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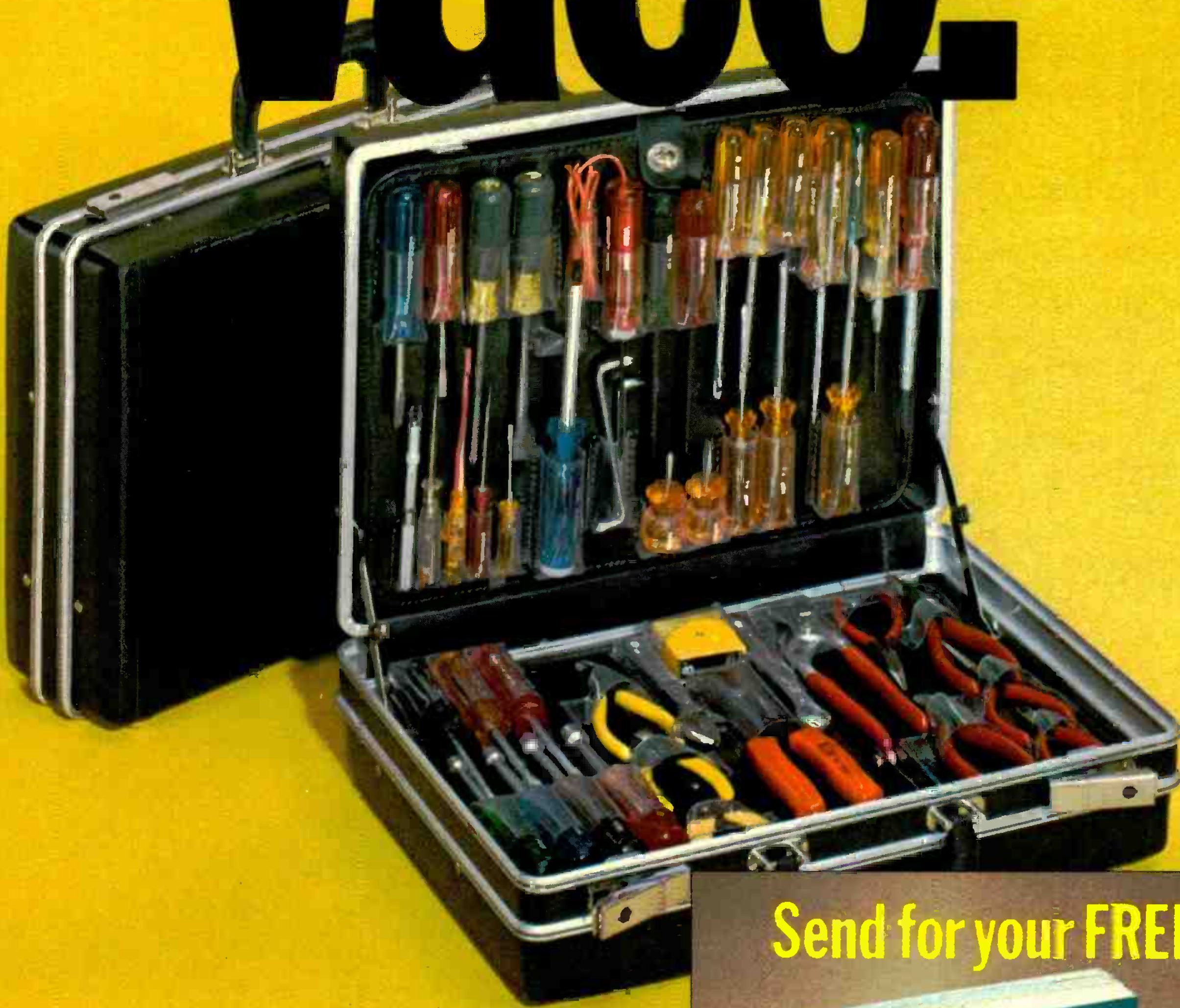

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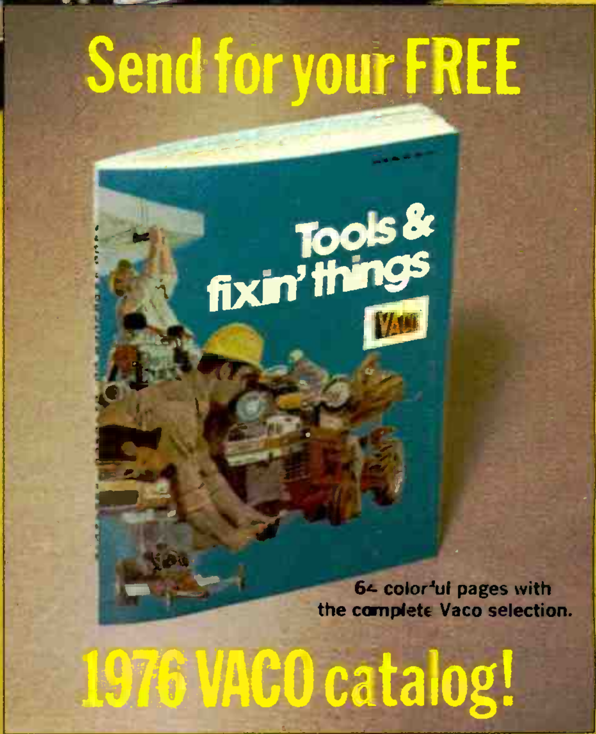

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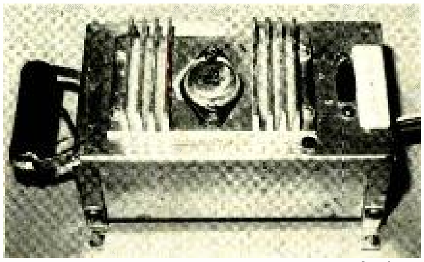
Electronics publishers since 1908

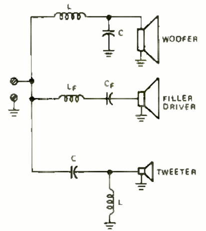
MAY 1976 Vol. 47 No. 5

ON THE COVER

The computer hobbyist needs a better machine. So we've introduced the "dyna micro." It's an 8080 architecture on a single circuit board. We'll be presenting complete plans and construction information starting on page 33 in this issue.



SOLID-STATE IGNITION for your car isn't a difficult project. This unit is easy to build and works with almost any standard ignition coil. .... **see page 47**



PHASE RESPONSE in speaker systems is an important measurement. Here's how a third speaker can fill the null between woofer and tweeter. .... **see page 43**

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looking ahead

Secret picture tube

Around the television industry it had been rumored for some time that Zenith was up to something big in picture tubes. Suspicion grew after an unusually large number of new picture tube patents were issued to Zenith scientists and engineers. Then *Television Digest*, a trade publication, broke the story that Zenith had developed a "radically new picture tube, re-engineered from glass to gun, yoke to mask," that would provide high performance at considerably lower cost than present designs.

Zenith finally confirmed that it did indeed have a new color tube that would be introduced in the 19-inch size in some sets late this summer, in other sizes next year. It indicated that the development took four years of intensive effort, in cooperation with Corning Glass Works, and that Zenith considered the new tube to be a major weapon against the inroads now being made by imports in the 19-inch size. Although Zenith hasn't yet released details, it's understood that the new tube presents a picture with a distinctive appearance, that it's lighter in weight than present types and that many operations in its production may be automated.

No picture tube

Getting rid of the picture tube completely is the goal of inventor William Glenn, whose previous contributions to television have been made at General Electric and CBS Labs. Glenn is now director of New York Institute of Technology's Science and Technology center, and he's working on a high-brightness projection television system that uses a charge-coupled device (CCD) instead of an electron gun.

The Glenn TV will be about the size of a Kodak Carousel projector and will be based on light-valve (or Eidophor) principles that use an external light source rather than a CRT to provide illumination for the projected picture. Glenn plans to use a CCD chip to modulate a membrane about the size of a 35-mm slide. A projection lamp is aimed through the membrane. The surface of the membrane is deformed by the CCD chip in accordance with the video signal. Actually, there would be three chip-membrane combinations—one for each color—converged by dichroic mirrors.

Glenn feels that his projector could make possible pictures of virtually any size, viewable in room light. "We've made small pieces of chips that work, but we don't have television resolution yet," he says, but he notes that CCD chips with adequate resolution have already been made for developmental TV cameras. He estimates he'll have his tubeless TV in about three years.

More on projection

An increasing number of projection TV systems are coming on the market, most of them offered by small companies and based on the use of small-screen color sets, lens systems and directional Kodak Ektalite screens. Most major manufacturers have sat by with little real interest (exception—Sony, which has its own TV projector). Now the majors are beginning to stir. The most enthusiastic, apparently, is the Admiral Group of Rockwell International, whose president, Charles Urban, says: "There are so many reasons projection TV's going to fly that it's beyond the imagination. I've seen a lot of interesting ideas. Our Science Center is working on it. You'll start seeing prototypes of high-brightness systems in about a year and a half."

In addition, Zenith is understood to be underwriting development of special fresnel lenses for projection television, and General Electric is believed to be giving the projection concept another long look. Once there's a major breakthrough permitting the use of an ultra-bright light source (such as the Glenn project), projection TV could be off to the races.

New TV services

The White House Office of Telecommunications Policy has urged the FCC, broadcasters and television set manufacturers to start looking into new services that could be provided by home television without degradation of the broadcast signal. Based on a specially commissioned study made by the University of Denver, a concerted effort was urged to develop "ancillary signals for television."

The Denver study specifically dealt with three major projects: The first was stereophonic sound for television. It estimated that 10 to 25 percent of TV set buyers might be willing to pay $50 to $100 extra for stereo television sets. The second was a special captioning service for the nation's 13,000,000 people with hearing problems and 7,000,000 with limited knowledge of English. The captions would be receivable only on sets with special converters (at probably $55 to $110 installed) or on new sets equipped with captioning circuits (at $30 to $50 extra). The third was Teletext services that use the TV screen to display graphic material transmitted in the vertical interval between pictures. The report says Teletext should reach the commercial stage in the next 5 to 10 years.

One of the proposals promises to get prompt attention from the FCC. In response to an earlier petition by Public Broadcasting Service, the Commission has already proposed a special captioning system for the deaf and said it will move quickly to implement the proposal unless "compelling arguments" are offered against it. The PBS system would reserve line 21 of the vertical interval for captions, which could be decided by optional TV set circuitry.

High-speed TV

A new, economical system for closed-circuit TV educational courses in the school or home has been developed by Peter Goldmark, president of Goldmark Communications Corp. It will be placed in service this fall in six community college districts across the country. Called Rapid Transmission & Storage (RTS), the system uses videotape or broadcast television. The tape system, RTS I, will be used this fall and makes possible the storage of up to 60 different half-hour programs on a single one-hour videotape reel—and up to 30 may be shown simultaneously and directed to different monitors.

The RTS Mark II system, to come later, provides for over-the-air transmission of similar information during nighttime non-program hours. A 30-minute course is transmitted in 12 seconds and stored in a special cassette recorder at the student's home for playback at will. The transmission speed of the Mark II system will make it possible to transmit 2,800 different half-hour lessons during an eight-hour period on a single channel.

AM stereo coming

The National AM Stereophonic Radio Committee (NASRC), an industry-wide organization, has set up shop to test various proposed systems to bring two ears to AM. Three systems have been proposed so far: RCA proposed one using frequency-modulated left-and-right information. Sansui and Comm Associates proposals use sideband approaches. Kahn Research Laboratories has also proposed a sideband system in the past and says it will urge immediate standardization of its system by the FCC, rather than submit it to testing by NASRC.

DAVID LACHENBRUCH
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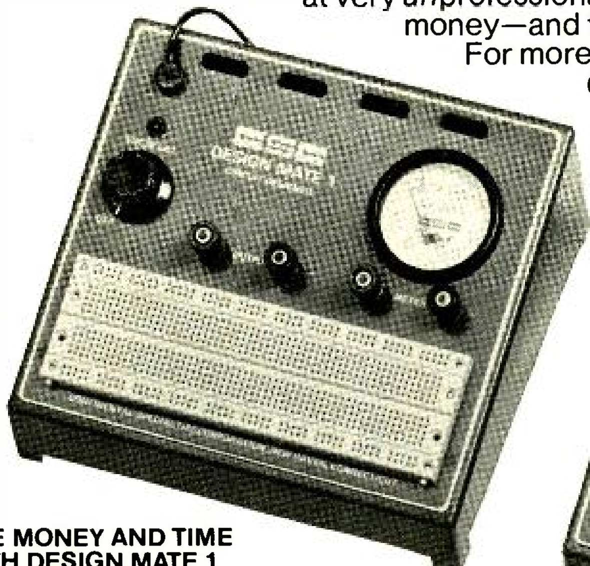

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new & timely

Electronic sales downtrend reversed at end of 1975

The year 1975 ended on an up-beat in all categories of consumer electronic products sales, except automobile radios, says Jack Wayman of the Electronic Industries Association (EIA). This was in contrast to the figures for the year, which were significantly lower than in 1974. In the final December sales week, television was up 19.8 percent, radio was up 66.2 percent and compact and component phonograph systems was up 10 percent.

The EIA reports color television sales for the whole of 1975 just short of 6.5 million, down 17 percent from 1974. Black-and-white TV sales were just below 5 million, down 16.4 percent from 1974. The AM and FM radio sales totalled approximately 25.5-million units in 1975, lower by 22.8 percent from the almost 33-million units sold in 1974. Automobile radio sales of about 9.2-million units were down 14.1 percent from the 1974 figures.

Total radio sales to dealers in 1975 were almost 34.7 million, a drop of 20 percent from 1974 sales. Compact and component phonograph sales to dealers, in round figures, were 3.4-million units, off 22.7 percent from the 4.4-million 1974 sales.

CSEA names Norman Woelfel new executive director

The California State Electronics Association has announced the appointment of Norma J. Woelfel as successor to Howard G. Wooliscroft, the present executive director of the association. CSEA is a 21-year-old statewide trade association of more than 1,000 sales and service retailers of electronic home entertainment equipment.

Ms. Woelfel joins CSEA after 13 years with the California Moving and Storage Association, where she was assistant director. She is a second-year graduate of the U.S. Chamber of Commerce's Institute for Organizational Management, a member of the American Society of Association Executives and of the California society of the same name, serving for several years on its Executive Board. Until Mr. Wooliscroft's formal retirement later this year, she will assume title of assistant executive director of CSEA.

NESDA check shows big jump in number of service technicians

Figures submitted to the National Electronic Service Dealers Association by the ten major state or city licensing boards around the country indicate that the total number of service technicians in the United States has increased to 196,347—an increase of 6.5 percent—during 1975. At the same time, the number of businesses engaged in electronic servicing declined about 9 percent, from 72,165 in early 1975 to 66,000 at the beginning of 1976.

The increase in the number of service technicians is due to the recession, believes NESDA executive vice president Dick Glass, CET. "I think that the statistic showing 196,000 technicians is correct," he said. "My opinion is that the recession has cut overtime for many technicians working full time in other industries and has caused others to lose their jobs or be laid off. Many have therefore obtained licenses to obtain income with repair work, either for themselves or as employees of existing firms."

Radio tracking to help wolves

A Red Wolf Recovery Program has been organized by the U.S. Fish and Wildlife Service, cooperating with the Louisiana Wild Life and Fisheries Commission and the Texas Parks and Wildlife Department, with the object of preventing the wolf from becoming extinct.

TWO MEMBERS of the Red Wolf Recovery Program recording the vocal responses of a wolf—and any friends he might meet—on a Uher 4000 portable open-reel tape recorder.

As part of the program, wolves are fitted with collars carrying radio transmitters. Their movements are then monitored with the idea of gaining more knowledge of their wanderings and habits. The receivers are directional and make it possible to get a good idea of the whereabouts of the animal being tracked.

Technician apprenticeships initiated in Wisconsin

Through the cooperation of the Wisconsin Electronic Service Association (WESA), the Wisconsin Department of Industry, Labor and Human Relations and the Waukesha County Technical Institute, a Radio and Television Technicians Apprenticeship Program is being carried on in Wisconsin.

Apprentices will be indentured to qualified electronic service establishments in the State for a working period of 8,320 hours (approximately four years). The apprentice normally starts at 50 percent of the skilled rate for technicians and receives raises in accordance with a schedule that forms part of the apprenticeship indenture.

While working, the student will study at a certified school, or if no school is available, will take 576 hours of instruction through home study from the Waukesha County Technical Institute. Upon successful completion of all the requirements of the apprenticeship, the apprentice will receive a diploma from the Wisconsin Division of Apprenticeship and Training.

FCC moves to expand, localize Emergency Broadcast Service

The Emergency Broadcast Service (EBS) is a means for distributing emergency information swiftly to licensees and regulated services of the FCC, non-government entities and the general public. It is made up of AM, FM and TV broadcast stations operating on a voluntary, organized basis during emergencies.

At the national level, the EBS already effectively provides the President with a means of speaking immediately to all the people of the country in any time of grave national emergency. The FCC has now moved to increase the usefullness of the system by increasing its use at the state and local level for day-to-day emergencies—fires, floods or other disasters.

A key element in the plans is the establishment of single EBS points that public safety officials can contact to get emergency messages on the air—a CPCS (Common Program Control Station) that will pass the messages on to other EBS stations. This can save valuable minutes that would be lost in contacting stations individually, especially in emergencies such as tornadoes or flash floods.

New two-tone attention signal for emergency broadcast stations

The FCC established April 15, 1976 as the date at which broadcast stations (other than non-commercial educational FM's with not more than 10-watts power) must be equipped to generate (encode) and detect (decode) the new two-tone inter-station Emergency Broadcast System attention signal. The EBS is a system

(Continued on page 12.)


OPTI-SCAN

Where do the pros get their training?

Almost half of the successful TV servicemen have home study training and with them, it's NRI 2 to 1.
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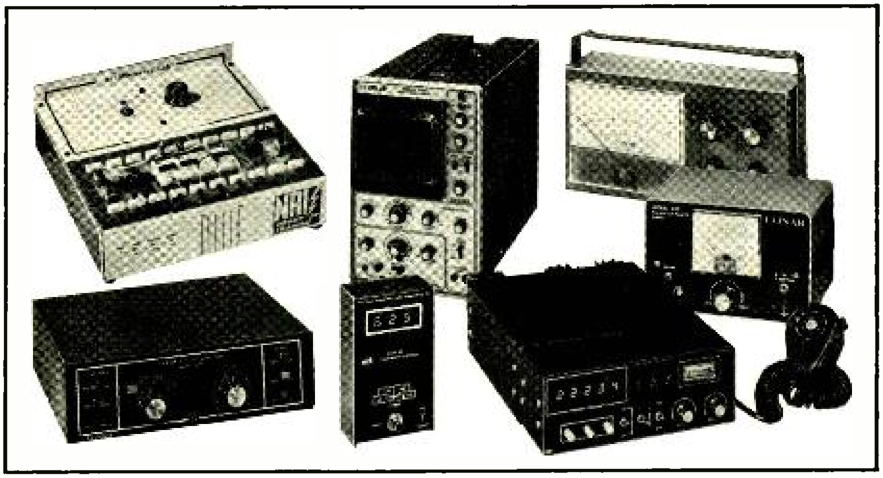

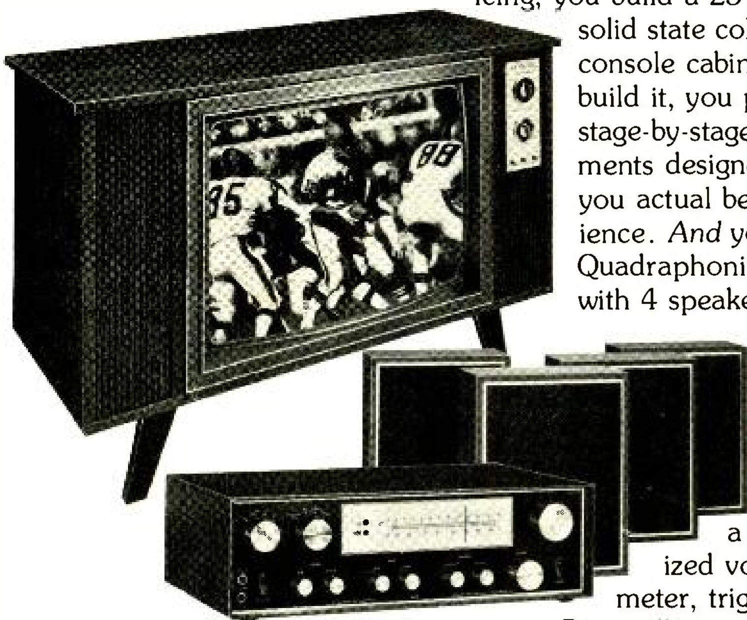

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(Continued from page 6)

that can keep the nation informed of national, state or local emergencies.

In November, 1974, the FCC amended its rules to substitute a two-tone signalling system (a transmission with two audio- tones) for the system then in use—two 5-second carrier breaks followed by a 1000-Hz tone for 15 seconds.

There was some opposition to the April 1 date from broadcasters' associations, who felt that more time should be allowed to make the changeover. They also demurred at the possible costs, which the National Broadcasters Association said could run to $700. The FCC's reply was that when the carrier-break system went into effect in 1967, the FCC put out public notices stating that a two-toned technique, expected to prove superior to the carrier-break, was being developed and might make obsolete the emergency broadcast receivers then in operation. Thus, in effect, the industry had been put on notice for eight years. As to price, combination encoder-decoders were available at prices as low as $195, therefore the cost was neither exorbitant nor prohibitive.

Servicers support attack on in-warranty injustices

The Florida Electronics Service Association has pledged $1,000 in support of the Electro TV court-suit in California. The suit is aimed at forcing manufacturers to stop violating California law by soliciting service repair work below cost.

The question has been asked: Why go too low—if in-warranty payment rates are too low, why not simply refuse to service the brands involved? Some service concerns can do just that. But many warranty repair stations are also sales firms and are agents for only the one or two brands they sell. To refuse to handle in-warranty repairs on those brands—even if the rates are below cost—would mean that the customer would have to call a direct competitor to have the in-warranty work done.

Another case is that of a shop that handles all the repair work for a department store. The store obviously wants to handle all its repair business through one shop—not two or three. If the shop will not handle the unprofitable brands, the department store will be inclined to drop it and find one to which it can channel all the repairs.

For these reasons many service groups are supporting the litigation with cash. The Orange County chapter of the California State Electronics Association (CSEA) donated $1,000 to the fund, and a single shop in Los Angeles contributed $500. Other donations of $100 and $50 have come in from all over the country. The National Electronic Service Dealers Association (NESDA) has set up a special fund for the in-warranty war-chest, and asks interested groups to send their donations to: SIS—Electro TV Fund, c/o the Finney Co., M. L. Finneburgh, Jr., EHF, 34 W. Interstate St., Bedford, OH 44146.

Federal Trade Commission rule helpful to mail-order customers

Under a new Trade Regulation Rule of the FTC, mail-order merchants will be required to make deliveries within a reasonable time, notify the customer if his order has to be delayed, and return his money if requested.

The Rule provides that if a mail-order seller is unable to ship merchandise within the time stated in his offer (or if no time is specified, within 30 days) he must notify the buyer of the delay and give him the option of cancelling the order and having the purchase money refunded.

The buyer must be provided with a cost-free device—such as a postcard or postage-paid envelope—for this purpose. If the buyer does not respond, it will be assumed that he has consented to an additional 30-day delay. For any longer delay, the customer's express consent must be gained; otherwise the money is to be refunded.

The Rule also makes provision for indefinite delays if agreed to by the customer, though a refund must be made if requested any time during the delay. It also requires sellers of mail-order merchandise to have a reasonable basis for claims about shipping time.

In the event of a violation, the FTC can obtain a court order for compliance or they could have the company fined $10,000 for each day of non-compliance. However, it is still legally debatable whether the FTC can go *directly* to Federal Trade Court.

Nationwide emergency channel adopted for police use

The FCC has designated 155.475 MHz as a nationwide emergency channel frequency for use in police emergency communications networks operated under statewide law-enforcement plans. The action was initiated on request of the APCO (Associated Public Safety Communications Officers).

Several states, APCO stated, now employ statewide emergency channels. It has been demonstrated that police can respond more effectively by using such common facilities. The 155.475 MHz frequency is limited to state police systems.

Operations on 155.475 MHz that are not now limited to emergency communications may continue until January 1, 1985.

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IF YOU WANT TO BRANCH OUT INTO THE TV TUNER REPAIR BUSINESS, WRITE TO THE BLOOMINGTON HEADQUARTERS ABOUT A FRANCHISE.

Circle 6 on reader service card

letters

AMERICAN TV STANDARDS

I note with horror that the changing of American TV standards is being seriously considered ("Looking Ahead", February issue). While it is true that the present system was developed in the middle 30's and the color system added to it in the early 50's, the system isn't all that bad. Consider:

- The information bandwidth in the present system is 4.2 MHz. Color sets normally pass about 3.5 MHz of it; black-and-white sets more like 2.5 to 3 MHz.
- The color signal consists of two variables, called I and Q, corresponding more or less to red-blue and green-purple separations. The I signal bandwidth is 1.5 MHz, the Q is 500 kHz. Most sets use 600 kHz for both.
- The soundtrack is required to have frequency response from 50 to 15,000 Hz —the same as "hi-fi" FM. Most sets come with amplifiers and speakers of quality similar to that of a portable transistor radio.

Clearly, if receiver manufacturers were convinced that the people would pay more for higher quality, they'd make sets that could take full advantage of this 25- to 35-year-old set of standards. Such a set wouldn't cost much more. But there are a few other reasons, all due to the TV stations and the networks:

- Many programs are on film, which has an inherent contrast limit compared to TV—film does not look "live." Most film uses an optical sound system, developed in the twenties. The frequency response, distortion, and signal-to-noise ratio are decidedly inferior to that of the transmitter.
- Networks limit audio frequency response from any source to about 200 to 5000 Hz, and signal-to-noise is well below the transmitter capability.
- Network shows delayed for viewing in the western half of the U.S. are played back one generation down, no matter what the source. This often causes color banding, usually seen as stripes of off-color or color contrast changes, especially in the red hues (which include most skin tones).
- Local newsfilm is 16 mm or super-eight, with the limited resolution already mentioned. Some improvement is made on the audio track of super-eight by use of magnetic recording, but it is partially offset by the even slower film speed.
- Electronic news-gathering (ENG) equipment, which uses videotape instead of film, uses less than one-fourth of the capability of the television channel, since the increased bandwidth would increase the complexity, size, weight, and cost of those items.
- Almost all pay-TV "movie packages" are played from videocassettes, which have less than half the resolution the channel can provide. This degradation is obvious on almost any receiver.

If we were to go to a 1000-line system, we would no longer be compatible with Canada, Mexico, or Japan, just to name a few, and anything we presently have on videotape would be obsolete—we could scan-convert it, but that wouldn't improve it. The thought of "Let's Make A Deal" on a 10-foot screen makes me ill. Incidentally, the main resolution limitation on our present system is in the vertical direction, since that's across the lines, while the horizontal is continuous. Vertical resolution could be doubled by going to a 4:1 interlace instead of the present 2:1, and still be compatible with all the TV sets in the country. Such an arrangement could be switched on and off at will by the TV station, FCC consenting.

Let's hope that nobody's serious about all this. Look at the picture from an Advent 7-foot screen projector set—it ain't half bad. And there's always the movies.

JAMES REIGER
Ridgecrest, CA

COMPUTER HOBBYISTS

To me, the most critical thing in the hobby market right now is the lack of good software courses, books and software itself. Without good software and an owner who understands programming, a hobby computer is wasted. Will quality software be written for the hobby market?

Almost a year ago, Paul Allen and myself, expecting the hobby market to expand, hired Monte Davidoff and developed Altair BASIC. Though the initial work took only two months, the three of us have spent most of the last year documenting, improving and adding features to BASIC. Now we have 4K, 8K, EXTENDED, ROM and DISK BASIC. The value of the computer time we have used exceeds $40,000.

The feedback we have gotten from the hundreds of people who say they are using BASIC has all been positive. Two surprising things are apparent, however. 1) Most of these "users" never bought BASIC (less than 10% of all Altair owners have bought BASIC), and 2) The amount of royalties we have received from sales to hobbyists makes the time spent of Altair BASIC worth less than $2 an hour.

