
INTERNET LOS ANGELES (ADDRESS UNKNOWN)	CONCERT HALL IV	●			4	2																									79	TELE-MATCH UNDER PRIVATE LABEL
INTERSTATE INDUST., INC. 111 SOUTH WASHINGTON BLVD. MONDELEIN, IL 60060	TELE-MATCH 4400	●			4	2		●	●		●			●	●	●	●			●	●		●		●		●	GI	●	70	⑨
	TELE-MATCH 7700	●			4	2		●	●		●			●	●	●	●			●	●		●		●		●	GI		80	DIFFERENT CASE ⑨
JADE CO. 2007 W. CARSON TORRANCE, CA 90501	VIDEO GAME KIT		●		5	2			●		●				●	●	●			●		●	●			●		⑤	⑧	⑲	4 SOUNDS 3 PROM'S

COMPARISON CHART – VIDEO GAMES AND KITS (Continued)

MANUFACTURER OR DISTRIBUTOR	GAME NAME OR MODEL	GAME	KIT	PLANS	NUMBER OF GAMES	NUMBER OF PLAYERS	COLOR DISPLAY	PADDLES/PLAYERS: SIZE VARIABLE	MOVE VERTICAL	MOVE HORIZONTAL	KNOB	LEVER	JOYSTICK	REMOTE CONTROLS	BALL: DEFLECTION VARIABLE	SPEED VARIABLE	SCORING: ON-SCREEN DIGITAL	ON-SCREEN MARK	MANUAL	SERVE: AUTOMATIC	MANUAL	AUTOMATIC PLAY	SOUND	MONITOR BUILT-IN	POWER: BATTERIES	AC	AC ADAPTOR	IC USED	FCC APPROVED	PRICE ($)	NOTES & REMARKS
JAMES ELECTRONICS P.O. BOX 822 BELMONT, CA 94002	PROFESSIONAL VIDEO GAME		●		4	4			●	●			●	●		●		●		●		●	●			●			(5)	(8)	(19)	IC'S ASSEMBLED TO PCB AND PRE-TESTED
KENDALE TECHNOLOGY 814 PONCE DE LEON BLVD. CORAL GABLES, FL 33134	KEN-TECH 3000	●			3	2																								100	DID NOT REPLY TO INQUIRY
LLOYD'S 180 RARITAN CENTER PKWY. EDISON, N J 08817	MONTE VERDE	●			6	2								●		●													●	100	DID NOT REPLY TO INQUIRY
	LLOYD'S	●			6	2																				●				100	
LTA 9615 COZYCROFT CHATSWORTH, CA 91311	HOMEMACHINE	●			4	4											●							●					(8)	1495	(DID NOT REPLY TO INQUIRY) FREE-STANDING SELF-CONTAINED UNITS. ADD-ON GAME MODULES @ $200 EACH.
	ATTACHE CASE MODEL	●			30	?																		●					(8)	3000	
MAGNAVOX 1700 MAGNAVOX WAY FORT WAYNE, IN 46804	ODYSSEY®100	●			2	2			●		●				●				●	●			●		●		●	TI	●	60	
	ODYSSEY®200	●			3	2			●		●				●			●		●			●		●		●	TI	●	80	
	ODYSSEY®300	●			3	2			●		●				●	●	●			●			●		●		●	GI		70	(9)
	ODYSSEY®400	●			3	2			●	●	●				●	●	●			●			●		●		●	TI		100	(21) (22) (9)
	ODYSSEY®500	●			4	2	●		●	●	●				●	●	●			●			●			●		TI		130	(21) (9)
	MODEL 4305	(20)			3	2	●		●		●			●	●	●	●			●			●	●	(20)				(8)	500	(9) 19" COLOR TV WITH GAME BUILT-IN
MEGO (TOY CO.) (ADDRESS UNKNOWN)	PHASER BATTLE	●			1	1																						TI		40	
MICROLECTRONIC SYSTEMS CORP. ONE ELECTRONICS COURT MADISON HEIGHTS, MI 48071	RICOCHET™	●			4	2	●	●	●		●			●	●	●	●			●	●	●	●		●		●	GI	●	100	(9) DID NOT REPLY TO INQUIRY
MORSE 101-10 FOSTER AVE. BROOKLYN, N Y 11236	ELECTROPHONIC SUPER-PRO	●			6	4								●											●		●	GI		99	DID NOT REPLY TO INQUIRY
NATIONAL SEMICONDUCTOR CONSUMER PRODUCTS DIV. 1177 KERN AVE. SUNNYVALE, CA 94086	ADVERSARY	●			3	2	●	●	●			●		●		●	●				●	●	●			●			NS		99	(23)
PHONE-MATE INC. 325 MAPLE AVE TORRANCE, CA 90503	ZONK	●			4	2																						GI		99	DID NOT REPLY TO INQUIRY
	ZONK	●			6	2																								119	
QUADTRONICS (ADDRESS UNKNOWN)	MODEL Q476	●			4	2	●																					GI	●	80	
RADIO SHACK 2617 WEST SEVENTH ST. FORT WORTH, TX 76107	TV SCOREBOARD™	●			4	2	●	●	●		●			●	●	●	●			●	●	●	●		●		●	GI	●	100	(9) SAME AS RICOCHET EXCEPT GAME NAMES
RADOFIN ELECTRONICS 10 B ENGLEHARD AVE. AVENEL, N H 07001		●			4	2								●						●	●							GI		50	DID NOT REPLY TO INQUIRY
SHARK ELECTRONICS LTD. 19 W. 44TH ST. NEW YORK, N Y 10036	MECCA	●			4	2																						GI		89	DID NOT REPLY TO INQUIRY
SOUTHWEST TECHNICAL PRODUCTS 219 WEST RHAPSODY SAN ANTONIO, TEXAS 78216	SPACE WAR GAME		●		1	2			●		●			●					●		●				●			(5)	(8)	39.50	VIDEO OUTPUT ONLY
TOKYO PHOENIX, INC. 375 SYLVAN AVE. ENGLEWOOD CLIFFS, N J 07632	MULTI HOME VIDEO GAMES	●			4	2		●	●		●				●	●	●			●	●	●	●		●		●	GI	●	80	(23)
UNISONIC PRODUCTS CORP. 1115 BROADWAY NEW YORK, N Y 10010	TOURNAMENT 1000	●																												99	
	TOURNAMENT 2000	●			6	2								●				●										GI	●	119	DID NOT REPLY TO INQUIRY
	TOURNAMENT 3000	●			6	4																								149	
UNIVERSAL RESEARCH LABS, INC. 2501 UNITED LANE ELK GROVE VILLAGE, IL 60007	VIDEO ACTION IIA™	●			3	4			●		●						●			●		●	●							●	299	
	VIDEO ACTION III™	●			3	4	●		●		●					●	●			●		●	●		●		●			●	199	(25)
	VIDEO ACTION IV™	●			4	4	●		●		●					●	●			●		●	●		●						100	(25) (26)
	VIDEO ACTION GAME TABLE	●			4	4			●		●					●	●			●		●	●	●		●			(8)	475	(25) (26)
	VIDEO ACTION™ FACT	(27)			7	2																●			●		●			300	(26)
VIDEOMASTER AMERICAN CONSUMER ELECTRONICS 21 BREWSTER RD. CORNWALL, N Y 12518	VIDEOMASTER™ RALLY	●			4	2			●		●					●			●		●	●			●					70	
	VIDEOMASTER™ OLYMPIC	●			7	2			●		●					●			●		●	●			●					100	
	VIDEOMASTER™ 6000	●			6	2		●	●			●				●	●			●		●	●		●			GI		150	
VISULEX P.O. BOX 4204 MOUNTAIN VIEW, CA 94040	SUPER SMASH		●		2	2		●	●	●			(1)			●	●			●		●	●			●			(5)	(8)	(19)	(2) COMPLETE INFO IN JUNE, JULY AND (7) AUGUST, 1976 ISSUES OF RADIO-(12) ELECTRONICS

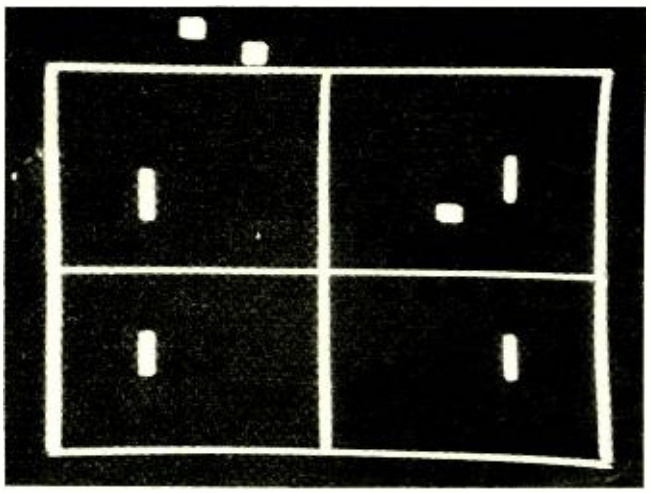
LEGEND

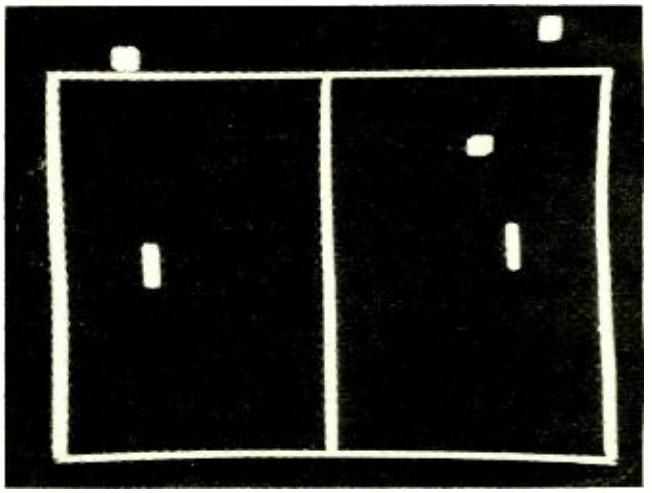
(1) BUILDER DETERMINES PLAYER CONTROLS
(2) IC'S & PC BOARDS OFFERED. SEE TEXT
(3) SCORES UP TO 99 POINTS EACH
(4) 7 MORE PONG OPTION PLANS - $7 EXTRA
(5) DISCRETE IC'S USED. SEE TEXT
(6) SWITCHES ARE USED FOR PLAYER CONTROLS
(7) FOR ADVANCED BUILDERS ONLY
(8) FCC APPROVAL NOT REQUIRED. SEE TEXT
(9) THREE DIFFERENT SOUNDS. SEE TEXT
(10) POWER SOURCE IS BUILDER'S OPTION
(11) GI OR MPS CHIP USED
(12) OPTIONS AVAILABLE. SEE TEXT
(13) REPLACEABLE CARTRIDGES PROGRAM MICROPROCESSOR
(14) ELAPSED TIME DISPLAYED
(15) BOUNDARIES ADJUSTABLE
(16) RIFLE AVAILABLE EARLY 1977
(17) WIRES DIRECTLY TO HEATHKIT TV'S
(18) DRAWS POWER FROM TV SET
(19) SEE TEXT
(20) GAME BUILT-IN TO COLOR TV SET
(21) WALL CENTER CONTROL
(22) TENNIS-DOUBLES SWITCH
(23) SOUND THRU TV
(24) RIFLE INCLUDED
(25) VARIABLE ROBOT SKILL
(26) ROAD RACE GAME INCLUDED
(27) EDUCATIONAL GAME
(28) INCLUDES 2 CARTRIDGES

the antenna switch to the TV: connecting the twin lead from the antenna switch to any television antenna or cable TV outlet; or attaching loose wires to your TV antenna terminals when the antenna switch is connected to your TV.

The kit builder

The necessity of FCC approval affects the consumer by cutting down the number of available choices—but there are still plenty to choose from and they are quickly and easily attached to the TV, legally. For the hobbyist or experimenter, however, who likes to "roll his own" from plans or a kit, the problem is that no units are sold in kit form with oscillator parts. The instructions might show a modulated oscillator circuit, however, and the builder finds himself in a dilemma: Readily available circuits in radio handbooks show typical VHF oscillators that he can build from easily obtained standard parts—but if he does so, he may be violating FCC regulations regarding transmission frequency or allowable radiated energy. It takes relatively sophisticated test equipment and procedures to assure compliance with FCC requirements.





A way out of this dilemma is offered by ATV Research (13th and Broadway, Dakota City, NE 68731). They offer the *model PXV-2A Pixe-Verter* transistorized oscillator in kit form for $8.50 postpaid. This kit has been on the market for over 10 years with a perfect record for not causing interference when properly assembled in a metal box (or within existing shielded equipment) and operated according to the instructions. It is built on a printed-circuit board that contains a foil output-inductor; the builder selects operation on TV Channels 2 through 6 by tapping into the appropriate turn of this printed-circuit coil with a jumper.

A home-made antenna switch could also violate FCC regulations. If you are looking for a switch that has a very low insertion loss and meets the 60-dB isolation requirement of the FCC, consider the one made by Manu-Tronics, Kenosh, Wisconsin. This switch is sold by Atari dealers as a game accessory and is also available from Sears Roebuck as an Extra Antenna Switch, catalog No. 6-99726, $9.95.

Technology

While a few die-hards (mostly kit manufacturers or plan sources) still use individual IC's, most game manufacturers this year used dedicated IC's—IC's designed specifically to perform game functions. General Instruments (GI), National Semiconductor (NS), MOS Technology, American Microsystems Inc. (AMI) and some others offer dedicated IC's. But many industry observers feel that the demand for these games will dwindle unless more variety and sophisticated game formats are offered. Enter the microprocessor, ideally suited for this purpose!

The microprocessor, really a minicomputer on a chip (without the peripherals) is more expensive than the dedicated IC, but is far more flexible and versatile. It can be programmed to perform innumerable functions—it can even play chess! A dedicated IC is limited to a particular set of instructions that are established when it is made. Because of the wide-ranging capabilities of the microprocessor, a broad spectrum of game complexities can be introduced to the user.

A number of manufacturers are taking a "let's wait and see" attitude before committing themselves heavily to this largely-seasonal market. RCA and Rockwell International, usually in the forefront of new consumer electronic devices, have apparently chosen to watch others fight it out this year in the marketplace while they keep some exotic designs on the back burner under tight wraps. Fairchild, however, has taken the proverbial bull by the horns and bypassed current dedicated IC's to jump right into a system built around their F8 microprocessor! In Fairchild's Video Entertainment System, programming will be done by slip-in cartridges to be issued regularly—kind of a "game-of-the-month" plan.

It seems probable that the market for the higher-priced but much-more-challenging microprocessor units will grow, while the present-day units will end up in toy departments.

Comparison chart

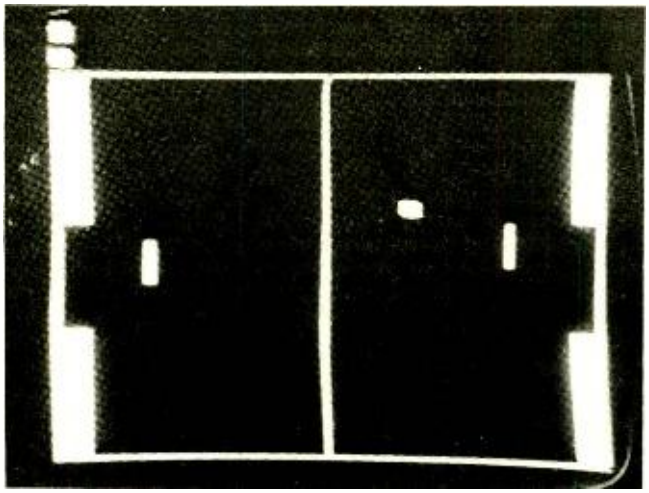
The Chart shows many features of the video games that were surveyed. A blank space in the chart does not necessarily mean that game does not have the listed feature, since information on some units was very limited. Since the terminology associated with these games may be new to many readers, explanations of some of the column headings are in order.

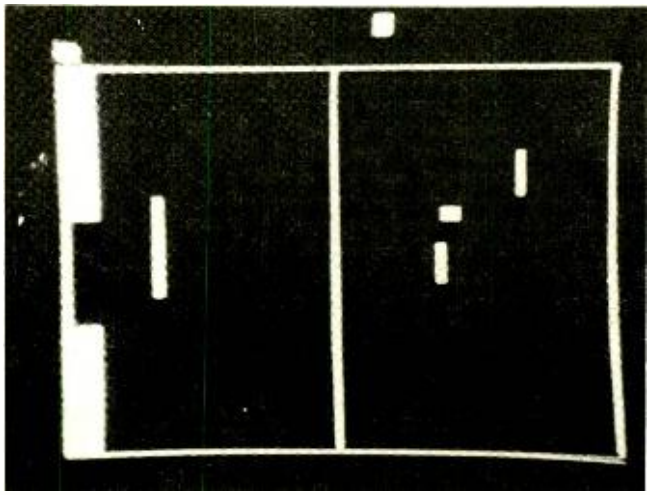
Number of Games: In the original *Odyssey* TV game, plastic overlays fit over the TV screen to establish playing boundaries, and 12 games could be played. All the units in this survey, however, use electronic borders for each game. Some borders may be off the screen, or not displayed, but they are there electronically. Most units offer a variety of games by just operating a switch. This sets the circuitry for the appropriate borders, paddles, ball and scoring sequence for the selected game. Some games are identical, but manufacturers assign them different names: for example, 2-player Handball seems to be identical to Squash; 1-player against the machine may be called Solitaire, Robot, Pelota, Automatic, 1-player Handball or Cybernetic-mode! Similarly, Target Shoot and Rifle are the same.

Number of Players: This is intended to mean the number of people who have individual controls. On some games, although 4 paddles may appear on the screen, they move in pairs and only two controls are available—these are listed as 2-player games.

Color Display: All games can be used on either color or black-and-white TV receivers or monitors. Some, indicated by a dot in this column, produce a color display on a color TV. This may be colored borders, paddles and ball, or different colored scoring digits, or different colored playing fields, or a "light show" between games (Atari), or a rainbow color pattern (*Video Action*), or some combination of these.

Paddles/Players: Promotional literature uses the term "players" almost interchangeably with "paddles" and "bats". On this chart, this refers to the controlled images. Confusion arises here because some new games actually display shaped figures on the screen, such as a shark, diver, fish, tennis player, racing car, tank or airplane. The majority of games, however, simply display small rectangles that are usually called paddles. To make the game easier for beginners, paddle size on some games is controllable and may be made larger to make a "hit" less difficult. A dot in this column means the game either has a switch or a potentiometer available to the players to change paddle size—internal adjustments are not considered.





All games offer vertical paddle control with either a knob that turns, or a slide-lever—both of which, of course, are potentiometers. The more sophisticated games provide a means of controlling horizontal movement as well, and some of these offer a joystick to allow control of both vertical and horizontal movement together!

The lower-priced games have all the controls and switches on a single console, so the players must be right at the console to play. Wired-remote controls are simply controls at the end of cables allowing the players to be more comfortable and relaxed—they can even play from an easy chair.. *Wireless* remote controls may be offered in the future.

Ball Control: Even some of the most inexpensive games, because of the flexibility of the IC, offer switches to control ball speed and deflection to make the game tougher as you become more skilled. Normally, the paddles return a hit ball at some angle (called "english" by the ad men) unless it is hit with the center of the paddle, in which case it is returned straight back. This gives the player a degree of control in trying to outplay the opponent. A dot in the Deflection Variable column means that the game has a switch to *change* these return angles.

Some games have circuits that cause the ball to speed-up automatically after a certain number of "hits" in a volley. The Interfab unit has a *randomly* variable speed—the ball can speed up at any time, for any single shot—which is most realistic. A dot in the "Speed Variable" column means that either the ball speed changes automatically in some manner, or the players can control the speed with a switch or a pot.

Scoring: Early units used manual techniques (a scoring dial or marker to be moved by the players after each miss) and later units used marks or bars on the screen to indicate score. Most units now display the score for each player in digital numbers on the screen—some continuously, others only after a miss. Constant on-screen digital scoring is the most practical unless it takes up too much of the playing field. If the scoring appears outside the playing boundaries, as it does on the Interfab unit, it poses no problem. Usually 15 is "game", after which the paddles disappear and the ball randomly bounces around the court until a RESET button is pushed.

Serve: Most units serve the ball automatically. The ball is served to one of the players at the start of a game and is re-served after a miss to the one that last missed. Some games are strictly manual serve—you press a button to serve the ball; this allows you to take time out or to keep score if scoring is not automatic. Some games have a switch to allow you to select manual or automatic serve.

Automatic Play: This is a desireable feature for two reasons: It permits you to sharpen your skill with practice and it allows you to play against the game when you don't have a playmate. In this mode, you play against the machine's usually-infallible electronic brain—so you'll probably lose! Some games have a control to adjust the skill level in automatic play. If you build a kit, you can make the machine sluggish (see Interfab text) so you have a chance to win. A few units allow you to set up the machine controls so it will play a game against itself—which is interesting to watch and great for demonstration purposes if you're selling these games.

Sound: Virtually all the units provide sound through a built-in speaker rather than through the TV audio. This allows you to turn the TV audio off completely, so there is no hum or background noise. Also, games with built-in sound will "beep" while they're turned on, even if the TV is turned off, so there's no need for a game pilot light. Since most of the games are battery-operated, this can be important. Some games have *different* sounds for the ball hitting a boundary, the ball hitting the paddle, and the paddle missing the ball.

Monitor Built-In: Commercial units and some expensive home units have the video game connected directly to a video monitor, thus eliminating the need for FCC approval since the video is not modulating an RF output. One company, Magnavox, offers a 19-inch color TV with a video game built-in! Heath has avoided the necessity for FCC approval by providing instructions for its *Sportscreen* game to be wired directly into any solid-state Heathkit TV, thus using the TV as a video monitor.

FCC Approved: A blank in this column does not mean the FCC has rejected the game. When the information in this chart was compiled, many units were still pending approval and some had still not applied for approval. Some manufac-

continued on page 84

Projection TV Roundup

A new twist has been added to television in the form of large-screen projection systems for the home. Here's a look at the systems that are currently available

ROBERT GERSON

NOT EVEN RANKED AS A SERIOUS CONTENDER for the consumer market by industry experts as recently as three years ago, the big-screen home television projector has swept past the video tape recorder and the videodisc to become today's hottest new product.

An estimated 20,000 to 30,000 home-type television projection systems were sold in 1975, though admittedly the bulk of them went into taverns, discos and the like. Indications are that upwards of 50,000 will be sold in 1976 as the developing industry gears up to a claimed 100,000-unit annual production rate. With retail list prices averaging in the $1,000-$2,000 range, it's obvious that projection television is quickly moving into the big leagues.

Early Projection TV

This is the second go around for video projectors. Home video projectors came on the market at the very start of the current television craze in 1946. Most used the *Protelgram* 2.25-inch projection tube made by North American Philips to throw a somewhat murkey picture on a then-giant 25-inch screen. The screen was giant compared with the 7, 10 and 15-inch direct-view sets available at the time. The price for those projectors was about the same as is being charged today, that is in the $900 to $1,500 range. Incidentally, the prices for the small-screen monochrome direct-view sets, $300 to $1,000 for name brands, was about what the current-model color TV sets bring. Output of projection TV models peaked in 1948 at 18,500. North American Philips announced it was doubling tube production for 1949, but it needn't have bothered. That year the direct-view 19-inch picture tube became available in quantity for the first time and demand for the projection sets dwindled to virtually nothing.

From then until 1971, when Advent announced plans to market a home projection unit for $2,500, video projectors existed as high-priced ($15,000-and-up) curiosities relegated to use in theatres and at conventions. Experimental big-screen television sets were to be found in the research labs of most major television manufacturers. Among the more interesting were Zenith's three-laser projector (abandoned because of enormous power consumption) and Sony's eight-foot computer-controlled lightbulb display. Both units were shown late in 1968.

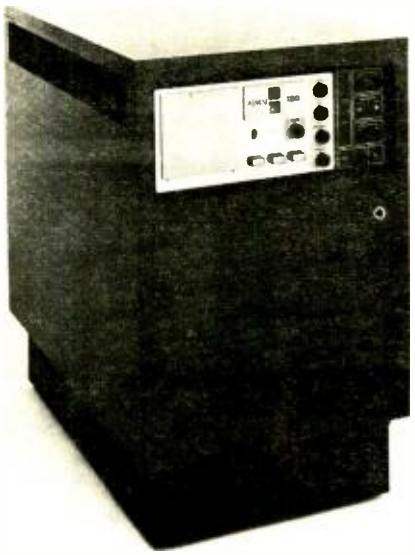
While the Advent projector revived interest in home projectors, it was

GIANT SCREEN TV models VM-1 (left), VM-2 (right rear), and VM-3 (right front).

PROJECTION ELECTRONICS model 351-SI

MUNTZ ELECTRONICS

SONY model KP-4000



CONTROLS, Advent model 750

PROJECTION LENSES, Advent model 750

considered to be too expensive for consumer use and its trio of special Schmidt optical projection tubes were not deemed suitable for mass production. The start of the current market growth can be traced to the 1972 demonstration by Sony of a projector using a single high-output Trinitron as a light source. This was followed in 1974 by a demonstration by Shannon Communications of New York of a system that threw an acceptable (in a darkened room) picture on a seven-foot screen using a special lens mounted on a standard Sony Trinitron color television.

That opened the flood gates. By the end of the year a dozen companies had entered the field—some were dedicated pioneers planning to help write a new chapter in the history of television, others quick-dollar artists. Units available ranged in price from $2,750 for the Advent to the $19.95 a mail-order house charged for a plastic lens mounted in a cardboard box that, the marketer said, should be placed in front of an upside-down television set.

Today's systems

Today more than two dozen companies are known to be active in home video projectors, and there may be an equal number of local system builders. All of the models on the market today use light-amplifying Kodak or 3M screens. Except for the higher priced projectors that use three cathode ray or Schmidt optical tubes (one for each color), virtually all the units use standard color television sets as the picture source.

The most expensive of the latter is Theatervision from Worldwide Entertainment Systems, Inc. The complete system is housed in a furniture-styled highboy and uses mirrors and lenses to direct the light from the conventional receiver located in the base to the top-mounted screen. The less costly versions have a lens mounted on the front of a television receiver and a separate screen. The quality of the picture provided by the two-piece models varies from acceptable to terrible.

The coming of the home video projector age has created both a black market in the sale of television sets and concern about safety at the Food and Drug Administration. Television manufacturers and importers have generally refused to sell receivers directly to projector marketers. They say their sets weren't designed for such use and caution that operating them in cabinets without adequate ventilation could be dangerous. They also don't like the idea

DIRECTORY OF HOME PROJECTION-TV SYSTEMS

Company	Model	Pieces	Screen Size (in.)	Picture Source	Retail	Comments
Advent Corp. 195 Albany St. Cambridge, MA 02139	VideoBeam 1000A	2	52 × 69	3 tubes, Schmidt optics	$3,995 up	
	VideoBeam 750	2	41 × 60	3 tubes, diffraction op.	2,495	Remote control
Giant Screen TV, Inc. 308 N. Minn. St. New Ulm, MN 56073	VM-1	2	32 × 40	TV set	1,995	Floor standing
	VM-2	1	32 × 40	TV set	1,995	Floor standing
	VM-3	2	32 × 40	TV set	1,695	Ceiling or Floor
	VM-4	2	32 × 40	TV set	1,995	Wireless Remote
Creative Optics 6733 Variel Ave. Canoga Park, CA 91303	Tele-D Theatre	1	32 × 40	15" Sony remote	2,950	"Teledimension" depth effect
Cygnus Video Systems 5750 Rymark Court Indianapolis, IN 42650	CV-1750	2	32 × 40	17" Sony	1,399	
Electrohome Ltd. 809 Wellington St. N. Kitchener, ON. Canada	VideoBeam 750	2	41 × 60	3 tubes, diffraction op.	3,500	Same set as Advent
General Equipment Corp. 1401 N. Kraemer Blvd. Anaheim, CA 92806	—	1	32 × 40	17" Zenith	1,995	
	—	1	41 × 60	17" Zenith	2,595	
Global Video Ind. 1818 Westlake Ave. N. Seattle, WA 98109	BB7600	1	30 × 40	17" Zenith remote	1,995-2,295	Rear projection
Keyser Video Inc. 2537 Wilmington Pk. Dayton, OH 45419	Eye-Beam KVI-1	2	32 × 40	13" Toshiba	1,495	Ceiling mount
	Eye-Beam KVI-2	1	32 × 40	13" Toshiba	1,595	Console
	Eye-Beam KVI-3	1	32 × 40	13" Toshiba	3,495	Includes VTR
	—	-	40 × 54	—	—	Optional screen
	—	-	60 × 80	—	—	
Melody Music Co. 2286 Fowler St. Ft. Myers, FL 33901	Cine Vision	1	32 × 40	15" Sharp or MGA	1,195	
	—	1	32 × 40	15" Sony remote	1,295	
	—	1	32 × 40	none	895	kit
Miami Projection TV 304 N.E. 79 St. Miami, FL 33138	—	2	32 × 40	none	325	kit
	—	2	32 × 40	13" Toshiba	725	
	—	2	60 × 84	3 tubes & lenses	—	
Muntz Electronics Van Nuys, CA 91406	Earl Muntz Signature	1	32 × 40	15" Sony remote	1,395	
New Products Co. 27 Devon Court Maple Shade, NJ	501-C	2	35 × 40	single tube	1,595	Ceiling mount
	501-B	2	35 × 40		1,795	Floor model

that most sets used for projection have their yoke leads reversed to provide the required inverted picture. All of this, they say, voids the terms of the factory warranty. Projection companies get around this, however, by buying from understanding distributors, reps and retailers who agree in advance to look the other way when a modified set is brought in for a warranty repair.

For the Food and Drug Administration, the problem is more serious. The agency's Bureau of Radiological Health (BRH) is disturbed by reports that some projector companies are increasing the high-voltage supply to the picture tube to generate a brighter picture. This, and other modifications, BRH fears, could cause some sets to emit X-radiation in excess of Federal standards. Also starting to worry about the effects of modifications are the Federal Communications Commission, which enforces standards for incidental RF radiation emissions, and Underwriters' Laboratories, which certifies receivers for compliance with safety standards.