Why is this? As the majority of hobbyists must be aware, most of you steal

(continued on page 16)

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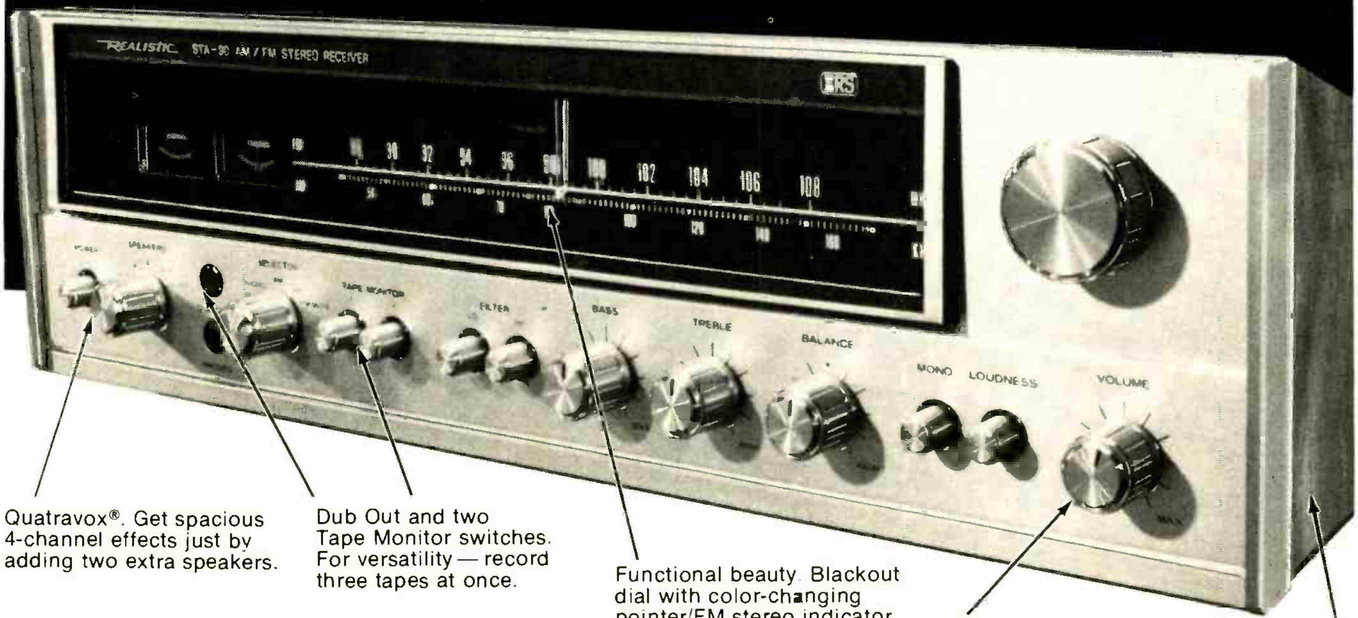

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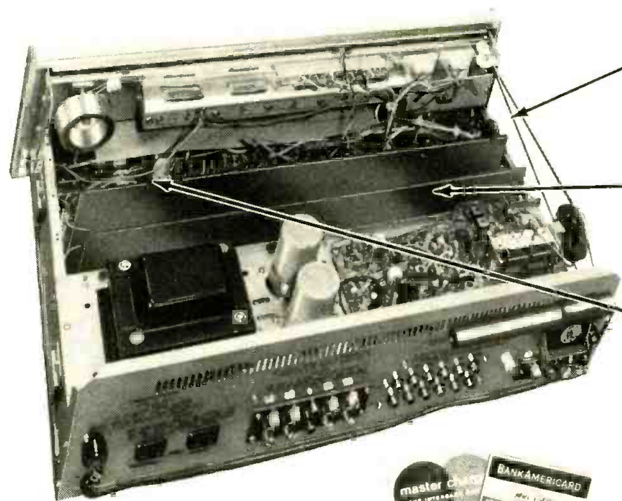

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LETTERS

(continued from page 14)

your software. Hardware must be paid for, but software is something to share. Who cares if the people who worked on it get paid?

Is this fair? One thing you don't do by stealing software is get back at MITS for some problem you may have had. MITS doesn't make money selling software. The royalty paid to us, the manual, the tape and the overhead make it a break-even operation. One thing you do do is prevent good software from being written. Who can afford to do professional work for nothing? What hobbyist can put 3-man years into programming, finding all bugs, documenting his product and distribute for free? The fact is, no one besides us has invested a lot of money in hobby software. We have written 6800 BASIC, and are writing 8080 APL and 6800 APL, but there is very little incentive to make this software available to hobbyists. Most directly, the thing you do is theft.

What about the guys who re-sell Altair BASIC, aren't they making money on hobby software? Yes, but those who have been reported to us may lose in the end. They are the ones who give hobbyists a bad name, and should be kicked out of any club meeting they show up at.

I would appreciate letters from any one who wants to pay up, or has a suggestion or comment. Just write me at 1180 Alvarado, SE, #114, Albuquerque, New Mexico 87108. Nothing would please me more than being able to hire ten programmers and deluge the hobby market with good software.

BILL GATES
General Partner, Micro-Soft
Albuquerque, NM

OOOOPS!

In your February, 1976, Komputer Korner example on page 88, it appears that you have mixed up your architecture and the direction of the moves.

With architecture B; to move A to output requires:

02 (move A to C)
07 (move C to output)

But if C contains needed data, the instructions should be:

06 (move C to B) not B to C
02 (move A to C)
07 (move C to output)
04 (move B to C)

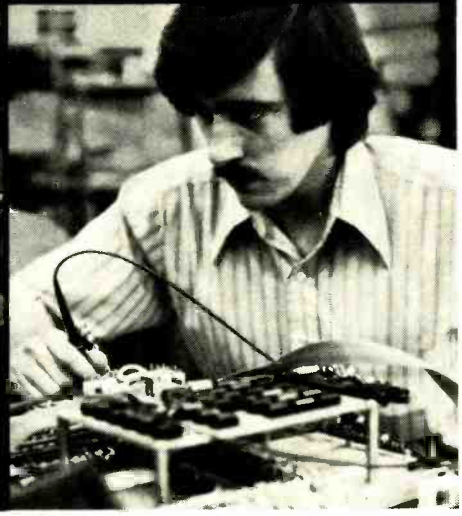
PHILLIP L. EDELSBERG
Systems Analyst
Indianapolis, IN

R-E

DON'T MISS THEM!

This month's hi-fi test reports include two stereo receivers. One is the Marantz model 2325 and the other is Lafayette's model LR-2200. See how these two receivers match-up against each other. Turn to pages 50 and 56 for the complete story and full specifications.

16 ways to move ahead in electronics!



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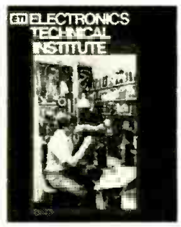

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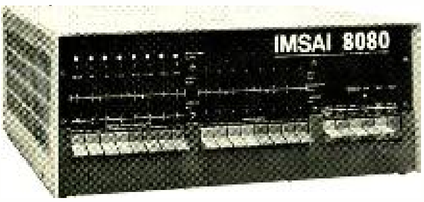

KOMPUTER KORNER

How to interface the microcomputer with input/output devices.

DAVID LARSEN, PETER RONY, and JOHN TITUS*

THE VARIOUS DATA PATHS IN A MICROCOMputer consists of the data input, data output, external device addressing, in and out function pulses, and interrupt signals. These are the vital lines of communication between the microcomputer and the "outside world", for example, those signal lines that are necessary to interface the microprocessing unit (MPU) to the input/output or I/O devices that you would like to control.

What is an I/O device?

Some useful definitions include the following:

input/output—General term for the equipment used to communicate with a computer and the data involved in the communication.[1]

I/O—Abbreviation for input-output.[2]

I/O device—Input/output device. Any digital device, including a single integrated-circuit, that transmits data to or receives data or strobe pulses from a computer. The in and out functions are always referenced to the computer.[3]

The traditional view of an I/O device is that it is somewhat large or complex. Card readers, magnetic tape units, cathode-ray tube displays and teletypes certainly fit such a description. However, a single integrated circuit such as a latch, shift register, counter or small memory can also be considered to be an I/O device to a computer.

Another important point is that several device-select pulses may be required to interface a single I/O device. For example, a 74198 shift register has a pair of control inputs that determine whether the register shifts left, shifts right, or parallel-loads 8-bits of data. This IC also has a clock input and a clear input. Thus a single 74198, when serving as an output device, may require up to four device-select lines from the microcomputer. Therefore, the fact that we can generate 256 different input and 256 different output device-select pulses does not necessarily mean that we can address 512 different "devices." A more reasonable number is of the order of 50 to 100 different devices.

Device-select pulses are inexpensive and easy to implement. We encourage you to use them as often as possible as you attempt to substitute computer software for integrated circuit hardware. We shall repeat this theme often: software vs. hardware. There exists a tradeoff between the two, but your main objective in using microcomputers will usually be to substitute software for hardware. When you do so, the only penalty that you may pay is time—it takes time to execute computer instructions. If you can accept the delays inherent in computer programs, then you can vastly simplify the circuitry required to accomplish a specific interfacing task.

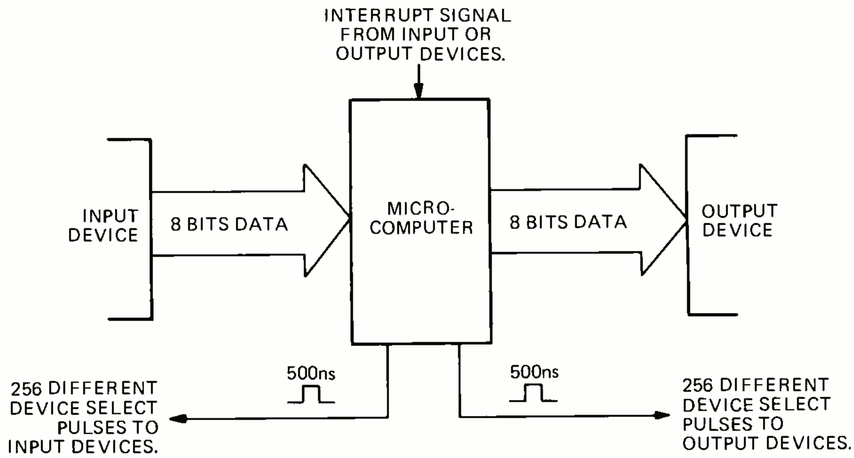

FIG. 1

Interfacing

Interfacing can be defined as the joining of members of a group (such as people, instruments, etc.) in such a way that they are able to function in a compatible and coordinated fashion. By "compatible and coordinated fashion," we usually mean synchronized. Some important definitions include the following:

synchronous—In step or in phase, as applied to two devices or machines. A term applied to a computer where a sequence of operations is controlled by equally spaced clock signals or pulses.[2]

synchronous computer—A digital computer that has all ordinary operations controlled by equally spaced signals from a master clock.[2]

(continued on page 22)

*This article is reprinted courtesy American Laboratories.

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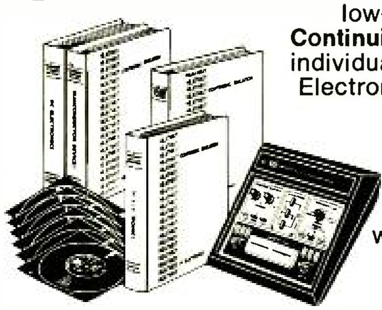

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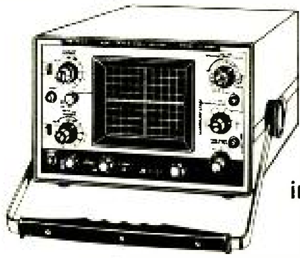

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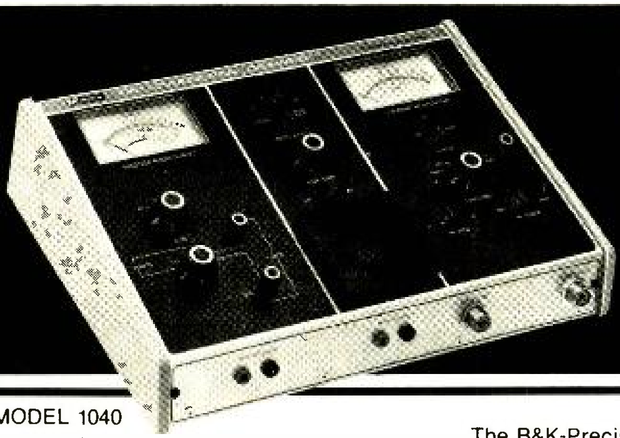

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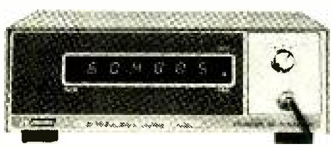

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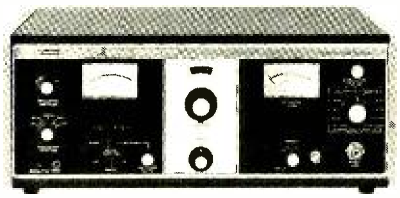

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KOMPUTER KORNER
(continued from page 18)

synchronous operation—Operation of a system under the control of clock pulses.[3]
synchronization pulses—Pulses that are originated by the transmitting equipment and introduced into the receiving equipment to keep the equipment at both locations operating in step.[2]
computer interfacing—The synchronization of digital data transmission between a computer and one or more external input/output devices.[3]

Although the details of computer interfacing vary with the type of computer employed, the general principles of interfacing apply to a wide variety of computers. Such principles include the following:

- The digital data transmitted between a computer and an I/O device are either individual clock pulses or else full data words.
- The computer and the I/O device are both clocked devices. At the very least, the I/O device has a single flip-flop that is set or reset by the computer. All data transmission operations are synchronized to the internal clock of the computer.
- The computer sends synchronization pulses, called device-select pulses, to the I/O device. These pulses are generated by the computer program and are usually quite short—for an 8080 microcomputer operating at 2 MHz, they last for only 500 ns. *The pulses synchronize and select at the same instant of time.*
- Individual device-select pulses are sent to individual input or output devices. This is called *external device addressing*. The pulses are used for latching data output and strobing data input.
- Computer program operation can be interrupted by the transmission of a clock pulse from an I/O device to a special input line to the computer. This is called *interrupt generation*. Upon being interrupted by an external I/O device, the computer goes to a computer subroutine that responds to, or *services*, the interrupt.
- Full data words can be output from, or input into, the accumulator register. For the 8080 microcomputer, a full data word contains 8 bits. Output data from the accumulator is available for only a very short period of time and usually must be latched. Input data into the accumulator is acquired over a very short period of time and usually must be strobed into the accumulator.

Interfacing basically consists of the synchronization of parallel input or output data via the use of the 512 device-select pulses. (See Fig. 1.) Hardware is required to tie the MPU to the external device and is just as important as the microcomputer software. We shall tackle both of these facets of microcomputer interfacing in detail in subsequent columns. **R-E**

References

1. *Microprogramming Handbook* (Santa Ana, CA: Microdata Corporation, 1971).
2. Rudolf F. Graf, *Modern Dictionary of Electronics*, Howard W. Sams and Company, Inc., Indianapolis, IN, 1972.
3. *Bugbook III* (Derby, CT: E & L Instruments, 1975).

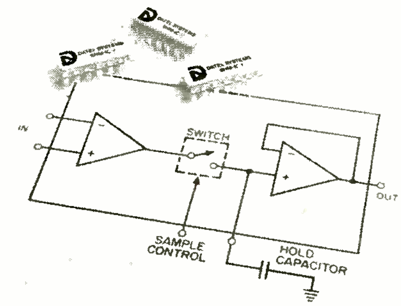
Solid-State News

National Semiconductor has submitted a 4K RAM memory that is different from the competition.

The MM5270 Tri-Share™ 4096 × 1 bit RAM is packaged in an 18 pin DIP in contrast to the industry standard 22 pin packages. Three functions share the use of a single lead—read/write, logical chip select and V_{cc}. One lead is also used for both data input and output.

The 18-pin packages can be squeezed in with a density nearly twice that possible with the 22-pin packages. National claims memory system costs are kept low because of the savings in PC cards, card frames, connectors and wiring. The cost of the memory package itself is lower. The access and cycle times are 200 ns and 400 ns, respectively.

RCA has also joined the NMOS memory field with the MW7001ID 1024 x 1 bit static RAM. The device is pin compatible with the AMS7001I and has a 60 ns maximum access-time and 180 ns maximum cycle-time. Also planned is a 4096 bit dynamic RAM.



DATEL SYSTEMS SHM-IC-1 high performance sample-and-hold.

Both the National and RCA chips are TTL compatible except for the chip select input.

The SHM-IC-1 from Datel Systems is a high performance sample-and-hold that uses only an external storage capacitor. Sample-and-hold systems are used in sampled data control systems, in the reconstruction of sampled waveforms and for data acquisition.

Acquisition time is 4 μs with a .001 μF capacitor; the signal droop is 50 mV/s. The capacitor can be lowered to 100 pF for a faster 2 μs acquisition time, but droop also increases in the same ratio.

Three blocks make up the sample and hold. A high gain input differential amplifier, the electronic sampling switch, and an output buffer amplifier. The SHM-IC-1 sells for $29 in small quantities.

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Radio Electronics & Shopping Centers

Circle 14 on reader service card

equipment reports

American Technology Corp. ATC-10 Color Pattern Generator

Circle 97 on reader service card

THE AMERICAN TECHNOLOGY CORP., 225 Main St., Canon City, CO 81212, is one of the new "high-technology" companies in the test-equipment field. Their first instrument is a color-bar pattern generator, model ATC-10. This is an all solid-state instrument, using the newest digital IC techniques to produce not only the stock test patterns, but several new ones. Its a versatile instrument that will do all of the regular things, and many others as well; its really a "Color-Bar-Plus" generator!

The ATC-10 uses 31 digital IC's, an IC-regulated DC power supply, and is well made. For stability, *all* frequencies, line-widths and spacing are crystal controlled. Due to the crystal control, all patterns are as solid as a rock.

All of the standard test patterns can be used for purity, convergence and color alignment. The ATC-10 provides 10 × 10 dot, crosshatch, vertical and horizontal lines, and the standard 10-bar gated rainbow color patterns.

Now for the new patterns. There is a Hatchdot—a crosshatch with a single dot in the exact center. There is also a Hatchdots pattern—a crosshatch with center dot and a "frame" of dots all the way around the edges. Handy for centering and linearity adjusting. By the way, the center dot in the dots pattern is isolated—the dot above and below the center is blanked out so that you can identify it instantly.

In the 10-bar color-bar pattern, the 6th (blue) bar is "flagged"—there is a blank in the center that saves a lot of counting! The ATC-10 actually has three color-bar patterns in all. The next one is called Vector. This is the 10-bar pattern with the luminance signal blanked out. It produces much sharper vectorscope patterns. The last one is really useful. This one is called 3.58 Monitor and it is the ten-bar pattern once more, but this time the *burst* has been blanked out. You will see exactly the same effect you get when you ground the burst-amplifier grid to let the TV set's 3.58 MHz oscillator free wheel. You can do this *without* taking the back of the set off. If the color bars float or fall out of sync, you definitely know that the 3.58 MHz oscillator is or isn't able to run on-frequency.

The next color pattern is one called Red Raster. It's a 3.58 MHz signal that is 67.5-degrees away from the burst. You do not have to do anything to the receiver aside from turning the color control up. (Painless purity!) Turn the color-control down and the brightness up, and you get a clear white raster for checking gray-scale adjustments. For another test like this, turn to the GRAY QUAD position. This displays a screen divided into four segments—white, light gray, dark gray and black. This can also be used to check deflection yoke polarity. If the white quadrant isn't in the lower right corner, one of the yoke windings is reversed. There are eleven different test patterns in all. Since all of these have their chroma and sweep frequencies tightly phase-locked, the stability is excellent. Another automatic circuit prevents over-modulation.

The RF output of the ATC-10 is on channel 2, crystal controlled. If channel 2 is used in your area, you can change to channel 3 by installing another crystal. The RF output of the ATC-10 can be varied from 15 μV to 90,000 μV at 75-ohms output, and 180,000 μV on the 300-ohm output. There is also an IF crystal-controlled output at 45.75 MHz. To obtain this, just pull out on the RF gain-control knob.

Both 75- and 300-ohm output cables are provided. These two cables and the line cord stow in a compartment provided in the back of the case. The 75-ohm IF output can be used to check the tuner in any TV set. In sets with the IF input soldered, just hook the cable right across the terminals. There is ample output.

Video signals, in either sync polarity are available from a separate jack. These too are variable, from 0 to 1.8 volts P-P. Both IF, RF and video outputs may be used at the same time. One novel use for this is to feed the video signal directly to one trace of a dual-trace scope and feed the signal picked up from the TV set to the lower trace input. (The signal may be fed to the TV antenna input or IF input.) This will let you use the burst signal from the video for phase checks, bandwidth and several other things in the TV set circuitry. The luminance pedestal in the color-bar pattern is a good square wave. By tracing this through the TV set's video circuitry, you can check damping, bandwidth, frequency and phase response. Works in other stages as well, of course.

(continued on page 30)

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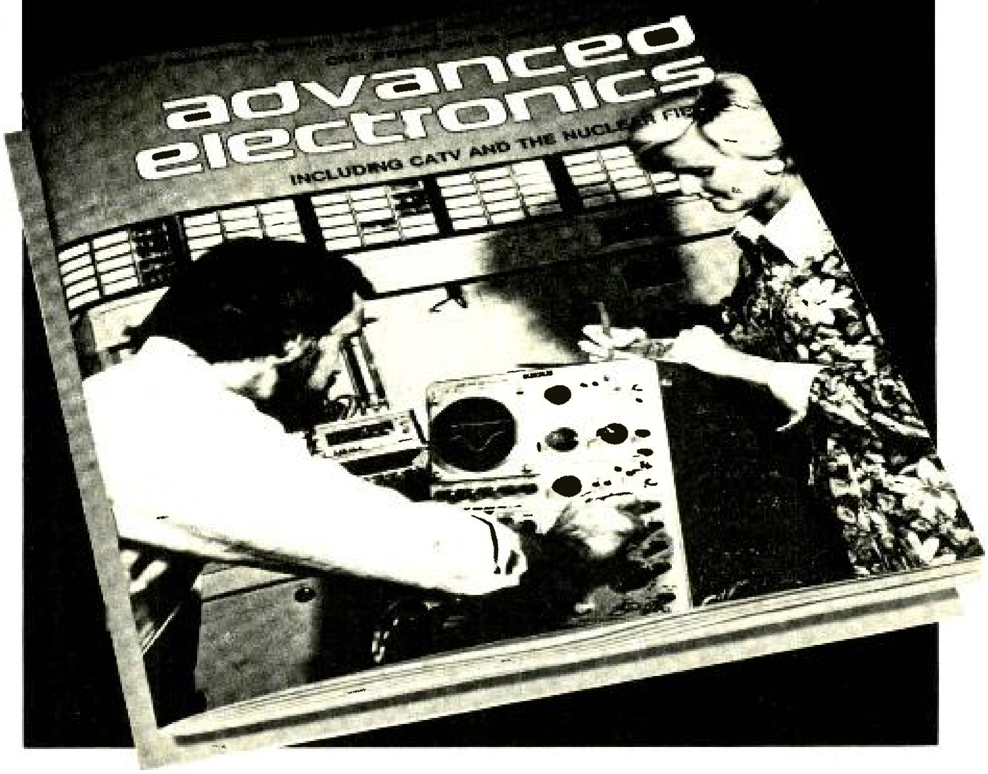

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EQUIPMENT REPORTS
(continued from page 24)

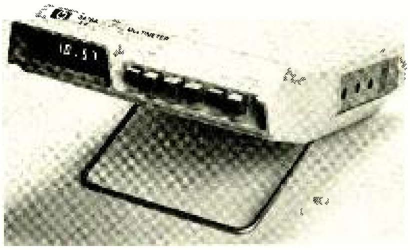
Finally, horizontal or vertical trigger signals for a scope can be obtained from front-panel jacks. For checking horizontal sync, burst, etc., use — sync polarity; for looking at the scan period of the sweep, use + sync polarity on the scope.

Before I forget to mention it, the panel and controls of the ATC-10 are an excellent example of human engineering. Knobs are large enough to get hold of, and they're all very plainly marked. The use of push-pull switches makes for a compact yet handy panel layout. Only four knobs are needed, and three banana jacks for the trigger signals. BNC connectors are used for RF, IF and the video outputs. These are at each end and out of the way.

It's a very easy instrument to use. When I first hooked it up, I obtained some very peculiar patterns! Then, I found that I had the RF cable in the video jack and that the TV set was on Channel 8. After *reading* the plainly marked panel and hooking it up right, it worked much better! Speaking of reading, you get not one but two instruction books with the ATC-10. One covers in-home servicing (including a darned good basic course in convergence!) and the other covers in-shop techniques using a scope. A great many previously difficult tests can be made with the precise patterns from this instrument—DC restoration, demodulation angle, vector-scope patterns, bandwidth, phase shift, and many more. All of these are covered in simple terms in the well-written manuals.

The instrument has a two-year warranty on it. Price is in the ball-park for an instrument that will do as many things as the ATC-10 will. The firm told me that this instrument had been field tested by several TV technicians, and their reports were used in the final design. This testing was carried on for over a year and a half period. **R-E**

Hewlett-Packard 3476A Digital Multimeter



Circle 98 on reader service card

I OPENED THE BOX AND SAID TO MYSELF "Oh, good! Someone has sent me a beautiful *shoulder purse*!" A closer look showed a modest little bug at one side and the name Hewlett-Packard. Unzipping the case, I pulled out a little light gray plastic case. This turned out to be the newest thing in portable digital multimeters; Hewlett-Packard's 3476A digital multimeter. It's not at all the conventional instrument, the case is flat and very thin. The 3½ digit bright red LED display is at one side and six pushbuttons at the other. The test leads plug into the right side of the case.

The small size is made possible by the use of new technology. This includes tantalum-nitride precision resistor networks that eliminates the need for more expensive and bulky discrete precision resistors in the dividers. The circuitry is on only one PC board although the 3476A has full autoranging capability on all of its five functions: DC volts, AC volts, DC current AC current and resistance. The decimal point and polarity indications are automatic and so is the zeroing. All you have to do is touch the test prods to the circuit and note the reading.

Ranges cover everything needed. You can read DC voltages from .0001 volt (100 microvolts!) up to 1,000 volts, and AC voltage from the same low point up to 700 volts RMS. Accuracy on DC volts is 0.5% or better; on AC volts, 0.6% or better. Current ranges, both AC and DC cover from ±0.11 A up to 1.1A. The AC volts range is rated up to 10 kHz with good accuracy.

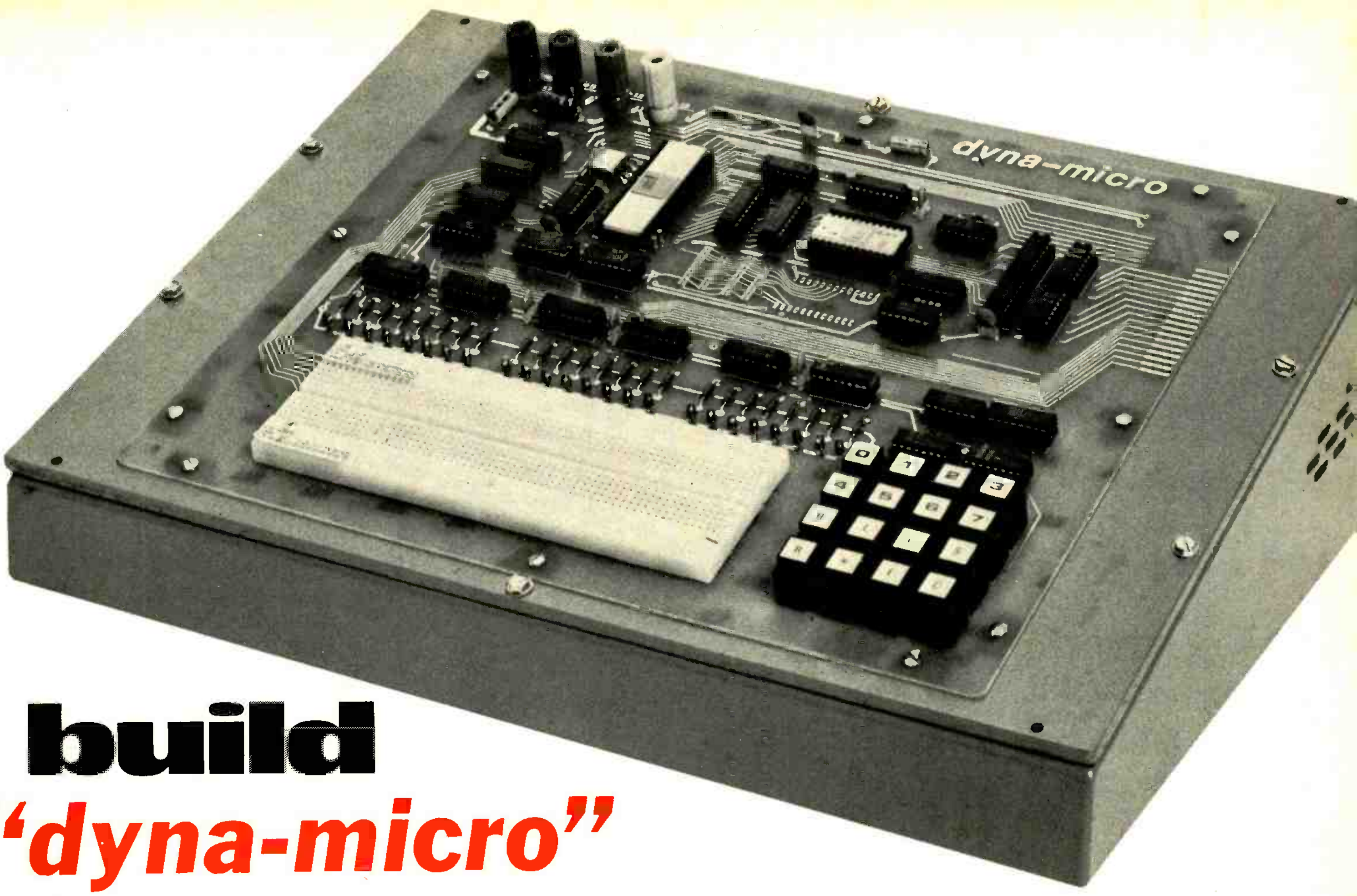
The shoulder purse turned out to be a very cleverly designed carrying case. With this, the instrument can be hung around your neck. Opening it up will let you see the display and controls. Both hands are free to do the testing. Ample space is provided to hold the instrument, test leads and accessories. It *is* a very good-looking accessory.

The 3476A is the AC-powered version and the 3476B can be powered from AC or rechargeable batteries. The power supply is the only difference.

There are several useful features built-in. Using the 3476A in the AUTO-RANGE mode, it will set itself to whatever range is needed to display the voltage or resistance across the test prods. If you want to, you can take one reading and press the HOLD button. This locks the instrument on that range so that you can take several readings around the same stage without waiting. This doesn't take too much time since it updates very rapidly, but in the HOLD position it's even faster.

Another handy though too often neglected feature is the test leads. An instrument must be easy to connect into or across a circuit if it's to be of any use. The instrument comes with a pair of stout test prods and a neat little plastic pouch that contains a whole array of different screw-in tips, clips, spade lugs, etc., to make hooking the leads to any type of circuit construction very easy. They're easy to change and they make this instrument even more versatile.

The price of the 3476A is even more impressive. It's only $225.00 for the 3476A AC version. This is quite a bit less than many other instruments with the same ratings. This has been made possible by the use of only two chips—one is the tantalum-nitride film resistor pack and the other a N-MOS control chip that does everything else! It contains the counters, buffer storage, display circuits, 3,500 bits of ROM and all of the solid-state analog switching for the autorange circuitry and so on and on. All in all, quite a piece of fine test gear. **R-E**



build "dyna-micro" an 8080 microcomputer

Complete with keyboard for data entry, LED readout of the address and data, breadboard socket for experimenting, 500-bytes of PROM and 500-bytes of RAM, expandable to 65K and self-contained power supply

JOHN TITUS

MANY EXPERIMENTERS, HOBBYISTS AND professionals are interested in learning about microcomputers and how they work, but the cost of a development system can be high and even inexpensive systems may require an expensive peripheral such as a teletypewriter to get them to work. None of the available systems have any easy hardware breadboarding capability and none have a series of experiments to teach you both interfacing and software fundamentals.

The Dyna-Micro is a complete microcomputer using the 8080A microprocessor chip. It isn't a stripped-down version of another system since it was designed specifically for the beginner. This system has been designed to teach you about microcomputers whether you're a high-school student or a digital design engineer—both will learn a great deal about computers. With the Dyna-Micro, you won't be spending your time wire wrapping a prototype or debugging a complex "hobby" system, you'll be doing hardware and software experiments to learn more about the microcomputer revolution.

The Dyna-Micro has many features that make it easy to use. These features include:

- Complete, software controlled "front-panel."
- Fully-encoded keyboard input containing 15 keys.
- Three, eight-bit output ports with LED indicators.
- Complete solderless breadboarding area that provides easy access to all the bus signals.
- 500-bytes of Read/Write memory (R/W) and 500-bytes of Programmable Read Only Memory (PROM).
- Edge connector provided for future memory expansion.

The Dyna-Micro won't run FORTRAN, BASIC, editors, assemblers or other complex software in its present form. It isn't meant for that. You can, however, expand the memory if you want to. By the time you finish the experiments, you will know how this is done.

All the Dyna-Micro functions, including the keyboard, are contained on a single 10" × 12" printed-circuit board. The power supply is external.

Using the Dyna-Micro

The Dyna-Micro is one of the easiest

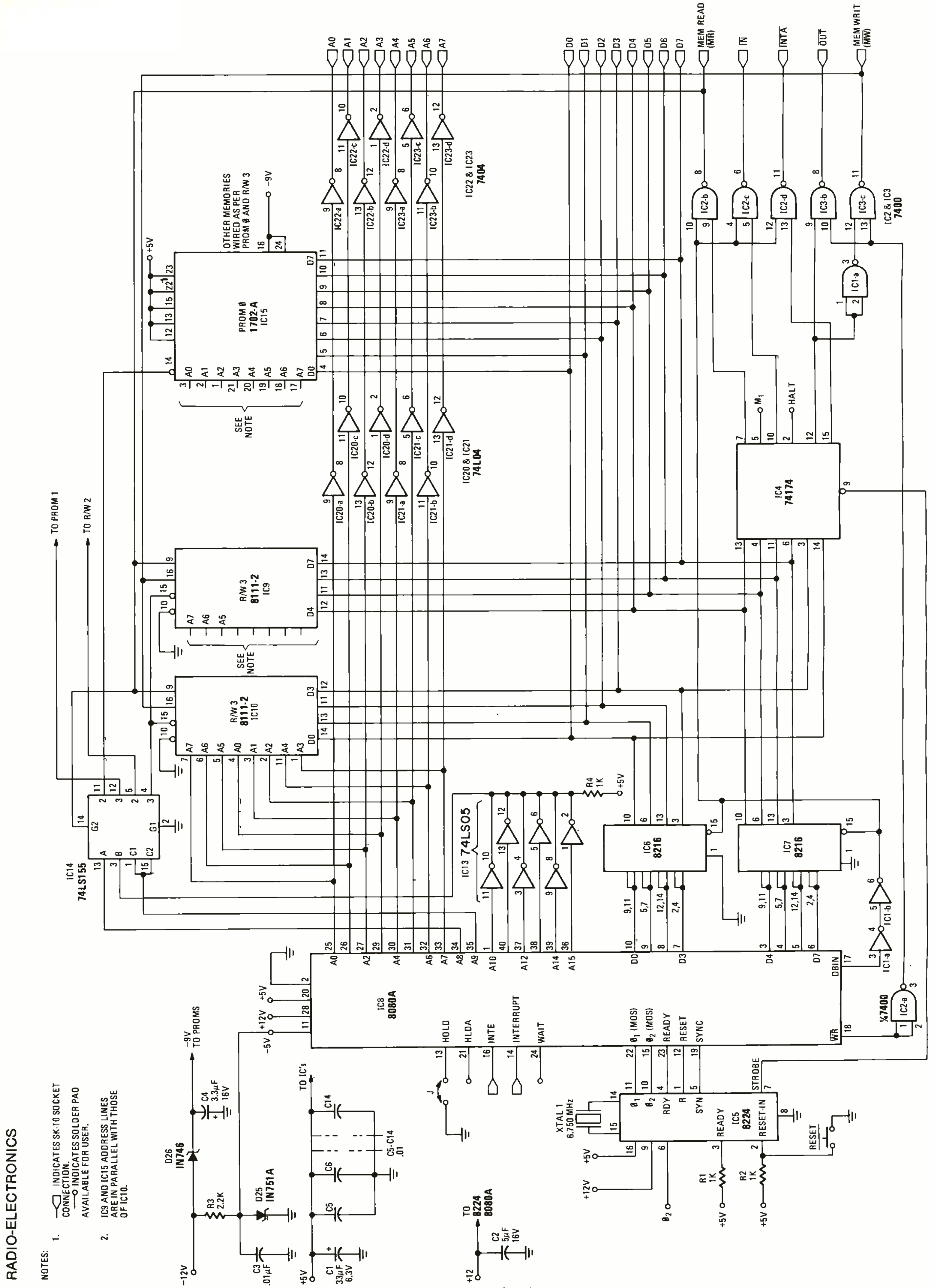


FIG. 1—CENTRAL PROCESSOR shows 8080A microprocessor and associated components. Power supply is external while voltage regulator is on-board.

to use microcomputers since it uses a software controlled "front-panel." Data is entered through a 15-key keyboard and data is displayed by LED's. The keyboard is used to enter address and memory data, to examine the contents of any memory location and to start your program from any location desired. The software to do this is preprogrammed in a 1702A PROM and is called the Keyboard Executive or KEX program.

Since the 8080A microcomputer uses 16-bits of address and 8-bits of data, the LED display registers are divided into groups of 8-bits each. The KEX program uses OUTPUT 1 for the highest 8-bits of address (HI) and OUTPUT PORT 0 for the lowest 8-bits of address (LO). OUTPUT PORT 2 is used to display data. With 16 address-bits, up to 65,536 words (commonly referred to as 65K) of memory may be addressed and added to the basic 8080 system. The Dyna-Micro uses only 1K of memory, more than enough for all the experiments and for most of your own needs when getting started. The memory is segmented, with the first 500-bytes being PROM and with the next 500-bytes being R/W. Table 1 shows how the memory is divided between PROM and R/W.

The output ports and the keyboard input are used in conjunction with the KEX program, but since they are not

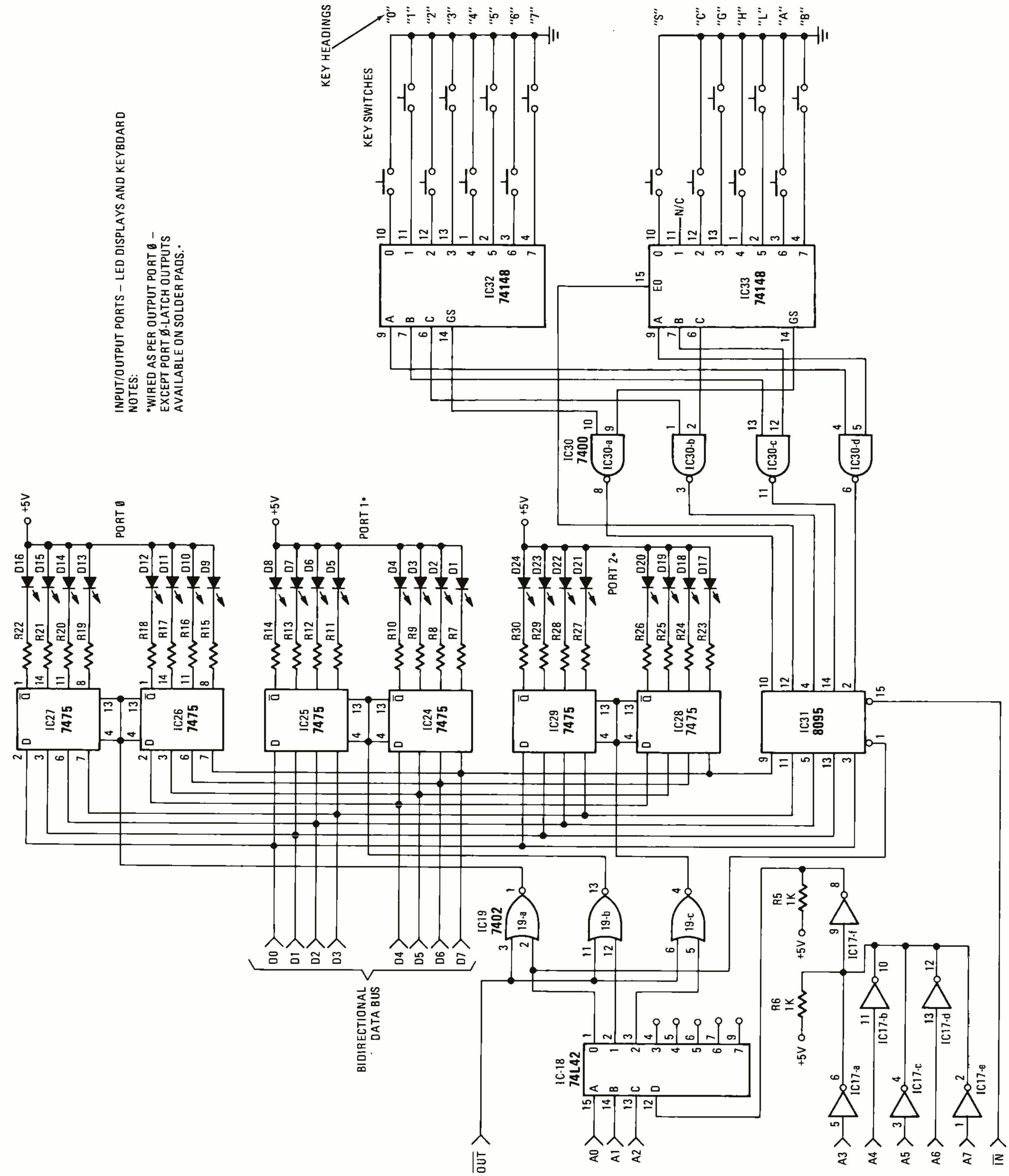


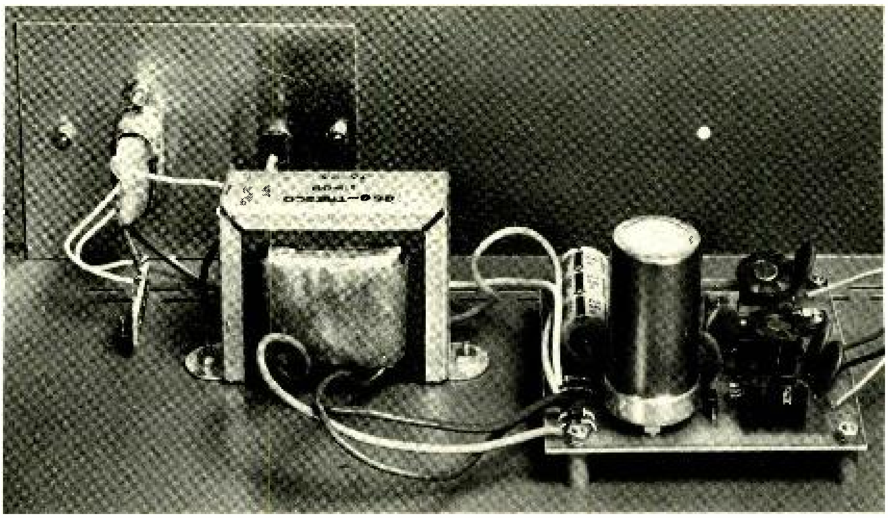
FIG. 2—INPUT/OUTPUT SECTION of the Dyna-Micro contains the keyboard and LED display.

hardwired, you can use them for data input and output with your own software. This is easily done with the software as we'll see later. Additional input and output ports are easily added by breadboarding them on the SK-10 socket or connecting them to the edge connector.

Interfacing experiments are all done on the SK-10 socket. All you will need to do the experiments are some no. 24 jumper wires and the necessary integrated circuits. No additional soldering or wire wrapping is necessary with the Dyna-Micro.

Construction

The Dyna-Micro is constructed on a single printed-circuit board and it will be built and checked-out in stages to assure proper operation. These checks are fairly simple and all that is required is a voltmeter and a means of detecting for TTL level pulses. A monostable and LED will work quite well for this purpose. An oscilloscope is not needed, but might be helpful if you have one.



THE DYNA-MICRO POWER SUPPLY provides +5 volts at 1.5 amps and ±12 volts at 150 mA. You can design and build your own or purchase assembled supplies from surplus dealers.

The schematic diagram of the Dyna-Micro is divided into two sections—the central processor unit and the I/O (*I*nput/*O*utput) section. The schematic diagram of the central processor unit is shown in Fig. 1 and the I/O section is shown in Fig. 2.

All the components of the Dyna-Micro, including the keyboard, are contained on a single 10" × 12" printed-circuit board. A double-sided board is used to minimize the number of jumper wires necessary for construction.

The power supply should be constructed first. If an assembled supply is purchased, it should be tested. The power supply must be capable of providing +5 volts at 1.5 A, and ±12 volts at about 150 mA. The power supply may be purchased from one of the many suppliers or from a surplus house. It should be ready before construction proceeds since it will be used to check the sections as we go along.

Mount the capacitors, resistor and Zener diodes in the voltage regulator section of the PC board. Be sure that the binding posts are in the upper-left corner when the board is in front of you. The +12 volts is used only by the 8080A and the 8224 crystal clock IC. The −12 volts is used by the voltage regulator circuitry to obtain the −5 volts for the 8080A chip and the −9 volts for the 1702A type PROM's. After soldering in the parts, connect the power supply and check for the voltages at the power supply to be sure that there aren't any shorts. Check for +12 volts at pin 28 of the 40-pin socket and at pin-9 at IC5 (both sockets will not be soldered in at this time). You can also check for −5 volts at pin 11 of the 40-pin socket. The −9 volts will not be present unless a PROM is in one of the sockets.

The clock circuit uses an Intel 8224 integrated circuit. This is a crystal clock oscillator that provides the proper MOS clock levels for the 8080 system. It also contains circuitry for a TTL level clock (Ø2), RESET and

(Continued on page 74)

PARTS LIST

R1, R2, R4, R5, R6—1000 ohms, ¼ W, 10%
R3—2200 ohms, ¼ W, 10%
R7-R30—220 ohms, ¼ W, 10%
C1—33 μF/6.3V electrolytic
C2—5 μF/50V electrolytic
C3, C5-C14—0.01 μF disc ceramic
C4—3.3 μF/16V electrolytic
D1-D24—Small red LED (Hewlett-Packard 5082-4484, Monsanto MV5075B, or equal.)
D25—1N751A, 5.1V Zener
D26—1N746, 3.3V Zener
IC1, IC22, IC23—SN7404 Hex inverter
IC2, IC3, IC30—SN7400 Quad 2-input NAND gate
IC4—SN74174—Quad type-D flip-flop
IC5—8224 Clock generator (Intel)
IC6, IC7—8216 Bus driver (Intel)
IC8—8080A CPU (Intel) (Must be "A" version)
IC9, IC10—8111-2 RAM memory (Intel)
IC13, IC17—SN74LS05 Open-collector hex inverter
IC14—SN74LS155 Dual 2-to-4 line decoder
IC15—1702A PROM memory (Intel)
IC18—SN74L42 BCD to decimal converter
IC19—SN7402 Quad 2-input NOR gate
IC20, IC21—SN74L04 Hex inverter
IC24-IC29—SN7475 Bistable latch
IC31—DM8095 or SN74365 Buffer
IC32, IC33—SN74148 8-to-3 line priority encoder
S1-S16—Keyswitches with legends
XTAL—6.750 MHz crystal, HC-18/U holder
Solderless breadboard—SK-10 IF18
Chassis—10" x 12" x 3" (Bud type AC-413)
Misc.—Binding posts, IC sockets, hardware
Optional IC's for expanded memory
IC11, IC12—8111-2 RAM memory
IC16—1702A PROM memory

Keyswitches are available from Solid State Systems, Inc., P.O. Box 617, Columbia, MO 65201. Order type LM or LFW-LT, with legends shown in Fig. 7.

Breadboarding socket is available from Circuit Design, Inc., Box 24, Shelton, CT 06484.

Power supplies are available from ....

The following kits are available from Circuit Design, Inc., Box 24, Shelton, CT 06484. Phone 203-735-8774. All kits, except MMD-1IC, MMD-1 PROM, and MMD-1 RAM come complete with construction details, experiments, and tutorial material.

#MMD-1CBK—Etched, plated-through PC board, keyboard parts and breadboarding socket. $125 postpaid.

#MMD-1K—Complete kit of parts including 1702A PROM preprogrammed with KEX software. $350 postpaid.

#MMD-1A—Completely assembled and tested system. $500 postpaid

#MMD-1IC—Microprocessor IC set includes one 8080A CPU, one 8224 clock generator, two 8216 bus drivers, two 8111-2 RAM memory, one 1702A PROM preprogrammed with KEX. $100 postpaid.

#MMD-1 PROM—Additional 256-word PROM (1702A). $40 postpaid.

#MMD-1 RAM—Additional 256 words of RAM (8111-2). $15 postpaid.

A user's group has already been formed for the Dyna-Micro. Interested people should contact:
Dr. Frank Settle, Jr.
Digital Directions
Box 1053
Lexington, VA 24450

understanding MATV accessories

There's a lot of individual parts in a MATV system. Here we look at the most important ones and see what it is that they do and how best to use them

WARREN ROY

THERE ARE MORE THAN 30 DIFFERENT kinds or categories of equipment that go into a MATV system. The individual items vary from antennas and rotators, to distribution amplifiers and power supplies, to connectors and cables. You need every one of these items to assemble a complete working system. In this article we will take a look at the more common elements; discuss their important characteristics and applications; and try to provide some guidelines to us when buying them.

Start at the top

We'll start with the antenna, the top of the iceberg in a MATV system. For the purposes of this article we'll look at broadband antennas as opposed to the single-channel antennas used in some systems. The single-channel approach works well where the stations to be received lie in different directions from the receiving antenna or where the signal from one station is much stronger than another. But in many systems a single broadband antenna is all that is needed.

The antenna selected must provide adequate signal levels for all of the channels to be received. Obviously, the further the antenna is located from the transmitters, the more gain, and therefore the more elaborate it must be. Most antenna manufacturers provide a full range of antennas to cover all possible circumstances. We suggest that you get an antenna that exceeds the minimum requirements. In other words, get an antenna that's one step better than you need.

Almost all modern antennas are made of aluminum and are anodized or otherwise plated or coated to protect against corrosion. In most instances a VHF/UHF antenna will do the job. But if there are no active UHF channels in your area, you can use a simpler and less costly VHF-only antenna. When using either a VHF only or a VHF/UHF antenna there is one possible complication. Does the antenna cover the FM radio band or does it drop out those signals? If your customer wants FM reception, obviously you'll have to use an antenna that does provide that coverage.

Preamps fight snow

Preamps for weak signals are a must in many fringe areas. The preamp should be mast mounted and provide a lot of gain. At the same time it must have a low noise figure. Preamps are available that provide one wide-band amplifier or as many as three separate amplifiers in one package. The separate amplifier approach offers the benefits of greater reliability and protection from strong signal overloads. Since noise is the most important specification in a preamplifier, make sure you select one with the lowest noise figures you can obtain.

One important point to remember. A preamp can improve a snowy picture by reducing fading and loss of color and compensating for losses in the transmission line. But it cannot make a poor picture perfect.

Since the preamp contains a transistor amplifier it also requires a source of dc power. This is frequently provided by a separate power supply, located inside the house, that feeds the needed voltage up the transmission line to the amplifier. Older units may require a separate power supply connection, but this type unit is almost never seen any more.

By selecting a preamp that also converts a 300-ohm input to a 75-ohm output you can kill two birds with one stone–amplify the signal and reduce snow in the picture and match the antenna to the coax cable of the antenna system at the same time.

Filters and traps

Filters and traps are used in the head-end of many MATV systems to eliminate undesired signals and provide interference-free signals. A wide variety of equipment is available. Some are fixed, others are variable. The fixed ones are designed to cover a specific frequency range, such as individual television channels. The variable type can be tuned to any given frequency in its range.

Traps and filters

Bandpass filters permit the desired range of frequencies to pass through unobstructed, yet severely attenuate all other signals. The ideal filter has sharp slopes that make it possible to attenuate even nearby unwanted signals.

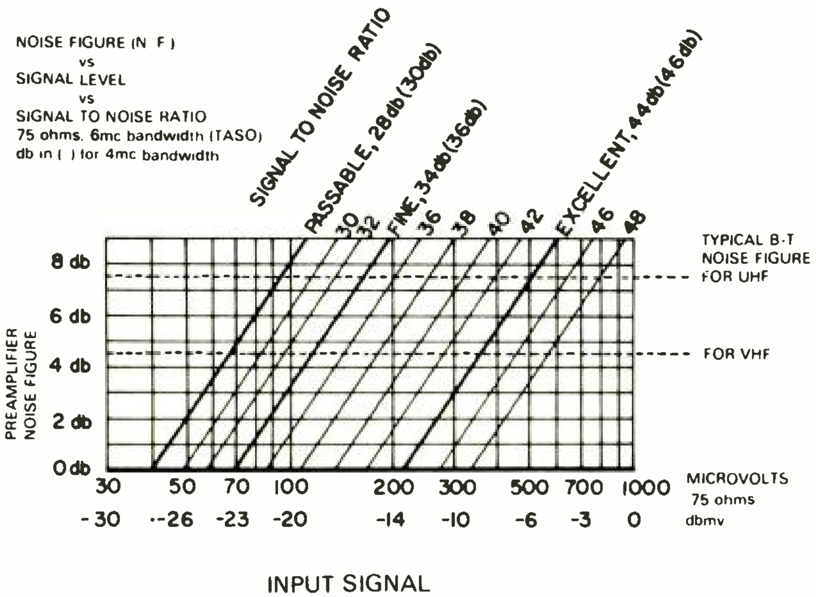
Traps are actually the opposite of a bandpass filter. They are designed to attenuate some specific undesired frequency. A good trap must have a high Q, making it extremely selective. The more selective it is, the better it can eliminate the undesired frequency without having any great effect on the wanted signals.

System amplifiers

The more sets you have connected to an antenna system the more signal you need to feed them all and have them deliver clear snow-free pictures. Remember, no matter how good the antenna itself is, there is a finite limit to how much signal it can pick up. When the demands on the system exceed this, we must use an amplifier to make up the difference. The amplifier also compensates for losses caused by the coaxial cables used in the system.

While these amplifiers are selected to deliver enough gain to operate the system, an equally important operating parameter is the noise figure of the amplifier. Amplification must be relatively

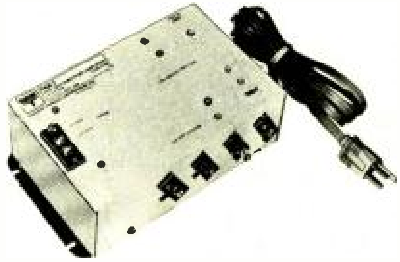
BOOSTER MOUNTS ON MAST and connects between lead in and transmission coax. In typical installations the antenna should be mounted further above the chimney.



Signal-to-noise ratio, noise figure and signal level are interrelated as shown on the nomograph.

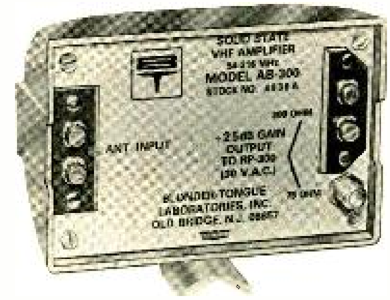
Anybody working in TV knows that snow (noise) can be seen in a TV picture when antenna signals are low, one can also see that snow increases gradually as the signal level is decreased, and that it is a matter of personal judgment when the snow is so bad as to render a picture unusable. The industry some years ago got together and showed TV pictures to a large group of average people asking them to rate picture quality in the presence of noise. Out of this study came the TASO (Television Allocation Study Organization) report with the finding that a signal to noise ratio of 34 db means a fine picture to an average viewer, a 28 db ratio means a passable picture and so on.

The TASO study used a bandwidth of 6 MHz, some people now favor a bandwidth of 4 MHz, (the difference is indicated on the nomograph) however, this is of minor importance to most users of the graph.



TYPICAL DISTRIBUTION AMPLIFIER provides four separate outputs. Watch the noise figure when selecting one of these.

REMOTE POWER SUPPLY feeds amplifier operating voltage right up the TV transmission cable. This approach is the most common one.