SONY MODEL KP-4000

Of the companies active in the field today only two—Sony and Canada's Electrohome—are also active television manufacturers, and even their role is limited. Sony admits it's doing little more than maintaining a presence in the market, while Electrohome is acting as a supplier and marketer for Advent. But this may be temporary. Admiral and Magnavox have video projector development efforts underway and may demonstrate them before the year is out. Zenith is known to have supported

DIRECTORY OF HOME PROJECTION-TV SYSTEMS

Company	Model	Pieces	Screen Size (in.)	Picture Source	Retail	Comments
Projecta-Vision, Inc. 444 Brickell Ave. Miami, FL 33131	—	2	34 × 40	15" RCA	1,495	Larger screens available
Projection Electronics Co. 306 N.E. 79 St. Miami, FL 33138	351-SI	2	50" diagonal		1,295	
Projection Systems Inc. 517 Van Houten Ave. Passaic, NJ 07055	PSI Cinevision	2	75 × 100	3 tubes, Schmidt	4,995	
	—	2	—	3 tubes, diffraction	1,200-1,300	
PM Systems Corp. 3303 Harbor Blvd. Costa Mesa, CA 92626	Cinema IV	1	27 × 36	15" Sony	1,795	
	Cinema IV Mod. CR	1	32 × 40	15" Sony	1,995	Folding-screen
Shannon Communications 49 E. 68th St. New York, NY 10021	—	2	52 × 69	TV set	—	
Sony Corp. of America 9 W. 57th St. New York, NY 10019	KP-4000	1	24 × 32	special 12" Sony	2,500	
Spectra-Vue 395 South Pitcher St. Kalamazoo, MI 49006	1200		30 × 40	TV set		Ceiling mount avail.
	2000		40 × 54			Remote Control
	4000		54 × 72			
	5000		60 × 80			
Sunyet TV, Inc. 21630 McNichols Rd. Detroit, MI	—	2	40 × 40	single tube		Expandable screen
Superscreen TV Inc. 101 Park Ave. New York, NY 10017	—	1	32 × 40	TV set		
	—	2	32 × 40	TV set		
Tandom Enterprises 2323 Bluemound Rd. Waukesha, WI 53186	VP-2	2	32 × 40	13" Quasar	1,595	
	—	2	32 × 40	13" Quasar	1,795	Video input
Tape Head Co. 665 S. State St. Salt Lake City, UT 84111	TLB-1000	2	n.a	none	400	Kit
Tele-Theatre Lawrenceburg, IN 47025	—	1	30 × 40	12" Sony	1,695-3,495	
	—	2	42 × 56	n.a.		
Video-1 Inc. 1401 Brickell Ave. Miami, FL 33131	Magna-Video	1	32 × 40	13" Toshiba	2,000-2,500	
	—	2	52 × 69	13" Toshiba	2,600	
Worldwide Entertainment Systems 1148 Taft St. Rockville, MD 20850	WES-76, 77, 78	1	32 × 40	15" Sony	1,295-1,995	
	Stereovision	1	32 × 40	15" Sony	2,495	Stereo sound
	Megavision	2	41 × 60	15" Sony	2,695	
	—	2	8-ft. diag	3-tube Schmidt	3,495	

research on the manufacture of an inexpensive plastic Fresnel lens that, if it works, could cut the price of a two-piece projection system in half.

Future trends

There is a general feeling in the industry that a conventional picture tube will never prove to be an adequate picture source for a projector, and research on more esoteric systems continues. General Electric is working on a low-cost version of the *Light Valve* projection tube now used in professional projectors. Hughes Aircraft has produced a liquid crystal television cockpit display for fighter planes and is now trying to adapt the device for use as a video projector light modulator. In Florida, William Glenn who helped develop G-E's *Light Valve*, is attempting to make a solid-state projector using a charge-coupled device to deform a thin membrane that in turn would refract a beam of light. The principle is the same as that used in the Light Valve and Swiss-made Eidophor projectors that refract light off an oil layer modulated by an electron beam.

SUPER LENS from Miami Projection TV has a 12-inch focal length and an aperture of f2.8. It comes $195.00 with mounting ring.

Of course by the time any of the more promising new systems is ready for market we may already have giant flat-screen video systems using one of the light-emitting diode displays, gas-discharge or electro-luminescent panels now being worked on in laboratories around the world. One thing seems likely though. With all the effort and money being expended, giant-screen video will be as commonplace as pocketable television before the end of the next decade. **R-E**

all about digital multimeters

PART II. *An in-depth look at digital multimeters—how they work, their specifications and applications*

CHARLES M. GILMORE*

Last month, part I discussed single- and dual-slope analog-to-digital conversion techniques.

This month, we look at the voltage-to-frequency converter and discuss how voltage, current and resistance measurements are made using an analog-to-digital converter.

The V-F converter

As the name implies, this converter produces a frequency directly proportional to voltage. A simple digital frequency-counter may then be used for the counting and display circuits.

The V-F converter is a wide range, highly linear, voltage controlled oscillator (VCO). A typical dynamic range for the VCO might be 10 Hz to 100 kHz, or 10,000 to 1. Figure 7 shows a block diagram of a converter designed to cover such a range linearly. The basic blocks consist of an integrator, a wide-range but not linear VCO, a clock (oscillator) of known frequency to serve as a time reference, a logic circuit that generates a pulse of precisely known width for each cycle of the VCO, and a precision switched voltage reference source that, upon command from the logic circuit, generates a pulse of precise amplitude for the duration of the logic signal. The polarity of the unknown voltage must be opposite to that of the voltage reference.

When a negative unknown voltage is applied to the input, the output voltage of the integrator begins to increase. The frequency generated by the internal VCO then begins to increase also. As the VCO begins to generate signals, the logic circuit begins to generate switching signals. These pulses, produced by the voltage reference source and the logic circuit, are of precise amplitude and width. Each pulse therefore, represents a well defined amount of energy.

The output of the integrator is a function of the average of the total energy at the input. So long as the average energy in the pulses is less than that in the unknown voltage, the output voltage of the integrator continues to rise. If the total energy in the pulses is greater than that in the unknown voltage, the output voltage of the integrator decreases. And, of course, if the energy of the pulses is exactly equal to the energy in the unknown signal, then the output voltage of the integrator remains at the voltage which causes the VCO to generate pulses at a given rate.

Calibrating this converter consists of adjusting either the width or the height of the pulse so the generated frequency is directly related to the unknown voltage. The VCO frequency is now directly proportional to the voltage applied to the input of the integrator, and therefore may be measured with a digital frequency meter.

One advantage of this form of analog-to-digital conversion is its ability to reject noise. First, the integrator itself provides a sizable amount of filtering, as it acts as a low-pass filter. Second, the gate interval (time) of the digital frequency meter may be made equal to an integral multiple of the period of an interfering signal, and so average out any noise. In other words, the frequency meter itself can act as an integrator. The normal-mode rejection to line frequency interference is exceptionally high.

A second advantage is also due to the integrating feature. As a true integrator, the total number of output pulses represents the area contained under the curve of a varying input signal over the gate interval. For example, the area under a curve must be

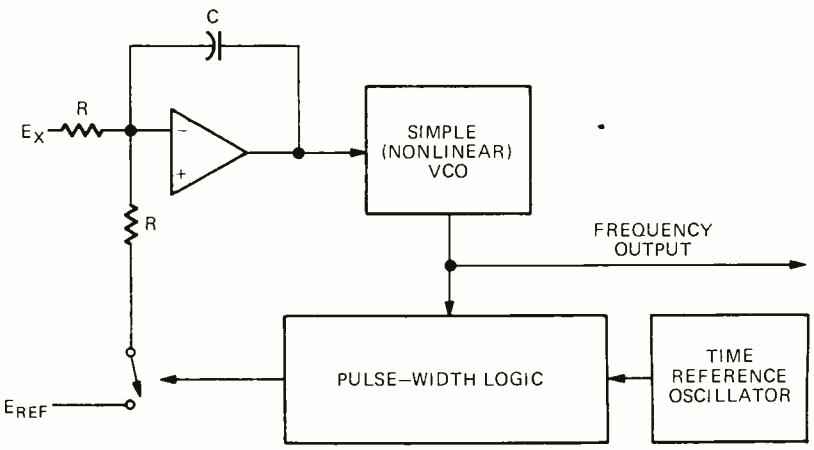


FIG. 7—BLOCK DIAGRAM OF A VOLTAGE-TO-FREQUENCY CONVERTER. The converter balances when the energy contained in the precise pulse generated by the pulse width logic and the reference voltage (E_{REF}) is exactly equal and opposite to the energy in the unknown signal (E_x). The amount of balancing energy is regulated by controlling the frequency of the pulses.

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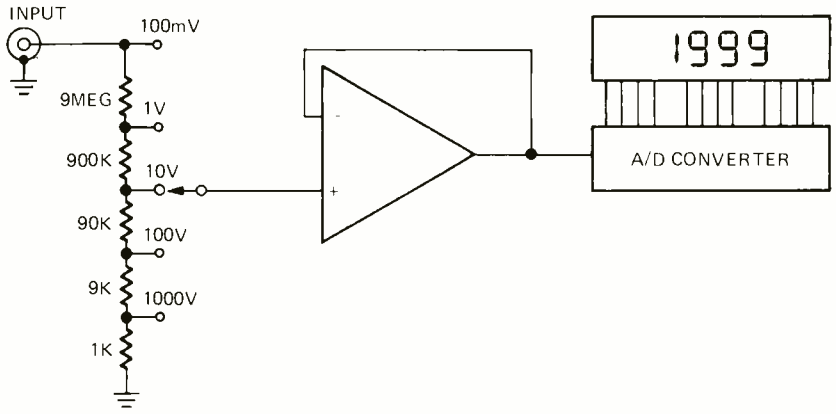


FIG. 8—BASIC DC VOLTMETER USING A/D CONVERTER AS THE MOVEMENT, and a high-impedance input buffer with an input voltage divider. Resistance values shown should yield a 10-megohm input impedance and a voltmeter with full-scale ranges from 100 mV to 1,000 volts.

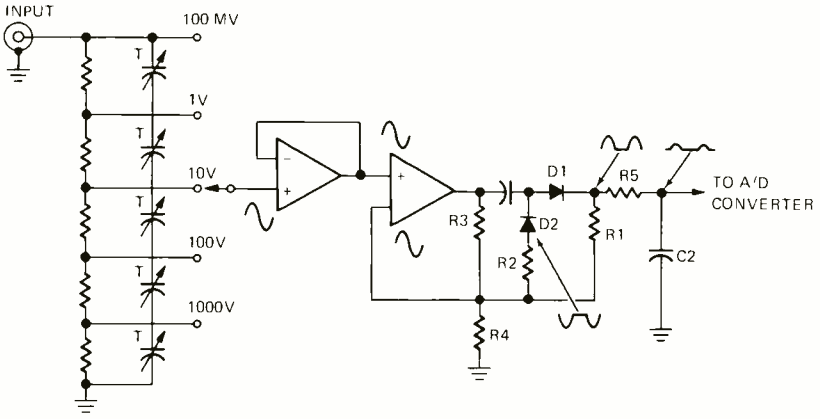


FIG. 9—THE AC INPUT CIRCUIT FOR A DIGITAL MULTIMETER. Compensating capacitors have been added to the voltage divider of Fig. 8 to extend operation into the 10 to 50-kHz range. The operational rectifier is used with DMM's to eliminate the low-voltage conversion errors of the simple AC rectifiers used with the analog type of meter.

measured. One common method of doing that is to plot the variable either by hand or on a strip-chart recorder and then count the number of squares contained under the curve. A second method is to use an integrating voltmeter. The V-F converter fits this application well. The only change from the voltmeter described earlier is that the gate interval of the digital frequency counter is now controlled by the user. To make the measurements, the user counts pulses from the V-F converter over the desired period. The displayed number on the digital counter represents the area under the curve.

A third reason for the popularity of this converter is its adaptability to a digital counting instrument. There are no requirements for special overrange circuits, etc. For some time, the V-F converter also represented the ultimate in accuracy; however, the dual-slope converter has taken this lead at the moment.

The basic analog-to-digital converter is not a complete DMM (digital multimeter), any more than a simple DC analog meter movement is a VOM. Other circuits must be added to provide the functions of ranging, AC to DC conversion, current measurement, and resistance measurement. Many of these circuits are common to those used with the analog multimeter, but a few of them take on special aspects when they are applied to the DMM.

DC voltage measurement

DC voltage measurement is relatively simple if an A/D converter with the autopolarity or polarity indication is available. Fig. 8 shows the simple addition of a precision voltage divider and a high input impedance unity-gain amplifier. The precision voltage divider reduces high voltages so they match the allowable input range of the converter. The input amplifier must have a high enough input impedance not to load the divider, have low noise, high gain stability and low drift, if this is not taken care of by an auto zero circuit.

The voltage divider usually presents an input impedance of either one or 10 megohms. It must have high precision, which can be obtained with precision resistors, hybrid circuits (frequently employed when the divider accuracy exceeds 0.25% or so) or a trimmed voltage divider when the utmost accuracy is desired. The basic voltage range of the converter dictates the minimum range of the DMM, unless an amplifier with gain is placed before the converter. Most converters have a sensitivity of either one volt or 100 millivolts.

AC voltage measurements

AC voltage measurements start with the voltage divider. Many DMM's use the same voltage divider for the AC and DC measurements. AC use requires the divider to be compensated for stray capacitances, which may be shunting the divider string. The capacitive division ratio must be the same ratio as the resistive ratio, or the division differs as the measurement frequency is increased. Such a compensated divider is shown in Fig. 9.

Also shown in Fig. 9 is the buffer amplifier and an example of an AC to DC converter. This circuit is called the operational rectifier. The AC signal is fed to an operational amplifier. On positive half cycles, feedback to the − input of the amplifier is made through D1 and R1. The gain is determined by the ratio of R1 to R4. The forward voltage drop of the diode is effectively eliminated by the high open-loop gain of the operational amplifier. This high gain allows the output to slew rapidly, driving the diode into conduction. Once it conducts, the output amplitude is controlled by R1 and R4. The output signal from the rectifier is filtered by R5 and C2 to provide a steady DC signal for the A/D converter. On negative half cycles, the feedback path is provided by D2 and R2; however, no voltage is contributed to the output. R3 provides DC stability during no-signal conditions. The bandwidth of this converter depends on the bandwidth of the operational amplifier.

Current measurements

Current is usually measured in the DMM by the same technique as in analog meters—by shunts. The DMM has an advantage over the simple VOM, as the shunts often have a lower voltage drop, permitted by a voltmeter of 100 millivolts full scale. Shunts are used for both AC and DC measurements. As with many other sections of the DMM, the accuracy requirements for some of the components becomes much greater than required with a VOM. In the analog multimeter, a 1% current shunt may have been quite adequate. With a DMM, shunt tolerance may need to be nearer 0.1%.

An alternative to DC current measurement by shunts is shown in Fig. 10. This current measuring technique is a sort of inverse of the potentiometer method of measuring voltage—no voltage drop is required to make the measurement, as no current is required to measure voltage by the potentiometer technique.

The unknown current is applied to the summing junction (the upper or minus terminal in Fig. 10) of a high-gain operational amplifier. Negative feedback keeps this terminal near zero voltage. To maintain this zero voltage at the terminal when current is applied, the amplifier output voltage has to generate through the feedback resistors a second current equal to the current at the input. This output voltage (actually the voltage drop across the feedback resistor) is therefore directly proportional to the current at the summing junction, so the A/D converter can be made to read directly in terms of current.

With this form of measurement, the input impedance is extremely low, as the current applied to the input simply flows on through the feedback resistor, and there is no voltage drop.

The disadvantage is that the measurement circuit must be able to supply a current equal to that being measured. The circuit therefore becomes impractical beyond a few hundred milliamperes. A second limitation is that the technique is applicable to DC measurements only.

Resistance measurements

The conventional analog multimeter usual-

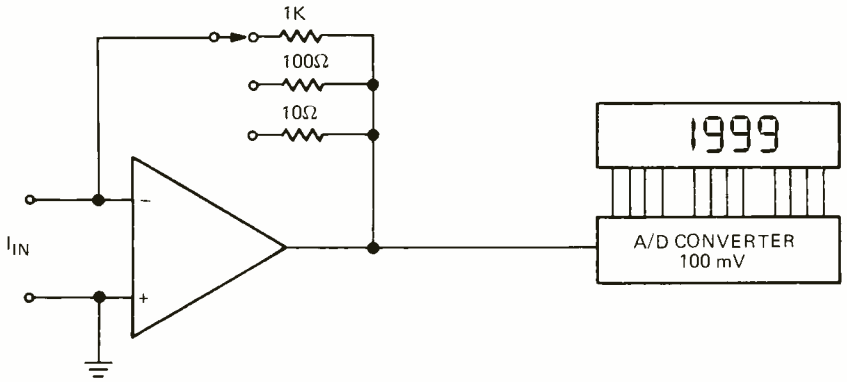


FIG. 10—AN OPERATIONAL CURRENT-TO-VOLTAGE CONVERTER FOR DC measurements with a DMM. Circuit provides a near-zero voltage drop across the input terminals and offers almost no impedance to the current being measured. The resistances shown would yield full-scale values of 100 μA (1,000 ohms), 1 mA (100 ohms) and 10 mA (10 ohms) for a converter with 100 mV basic sensitivity.

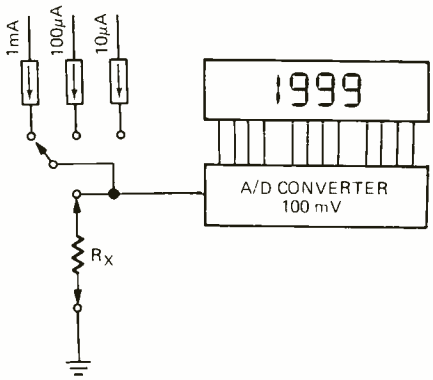


FIG. 11—RESISTANCE MEASUREMENT with a DMM. The 1-mA, 100-μA and 10-μA current sources give full-scale resistance ranges of 100 ohms, 1,000 ohms and 10,000 ohms with a 100-mV converter.

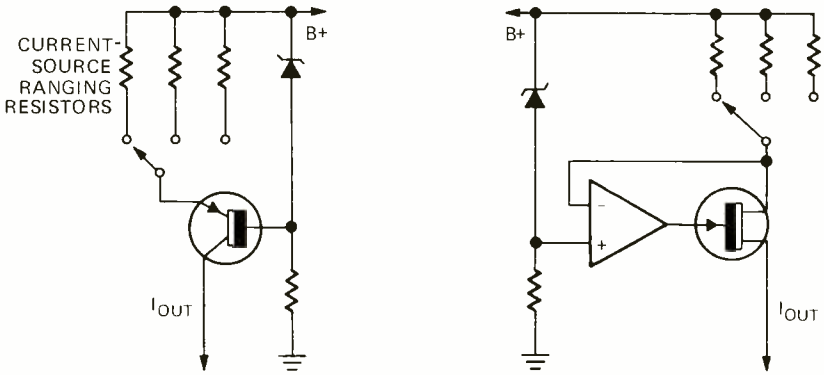


FIG. 12—CONSTANT-CURRENT SOURCES. *a*—Positive current source using a PNP transistor. *b*—Constant-current source using an N-channel junction FET and an operational amplifier.

ly applies an internal voltage to an internal resistance and the external unknown resistance in series. The meter has a specially calibrated nonlinear scale, which converts the voltage across the unknown resistance to a resistance reading. Nonlinear scales are very difficult to convert into digital readings; therefore a different technique is employed in the DMM. A constant-current source generates the test signal to be passed through the unknown resistance. A constant current of known value develops a voltage across the unknown resistor directly proportional to its resistance. The voltage is measured and displayed as resistance. Such a measurement system is shown in Fig. 11. The circuits used for the constant-current source may be either discrete (Fig. 12-a) or the operational type (Fig. 12-b).

The constant-current resistance measurement technique has a few special characteristics. First, the open-circuit voltage is rather high, often a few volts. Unless specially designed, they forward-bias semiconductor junctions. Second, as the current ranges must be the same number of decades as the resistance ranges, the high-resistance ranges use low currents. A small current charging a capacitance takes time; high resistance ranges tend to be slow responding. These types of meters are used most often with upper limits at about 20 megohms.

Auto-ranging

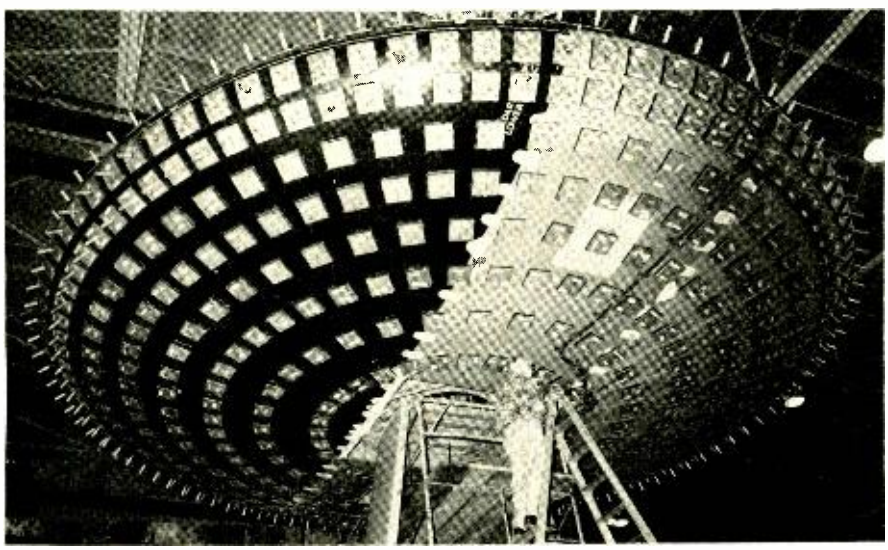
One of the more desirable features of the DMM is almost hands-free operation in comparison to its analog partner. The autoranging DMM is even easier to use. Special circuitry is added to the conventional DMM to sequence the instrument until the display is all but overranged. The techniques for autoranging vary, and involve both electronic and electromechanical methods. Generally, the instruments do not autorange high current ranges, but provide the user with two shunts, for example, then autorange the voltmeter about the selected shunt.

Specifications

There would seem to be little to specify on the digital multimeter once the functions, ranges, and accuracies are known. Unfortunately, unlike the simple analog multimeter, the DMM is specified extensively. Many of the variations from DMM to DMM are the subtly specified nuances that make all the difference to the user when the instrument is on the bench.

to be continued

World's Largest Radome



NOT A NEW TYPE OF CHANDELIER for a Texas mansion, but the world's largest radome, to be carried atop the US Air Force E-3A airborne warning and control system. This 30-foot diameter fiberglass and aluminum assembly, which houses large antennas on the E-3A, is shown undergoing static load tests at Boeing, the E-3A prime contractor. The hundreds of rectangular pads are attachment points for hydraulic jacks that simulate—under laboratory conditions—the aerodynamic loads on the radome in flight. Loads during the tests produced more than 12 million inch-pounds of pitching moment. An identical radome assembly is undergoing fatigue testing, which will simulate 80 years of stresses (four times its design life). During that test the radome, which revolves six times a minute when in use, will undergo a simulated 40 million revolutions.

What's New In Car Stereo

There's something for everybody—component systems for the audiophile, kits for the do-it-yourselfer, and even combination units that include CB

FRED PETRAS

IF ALL THE MANUFACTURERS OF AUTOMOBILE sound equipment placed all of their products on view in one huge display, here is what you would notice:

- Most of the equipment is designed for in-dash mounting.
- Much of it is smaller than a year or two ago.
- The proportion of car players with radio facilities is bigger by far than before.
- More combinations now feature FM stereo reception in addition to mono FM.
- More deluxe models are available than previously.
- The number of cassette players has increased tremendously, and the ratio of cassette to cartridge models is increasing accordingly.
- CB is "invading" the automobile in a significant way.
- "Big sound" has captured attention and is being reflected in car players with greater amplifier power, a variety of add-on power boosters/amplifiers and bigger and better speakers.
- Audio-component-type car sound equipment is now a reality.

The trend to in-dash equipment has been developing steadily. Today's in-dash car stereo units with adjustable control shafts and standardized face plates are easy to install; virtually anyone with "do-it-yourself" leanings can handle a player, radio or player/radio installation. Some companies claim that over 75 percent of equipment buyers are capable of installing it themselves. Sanyo (1200 West Artesia Blvd., Compton, CA 90220), for example, touts an *EZ Install* line of auto stereo products. "For exceptionally easy in-dash installation on over 80 percent of all cars without the need for extra mounting hardware." Audiovox (150 Marcus Blvd., Hauppauge, NY 11787) provides consumers with a large chart showing all the cars that can be fitted with in-dash Audiovox players, and 18 steps of a typical in-dash installation.

In-dash installations are neater looking than "hang-ons." They are far less obtrusive, especially in cars with limited

MOTOROLA model TC877AX.

dash-area. They are far less likely to be ripped-off because of the time and effort required to do so. And in-dash installations can also be a matter of good economic sense; some insurance companies will not insure under-dash, hang-on car stereo equipment.

MOTOROLA model TC876AX.

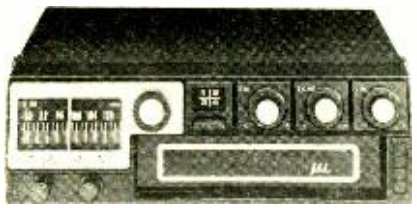
Reflecting the overall technology advances and spinoffs from efforts to produce compact in-dash stereo equipment, are the new small-sized players and combinations. An example is a new cassette unit, Sanyo *model FT400*, measuring 4¾-inches deep by 7-inches wide and 2-inches high. It is for under-dash, glove compartment or hump mounting. Another example—for in-dash mounting—is the *model 605*, from J. I. L. (737 West Artesia Blvd., Compton, CA 90220), a cassette player/radio combination measuring 5½-inches deep by 7-inches wide and 1¾-inches high. A third example is the Fulmer (260 Monroe Ave., Memphis, TN 38103) *model 5300*, a cartridge player/radio combo for in-dash mounting. It measures 4¾-inches wide by 6½-inches deep and 1¾-inches high.

Helping manufacturers produce compact, multi-function car sound equipment are smaller sized tape mechanisms. Gone are the king-size, giant-flywheel models. These have been replaced by mini-units with highly effi-

ROYAL SOUND model RS-2500.

cient tape drives. Also aiding them is the dial-in-tape-door system developed by Tenna Corp. (19201 Cranwood Pkwy., Cleveland, OH 44128) that reduces space requirements substantially. Many manufacturers are using this approach.

In the early days of auto sound, the average car owner had a radio in the dash and a hang-on cartridge player under the dash. Today, the majority of car owners have combination tape



J.I.L. model 517.

player/radios usually installed in-dash. But hang-on types are also available, their continuing popularity related to their size—far smaller than in the past

and they're easy to remove.

Along with a greater demand for player/radio combinations, consumers have been getting on the FM bandwagon and buying combinations that feature not only mono FM, but also stereo FM reception.

The trends to more combination sets and to units offering FM-stereo reflect a greater sophistication of today's music-oriented car owner who wants music in all formats. Inherent in that sophistication is also his willingness to buy better

SONY model TC-24FA.

quality combinations to get the best sound from tape or radio program sources. This applies especially to in-dash equipment since it is less likely to be pilfered than an under-dash model. Manufacturers, recognizing these facts, have come through admirably. Several are producing tape/radio combinations selling for over $200. In fact, one company, Becker Autoradio (756 Burr Oak Drive, Westmont, IL 60559), has a cassette player/radio combination priced at $844!

Cassette vs. Cartridge

While it has not taken over the car player field, the cassette is certainly making inroads into the province of the cartridge player. At the moment, over a third of all car players sold are cassette models. By this time next year, the figure will be close to 50 percent according to industry forecasters. But have no fear about the availability of cartridge equipment; no one is seriously expecting it to be nudged into oblivion by the cassette, popular as the cassette is.

While the cassette has been around for several years in the automotive field, its initial track record was pretty bad. Wow-and-flutter was exceedingly high, tape mechanisms jammed and tape tracking was often erratic. In essence, the cassette was not technologically ready. Today it is, and car sound buffs are rushing to buy. The general feeling is that the cassette is every bit as good as the cartridge as a car sound medium and has more to offer in terms of convenience, primarily in "instant" program selection. There's also another angle: while both the cartridge and cassette offer recording capability in *home* equipment, the cassette is the easier recording format. Many cartridge car player owners who figured they could make their own tapes at home for use in their cars have been disillusioned by the difficulty of recording their own cartridges. Some cartridge car player owners have switched to cassette players in their latest cars, and have abandoned their cartridge recorders in favor of cassette models to easily make tapes for both home and car use.

Additionally, many music buffs have found that they have a broader variety of commercially recorded tapes in cassette form. While the cartridge has the edge in terms of the latest rock-and-roll hits, the cassette wins hands down in terms of various other types of music, especially classics and easy-listening type music.

One company, Sanyo, recognizing the potential of the cassette as a music recording medium, has brought that

SANYO model FT415.

capability into the car. Its new in-dash *model FT415* cassette/radio combination priced at $150 offers *stereo* recording from its FM stereo radio. Further, the unit can be used for monophonic dictation recording while on the go. It features a locking pause control as part of the recording system. Clarion (5500 Rosecrans Ave., Lawndale, CA 90260) also offers mono recording capability via microphone in an under-dash cassette recorder/stereo player, *model 812* priced at $154.95.

Up until fairly recently, the cartridge had it all over the cassette relative to tape handling. Slip the cartridge in and it would play all the way through. Slip a cassette in and you would have to flip it at mid-play. Today many cassette players feature automatic reverse—which eliminates cassette handling at mid-play. And as time goes on, you'll see this feature in a bigger percentage of players coming into the market. For example, TZL International (2020 West 16th St., Broadview, IL 60153) (a new company in the car sound field) introduced four cassette players in the Evadin brand name as its initial line, all featuring automatic reverse.

EVADIN model CR-3000.

The cassette is also finding favor with owners of compact and mini-cars, both domestic and foreign, where space is at a premium. Several companies offer what they call "short" chassis, that extend into the dash by as little as 4⅜-inches (Inland Dynatronics, Inc., 110 Horizon Blvd., South Hackensack, NJ 07606) *(model AXT-885)*.

CB

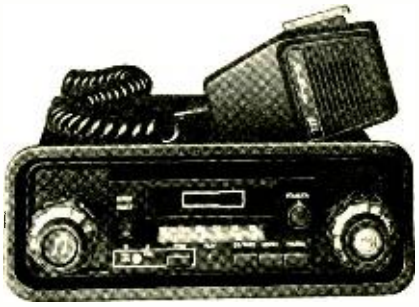
Several million auto owners have in the past few years involved themselves with CB. And more are getting involved every day. In fact, industry seers are predicting that the day is not far off when CB will be part of every new car's standard equipment, rather than as an option.

Since CB is such a natural for a car, in the same league as a car radio or stereo player, it was merely a matter of time

BOMAN model CBRT-8800.

before auto sound equipment makers hit on the idea of combining CB with tape players and car radios. The three-way combination is now available in perhaps a dozen brands. Prices are in the $300 to $420 range. (You can expect to see some at about $250 in the near future.)

The CB combos come in both under-dash and in-dash models, with the latter favored by theft-conscious car owners as far less likely to be stolen. (And far more likely to be insurable.) While the sets are usually a bit bigger than tape player/radio combinations, they can generally be fitted into most of today's new cars.



J.I.L. model 606CB.

Two companies—Audiovox and Clarion—have three-way in-dash CB combinations under what they call the "component separates" approach. Audiovox offers the consumer the option of mounting the separate cable-connected

transceiver electronics section out of sight behind the dash, under the seat or on the fire wall. Clarion additionally offers the option of mounting the separate unit in the car's trunk.

At press time, several companies revealed they were working on separable CB/tape/radio combinations. Some will be introduced early in 1977.

Notable among the under-dash CB combinations is a dual-function unit from Xtal (8749 Shirley Ave., North Ridge, CA 91324), *model XCB-9* priced at $300. In addition to 23-channel transceiver facilities, it also has automatic reverse cassette tape playback plus cassette *recording* capability.

More power

Along with a desire for better quality and more sophisticated car stereo equipment, today's drivers are after "big sound" from such equipment. Looking at our total-industry display of car stereo products closely you would find many attempts by equipment makers to fill that demand.

First off, you would find several companies selling car players or combination player/radios with 50 to 100 percent more amplifier power than traditional units. A typical auto player or combination has three to four watts-per-channel of amplifier power. This is plenty for the average listener driving the average car. However, if you own a big station wagon or van, or just like your music played at window-rattling levels, you can find a number of models with power of 8 watts-per-channel or more. Examples are the Craig (921 West Artesia Blvd., Compton, CA 90220) Powerplay series with 12 watts-per-channel; Sanyo *models 1001* and *1003* with 8 watts-per-channel; Panasonic (1 Panasonic Way, Secaucus, NJ 07094) *model CQ-1851* with 15 watts-per-channel and Clarion *model 423C* with 8 watts. Further, as the concept of more power is advertised by manufacturers and talked about by music/sound buffs, you'll see more companies providing high-powered car stereos.

PANASONIC model CQ-1851.