MAST MOUNTED VHF amplifier offers either 300-ohm or 75-ohm outputs. Normally, you would use the 75-ohm output.

noise free or the result will be worse than what you have without any gain at all.

About splitters

The first piece of equipment we encounter next is the splitter. The coaxial cable that carries the signal from the distribution amplifier toward the set is called the main trunk line. Some MATV systems have only a single trunk line, but it is much more common and practical to find that the signal is separated into individual lines that run directly to the sets in various parts of the house.

This kind of splitting usually requires a two-, three- or four-way splitter. Even if the plans call for only two outlets it may be wise to use a three-way splitter so that you can easily add another outlet at some later date. In strong signals areas use back-matched splitter/mixers. Back-matching provides a good match for reverse current flow, minimizing the possibility of signals re-entering the system.

REMOTE POWER SUPPLY is typical of this type unit. It provides DC for the transistor circuitry in the preamp.

Tapoff styles

The tapoff delivers the signal from the distribution lines to the TV sets. At the same time it keeps the sets from interfering with each other. Each set in a MATV system ideally gets about the same amount of signal, but there will be more signal available at outlets that are closer to the distribution amplifier than at outlets that are further away. By using variable-isolation wall tapoffs, it is relatively easy to balance this difference in signal strength out.

In most applications four types of tapoffs are most commonly used: the wall tap, the line drop tap, the directional coupler and the pressure tap.

The wall tap is the one that you are the most likely to see and use as part of an MATV system. It is used in much the same way as an electrician uses an AC outlet. In a new building, the distribution amplifier runs inside the wall and the tap is mounted in a standard electrical box inside the wall. In existing buildings it is not always possible or practical to snake transmission coax through the walls and in these instances the distribution coax can be run along the baseboard or the surface of the wall. The tapoff is then enclosed in a special surface-mounting housing.

DISTRIBUTION AMPLIFIERS are usually located inside the building and provide up to four outputs.

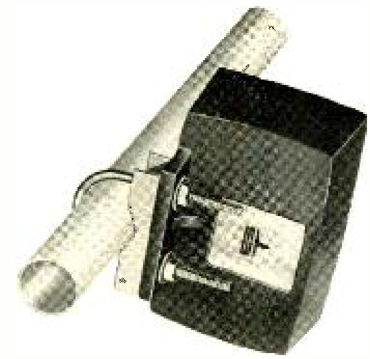
Wall taps

Three types of wall taps are available. There's a 300-ohm outlet, a 75-ohm outlet, and a dual outlet. The correct one to use depends on two factors: the number of outlets required per room and the signal strength in the area.

Generally, it is best to use a 75-ohm output with a matching transformer. In strong signal areas the 300-ohm line between the outlet and the set will pick up signals directly and can cause ghosts, and interference. Using coax cable and 75-ohm outlets prevents this since the cable is shielded from direct signal pickup.

In some systems you will have to provide an outlet or outlets for both television and FM. In these instances you'll want to use a dual 300/75-ohm tapoff. The 75-ohm section is used for TV and the 300-ohm section for FM.

THIS SPLITTER AMPLIFIER provides three television outputs and one FM output. It works from 75-ohm coax.



MAST MOUNTED PREAMPS and matching devices are usually housed right on the mast, and close to the antenna.

Line drop taps

The line drop tap is used in attics and crawl spaces. Each line-drop tap provides up to four drop lines to carry the signal to the set. The drop lines can be run directly to the set and the matching transformers or they can be run to a O-dB wall tap. The line-drop tap is most commonly used in schools, motels, and hospitals.

The pressure tap is used outdoors where distribution lines are strung between poles, under the gables of apartments or other external systems.

The circuitry inside directional couplers incorporates design techniques that assure excellent impedance matching at all terminals, high accuracy of coupling and low insertion loss. Directional coupler tapoffs provide attenuation of 40 to 60 dB to signals leaving the line and returning because of receiver mismatch or disconnection.

This directional coupler circuitry is available in line tapoff configurations with one, two or four taps to the line.

Band separators

These devices are used in all channel (UHF/VHF) MATV systems to separate the UHF signal from the VHF signal before it is fed into the TV set. Unlike splitters that divide the signal equally, band separators contain circuitry to separate one band from another.

Terminators

The end of each 75-ohm distribution cable must be terminated with a 75-ohm resistor to prevent signals from traveling back up the line and causing ghosts on the individual TV sets.

That about wraps up our coverage of the important elements of MATV systems. We did not cover every item, but did look at the important ones, and the part that they play in a total system. **R-E**

The function generator is now occupying more service benches than ever before. This series of articles will cover the fundamentals, specifications, operation and applications of this instrument

all about function generators

CHARLES GILMORE*

INTRODUCED TO THE LABORATORY IN THE 1950's as a multi-thousand-dollar instrument, the function generator had dropped in cost to a $250-plus product by the early 1970's. This generator has always been a popular laboratory signal source because of its numerous waveforms (sine, square, and triangle being the most popular), its low output-impedance, its wide frequency range, and versatile frequency control. The past year has seen function generators in the $100 range introduced. These will be serious contenders for the slot on the service bench now filled by the classic sine-wave oscillator. That instrument may soon be relegated to high-precision audio testing where ultra-low distortion (below 0.05%) is required. The standard bench generator will then be a function generator covering the 0.1-Hz to 1-MHz range or more and providing at least, sine, square, and triangle waveforms.

Fundamentals

The function generator produces waveforms very differently from the classical sine/square oscillator. In classic higher-frequency instruments, an L-C circuit is used in the basic oscillator. Square waves are obtained from squaring circuits acting on the sine wave. If low-frequency waveforms are desired, the twin-T R-C oscillator or some other variation of an R-C oscillator is usually employed. The function generator's requirement of an extended frequency range is not easily met by either of these two classic circuits.

This new generator must span from millihertz (thousandths of a hertz) to megahertz, and has evolved through a completely different technique. Note we are discussing a generator, as opposed to an oscillator, which implies a basic sinusoidal source. A simple block diagram of the function generator is shown in Fig. 1. The circuit's uniqueness is apparent on first inspection. The signal source itself is not a sinewave oscillator but a triangle generator. After passing the triangle through a special circuit (called a sine shaper), a sinewave of ½ to 2 percent total harmonic distortion is produced.

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The heart of the function generator is the triangle generator, the design of which is based on the special voltage-time characteristics of a capacitor charged by a constant-current source. Fig. 2-a shows the well known voltage-time curve on a capacitor when charged through a resistor from a constant-voltage source. Fig. 2-b shows the voltage-time curve of a capacitor charged from a source of constant current. If there is no stray resistance across the capacitor (usually ensured by using extremely low-leakage capacitors), the voltage across the capacitor increases linearly as time increases. Obviously, this curve may be reversed. As shown in Fig. 2-c, if the capacitor is discharged at a constant current rate, a linearly decreasing voltage will be produced.

A triangle generator may be created by first charging a capacitor with a constant-current source until a desired positive peak voltage is reached. At this point, the charging constant-current source is turned off and a discharging (oppositely polarized) constant-source is turned on. When the voltage across the capacitor is reduced to the desired negative peak by the discharging constant-current source, this source is turned off and the charging source is again turned on. The voltage across the capacitor will again begin to increase. The waveforms associated with this operation are shown in Fig. 3. A level-detecting circuit that monitors the triangle amplitude signals the reversal of the constant-current generators when the desired peak positive and negative voltages are reached. The output of this level-detecting circuit is used as the wave source.

Note that the phase relationship of the square wave is constant with respect to the triangle wave and is 90° out of phase with the triangle wave zero crossing.

In practice, one or two switched current sources may be used. For example, if the charging constant current source has a current I, and the discharging current source has a current —2I, only the discharging current source need be switched. As the capacitor is charged, with the discharging current source off, the rate of charge will be determined by the current I. When both current sources are on, the net current will be

$$I - 2I = -I;$$

thus the rate of discharge will be exactly opposite and equal to the rate of charge.

At any point in time the voltage across the capacitor is given by

$$E = (T \times I)/C,$$

E (volts) is the voltage across the capacitor, T (seconds) is the time of charge, I (amperes) is the charging current, and C (farads) is the value of capacitance being charged. Rearranging this expression, we have

$$T = (E \times C)/I$$

which gives the time for either the positive or negative slope of the triangle wave.

This expression shows that two parameters control the time required to reach a desired limit voltage *E*: C and I. The greater the charging current, the shorter the time; or the smaller the capacitor, the shorter the time. In most function generators both variables are employed. The capacitance is varied for purposes of range changing, usually in decade steps. The current amplitude is continuously varied by the front panel dial. Frequently this current can be varied by as much as a thousand to one, giving a wide range of frequency control to the front panel dial without a change in the RANGE (capacitor) setting. The upper frequency limit is determined by the maximum current available from the current source and the minimum value of the range capacitor.

At the lower frequency limit, the lowest

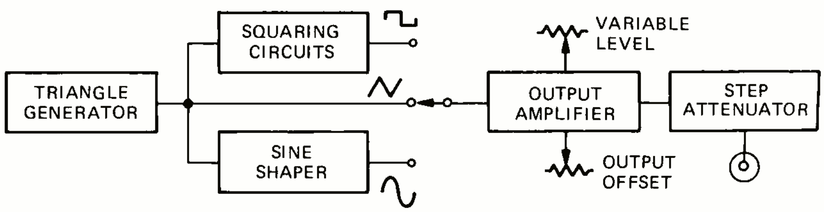


FIG. 1—FUNCTION GENERATOR, BLOCK DIAGRAM. A TRIANGLE WAVE generator is the basic signal source. Sine and square waves are produced from it by shaping.

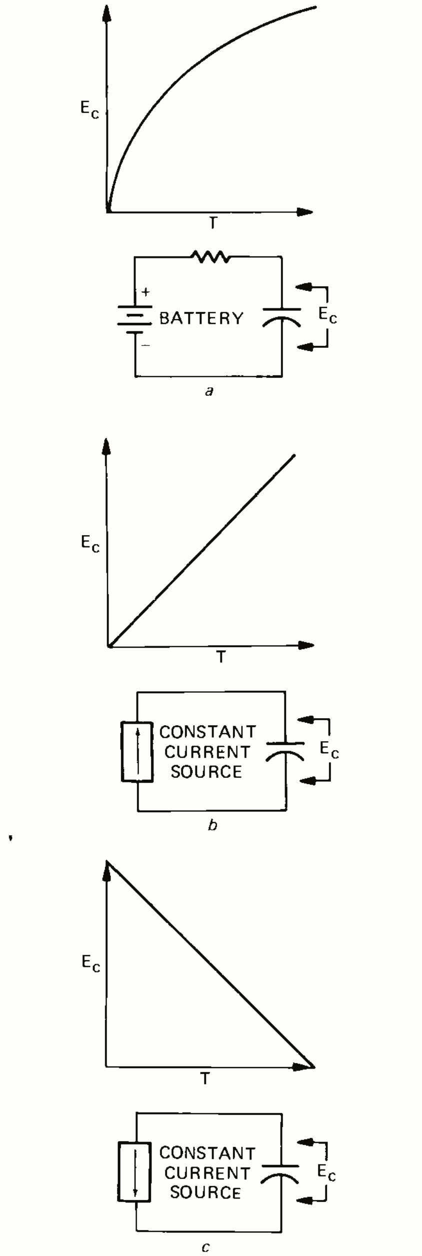


FIG. 2-a—CAPACITOR VOLTAGE WHEN charged from a constant voltage. 2-b—Same capacitor charged from constant current source. 2-c—Discharge curve at constant current rate.

feasible current that may be reliably drawn from the current sources and the largest range capacitor determine the frequency. This large capacitor must still be of extremely high quality to preserve the linearity of the triangle waveform. As an example, presume the constant current generators may be varied over the range of 1 microampere to 1 milliampere (1,000 μA), the largest capacitor is 5 μF, and the limit voltage is 10. Using the expression $T = (E \times C)/I$:

$T = (10\ V \times 5\ \mu F\ /\ 1 \mu A = 50$ Sec. But this is only the time for the positive slope. To complete a triangle wave, a negative slope must be generated as well. The time or period of the triangle becomes twice the above calculated rate, or 100 seconds. A cycle that has a period of 100 seconds has a frequency of 0.01 Hz or 10 millihertz.

To reach the highest frequency, a much smaller capacitor is chosen, but the same 10 volt limit is used. Assume a 50 picofarad (0.00005 μf) capacitor. Using the same formula gives

$$T = (10V \times 0.00005\ \mu F)\ /1000\ \mu A = 0.0000005 \text{ sec.}$$

or 0.5 microsecond. Again, this time must be doubled to arrive at the period of the triangle wave. This gives a time of 1 microsecond or a frequency of one megahertz. Thus, in this example the generator has an operating range of 10 millihertz to 1 megahertz or 100 million to one.

As the basic waveform is not a sinewave, the sinewave must be synthesized by some form of circuitry. The usual method of creating the sinewave is to shape the triangle wave with a circuit called a sine shaper. A simplified schematic diagram of a sine shaper and the associated waveforms is shown in Fig. 4. The technique is to increase the load on a high impedance triangle source as the level of the triangle waveform increases, thus distorting the triangle wave to approximate a sinewave with a series of straight line segments.

At levels below E1 (see Fig. 4), none of the diodes conduct and this portion of the triangle waveform is passed through the shaper undistorted. As the voltage level of the triangle wave reaches and exceeds the value E1, diode D1 conducts and the triangle source, of resistance R, is loaded by resistance R1. As the output voltage of the source continues to increase, diode D2 will conduct when the output voltage exceeds

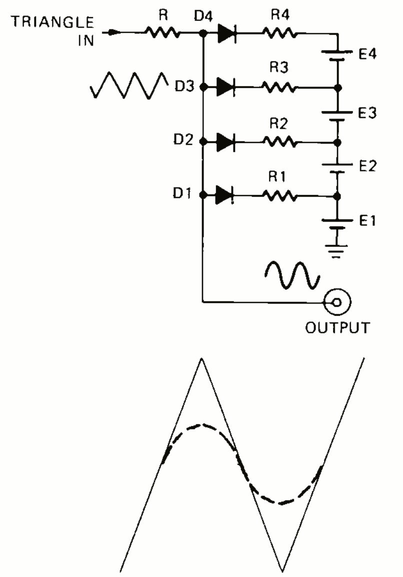


FIG. 4—THE WAVE SHAPING CIRCUIT that makes a sinewave from a triangle wave.

E2. When diode D2 conducts, the triangle source is now loaded by the parallel combination of R1 and R2. This increased loading further reduces the amplitude of the triangle source and further decreases the slope of the wave. This process continues until all diodes are conducting and the triangle source is completely loaded. As the triangle reaches its peak and reverses, the action of the sine shaper is reversed. As each diode stops conducting, the load on the triangle source is decreased.

The number of diodes determines the number of break-points shaping the sinewave, and so determines the purity of the wave. Typically, function generators are not known for their ultra-low distortion, and total harmonic distortion figures of 0.1 to 3 per cent are common. Note that figures of this order are usually quite acceptable for all but the most exacting audio work. Fig. 5 shows a typical aberra-

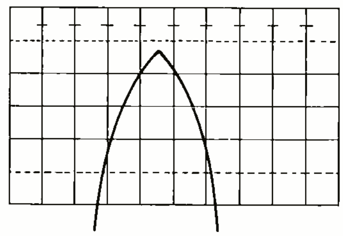


FIG. 5—THE MANUFACTURED WAVE departs somewhat from perfect sinewave form.

tion the sine shaper leaves at the crest of a sine wave. Such a peak will not substantially increase the total harmonic distortion of the sine wave, but may be quite noticeable when the waveform is viewed on an oscilloscope.

Referring to the simple block diagram, (Fig. 1) the three waveforms are selected by a waveform selection control and then applied to the output amplifier. This amplifier is somewhat more sophisticated than those in the output stages of the simple sine/square generator. As a typical amplifier must pass a square wave of one megahertz or more, its bandwidth must be nine to ten times that value.

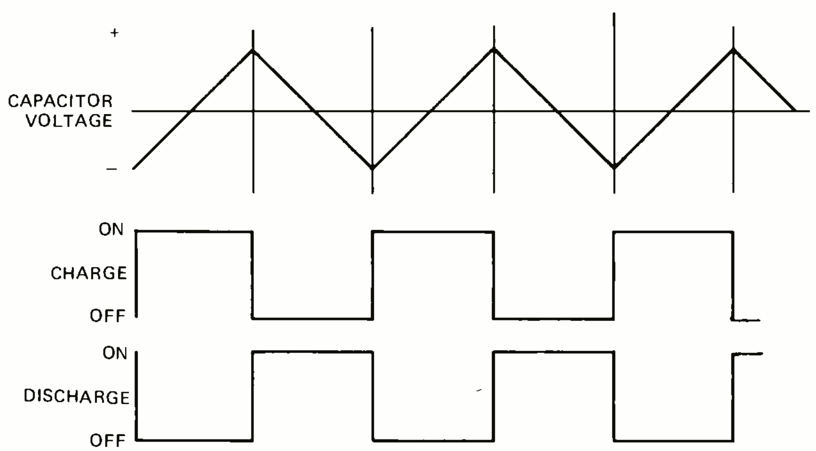


FIG. 3—VOLTAGE ACROSS CAPACITOR *vs* time is shown in top waveform. The bottom waveforms are those of the constant-current generators that produce the triangle wave.

Generally, an amplifier of fairly high gain, reduced by negative feed back, is used to obtain the low output impedance required of a function generator. Not only must the amplifier pass frequencies in the tens of megahertz, it is also required to faithfully reproduce signals whose frequencies are in the milli or microhertz region. This requirement dictates a DC-coupled amplifier.

Other frequent requirements for these amplifiers are: 10-volt peak-to-peak output into 50 ohms (2 watts); 20-volt peak-to-peak output into an open circuit; and short-circuit protection. Often a user-variable DC voltage is combined with the waveform entering the output amplifier so the user may add a DC bias or offset to the signal. The output amplifier is usually followed by some form of attenuator to decrease the output signal amplitude to a desired value. Generally, variable level controls are placed before the output amplifier and step attenuators are placed after it.

What has just been described is basic to most function generators; however, the function generator is commonly adorned with an abundance of "neat" features that vary from one manufacturer to another. Usually these features involve modifications to or additional controls on the triangle generator to produce such effects as swept frequency operation, variable symmetry waveforms, voltage (external) control of the oscillator, gated bursts, single cycle, and triggered start points.

Specifications

A common ground of understanding about specifications used in reference to function generators is needed before comparisons can be made. As in any complex instrument, the specifications that elaborate on the basic device are those that enable the user with a thorough understanding to obtain maximum usefulness from his purchase. Of course, a solid understanding of the basic specifications is also helpful when attempting to utilize even the simplest function generator.

Frequency range

As noted previously, the frequency range of function generators is controlled by two variables, the range selector and a continuously variable front panel dial. Typically the range control will be in decade steps, although some lower-cost generators have used steps that are a factor of 100. The specified frequency range for the generator will usually be from the lowest frequency that may be obtained (variable dial set at its lowest point and the range switch set in the lowest position) to the highest frequency that may be obtained (controls in the opposite settings). When selecting a generator for its low-frequency capability, the low-frequency limit should be considered, as the accuracy of the frequency setting at the low-frequency point will be rather poor. Frequency range specifications for the function generator will also note the frequency ratio given by the variable dial. Common ranges of control are 10:1, 100:1 and 1000:1. 1000:1 is popular, especially as it permits sweeping the complete audio range of 20 Hz and 20 kHz without step range changes.

Frequency stability, accuracy

Frequency stability is usually given for two different time spans. A short-term specification will be given for some time period such as 10 minutes, and long-term stability will be given for a period of 24 hours. Frequency stability specifications may be deleted on lower cost function generators.

The accuracy of the frequency setting is usually given as a percentage of full scale. For example, a genearator with a frequency accuracy rated at 3% of full scale is set on the X1K range. The variable dial has a 100:1 range, (0.1 to 10), and the dial is set at the "1". The generated frequency will be 1 kHz ± 300 Hz (3% of full scale setting of 10 kHz). The "0.1" setting on the dial yields a frequency of 100 Hz ± 300 Hz! The accuracy is often specified only over the first decade, with the additional decades strictly for wide manual frequency control.

Frequency control (external)

In addition to the variable dial and the range switch, many function generators offer frequency control from an external voltage source that duplicates the variable dial. Such an external control is known as a voltage controlled generator (VCG). A controlling voltage (such as 1 to 10 volts) is specified for the specified range of frequencies.

The maximum rate at which the VCG may be controlled is specified by the —3dB bandwidth of the VCG circuits as well as the slew rate specifications, which tell the maximum rate of change at which the VCG can be operated. The VCG specification indicating the degree of match between the theoretical frequency of the generator and the actual frequency caused by the controlling voltage is called VCG linearity. VCG linearity is usually expressed as a percent of maximum control voltage. The input impedance of the VCG is often in the one to ten-kilohm rannge.

Swept frequency mode

On more sophisticated function generators, a second generator with a sawtooth waveform which will give swept-frequency operation of the main generator, may be included. When this feature is present, the sweep generator will have a frequency range of its own, although its range is not usually as wide as that of the main generator. Frequently the rate of this generator will be given in time rather than in frequency, to assist in its use as a time base.

Other generator controls

Another control found on function generators is one to trigger the start of a single cycle externally. Some generators having trigger capability also have the ability to trigger a single cycle and define the phase of the start point with a level control. This allows the user to start the wave from at +90°, for example. The ability to gate permits the generator to output an integral number of cycles of the desired waveform during the presence of a DC gating signal. Gated cycles of the generator start and stop at zero crossing, usually on the positive-going slope of the triangle waveform.

Generators having a subgenerator for sweeping purposes may have a multiple cycle or burst mode. In this mode, the period of the subgenerator gates the main generator, again producing an integral number of cycles.

Sine wave harmonic distortion

The major specification applied to the sinewave output of a function generator is the total harmonic distortion (THD). THD will frequently be specified over a limited frequency range (such as 20 Hz to 20 kHz), as the ability to measure THD above a few hundred kHz and below a few Hz is limited. A specification indicating that all harmonics are below 30 dB, for example, may be given for frequencies above 100 kHz.

Triangle linearity

Triangle linearity indicates the degree to which the positive or negative slopes of the triangle waveform conform to a perfect straight line, and is given in one of two ways. The manufacturer may specify a triangle linearity of 95%, indicating the triangle waveform will not deviate from a perfect waveform by more than 5% of the full scale value. Other manufacturers specify maximum nonlinearity. A maximum nonlinearity of 5% would be the same specification as a 95% linearity specification. High degrees of linearity (1% to 0.5%) are obtainable at a price, but 5% nonlinearity is sufficient for most applications.

Square wave rise and fall

The rise and fall time of a square wave is defined as the time required for the wave edge to travel between its 10% and 90% voltage points. The rise and fall times lie in the 100-nanosecond range for 1-MHz generators and may be as fast as 10 nanoseconds on 10 to 30-MHz function generators. Rise and fall times will be consistent across the generator frequency range.

Time symmetry

Time symmetry specifies the time match between the positive and negative-going slopes of the triangle wave. Any deviation from a perfect match will cause some increase in total harmonic distortion of the sinewave and will effectively add DC offset to the sine, square, and triangle waves. Time symmetry is not specified in the same manner by all manufacturers. A specification of 2% time symmetry indicates the symmetry of the waveforms is such that the duty cycle of the positive pulse of the square wave will not be less than 48% nor more than 52%. This is alternately specified by noting that two of the narrowest pulses (positive or negative) would make up at least 96% of the period of the cycle.

Vertical precision or flatness

Another important feature of the function generator is the inherent flatness of the output amplitude. Flatness indicates the maximum variation in output amplitude with variations in frequency, including range changes. With the exception of the uppermost range, most function generators give flatness specifications in the tenths of a dB. Frequently the uppermost frequency range of the sinewave output

(continued on page 88)

Linear Phase Response

A new parameter for measuring speaker system performance that is gaining acceptance.

by LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

ANYONE WHO HAS EVER CONNECTED A pair of speaker systems to a stereo amplifier knows they need proper phasing. If the stereo pair is connected out of phase, we know that one speaker cone (or set of cones in a multi-driver system) will "push" air while the other "pulls". The result is a combination of loss of apparent bass and of vague positioning of instruments in the stereo sound field. The reason for the loss of bass is fairly obvious. Since low, bass tones are fairly non-directional (bass sound seems to fill a listening room rather than originate from a pin-point location), when recordings are made the left channel microphone or microphones pick up as much of the bass energy as the right channel mikes. In reproduction, both speakers are expected to deliver approximately the same bass energy. If the bass tones coming from one speaker are out of phase with those coming from the other, the wave fronts tend to cancel each other and there is a noticeable absence of bass in the reproduced music.

But what about the other effect? Why—when speakers are out of phase—do we find it difficult to pin-point instrument locations in the reproduced music? Despite early studies (which suggested that the human ear is not sensitive to "phase errors" in complex waveforms) an increasing amount of recent evidence suggests that, indeed, phase linearity (or, more simply, correct relative time relationships of all tones and their harmonics) is a necessary ingredient of true high-fidelity sound reproduction. It is simple enough to insure that left and right speaker systems are operating "in phase" (there's a 50-50 chance of correct connection to begin with, and if you suspect an out-of-phase connection you just reverse the wires to one of the speaker systems). But there's much more to "phase linearity" than that. Remember, most modern high-fidelity speaker systems consist of two or more drivers. We have woofers, tweeters, and in some cases mid-range drivers as well as super-tweeters, each attempting to reproduce a given portion of the audio spectrum. How about the phase relationship between these various drivers *within* a given speaker system?

Some manufacturers have come to the conclusion that the various speaker elements in a multi-driver system must be arranged so that all audio frequencies arrive at the listener's ear in correct time (or phase) relationship. The very nature of woofers and tweeters makes this difficult if all drivers are mounted on a common baffle, in a single plane, as illustrated in Fig. 1. Because the woofer cone is deeper than that of the tweeter, sounds produced by the woofer arrive at the listener's ear a fraction of a second later than those produced by the tweeter. Some manufacturers (such as Dahlquist in their DQ-10 design) have sought to compensate for this by

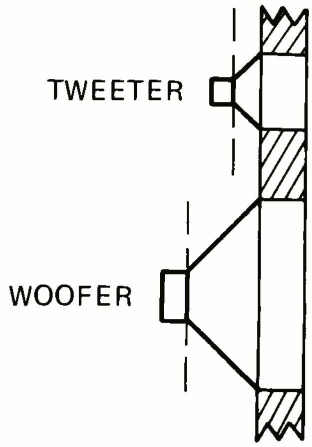


FIG. 1—DIFFERENT CONE DEPTHS of woofer and tweeter cause the two wave fronts to reach the ear at different times.

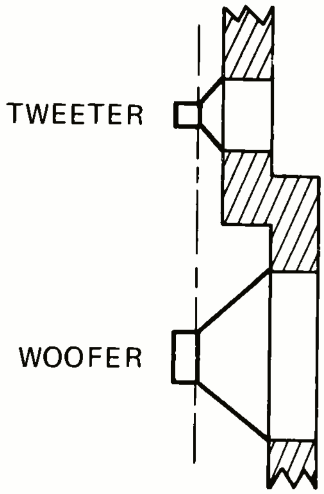


FIG. 2—OFFSETTING THE SPEAKERS is a way some manufacturers try to improve phase linearity between woofer and tweeter.

positioning the various drivers on different surfaces or planes, as illustrated in the diagram of Fig. 2.

What of the crossover network?

Recently, I had an opportunity to visit the well known Danish electronic firm of Bang & Olufsen. There, certain additional facts regarding phase distortion in speaker systems were brought to light most dramatically. Much of what follows is based upon original research by the famous acoustical engineer Erik R. Madsen who was, for many years, chief engineer at B & O and serves as a consultant to the firm these days. As he pointed out in a paper at the 1973 Audio Engineering Society convention in Rotterdam, the chief cause of phase distortion in a loudspeaker system arises not from the physical disparity between the positioning of the different drivers, but from the action of passive crossover networks that are used in the majority of today's commercially available loudspeaker systems.

A simple crossover system is shown in Fig. 3. It provides a 6-dB/octave slope in response at the selected crossover frequency (1 kHz in our example),

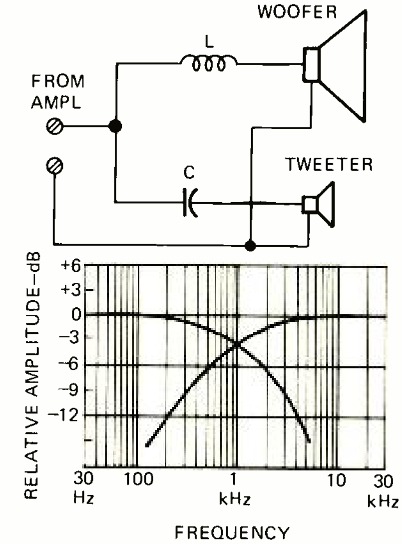


FIG. 3—CIRCUIT AND RESPONSES of a 6dB/octave standard crossover network.

feeding low frequencies to the woofer and high frequencies to the tweeter. Note that at the crossover point itself, relative amplitude is down 3 dB for each driver, so that the *sum* of energy delivered to the two drivers is the same as at frequencies outside the crossover region. With a simple crossover such as this, overall phase response of the system will be quite good—even in the region of crossover. If a square wave at 1 kHz were fed into such a system (and assuming that the drivers were otherwise perfect in response), the output waveform from the woofer would look like the waveform drawn in Fig. 4-a while the output from the tweeter would have the appearance of Fig. 4-b. Add these two components together and you have the waveform of Fig. 4-c —a perfect square wave with no phase distortion.

The problem with using such a moderate-sloped crossover network is that it requires woofers and tweeters to operate effectively (with low distortion and flat frequency response) well outside their intended regions of best performance. Since the contribution of each driver can be heard at least until it is 12 dB below reference program level, the overlap region in a 6 dB/octave crossover arrangement extends for a full four octaves, as illustrated in Fig. 5-a.

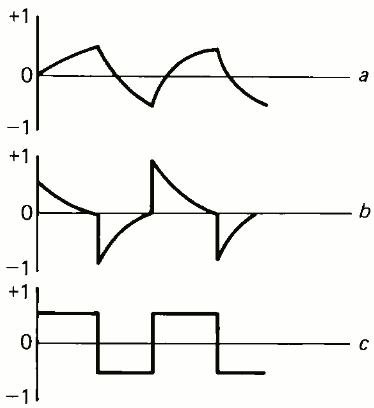


FIG. 4—WITH SQUARE-WAVE INPUT applied to a 6 dB/octave crossover, the outputs of the woofer (a) added to those of the tweeter (b) produce an accurate replica (c) of the original square-wave input signal.

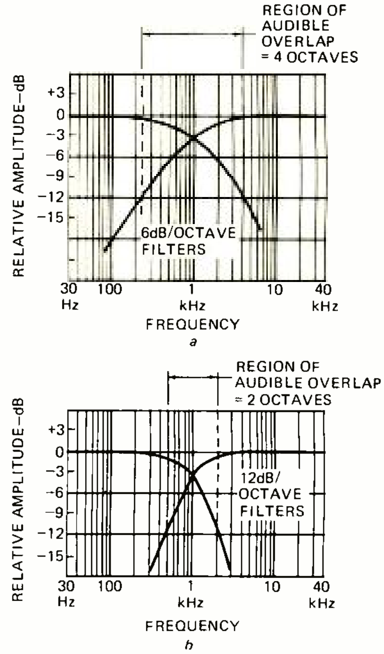


FIG. 5—COMPARING CROSSOVERS. The range over which drivers must work efficiently is twice as great (4 octaves) for 6 dB/octave networks as is the range for 12 dB/octave units (only 2 octaves).

If a steeper rate of roll-off—such as 12 dB per octave—were employed, overlap would need to extend only for a total of two octaves, as shown in Fig. 5-b and optimum performance of each driver would not have to be extended so far outside its "normal" frequency region. For this reason, most better systems do utilize 12 dB/octave crossover networks (some even employ 18 dB/octave slopes). But here is where the problem arises. When such a network is used, the phase angle of the waveform fed to the woofer goes in a negative direction as the crossover frequency is approached, while that for the tweeter goes positive, as shown in Fig. 6. Thus, although single-amplitude plots (without regard to phase) of the output voltages of a 12 dB/octave network, as shown earlier in Fig. 5-b, suggest that total energy output of the system in the

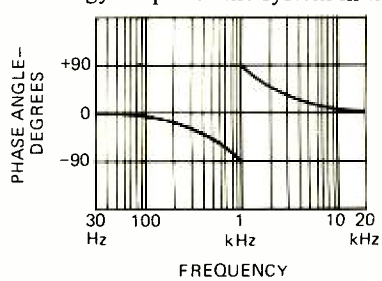


FIG. 6—PHASE RESPONSE of the high-frequency section of a 12 dB/octave unit is 180 degrees out of phase with that of the low-frequency section of the same network.

region of the crossover frequency will be "flat", yet if outputs are plotted with regard to amplitude *and* phase, the actual output energy in the crossover region appears as in Fig. 7 because of the cancelling effect of the out-of-phase outputs from the two legs of the crossover network.

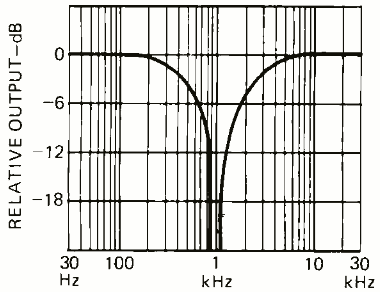


FIG. 7—PHASE ANGLES INTRODUCED by the 12 dB/octave network create a sharp cancelling null at the crossover frequency when the phases of the sections are reversed.

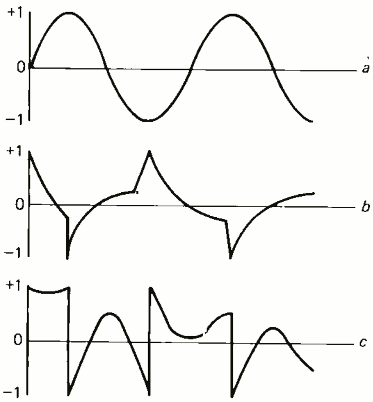


FIG. 8—MATHEMATICAL ADDITION OF woofer input waveform (a) and tweeter input waveform (b) from a 12 dB/octave crossover results in the distorted square wave of (c).

When a square wave is fed to such a system, the output from the woofer will theoretically appear as shown in Fig. 8-a, that of the tweeter as shown in Fig. 8-b, and the composite waveform will appear as shown in Fig. 8-c—not at all like the square wave input signal with which we started.

Some manufacturers have been aware of this out-of-phase problem for some time. One attempt at correction has been to reverse the phase of the tweeter with respect to the woofer (or, in the case of 3-way systems, the midrange with respect to the woofer). As can be seen from the composite diagram of Fig. 9, this produces a peak in total energy output in the frequency region of the crossover instead of a null. Because of the phase response characteristics over the entire frequency band (shown as a dotted line), application of a square wave to a system arranged in this manner would result in the woofer output shown in Fig. 10-a, the tweeter output in Fig. 10-b and the composite output shown in Fig. 10-c—still a long way from the desired square wave shape.

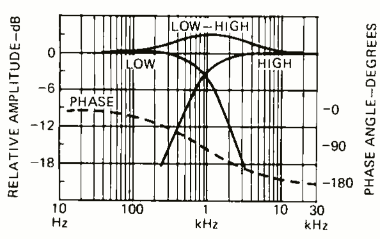


FIG. 9—REVERSING RELATIONSHIP of phases in the tweeter and woofer of a 12 dB/octave network results in an increase of output at the crossover frequency rather than the desired and correct level output.

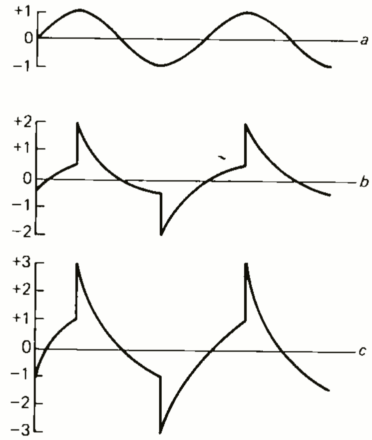


FIG. 10—SQUARE WAVE APPLIED TO the out-of-phase connected crossover network and producing conventional waveforms in the woofer (a) and tweeter (b) sections, give the distorted result of (c) when added.

Bank & Olufsen's solution

The answer to the problem of phase linearity in speaker design was discovered by Erik Baekgaard, who read a paper on his work at an AES convention in London. It is represented in a new line of speakers which were demonstrated to me while I was in Denmark. Design work on these speakers was led by Esben Kokholm, of B & O and I have since had an opportunity to evaluate them in my own laboratory.

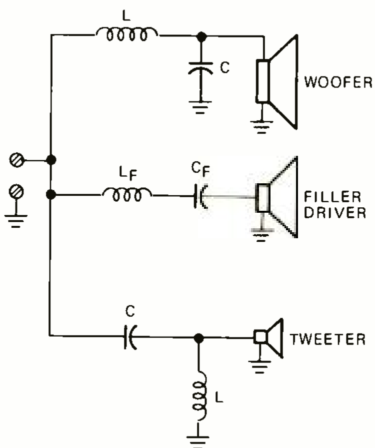


FIG. 11—A NOVEL SOLUTION of the problem is the B & O approach—a third unit with a series-connected circuit tuned to the crossover frequency to fill the null there.

In addition to the usual woofer, midrange and tweeter, this family of speaker systems employs what B & O calls a "filler driver". The general form of crossover network used is that of Fig. 11. Note that the center circuit is neither a low-pass or a high-pass filter, but rather a series resonant arrangement that provides a peaked response to the filler driver (or phase-link speaker, as they call it) at the crossover frequency and a roll-off of 6 dB per octave above and below that frequency. Added to the responses of a conventional 12 dB/octave network, we have the composite crossover network response shown in Fig. 12. The theoretical outputs from the three drivers are now as shown in the three parts of Fig. 13.

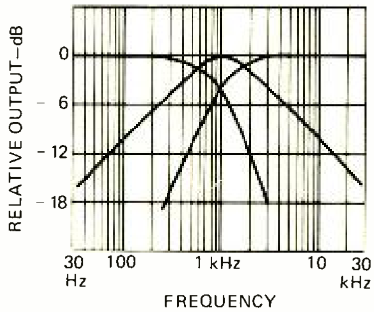


FIG. 12—THE COMPOSITE RESPONSE of the woofer, filler driver and tweeter in the new Bang & Olufsen crossover network.

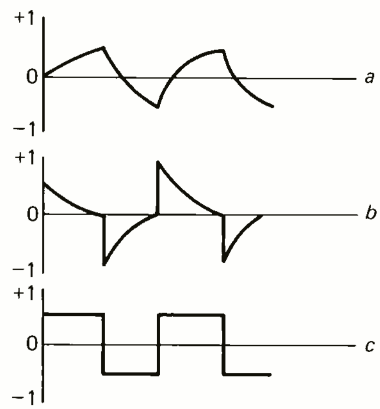


FIG. 13—APPLYING SQUARE WAVE TO the B & O network results in the response at (a) for the woofer, (b) for the filler, and (c) for the tweeter, and adding them gives the result in (d), or the original square wave.

When these are added together graphically, we do come up with an exact replica of the original square-wave input waveform.

Having achieved a solution to the crossover problem, the people at B & O were not about to ignore the driver positioning problem mentioned earlier. While they maintain that flat-baffle positioning produces less phase distortion than that introduced by conventional crossover networks, they nevertheless were looking for as near perfect a phase response characteristic as possible. Accordingly, they developed a new front-baffle shape (actually precision molded of high density foam resin which, they claim, is superior in damping and acoustic qualities to wood) which slants the woofer upward so that wavefronts produced by it arrive at the listener's ear at the same time as those produced by the other drivers. The principle is shown diagrammatically in Fig. 14. In the floor-standing versions of the new B & O speakers, a special pedestal is recommended, with which the listener can actually tilt the entire speaker box forward or back from the vertical, depending upon where he or she is seated in relation to the speakers, and even to compensate for different "ear heights".

was perfectly content with what later proved to be the somewhat vague stereo localization of music using a well-known speaker pair—until I pushed the A-B switching arrangement and listened to the linear-phase units for comparison. Suddenly, the previous pair's sound wasn't quite as gratifying.

The square-wave drawings shown in earlier diagrams are purely theoretical, and derived mathematically. I was curious to see if results could be duplicated in practice, allowing for the fact that my lab is anything but an anechoic chamber and that microphone placement would have a great bearing on the results. I therefore hooked up a square-wave generator to my system, placed a calibrated microphone at what I thought was an optimum spot in front of my regular lab speaker, and photographed what was picked up by the microphone. The results are shown in the scope photo of Fig. 15. Without moving the microphone, I carefully replaced my regular speaker with the sample M-70 model from Bang & Olufsen and repeated the experiment. The scope photo of Fig. 16 shows the results I then obtained. Maybe Bang & Olufsen has something here! R-E

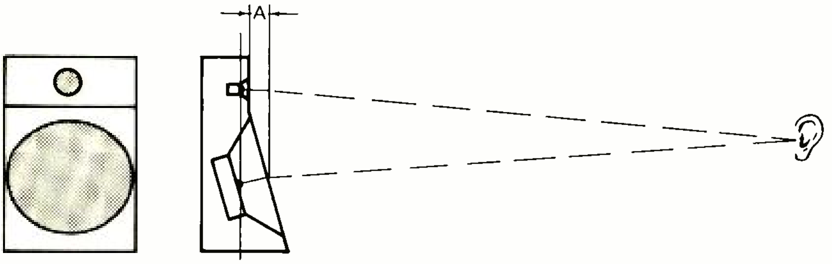


FIG. 14—ANGLED FRONT BAFFLE compensates for the phase delay caused by difference in depths of woofer and tweeter.

Does it make a difference?

Obviously, we don't listen to square waves, and it can be argued that when listening to complex musical waveforms some of these fine points tend to be obscured. I can only tell you that in comparison tests made with three other speaker system types (all popular, well-accepted brands) I was able to sense better localization of stereo images, better transient response with certain program material, and a more natural sounding overall musical quality.

How much of the improvement is a result of the linear phase response of these new systems and how much is simply the result of otherwise excellent driver selection, enclosure design and generally good speaker system design I am not prepared to say. The fact is that "hearing memory" in humans is extremely poor. We tend to listen to our favorite speakers and to convince ourselves that we are hearing reality. This happened in my listening tests, too. I

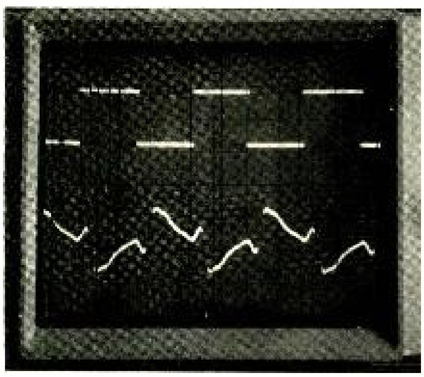


FIG. 15—SQUARE-WAVE SIGNAL IS reproduced by actual conventional speaker system much as shown in the theoretical mathematical addition of Fig. 8-c.

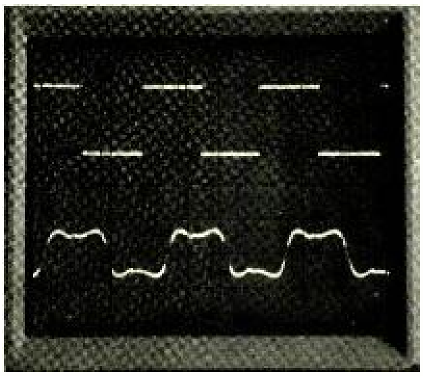


FIG. 16—TEST SETUP OF FIG. 15 with the new B & O speaker system. Output more closely resembles the square-wave input.

DON'T MISS IT!

This month's in-depth hi-fi test reports include the Marantz model 2325 stereo receiver and the Lafayette model LR-2200 stereo receiver.

RCA closes Harrison tube plant, oldest in world

"A sharp decline in demand for receiving tubes in the face of the continuing shift to solid-state devices in consumer, industrial and defense electronic systems" was given by Paul B. Garver, head of RCA's Distributor and Special Products Division, for the July closing of RCA's last tube manufacturing facility, at Harrison, NJ, July 30. Industry sales have declined almost 80 percent since 1966, he said, with replacements in older electronic equipment responsible for most of the present volume.

The Harrison plant was opened by Thomas Edison in 1882, to manufacture electric light bulbs. Ten years later, it was acquired by General Electric, who continued to manufacture lamps until 1918 when the first radio tubes were made. Throughout the 1920's, G-E continued to supply tubes to the various manufacturers of radios. In 1930 the plant was purchased by an RCA subsidiary, RCA Radiotron Co., and the tubes were called Radiotrons.

At its peak, the Harrison plant had a work force of more than 7,000 (as compared to a recent figure of 1,100 employees) and made 87 million tubes in one 12-month period. Besides mass-producing tubes for consumer use, the plant made special ones for industrial, military and aerospace equipment, some in rather small quantities.

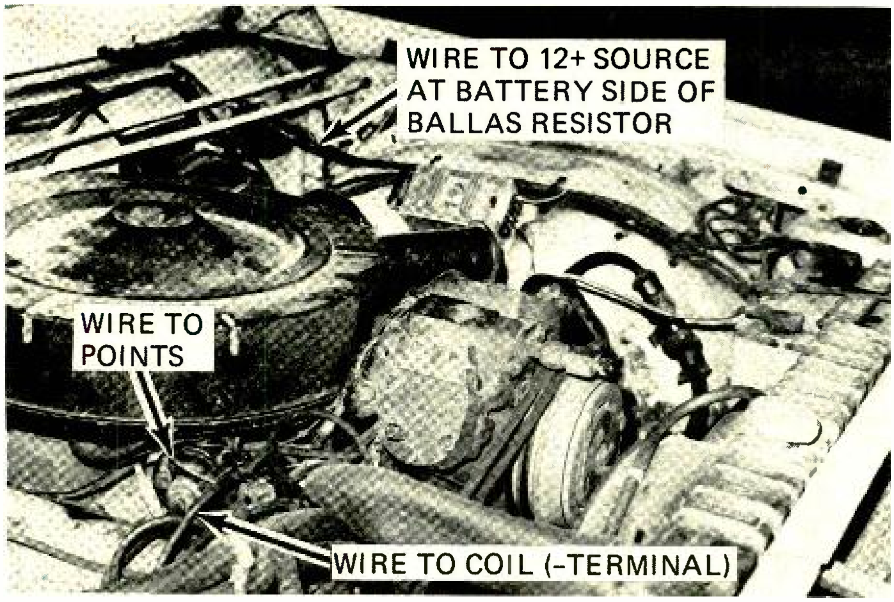
RCA, now the sole source for about 110 types of receiving tubes, plans to meet as far as possible all future requirements for these types, and will continue to sell replacement receiving tubes.

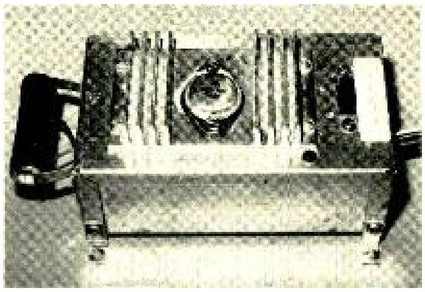
550,000 calls-per-hour on new telephone central system

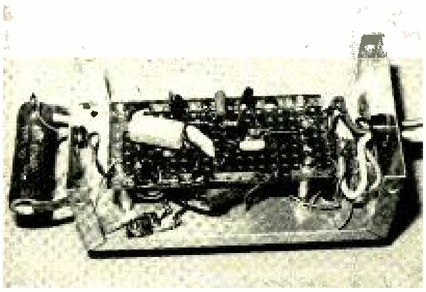
The world's highest-capacity long distance telephone switching system went into action in Chicago last January 17. The new facility, No. 4 Electronic Switching System (ESS), has a peak capacity of 550,000 calls-per-hour. This works out to a little over 9,000 calls-per-minute, or *150 calls-per-second.*

BELL LABORATORIES TECHNICIAN Mike Haverty inserts circuit packs in the "brain" of the No. 4 ESS System, the 1A central processor. The ribbon-like strips snaking down the front of the control unit are actually cables connected to test equipment.

Build This Solid State Ignition System For Your Car







This electronic ignition can be used with any standard ignition coil to provide a constant-amplitude spark

DICK PACE

TRANSISTOR IGNITION SYSTEMS WERE INtroduced by Ford as optional equipment in 1966. A year later, GM offered similar systems. Chrysler developed a system so economical and reliable that it was supplied as standard equipment on all models, beginning in 1973. Other manufacturers are following this lead, and electronic ignitions are becoming standard on most cars. The prime advantage of these systems is that they provide high peak voltage to drive the spark plugs.

The circuit to be described has several advantages over previous types. Most transistor ignition systems require special coils; this project is designed for use with any standard ignition coil.

It provides a constant-amplitude spark at engine speeds in excess of 6,000 RPM. At low speeds, spark duration is relatively long. This minimizes pollution and increases engine efficiency. At high speeds, spark duration is shorter, allowing time to charge the coil fully. (At high speeds, long spark duration is not necessary for thorough fuel burning.)

Since this ignition system is triggered by the ignition points on the car, point wear is virtually eliminated. A convenient switch enables you to operate the car from its regular ignition system in the unlikely event of circuit failure Finally, the unit is very stable. The spark duration is computed automatically so that once turned on by the car's points, shutdown occurs at the right instant. Previous transitor ignition projects were turned both on *and* off by the points.

Essentially, this is an electronics project rather than an automotive one. Except for hooking up the transistor ignition system, no changes are required to the automobile. All parts are readily available, for under $30.

How it works

When the points are closed in a conventional auto ignition system, current flows through the coil, charging it. When the points open, current is interrupted. The collapse of the magnetic field creates high voltage across the points. The voltage rise (about 200 volts peak) is stepped up by the coil, which is actually a transformer, about 100 times (to about 20,000 volts) to fire the spark plugs. The capacitor serves to slow the rate of voltage rise across the points and to form a resonant tank circuit, together with the coil. The capacitor and the coil resonate in damped oscillations until the stored energy is spent. Should the points close before the energy were completely dissipated, the points would arc.

When you add this transistor circuit to the ignition system, it is power transistor Q4 (see Fig. 1) that interrupts current to the coil, rather than the points.

Transistors Q1 and Q2 form a monostable or one-shot multivibrator with some modifications. A monostable multivibrator is a pulse generator that operates only when triggered. It has two states, stable and unstable.

In its stable state, Q1 is "off," with 12 volts at its collector, and Q2 is "on," with the collector at ground. (All the transistors act as saturation switches. Either they are completely on or completely off.) Q3, a PNP, is "on," because current flows through the collector-emitter junction of Q2, R8 and the base-emitter junction of Q3. Q4 is "on" because current flows through its base-emitter junction from collector emitter current of Q3 through R9.

When a pulse is applied to the base of Q1, it turns on and its output immediately goes to ground. Therefore, the plus end of C1 also goes to ground. Since the voltage or charge across the capacitor cannot instantly go to ground, the minus side of the capacitor goes to −12 volts.

This negative voltage turns off Q2 by reverse-biasing it. Q2 will not stay off for a fixed period of time. The collector of Q2 is now at battery voltage and the base of PNP Q3 is at battery voltage (equal to its emitter voltage) and is turned off. Base current to Q4 stops and Q4 turns off, interrupting the current in the coil.

While the sparkplug is firing, R3 is (relatively) slowly charging the minus end of C1 in a positive direction. Current is flowing through R6, keeping Q1 on. Eventually, the minus end of C1 reaches +0.6 volts and turns Q2 on. This removes the voltage from the base of Q1 and it turns off. At this point in time, Q2, Q3 and Q4 are all on.

The pulse that determines when Q1 turns on comes from the ignition points in the car. When the points are closed, the junction of R1 and R4 is at ground. When the points open, +12 volts appears at R4 through R1. Capacitor C6 differentiates the voltage, forming a positive spike that turns on Q1. R1 (40 ohms) allows about ¼-amp of current to flow through the points when they are closed. This is not enough current to cause contact wear but is enough to prevent the points from oxidizing, which could cause the system to fail. The charge time across the points capacitor (condenser?) through R1 is fast enough to be insignificant.

The spark is not turned off by the points. Spark duration is determined independently by the circuit time constants. The on time of the multivibrator is determined by C1 and R3 by the formular $T_{on} = 0.8RC$. This "on" time is relatively independent of supply voltages because when the capacitor charge increases, the available recharge current also increases.

The above formula assumes that C1 is fully charged. The recharge of C1 is through R2. In most multivibrator applications, a constant-duration output is desired. An attempt to operate the monostable multivibrator faster than a certain rate will cause the output pulse to become narrower, because capacitor C1 has not had time to fully recharge through its charge resistor R2. This problem is utilized to advantage in this circuit. R2 would normally be a smaller value (about 470 ohms) to allow for quick recharge. In this circuit it is made larger to increase C1 charge time. Thus, as engine speed is increased to exceed 900 RPM, the spark duration begins to narrow or shorten in time. The duration is about 1.7 milliseconds at 700 RPM, about 1.4 milliseconds at 2,000 RPM and only 0.75 milliseconds at 6,000 RPM.

The result is a long spark at low speeds, which will result in thorough combustion,

PARTS LIST

All resistors 10% carbon unless noted
R1—40 ohms, wirewound, 10 watts
R2—2700 ohms, ¼ watt
R3—1000 ohms, ½ watt
R4—1000 ohms, ¼ watt
R5, R6—3300 ohms, ¼ watt
R7—75 ohms, wirewound, 5 watts
R8—22 ohms, ½ watt
R9—10 ohms wirewound, with brackets, 25 watts (Mallory type 2.5HJ or equivalent)
R10—150 ohms, ½ watt
R11—220 ohms, ½ watt
R12—470 ohms, ½ watt
C1—2.7 μF, ± 10% high-quality tantalum (Mallory TAC 275K025P04 or equal.)
C2—0.1 μF ceramic, 50 V or higher, −20 +80%
C3—470 μF, 25-50 V, −20+80% electrolytic
C4, C5—.01 μF, ± 20% ceramic, 50 V or higher
C6—.068 μF, 50 or 100 V, Mylar
C7—0.22 μF 50 or 100 V. Mylar
C8—0.22 μF, 400 or 600 V, Mylar
Q1, Q2—transistor, NPN, 2N2222A, HEP S-0015 or equivalent (previous number HEP 736)
Q3—transistor, driver, PNP, MJE371, HEP S-5006 or equivalent (previous number HEP 700)
Q4—transistor, NPN high-voltage, high-power, MJ423, HEP S-5020 (previous number HEP 707)
D1, D2—Zener diodes, 150 volts, ½ or 1 watt, 10%. HEP Z0442 or equivalent
S1—switch, 3PDT slide (non-shorting) 3 A, 125 V. (Stackpole 55-34, Workman SW-14 or equivalent)

Miscellaneous:
Case—aluminum "Minibox" 5¼ x 3 x 2⅛-inch
Circuit board. Make your own PC board or use perforated board with push-in clips.
Heat sink for TO-3 case (Q4). Burstein-Applebee catalog No. 12A2229-9 or any type with equivalent radiating surface.
Silicone grease for Q3 and Q4
Coil dope for Q4
TO-3 transistor socket for Q4. (Radio Shack 276-029 or equivalent)
One-inch standoffs for printed-circuit boards.
Barrier strip or strain relief for wires going to car
Printed-circuit board L-brackets for mounting case to car.