At least twelve companies are handing car owners the option of stepping up the power of their car stereo equipment via add-on power boosters or powered speakers. Essentially, a power booster is a small amplifier that hooks into your car stereo system and raises its total amplifier power by as much as 25 watts-per-channel or more. Unfortunately, there is no consistency in the presentation/advertising of these devices, with some companies not specifying the actual output in watts but instead saying "Increases the power of any player 10 times!" or "Four times more power", etc. Some even use ancient, discarded and meaningless terminology such as "peak power." The units sell for $30 on up to over $100.

Medallion (P.O. Box 1903, Kansas City, MO 64141), Kraco (505 East Euclid Ave., Compton, CA 90224), Magnadyne (P.O. Box 5365, 20545 South Belshaw Ave., Carson, CA 90749), Comm Industries (One Gateway Center, Newton, MA 02158) and Tenna are among companies giving car stereo owners a chance to beef up their sound via amplified speakers. These consist of deluxe car speakers with heavy magnet structures and high power-handling capability, piggy-backed by small amplifiers rated up to 40 watts-per-channel. They generally sell in the $70 to $100 per pair range.

The great majority of companies selling car players also sell speakers. While most have been selling speakers at low, medium and high prices, a look at their product lineups today shows they are also selling big sound models to go with high-powered players or power boosters.

Further, some component speaker manufacturers such as Jensen (4310 Trans World Rd., Schiller Park, IL 60176), Utah (1124 East Franklin St., Huntington, IN 46750) and Altec (1515 South Manchester Ave., Anaheim, CA 92803), are pushing the development of car speakers that offer true hi-fi sound. Jensen's latest achievement is a three-way oval-shaped auto speaker dubbed "Triaxial." It combines a woofer, midrange and tweeter in one assembly.

Component systems

On a par with the debut of CB as an important part of the revolution taking place in auto sound is audio-component-type car stereo. It is, essentially, an off-shoot of the move to bigger sound and more audio power in the car. It is also part of today's auto owner's desire for quality sound that is an off-shoot of his quest for better sound from his home audio equipment.

At this writing there are two deluxe component-type auto stereo systems available. One comes from Audio Mobile (1891 McGraw Ave., Irvine, CA 92714) and consists of a stereo preamp/equalizer, a 25 watt-per-channel amplifier, and four speakers—two 6½-inch or 10-inch woofers (for rear deck mounting) and two 4-inch dome tweeters (for up-front mounting). This system sells for $388. Any existing car player, radio or combination can be fed into the Audio Mobile component system. To be available from the firm in 1977 will be a deluxe cassette player/AM/FM/FM-stereo tuner with Dolby noise reduction circuitry, for use with the above system. It is expected to sell for about $300. The amplifier has a total harmonic distortion (THD) rating of 0.3 percent from 20 Hz to 20 kHz, 20 watts-per-channel, and the preamp's signal-to-noise ratio is greater than 68 dB "with typical gain settings." (In listening to the Audio Mobile system installed in a car, I was impressed not only with the quality of sound but the visceral, gut-shaking physical aspect of it.

A second component-type auto sound system comes from a combination of two companies. The stereo cassette player priced at $275 is made by Nakamichi (220 Westbury Ave., Carle Place, NY 11514). The amplified speaker systems priced at $398.50 a pair are made by ADS (64 Industrial Way, Wilmington, MA 01887). The cassette player features Dolby noise reduction circuitry and its preamplifier section provides volume, balance and tone controls. The two-way speaker systems measuring about 7 × 4¼ × 4½-inches, each have three power-amplifiers built into them. Two amplifiers are for the woofer, one for the tweeter.

NAKAMICHI-ADS car stereo system.

ADS model 2002 speaker system.

The Nakamichi-ADS ensemble has double-duty potential. With the aid of two AC power adaptors (total price, $129.50), it can be used as an indoor system for use in weekend cottages, vacation hotels or motels, and elsewhere. (The system is quickly detachable from the car. A special case for easy carrying is being developed.)

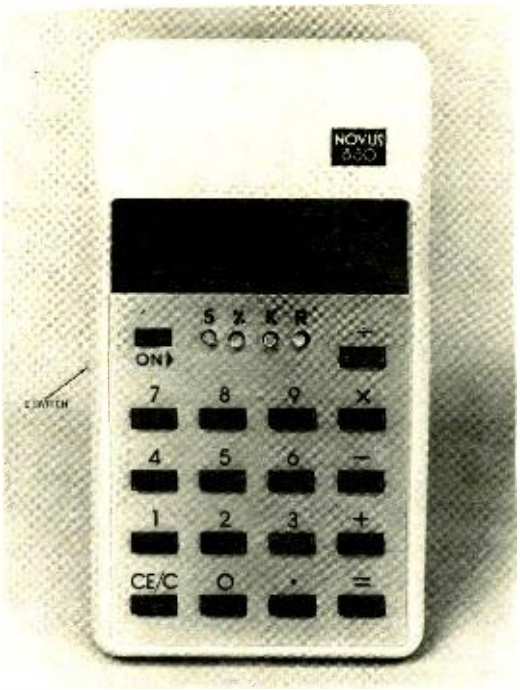
Several other companies make audio-component-type auto sound products. Four amplifiers are available under the Linear Power brand name (Shmegg Electronics, 113 Grenoble, Folsom, CA 95630). They have power outputs rang-

continued on page 90

Add 4 Functions to NOVUS 850

With the simple addition of switches, you can convert your 4-function Novus 850 calculator to 8 functions

HOWARD F. STEARNS



HOW THE 8-FUNCTION NOVUS LOOKS: The M has been left off the memory store and recall; D switch is barely visible on the side.

PROBABLY BECAUSE OF PRODUCTION ECONOMICS, National Semiconductor uses the MM5738 IC in the Novus 850 four-function calculator. This IC actually has eight functions. (A fifth function, auto squaring, is accessible in the 850 but they don't even mention it in the operating instructions!)

The remaining three functions, memory, constant and percent (plus display turn-off), may be used by adding switches to the keyboard as shown in the photograph. Access to a National MOS IC book or an MM5738 data sheet will help. Thus, for less than $14 (on sale) and a couple hours work, you can have an eight-function calculator.

No added active circuitry is required, only the five normally-open switches made from relay contacts. (Miniature push-button switches will work if they're small enough to fit.) The connections (see Fig. 1) are:

Function	Key	MM5738 Pin Numbers
Memory Store	MS	19 and 22
Memory Recall	MR	19 and 23
Constant	K	19 and 4
Percent (×0.01)	%	18 and 24
Display Reset	D	12 and 13

Pins 12 and 13 of the integrated circuit are connected on the printed-circuit board and must be separated to allow the battery-saving 16-second display shutoff circuit to function. Cut away 1/16-inch of copper from around pin 13 with a razor blade. The D switch may be omitted from your calculator, if desired, because pressing any of the keys automatically restores the display (resets timer).

Note that the MS, MR and K keys are common on pin 19 of the IC. This helps in the construction. Four holes are drilled through the control panel in the clear area between the power switch and the ÷ key. Plastic or metal rivets, inserted from the inside, make suitable key buttons. If screws are used as push-buttons, Teflon tubing must be placed over them or else they may bind on the threads. Fig. 2-a shows how the switches are made; Fig. 2-b shows how the bus is insulated for the % key.

Epoxy is the best way to attach the spring contacts to the panel underside. Hold and mask the contacts with masking tape until the epoxy sets. Bare AWG 14 bus wire is used for three of the fixed contacts. For the % key, first insulate the bus wire at this key with tape and then roll a relay contact around the taped wire. Solder a wire to the protruding end of the contact and anchor it with epoxy.

The construction will be smoother *if the following sequence is used:*

1. Drill holes.
2. Letter panel.
3. Epoxy spring contacts to panel.
4. Insert buttons.
5. Mount bus wire (epoxy) with plastic blocks on each end.
6. Wire.

Be careful not to overstress the spring contacts when inserting the push buttons.

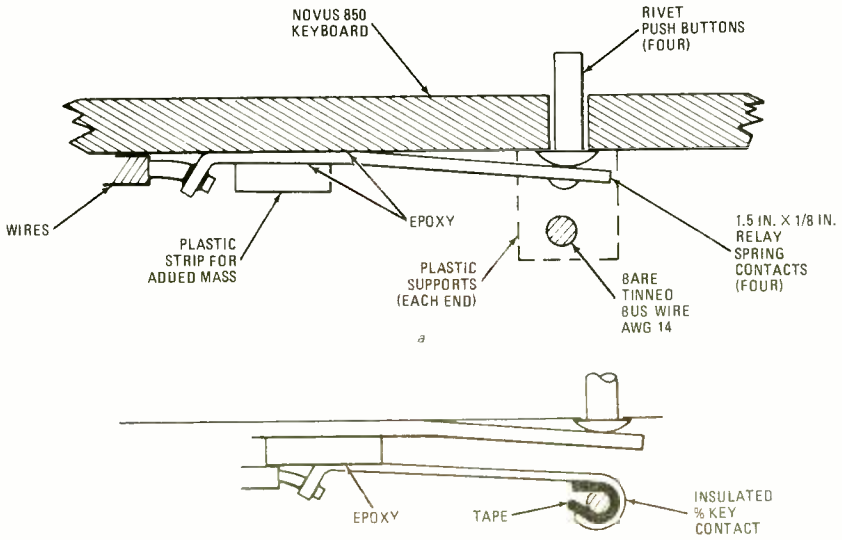
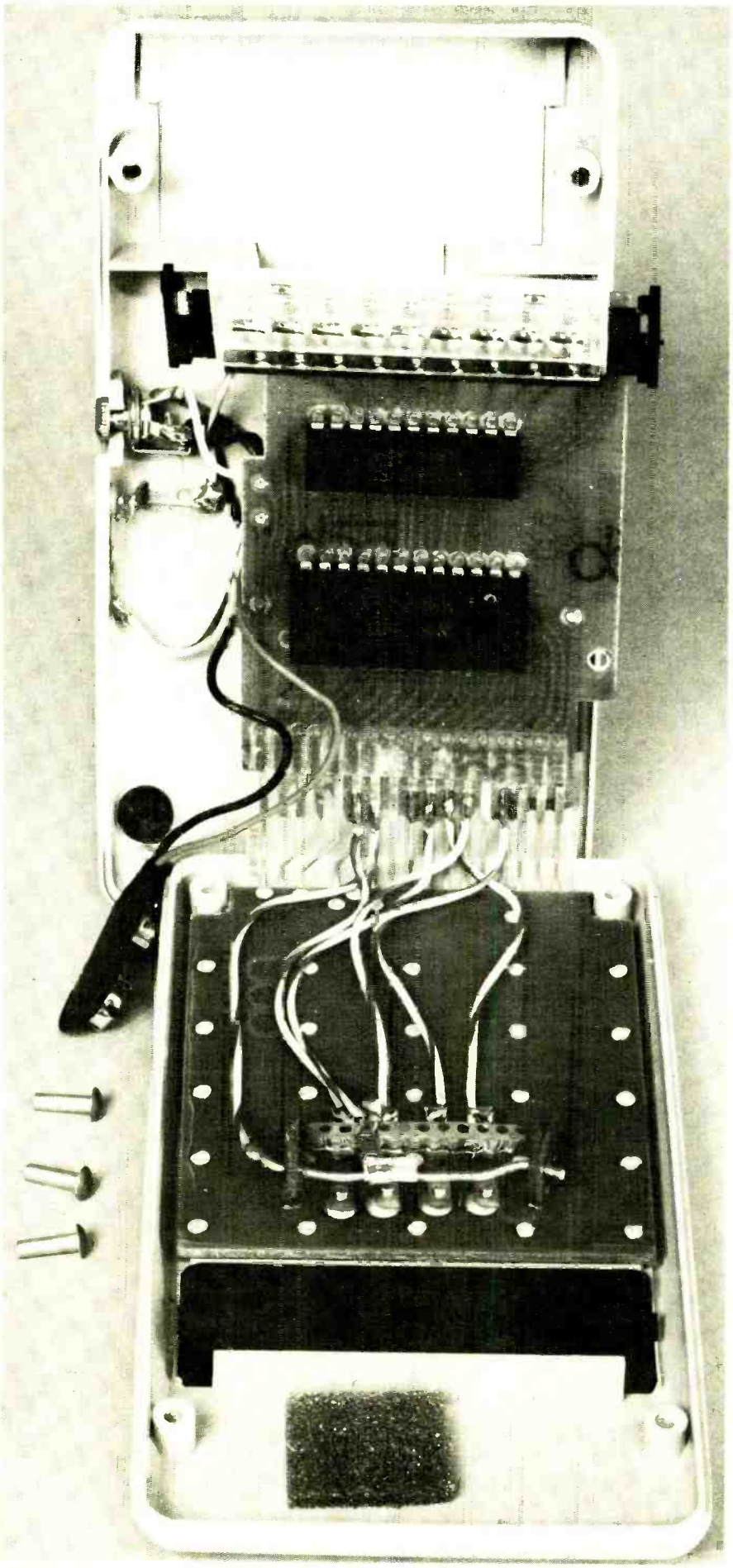


FIG. 2—DETAIL OF THE SWITCHES.



SWITCH INSTALLATION IN THE 850; the wiring job is reasonably simple.

The D key is located on the side of the 850 next to the power jack. This is convenient because the pushbutton may be depressed while holding the calculator.

Remembering how to use the extra functions will come with experience. Excellent examples are given in the MM5738 data sheet. Automatic squaring is simple; enter the number, press × and then =. For instance, if you square 5, you get 25. Now if you press = again, you get 25 squared, 625. Each time = is pressed, *the number on the display* is squared; not the first entry.

Storing a number in memory is also simple. Merely enter a number and press MS. (The M was not used on the panel marking.) Then press CE to clear the display. The number is recalled by pressing MR.

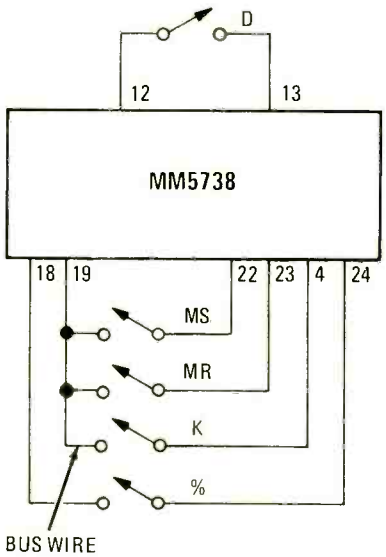


FIG. 1—SIMPLE ADDITION of switches converts the Novus 850 to 8-functions.

The % key simply moves the decimal over two places to the left. Since it converts a percentage number to the fraction, the same function may be accomplished by either dividing by 100 or by multiplying by 0.01. So essentially the % key reduces four operations to one.

The number entered after pressing either × or ÷ is stored as a constant, independently of the memory. Therefore, pressing K in a subsequent calculation repeats either ÷K or ×K, depending on how it was entered initially as a constant. A constant, once entered as times or divide-by, may be changed to the other function or to plus simply by pressing the desired function key (×, ÷ or +) before the K function.

The calculation does not work on subtraction of a constant. Entering − changes the sign of the entered number to minus when K is pressed, and subsequent pressing of K adds the constant in the negative direction. **R-E**

PROTECT YOUR CB-

theft-proof installations

A look at installation techniques for your mobile CB rig that provide maximum protection against thieves

HERB FRIEDMAN

POLICE NOW ESTIMATE THAT A PROFESSIONAL THIEF NEEDS LESS than 20 seconds to remove a CB transceiver from a dashboard installation. Even if the vehicle is equipped with an alarm system, the thief is in and your transceiver is out before anyone realizes someone's alarm is howling.

Many anti-theft devices have appeared in the CB marketplace, all of which promise to protect your transceiver. In most instances these anti-theft devices become an integral part of the transceiver, so the thief steals both the rig and the mount—a crowbar pops any mount off the dash quickly and efficiently.

It has been suggested that a CB'er simply not call attention to his car by using a removable antenna—when the car is parked the antenna is removed. Great idea, except that for the rather expensive motor-driven telescopic whip that disappears into the fender when not in use, there is no "removable" antenna that delivers anywhere near the performance of the standard 108-inch whip or the 48-inch trunk mounted antenna. You give up a lot of performance when you use a removable antenna.

But if you're willing to remove the antenna, why not work the other way round and remove the transceiver leaving the antenna permanently connected. No one can steal a transceiver that isn't there. The advantage to this arrangement is that you can use a high-performance antenna and lose nothing in the way of performance and yet maintain maximum security.

The easiest way to make the transceiver readily removable is to use a slide-mount device similar to those used for tape players and add-on FM stereo radios. But before we get to the transceiver, let's get the antenna on the car.

Antenna Installation

The most effective antennas are the full-length whip and the "short" (about 48-inches) trunk-lip mounted whip. Since the mount for the 108-inch whip requires drilling holes in the vehicle's body, or the use of a bumper mount, the *no-holes* trunk-lip mount has become, more-or-less, the most popular CB car antenna.

The trunk-lip mounts from the well known manufacturers have a U-shaped bracket that wraps itself around the lip of the trunk. As shown in Fig. 1, the center of the U-bracket is indented so the coaxial transmission-line also wraps around the trunk lip in such a manner the cable is neither deformed nor damaged. This might appear to be a small thing deserving of no attention because it is expected. In fact, however, cheap imported copies of these better known antennas look almost identical except that the wrap around U-bracket doesn't have the indent for the transmission line. The transmission-line is simply passed behind the U-bracket where it gets deformed on the very first closing of the trunk. A deformed transmission line can increase the standing-wave ratio (SWR).

FIG. 1—INDENTED CHANNEL prevents damage to the transmission line when the trunk is closed.

Almost all the "shortened" or loaded-type antennas must be tuned for minimum SWR at the antenna's mounting location. An adjustment that's good for the side of the trunk is probably not correct for the center of the trunk lip.

The antenna is usually adjusted for minimum SWR by loosening a screw at the bottom of the antenna and making small incremental adjustments of the antenna height until the SWR is minimum. As shown in Fig. 2, a hex key, always provided with the antenna, is required for most antennas. It's best to be suspicious of any antenna using an ordinary machine screw for the SWR adjustment as it is easily susceptible to tampering.

After the antenna is installed, simply drop the cable into the trunk until the transceiver is installed.

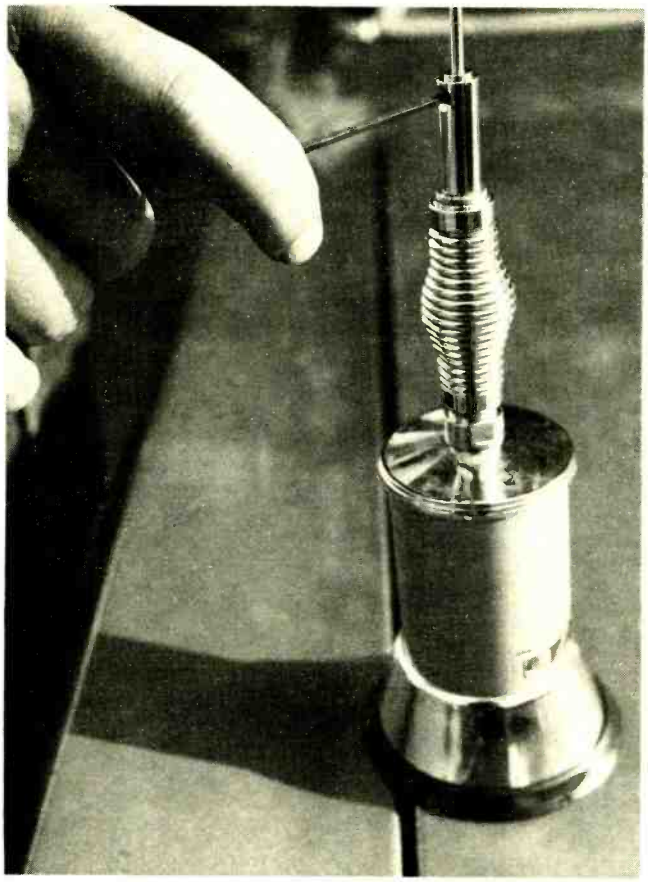


FIG. 2— SWR ADJUSTMENT is accomplished by varying the height of the antenna. Hex key supplied with antenna is used for this purpose.

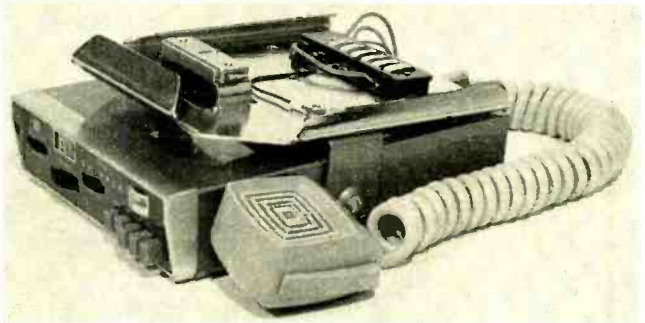


FIG. 3—SLIDE MOUNT is secured to the mounting bracket supplied with the transceiver.

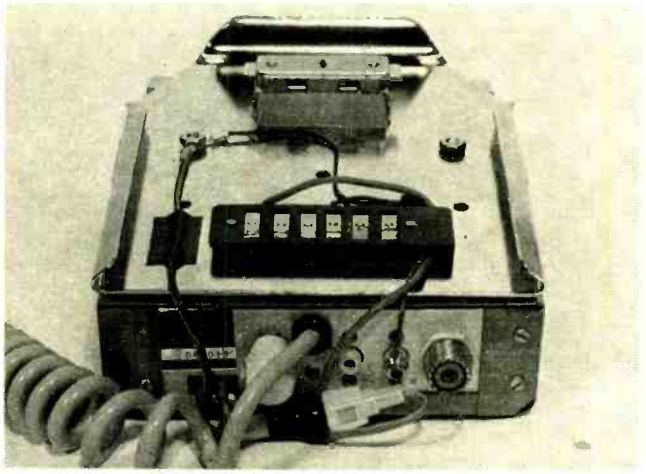


FIG. 4—RELIABLE CONNECTIONS are attained by unsoldering the wires supplied with the slide mount and soldering the wires from the transceiver directly to the terminals on the slide mount.

Transceiver installation

All mobile transceivers, and a few of the combination base and mobile models, come supplied with some form of mounting bracket. You can very easily install the transceiver by simply fastening the bracket to the dash with a couple of screws. You can also have the transceiver stolen in less time than it took you to secure the two screws. The only transceiver that can't be stolen is one that isn't there, and the *slide-mount* installation is becoming more popular as insurance companies refuse to pay off on stolen CB's.

The slide mount generally used for CB transceivers is the same model used for tape players and FM-stereo radio add-ons. Unlike the tape players, however, where all connections—speaker, battery and ground wires—are provided for the tape player, the regular slide mount doesn't make provision for the transmission line and you have to remove the antenna cable before removing the transceiver. Some FM-stereo radio slide-mounts have internal make-break connections for the FM antenna; these have been upgraded with RG-58/U cable and coax connectors for CB use. The problem here is that the discontinuity in the transmission line caused by the slide-mount contacts increases the system SWR and the contacts have caused a few intermittent problems. But you do get the advantage of a fast make-break connections for transceiver removal; so if a small RF-output loss is of no concern, go ahead and use the CB slide-mount. (CB mounts are often twice the price of the tape player version of the same mount.)

Going one step further, one slide-mount model has been provided with a fixed coaxial-jack on the back of the section that gets mounted to the dash. Another great idea gone wrong! It moves the coax connector up from the rig to the top of the mount. In many instances, the car's air-conditioning ducts get in the way and there's no way any connection can be brought into the dash-mounted section. Better check your car's installation area and mounting situation before investing in this relatively expensive mounting device.

The individual sections of some slide-mounts are available separately. This is ideal if you want your CB to do double or triple duty. You can order either the dash or equipment mounting sections. This allows you to install the dash section in two or more vehicles or boats and you need only one transceiver section. In this way, the transceiver will fit into all your vehicles and you don't have to pay for the unnecessary mounting sections.

Figure 3 shows how a transceiver fits to a slide mount. In Fig. 4 the transceiver is wired to the slide-mount terminals. If you look carefully at Fig. 4 you can probably see an extra wire from the transceiver to the mount's terminal-strip. The *external speaker* output from the transceiver has been connected to one of the terminals. For better sound quality, one of the car's stereo speakers has been connected to the matching dash-mounted section. When the transceiver is slipped into the slide-mount, the car speaker will serve for CB providing a much cleaner sound. If your car doesn't have an extra speaker, you can install a separate component speaker exclusively for the CB. Any of the "communications" speakers or even one of the speakers and enclosures used for car stereos can be used.

Secure the dash section of the slide-mount as shown in Fig. 5. While nuts and bolts are suggested and preferred as mounting hardware, because of air conditioning ducts it's often impossible to reach behind the dash. If the ducts get in your way and you're not inclined to dropping half the dash to mount the CB, use No. 10 or No. 12 sheet-metal screws with an internal starwasher between the screw and the dash.

Hook up

Connect the positive and ground wires from the car's electrical system to the slide mount—and a speaker wire if you've used an external speaker—and then route the transmission line from the trunk. The object is to bring the coax out

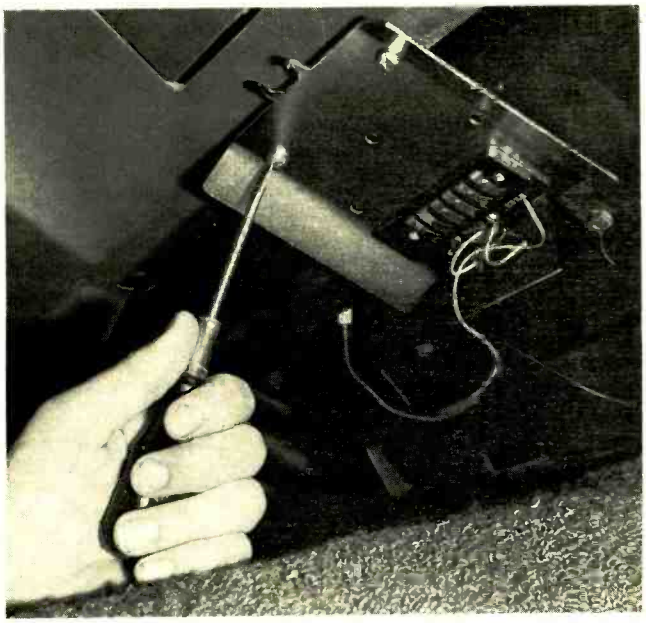


FIG. 5—STATIONARY SECTION of slide mount is secured under the dash using sheet metal or machine screws.

FIG. 6—TRANSMISSION LINE is run from trunk to passenger compartment in wiring-channel under the door saddle.

FIG. 7—TRANSMISSION LINE should be just long enough to reach the transceiver. Excess should be left in trunk, not under the dash where it can get tangled with the driver's foot.

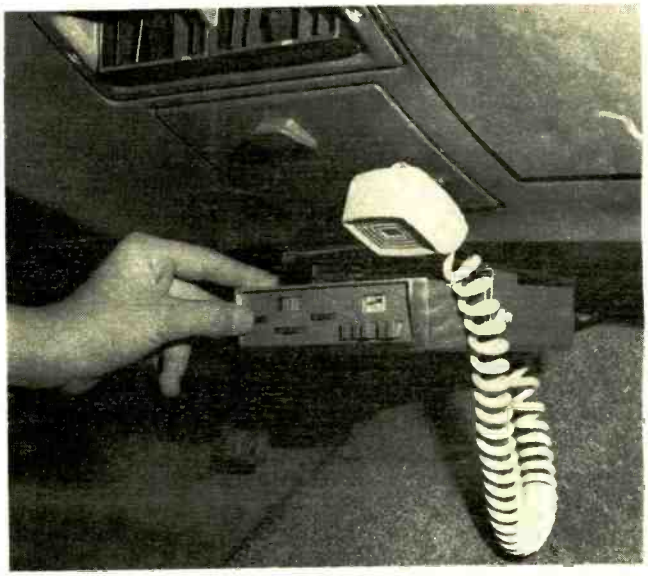


FIG. 8—MICROPHONE BRACKET should be mounted so that the microphone cable does not interfere with the driver's foot.

from under the carpet or firewall shield near the transceiver so there's no possibility of the gas/brake foot getting snagged in the coax.

Whether you have to remove the rear seat to get the coax from the trunk into the passenger compartment, or whether you can pass the coax directly into the compartment, depends on the particular type and model car you own. If you have a late model General Motors car, you will probably have to remove the rear seat. You will find there's no real wiring channel—the wires from the rear lights are simply enfolded in a plastic shield. Just follow the shield to the passenger compartment and run the coax under the carpet adjacent to the transmission hump.

Ford Motor cars also usually require the removal of the rear seat. Run the coax up to the front by following the wiring for the tail lights which is inside a wiring channel. A short snake is usually required for passing the wire through the channel. If there's an obstruction in the channel, you'll have to snake the coax under the carpet.

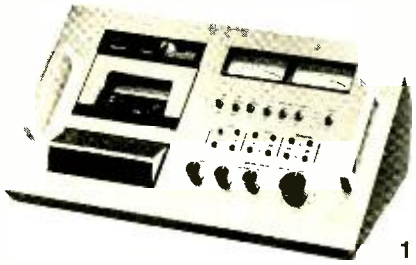
Chrysler cars are often the easiest to wire as you can usually pass the coax from the trunk directly into a wiring-channel running along the left side of the car. As shown in Fig. 6, removal of a left door saddle exposes a front-to-rear wiring channel concealed beneath the carpet. Just lay the coax in the channel all the way to the fender wall kick plate. Remove the plate and fish the wire up to the firewall and over to the transceiver. You must cross over the pedals so make certain the coax is tied up and away from the gas and brake pedals.

If you have excess coax after making the run to the front, pull the excess back into the trunk. You should have just enough wire up front to reach the CB or slide mount, as shown in Fig. 7. Loops or coils of coax near the right foot leads to an accident. There should be no possibility of the driver's foot getting tangled in the coax.

Finally, install the transceiver and connect an SWR meter—as shown in Fig. 8—between the transceiver and the coax. Adjust the antenna for minimum SWR. If you can, also check for approximately 3 to 4 watts RF output to be sure the rig is working correctly. Remove the SWR meter, connect the coax to the transceiver and the rig is ready for use.

Figure 9 shows the completed installation. Note the microphone bracket is positioned so the microphone cable hangs down on the passenger side of the transmission hump, there are no loose wires near the driver and the transceiver controls can be reached by both the driver and passenger. A safe, convenient and theft-proof installation. R-E

Radio-Electronics Tests Nakamichi 600 Cassette Deck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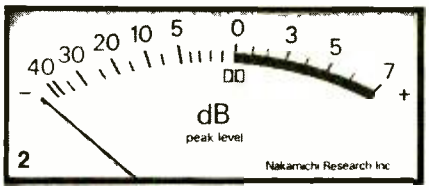
LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

ALL ONE HAS TO DO IS TAKE A GOOD LOOK AT Nakamichi's new *model 600* Stereo Cassette Deck to realize that here is something that is a bit different from the norm for this category of product. But the full impact of that difference cannot be appreciated until you have had a chance to work with the unit, as we did in our laboratories over the past several days. Physically, the deck is quite a departure from Nakamichi's earlier state-of-the-art cassette deck *models 1000* and *700*, each of which was fairly bulky in size. Each of those higher priced models featured separate record and playback heads whereas the new 600, according to literature provided by the company, sets out to prove just how well a two-headed machine can do if its heads and electronics are designed properly and with painstaking care. The wedged shape of the *model 600* afford control panel visibility and access that is unequalled in either the table top or front-loading formats.

Figure 1 is an overall view of the Nakamichi 600. While too small in width to be accommodated in a standard 19-inch rack, Nakamichi recently introduced a miniature sized rack that can hold the *600*, along with the new companion *model 610* preamplifier and *model 620* power amplifier all in a vertical or upright position.

The tape cassette compartment at the left of the panel provides easy access to heads for cleaning and pops up when the STOP/EJECT button is depressed. Because it is not completely protected by a glass or plastic window, a dust cover is supplied (not shown) that fits over the entire front panel when the machine is not in use. A three-digit tape counter and REWIND-MEMORY button are located above the compartment while below are six piano-key mechanically operated transport controls including RECORD, REWIND, STOP/EJECT, PLAY, FAST FORWARD and PAUSE. It is necessary to depress the STOP button before switching from one tape motion to another, and both RECORD and PLAY buttons must be depressed simultaneously to begin recording. The PAUSE button, however, permits the user to cue up levels before recording actually commences.



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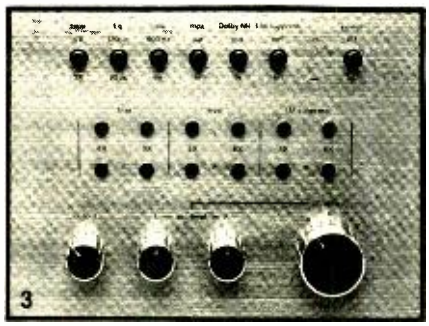
The two recording level meters at the upper right have the same expanded scale (from −45 dB to +7 dB) as those found on Nakamichi's higher priced *model 1000* and the Dolby calibration point corresponds to 0 dB on these meters (200 nanowebers-per-meter) and is marked on their face (see Fig. 2). A close up view of the control section at the lower right is shown in Fig. 3. Rotary controls include a MASTER recording level control, individual channel RECORD LEVEL controls and an OUTPUT level control. The seven tiny pushbuttons at the top take care of POWER on/off switching, TAPE bias and EQUALIZATION selection, actuation of a built-in 400-Hz test TONE, an MPX filter, DOLBY IN and OUT, and what Nakamichi calls an IM suppression circuit about which we shall have more to say shortly. What appear to be twelve more "buttons" at the center of the control area are in reality tiny plastic rubber plugs that cover up screw-driver adjustments for setting up optimum bias and recording sensitivity for tape types other than Nakamichi's own EX and SX tape for which the machine is calibrated at the factory. Four more plugs can be removed to adjust the working parameters of the special IM suppressor circuit which is also tape-dependent. Nakamichi warns against customers attempting to alter these factory settings unless they are equipped with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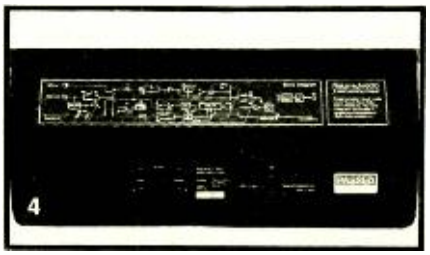
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suitable test equipment and technically competent to perform these critical adjustments. Since Nakamichi's EXII tape is fairly close in its characteristics to other better quality low-noise high-output ferric tapes and their new SX tape is, in effect, a ferric replacement for chrome tapes, good results should be obtained when using other similar tapes even without readjusting all these control settings.

The rear panel of the Nakamichi *model 600* is shown in Fig. 4 and contains only the usual LINE INPUT and LINE OUTPUT jacks plus a combination DIN connector and a tiny slide switch which is "locked" in the 120 VOLT position, since this machine can be switched to 220-volt operation for overseas use. Also visible is a block or signal-flow diagram screened on the sloped surface behind the front panel.

Laboratory measurements

A summary of our usual cassette deck measurements will be found in Table I and can be compared with published specifications shown elsewhere. Frequency response, using Nakamichi EXII and SX tapes exceeded published specifications by far, extending from 30 Hz to 21.2 kHz in the case

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Frequency Response: 40 to 18,000 Hz, ±3 dB (SX or EX tapes). **Signal-To-Noise Ratio:** Better than 60 dB, weighted, RMS, referenced to 0 dB; Better than 68 dB, weighted, RMS, referenced to 3% THD with IM suppressor. **Total Harmonic Distortion:** 1.5% at 0 dB, 400 Hz (SX or EXII tape). **Wow-and-flutter:** Less than 0.12% weighted, peak. **Erasure:** Better than 60-dB below saturation level. **Separation:** Better than 35 dB, 1 kHz, 400 Hz. **Cross-talk:** Better than 60 dB, 1 kHz, 0 dB. **Bias Frequency:** 105 kHz. **Input Sensitivity:** 60 mV for 0 dB recording level. **Output Level:** 580 mV (output level at maximum, 0 dB). **Power Consumption:** 15-watts maximum. **Dimensions:** 15¾ W × 6.7 H × 9.33-inches D (40 × 17 × 23.7 cm). **Weight:** 14.3 pounds (6.49 kg).

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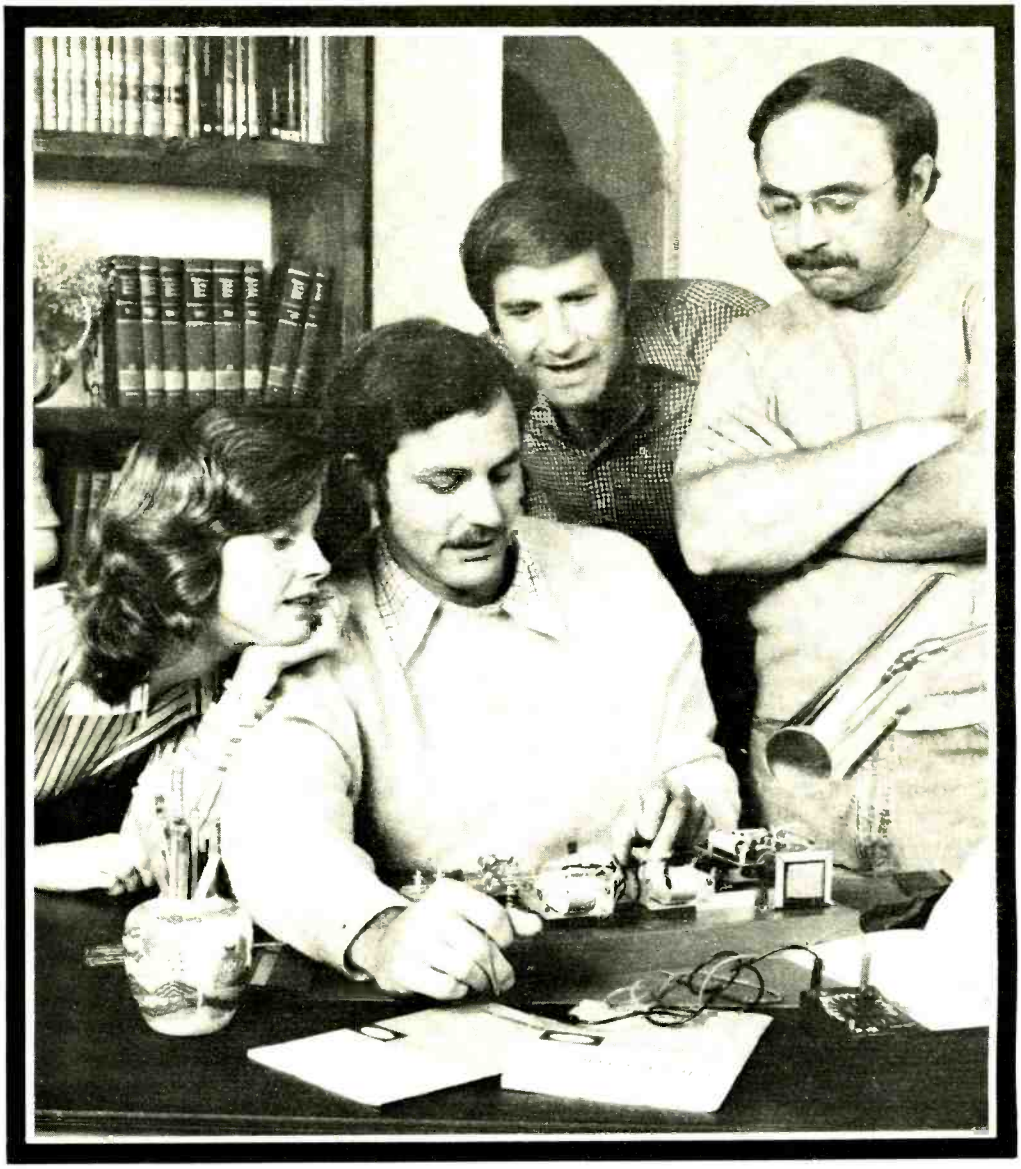

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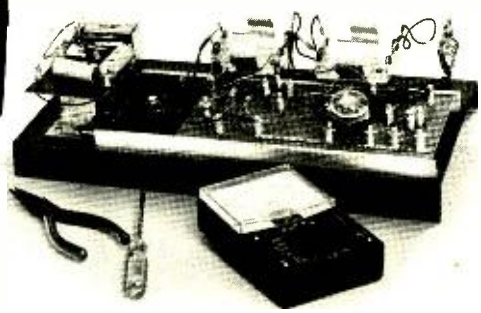

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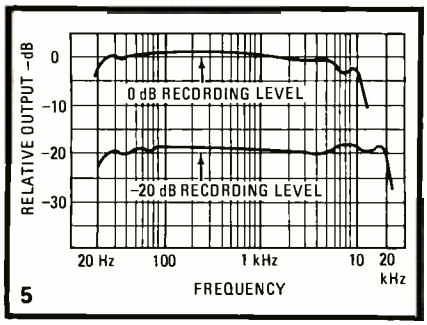
of the EXII tape and from 28 Hz to 21.0 kHz for the SX tape (see Fig. 5). Note that our signal-to-noise measurements are made with no weighting filter added but are referenced to the 3% total harmonic distortion point.



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Wow-and-flutter were an exceptionally low 0.05% WRMS or 0.09% RMS unweighted. All of which brings us to the subject of total harmonic distortion and, as we promised, a brief explanation of Nakamichi's amazing new IM suppression circuit. As you can see from our results in Table I, distortion up to and including a +3 dB recording level is normally quite low and typical of good quality tape and cassette decks working together. As most readers realize, if one records at higher levels than these, tape saturation causes distortion to rise rapidly. This is especially true of cassette decks, where record equalization is such that to achieve good frequency response, one quickly reaches tape saturation particularly at high frequencies.

Nakamichi reasoned that each tape has a particular magnetization characteristic and therefore its "lack of linearity" can be measured and can be expected to be fairly consistent for that kind of tape. In a complex 8-stage equalization circuit, Nakamichi developed a network that "shifts" gain at a predetermined level in such a way as to compensate for the "squashing" of the signal by the effects of tape saturation. Thus, the IM suppression works on playback ONLY. What's more, if it is calibrated correctly, it will even reduce distortion (BOTH IM and THD) on over-recorded tapes made on other machines. The other stages in the 8-stage system perform some neat phase compensation tricks with playback signals—so neat, in fact, that this is the first machine we have ever encountered (open reel or cassette) in which we could record a squarewave and have it play back still looking remarkably like a squarewave. Try doing that on any tape machine you now own—you may be in for a surprising disappointment. A complete explanation of the operation of the IM suppression circuit would take a sixteen-page pamphlet to fully explain.* What concerned us, in testing the *model 600,* was to find out whether it actually does work. As a worst-case example, we recorded a 1 kHz signal at a level of +5 dB. When we played this test tone back and measured THD, we obtained a reading of 3.5%, using SX tape. Punching in the IM SUPPRESS button, we watched the distortion reading settle down to 1.8%. Mind you, this was tape that already had the distorted recording on it! Readers may pounce upon us at once and suggest that some sort of filter (which rolls off harmonics) is introduced during playback. Not so! Response is just as flat out to 20 kHz or so whether or not you depress the IM SUPPRESS button.

TABLE I

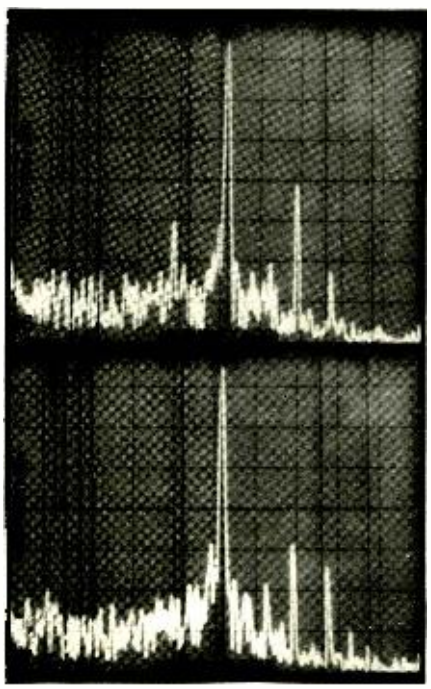
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Nakamichi Research, Inc.** Model: **600**

CASSETTE TAPE DECK MEASUREMENTS

	R-E Measurements	R-E Evaluation
FREQUENCY RESPONSE MEASUREMENTS		
Frequency response standard tape (Hz—kHz ± dB)	30-21.2, 3	**Superb**
Frequency response, SX tape (Hz—kHz ± dB)	28-21.0 See Fig. 5	**Excellent**
DISTORTION MEASUREMENTS (RECORD/PLAY)	Std./SX	
Harmonic distortion @ −10 VU (1 kHz) (%)	See Text	**See text**
Harmonic distortion @ −3 VU (1 kHz) (%)	1.2/1.1	**Excellent**
Harmonic distortion @ 0 VU (1 kHz) (%)	1.3/1.2	**Excellent**
Harmonic distortion @ +3 VU (1 kHz) (%)	1.5/2.0	**Very good**
SIGNAL-TO-NOISE RATIO MEASUREMENTS		
Standard tape, Dolby off (dB) (unweighted)	50	**Excellent**
Standard tape, Dolby on (dB) (unweighted)	60	**Excellent**
SX tape, Dolby off (dB) (unweighted)	52.5	**Excellent**
SX tape, Dolby on (dB) (unweighted)	61.0	**Excellent**
MECHANICAL PERFORMANCE MEASUREMENTS		
Wow-and-flutter (%, WRMS)	0.05 WRMS	**Superb**
Fast wind and rewind time, C60 (seconds)	105	**Fair**
COMPONENT MATCHING CHARACTERISTICS		
Microphone input sensitivity (mV)	N/A	
Line input sensitivity (mV)	60	
Line output level (mV)	600	
Phone output level (mV)	N/A	
Bias frequency (kHz)	105	
TRANSPORT MECHANISM EVALUATION		
Action of transport controls		**Good**
Absence of mechanical noise		**Excellent**
Tape/head accessibility		**Excellent**
Construction and internal layout		**Very good**
Evaluation of extra features, if any		**Superb**
CONTROL EVALUATION		
Level indicator(s)		**Excellent**
Level control action		**Very good**
Adequacy of controls		**Good**
Evaluation of extra controls		**Excellent**
OVERALL TAPE DECK PERFORMANCE RATING		**Excellent**

In utter disbelief, we decided that this needed additional investigation. We therefore used our spectrum analyzer to examine the distortion components (harmonics) of the recorded 1 kHz signal with and without the IM suppression feature switched in. In the sweep of Fig. 6, we see the large fundamental peak (1 kHz) at center screen. Note that the third harmonic (3 kHz) is some 35-dB down, or roughly 1.78%. With the same signal from the same tape being played, we depressed the IM SUPPRESS button. The results are shown in Fig. 7. Note that the third harmonic contribution to THD is now down some −45 dB, which corresponds to around 0.56%, an improvement of 3-to-1 in third harmonic distortion! Interestingly, the fourth harmonic has actually gotten somewhat larger with the introduction of the IM suppression circuit, but since, in both Figs 7 and 8, it is substantially below the 3rd harmonic contribution, its net contribution to audible distortion in both cases may be considered negligible compared to the obvious lowering of third harmonic with the activation of the IM suppression circuit.



Having become convinced of the effectiveness of the IM suppression circuit in reducing THD, we returned to our distortion analyzer and plotted THD as a function of recording level (of a 1 kHz tone) with and without the IM suppression in the circuit. The results are shown in the graph of Fig. 8 and speak for themselves. Suddenly, headroom has been improved to a +7.5 dB from a +6 dB, if one uses the 3% overall THD point as a reference. In effect, the dynamic range has been improved by that hard-to-come-by 1.5 dB but, more important, those inadvertent moments of VU meter needle-pegging that most recordists run into from time to time are now not going to render a recording useless during playback.

TABLE II

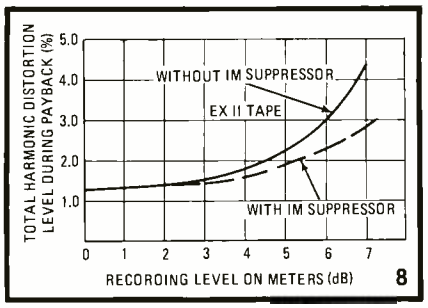
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Nakamichi Research, Inc.** Model: **600**

OVERALL PRODUCT ANALYSIS

Retail price	**$500.00**
Price category	**Medium-high**
Price/performance ratio	**Excellent**
Styling and appearance	**Superb**
Sound quality	**Excellent**
Mechanical performance	**Very good**

Comments: It is obvious that when Nakamichi set out to design this marvellous little cassette deck, the emphasis was on superb electronics and tape head superiority. The target suggested retail price obviously prevented them from incorporating such "luxury" features as electronically controlled transport functions (found in their models 700 and 1000). The most worthwhile feature found in this deck is the IM suppression circuit that adds substantially to the headroom of any tape when it is properly calibrated for that tape. The action almost defies scientific reasoning, but take it from us, it actually works. It is also clear that Nakamichi sought to deliver a two-head machine that does as well (or nearly as well) as their three-headed more expensive models insofar as frequency response and signal-to-noise ratios are concerned. In this they have succeeded remarkably. Because the deck is part of new series that Nakamichi calls their Recording Director series (it now includes a matching sloped or wedge shape preamplifier and a similarly configured power amplifier), certain basic features which one has come to expect on almost any high-quality cassette deck, such as microphone inputs and line/mic mixing are missing, appearing instead on the matching *model 610* preamplifier. Purchased by itself, only line input recording is possible and one would have to provide other means (such as a mic mixer preamplifier) if one wishes to record "live" sounds. In view of the remarkable IM suppression circuit (which, in our view, is misnamed since it reduces harmonic distortion on playback as well as IM), the absence of any peak indicators is not a serious drawback, since recording "into the red" is no longer as serious a recording error as it would be without the IM suppression circuit. Alone, the *600* is certainly worth its price. Used with the matching *610*, it's a miniature recording studio that looks great and operates superbly.

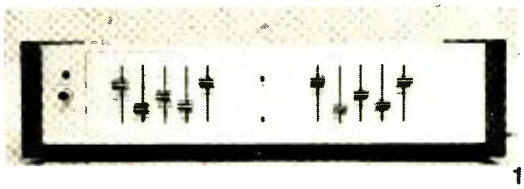


Summary and listening tests

The effect of the IM suppression circuit is clearly discernible on recorded test tones as well as on recorded musical material that has been deliberately recorded on the high side of the level meter indications. Obviously, if recording practice is such that levels are maintained at or below 0 dB in all instances, you will not be able to hear any audible reduction in distortion. However, it's extremely comforting to know that if we do over-record occasionally, the tape need not be relegated to the wastebasket but can be resurrected by means of Nakamichi's novel development. Incidentally, it should be clear from our description that an over-recorded tape played on any other machine will still have the basic distortion that's impressed onto the tape, since the correction only takes place during *playback* of such tapes on the *model 60*. But, to counter that disadvantage, consider this. A tape that is over-recorded on any *other* machine can be played back with lower distortion on *this* machine (providing, of course, that it is the type of tape for which the IM suppression calibration-controls have been adjusted). Our overall comments concerning this product will be found in Table II, along with our overall analysis. **R-E**

* Copies of *Technical Bulletin #6*, explaining the operation of the IM suppression circuit in greater detail may be obtained by writing to Nakamichi Research, Inc., at 220 Westbury Ave., Carle Place, NY 11514.

Radio-Electronics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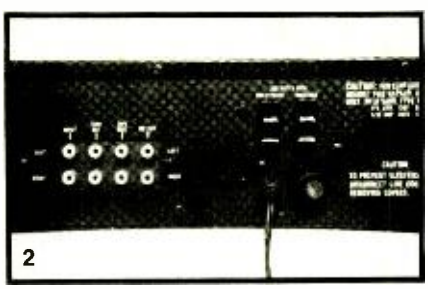
Tests Heath AD-1305 Equalizer

RECENT INTEREST IN GRAPHIC EQUALIZERS HAS prompted many high-fidelity component manufacturers to design and produce these handy add-on devices. The most elaborate of these may contain as many as twenty or more separate frequency controls that permit adjustment of frequency segments as narrow as one third of an octave. Others offer ten controls per channel for octave-by-octave frequency response adjustment, while the least elaborate of these hi-fi accessory units settle for five controls per channel, each control covering a range of approximately two octaves.

The Heath AD-1305 fits in this last category. Shown in Fig. 1, the AD-1305 has twin sets of slide controls, each of which has a mechanical detent or stop at its mid-position that corresponds to a flat response. Each quintet of controls handles one channel of the stereo pair. Mounted between these control arrays are two 2-position toggle switches, one of which is a tape monitor switch (that permits you to substitute corresponding TAPE OUT and TAPE IN jacks on the AD-1305 if you have used up such facilities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MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Input Impedance: 100K ohms. **Output Impedance:** 100 ohms. **Rated Output:** 1.5 volts RMS. **Overload:** 5 volts RMS. **Signal-to-Noise Ratio:** 90-dB below 1.5 volts. **Total Harmonic Distortion:** 0.05% from 20 Hz to 20 kHz at 1.5-volts output. **IM Distortion:** 0.05% at 1.5-volts output. **Separate Frequency Control Ranges:** 30—125 Hz, 125—500 Hz, 500 Hz—2,000 Hz, 2 kHz—8 kHz, 8 kHz—32 kHz. **Overall Gain** (Controls Flat): 0 dB. **Response of Filters:** 12 dB-per-octave. **Dimensions:** 17½ W × 4 7/32 H × 8-inches deep. **Shipping Weight:** 11 lbs. **Price:** $119.95 (available only in kit form).

on your amplifier or receiver to connect the AD-1305), while the other switch bypasses the equalizer and permits instant comparisons between equalized and unequalized sounds. A power on/off pushbutton at the left of the panel and a power light indicator complete the front-panel layout.

A close-up view of a portion of the rear panel is shown in Fig. 2. In addition to the INPUT, OUTPUT, TAPE MON and TAPE OUT pairs of phono-tip jacks, there are SWITCHED and UNSWITCHED convenience AC receptacles and a line FUSE. It should be noted that the TAPE OUT jacks of the AD-1305, as arranged in this unit, provide a flat response signal. In other words, the tape out signal comes before any equalization. Thus, while a normal connection via the tape monitor jacks on your receiver or amplifier would enable you to equalize reproduced or played-back music from any program source (by simply choosing the monitor position of the front-panel control on your amplifier or receiver), such a connection would not permit you to pre-equalize program material that you wish to record onto your tape. For such applications, the AD-1305 would have to be re-installed between your program source and the line inputs to your tape recorder. Then, for playback, you would have to restore original connections to the tape monitor jacks on your amplifier or receiver.

Internal layout

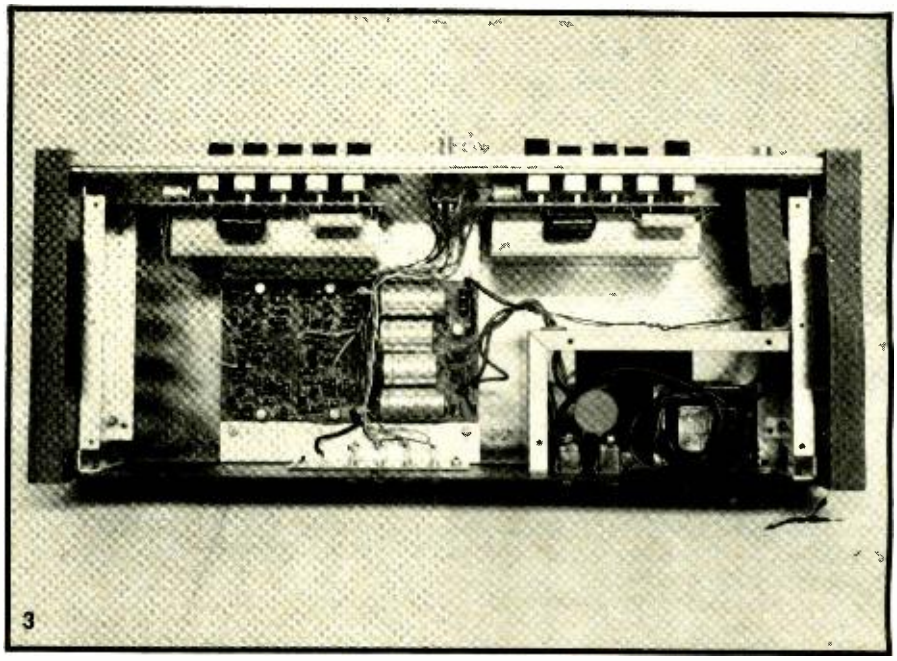
Removal of the top cover of the AD-1305 (ours was supplied fully wired by the factory) reveals an excellent circuit layout consisting of a primary circuit board that contains the active stages of the device, and individual vertically mounted PC boards that contain the slide potentiometers and the LC filter components. Each of these latter boards has its own metal shield cover to prevent stray magnetic hum fields from reaching the inductors. The power transformer is also completely shielded in its own compartment at the lower right (see Fig. 3). (We removed the top cover for the purposes of this photo.) Although we were not supplied with a construction manual for the AD-1305, judging by the completed unit, even a novice kit-builder would have no trouble assembling this product. We would estimate that an experienced kit-builder could complete the job in under 8 hours whereas a newcomer to electronic kit building might require up to 12 hours or so.

Circuit description

A partial schematic of the AD-1305 circuit is shown in Fig. 4. Only one channel is shown since the opposite channel is identical. Of particular interest are the frequency control circuits. Signals from the input amplifier are coupled to the base of Q7 and through C101 to each of the five frequency controls. Each control consists of a potentiometer that is center-tapped, plus a series circuit consisting of a capacitor, coil and resistor. The center tap of each control is grounded so that when the control is set to its center position, both ends of the series circuit are grounded and the circuit has no effect.

As the control is moved to the boost side, the series circuit is connected to the inverting input at the base of Q8 of the equalizer amplifier. This results in a voltage gain at the resonant frequency (determined by the series inductance and capacitance in each frequency control circuit). As a control is moved to the attenuate side, that circuit is connected to the non-inverting input at the base of Q7. This presents a low impedance to ground for the signal that results in reduced gain at the resonant frequency. The series resistor in each resonant circuit limits the possible voltage attenuation at the resonant frequency to a maximum of 12 dB.

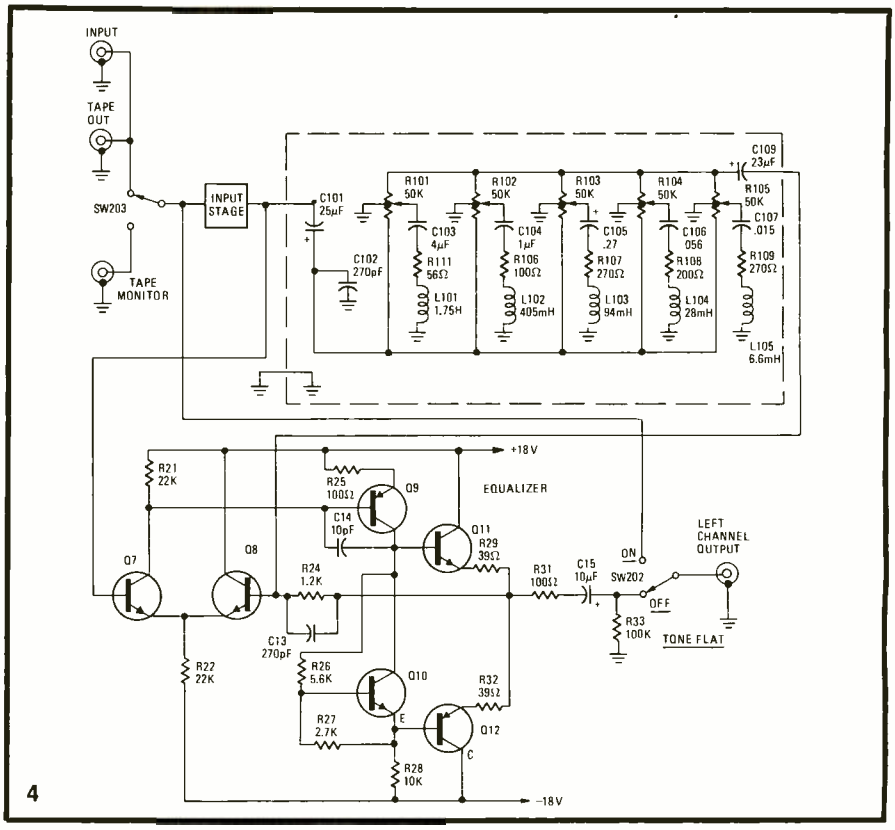
Transistors Q7, Q8, Q9, Q10, Q11 and Q12 and associated circuitry form a discrete-device operational amplifier with full complementary symmetry output. Switch SW202, when thrown to the TONE FLAT position, connects input and output terminals together, bypassing the equalizer circuits entirely.



3

Laboratory measurements

Some of the more important performance measurements we made on the AD-1305 are summarized in Table I. Our enthusiasm regarding the low distortion observed at rated output across the entire audio band from 20 Hz to 20 kHz does not really tell the entire story. Often, equalizers of this type measure low in distortion when all controls are set flat, but tend to show increased distortion when the slide controls are pushed towards the boost settings. In the case of the



4

TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

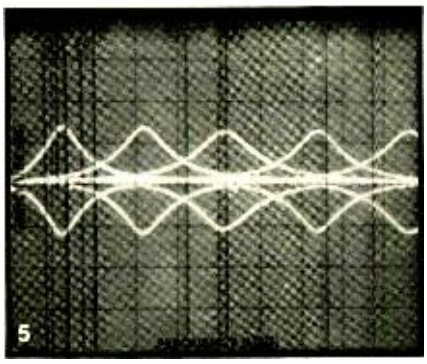
Manufacturer: **Heath Company** Model: **AD-1305**

GRAPHIC EQUALIZER PERFORMANCE MEASUREMENTS

PERFORMANCE MEASUREMENTS	R-E Measurement	R-E Evaluation
Rated output, reference (volts)	1.5	
Output voltage at overload	10.0	**Excellent**
THD at rated output, 20 Hz	0.006%	**Superb**
THD at rated output, 100 Hz	0.006%	**Superb**
THD at rated output, 1 kHz	0.005%	**Superb**
THD at rated output, 20 kHz	0.008%	**Superb**
IM distortion, rated output (V)	0.015%	**Excellent**
S/N re: rated output	90 dB	**Excellent**
Frequency response (Hz-kHz, ± dB) (filters set to flat)	5Hz to 60 kHz, ±1dB	**Excellent**
Frequency control ranges	See Fig. 5	**Good**
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Action of controls and switches		**Fair**
Design and layout		**Excellent**
Ease of servicing		**Excellent**
OVERALL EQUALIZER PERFORMANCE RATING		**Very good**

AD-1305 we actually measured somewhat lower distortion figures than those tabulated when all controls were at their maximum boost position and input level was reduced so that the output remained at the rated 1.5-volts RMS.

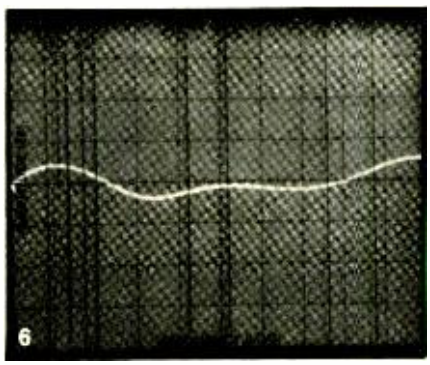
As can be seen from the scope photo of Fig. 5, the control range is approximately ± 12 dB at center frequencies within each two-octave control segment (vertical scope gain is 10 dB-per-division and horizontal sweep is from 20 Hz to 20 kHz, logarithmic, so that distances per octave are equal across the scope face). Since overload does not occur until an output of 10 volts is reached (far better than the Heath claim of 5.0 volts), even if the input



level were as high as 1.5 volts and all slide controls were set to their maximum boost positions, the output level would be approximately 6.0 volts at the center frequencies of each of the bands so boosted, or well below the overload point.