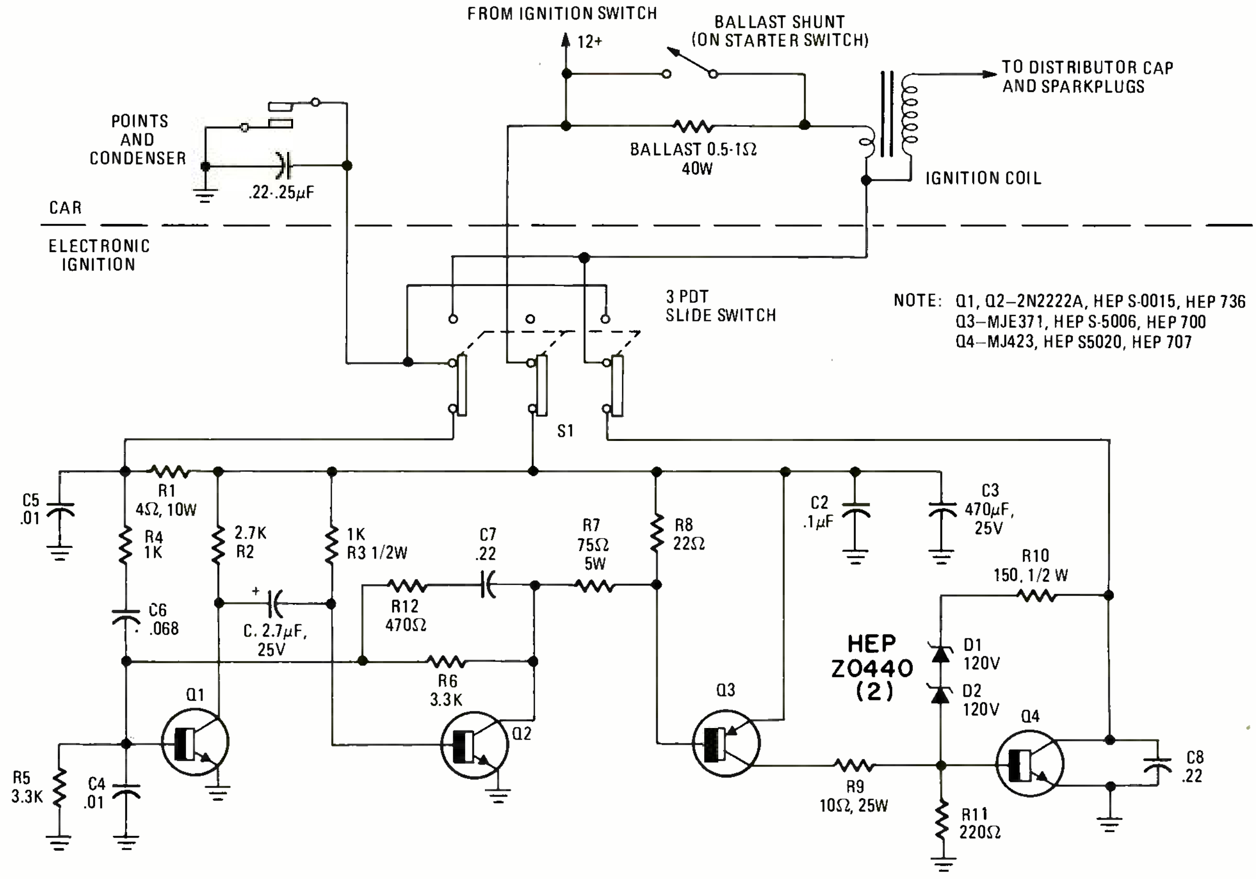


FIG. 1—THE FOUR-TRANSISTOR ELECTRONIC IGNITION SYSTEM.

and a short spark at high speeds. This short spark allows a longer charge time for the ignition coil at high speeds than with points. Points have about a 50% duty-cycle or a nearly square-wave output. An attempt to have the points open for a shorter time would cause point arcing as the coil would not have discharged completely. A transistor can be turned on while the coil is still charged and sparking, without any problem.

While standard ignition systems rapidly lose voltage above 2,000 RPM, this system insures virtually constant output voltage to over 6,000 RPM. (See Fig. 2).

Standard ignition systems sometimes have a problem known as point bounce at high speeds. Points operating at high speeds tend to ricochet slightly, causing an erratic charge and discharge of the coil. This erratic point operation could cause the electronic ignition to operate erratically, but circuitry is included in the system to prevent this problem. Basically, the circuit prevents the unit from retriggering for a fixed period after the spark has ended. This effectively places an upper speed limit on the engine at about 10,000 RPM. The network is formed by C7, R12

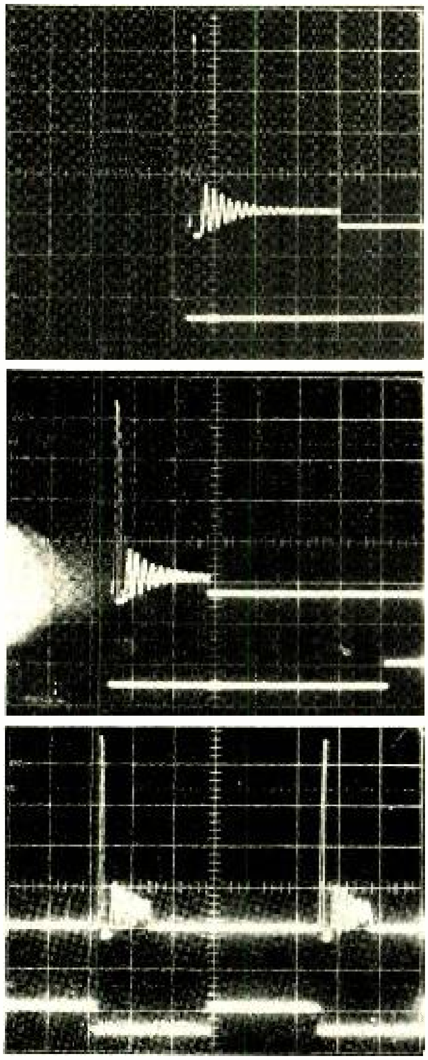


FIG. 2—WAVEFORMS, COIL PRIMARY. Top—Spark duration at 600 RPM (idling speed) 1.7 ms; middle, at 2,000 RPM (highway speed) 1.4 ms; bottom—6,000 RPM (faster than most cars can go) 0.75 ms. Horizontal divisions are 0.5 milliseconds; vertical ones, 50 volts.

and R5. When the monostable multivibrator is in its unstable state, there is a charge on C7, with +12 volts on its right side through R4. When Q2 turns on, −12 volts appears at the base of Q1. This discharges through R5. Until it does, the unit will not trigger. When the points close, a negative voltage appears at the base of Q1 from differentiation capacitor C6. This adds to the negative charge from C7 and further prevents premature operation.

R10, D1 and D2 form a protective network to prevent excessive voltage from destroying Q4. D1 and D2 are Zener diodes in series, giving a Zener voltage of 300. R10 provides isolation and circuit limiting. If the voltage across the diodes exceed 300, the Zeners conduct and the current flows into the base of Q4, turning it on slightly to limit the voltage at its collector. The gain of Q4 is utilized to lower requirements of the Zeners.

C8 allows a controlled buildup of voltage when Q4 turns off and effectively limits the voltage to about 220 to 270. The unit will work without it but the waveform is uncontrolled and spiky. The initial spike, if not limited by the Zener circuit, will go above the breakdown voltage of the transistor and eventually cause it to fail.

C2, C4, C5 are RF and transient filters. C3 is a power supply ripple filter. The switch is used to bypass the unit, in case of component failure, for tuneup purposes or for comparison. When switched to the bypass position, the +12 volt supply is removed; the points and coil are switched out of the circuit and connected to each other.

Construction

A conventional aluminum box can be used to house the unit. The circuit layout is not critical. Most of the components can be mounted on a circuit board. While a pre-patterned board was used for the original, a perforated board with clips will be fine, or you can make a printed circuit board. D1, D2, D11 and C8 can be wired point-to-point near Q4 using a terminal strip. Mount Q4 to a heat sink, using a TO-3 socket. Heatsink Q3 by fastening it with a screw to the case. Don't forget the mica insulators and silicone grease. Wipe off excess silicone grease and coat transistor Q4 with coil dope, especially where it meets the case, to prevent water splashing from shorting across the transistor. Mount R9 outside the case with brackets; it gets quite hot. Wires running to the engine should be passed through a strain relief, or a barrier strip can be used. Use No. 18 gauge stranded wire.

In choosing transistors, there is nothing really critical about Q1 or Q2. Q3 is not critical, but should have low leakage. If you substitute, be sure to use silicon transistors that will saturate easily at the required currents. If Q2 does not saturate, for example, the unit will oscillate. The collector–base voltage ratings should be 35 volts or better. Use discretion in substituting for Q4. Here we need a high-voltage power transistor, at least 300 collector-emitter volts, high current capability, operating from 3.5 amps to 5 amps, with some gain and a low saturation voltage (V_{ce} Sat.). The Motorola HEP 707 and HEP-S5020 have these characteristics. Many high-voltage transistors do not.

When selecting parts remember that the unit will be operated in temperature extremes from −10°C to 100°C or greater.

Bench Testing

This unit, or other electronic ignition systems, can be bench tested without a car or even a distributor. You will need:

1. Ignition coil of the type for use with the ignition system under test.
2. a single spark plug
3. squarewave generator
4. audio amplifier
5. ballast resistor or a ½- to 1-ohm 25 to 50-watt resistor
6. oscilloscope with attenuator probe
7. 12-volt power supply
8. 500 µF 25V capacitor
9. clip leads

The coil and ballast resistor are connected to the unit and power supply as they would be in the car.

The squarewave generator and amplifier replace the points. For ignition systems that use points, connect the generator to the amplifier and connect the amplifier through a 500 µF, 25V or larger capacitor to the points input (minus to the amplifier, plus to the system). Adjust the amplifier volume control for a 12-volt peak-to-peak squarewave. The capacitor is to keep the 12 volts DC out of the amplifier. Ignition systems without points, such as those with a pickup coil, should be connected direct to the squarewave generator, since these units are very sensitive.

Connect the scope probe to the primary terminal of the ignition coil. Connect a sparkplug to the secondary. Don't forget to ground the spark plug. RPM is determined by the formula for a 4-cycle engine:

$$\text{Hz} = \frac{\text{RPM}}{60} \times \frac{\text{No. of cylinders}}{2}$$

$$\text{Hz} = \frac{\text{RPM}}{15} \text{ for a V8}$$

Operate the squarewave generator from 40 to 400 Hz.

Installation

The unit can be attached to the car with "L" brackets. Mount the unit in a dry location in the engine compartment, well away from the exhaust manifold and other hot spots. Connect the wires to the car as shown in the schematic (Fig. 1).

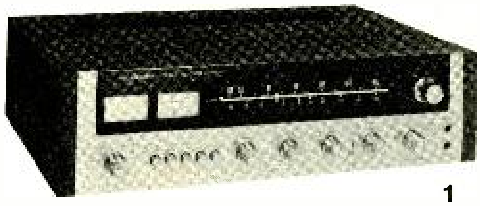
At the ignition coil, remove the wire that goes to the points. Connect the collector of Q4 to this coil terminal. Fasten the point wire to its input (junction of R1 and R4). Connect the + 12V terminal to the car's ignition circuit. It can be attached to the battery side of the ballast resistor in cars that have it, or to an ignition terminal at the fuse block (not an accessory or battery terminal). Some cars (typically GM) use a piece of resistance wire in the lead to the coil (+) terminal for ballast resistance. Others (frequently foreign cars) have the ballast resistor inside the coil. Only in these cars can the +12 volts be taken from the coil's plus terminal.

Tune-up

Follow manufacturers specifications on tune-ups. Timing can be set with the switch at "normal". If you use the dwell meter technique to set the points, be sure to set

(continued on page 85)

Radio-Electronics Tests Lafayette LR-2200



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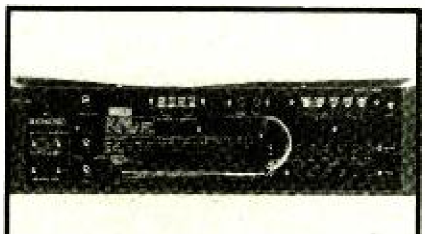
LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

WHEN THE NAME LAFAYETTE IS MENtioned in electronic circles, most people think of a national network of retail stores that sell all types of consumer electronic equipment from ham gear to hi-fi. In fact, the people who run Lafayette also consider themselves to be a major manufacturer of electronic equipment and their line of high-fidelity amplifiers, tuners, receivers and other hi-fi components is as broad as that of some of the better known makers of sound equipment. Furthermore, since they act as supplier and retailer, they claim to offer more performance per dollar in their hi-fi equipment than do some of their competitors who have to first make a profit in selling to dealers before the dealer applies his or her profit.

We chose to investigate their moderately priced LR-2200 receiver because it seemed to offer good features and power output for its under $300.00 price. The receiver, shown in Fig. 1, follows a traditional front panel design approach with a well illuminated dial area that lights up when power is applied. Frequency calibration is minimal, with marks supplied only every 2 MHz apart of the FM scale. To the left of the tuning scales are a pair of tuning meters—one for signal strength indications on AM or FM, the other for center-of-channel tuning when listening to FM. The usual stereo indicator lights up between the frequency scales and the meters when a stereo FM signal is received. A tuning knob is located to the right of the dial scales and is coupled to a fairly effective flywheel for ease of tuning.

Along the bottom of the control panel are six major rotary knobs. The first of these, at the left, is a program selector. The master volume and balance controls are located near center of the panel. The bass and treble controls are of the dual concentric, clutch type so that individaul tonal control of each channel is possible. At the lower right is a speaker mode knob that includes a power-off position as well as a position for synthesizing 4-channel effects from stereo program sources if two pairs of speakers are connected in the same room. Alternatively, two pairs of speakers may be arranged as "main" and "remote" for stereo reproduction in two different locations. Small pushbuttons located between the two left-most knobs take care of such functions as loudness, hi-cut filtering, stereo/mono switching and activation of either or both of the available tape-monitor circuits. The rear panel, shown in Fig. 2, has switched and



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unswitched convenience AC receptacles at the left, the required input and tape out jacks at the upper right and a loop-stick ferrite AM antenna that can be retracted from chassis surface for better AM reception. Adjacent to the phono input jacks is a slide switch that alters phono input sensitivity from 2.5 millivolts to 6.0 millivolts to better accommodate cartridges of widely varying outputs. The main pair of speakers are connected via a barrier-type terminal strip while connection of a second pair of speakers (or rear speakers if the pseudo-quadriphonic effect is desired) is made by means of phono-type pin plugs. A screw-terminal strip accepts outdoor AM or FM antennas and two of the terminals are connected by a removable jumper that couples to a line cord-capacitor arrangement that serves as an indoor FM antenna. A chassis ground terminal, left and right speaker fuses and a power line fuse complete the rear panel layout. Connection of possible associated equipment is illustrated in the diagram of Fig. 3.

Figure 4 is a photo of the internal layout of the LR-2200 receiver. Four major circuit board modules are used: a large one for the FM and AM tuner section, one for the preamplifier and voltage amplifier plus tone control section, a third module for the power amplifiers, and a fourth module that houses the power supply.

Circuit highlights

The FM front-end of the LR-2200 employs a four-section variable capacitor for tuning, a dual-gate FET as an RF amplifier, a junction FET as a mixer and a bipolar device as a local oscillator. Two ceramic filters are used to tune IF frequencies with IF amplification accomplished by one bipolar transistor and pair of IC stages. Most of the multiple decoding circuitry is contained in a single IC. The AM circuitry consists largely of a multipurpose IC, with IF frequencies tuned by another ceramic filter. Phono preamplifiers and equalizers are IC's (one per channel), while voltage amplification and tone control stages of the popular feedback type employ discrete bipolar devices. The input stage of each power amplifier section is a differential ampli-

MANUFACTURER'S PUBLISHED SPECIFICATIONS

FM TUNER SECTION:
IHF Sensitivity: 1.75 μV. **Alternate Channel Selectivity:** 60 dB. **Capture Ratio:** 1.5 dB. **Signal-to-Noise Ratio** (Mono): 70dB. **Distortion** (Mono): 0.5%. **IF Rejection:** 80 dB. **Image Rejection:** 80 dB. **Spurious Rejection:** 90 dB. **Stereo FM Separation:** 40 dB @ 1 kHz. **FM Mute Defeat Level:** 8-10 μV.

AM TUNER SECTION:
IHF Sensitivity: 20 μV (external antenna). **Alternate Channel Selectivity:** 45 dB. **Signal-to-Noise Ratio:** 45 dB. **Image Rejection:** 60 dB.

AMPLIFIER SECTION:
Power Output: 27 watts-per-channel, 8 ohms, from 20 Hz to 20 kHz. **Rated THD:** 0.5%. **Input Sensitivity:** Phono: 2.5 mV/6.0 mV. **High Level Inputs:** 250 mV. **Phono Overload:** 130 mV/60 mV. **Hum and Noise:** Phono: 60/65 dB (depending upon sensitivity); High Level: 80dB. **Tone Control Range:** Bass: ±12 dB @ 50 Hz; Treble: ±10 dB @ 10 kHz. High Filter: −10 dB @ 10 kHz.

GENERAL SPECIFICATIONS:
Power Consumption: 83 watts, 105-120V, 50/60 Hz. **Dimensions:** 17½" wide by 5" high by 12¾" deep. **Net Weight:** 17 pounds. **Retail Price:** $299.95.

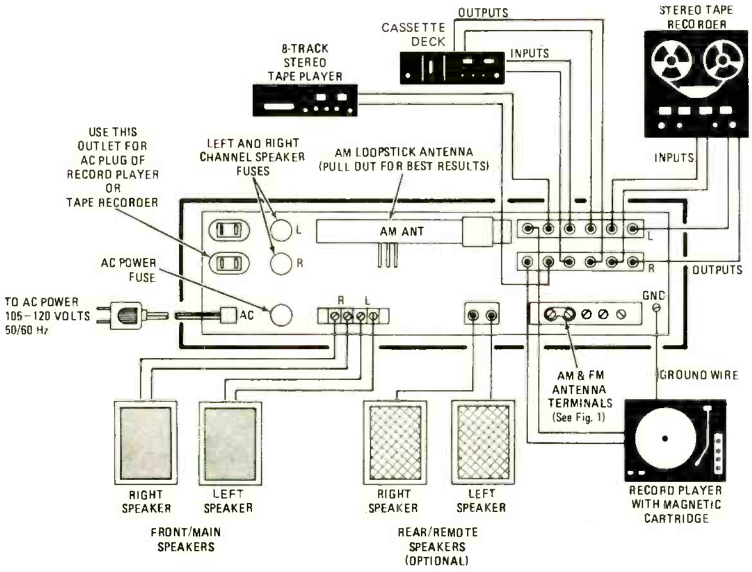
TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Lafayette** Model: **LR-2200**

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	R-E Measurement	R-E Evaluation
IHF sensitivity, mono: (μV) (dBf)	2.4 (13.0)	Fair
Sensitivity, stereo (μV) (dBf)	10.0 (25.4)	Good
50 dB quieting signal, mono (μV) (dBf)	3.0 (14.9)	Very good
50 dB quieting signal, stereo (μV) (dBf)	35.0 (36.3)	Good
Maximum S/N ratio, mono (dB)	70	Excellent
Maximum S/N ratio, stereo (dB)	65	Very good
Capture ratio (dB)	1.6	Very good
AM suppression (dB)	50	Fair
Image rejection (dB)	82	Very good
IF rejection (dB)	80	Very good
Spurious rejection (dB)	88	Good
Alternate channel selectivity (dB)	61	Good
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz (±dB)	0.75	Excellent
Harmonic distortion, 1 kHz, mono (%)	0.35	Very good
Harmonic distortion, 1 kHz, stereo (%)	0.5	Very good
Harmonic distortion, 100 Hz, mono (%)	0.35	Very good
Harmonic distortion, 100 Hz, stereo (%)	0.5	Very good
Harmonic distortion, 6 kHz, mono (%)	0.6	Good
Harmonic distortion, 6 kHz, stereo (%)	0.8	Excellent
Distortion at 50 dB quieting, mono (%)	1.2	Good
Distortion at 50 dB quieting, stereo (%)	0.5	Very good
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV)	10	Fair
Separation, 1 kHz (dB)	40	Excellent
Separation, 100 Hz (dB)	42	Excellent
Separation, 10 kHz (dB)	28	Good
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV)	10	Fair
Dial calibration accuracy (± kHz @ MHz)	200 @ 88	Good
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION		
Control layout		Fair
Ease of tuning		Good
Accuracy of meters or other tuning aids		Very good
Usefulness of other controls		Good
Construction and internal layout		Very good
Ease of servicing		Excellent
Evaluation of extra features, if any		Good
OVERALL FM PERFORMANCE RATING		**Good to very good**



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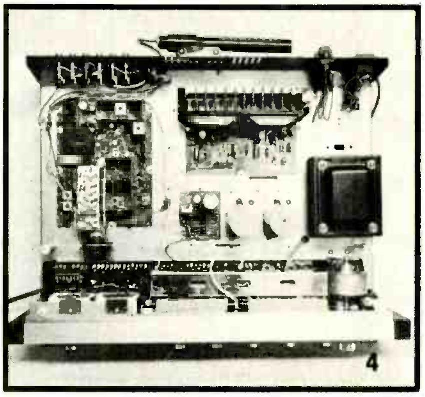
fier followed by a power module, or thick film hybrid IC that operates from a ±34 volt DC supply. The familiar passive network developed by Dynaco some years ago is used to develop "out of phase" outputs for the "rear" speakers when the receiver is used in the 4-channel mode. Critical tuner, preamp and voltage amplifying stages are powered from a well regulated source of +13 VDC that uses a series transistor and a Zener diode in the now familiar regulating arrangement.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Laboratory FM measurements

Results of our FM performance measurements are listed in Table I and may be compared with those published by the manufacturer. It should be noted that Lafayette seems to be a bit behind the times, or is reluctant to publish all the specifications now required by the new FM Tuner Measurement Standards. Or, perhaps, they have not had sufficient time to amend or add to their manuals, which may have been published before the new standards went into effect last May. While usable sensitivity fell short of the 1.75 μV claimed (which would have equaled 10.25 dBf if Lafayette has used the new power reference as we do), the 2.4 μV figure (13.0 dBf) obtained is considered quite acceptable for a unit in this price class. While distortion figures were not as low as those measured for more expensive sets, Lafayette is to be complemented in keeping stereo distortion as low as it measured (0.8%) at 6 kHz, where most other low-cost sets produce greater distortion. Separation was excellent, measuring exactly the 40 dB claimed at mid-frequencies and even a bit better at the low end. Smooth transition from mono to stereo at about 10 μV (25.4 dBf) is just about the optimum point of switching for a set with this quieting characteristic. AM suppression was acceptable, though not outstanding, but this is offset in part by the low measured capture ratio. Used with a good outdoor antenna (Lafayette should not have encouraged use of an indoor line-cord antenna by supplying that jumper), the FM performance of this receiver in most signal areas will be hard to distinguish from that of sets costing much more.

Laboratory amplifier measurements

If we had to rate the amplifier section and the tuner section of this receiver separately we would probably favor the amplifier section. One tends to view those power modules skeptically, but they certainly delivered what was ex-

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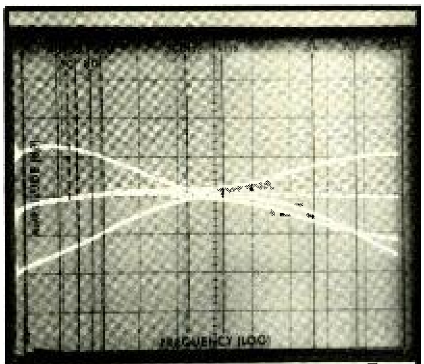

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pected of them and then some. Results of our amplifier measurements are shown in Table II. The amplifier delivered 37 watts into each 8-ohm load before reaching rated THD of 0.5%. At the rated output of 27 watts-per-channel at mid-frequencies, harmonic distortion measured 0.15% though there was a tendency for the THD to rise with decreasing power output levels, suggesting the presence of a small amount of notch or crossover distortion.

Ordinarily, we would consider an overload capability of only 67 mV for the phono inputs as being on the low side but since Lafayette does offer a lower sensitivity setting for high output cartridges (at which setting overload capability increased to 160 mV) we cannot fault the phono circuits on this point.

The spectrum analyzer scope photo of Fig. 5 shows the range of control of the bass and treble controls and the action of the high-cut filter circuit which has no greater slope than the treble control when the latter is turned fully counter clockwise. We would not be overly critical of this point if the beginning of the filter action were set to a higher pivot or turnover frequency, but as you can see from the superimposed curves of Fig. 5, the cut action begins almost at the same frequency as does the treble action. The behavior of the loudness control is depicted

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Lafayette** Model: **LR-2200**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	37	**Excellent**
RMS power/channel, 8-ohms, 20 Hz (watts)	30	**Very good**
RMS power/channel, 8-ohms, 20 kHz (watts)	33	**Excellent**
RMS power/channel, 4-ohms, 1 kHz (watts)	43	**Good**
RMS power/channel, 4-ohms, 20 Hz (watts)	38	**Very good**
RMS power/channel, 4-ohms, 20 kHz (watts)	41	**Very good**
Frequency limits for rated output (Hz-kHz)	10-32	**Excellent**
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.15	**Very good**
Intermodulation distortion, rated output (%)	0.076	**Excellent**
Harmonic distortion at 1 watt output, 1 kHz (%)	0.5	**Good**
Intermodulation distortion at 1 watt output (%)	0.053	**Excellent**
DAMPING FACTOR, AT 8 OHMS	36	**Excellent**
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ±—dB)	1.4	**Fair**
Maximum input before overload (mV)	65/160	**Good**
Hum/noise referred to full output (dB) (at rated input sensitivity)	67/67	**Excellent**

TABLE III

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Lafayette** Model: **LR-2200**

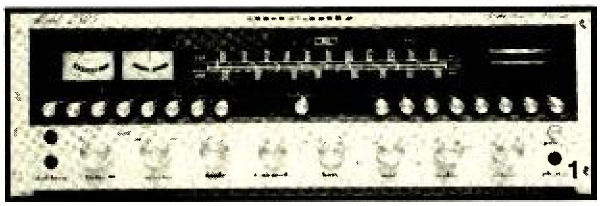
OVERALL PRODUCT ANALYSIS

Retail price	**$299.95**
Price category	**Low-Medium**
Price/performance ratio	**Very good**
Styling and appearance	**Excellent**
Sound quality	**Good**
Mechanical performance	**Good**

Comments: While the control layout of this receiver is generally well executed, we found it awkward to have to switch through the FM MPX filter position to get from FM muting to unmuted FM operation. The muting switch should have been a separate control. The use of pin-jacks for one set of speakers and screw terminals for the other strikes us as a poor choice, since few, if any, separately purchased speaker systems come with pin cables of this sort.

Aside from these cosmetic and human engineering problems, the LR-2200 performed well for its price category. The inclusion of two full tape monitor

Marantz Model 2325



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IF YOU'LL CHECK THE DIMENSIONS OF THIS hefty top-of-the-line stereo receiver from Marantz you'll find that it measures exactly the same as their popular model 4400 4-channel receiver reviewed in these pages some months ago and weighs four pounds less than that quadriphonic model. Styling is similar, too, with the easily identified thumb-wheel "gyro-touch" flywheel tuning arrangement (as Marantz calls it) identifying the product the moment you look at its attractively finished, precision machined front panel and matching metal knobs and buttons as shown in Fig. 1. The blacked-out dial area lights up in a soft blue color when power is applied, revealing a linearly calibrated FM dial scale, an AM dial scale and a 0—100 reference logging scale. Multicolored illuminated words appearing just above the dial scales spell out the program source selected, a red colored word indicates when stereo is selected for other program sources by means of the front-panel MODE switch. To the left of the dial scale area are a pair of meters, each of which performs a double function. The center-of-channel tuning meter doubles as a multipath indicator when a button is depressed, while the signal-strength meter is also used to calibrate the built-in Dolby noise reduction circuitry when that feature is selected. Centered below the dial scale, but still in the dark panel area, is a slide BALANCE control that operates horizontally from left to right. Its knob resembles the knobs of the two clusters of push-button and subcontrols located at the left and right ends of the front-panel. The left cluster of eight knobs and buttons includes a switch that selects left- or right-channel metermonitoring of the Dolby calibration, a

TABLE II continued

HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ±—dB)	15-65	**Very good**
Hum/noise referred to full output (dB)	83	**Excellent**
Residual hum/noise (min. volume) (dB)	93	**Very good**
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	see Fig. 5	**Good**
Action of secondary tone controls		....
Action of low frequency filter(s)		....
Action of high frequency filter(s)		**Poor**
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.3/5.3	
Input sensitivity, auxiliary input(s) (mV)	220	
Input sensitivity, tape input(s) (mV)	220	
Output level, tape output(s) (mV)	210	
Output level, headphone jack(s) (V or mV)	430 mV	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		**Very good**
Adequacy of input facilities		**Very good**
Arrangement of controls (panel layout)		**Fair**
Action of controls and switches		**Good**
Design and construction		**Very good**
Ease of servicing		**Excellent**
OVERALL AMPLIFIER PERFORMANCE RATING		**Very good**

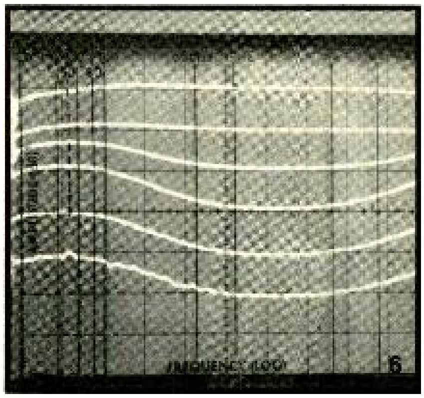
TABLE III continued

circuits is worthwhile, and rarely found on receivers in this price class. The high-cut filter might just as well have been omitted, since it is no more useful in reducing noise than the already available 6 dB-per-octave treble controls. The parallel connection of one of the tape out circuits on the front panel is handy when friends bring over their tape decks for dubbing of your favorite tapes.