The signal-to-noise ratio of the AD-1305 equalizer is great enough so that it is not likely to add any audible background noise to even the best component systems providing a reasonable match of input levels is maintained between it and the other components. It should be mentioned that if users happen to own a separate preamplifier and a separate power amplifier, the equalizer may be connected between them, too. Since most power amplifiers sold for hi-fi use generally have input sensitivities of between 0.75 and 1.5 volts for full rated output, a good match and no danger of overload of the equalizer would result from that alternate hook-up arrangement.

In order to give readers some idea of the type of overall response curve that can be achieved with this equalizer, we set the controls to the arbitrary positions shown in Fig. 1 and applied a sweep-frequency from 20 Hz to 20 kHz to the input. We recorded the overall response with our spectrum analyzer. The resultant curve is shown in the scope photo of Fig. 6. While there is some



overlap of action between adjacent-band filters, the overall curve trend follows that of the positions of the five control knobs in Fig. 1. Where adjacent filters are set in opposite directions (that is, lowest two octaves require boost while the next two octaves require cut, for example), the amount of boost and cut may have to be slightly exaggerated so that the two actions don't tend to cancel each other out in the region of common frequencies of both filters.

Our overall product summary, together with comments regarding the Heath AD-1305 will be found in Table II. **R-E**

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Heath Company** Model: **AD-1305**

OVERALL PRODUCT ANALYSIS

Retail price	**$119.95 (Kit)**
Price category	**Low**
Price/performance ratio	**Very good**
Styling and appearance	**Excellent**
Sound quality	**Very good**
Mechanical performance	**Excellent**

Comments: The Heath AD-1305 equalizer more than meets its published specifications, which is no real surprise. Heathkits have always been conservatively rated because the manufacturer must take into account the fact that the units will be assembled by a great variety of people, many of whom have no previous experience with electronic product assembly.

Of more fundamental importance is the question of the function and adequacy of the product in terms of its purpose. Five-band equalization is the minimum that is required to provide more effective tonal tailoring than can be achieved with simple tone controls. In fact, given the interaction between adjacent band controls evidenced by the AD-1305, there are now some amplifiers and receivers on the market which, with the aid of a third, midrange tone control over and above the usual bass and treble controls, can achieve virtually the same combinations of overall response as are possible with the AD-1305. Its chief virtue is its ability to alter the response at the frequency extremes, something that cannot normally be done with conventional tone controls without also seriously altering mid-frequency response.

Some of the more elaborate equalizers on the market also feature an overall gain control that permits the user to readjust overall gain (after equalization) to unity. This control insures against possible overload (no problem in the case of the AD-1305, since it is immune to overload even up to 10-volts output) and also to make more meaningful "A-B" comparisons of equalized and unequalized sound. Without such a control, audible change in level tends to influence the listener and can mask the true effects of equalization settings selected. Certainly, for the modest price of the AD-1305, Heath has come up with excellent specs and about as much circuitry as could be had for that price. Our real question is whether or not they would have been better off to offer a somewhat more elaborate unit (perhaps with octave-by-octave equalization, which would require ten slide controls per channel), even if that meant charging a somewhat higher price for the unit? Even at this level of sophistication, however, it beats anything you can do with simple bass and treble controls you might now have on your central component in your hi-fi system.

BUILD FOR YOUR CAR

Anti-Theft Devices

PART II. Practical circuits you can build and connect to any vehicle with a 6- or 12-volt electrical system for protection against thieves

R. M. MARSTON

LAST MONTH, IN PART I OF THIS ARTICLE, we discussed various types of automotive anti-theft devices and presented a few practical circuits you can build.

This month's concluding part presents the rest of the practical circuits.

Auto-turn-off alarm

A weakness of the circuits shown is that since car horns and their associated components are not designed to withstand continuous long-period operation, these components may be damaged if the alarm sounds for too long. Fig. 8 shows how the Fig. 6 circuit can be modified so that the horn and lights turn off automatically after four minutes or so, thus minimizing the possibility of horn damage.

Here, RY1 energizes and self-latches in the same way as the Fig. 6 circuit. As contacts RY1-1 close, the full battery voltage is applied across the Q1-Q2-RY2 network. At the moment that power is applied, C1 is fully discharged and behaves like a short, so the base and collector of Q1 are effectively shorted together. Relay RY2 is immediately turned on via the Q1-Q2 Darlington emitter-follower and the horn and lights operate.

As soon as power is applied to the circuit, C1 starts to charge up via R1, and the voltage across the coil of RY2 starts to decay exponentially towards zero. After a delay of about four minutes, this voltage falls so low that RY2, horn and lights turn off. Relay RY1 remains on, however, until the system is turned off via the key switch, so the vehicle remains immobilized via its breaker points.

The Fig. 8 circuit is shown as for use on negative ground vehicles. The circuit can be modified for use on positive ground vehicles by reversing the polarities of D1 and D2, and by reversing the supply connections to the RY1 driving network, as shown in Fig. 9.

Pulsed alarm

A minor snag with the circuit in Figs. 8 and 9 is that since it gives a 'monotone' form of horn operation, its owner is unlikely to be able to recognize the sound of his own vehicle and will tend to check his own vehicle whenever he hears any horn sound. This snag is

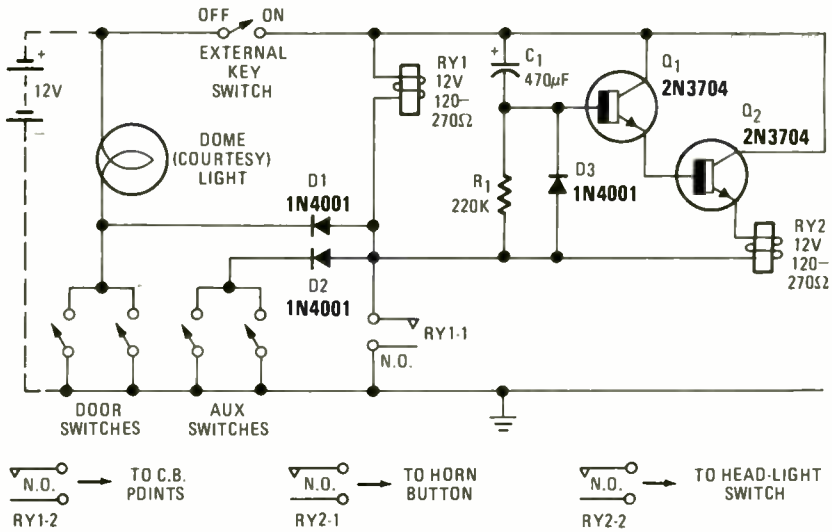


FIG. 8—IMPROVED MICROSWITCH-ACTIVATED alarm/immobilizer turns horn and lights off after 4 minutes. Circuit is for vehicles with − V ground electrical systems.

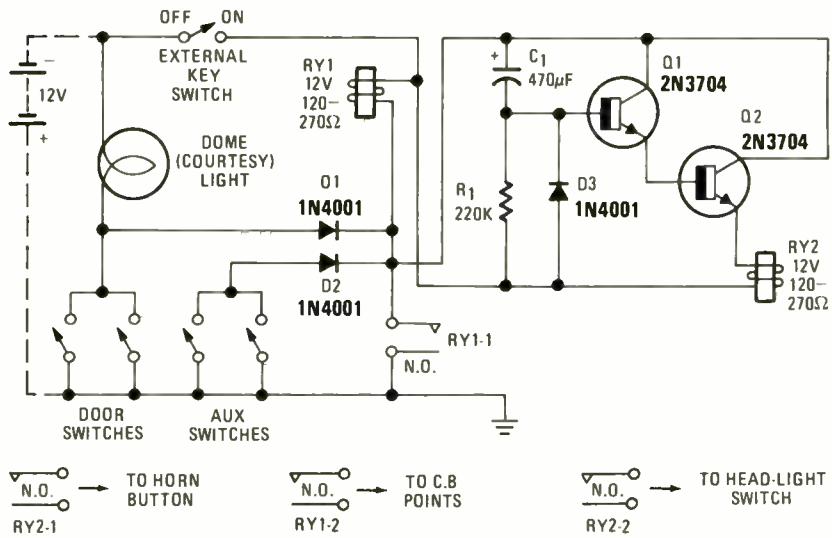


FIG. 9—IMPROVED MICROSWITCH-ACTIVATED alarm/immobilizer for vehicles with + V ground electrical systems.

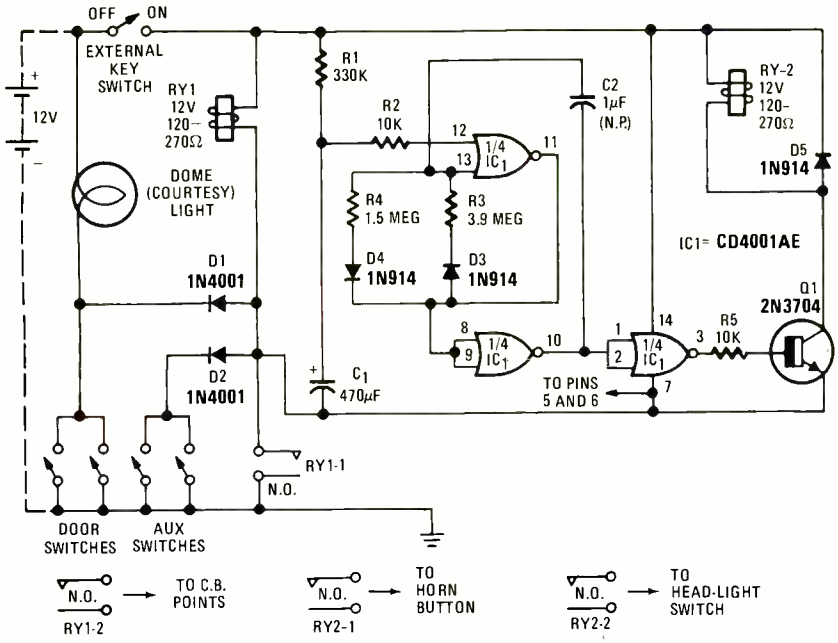


FIG. 10—MODIFIED MICROSWITCH-ACTIVATED alarm/immobilizer gives distinctive pulsed operation of horn and lights, but turns them off after 4 minutes. Circuit is for vehicles with −V ground electrical systems.

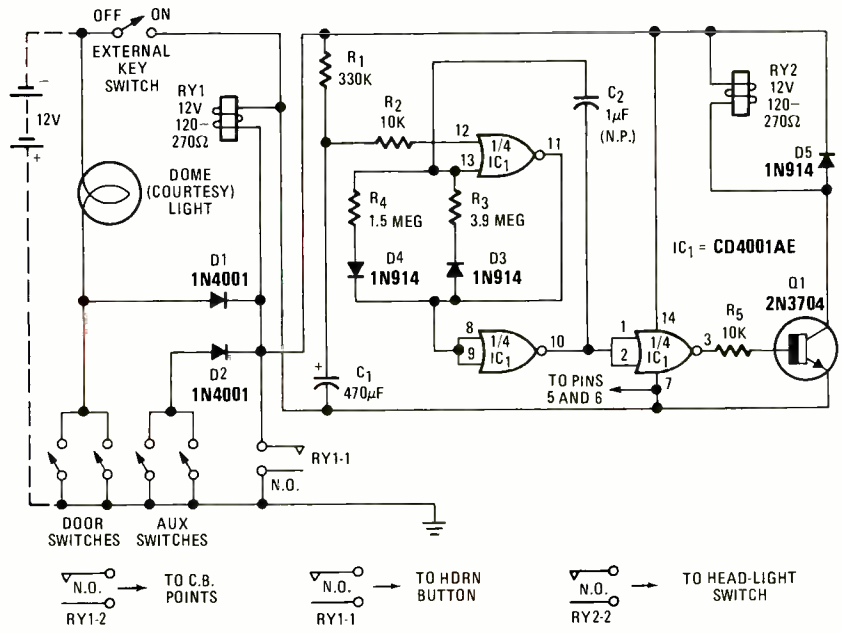


FIG. 11—MODIFIED MICROSWITCH-ACTIVATED alarm/immobilizer for vehicles with +V ground electrical systems.

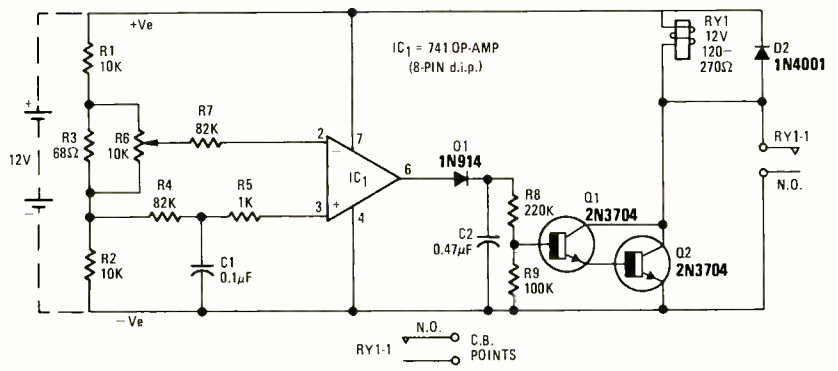


FIG. 12—VOLTAGE-SENSING circuit can be used to replace the RY1 drive-network in the −V ground alarm electrical systems.

overcome in the circuit shown in Fig. 10. This circuit pulses the horn and lights for 4 seconds on and for 1½ seconds off repeatedly for about four minutes under the alarm condition, thus producing a very distinctive warning signal.

The Fig. 10 circuit is similar to the circuit shown in Fig. 8 except that RY1 is driven by a simple pulse generator formed from Q1 and a type CD4001AE COS/MOS digital IC. Here, the IC is wired as a buffered-output gated astable-multivibrator with unequal on and off times. The gating is controlled by time-delay network R1–C1. The on time of the relay (approx. 4 seconds) is controlled by R3–D3 and the off time (approx. 1.5 seconds) is controlled by R4–D4. Note that capacitor C2 is nonpolarized. The pulse generator turns on and activates RY2 and the horn and lights as soon as RY1 turns on, but turns off again automatically after about four minutes via the R1–C1 time-delay network.

The circuit shown in Fig. 10 is for use on vehicles fitted with negative ground electrical systems. The circuit can be modified for use on positive ground vehicles by reversing the polarities of D1 and D2, and by reversing the supply connections to the RY2 driving network as shown in Fig. 11.

Voltage-sensing alarm

Figure 12 shows the practical circuit of a voltage-sensing type of alarm that can be used in place of the simple RY1 driving network described in the earlier circuits. Circuit operation relies on the fact that a small but sharp drop occurs in battery voltage whenever a vehicle courtesy light, etc., is turned on. This sudden drop in voltage is detected and made to operate RY1. The system has the advantage that the alarms' pick-up can be attached directly to the vehicles battery, rather than to a number of microswitches.

The operation of the Fig. 12 circuit is fairly simple. Here, voltage divider R1–R2–R3 is wired across the vehicles supply lines. The output of this divider is connected directly to the inverting (pin-2) terminal of an open-loop type 741 op-amp. The output of the divider is also connected via a simple (R4–C1–R5) time-delay or 'memory' network to the non-inverting (pin-3) terminal of the op-amp. A small 'offset' voltage can be applied between the input terminals of the op-amp via trimmer R6.

Suppose, then, that this offset control is adjusted so that the pin-2 voltage is fractionally higher than that of pin-3 under steady-voltage conditions, and that under this condition the output of the op-amp is driven to negative saturation. If now a small but abrupt fall occurs in the supply voltage, this fall is transferred immediately to pin-2 of the op-amp but does not immediately reach

pin-3 because of the time-delay or memory action of C1. Consequently, pin-2 briefly goes negative relative to pin-3, and as it does the output of the op-amp is driven briefly to positive saturation, thus giving a positive output pulse. This pulse is used to charge C2 via D1, and C2 energizes RY1 via Q1, Q2 and R8. As the relay energizes, contacts RY1-1 close and cause the relay to self-latch. Contacts RY1-2 close and immobilize the vehicle via the CB points.

Note that the above circuit responds only to sudden drops in potential, and is not influenced by absolute values of battery voltage. Thus, leaving the car lights on or off, etc., has no influence on the operation of the alarm system.

The Fig. 12 circuit is intended for use on negative ground vehicles and can be used directly in place of the RY1 network in any of the circuits shown in Figs. 6, 8 or 10. The circuit can be modified for use on positive ground vehicles by using the connections shown in Fig. 13, and can then be used directly in place of the RY1 network in any of the circuits shown in Figs. 7, 9 or 11.

When installing the circuit in a vehicle, R6 must be adjusted so that the alarm turns on reliably when the courtesy light goes on, but is not excessively sensitive to small shifts in battery voltage. The best way of finding the right setting for R6 is as follows.

First, remove the courtest lamp and replace it with one with half of the original current rating. Now adjust R6 just past the point where the alarm fails to operate when the lamp goes on, and then turn R6 back a fraction so that the alarm only just operates via the courtesy light. Finally, replace the original courtesy lamp. Reliable operation should then be obtained.

Intallation

The alarm systems that we have described are all designed to be turned on and off via an externally-mounted switch. There are three different approaches that can be used in installing this switch.

The best and most reliable approach is to use a key switch to turn the alarm system on and off. This switch should be secured to the outer bodywork of the car in a clearly visible position close to the drivers door. The switch should be mounted so that its face is vertical and rain does not run into its mechanism. The switch should also be positioned so that its wiring is not vulnerable to road dirt or to potential car thieves. The best position is on the upper wing or fender, where the bodywork also forms part of the vehicles engine compartment. The idea of mounting the switch in a very prominent position is that potential thieves will readily see that the vehicle is protected by an alarm device and will be detered from trying to steal it.

An alternative solution to the switch installation problem is to use a simple toggle switch. Mount the switch in a carefully concealed position on the outside of the vehicle. The weakness of this system is that a potential thief simply has to watch the owner enter the vehicle in order to discover the location of the concealed switch.

A third and rather elegant (but expensive) solution to the problem is to use some kind of short-range remote controlled electronic switch. Ultrasonic and light-activated switched are not very suitable for this type of application, but radio and inductive-controlled switches are. If there is enough reader interest, we'll publish some suitable inductive-controlled circuits in a future issue of **Radio-Electronics.**

Once the alarms master on/off switch has been fitted, the next installation job is to fit suitable microswitches to activate the system. As already mentioned, two suitable switches are already fitted to most vehicles and are used to operate the dome or courtesy light. It is worth fitting additional switches to the rear doors and essential to fit them to the trunk and hood if full anti-theft protection is to be obtained. Note that if your vehicle is fitted with a voltage-sensing type of alarm system, these microswitches must be made to switch a lamp or similar kind of current load. The higher the load current used, the more reliable will be the operation of the alarm circuit. The microswitches can all be wired in parallel and a single load used.

Finally, when the installation is complete, give your system a complete functional check. When conducting this test, try not to disturb anyone. **R-E**

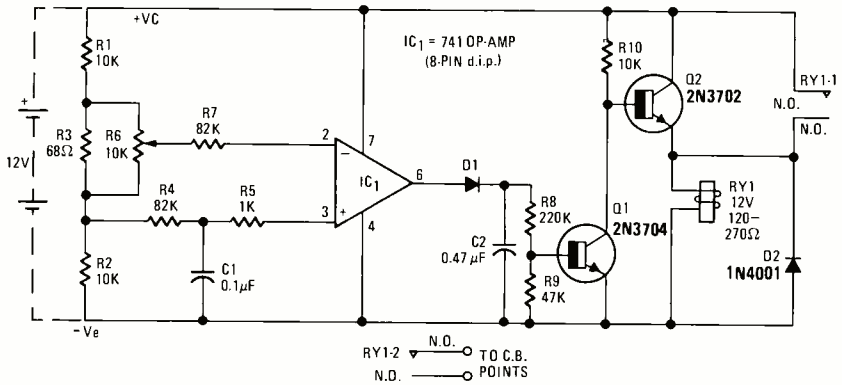


FIG. 13—VOLTAGE-SENSING circuit for vehicles with + V ground electrical systems.

Western Electric now making optical transmission lines

A pilot production line for the manufacture of fiber lightguides for lightwave transmission systems is already in operation at Western Electric in Atlanta, GA. A prototype lightwave communications system is currently being evaluated.

The optical cables are made from extremely-pure silica glass, with losses of only 10 dB-per-mile. (Light passes through 500 feet of lightguide with the same loss it would have going through an ordinary window pane.) Twelve of the hair-thin fibers are formed into a flat ribbon, and a dozen of these ribbons are enclosed in a cable of 144 conductors. This half-inch diameter cable can carry the equivalent of 50,000 telephone voice channels.

Electrical signals are fed into each of the guides by gallium-aluminum-arsenide lasers that translate the electrical impulses into infrared light at a wavelength of 0.82 microns. Average power into each fiber is about 0.5 milliwatts. A modulator circuit associated with each laser can turn it on and off completely at a 44.7 megabit rate (nearly 50 million times a second). A silicon "avalanche" photodetector converts the light pulses to electrical signals at the receiving end of each fiber.

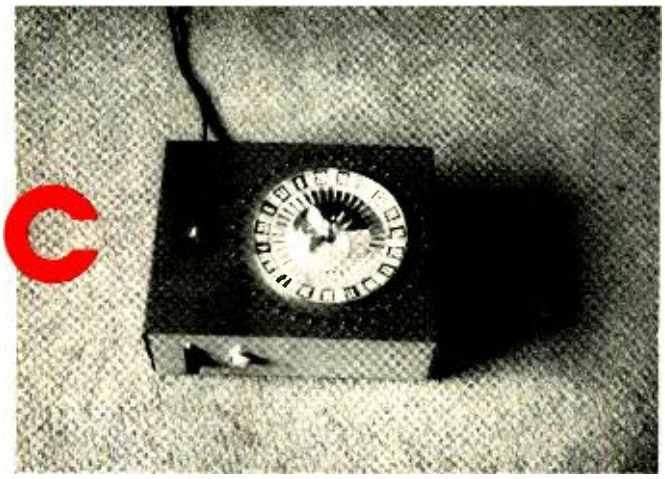
Signals in these low-loss cables can be carried at least four miles without regeneration. The first applications are therefore expected to be between telephone switching centers in metropolitan areas, where duct space for cables is at a premium and distances are likely to be less than four miles. Later, long-distance communication is envisaged, with the signals being regenerated at regular intervals along the line as is now done in the transcontinental microwave relays.

Second Comstar satellite tests super high frequencies

The second Comstar domestic communications satellite went into synchronous orbit July 22, adding nearly 3,000 voice channels to the present facilities. The satellite carries 24 transponders, each with a capacity of at least 1,200 high-grade voice channels. Vertical and horizontal polarization effectively double the number of channels for the antenna system. The satellite's principal beam is directed to the continental United States; three spot beams cover Hawaii, Alaska and Puerto Rico.

Comstar II carries a super-high-frequency radio beacon package, designed to make tests on frequencies near 19 and 28 GHz. These are being used by Bell and GTE laboratories for gathering data on signal propagation at these frequencies, with a view to their future use. **R-E**

Build Electronic Roulette



This electronic roulette game has a stationary wheel and uses discreet LED's to simulate a spinning effect

BARTON EVANS, Jr.

"ALL WORK AND NO PLAY MAKES THE ELECtronic hobbyist dull and irritable" wrote an ancient sage whose identity has since been lost. Now you can break up the monotony in your electronic life with your own home electronic roulette wheel. Obviously to be used for entertainment only, as gambling for money is illegal in most states, this project will give a truly random roulette run without requiring an elaborate casino-type wheel. After constructing this roulette wheel and studying the rules of play, you will be able to host your own roulette party.

Theory of operation

The circuit (see Fig. 1) consists of three basic elements: the 5-volt power supply, the 500 Hz to 1 Hz declining-frequency oscillator, and the counting/decoding logic.

The power supply is a simple 200-mA supply built around an LM340 5-volt regulator IC and a bridge rectifier module.

The oscillator is designed to run at 500 Hz while C3 is shorted and then slow down as the charging C3 slowly cuts off Q1, which controls the rate of charging current to C4. Capacitor C4 in turn discharges through unijunction transistor Q2 which is the oscillating element. The output is taken from the base of Q2 and fed to the counter/decoder logic.

The counter/decoder consists of two SN7493 4-bit binary counter IC's and three SN74154 one-in-sixteen decoders. The 7493's are wired to count to 256, although they are reset after every 38 counts. The outputs of the first counter (bits 0-3) are fed to all three decoder inputs. Bits 4 and 5 from the second counter are fed to the enable inputs (pins 18 and 19) of the decoders to turn each on during the proper interval. For example, for counts 0-15, IC5 is enabled and IC6 and IC7 are disabled by feeding bits 4 and 5 to IC5 unaltered. During counts 16-31, bits 4 and 5 will be "1" and "0" respectively and are fed to the enable inputs of IC6. Finally, during counts 32-37, bits 4 and 5 will be "0" and "1" and are thus fed to IC7. As the count increases, one by one the outputs of IC5, 6, and 7 go "low" and sink current through the LED's which then light. When the count reaches 37 (roulette number "00"), the counter is reset to 0.

Note that only one current limiter resistor (R6) is required for all 38 LED's since only one LED is ever on at one time.

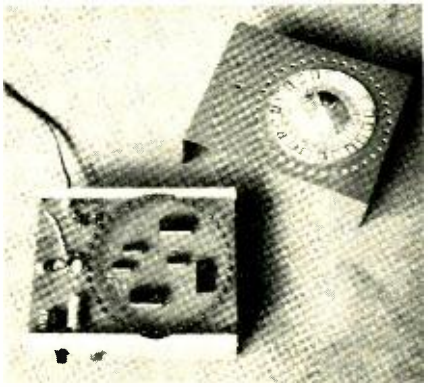
Construction

A printed circuit board is highly recommended. The artwork (half-size) is provided (see Fig. 2) as well as a parts location diagram (Fig. 3) for a 150 x 200 mm board. While the prototype used a single-sided board, purists will want to eliminate the dozen or so jumpers with a double-sided board. The cost of the blank will, of course, be greater.

After etching and drilling the board, install all resistors and capacitors. Next, firmly screw down IC1 for good heat transfer. IC's 2 to 7 should be either directly soldered or mounted in *Molex*® connectors to maintain the low profile.

Note that among any batch of MV5024 LED's there is a varying length of leads as well as a difference in plastic lens size. Choose your three shortest LED's and mount them 120° apart on the board, using a temporary spacer made of cardboard (see Fig. 4). Note the polarity of the LED's: the small post with the chip on it is the cathode and must face toward the center of the printed circuit board. If the height of C1 is greater than the flanges of the LED's, remount it below the board.

After the first three LED's are in place, insert several more, invert the board on a flat surface and gently tap them until their lenses rest against the surface. This will insure that all LED's are mounted at the same height. Solder



LAYOUT OF PARTS on the PC board.

one lead of each, check for alignment, and solder the other lead. Repeat this process until all LED's are in place. Be careful not to overheat the printed circuit pads.

Mount the line cord, switch, and power transformer in the base of the cabinet (see photos). Using the printed circuit artwork as a guide, carefully locate and drill the 38 holes for the LED's. Also cut a hole in which to

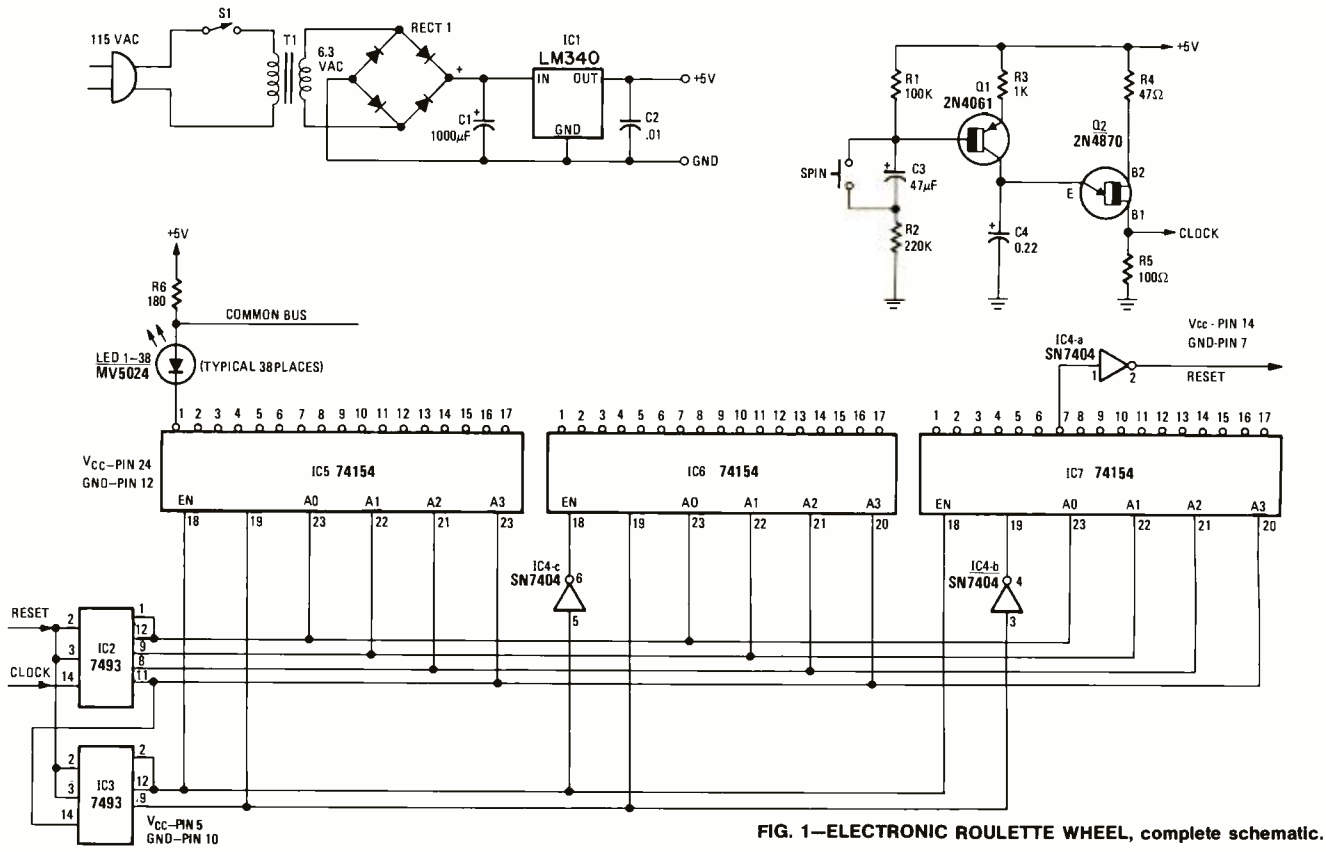
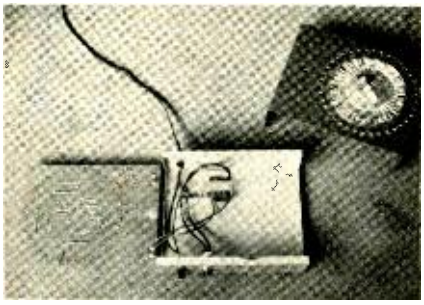


FIG. 1—ELECTRONIC ROULETTE WHEEL, complete schematic.

mount a small plastic roulette wheel, available from your local game store. PVC liquid vinyl makes an ideal adhesive for this purpose. Using spacers, mount the circuit board at a height such that the LED's will protrude as much as possible through the cabinet top while at the same time not cause interference with other board-mounted components. Mount the SPIN button wherever convenient, being careful to avoid interference with other parts.



UNIT WITH PC BOARD REMOVED.

Testing

When first turned on, C3 will charge, causing one "spin" cycle to take place. If this does not occur, check the 5-volt supply if no LED is lit. If an LED is lit, but no oscillation is taking place, check the installation of Q1 and Q2. The LED moving light should rotate counterclockwise. Each time the SPIN button is depressed, the oscillator will instantly return to maximum frequency and not begin to slow until the button is released. A spin takes 20-30 seconds.

PARTS LIST

All resistors ¼ watt, 10%, unless noted.
R1—100,000 ohms
R2—220,000 ohms
R3—1000 ohms
R4—47 ohms
R5—100 ohms
R6—180 ohms
C1—1000 μF, 16V, electrolytic
C2—0.01 μF disc
C3—47 μF, 10V, electrolytic
C4—0.22 μF, 10V electrolytic
IC1—LM340 (T0-5) 5-volt regulator
IC2, IC3—SN7493 4-bit binary counter
IC4—SN7404 hex inverter
IC5, IC6, IC7—SN74154 4–16 decoder
Q1—2N4061 PNP
Q2—2N4870 UJT
LED(38)—MV5024 red LED's
REC1—full-wave bridge rectifier, 1A, 50 PIV
S1—SPST 115V power switch
S2—SPST normally-open pushbutton
T1—6.3VAC filament transformer
Misc: plastic roulette wheel, line cord, strain relief, cabinet, Molex connectors, hardware, solder, etc.

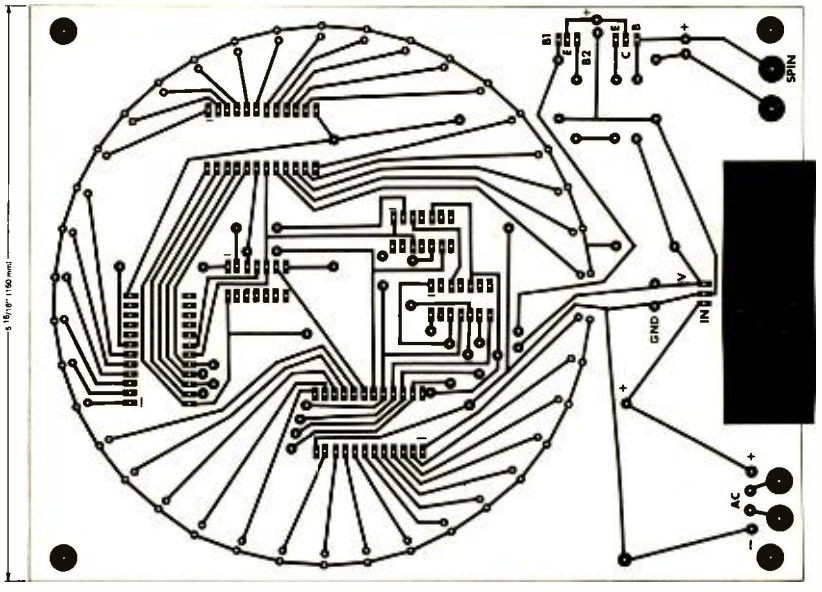


FIG. 2—PRINTED CIRCUIT BOARD shown half-size.

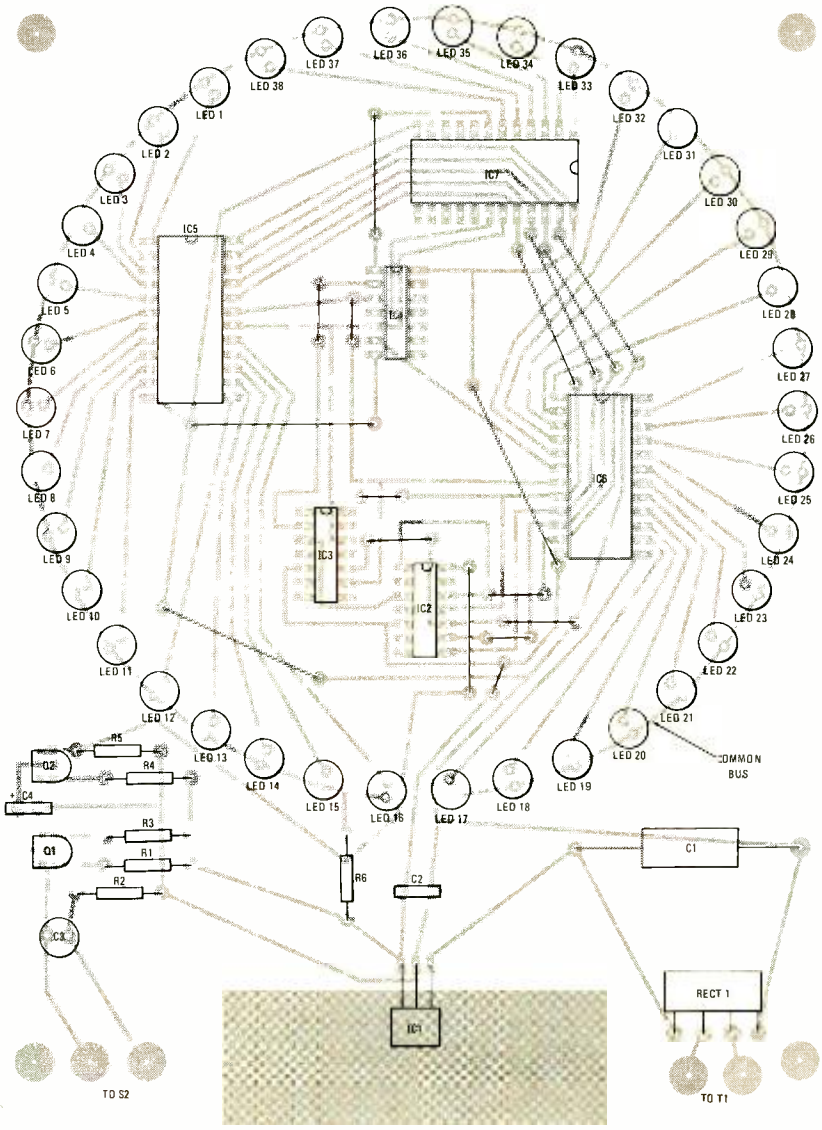


FIG. 3—PARTS PLACEMENT shown from component-side of board. LED anodes connect to common bus.

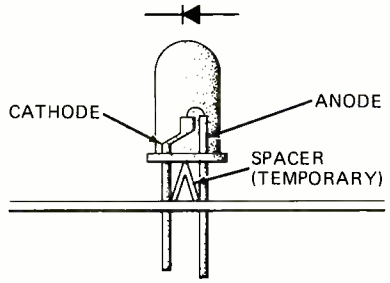


FIG. 4—LED DETAIL AND MOUNTING

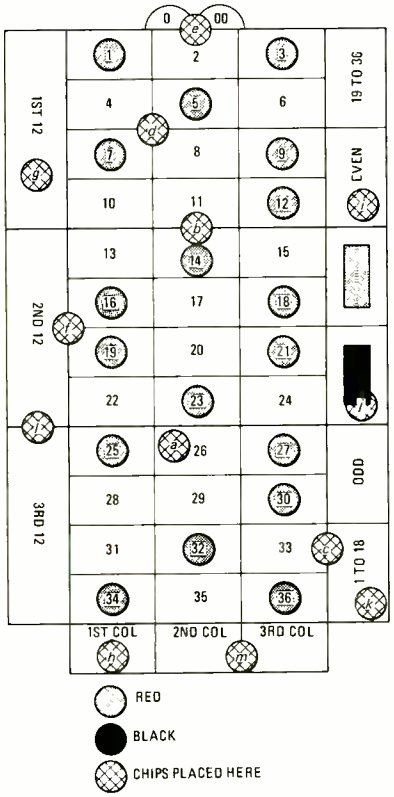


FIG. 5—THE ROULETTE "LAYOUT." Discs indicate positioning of chips for the "bets," as described in the text.

TABLE 1—ODDS

	Pays
a. Any single number (38 ways)	35 to 1
b. Two adjacent numbers (57 ways)	17 to 1
c. Three numbers in a row (12 ways)	11 to 1
d. Four numbers in a square (22 ways)	8 to 1
e. Five numbers (1, 2, 3, 0, 00) (1 way)	6 to 1
f. Six numbers in two adjacent rows (11 ways)	5 to 1
g. 1st, 2nd, 3rd twelve	2 to 1
h. 1st, 2nd, 3rd column	2 to 1
i. Odd/Even	1 to 1
j. Red/Black	1 to 1
k. 1-18/19-36	1 to 1
l. Line between 1st/2nd or 2nd/3rd twelve	1/2 to 1
m. Line between 1st/2nd or 2nd/3rd column	1/2 to 1

Playing roulette

A standard roulette "layout" is shown in Fig. 5 with one of each of the various types of bets indicated. (A nicely printed layout should have been included with the toy roulette wheel purchased.) All players place their bets on the locations of their choice until the "croupier" or banker, calls: "les jeux sont fait," or "no more bets."

As indicated by the call-out letters in Fig. 5, bets may be placed on:

a. one number: place chip on that number;
b. two numbers: place chip on line between any two adjacent numbers;
c. three numbers: place chip on the outside line next to three numbers in a row;
d. four numbers; place chip on the intersecting lines between four numbers in a square;
e. five numbers: may be bet only on 1, 2, 3, 0, 00;
f. six numbers: place chip on point at the end of two adjacent three-number rows;
g. first, second or third twelve;
h. first, second or third column;
i. odd/even;
j. red/black (rouge/noir);
k. 1-18/19-36;
l. two twelves;
m. two columns.

After betting is finished the spin is started and no one may touch any chips on the table. When the spin stops, the croupier calls the winning number, points to it on the layout, and removes all losing bets. Winning bets are then paid to their owners according to the odds in Table I, from the most significant to the least significant odds. The croupier leaves the player's bet on the table while he pays him. The player may then elect to retrieve it or "let it ride" for the next play. **R-E**

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JANUARY 1976—DECEMBER 1976

Abbreviations: (C) Construction; (D) Department; (ER) Equipment Report; (LTER) Lab Tested Equipment Report; (F) Filler; (SC) Service Clinic

R-E's Service Clinic

RF interference

Causes and cures

JACK DARR
SERVICE EDITOR

THIS ISN'T A NEW SUBJECT: I'VE WRITTEN about it several times before. However, it could be useful to look up some of the old tricks that we used to use; they're still very handy. The subject is assorted radio-frequency interference (RFI) as well as TVI. If you know how, you can identify the thing causing the interference and locate the source. There are two basic kinds.

One is random noise or hash. This can be due to defective pole hardware on the AC lines, arcing due to a broken insulator, and so on. This causes a harsh roaring or buzzing sound in radios. The characteristic symptom in TV is "two lines of dots" across the screen, like a

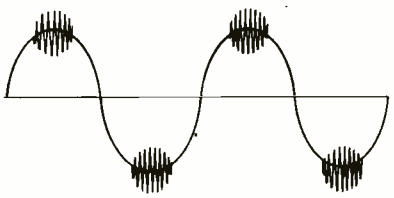

FIG. 1

120-Hz hum-bar. Anything breaking down on the AC line will normally arc over on both positive and negative peaks of the voltage. This is where we get the 120-Hz characteristic. If you have something in your own shop that causes this, like an antiquated fluorescent lamp, you can place a scope probe down alongside the line cord and see a pattern like the one shown in Fig. 1. The glitches on each peak are actually bursts of pure random noise; so, they have some RF energy in practically all bands. This drops off as the frequency goes up. The AM broadcast band is worst, the low VHF TV channels will be affected, but the high band TV channels often won't be, at least not quite so badly. UHF is normally not bothered by this.

Locating the source

The interference has an odd characteristic, one we can use to find the source. All you need is an automobile radio. Set it to about 800 kHz, preferably on a dead spot. Now, drive around the area where the interference was reported. You'll hear the typical roar and buzz. Look for a place where the noise gets louder. Then, tune the radio back and forth around 800 kHz. If it is now covering more of the dial, you're getting closer. Keep looking and tuning. When you find a place where the noise comes in loudly from one end of the AM band to the other, you're very near the source!

This is more accurate than trying to use the amplitude of the noise as a clue. This noise travels along AC power lines, and it is often hard to find a peak in the amplitude. However, when you get to a place where it covers the whole dial, you're close. Out in the country you may have to do quite a bit of driving and tuning, for this hash can run a long way along the wires.

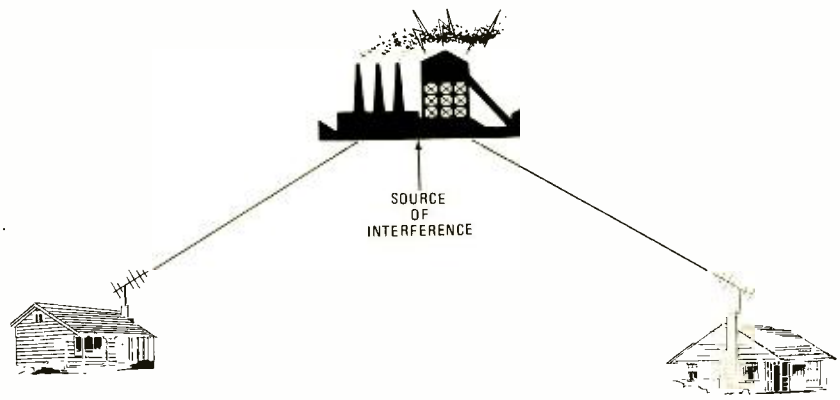

FIG. 2

That's one type of interference. If the interference shows up as "fine wiggly lines" in a TV picture, this indicates that

the cause is some type of RF signal. It may or may not be modulated. If it is, the modulation will make the pattern vary. This will usually affect several houses in an area. Find one of the houses reporting severe interference. If they have a directional outside antenna with a rotator, turn the antenna until you get the strongest *noise* signal. Note the direction, and draw a line on a city map or rough sketch of the area.

Now, find another house as far away as possible with the same interference. Find another bearing and draw another line. At the point where the lines cross, there is the source of the interference. (See Fig. 2.) You may have to repeat this test at a third place to get a better pinpoint, but in most cases two bearings will do.

If directional antennas aren't available, use a small antenna on a short piece of mast (Aluminum is preferred, especially after you've had to lug it a little way). Use a portable TV or even a TV field-strength meter to get the bearings. This technique doesn't require a big antenna; a 4 or 5 element Yagi does nicely.

Once you get a fix on the location, go there and probe the area with the car radio, portable TV, etc. You can get an idea of the source from the area. If it's industrial, it could be something like an old model radio-frequency heating de-

For faster service

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vice, etc. These machines should not radiate interference if they are working *properly*. By the way, these will often show a 60/120 Hz characteristic if they are using raw AC on the plates of the tubes, as some of the older models did. Contrary to popular belief, arc-welders radiate surprisingly small amounts of RFI, though they're often suspected!

This type of RFI will usually be continuous. If the interference is not continuous but only in short bursts, it could be coming from a radio transmitter. Police radios, etc., working in the 30–40-MHz band, particularly those near the 40-MHz end, will often be picked up by older TV sets. This is direct pickup by the TV set's IF, and *not* a fault of the radio transmitter! (Ask me how I know! I live on a highway.) CB radios, both base and mobile, can cause interference if they radiate harmonics that fall in some TV channels. Channel 2 will pick up the second harmonic, and Channel 5 will pick up the third harmonic.

The cure

This is quite simple to clear up. Locate the CB station and install a low-pass filter on the transmitter output. The J. W. Miller Co. has a new line of these; they are all plug-in or screw-in. The C-511-T is a plug-in type, with SO-239 connectors on each end. It will not

attenuate the CB signal, but has an 80-dB attenuation for 54 MHz. A high-pass filter can be used on the antenna input of the TV set; this could be a C-512-T which is 300-ohm with screw terminals. This could help to eliminate police radio interference and also reduce some ignition interference from the older cars.

With the tremendous increase in highly sensitive audio amplifiers, we are now getting RFI complaints from them, too. The cause is the same: the highly sensitive input stage of the amplifier simply detects the RF signal. It becomes audio and goes sailing on through the amplifier. Curing these is much simpler; you can do it right in the home. Just add an RF filter to the amplifier's input, *or* output. It is possible to get RF pickup on long speaker lines. This pickup can feed back into the amplifier chassis and be detected. There are plug-in filters for this, too. Miller's C-505-R with standard phono jacks and plugs for the inputs, and C-506-R for the outputs. Home intercom systems are also vulnerable. The same technique and filters can be used. This will work with mono, stereo or quad, although you need one filter for each speaker line

In a situation where noise could be coming from any one of four or five houses, there is a quick way of finding out. Monitor the interference and pull

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EQUIPMENT REPORTS

continued from page 37

In either the PH-1 or PH-2 phono positions, the SELECTOR switch enables the low-cut filter regardless of the front-panel filter switch.

Turn-on transients are suppressed by a 10 second time-delay circuit. Transients from sources energized earlier or at the same time as the preamp are blocked by the circuit. A relay contact shorts the output of the amplifier to ground until a three transistor circuit responds to the increasing potential on a capacitor. At the end of the 10 second initialization interval, the relay is activated.

The tape monitor function allows simultaneous monitoring of source material as well as amplification of the low-level source feeding the recorder. High level inputs such as from a tuner are routed directly through to the tape output connector into the recorder input terminals. The front panel TAPE MON switch breaks the connection between the first and second amplifier sections so they can be used separately.

Stereo TAPE DUB input and output jacks on the panel facilitate temporary patching in of a tape recorder or other high-level source without groping for rear-panel connectors. One of the six lever switches is assigned to this operation. The TAPE DUB connectors are similar to the TAPE MON connectors but they are mounted on the front-panel.

The OUTPUT DEFEAT switch grounds the output connector and disconnects the preamp output. L+R is the last of the switches. It parallels the left and right channels at the input to the high-level preamp for monaural

output. The TAPE MON and TAPE DUB switches are after the L+R function and cannot be switched to monaural.

Three stereo jacks are mounted on the front panel: the two TAPE DUB connectors and the headphone jack.

Frequency response between the high-level input and the preamp output jacks is ±0.2 dB from 20 Hz to 20 kHz. Harmonic and intermodulation distortion is under 0.05% over the frequency range at 1.5-volt output. Input overload levels are 100 mV at 1 kHz at the phono inputs and 10 volts at the high-level inputs.

The Heathkit *AP-1615* is priced at $129.95 and measures 17.5 × 8.1 × 4.5-inches. It weighs 9 pounds and is finished neatly with oiled walnut end panels. **R-E**

Alaska villages have pay phones with help from satellites

The Satcom domestic communications system is bringing communications to 161 Alaskan villages with more than 25 inhabitants. To make this possible, RCA Alascom and the State of Alaska are building 100 small earth stations throughout the frontier.

Each village served by an earth station has a public telephone with direct distance dialling capability and a push-to-talk telephone for emergency medical service. An additional 50 stations—to be completed before the end of the year—are under construction.

RCA Alascom has found it necessary to publish a telephone book in several languages for the villages. **R-E**

SERVICE CLINIC

continued from page 79

the main AC switch. If this has no effect on the noise, that house is eliminated. If you find a case where hardware noise is apparently the cause, notify the power company and they will almost always take care of it.

A portable transistor radio is fine for close checking of areas after the general area has been found. These are all mildly directional due to the loop antennas. TVI can also be chased with these if you can get one that picks up TV sound signals and/or short wave frequencies. The same "all the way across the dial" check can be used. To get a more accurate reading of the actual noise amplitude, plug an "output meter" (AC voltmeter with capacitor in series) into the earphone jack of the radio. The meter readings will give you a better idea of exactly where the noise is the strongest.

I've told you what you *can* do in cases of RFI and TVI. Now I'll tell you something you *can't* do. You can't get the TVI out of the modern small hair-care appliances, like the hot-air combs, hair-driers, detangling combs, and so on. These are driven by miniature brush-type DC motors, fed through a

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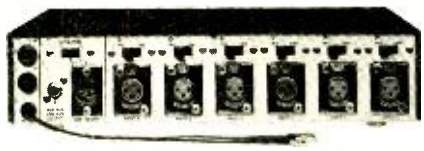
new products

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Free Information Card following page 94.

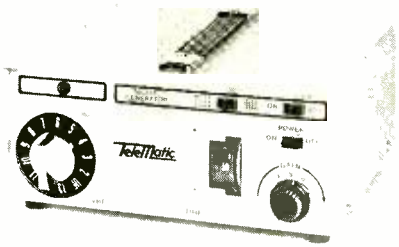
MICROPHONE MIXER, *model M677,* adds six additional low-impedance balanced microphone inputs to a sound system. Specifications include: frequency response, ±2 dB from 30 Hz to 20,000 Hz; equivalent input noise, −128 dBv, 300 to 20,000 Hz noise bandwidth at full gain; equivalent input hum-and-noise, −125 dBv, 30 to 20,000 Hz noise bandwidth at full gain; distortion less than 1% THD at 1,000 Hz; low-cut filters, −6 dB at 1,000 Hz typical.



The new *M677* mixer can be powered from the nominal 28—30-volt DC output of the attached master mixer or from a Shure *A67B* battery power supply. Measures $11^{3}/_{8} \times 7 \times 2^{1}/_{2}$ inches, weighs $3\text{-}^{3}/_{4}$ pounds and sells for $181.20—**Shure Bros., Inc.,** 222 Hartrey Avenue, Evanston, IL 60204.

CIRCLE 85 ON FREE INFORMATION CARD

TUNER SUBBER AND PATTERN GENERATOR. The *Ferret model SG 785* is a multi-functional instrument, indispensable for efficient trouble-shooting and adjustment of all color and black and white TV's. Speeds service by pinpointing troubles accurately and quickly in the tuner, IF, video and picture sections of the TV receiver.

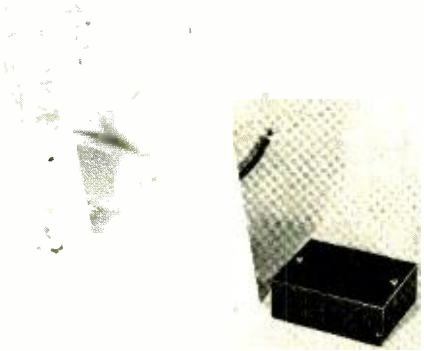


The VHF/UHF section of the *Ferret* allows direct substitution of the TV's tuner for fast, positive localizing of front-end trouble. It tunes channels 2 through 83 with standard 40-MHz output. Switching is provided to select internal or external tuners. The generator section produces stable patterns for use in converging the pix tube. It has a pattern of 20 vertical and 16 horizontal lines switchable to 320 white dots on a black background.

The crystal-controlled digital circuitry assures complete accuracy of both the vertical and horizontal frequencies. Accuracy is better than .005% with no change when switching to the TV signal. Output from the generator may be coupled through the tuner section or directly to the IF-video-stages. Resolution is limited only by the picture quality of the TV receiver. Output of the generator is DC, decoupled and safe for direct connection to transistors or IC's of the receiver. The *SG 785* operates from 105–125 volts, 50–60 Hz. The unit weighs 5 pounds.—**U.X.L. Corp.,** 2245 Pitkin Ave., Brooklyn, NY 11207

CIRCLE 86 ON FREE INFORMATION CARD

ELECTRONIC SIREN, *model M17,* is a high-powered electronic siren that is audible at well over a mile in still air, comparable in level to emergency vehicle sirens. The 30-watt 8-ohm speaker produces a 125-dB signal and can be used indoors or outdoors. An optional outdoor speaker in a tamperproof housing is also available.



The sound is extremely painful to human hearing indoors. Optional 18-volt DC power supply features plug-in charger, tapered charging circuit and 18-volt sealed lead-acid rechargeable battery. The basic siren is $102.00 and includes the high-powered siren driver and indoor/outdoor speaker. The power supply and tamperproof speaker is additional.—**Mountain West Alarm Supply Company,** 4215 North 16th Street, Phoenix, AZ 85016.

CIRCLE 87 ON FREE INFORMATION CARD

FREQUENCY COUNTER. The *model WB-752A* is designed for making frequency measurements between 10 Hz and 50 MHz in audio, video, CB, ham radio and other communications equipment. A unique feature of the counter is its 1 kHz audible sidetone with separate on/off volume control. The tone is valuable in modulating single-sideband transceivers for carrier-frequency measurement. The counter has a selectable input sensitivity of either 10 or 100 mV; the lower sensitivity is valuable when considerable noise is present with the signal.

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turers, with their own test facilities and enough electronic experience to assure their designs would meet FCC approval, chose to freeze their designs early and file for FCC approval later.

Some units, as noted, don't need FCC approval if they are hard-wired to the video display.

Price: As with any new consumer item, prices are high at first, then drop. Calculators and digital wrist-watches are good examples of recent electronic devices that went through radical price adjustments in a short time after consumer acceptance. The fierce competition in the video game field can be expected to create drastic excursions in pricing, especially just before and after Christmas.

The prices shown in this column are the lowest prices quoted by any of the various sources used for this article, and should just be used as a guide. Some units at the high end of the price scale will have to reduce their prices to be competitive, and as production is increased—or a design breakthrough is incorporated into their production—others will drop their selling prices.

In regard to kit prices, it's best that you write for a current price list and order form. In most cases, shipping and tax must be added to the prices shown. **R-E**

6 Digit LED Clock Kit - 12/24 hr.

$9.95 ea. QTY. 12 OR MORE — $10.95 ea. QTY. 6-11 — $11.95 ea. QTY. 1-5

KIT INCLUDES
- INSTRUCTIONS
- QUALITY COMPONENTS
- 50 or 60 Hz OPERATION
- 12 or 24 HR OPERATION

6-LED Readouts (FND-359 Red, com. cathode)
1-MM5314 Clock Chip (24 pin)
13-Transistors
3-Switches
6-Capacitors
5-Diodes
9-Resistors
24-Molex pins for IC socket

LARGE .4" DIGITS!
ORDER KIT #850-4
AN INCREDIBLE VALUE!

"Kit #850-4 will furnish a complete set of clock components as listed. The only additional items required are a 7-12 VAC transformer, a circuit board and a cabinet, if desired."

Printed Circuit Board for kit # 850-4 (etched & drilled fiberglass) $2.95
Mini-Brite Red LED's (for colon in clock display) pkg. of 5 ..... 1.00
Molded Plug Transformer 115/10 VAC (with cord) 2.50
NOTE: Entire Clock may be assembled on one PC Board or Board may be cut to remote display.
Kit # 850-4 will fit Plexiglas Cabinet II.

PLEXIGLAS CABINETS

Great for Clocks or any LED Digital project. Clear-Red Chassis serves as Bezel to increase contrast of digital displays.

CABINET I
3"H,6¼"W,5½"D

CABINET II
2½"H,5"W,4"D

Black, White or Clear Cover

ANY SIZE/COLOR **$6.50** ea. **2/$12.**

RED OR GREY PLEXIGLAS FOR DIGITAL BEZELS
3"x6"x1/8" **95¢** ea. **4/$3**

MOBILE LED CLOCK

12 OR 24-HOUR OPERATION

12 VOLT AC or DC POWERED FOR FIXED OR MOBILE OPERATION.

SIX JUMBO .4" DIGITS!

KIT OR ASSEMBLED

MODEL 2001

ACCURATE TIME WITH ADJUSTABLE XTAL TIME BASE

BATTERY BACK-UP FOR POWER FAILURE OR TRANSPORTING FROM HOUSE TO CAR, ETC

Approx. Size:
1¾"H x 4"W x 4½"D

- 6 JUMBO 4" RED LED'S BEHIND RED FILTER LENS WITH CHROME RIM.
- SET TIME FROM FRONT VIA HIDDEN SWITCHES • 12/24-Hr. TIME FORMAT
- STYLISH CHARCOAL GRAY CASE OF MOULDED HIGH TEMP. PLASTIC
- BRIDGE POWER INPUT CIRCUITRY — TWO WIRE NO POLARITY HOOK-UP
- OPTIONAL CONNECTION TO BLANK DISPLAY (Use When Key Off in Car, Etc.)
- TOP QUALITY PC BOARDS & COMPONENTS - EXCELLENT INSTRUCTIONS

KIT #2001 COMPLETE KIT (Less 9V Battery) **29.95** EA 3 OR MORE **$27.95** EA

115 VAC Power Pack #AC-1 **$2.50** EA

ASSEMBLED UNITS ORDER #2001 WT WIRED & TESTED (LESS 9V BATTERY) **$39.95** EA 3 OR MORE **$37.95** EA Assembled Units May Be Mixed With Kits for Qty. Price

JUMBO RED LED's **12/$1.00** **50/$3.95**

6 Digit-LED Clock-Calendar-Alarm Kit

This is a complete, top of the line, Kit ror the person that wants the best. Some of the many features and options are: 12/24 time, 28-30-31 day calendar, alternates time (8 sec) and date (2 sec) or can display time only and date on demand, 24 hr alarm - 10 minute snooze, alarm set indicator, 50/60 HZ. line operation or use with Xtal time base (#TB-1), built in OSC for battery back-up / AC failure, Aux. timer. Large digits.

Kit #7001B 6 - .4" Digits Man-64 **$39.95**
Kit #7001C 4 - .6" Digits & 2-.3" (seconds) **$42.95**

Kits are complete (less cabinet) including PC boards, power supply, IC socket, 9 switches, 16 transistors and all parts required for above features and options (Ideal fit in Cabinet I above).

60 HZ. XTAL TIME BASE KIT

Will enable Digital Clock or Clock-Cal. Kits to operate from 12VDC. Uses MM5369 and 3.58MHZ. XTAL. Req.: 5-15VDC/2.5 MA. 1"x2" PC Board. Easy 3 wire hookup. Accuracy: + - 2 PPM

#TB-1 [adjustable]
Complete kit $4.95 ea
Wired & Cal. $9.95 ea

PRINTED CIRCUIT BOARDS for CT-7001 Kits sold separately with assembly info. PC Boards are drilled Fiberglass, solder plated and screened with component layout. Specify for # 7001B or # 7001C (Set of 2) $7.95

JUMBO DIGIT CLOCK KIT

A complete Kit (less Cabinet) featuring: six .5" digits, MM5314 IC, 12/24 Hr. time, 50/60 HZ., Plug-Transformer, Line Cord, Switches, and all Parts.
[Ideal Fit in Cabinet II]
Kit #5314-5 ..... **$19.95** ea **2/$38.**

JUMBO DIGIT CONVERSION KIT

Convert small digit LED clock to large .5" displays. Kit includes 6-.5" LED's, Multiplex PC Board & easy hook-up info.

Kit #JD-1CC For common Cathode
Kit #JD-1CA For common Anode
$9.95 ea. **2/$19.**

Fairchild Super Digit FND-359

4" Char. Ht. 7 segment LED RED Com. Cath. Direct pin replacement for popular FND-70

95¢ ea, 10/$8.50
100/$79.00

SET OF 6 FND-359 WITH MULTIPLEX PC BOARD $6.95

25 AMP BRIDGE
$1.95 ea.
3/$5.00
100 PIV

TELEPHONE FORMAT KEYBOARD BY Chomerics

2-1/4"x3"
5/32" thick
$4.95
6/$28.

SEE THE WORKS Clock Kit
Clear Plexiglas Stand

- 6 Big .4" digits
- 12 or 24 hr. time
- 3 set switches (back)
- Plug transformer
- all parts included

Plexiglas is Pre-cut & drilled
Size 6"H, 4½"W, 3"D

A SUPER LOOKING CLOCK!