FM reception was better than we would have guessed from reading the "numbers" but we did experience one or two cases of poor selectivity on the dial. We do object to the labelling of the mode switch. One of the positions is identified as "4 channel," suggesting four independent amplifiers, which of course are not present in this strictly stereo receiver.

As for power output, the LR-2200 is conservatively rated and more than meets its claims. The unit was found to be thermally stable even after running for several hours at high volume levels and with continuous sine-wave test signals. This Lafayette receiver offers good to very good value for the budget minded audiophile who wants control flexibility, reliable performance and good styling without having to purchase more power than he or she rightly needs. The unit will drive medium to high efficiency speaker systems to adequate sound levels for serious listening in all but the very largest home listening areas.

in the scope photo of Fig. 6 and is typical of this type of circuit where manufacturers choose to emphasize both low and high frequencies at low volume settings.



A summary of our reaction to the LR-2200 will be found in Table III, together with our overall product analysis. In our view, whether you consider Lafayette a retailer or a manufacturer, their LR-2200 qualifies as a worthwhile product in its price category. **R-E**

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pair of knobs for Dolby "play" calibration, another pair for "record" calibration of Dolby, a button that actuates a 400-Hz built-in tone generator useful for calibrating the Dolby circuitry and two more buttons that select either the TAPE 1 or TAPE 2 monitor circuits and choose either source or tape to be fed through to the rest of the amplifier circuitry.

The right-most cluster of pushbuttons includes one that converts the meter to a multipath indicator, HIGH-FILTER and LOW-FILTER buttons, a HIGH-BLEND switch (for reducing noise during stereo FM listening), a LOUDNESS switch, and FM MUTING switch and individual speaker switches for MAIN and REMOTE pairs of speaker systems connected to the receiver.

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

FM TUNER SECTION:
FM Quieting: 30 dB for 1.8 μV; 55 dB for 5.0 μV; 70 dB for 50 μV. **Harmonic Distortion** (mono): 0.15%; (stereo): 0.3%. **Selectivity:** 80 dB. **Capture Ratio:** 1.25 dB. **Image, Spurious and IF Rejection:** 100 dB. **AM Suppression:** 65 dB. **Stereo Separation:** (1 kHz): 42 dB.

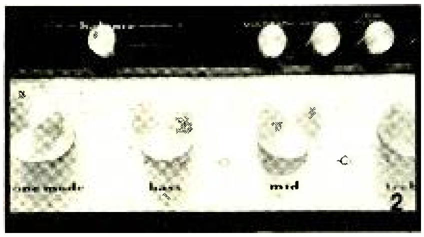
AMPLIFIER AND PREAMPLIFIER SECTION:
Power Output: 125 watts minimum continuous average power per channel into 8 ohm loads, from 20 Hz to 20 kHz at no more than 0.15% total harmonic distortion. **IM Distortion:** 0.15%. **Damping Factor:** 70. **Frequency Response** (High Level) 20 Hz to 20 kHz ±0.25 dB. **Input Sensitivity:** (phono): 1.8 mV; (high level): 180 mV. **Equivalent Input Noise:** 1.5 μV. **Dynamic Range:** (phono): 96 dB. **Tone Control Range** (bass, 50 Hz): ±15 dB; (treble, 15 kHz): ±15 dB; (mid-range 700 Hz): ±6.0 dB.

GENERAL SPECIFICATIONS:
Power Requirements: 120 VAC, 50/60 Hz, 550 watts maximum. **Dimensions:** 19¼" wide by 5¾" high by 18" deep (including knobs). **Net Weight:** 49 lbs. **Suggested Retail Price**; $799.95.

The lower gold-anodized section of the panel contains eight rotary controls, some of which are dual concentric types for individual control of each channel. Such dual knobs are used for the BASS, TREBLE and MID-RANGE tone controls, while single knobs are used for master VOLUME, program SELECTOR, MODE switch, TONE MODE and DOLBY selector switches.

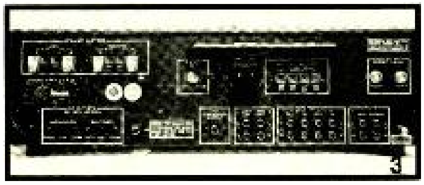
The TONE MODE switch requires a bit of explanation. It has positions for defeating the tone controls, and for inserting tone control circuitry in its normal form (with turnover points set at the usual mid-frequency region). In addition, there are positions that vary the crossover point of both the TREBLE control (to 4 kHz) and the BASS control (to 250 Hz) or combinations of both. In this way, a single knob is used to duplicate the function of at least two and sometimes three separate controls on other sophisticated amplifiers and receivers we have seen. As for the DOLBY switch, it is placed in the DOLBY FM position for listening to properly decoded Dolby FM broadcasts, in the PLAY position for playing back other Dolbyized program sources or in the OFF position for bypassing of Dolby circuitry entirely, in the RECORD I position for making a Dolbyized recording of a non-Dolby program source and—you guessed it—in the RECORD II position for making a non-Dolbyized recording of a previously Dolby encoded program source.

Have we (or Marantz) left anything out? We strongly doubt it. The interesting combination of tone-mode and tone control knobs is shown in detail in the photo of Fig. 2. A pair of DUBBING IN and OUT



jacks on the front-panel duplicate the TAPE 2 jacks on the rear panel and are useful for connecting a tape deck without having to gain access to the rear panel once the unit has been permanently installed.

A view of the rear panel is shown in Fig. 3. Speaker connection terminals for MAIN



and REMOTE speaker systems are of the push-to-insert-wire type and are color coded. Below the speaker connectors are SWITCHED and UNSWITCHED convenience AC receptacles and a power line FUSE post. A MUTING threshold control is screwdriver adjustable and varies the signal strength at which interstation noise muting is overcome. Terminals for AM, 75-OHM and 300-OHM FM external antenna connections are spring loaded and similar to those used for speaker connection.

What Marantz chooses to call an FM QUADRADIAL OUTPUT jack is simply an FM detector output jack that provides access to the composite FM audio signal that may be needed some day for connection to a discrete 4-channel FM adaptor. A pair of screwdriver-adjustable controls are used to adjust the FM Dolby level to correspond with tones transmitted by FM stations who broadcast Dolby programs for that purpose. The usual complement of input and tape output jacks, plus a pivotable AM ferrite bar antenna complete the rear-panel layout. The flexibility of the receiver is indicated by Fig. 4 which shows how the receiver fits into a complete system and how many additional program sources can be connected to it.

Circuit description

A view of the inside of the chassis of the model 2325 is shown in Fig. 5. The power transformer is one of the most massive we have ever seen in a one-piece receiver. Power output stages are mounted on large heat sink assemblies, one on each side of the chassis. Amplified signals from the RF amplifier are fed to a triple-tuned Butterworth filter and then to an FET mixer stage. A five-section tuning-capaci-

TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Marantz** Model: **2325**

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	**R-E Measurement**	**R-E Evaluation**
IHF sensitivity, mono: (μV) (dBf)	2.1 (11.8)	Good
Sensitivity, stereo (μV)	27.0 (34.0)	Fair
50 dB quieting signal, mono (μV)	4.0 (17.4)	Very Good
50 dB quieting signal, stereo (μV)	55.0 (40.2)	Poor
Maximum S/N ratio, mono (dB)	74.0	Excellent
Maximum S/N ratio, stereo (dB)	72.0	Excellent
Capture ratio (dB)	1.2	Very Good
AM suppression (dB)	65	Excellent
Image rejection (dB)	100+	Superb
IF rejection (dB)	100	Superb
Spurious rejection (dB)	100+	Superb
Alternate channel selectivity (dB)	82	Excellent
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50Hz to 15 kHz (±dB)	1.0	Very Good
Harmonic distortion, 1 kHz, mono (%)	0.10	Very Good
Harmonic distortion, 1 kHz, stereo (%)	0.50	Fair
Harmonic distortion, 100 Hz, mono (%)	0.09	Excellent
Harmonic distortion, 100 Hz, stereo (%)	0.90	Fair
Harmonic distortion, 6 kHz, mono (%)	0.12	Very Good
Harmonic distortion, 6 kHz, stereo (%)	0.27	Very Good
Distortion at 50 dB quieting, mono (%)	0.67	Fair
Distortion at 50 dB quieting, stereo (%)	0.60	Good
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV) (dBf)	27 (34.0)	Poor
Separation, 1 kHz, (dB)	44	Excellent
Separation, 100 Hz (dB)	39	Excellent
Separation, 10 kHz (dB)	30	Excellent
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV) (dBf)	12-70 (27.0-43.3)	Fair
Dial calibration accuracy (±kHz @ MHz)	0.15 @ 108	Very Good
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION		
Control layout		Excellent
Ease of tuning		Very Good
Accuracy of meters or other tuning aids		Excellent
Usefulness of other controls		Very Good
Construction and internal layout		Excellent
Ease of servicing		Good
Evaluation of extra features, if any		Good
OVERALL FM PERFORMANCE RATING		Good

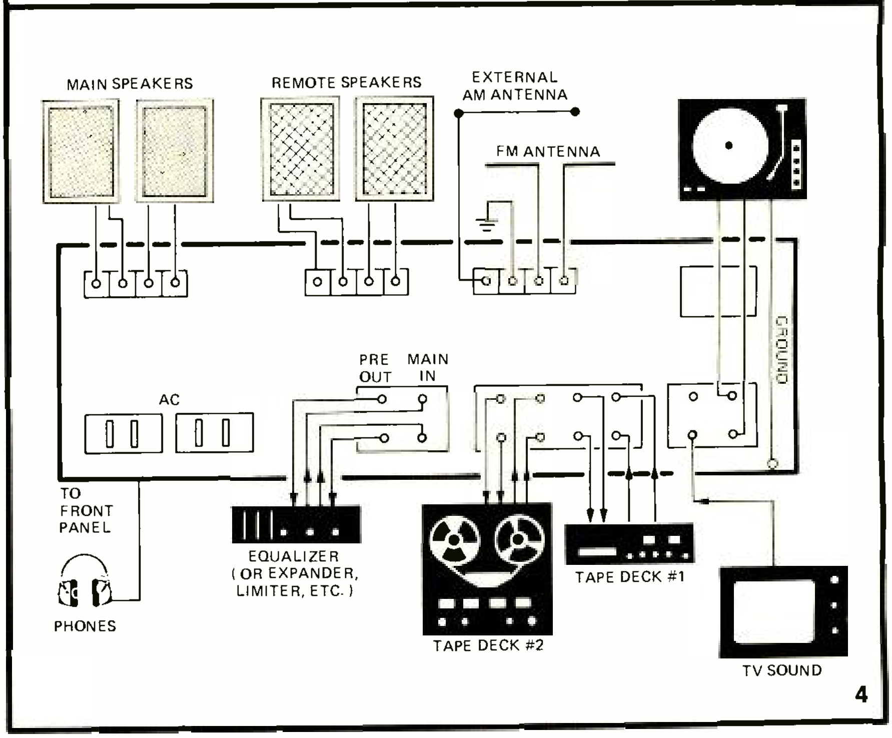


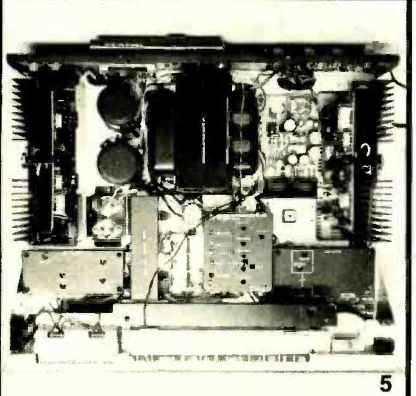
TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Marantz** Model: **2325**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	140.0	Very good
RMS power/channel, 8-ohms, 20 Hz (watts)	133.0	Excellent
RMS power/channel, 8-ohms, 20 kHz (watts)	125.0	Good
RMS power/channel, 4-ohms, 1 kHz (watts)	N/A	—
RMS power/channel, 4-ohms, 20 Hz (watts)	N/A	—
RMS power/channel, 4-ohms, 20 kHz (watts)	N/A	—
Frequency limits for rated output (Hz-kHz)	11-20	Very good
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.10	Excellent
Intermodulation distortion, rated output (%)	0.11	Excellent
Harmonic distortion at 1 watt output, 1 kHz (%)	0.022	Excellent
Intermodulation distortion at 1 watt output (%)	0.004	Excellent
DAMPING FACTOR, AT 8 OHMS	73	Very good
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ±___dB)	0.5 dB	Very good
Maximum input before overload (mV)	125	Good
Hum/noise referred to full output (dB) (at rated input sensitivity)	71	Excellent
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ±___dB)	20-20, 0.25	Excellent
Hum/noise referred to full output (dB)	95	Superb
Residual hum/noise (min. volume) (dB)	99	Excellent
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. 7	Very good
Action of secondary tone controls	See Fig. 8	Very good
Action of low-frequency filter(s)		Good
Action of high-frequency filter(s)		Good
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.05	
Input sensitivity, auxiliary input(s) (mV)	187	
Input sensitivity, tape input(s) (mV)	187	
Output level, tape output(s) (mV)	187	
Output level, headphone jack(s) (V or mV)	Not measured	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		Excellent
Adequacy of input facilities		Very good
Arrangement of controls (panel layout)		Excellent
Action of controls and switches		Very good
Design and construction		Excellent
Ease of servicing		Good
OVERALL AMPLIFIER PERFORMANCE RATING		Very good



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tor is used to tune the RF stage and local oscillator. The IF amplifier consists of eight ceramic-filters and eight IF stages including four limiter stages. Symmetrical diode limiting is used. The stereo composite signal derived from the linear FM detector and amplified by the buffer stage is first fed to an FET muting circuit and then to the phase-locked-loop stereo demodulator IC circuit where it is decoded into left and right channel signals.

The AM tuner section consists of one IC and three transistors. A three-section variable capacitor is used for AM tuning and automatic AGC circuits are applied to RF and IF sections.

The Dolby system circuitry is a single-process two-channel circuit with inputs and outputs determined by the setting of the front-panel Dolby selector switch. The phono preamp-equalizer section provides RIAA equalization and 40 dB of gain (at 1 kHz) for phono input signals. Tone control amplifiers are of a continuously variable feedback type and turnover frequencies are determined by the TONE MODE switch explained earlier. Filters provide high- and low-frequency roll-off at a 12 dB-per-octave slope with the 3-dB points set at 9 kHz and 50 Hz.

Power amplifier stages are direct-coupled from the input differential stage all the way through to the loudspeaker outputs. The output stage consists of four push-pull parallel complementary-symmetry power transistors (NPN-PNP pairs). Electronic protection circuits sense excessive output current and voltage conditions and limit the signal to the driver transistors to a safe, predetermined value. Thermal compensation circuits are also provided and a relay protects speakers in the event of transistor failure and also eliminate pops and transient bursts when the unit is turned on or off.

Laboratory FM measurements

Considering the price and quality of Marantz receivers, we have often wondered why that company steadfastly refuses to quote specifications in accordance with accepted new standards. For that matter, they did not even subscribe to the old IHF standards that everyone else used for years before the new, universally accepted (by IHF, IEEE and EIA) standards became official. We don't know what they claim for usable sensitivity in the case of the 2325, since they insist on giving quieting figures only—which do not take into account distortion at low signal strengths.

By our more standardized measurement, IHF usable sensitivity was 2.1 μV (11.8 dBf) in mono and a rather unimpressive 27.0 μV in stereo. This is also the point at which the circuits switch from mono to stereo automatically—and far too late in our opinion. A signal level 55 μV (40.2 dBf) was required to produce 50 dB of quieting in the stereo mode—again not particularly outstanding in view of the price and features of this otherwise excellent piece of equipment.

It wasn't long before we realized that this particular set was not optimally aligned, as evidenced by some of the other test readings (particularly stereo distortion) listed in Table I. Despite certain performance failings in FM, other performance factors such as rejection of IF, image rejection and spurious rejection were excellent—as good or better than claimed. Signal-to-noise ratio in mono and stereo was also superb. Generally, those tests which involve weak signals were the ones that turned up poor performance, indicating clearly that the front end of our sample was not properly aligned.

Laboratory amplifier measurements

The amplifier, which of course involves no alignment, did much better than the tuner section, as evidenced by the measured results listed in Table II. The output power of 125 watts-per-channel proved to be the limit at the high frequency end of the spectrum (20 kHz) rather than at 20 Hz. Unlike many amplifiers whose rated power is determined primarily by the power supply resulting in limitations at the low-frequency end of the spectrum, the Marantz 2325 delivered 133 watts-per-channel at 20 Hz with both channels driven—at a rated THD of only 0.15%. IM and THD at the low-power levels were so low as to be barely measurable on our equipment.

In quoting phono hum and noise specifications as well as overload capabilities, Marantz again takes off on a path of its

(continued on page 65)

Make Graphs Work for You

Graphs contain a lot of information that can be easily misinterpreted. Understanding graphs and interpreting them correctly is easy if you know how.

by IRVING M. GOTTLIEB

GRAPHS ARE USED EXTENSIVELY IN THE TECHNICAL LITERATURE of electronics. When we see a graph depicting the relationship between a cause and its effect, we know we have encountered a fast and effortless educational mechanism. At a single glance, the behaviour of a device or system becomes clearly obvious. *But, does it?* The following scenario, though fictional, accurately discloses some misleading interpretations that can be both plotted into, and misread from graphs.

A project engineer for a large firm wanted to develop a complex system. The easiest way to get the ball rolling was to collect "building blocks" from the company's file of circuits already used for other projects. One functional block of the system required a simple low-frequency amplifier with priority on faithful response. In other words, such an amplifier had to be *linear* (input signal amplitude vs. output signal amplitude). For the purpose at hand, all other performance parameters, such as frequency response beyond a few hundred Hz, power output, gain, etc., need not be considered for the first go-around. Four departments were requested to submit examples of linear amplifiers that they had previously used. Compliance with this request was inordinately fast—perhaps *too* fast, as we shall see.

Department "A" submitted the graph shown in Fig. 1. Departments "B", "C", and "D" submitted the curves respecfully illustrated in Figs. 2, 3, and 4. All claimed the amplifiers had a linear transfer characteristic *as evidenced by the graphs.* Although all of the graphs were valid plots of output power vs. input voltage, only one was acceptable. Let's analyze these "linear" amplifiers and see where the three unacceptables went astray.

Interpreting graphs

It cannot be said that the graph of Fig. 1 is not linear—it obviously does show a straight line relationship between the input signal voltage and the output power delivered by the amplifier. But, unfortunately, such a relationship does not describe a linear amplifier. In a linear amplifier, the output power is proportional not to the input voltage, but rather to the square of the input voltage. Indeed, in any circuit, not necessarily an amplifier, power increases as the square of the voltage monitored across a constant resistance. So, we see, department A made an incorrect interpretation of their graphically-linear curve. Actually, had their amplifier been linear, it would have plotted out as shown in Fig. 5.

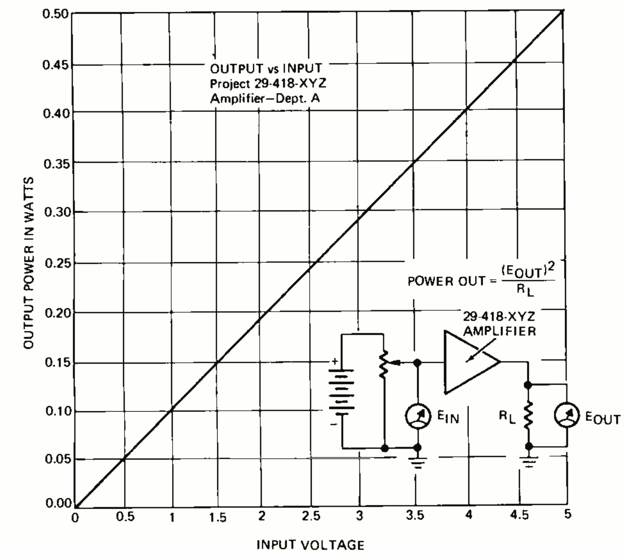


FIG. 1—STRAIGHT LINE CURVE does not necessarily describe the performance of a linear amplifier.

The plotter of Fig. 2 from department B did not forget about the square law relationship between voltage and power. However, to translate this relationship from mathematics to graphics, he used dBm units for power. Enclosed with his straight line curve was an explanation of how he obtained a straight line relationship. This, he accomplished by adjusting the bias networks in the amplifier. Alas, this amplifier, too, was relegated to the "circular file." Even with the uniformly-spaced coordinates of his graph and the use of the logarithmically derived dBm units, a little study reveals something very much wrong. For example, if the amplifier develops 20 dBm when the input signal is 1.25 volts, we shouldn't see 40 dBm for 2.5 volts input (40 dBm represents *ten times* as much power as 20 dBm. No hi-fi amplifier is this!

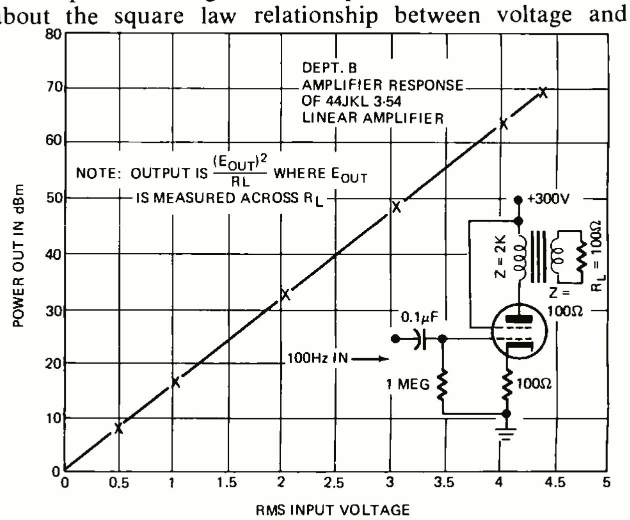


FIG. 2—STRAIGHT LINE CURVE may not be a linear graph. Vertical axis is marked off in logarithmic units.

Having been momentarily caught off guard by department B, the project engineer inspected the graphical results of department C's amplifier (Fig. 3). With a chip-on-the-shoulder attitude, he noted the use of semi-log paper. This should have solved the oversight of department B's plotter—but hold on a minute! It happens that the technique used by department C is exactly equivalent to the erroneous plot submitted by department B. A little contemplation shows that both must be faulted for the same reason—non compliance with the square law relationship between voltage and power. More exasperated than hopeful, the project engineer turned his attention to the work of the next "contestant", department D.

Another straight line plot (Fig. 4)—but did it represent the transfer characteristics of a linear amplifier? The answer was speedily forthcoming, for it was seen that any time the

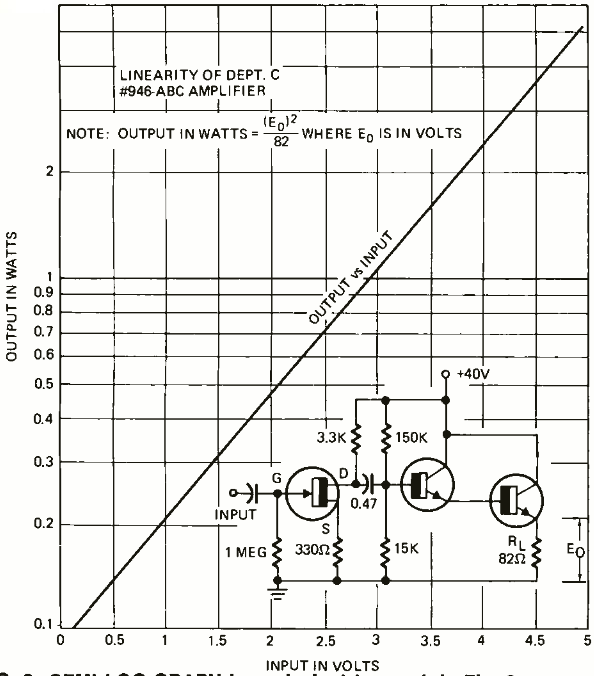


FIG. 3—SEMI-LOG GRAPH is equivalent to graph in Fig. 2.

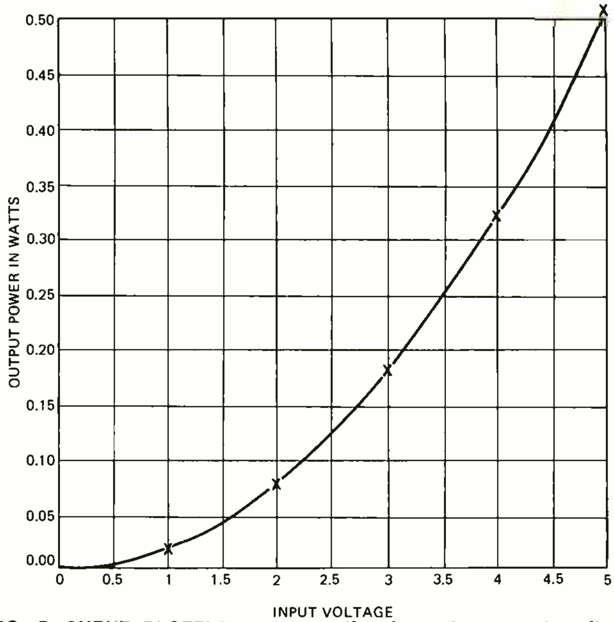


FIG. 5—CURVE PLOTTED on conventional graph paper describes linear amplifier.

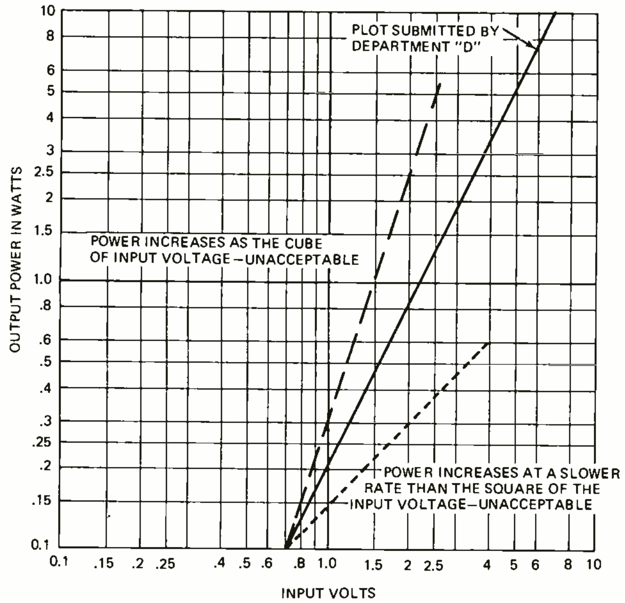


FIG. 4—LINEAR AMPLIFIER is described by solid line plot. Curve is plotted on log-log graph paper.

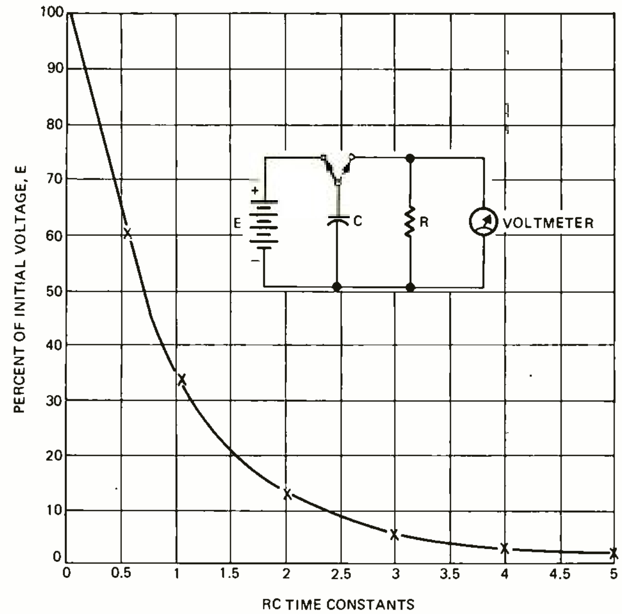


FIG. 6—VOLTAGE across a discharging capacitor presented on conventional graph paper.

input voltage doubles, the output-power quadruples. This was recognized as clear evidence of the required square-law relationship. However, a straight line plot on log-log paper does not *necessarily* reveal a square-law relationship. For example, the dashed and dotted lines superimposed on Fig. 4 indicate other than square law functions. So, log-log paper is great, if such plots are interpreted with a practiced eye. Significantly, once it is determined that the slope of the straight line does represent the square-law relationship, we know that the amplifier is very linear indeed! This is because the slightest departure from the square-law is readily recognized as a *change in the slope of the graph*. Note that to make a similar evaluation of the curve of Fig. 5, many coordinate points and much computation would be required to determine whether the curvature is just right.