Kit #850-4 CP **$23.50** ea **2/$45.**

7-SEG LED

COMMON CATHODE	COLOR	HT.	DEC PT.	PR EA.
FND-359	RED	.4"	RHDP	$ .95
FND-503	RED	.5"	RHDP	$1.35
DL-750	RED	.6"	LHDP	$2.95
XAN-654	GREEN	.6"	NDP	$2.95
XAN-664	RED	.6"	NDP	$2.95

COMMON ANODE				
DL-747	RED	.6"	LHDP	$2.95
XAN-72	RED	.3"	LHDP	$1.25
XAN-81	YELLOW	.3"	RHDP	$1.75
XAN-351	GREEN	.3"	RHDP	$1.50
XAN-361	RED	.3"	RHDP	$1.50
XAN-362	RED	.3"	LHDP	$1.50
XAN-662	RED	.6"	NDP	$2.50
XAN-692	RED	.6"	NDP	$2.50

Form Inexpensive Sockets 100 for $1.25 Reel of 1000 - $8.50

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SCHOTTKY TTL		DTL	
74S00	$ .35	930	$ .09
74S01	.40	932	.09
74S04	.55	937	.09
74S05	.60		
74S09	.55		
74S10	.40		
74S15	.55		
74S20	.50		
74S22	.45		
74S40	.45		
74S50	.45		
74S51	.55		
74S60	.85		
74S64	.55		
74S73	1.25		
74S74	.85		
74S75	1.75		
74S78	1.50		
74S86	.95		
74S107	.95		
74S112	.95		
74S113	1.40		
74S114	.95		
74S121	.95		
74S133	.75		
74S134	.75		
74S138	1.75		
74S139	1.50		
74S151	1.95		
74S153	1.95		
74S155	1.95		
74S156	1.95		
74S157	1.80		
74S158	2.50		
74S174	2.50		
74S175	2.50		
74S181	2.95		
74S182	1.95		
74S251	2.75		

LED DRIVERS	
7447	$ .95
7448	.95
75491	.65
75492	.65

VOLTAGE REGULATORS		
LM 309 H	TO-5	$ .95
LM 309 K	TO-3	1.25
7805	TAB	.95
7812	TAB	1.25
7815	TO-3	1.25
7815	TAB	1.25
78L15	TO-5	.75
7824	TO-3	1.25
723	DIP	.75
723	TO-5	.75

DIGITAL CLOCK IC's	
MM 5312	$ 4.95
MM 5314	3.95
MM 5375 AB	3.95
CT 7001	7.95
CT 7002	13.95
50380	3.95
MM 5369	2.50

XTAL	
3.579545 MHZ.	$ 1.95

UART	
AY5-1013	$ 6.95

DIODES		
IN 4002	1A, 100 PIV	12/$1.00
IN 4003	1A, 200 PIV	12/$1.00
IN 4005	1A, 600 PIV	11/$1.00
IN 4007	1A, 1000 PIV	10/$1.00
RECTIFIER	2.5A, 1000 PIV	4/$1.00
RECTIFIER	3A, 1000 PIV	3/$1.00
IN 5400	3A, 50 PIV	5/$1.00
IN 914	SIL. SIGNAL	20/$1.00
IN 4148	SIL. SIGNAL	20/$1.00
DIAC	28V	4/$1.00

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556	DUAL TIMER	.95
565	PLL	.95
566	FUNCTION GEN	1.75
567	TONE DECODER	1.75

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PINS	1-24	25	100
14	$ .25	$ .22	$ .20
16	.28	.25	.23
18	.31	.28	.26
24	.50	.45	.40
28	.60	.55	.50
40	.75	.70	.65

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21L02	$2.35

EXAR	
XR 2556	$ 1.75
XR 2567	$ 1.95

TRANSISTORS		
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2N3415	TO-92	5/$1.00
2N3704	TO-92	5/$1.00
2N4249	TO-92	5/$1.00
2N4400	TO-92	5/$1.00
2N4437	TO-92	5/$1.00
2N5089	TO-92	5/$1.00

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MINI SLIDE SPDT	5 $1
REG. SLIDE DPDT	6 $1
PUSH BUTTON N.O.	3 $1.

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CIRCLE 81 ON FREE INFORMATION CARD

NEW PRODUCTS

continued from page 83

The instrument uses a 10,000-MHz crystal to ensure the accuracy of the 10-, 100-, and 1,000-ms gate signals and logic control. A six-state IC counter feeds into a readout of six 0.3-inch seven-segment LED's. The frequency, decimal point, and range (either MHz or kHz) are all displayed automatically. A signal lamp indicates when the signal is sufficiently strong to be counted and indicates when the higher-sensitivity input is required. An overflow lamp indicates a signal that exceeds 1 MHz when using the 1-second fixed gate.

The BNC input is compatible with most standard broadband oscilloscope probes. When measuring transmitter or transceiver AM frequencies, the counter is positioned near the transmitter and a one-meter cable attached to the input serves as a pickup antenna. The counter can also be attached directly to a transmitter or transceiver with a directional coupler and dummy load.

The counter operates on 115V ± 10V 50-60 Hz. The unit measures only $2^5/_8$ by $5^3/_4$ by $9^1/_4$ inches, and weighs 4 lbs. $255.00.—**VIZ Mfg. Co.**, 335 E. Price St., Philadelphia, PA 19144.

CIRCLE 88 ON FREE INFORMATION CARD

CB SPEAKER, *model 101C,* features leather grain enclosure with a weather resistant 3 × 5-inch speaker. The speaker has a 3-ounce ceramic magnet and an 8-ohm impedance. A metal mounting bracket is provided with detente

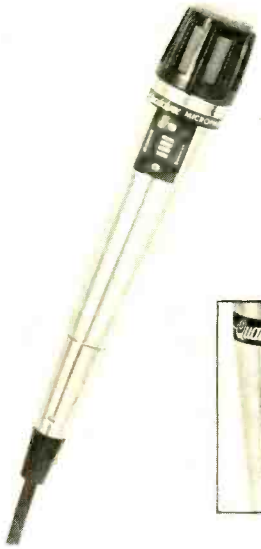
lock knobs. A special foam grill allows full sound passage without restriction.—**Electronic Industries, Inc.**, 33 Taft Drive, So. Holland, IL 60473.

CIRCLE 89 ON FREE INFORMATION CARD

TAPING MICROPHONE. The *model 516EQ E-Qualidyne* allows the user to effectively control the microphone's response characteristics by means of four filter switches. For example, by activating the microphone's high-frequency switch, a user can smooth out nasal and sibilant "sss" sounds. Activating the unit's low-frequency switch results in the reduction of resonating boominess. Up to 16 different combinations of switch settings change the microphone characteristics from mellow to bright, or strengthen or

CIRCLE 62 ON FREE INFORMATION CARD

de-emphasize mid-range material. The *model 516EQ E-Qualidyne* also offers an excellent unidirectional pickup pattern to minimize the pickup of unwanted background noises. A highly efficient mechanical isolation mount also



reduces handling and stand noises. This microphone is available singly for $75.00 and in pairs for stereo tape recording for $135.00.—**Shure Brothers, Inc.**, 222 Hartrey Ave., Evanston, IL 60204.

CIRCLE 90 ON FREE INFORMATION CARD

next month

JANUARY 1977

40-Channel CB Spectacular

Special 16-page section covers all the latest developments

- **Preview of 40-channel CB gear**
- **How manufacturers plan to handle trade-ins or conversions on 23-channel gear**
- **How to tune 40 chan-**

nels. Rotary, Keyboard, Thumbwheel

- Directory of manufacturers
- Antennas for 40 channels. Can present antennas be used?
- New FCC regulations

PLUS

More On TV Games

TV Game Data & Applications Sheet

Lab Tested Hi-Fi Reports

- Sony STR6800
- Yamaha B1

Logic Prone

Jack Darr's Service Clinic

Komputer Korner

CAR STEREO

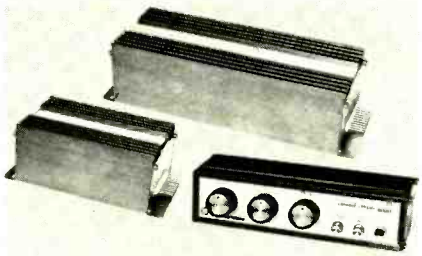
(continued from page 53)

ing from 15 to 125 watts-per-channel and are priced from $70 to $400.

Clarion is marketing a combination equalizer/booster amplifier, *model 100-EQB*, at $110, with 15 watts-per-channel.

Uher of America (621 South Hindry Ave., Inglewood, CA 90301) provides owners of their *models CR-124, 134* and *210* portable stereo cassette tape recorders a chance to use them as the nucleus of a car stereo component system with the aid of a new powered car mounting bracket priced at $195—the *model CR200* Stereomatic. The power bracket is supplied in two parts: a 25-watt-per-channel amplifier for mounting anywhere in a car (including trunk) and a combination matte-black finish preamplifier and mounting bracket to accommodate the front-loading cassette.

Available as either a kit for the do-it-yourselfer or completely assembled is a component-type system from the Jandy



THE JANDY CORPORATION markets the model 6000 power amplifier (top), the model 3001 power amplifier (lower right) and the model 4000 control console (lower left) in either kit-form or completely assembled.

Corporation (2001 North Buena Vista, Burbank, CA 91504). They offer a control console and two power amplifiers. The *model 4000* control console contains bass, treble and midrange controls, a hiss filter, power switch and headphone jack and is priced at $47.50 completely assembled and $32.50 for the kit version. The *model 6000* companion stereo power-amplifier delivers 30 watts-per-channel and is priced at $79.50 assembled and $49.50 in kit form. For those that are interested in less power, they also offer the *model 3001* 15 watts-per-channel power-amplifier for $49.50 assembled and $36.50 in kit form.

For the do-it-yourselfer, Heath (Benton Harbor, MI 49022) offers a car stereo FM tuner in kit form for $69.95, plus a power amplifier kit at $29.95.

The foregoing are some examples of the component-type equipment you'll be seeing more of as the concept of true hi-fi sound in a car is accepted and adopted. If ever you dreamed of having the kind of top quality sound you experience in the home in your car, now is the time to trade in the dream for the reality. **R-E**

SERVICE CLINIC

continued from page 82

full-wave bridge rectifier connected right across the AC line. These are high-speed motors and they radiate a tremendous amount of interference. In fact, you can lay one on the bench, turn it on, and pick up the noise without taking the scope probes off the hook!

I have worked on one of these units for the last 8 months. I've tried every kind of known noise suppression device on it, and so far I have made absolutely no progress. Writing to the maker produces a condescending letter that says "As you know, small electrical appliances *sometimes* generate *some* interference!" A-Men! At one time, I had two 40-μF electrolytic capacitors (something like twice the size of the unit itself) right across the motor, with zero results. I wouldn't say that *all* of them do this. I will say that all of them that I have seen do, and I have seen quite a few. If anyone has a practical cure for this, I think he could make some money out of it. (Let me know; I'll buy the first one!) **R-E**

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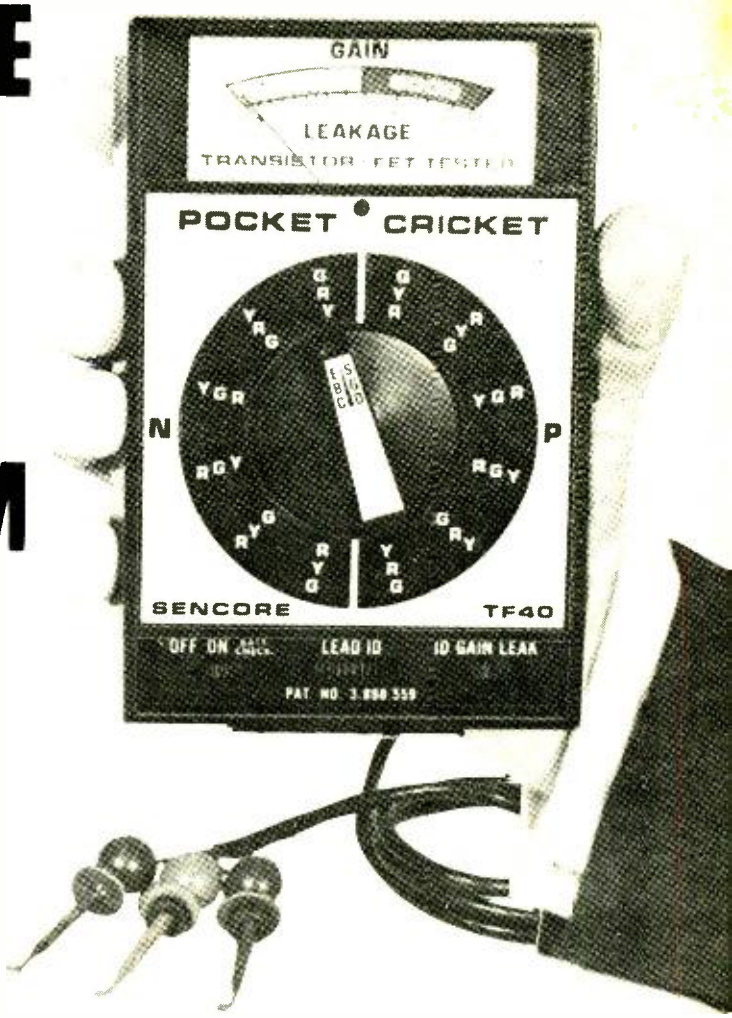

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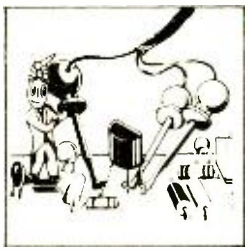
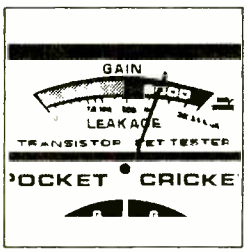
TRANSISTOR/FET TESTER





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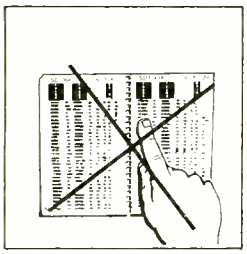

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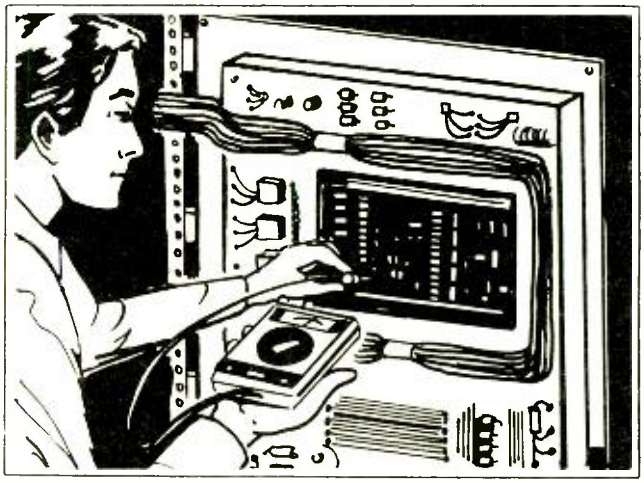

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7406	.25	74L78	.70
7408	.25	7480	.50
74H08	.30	7483	.50
7410	.18	7490	.50
74H10	.30	7492	.35
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74L54	.25	74193	1.00
74L55	.25	74197	.80
7460	.16	75491	1.00
74L71	.20	75492	1.00
7472	.40		

3 Amp Power Silicon Rectifiers

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PRV	EACH	PRV	EACH
50	$.08	600	$.24
100	.13	700	.27
200	.15	800	.30
300	.18	900	.40
400	.20	1000	.50
500	.22	1200	.60

1400 $.70

25K Trimmer

Printed Circuit Board Type
Each $.20
10 for $1.50

CD-2 COUNTER KIT

This kit provides a highly sophisticated display section moldule for clocks, counters, or other numerical displays. Unit is .8" x 4 3/8", and requires a 5V power source. Kit includes 2-sided PC board with plated-through holes, 7490, 7475, 7447, RCA DR2010, complete instructions, and Molex. When ordering please specify single digits or panels of up to 10 digits (with all interconnects.)

COMPLETE KIT $7.95 per digit

PCB IC Sockets

8 pin	$ .19
14 pin	.19
16 pin	.21
24 pin	.55
28 pin	.70
40 pin	1.10

14 pin wire wrap sockets gold inlay, long leads, Texas Instruments.

MOLEX

500	$ 4.50
1000	8.00
2000	15.00
5000	35.00
10000	70.00
25000	150.00

CD-3 COUNTER KIT

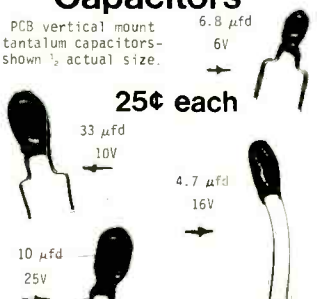
This kit can be programmed to count to any modulus: 2-9 for one kit, 2-99 for two kits, etc. Includes all as in CD-2, 2 resistors, 3 diodes, but without the 7475 quad latch. Perfect for displays of seconds, minutes, hours, etc. Full instructions included.

When ordering please specify single digits or panels of up to 10 digits (with all interconnects).

COMPLETE KIT $6.25 per digit

Capacitors

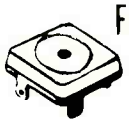
PCB vertical mount tantalum capacitors-shown ½ actual size.



CMOS

CD4001	$ .29	CD4029	2.25
CD4002	.29	CD4030	.65
CD4009	.59	CD4042	1.50
CD4010	.59	74C20	.65
CD4011	.29	74C42	2.00
CD4012	.29	74C160	2.50
CD4013	.69	74C195	2.25
CD4015	1.90	74C74	1.00
CD4016	.69	74C151	2.50
CD4019	.69		

FULL WAVE BRIDGE RECTIFIERS



25A - 500 PIV
$2.50 ea. 10/$20.00
25A - 100 PIV
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-12 turn trimpots which plug into a DIP socket
-5K and 200K
-⅜" x ¼" x ¼"
-4 leads spaced .3" x .2"

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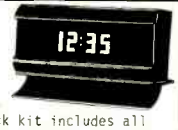
DPDT - 1A Contacts
Prime - 500 ohm coil
PCB - rated 12V, but works well at 6V.
Dimensions: 11/16" x 13/16" x 15/16"

Each $1.35 Ten for $12.50

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

KEYBOARD ASSEMBLY

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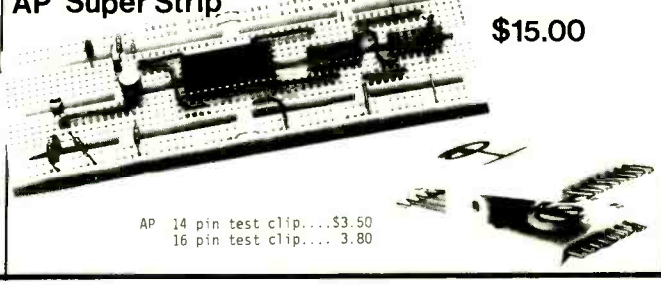

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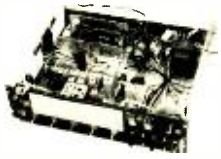

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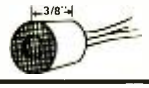

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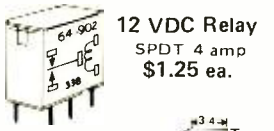

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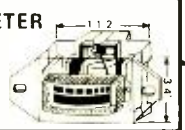

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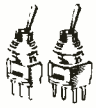

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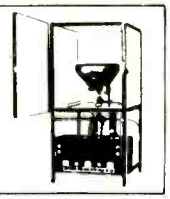

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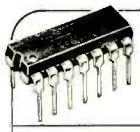

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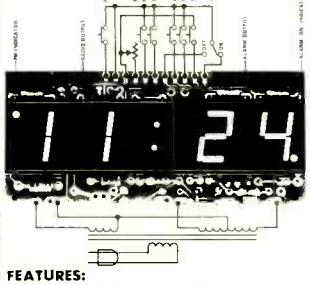

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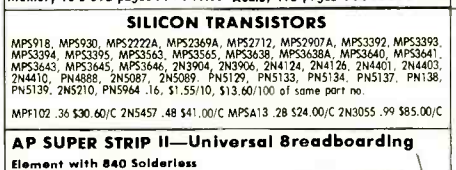

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3900	Quad Amplifier DIP	.49
7524	Dual core memory sense Amp	.71
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8038	Voltage contr. osc. DIP	4.16
8864	9 DIG Led Calh Dvr DIP	2.25
75150	Dual Line Driver DIP	1.75
75451	Dual Perepheral Driver mDIP	.35
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75453	(351) Dual Periph Driver mDIP	.35
75491	Quad Seq Driver for LED DIP	.71
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14 pin	.20	28 pin	.59
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WIRE WRAP - gold plate

14 pin .49

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7401	.16	7453	.17	74154	1.20
7402	.15	7454	.17	74155	.97
7403	.15	7460		74156	.97
7404	.16	7464	.35	74157	.99
7405	.19	7465	.35	74158	1.79
7406	.20	7470	.30	74160	1.23
7407	.28	7472	.30	74161	.97
7408	.18	7473	.35	74162	1.39
7409	.19	7474	.28	74163	1.09
7410	.16	7475	.49	74164	.99
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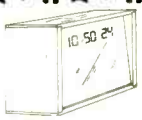
7413	.43	7483	.68	74166	1.25
7414	.65	7485	.88	74170	2.10
7416	.35	7486	.40	74173	1.49
7417	.35	7489	2.25	74174	1.23
7420	.16	7490	.43	74175	.97
7422	.30	7491	.75	74176	.89
7423	.29	7492	.48	74177	.84
7425	.27	7493	.48	74180	.90
7426	.26	7494	.78	74181	2.45
7427	.29	7495	.79	74182	.79
7430	.28	7496	.79	74184	1.90
7432	.23	74100	.98	74185	2.20
7437	.25	74105	.44	74187	5.75
7438	.25	74107	.37	74190	1.15
7440	.15	74121	.38	74191	1.25
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

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

6 Digit Clock Kit

MM5314 with 6 NS71 .27" displays 2 P.C. boards — Display board may be remote. Internal or wall transformer can be used. 50-60 Hz, 12-24 hour. Includes all necessary transistors, resistors, capacitors, diodes, 3 switches and complete assembly instructions.

CK6-3 ..... **$14.95**



Mark I

A six digit clock kit with one double sided P.C. board accommodates MM5314 clock chip and 6 FND359 .375" displays. 12-24 hour, 50-60 Hz. Contains all necessary components, 3 switches and complete assembly instructions with schematics. Connections for remote displays.

Mark I **$13.95**

4 Digit Clock Kit

MM5312 and 4 NS71 .27" displays 12-24 hours, 50-60 Hz. One P.C. board accommodates clock, displays, and all necessary transistors, resistors, capacitors, diodes, 2 switches, complete instructions and schematics for assembly.

CK4-2 ..... **$10.95**

Optional case available for all of the above clocks. Unfinished redwood designed individually for each clock. Internal or wall transformers may be used.

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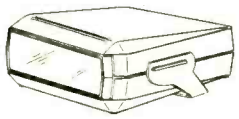

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Uses 5314 clock circuit
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Electronic Craps

Dimensions 6½" x 3½" x 1½" **$14.95**

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4007A	.26	4023A	.25	4072A	.35
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4011A	.29	4028A	.98	4082A	.35
4012A	.25	4030A	.44	4518A	1.56
4013A	.45	4035A	1.27	4528A	1.56
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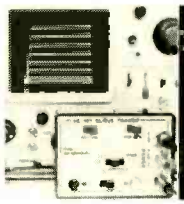

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CA 3047 Hi Pef. Op. Amp.	$ .95
340T 5, 6, 8, 12, 15, 18, 24V POS REG. TO-220	$1.50
101 OPER. AMP. HI PERFORM.	$ 75
LM 308 Oper. Amp., Low Power	$ .95
747 — DUAL 741	$ .65
556 — DUAL TIMER	$1.00
537 — PRECISION OP. AMP.	$1.70
LM 3900 — QUAD OP. AMP	$ .49
LM 324 — QUAD 741	$1.50
560 — PHASE LOCK LOOP	$2.00
561 — PHASE LOCK LOOP	$2.00
565 — PHASE LOCK LOOP	$1.25
566 FUNCTION GEN.	$1.65
567 — TONE DECODER	$1.50
LM 1310N FM STEREO DEMOD.	$2.75
8038 IC VOLTAGE CONT. OSC.	$3.90
LM 370 — AGC SQUELCH AMP.	$1.15
555 — 2μs — 2 HR. TIMER.	$ .45
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FCD 810 OPTO-ISOLATOR	$ .80
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LM 380 — 2W AUDIO AMP.	$ .95
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LM 382 — DUAL AUDIO PREAMP	$1.50
LM 311 — HI PER. COMPARATOR	$ .90
LM 319 — Dual Hi Speed Comp.	$1.25
LM 339 — QUAD COMPARATOR	$1.50

TRIACS

PRV	1A	10A	25A
100	.40	.70	1.30
200	.70	1.10	1.75
400	1.10	1.60	2.60
600	1.70	2.30	3.60

SCR'S

1.5A	6A	35A
.40	.50	1.20
.60	.70	1.60
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CIRCLE 52 ON FREE INFORMATION CARD

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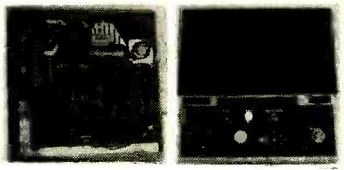
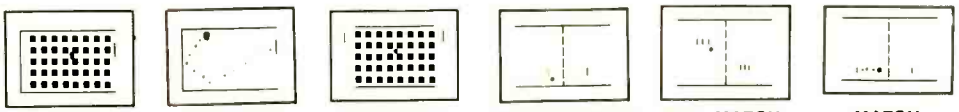


MADE FOR HOTEL ROOM SERVICE WAKE UP SERVICE
Here's a parts list- All new not used, just installed in the board.
1-LM309K, heat sink, 2-2N5137, 5-2N3904, 2-7400, 7402, 1-7403, 3-7410, 1-7413, 2-7430, 9-7474, 1-7486, 1-74151, 1-74154, 1-4001, 2-741CT, 5-TIP29 & 30, 1-LM380 AN (14), 3-MDA942-1 Bridges, 1-555 Timer, 1-OnOff 10K Vol Con 1-Fuse Block with 1 A SloBlo 1-4" Speaker 3.2 Ohm 1 Watt, 1-Transformer 16V Pri 5V-12V 1-Thumbwheel Switch 2 Digit 12 Positions, 40 other Misc. Weight 4 lbs
USE FOR: 5V DC Power Supply P.A. or Music Outlet
Price: $12.95

VIDEO GAME KIT
NOW 6 GAMES TO PLAY

A CHALLENGE TO BUILD, A CHALLENGE TO PLAY.



WIPE OUT I | HANDBALL | WIPE OUT II | GRAVITY MATCH | PRO MATCH | MATCH

WIPE OUT the squares — 7 serves from center — 40 squares — 10 pts each square hit by ball. On each serve square disappears when hit by ball. For 1 or 2 players.

HANDBALL — You may not win but you get alot of practice.

GRAVITY MATCH — You never know how high it will bounce when returning this one.

PRO-MATCH — You have 3 paddles to return a ball almost as fast as a hockey puck.

MATCH — The game that started the action.

Also a curve button while depressed sends the ball off at a new angle.

On screen scoring between automatic serves. 4 different sounds.

VK-2-A wt 4# 130.00
P.C. Board with 78 IC's, PROMS's (programmed), resistors, capacitors to stuff board for game
Requires 5V + DC 2 Amp

VK-3 wt 2# 17.50
HARDWARE KIT
Controls, switches, speaker, 22 pin edge connector

VK-4 wt 1# 22.50
R.F. MODULATOR KIT
To convert video signal to TV signal. Eliminates internal T.V. wire-in

VK-5-A wt 5# 17.50
POWER SUPPLY KIT
for P.C. board mounting transformer, high current Voltage Reg. capacitor heat sink

VK-4-A Antenna-Game Switch 9.50

CLOCK KIT $12.95

MM5316, pc bd., display tubes switches, etc, instructions.

FTK0106 Auto Clock Kit 40.00
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CLOCK CHIPS

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7401 .20	7442 .44	7497 2.00	74161 .62
7402 .20	7443 1.20	74100 1.25	74162 1.35
7403 .20	7445 .89	74107 .26	74163 .76
7404 .20	7446 .87	74109 .35	74164 .80
7405 .20	7447 .69	74110 .50	74165 .90
7406 .39	7448 .81	74116 2.00	74166 1.00
7407 .39	7450 .20	74120 1.25	74167 3.00
7408 .20	7451 .20	74121 .34	74170 2.00
7409 .24	7453 .20	74122 .39	74172 9.72
7410 .20	7454 .20	74123 .50	74173 1.25
7411 .20	7460 .20	74125 .45	74174 .85
7412 .24	7470 .20	74126 .45	74175 .75
7413 .35	7472 .23	74128 .65	74176 .85
7414 .70	7473 .26	74132 .95	74177 .85
7416 .33	7474 .29	74136 .50	74180 .75
7417 .33	7475 .39	74141 .80	74181 2.00
7420 .20	7476 .31	74142 4.00	74182 .90
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7425 .24	7482 .72	74145 .70	74190 1.00
7426 .24	7483 .75	74147 2.50	74191 .65
7427 .24	7485 .90	74148 1.75	74192 .85
7428 .40	7486 .25	74150 1.00	74193 .85
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7430 .20	7489 1.50	74153 .70	74195 .55
7432 .28	7490 .39	74154 .90	74196 .80
7433 .34	7491 .65	74155 .70	74197 .83
7437 .28	7492 .39	74156 .90	74198 1.50
7438 .28	7493 .39	74157 .70	74199 1.75
7439 .36	7494 .70	74158 1.75	74200 3.50
7440 .20	7495 .50	74159 2.25	74279 1.75

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8080	Improved 8008	24.95
8080A	Super 8080	34.95
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2107B-4	4096xl	8.00
8225B	16x4	1.50
93407	16xl	4.85
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2102	1024xl	2.00
2501B	256xl	1.75
3107	256xl	4.00
7489	64 Bit R/W	2.00
74200	256 Bit R/W	5.75
	PROMS	
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1702AL	256x8 low pow	12.00
8223B	32x8	3.50
74S287N	256x4	6.95
	SHIFT REGISTERS	
MM5058	1024xl Static	4.75
TMS3002LR	Dual 50	4.00
TMS3132NC	Dual 144	3.00

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2102 AMD9102, ISL7552-1, TMS4033
MM5058 AMD2533, FSC3355, TMS3133
TMS3002 SIG2509
TMS3132 MM4060, FSC3346

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Silicon photo voltaic cell wafers unmounted or encapsulated with output wires attached —
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11 ea quartered 3" dia 0.45V 0.2 to 0.3 amp	27.50
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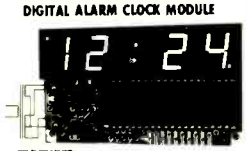
DIGITAL ALARM CLOCK MODULE



FEATURES:
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- 50 or 60 Hz Operation
- Power Failure Indication
- Brightness Control Capability
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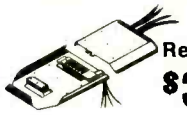


Reg. $3 1.99

Locks player in place. Slides in & out. 6 x 13/16 x 7". 6 or 12 VDC. Shipping weight 2 lbs.

CB Monitor Converter

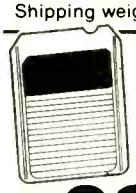
Reg. $17

11.99 CB-417

- *Covers Channels 1 Thru 23*

Converts AM auto radio to CB monitor. 12 VDC neg. grnd. Styles may vary. Shpg. wt. 2 lbs.

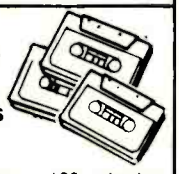
8-TRACK 40-Minute Recording Tape TA-907



Reg. 69¢ 39¢ Ea.

Blank tapes. Erased, not used. Shpg. wt. ½ lb.

Three 60-Minute Blank Cassettes TA-879



Reg. 1.49 99¢

180 minutes of recording time. Shpg. wt. ½ lb.

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1 RPM Timing Motor, 117 V. AC	MO-289	.49	.30
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Tubular Capacitor Kit, 100 Pcs.	CC-229	2.00	1.29
Ceramic Capacitor Kit, 100 Pcs.	CC-211	1.49	1.19
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500 MW Zener Diodes, 4.3-6.3-9.1-12 & 15 Volts	OI-052	1.00	.50
3 Unijunction Transistors, 40 V. 375 MW. 4 ON/S	TR-441	1.29	.50
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Photo Transistor, 5 Pieces - Epoxy Type	TR-502	1.00	.60
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Hobby Motor Kit, 3-6 V. OC, Pkg. 5	MO-333	.59	.49
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Tuner/Contact Cleaner, 6 Oz. Can	TL-459	1.49	.80
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- Displays Hrs. & Min. — Switch to Min. & Secs. on Command.

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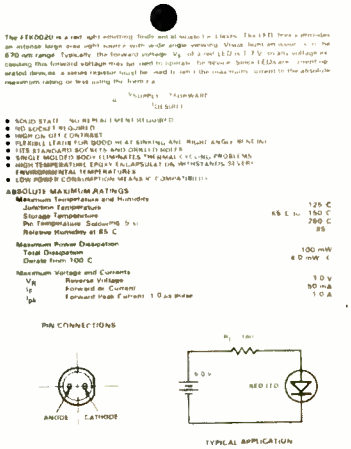
FTK0020

CARD FRONT

FTK0020



CARD BACK

FTK0106

CARD FRONT

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FTK0004	0.8" High Common Cathode Digit	2.00
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with 2102-L1 (low power, 450 ns) including IC sockets) $99.95

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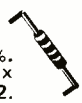

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DISCRETE LEDS

	.125" dia.					.200" dia					.185" dia.					.200" dia.					.090" dia.	
XC209	Red	10/$1				XC22	Red	10/$1			XC526	Red	10/$1			XC556	Red	10/$1			XC111	Red	10/$1
XC209	Green	4/$1				XC22	Green	4/$1			XC526	Green	4/$1			XC556	Green	7/$1			XC111	Green	4/$1
XC209	Orange	4/$1				XC22	Yellow	4/$1			XC526	Yellow	4/$1			XC556	Yellow	7/$1			XC111	Yellow	4/$1
						XC22	Orange	4/$1			XC526	Orange	4/$1			XC556	Orange	7/$1			XC111	Orange	4/$1
						SSL-22	RT	4/$1			XC526	Clear	4/$1			XC556	Clear	7/$1					

.085" dia. Micro red LED 6/$1

DISPLAY LEDS

DL707 DL338

TYPE	POLARITY	HT		TYPE	POLARITY	HT	
MAN 1	Common Anode	.270	2.95	MAN 3620	Common Anode-orange	.300	1.75
MAN 2	5 x 7 Dot Matrix	.300	4.95	MAN 3640	Common Cathode-orange	.300	1.75
MAN 3	Common Cathode	.125	.39	MAN 4710	Common Anode-Red	.400	1.95
MAN 4	Common Cathode	.187	1.95	DL701	Common Anode-red ±	.300	1.85
MAN 7	Common Anode	.300	1.25	DL704	Common Cathode	.300	1.50
MAN 7G	Common Anode-green	.300	1.95	DL707	Common Anode	.300	1.50
MAN 7Y	Common Anode-yellow	.300	1.95	DL 728	Common Cathode	.500	2.95
MAN 52	Common Anode-green	.300	1.75	DL 747	Common Anode	.600	2.25
MAN 64	Common Anode-red	.400	1.75	DL 750	Common Cathode	.600	2.49
MAN 72	Common Anode	.300	1.25	DL 336	Common Cathode	.110	.99
MAN 74	Common Cathode	.300	1.50	FND70	Common Cathode	.250	.75
MAN 82	Common Anode-yellow	.300	1.75	FND503	Common Cathode	.500	1.00
MAN 84	Common Cathode-yellow	.300	1.75	FND507	Common Anode	.500	1.00

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

WIRE WRAP TOOL

Part Number WSU-30 **$5.95 ea.**

WIRE WRAP WIRE

30 AWG — 25 ft. min. - $2.10 50 ft. - $2.75 100 ft. - $3.50 1000 ft. - $24.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 ea.	10 OHM	12 OHM	15 OHM	18 OHM	22 OHM	1/4 WATT 5% = 50 PCS.
		27 OHM	33 OHM	39 OHM	47 OHM	56 OHM	
ASST. 2	5 ea.	68 OHM	82 OHM	100 OHM	120 OHM	150 OHM	1/4 WATT 5% = 50 PCS.
		180 OHM	220 OHM	270 OHM	330 OHM	390 OHM	
ASST. 3	5 ea.	470 OHM	560 OHM	680 OHM	820 OHM	1K	1/4 WATT 5% = 50 PCS.
		1.2K	1.5K	1.8K	2.2K	2.7K	
ASST. 4	5 ea.	3.3K	3.9K	4.7K	5.6K	6.8K	1/4 WATT 5% = 50 PCS.
		8.2K	10K	12K	15K	18K	
ASST. 5	5 ea.	22K	27K	33K	39K	47K	1/4 WATT 5% = 50 PCS.
		56K	68K	82K	100K	120K	
ASST. 6	5 ea.	150K	180K	220K	270K	330K	1/4 WATT 5% = 50 PCS.
		390K	470K	560K	680K	820K	
ASST. 7	5 ea.	1M	1.2M	1.5M	1.8M	2.2M	1/4 WATT 5% = 50 PCS.
		2.7M	3.3M	3.9M	4.7M	5.6M	

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$10.95 ea.**

EXAR

XR-2206KA Kit		$17.95	XR-2260KB Kit		$27.95
TIMERS		PHASE LOCKED LOOPS	WAVEFORM GENERATORS		STEREO DECODERS		MISCELLANEOUS	
XR-555CP	$.69	XR-210 5.20	XR-205 8.40	XR-1310CP	$3.20	XR-2211CP	6.70
XR-320P	1.55	XR-215 6.60	XR-2206CP 4.49	XR-1310EP	3.20	XR-4136	2.00
XR-556CP	1.85	XR-567CP 1.95	XR-2207CP 3.85	XR-1800P	3.20	XR-1468	3.85
XR-2556CP	3.20	XR-567CT 1.70		XR-2567	2.99	XR-1488	5.80
XR-2240CP	3.25					XR-1489	4.80
						XR-2208	5.20

All Advertised Prices Good Thru December
Satisfaction Guaranteed. $5.00 Min. Order. U.S. Funds.
California Residents — Add 6% Sales Tax — Data Sheets 25¢ each
Send a 24¢ Stamp (postage) for a Free 1977 Catalog

NOW OPEN SATURDAYS

JAMES

1021-A HOWARD AVE., SAN CARLOS, CA. 94070
PHONE ORDERS WELCOME — (415) 592-8097

MINIATURE TOGGLE

DPDT				#MT	1	2-9	10-28	29-99
	ON	OFF	ON	221	2.95	2.55	1.87	1.70
	ON	NONE	ON	223	2.95	2.15	1.58	1.43
	ON	OFF	ON	121	2.35	1.95	1.43	1.30
	ON	NONE	ON	123	2.06	1.85	1.21	1.10

PUSH BUTTON

SPDT — SERIES PB, PB1
Maintained Action Switch — Push To Make Contact And Push Again To Reverse Action
Momentary Action Switch — Normally Open or Normally Closed. (For N.C. circuit use terminals 2 & 1 for N.O. & 3 for N.C. and N.O. 1, 2 & 3)

PB-123 $1.75
PB-126 $1.75

5 AMP RATINGS

THUMBWHEEL SWITCHES

THUMBWHEEL SWITCH ONLY

Part No.	Description	Price
SF-12	Single Pole 10 Position	$2.50
SR-12	Decimal	3.00
SF-21	10 Position BCD only	2.50
SR-21		3.00

Ordering: Order desired switch or switches and add necessary accessories for your particular application.

SF – Front Mount SR – Rear Mount

SERIES SF Front Mount Assembly

SERIES SR Rear Mount Assembly

ACCESSORIES

Part No.	Description	Price
SF EP	End Plate (Pair)	.50
SF DP	Divider Plate (each)	.40
SF BB	Blank Body (each)	.40
SF HB	Half Body (each)	.40

ACCESSORIES

Part No.	Description	Price
SR EP	End Plate (pair)	$ .50
SR DP	Divider Plate (each)	.40
SR BB	Blank Body (each)	.40
SR HB	Half Body (each)	.40

DIP SWITCH

These switches feature seven SPST slide switches in a molded dip. They are ideally suited for microprocessor applications.

$1.95

CLIPLITE !! 4/$1.00

NEW LED MOUNTING SYSTEM

- CLIPLITE mounts from the front of the Panel in a .250 hole on 3/8" centers. Panel thickness from 1/16" to 1/8".
- CLIPLITE equalizes and increases the brightness of commonly used wide beam LEDS.
- CLIPLITE is to be used with XC556 LEDS.
- Specify colors—red, green, amber, or yellow when ordering.

ZENERS—DIODES—RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
IN746	3.3	400m	4/1.00	1N4005*	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006*	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007*	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	8/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25M	20/1.00
1N5232	5.6	500m	28	1N4734	5.6	1w	28
1N5234	6.2	500m	28	1N4735	6.2	1w	28
1N5235	6.8	500m	28	1N4736	6.8	1w	28
1N5236	7.5	500m	28	1N4738	8.2	1w	28
1N4554	25	40m	6/1.00	1N4742	12	1w	28
1N458	150	7m	6/1.00	1N4744	15	1w	28
IN485A	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	IN1185	150 PIV	35 AMP	1.50
1N4003	200 PIV	1 AMP	12/1.00	IN1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR	$1.95
C38M	35A @ 200V	SCR	1.95
2N2328	1.6A @ 200V	SCR	.50
MDA 980-1	25A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	25A@ 200V	FW BRIDGE REC	1.95

TRANSISTORS

MPS A05	5/$1.00	PN3567	3/$1.00	PN4249	4/$1.00
MPS A06	5/$1.00	PN3568	3/$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	3/$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	2N5961	5/$1.00
2N3392	5/$1.00	2N4123	10/$1.00	C106B1SCR	2/$1.00
2N3398	5/$1.00			2N5432	$2.00
				40673	1.75ea.

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	.26
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

CIRCLE 37 ON FREE INFORMATION CARD

DELTA ELECTRONICS

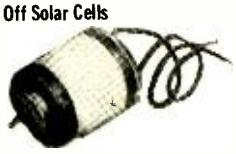
POST OFFICE BOX 2, 7 OAKLAND ST, AMESBURY, MASS 01913

MAGNUS

We now have a limited number of matching 2 & 3 octave keyboards Use with tone generator, or with a synthesizer of your own. This keyboard has 37 keys, The size is 9 3/4 x 19 The 2 octave board has 28 keys, and the 1 octave board has 13 keys

3	octave boards	STOCK NO. R5210	4 lbs.	17.95	2/35.00
2	octave boards	STOCK NO. R5280	3 lbs.	8.95	2/17.00
2	octave kit	STOCK NO. R5455	3 lbs.	5.95	2/11.00
1	octave boards	STOCK NO. R5454	2 lbs.	4.95	2/ 9.00

Miniature DC Motor Runs Off Solar Cells
Use in Science Fairs!



Solar cell large: 430 mv, 500ma. Dia. 2.25 STOCK NO. R1001 $8.95
Solar cell small: 430 mv, 130ma. .788 sq. STOCK NO. R5456 $2.50
Solar cell motor large, 1.80 lgx 1¾ dia. STOCK NO. R5456 $3.95
Solar cell motor small, 1.65lg x 1" dia. STOCK NO. R5457 $2.50
If you buy the large cell & motor together..... $12.00
If you buy the small cell & motor together..... $4.50

LO DUCA

A very attractive, 3 octave keyboard, Made in Italy. The dimensions are 23 inches x 10¾ inches x 8 inches. The keyboard is pictorially the same as the one above, but the rail is not present because of its superior construction there is no need for it. A 37 key aray.
STOCK NO R5453 5lbs. $45.00 each

MAGNUS TONE GENERATOR BOARD

Magnus model 1700 tone generator board, with slight damage due to handling. The board contains 12 seperate oscillators for 37 notes, plus power output stage. The boards are new, but may have a component broken. They could be operable, or used as a basis for your own design They are ideal for a synthesizer project. 4½ inches x 27 inches.
STOCK NO R5295 $6.95 each 2/12.00

MAGNUS TONE GENERATOR BOARD

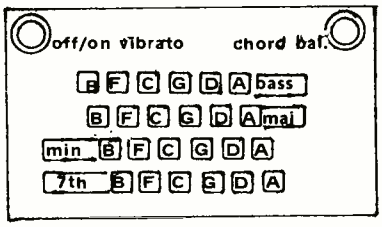
This MAGNUS tone generator board has 12 SCR oscillators & IC dividers for 37 notes (3 octaves), plus 3 chord oscillators. The basic component for your organ or synthesizer. Requires only +5v,+15v, and an amplifier. Use with our R5210 keyboard, 5¾ inchesx 19¾ inches.
STOCK NO. R5244 $17.95 each 2/35.00

13 WATT AMPLIFIER

Matching 13 watt amplifier for use with R5244 tone generator. Complete with power supply rectifiers and filters. 4¾ inches x 6 inches
STOCK NO. R5245 $9.95 each 2/18.00

POWER TRANSFORMER

A power transformer to match the amplifiers above.
STOCK NO. R5348 $3.75 each †/7.00



MAGNUS CHORD BOARD (complete)

The MAGNUS chord board (complete), generates signals that produce six MAJOR, six MINOR, six SEVENTH and six BASS chords of the organ. The chord board has vibrato and chord balance switches.
STOCK NO. R5445 $9.50

MAGNUS CHORD BOARD (incomplete)

MAGNUS chord board (incomplete) has six MAJOR and six MINOR chords, the board also has tremble control. IThe board is incomplete due to the fact that the buttons and the front or top panel is not included with this chord board.
The chord board also has a set of four push buttons.
STOCK NO. R5449 $4.75

MAGNUS INTERCONNECTING CABLE

This interconnecti ng cable is for the Magnus tone generator bd to the chord board. the cable is a flat ribbon cable type.
STOCK NO. R5252 $1.00 ea 6/5.00

Send for our latest catalog, Minimum order $5.00. Phone orders welcome:(617 388-4705) Include sufficient postage: excess will be refunded: BANKAMERICARD & MASTERCHARGE welcome, ALL numbers needed for processing. Minimum charge $15.00

CIRCLE 64 ON FREE INFORMATION 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
709C OP. AMP.	.25
741C OP. AMP.	.25
7400	.15
TA7061P	3.50
TA7205P	8.00
UPC1001h2	6.00
Ne555	1.25

RECTIFIERS

	10	100
IN4001	.60	5.00
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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$1.98 YOUR CHOICE OF ANY KIT

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100's OF BARRELS PURCHASED!

For the first time anywhere, Poly Pak merchandisers introduce a new way in buying the economical way. Raw stock from the "barrel". Remember the "good ole days"? They're back again. The same way merchandisers throughout the United States buy from various factories . . . their over-runs in barrels. Poly Pak has done the same. Therefore you are getting the same type of material as the RE-TESTERS DO!

TEST 'EM YOURSELF 'N SAVE!

BARREL KIT #202 PLUGS, SOCKETS, RECEPTACLES
100 for $1.98
Distributor unloads! Includes AC, DC, RF, audio, 4-9 pin, all kinds. Wt. 1 lb.
Cat No. 12R3527

BARREL KIT #203 CALCULATOR KEYBOARDS
10 for $1.98
It's true! 20-key, 4 function keyboards at ridiculous give-away. Wt. 12 ozs.
Cat. No. 12R3524

BARREL KIT #201 6V INDICATORS w/leads
15 for $1.98
Test lamp manufacturer dumps inventory! Worth 69¢ ea. Like grain-o-wheat.
Cat. No. 12R3526

BARREL KIT #200 9 DIGIT READOUT MODULES
5 for $1.98 with calculator & driver chips beneath epoxy. How good? Who knows!
Cat. No. 12R3515

BARREL KIT #198 TRANSISTORS & DARLINGTONS
50 for $1.98
Motorola dumps 1,000,000 TO-220 in barrels. NPNs & PNPs. All color-coded, high yield. 6 ozs. 12R3533

BARREL KIT #196 YELLOW JACKET MYLARS
75 for $1.98
Top grade, asstd values, some preformed. Marked with internal numbers 100%. Cat. No. 12R3476

BARREL KIT #195 CARBO-FILM RESISTORS 12R3534
75 for $1.98
millions. Lo & Hi values, ¼ & ½ watt, 5%, 10% tol. All marked. 100%.

BARREL KIT #191 CARBOFILM RESISTORS
800* for $1.98
*½ pound, approx. ⅛, ¼ watters. Asst values. Unmarked, but with ohmmeter you can separate urself-n-save! Cat. No. 12R3445

BARREL KIT #188 400 Parts $1.98
Includes resistors, caps, transformers, rectifiers, diodes, etc. for p.c. work. Preformed, dumped into barrels by factories. 100%. Cat. No. 12R3401

BARREL KIT #186 KEYBOARD CHIPS
10 for $1.98
Truthfully we can't test 'em, MM5740's, keyboard encoder chips. How good they are we don't know.
Cat. No. 12R3414

BARREL KIT #184 ¼-WATT METAL FILM
150 for $1.98
100% metal film resistors. Long leads. 12R3413

BARREL KIT #182 JUMBO RED LEDS
15 for $1.98
100% material, user cancellation from factory dumps, 3V 10 mils. For 100's of projects, red lens.
Cat. No. 12R3369

BARREL KIT #183 MINI TRIM POTS
30 for $1.98 1 oz.
Asst. values 100 to 1 meg 'em. What a buy. Single turn. ¼ W. Wt. 6 oz.
Cat. No. 12R3345

BARREL KIT #160 V. REGULATORS
15 for $1.98
LM309KC TO-3 V.R.'s barreled. Bot by the pound.
No.12R3330

BARREL KIT #159 MODULAR SWITCHES
25 for $1.98
Centralab switches. TV-makers excess. Dpdt, 6pdt, etc. Brand new. Cat. No. 12R3150

BARREL KIT #158 MAGNIFIED MAN-3's 1 oz.
15 for $1.98
Famous style MAN-3's 7-seg readout, with built-on magnifier. Factory discontinued line, 100% material. Cat. No. 12R3325

BARREL KIT #157 MOLEX CONNECTORS
100 for $1.98 12 ozs.
Nylon, white cable connectors, asst. factory over-run. NO PICKEE! Mixed in barrels. Cat. No. 12R3324

BARREL KIT #154 CLOCK CHIPS
20 for $1.98
We gathered an assortment of clock chip, alarm, calendar, beepers, who knows, all mixed. Cat. No. 12R3308

BARREL KIT #149 ROCKER SWITCHES
25 for $1.98 15 ozs.
Barrels 'n barrels, so many, our customers should get the deal. No. 12R3302

BARREL KIT #147 OVER-FLO FLUORESCENT NIXIES
5 for $1.98
Gas discharge type, color: Blue. Cat. No. 12R3286

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. 12R3293

BARREL KIT #142 DARLINGTON TRANSISTORS
40 for $1.98
TO-92, a Motorola dump, unknown numbers, but high yield to good darlingtons.
12R3285

BARREL KIT #141 10 WATT ZENERS
15 for $1.98 4 ozs.
Mfr. dumps to prepare for new styling, voltages all over the place. Good yield.
Cat. No. 12R3298

BARREL KIT #140 LAMPS, INDICATORS
20 for $1.98
Precision mini lamp, all-metal, panel, with mtg hardware. Lamp maker's overstock. No. 12R3297

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. 12R3268

BARREL KIT #134 CALCULATOR CHIPS
15 for $1.98
National type. Can be MM5736, 38, etc. Untested. Cat. No.12R3258

BARREL KIT #131 TANTALUM ELECTROS
30 for $1.98
Mixed, marked brime, top grade assrt values, voltages. Cat. No. 12R3255

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. 12R3250

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? Wt. 1 lb. 12R3245

BARREL KIT #127 AXIAL ELECTROS
40 for $1.98
Asst. capacities and voltages. Cat. No.12R3227

BARREL KIT #126 UPRIGHT ELECTROS
40 for $1.98
1mf to 3300mf in mixture of voltages, 100% marked 'n good. 12R3226

BARREL KIT #121 "MINI" MAGNETS
100 for $1.98 2 ozs.
Magnet circular and rectangular cuttings from a major maker — barrelled to save space. 912R3168

BARREL KIT #119 PRECISION RESISTORS 100% good
100 for $1.98
PREFORMED! Designed for printed circuit work. ¼, ½ w. Marked values, 1 and 2% values 2 ozs. 12R3205

BARREL KIT #117 2 OPTICAL FIBERS 2 ozs.
20-MIL 912R3206
200-FT. $1.98
Fiber optics factory bankruptcy purchase! High quality, most-commonly used size (20-mil). CLEAR.

BARREL KIT #115 MOLEX SOCKETS 100% good
200 for $1.98 Cat.No. 12R3144
Calculator maker dump! We gut a zillion of 'em. Used for IC sockets, etc.

BARREL KIT #112 MICRO MINI LEDS
40 for $1.98
All the tiny leds, axial, upright of Monsanto, Litronix, variety of colors. Yield 60% or better. 12R3138

BARREL KIT #110 SUPPRESSOR DIODES
100 for $1.98
Keeps ignition noises out axial. Untested, but the of your eqpt., car, industrial, etc. 12R3137

BARREL KIT #109 TERMINAL STRIPS
100 for $1.98
Wide asst. of terminal strip connectors, from 1 contact up. Strip manufacturers barrel dump is your gain. Wt. 1 lb. Cat.No. 12R3136

BARREL KIT #108 TO-5 PLASTIC TRANSISTORS
40 for $1.98
Cat.No.12R3101
Includes PNP, NPN, 2N-3638, 2N3641, 2N5000 series, etc. Untested, but guaranteed to a 60% yield.

BARREL KIT #104 SLIDE VOLUME CONTROLS
10 for $1.98
Cat.No.12R3057

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.12R3052

BARREL KIT #93 HALF WATTERS
200 for $1.98
Resistor factory tried to fool us by mixing 100's color-coded resistors in barrel. But value is there. 4 oz. 12R3046 Untested

BARREL KIT #92 3 AMP EPOXY RECTIFIERS
100 for $1.98
Cosmetic rejects, electrically fine business! You check 'em, it's not for us. Assrt. voltages. Untested 12R3204

BARREL #91 SILVER MICAS
100 for $1.98
Axial, red case, variety of physical sizes & values.
Cat.No.12R3018

BARREL KIT #88 LITRONICS LED READOUTS
10 for $1.98
7475's, 7275's, singles, triples, etc. .03 to 0.6. Rejects from factory, all mixed! have fun! No. 12R2861

BARREL KIT #87 NATIONAL IC BONANZA
100 for $1.98
Types 8800, 7400 series, DTLs, ROMs, registers, clock & calc. chips, linears, etc.
Cat.No.12R2860 Untested.

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. 12R2859

BARREL KIT #83 15 for $1.98
LM-340T VOLT REG
Factory rejected them for length of leads. May include 5, 6, 8, 12, 15, 18, 24 volts. Power tab Cat.12R2635

BARREL KIT #81 SUBMINI RESISTORS
200 for $1.98
PC, upright type, color coded, ⅛ watt. Assrt values. Come to us in a barrel.
Cat.No.12R2746 100% good.

BARREL KIT #76 1-WATT ZENERS
100 for $1.98
Factory same as 400-mw's. Never-to-see-again offer. 6, 8, 10, 12, 15V, unidec glass. Double plug.
Cat.No.12R2741 Untested.

BARREL KIT #75 400MW ZENERS
150 for $1.98
Factory out of biz! Amazing offer: 6, 8, 10, 12 to 15V. Youtest. Hermetically sealed glass pak. Double plug.
Cat.No.12R2740

BARREL KIT #73 TRANSISTOR ELECTROS
50 for $1.98
We don't wish to separate wide assrt voltages & values up to 300 mf. Cat12R2747

BARREL KIT #71 CAPACITOR SPECIAL
100 pcs. $1.98
meas., molded, plastics, ceramics discs, etc. Nifty 100% good. Cat.No12R2738

BARREL KIT #68 2 WATTERS
100 for $1.98 100% good.
All marked. Cat.No.12R2735

BARREL KIT #65 MIXED READOUTS
10 for $1.98
Factory returns — such numbers as MAN-4's, MAN-7's, MAN-3's, 11 barrels & no time to separate.
Cat.No.12R2733Untested.

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.12R2729

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.12R2726 100% good

BARREL KIT #56 POWERS! POWERS!
100 for $1.98
Large distributor cleaned house. Barrels of power resistors 3 to 7 watts.
Cat. No. 12R2724

BARREL KIT #54 8-DIGIT READOUTS
10 for $1.98
Bargain of a lifetime! All we got was 1 barrel — the "blisdor digit" types. Multiplexed. Cat. No.12R2722

BARREL KIT #46 G.E. 3.5 WATT AMPLIFIERS
25 for $1.98
Hobby type, factory fall-outs. 12R2624 Untested

BARREL KIT #40 PNP HIGH-POWER TRANSISTORS
20 for $1.98
Popular germanium TO-3 case 12R2618 100% good

BARREL KIT #39 2N3055 HOBBY TRANSISTORS
15 for $1.98
Fallouts of the famous 2N3055. 12R2617 100%

BARREL KIT #37 1 AMP "BULLETT" RECTIFIERS Untested
100 for $1.98
Famous style, assrtd. voltages, silicon, axial. Includes all types of voltages to 1KV. Cat.No 12R2615

BARREL KIT #36 GERMANIUM DIODES
200 for $1.98 Untested
This is the way the RE-TESTERS buy 'em from the factories. Cat.No.12R2614

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 12R2613

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. 12R2609

BARREL KIT #30 PREFORMED RESISTORS
200 for $1.98
We got barrels of ¼ and ½ watters for pc use. 100: ¼, 100 ½ watters.
No.12R2608 100% good

BARREL KIT #26 PLASTIC TRANSISTORS
100 for $1.98 Untested.
Type TO-92 (TO-18), all manufacturers variety of 2N #'s. Cat.No.12R2604

BARREL KIT #25 METAL CAN TRANSISTORS
100 for $1.98
Includes TO-5, TO-1, TO-18, etc., assorted 2N numbers, unmarked etc.
Cat.No.12R2603 Untested.

BARREL KIT #20 LONG LEAD DISCS
100 for $1.98
"auction sale" Prime, marked only. Long leads
Cat.12R2598 100% good

BARREL KIT #19 DIPPED MYLARS
60 for $1.98
Finest capacitors made, shiny finish. Imagine factory dumping 'em in barrels.
Cat.No12R2597 100% good

BARREL KIT #15 MOSFET TRANSISTORS
60 for $1.98
All 4 leaders TO-18 case. Includes UHF transistors too! Cat.No. 12R2449

BARREL KIT #14 PRECISION RESISTORS
200 for $1.98
Marked and unmarked ¼, ½, 2 watts. No. 12R2428

BARREL KIT #12 POWER TAB TRANSISTORS
40 for $1.98
PNP, plastic TO220 type. Assorted 2N numbers.
Cat.No.12R2426 Untested.

BARREL KIT #11 POWER TAB TRANSISTORS
40 for $1.98
NPN, plastic TO220 type. Assorted 2N numbers.
No. 12R2425 Untested.

BARREL KIT #10 ROMS-REGISTERS
75 for $1.98
28 to 40 pin devices, marked, internal factory numbers, etc 12R2424 Untested

BARREL KIT #7 VOLUME CONTROL BONANZA!
30 for $1.98 100% good
Singles, duals, variety of values, styles, big ones small ones. Cat.No12R2421

BARREL KIT #4 "4000" RECTIFIERS
100 for $1.98 Untested.
1N4000 series. May include 25, 50, 100, 200, 400, 600, 800 and 1000 volters. 12R2417

BARREL KIT #3 1N4148/914 SWITCHING DIODES
100 for $1.98
Imagine famous switching diodes at these prices!
Cat.No.12R2418 Untested.

BARREL KIT #2 LINEAR OP AMPS, DIPS Untested
75 for $1.98
May include 709's, 74 's, 703's, 660 series, 555 includes Cat.No.12R2416

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. Cat.No.12R2415 Untest

BARREL KIT #5 SCRS, TRIACS QUADRACS
40 for $1.98 Raw factory stock! All the 10 amp types.
Cat.No.12R2419 Untested.

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TYPE SALE							
☐ SN7400N	$0.16	☐ SN7442N	.53	☐ SN7494N	.78	☐ SN74160N	.88
☐ SN7401N	.16	☐ SN7445N	.69	☐ SN7495N	.78	☐ SN74161N	.88
☐ SN7402N	.16	☐ SN7446N	.79	☐ SN7496N	.72	☐ SN74164N	.79
☐ SN7403N	.16	☐ SN7447N	.69	☐ SN74100N	.98	☐ SN74165N	.99
☐ SN7404N	.16	☐ SN7448N	.76	☐ SN74106N	.65	☐ SN74173N	1.39
☐ SN7405N	.18	☐ SN7450N	.16	☐ SN74107N	.33	☐ SN74174N	.97
☐ SN7406N	.20	☐ SN7451N	.16	☐ SN74112N	.65	☐ SN74175N	.89
☐ SN7407N	.25	☐ SN7454N	.16	☐ SN74113N	.65	☐ SN74176N	.79
☐ SN7408N	.25	☐ SN7464N	.16	☐ SN74121N	.65	☐ SN74177N	.79
☐ SN7409N	.18	☐ SN7470N	.45	☐ SN74123N	.38	☐ SN74181N	2.05
☐ SN7410N	.16	☐ SN7472N	.34	☐ SN74125N	.59	☐ SN74184N	1.75
☐ SN7411N	.25	☐ SN7473N	.36	☐ SN74126N	.59	☐ SN74185N	1.75
☐ SN7413N	.45	☐ SN7474N	.31	☐ SN74132N	1.00	☐ SN74190N	1.15
☐ SN7417N	.32	☐ SN7475N	.49	☐ SN74141N	.88	☐ SN74191N	1.05
☐ SN7420N	.16	☐ SN7476N	.31	☐ SN74145N	.69	☐ SN74192N	.87
☐ SN7421N	.29	☐ SN7478N	.79	☐ SN74148N	1.29	☐ SN74193N	.83
☐ SN7423N	.35	☐ SN7483N	.69	☐ SN74150N	.99	☐ SN74195N	.73
☐ SN7425N	.27	☐ SN7485N	.86	☐ SN74151N	.70	☐ SN74196N	.88
☐ SN7430N	.16	☐ SN7489N	1.95	☐ SN74153N	.65	☐ SN74198N	1.49
☐ SN7437N	.26	☐ SN7490N	.44	☐ SN74154N	1.03	☐ SN74199N	1.49
☐ SN7438N	.26	☐ SN7491N	.73	☐ SN74155N	.70	☐ SN74200N	3.95
☐ SN7440N	.16	☐ SN7492N	.47	☐ SN74157N	.70	☐ SN74251N	1.09
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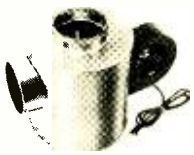

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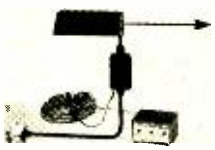

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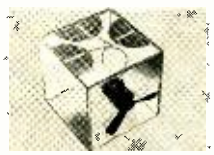

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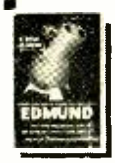

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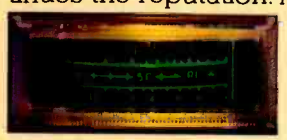

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