The log-log plot shown in Fig. 4 does, however, leave us in the dark concerning the operation of the amplifier at low levels. To convey full information, graphs should start at the origin—the zero-zero point. But, how does one define the origin of log-log graph paper wherein the left-bottom corner is never 0-0? Here, experience and common sense must be used. In Fig. 4, the characteristic of the amplifier is shown over an output range of 0.1 watt to ten watts. Thus, we see its performance down to one-hundredth of the highest power plotted. And if the relationship had been plotted on a three-cycle graph, rather than two, the plot would have extended down to 0.01 watt, or one thousandth of the highest power plotted. Not bad, but for the purist who must see the action right down to zero-zero, the log-log graph will forever frustrate him regardless of the number of cycles used.

Log graphs

Open almost any engineering textbook to the chapter on *transients* or *energy storage*, and the chances are good that you'll find graphs similar to that shown in Fig. 6. This graph tells us what percentage of original voltage is left in a charged capacitor C after a discharge path is provided by a resistance R. Time is scaled off in R-C units, otherwise known as time constants. (To determine actual elapsed time in seconds, simply evaluate the R-C product—thus; if R = 100,000 ohms and C=5.0 microfarads, then one time-constant = $1\times10^5\times5\times10^{-6}=5\times10^{-1}$ or 0.5 second). The curve of Fig. 6 has the following shortcomings:

- Many points must be plotted to produce an accurate plot.
- The measurement of coordinate values is difficult.
- After two, and most certainly three time-constants, both plotting and reading become increasingly difficult.

Consider next, the same function plotted on semi-log paper. In Fig. 7, the plot is made on two-cycle paper. Note that the time constant corresponding to 1% of the initial capacitor voltage can be accurately determined. And with

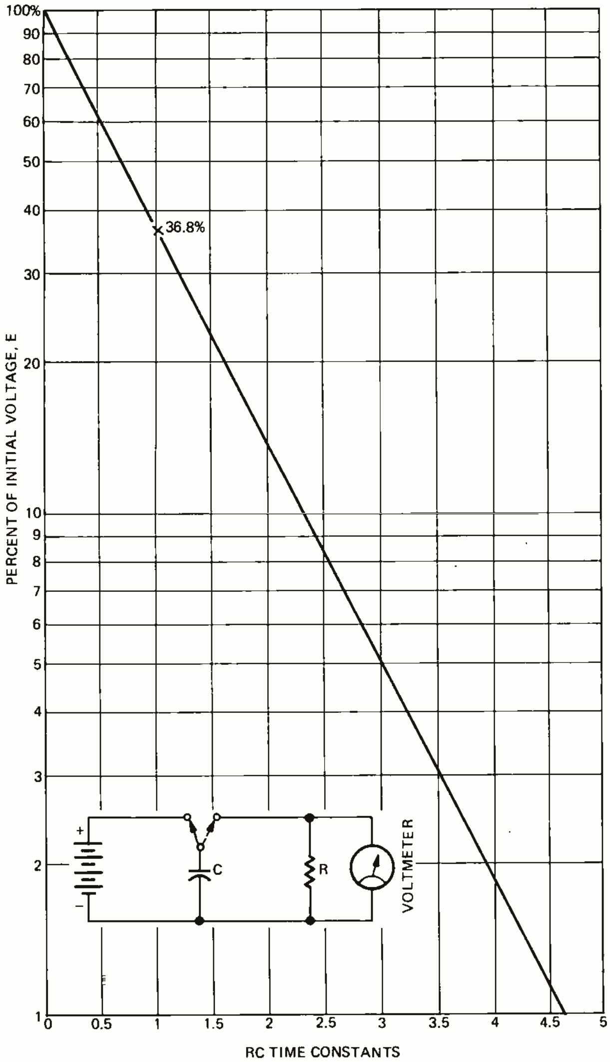


FIG. 7—SEMI-LOG PLOT of the voltage across a discharging capacitor.

three-cycle paper, the range could be extended down to 0.1% of the initial voltage. Another aspect of this graphical technique is that we only need know two coordinates to lay out such a "curve" for any number of time constants. It happens that we already know those two points! At zero time, the capacitor voltage is 100%. And it is a mathematical axiom that one time-constant always corresponds to a capacitor voltage of 36.8%. We do not even have to know the values of R or C to make this straight-line plot. Even if the plot on ordinary graph paper shown in Fig. 6 were desired, it would be wise to first construct the semi-log graph. With this procedure, we avoid measurements and math.

An interesting and useful straight-line graphical technique is illustrated in Fig. 8. This is the plot of the reactance of an electrolytic capacitor as a function of frequency. In other words, it is a plot of $1/2\pi fC$. A quick inspection of this log-log graph tells us that this is not the best of capacitors for

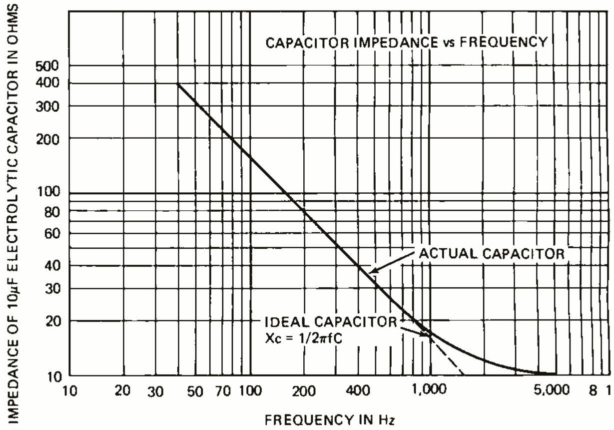


FIG. 8—CAPACITOR IMPEDANCE vs. frequency plotted on semi-log graph paper.

hi-fi amplifier circuits or for the output capacitor of a regulated power supply. The change in the slope of the plot in the 7 kHz to 10 kHz region, and thereafter, indicates that the impedance of this capacitor no longer obeys the law, $X_c=1/2\pi fC$ for these higher frequencies. The practical aspect of this is that the bypass or filter-action of this capacitor becomes progressively worse at higher frequencies. Note that this phenomenon is not obvious in the "conventional"

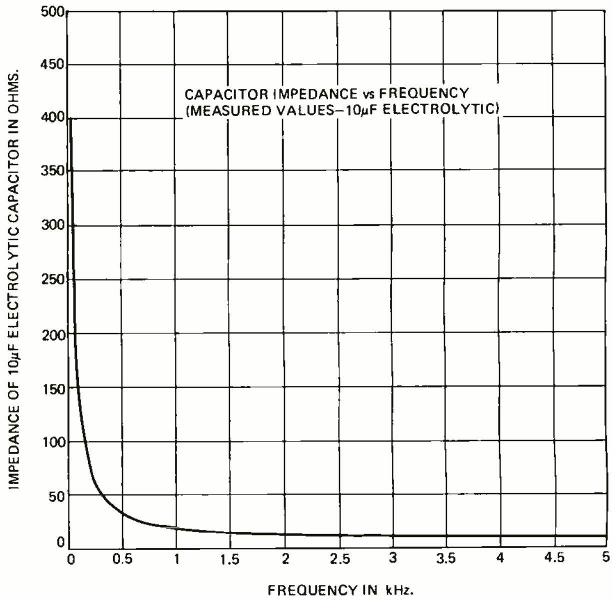


FIG. 9—CONVENTIONAL plot of capacitor impedance vs. frequency. Data is identical to that shown in Fig. 8.

plot of Fig. 9. Here, several or more computations would be required in order to discover the poor high-frequency performance. To make matters even worse, Fig. 9 is both difficult to plot and to read.

When to use which graph

A natural question is when to use conventional, semi-log or log-log graph paper. First, it is permissible to use any type of graph to represent any relationship! All three techniques can display cause and effect information. The subtle trap lying in our pathway is the interpretation of the shape of the plotted curve. With regard to straight line graphs on log paper, the following rules apply:

Semi-log paper: Use for exponential functions. This includes the equations for the charge and discharge of voltage or current in R—C or L—R circuits. Plot voltage or current on the vertical axis. Plot time units on the horizontal axis. The plotted "curve" will then be a straight line.

(continued on page 90)

R-E's Service Clinic

Loop circuits

A circuit that controls itself

by **JACK DARR**
SERVICE EDITOR

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. If return postage is not included, we cannot process your question. Write: Service Editor, Radio-Electronics, 200 Park Ave. South, N.Y. 10003.

A LOT OF "LOOP CIRCUITS" ARE USED IN electronics; feedback loops, control loops, and on and on. We find a lot of them in TV and radio. By a "loop circuit" I mean a function consisting of an active circuit (amplifier, oscillator) *and* a control circuit. The output of the circuit is used to control its own action. When we find trouble in such a circuit, we must remember that it could be one of *two* things: a fault in the active circuit or a fault in the *control* circuitry.

Let's look at the basic test method we must use. We have a circuit with two parts. So, we can't tell which one is the guilty one as is. To isolate the trouble we disable the control circuitry and let the controlled circuit run free to see if we can get a normal output from it. If it will do this, we know that the fault is in the control circuit; if it still won't work, the fault is in the active circuit.

A good example of this is the horizontal oscillator and AFC circuit. This is a servo-loop; the phase of the reference signal is compared to the phase of the horizontal sync signal. The result is a small DC voltage directly proportional to the phase error. This voltage is used to control the frequency of the horizontal oscillator. (Yes; this is a phase-locked loop. The horizontal multivibrator type of oscillator is actually a voltage-controlled oscillator.) Figure 1 shows a block diagram.

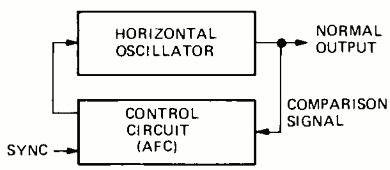


FIG. 1

Troubleshooting

Suppose the horizontal oscillator won't run on-frequency. We have two possibilities; either the horizontal oscillator has a bad part which is throwing it off-frequency or a fault in the AFC Automatic (Frequency Control) circuit is pulling it off frequency. So, we kill the AFC by grounding the output of the phase detector.

In the tube-type multivibrator circuit, we have an open grid that isn't really needed in the oscillator itself. The AFC control voltage is applied to this grid. If the frequency goes high, the AFC develops a voltage that pulls it back on. If it goes low, the voltage is of opposite polarity. If the oscillator is running right on frequency, this grid will be zero volts. To clamp this and kill the AFC, we simply ground this grid.

Now check to see if the oscillator will run on-frequency under this condition. Adjust the frequency control (horizontal hold) to see if you can get a *single* picture, with straight sides. If you can, the oscillator is definitely able to run on-frequency. This picture will float from side to side since there is no control, but if you can see that there is only one picture, that's it. We've cleared the oscillator circuit.

Now put the AFC back in. The picture should snap in sync and hold. If it falls *out* of sync, we know that there is a fault in the AFC circuit. In only two steps we have isolated the cause of the trouble. This narrows it down to about 4 or 5 components—the AFC diode unit and a few resistors and capacitors.

AFPC

There are several other common circuits that are actually identical to this one. The Automatic Frequency and Phase Control (AFPC) in a color TV set works exactly like the horizontal AFC. All tests and reactions are the same. The only difference is in the observed symptoms. In this case the color will fall out of sync while the picture remains locked.

To break the control loop and let the 3.58 MHz oscillator free-wheel, just kill the control voltage. In most sets this is done by grounding the grid of the burst amplifier. Now adjust the frequency control(s) to see if you can make the colors straighten up and hold momentarily. Note the similarity of the color-rainbows to a picture out of sync horizontally. Out of sync, they make slanting lines of red, green and blue. As the frequency control is adjusted, they will become fewer and wider, and slant less.

If the oscillator can be adjusted to the right frequency, the bars will straighten up and the colors lock in momentarily. If you can *not* make them lock in, the oscillator is not able to run on the precise frequency we need. For example, if the bars start to straighten up but then turn around and start slanting more instead of straightening up and then slanting in the opposite direction, the oscillator can't run at the right frequency (crystal slightly off frequency, etc.)

If you can get this reaction, then the oscillator circuit is working. If you put the AFPC back in the circuit and the color sync is still poor, go directly to the color sync circuits themselves—the burst amplifier, AFPC diodes, and so on. The details of the circuit differ in many sets, but if you'll check it out, the basic reaction is always the same—the burst is compared to the frequency of the 3.58 MHz oscillator and the resulting control voltage used to lock the color in place.

We could draw a block diagram of this circuit, but it would look just like Fig. 1, so we won't bother. Only the operating frequency is different!

AGC

Another loop that is often unrecognized is the IF and its AGC circuit. The IF is a multi-stage amplifier with its gain controlled by the amplitude of the video signal *from its output*. This is fed back to the *input*, once again in the form of a small DC control voltage. Here, it controls the gain of the circuit so that it will neither clip nor drop below a certain level.

Test methods are exactly the same though with one minor difference. We have been killing the control by grounding things to clamp the active device input at zero. Now we have to use a definite value of DC voltage to clamp the control loop. If we have what we think is an IF problem, its symptoms will be no picture at all or a distorted picture—too dark, too light, etc.

So, we clamp the control voltage so that the IF amplifier is held at maximum gain. Now, we use the same old simple method—look at the picture! If we can get a good picture, this shows that the IF stages are able to amplify the signal properly.

How do we know exactly what voltage and polarity we need to do this? Look at the schematic! The bias voltages shown on the IF amplifiers are read at *no-signal input*. In this condition, they are at *maximum* gain. This may be a very low DC voltage or quite high and of either polarity. The last is especially true in solid-state TV sets. Just check the voltage shown on the schematic and hook up a bias box to the AGC test point. This will always be somewhere in the grid return circuit

(continued on page 68)

(continued from page 59)

TABLE III

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Marantz** Model: **2325**

OVERALL PRODUCT ANALYSIS

Retail price	**$799.95**
Price category	**High**
Price/performance ratio	**Good**
Styling and appearance	**Excellent**
Sound quality	**Very good**
Mechanical performance	**Excellent**

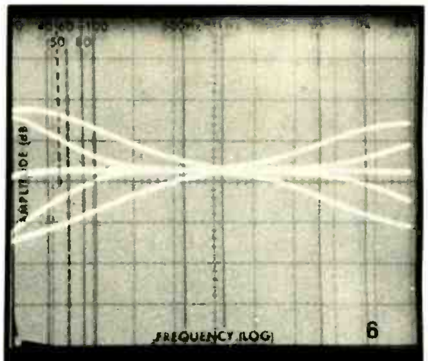
Comments: We especially appreciated the tone control permutations available on this receiver. With its selectable crossovers for both bass and treble plus the extra mid-range control it comes close to being able to adjust response for almost any listening situation or component deficiency, much like the separate graphic equalizers can do. Clearly, the amplifier has enough power to drive virtually any speaker system to loud, clean listening levels and it seemed adequately protected in terms of thermal overload and accidental shorts. We suspect that in our sample, FM performance, and particularly stereo FM performance, was not up to standards and that a minor realignment could have brought things into line. Stereo switching takes place at too high a level, preventing reception of weaker stations in that mode. Stereo sensitivity was also poorer than on receivers costing far less, all of which suggests that quality control must have missed a few points on this one. We very much doubt if this is a design fault, having measured any number of Marantz tuners and receivers that do much better on FM and stereo FM. It is our policy, however, to "call them as we see them", since an unsuspecting consumer could just as easily have ended up with this particular unit.

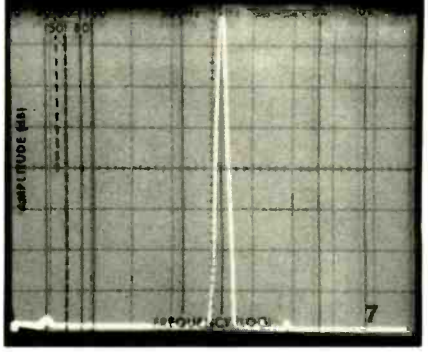
Performance of the amplifier section and preamplifier section, on the other hand, was as near perfect as anything we've heard from an all-in-one receiver. The front-panel control arrangement is sensibly organized, considering the number of control features, tape monitoring facilities, and the like.

(continued on page 66)

(continued from page 65)

own. This time, the numbers are at least translatable to ones we are all more accustomed to reading. For example, when Marantz says that phono input noise is 1.5 μV and that input sensitivity for full output is 1.8 mV, it is easy enough to establish a ratio of these two numbers, take a log of the ratio and multiply by 20 to get the S/N ratio in dB. It works out to 61.5 dB, but why not state that in the first place. In fact, we measured an impressive 71 dB for this important specification. In the case of overload capability of the preamp-equalizer section, Marantz comes up with a figure called dynamic range, which they define as the ratio of input overload voltage to equivalent input noise. Happily, our scientific calculator could translate all this to a millivolt figure for phono overload which turns out to be about 95 millivolts, given their "96 dB dynamic range" specification. Again, our test sample did much better than that, with overload of the phono inputs occurring at about 125 millivolts—not the highest we have measured for a receiver but certainly good enough. Additional lab measurements are shown in Table II and, generally speaking, the amplifier section of this receiver comes off looking a lot better than the tuner section. While no measurements are presented in





terms of the Dolby circuitry effectiveness, we found it easy to calibrate these circuits for use with FM reception and recording. It should be noted that when the Dolby FM position is selected, FM de-emphasis is automatically switched from 75 microseconds to 25 microseconds as it should be.

(continued on page 76)

SERVICE CLINIC

(continued from page 64)

of the first IF amplifier stage if you don't have a schematic.

If you have a good strong signal, you may see that the picture shows signs of overload—too dark and with bending or buzz. If you see this, *vary* the control voltage toward the direction of reduced gain. If you can find a setting that gives you good picture and sound, this clears the IF stages. Go and scratch around in the AGC circuitry for the trouble.

There are quite a few other circuits that turn out to be loops. For example, the boost voltage in the horizontal output stage is one form of a loop. This voltage is developed by the high pulse-voltage from the plate of the horizontal output tube. It also serves as the *plate voltage* of that same stage. So, you can't have one without the other. Low boost-voltage produces a low output that produces low boost.

When you run into mysterious symptoms, look around carefully and see if the circuit is some form of a loop. If it is, then divide and conquer"—kill the control voltage and then see if the active circuit will work. This will tell you instantly where to look for the cause of the trouble! **R-E**

Circle 25 on reader service card

State of SOLID STATE

KARL SAVON
SEMICONDUCTOR EDITOR

LET THERE BE NO DOUBT ABOUT IT! THE microcomputer is a full-fledged member of the computer clan. All the basic functional processes are found on a single or a compatible series of integrated circuits. "Micro" is much less a characterization of the processing power than the physical size and fabrication process. As a computer, the micro carries out a programmed sequence of arithmetic and data-shuffling instructions in a way that completes a useful task. The task may be a scientific calculation, thousands of calculations, or intelligent control of a simple or complex piece of machinery.

Logic designers are learning a new discipline—programming—and leaving their AND's and NOR's behind. Many sequential logic systems that were controlled by gates and flip-flops are now done cheaper and quicker with the μP. They are cropping up all over in electronic sales, appliances, pinball machines, auto ignition controls, games, communication controllers, medical instruments, and test equipment. Updating and logic flaws are corrected by changing a few lines of program code rather than costly circuit redesign.

But although the microcomputer is aptly named, you would be a little optimistic to expect it to replace an IBM370 or a large scale minicomputer system. Here lies one of the principal areas of confusion quite evident in discussions with people new to this revolutionary art. In general, the μC is slower and more awkward in carrying out its computer assignments than its bigger brothers. They are the most economical when the job is small or medium sized. When the project acquires large dimensions, the computer may be the lowest cost item on the list. Outshadowing it will be the expensive peripherals.

There are wide variations in speed capability, in memory addressing, and instruction repertoire. Remember though that speed alone is not the selection criterion. Overall ability to do the prescribed job at the lowest cost is the objective. Some applications are best handled by 4-bit microprocessors. If there is not much computation to be done the use of an 8-bit machine would unnecessarily up the cost.

Then there are the NMOS types, a notch up including the latest with depletion mode loads. Here we have the Intel 8080 and Motorola's 6800 at 2 μS, the Signetics, 2650 at 4.8 μS, the Fairchild F8 at 2 μS, and Electronic Arrays' 9002 with a 2 μS add time.

Continuing, we come to a group of elite devices which have been designed to be building blocks for the larger machines. These are the 2 and 4-bit slice machines with their microprogrammibility and higher prices. On this list you'll find the TI I^{2}L SBP0400 at 1 μS, and the TTL group including the MMI 5701 (0.2 μS), the Intel 3002 (0.15 μS), and AMD's 2900 (0.125 μS). They are in a class by themselves and are not chips you are likely to build into a home project.

[Already a number of processors have become popular with users. Notably the Intel 4040 and 8080, the Rockwell PPS-4, and the Motorola 6800 have been taken into the confidence of manufacturers.] Speed is largely governed by the monolithic process. Silicon-gate MOS seems like it will be the dominant process for a while. Using PMOS are Mostek's MK5065, Rockwell's PPS-8 and National's SCAMP, which have add times of 7, 4, and 28 microseconds respectively.

In an effort to dominate a segment of the market, each manufacturer has developed a specific computer organization or architecture which he feels best meets particular needs. Some of the latest types are designed to take a crack at minicomputer applications. General Automation has a new GA-16 system that uses two NMOS chips by Synertek. The new machines are software compatible with their versatile SPC-16 minis. Also in the mini category are Motorola's 10800 ECL, MMI's system 300 Micromini, and TI's 9900. Texas Instruments is one of the stronger contenders with a sophisticated line of hardware and software designed around the 9900. Just as minicomputers are creeping up on the big boys, micros are closing in on the minis. μC's are today about where the mini was 10 years ago.

Micros are in their third generation of development. Concentration is now on putting the clocks on the processor chip and using single voltage supplies. The AMI 9209, TI's TMS-1000, the Rockwell PPS-1, and National's SCAMP are all efforts in this direction. Slower PMOS is used so they can sell close to calculator chip prices. National's PACE has most of the features of the earlier IMP16 on one chip reducing costs. The comparison reference for all these is the Intel 8080, the most widely used of all μP's. San Francisco's BART system has just finished development on an automatic fare collection system using the 8080.

The μP is only one element of a complete μC system. It receives the lion's share of attention because its design dictates the performance limitations of the entire system to which it is connected. Designers have learned to shun types with an incomplete supporting family. When micros first came out the designer had his hands full figuring out driver, multiplexing, and decoder circuitry. Newer devices have this critical logic on the chip. The total package count has been slashed. Interface problems have been reduced to cookbook procedures.

Understandably there is general confusion as the manufacturers huddle and reduce their prices and update their designs. Designers are uneasy that the model they are working with today will be obsoleted by next year's model. The rapidly changing technology makes it very hard to keep up. Choosing the right machine is no easy task. But using one of the leading types is a pretty sure bet. Hand's on experience is vital for real solid evaluation and fortunately distributors are setting up so—they can run benchmark programs for your application on competitive machines.

When the dust clears, for an unbelievable few dollars you will see products that make life more fun. And the general purpose computer will be introduced as a mind expanding tool for both you and your school-age child.

Microcomputer news

We might as well finish up with some μC related items.

Processor Technology Co. (2465 Fourth St., Berkley, CA 94710) has put together an operating system for program development on Intel 8080 systems. The program listing is available for $3 and paper tapes will be sent to computer clubs or societies.

Software Package No. 1 requires 6K of memory plus additional space for user storage of source and object files.

The operating system will keep track of 6 program files that are assigned names by the programmer. A line oriented editor is part of the package. Two assembly passes convert the mnemonic program listing produced with the editor into machine code which can then be executed by the EXEC command. The operating system will provide an output to program 1702A PROM's.

IASIS, Inc. (110 First St., Suite B, Los Altos; CA 94022) has developed a six-volume programmed learning course on microcomputers. It specifically covers the Intel series in detail starting with the 4004, through the 4040, the 8008, and the 8080. The course proceeds with 700 pages beginning with binary arithmetic through microcomputer assemblers and prototype systems.

Additional learning materials include wall-size system charts, pocket reference books, and programming pads. The introductory course is $99.50 and has a 15-day money back guarantee. **R-E**

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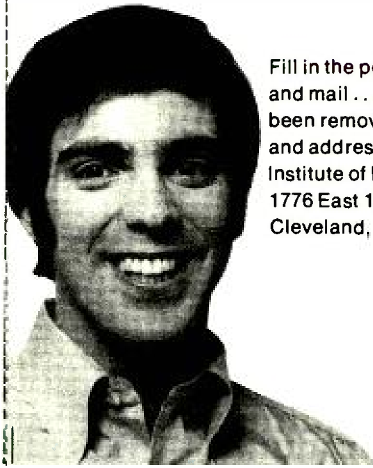

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DYNA-MICRO

(continued from page 38)

constantly be fed to the bus. With these two pins grounded, apply power and depress the keys, one at a time. The binary data for each keyswitch will be indicated on the LED's at all of the output-ports simultaneously. Note that the most significant bit, D7, will be on whenever one of the keys is depressed. This is often called a 'flag' since it is used to flag down the computer and tell it that one of the switches is ready with data.

The lower-left reset (R) key will not output any data since it is hardwired to the 8224 clock chip. You can check this key's operation by testing the voltage at pin 1 of IC5, the 8224 clock chip. It should normally be at about zero volts and will rise to 3 volts when the R key is depressed.

If all the keys operate correctly, peal off the protective backings and apply them to the tops of the keys.

After the power supply, voltage regulator, clock, LED display and keyboard sections have been tested, install the remaining parts. Remember to add the 0.01 μF decoupling capacitors. If you are only going to be using 256 words of R/W memory, at least to start, be sure that it is correctly installed in the locations allocated for IC9 and IC10. If you have not already done so, obtain one of the 1702A PROM's with the Keyboard Executive (KEX) software in it. Preprogrammed PROM's are available (see parts list) and if you already have a 1702A PROM, it may be programmed from the listing provided. There are currently a number of 1702A type PROM's available. These are the 4702A and the 8702A. These are pin-for-pin equivalents of the 1702A, but their access times are slower. The 1702A PROM's or equivalents should have a maximum access time of about 1.3 ms to work with the Dyna-Micro. If you purchase a "surplus" PROM, be sure that these conditions are met.

The PROM containing the KEX software must be placed in the location allocated for IC15. It will not work correctly if placed in the location for IC16 since the addresses will be incorrect.

Next month, the foil patterns, component placement diagram, schematic diagram of the monostable-LED circuit and the final check procedures will be given. **R-E**

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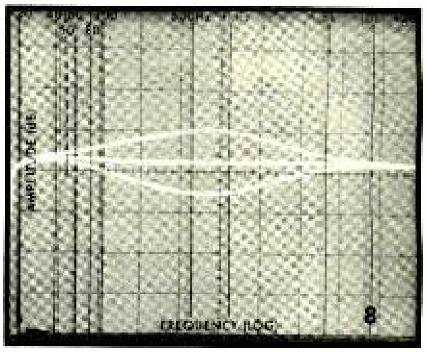
Circle 30 on reader service card

R-E LAB TEST REPORTS

(continued from page 66)

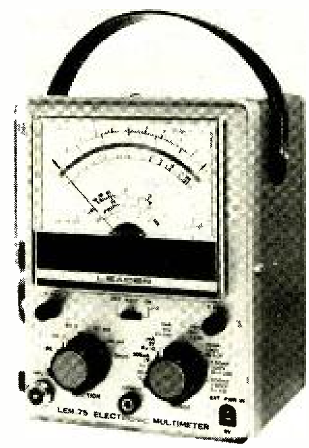


Having convinced ourselves that the tuner section was not up to par in this sample, most of our listening and further experimenting was confined to tape and record sources. These were reproduced cleanly and solidly, with no evidence of distortion or problems in reproducing difficult musical transients. Range of tone controls in both turnover positions is shown in the scope photo of Fig. 6. Our spectrum analyzer was also used to display harmonic distortion content of a 1 kHz signal delivered by the amplifier at 125 watts output (rated power) per channel. Results are shown in the photo in Fig. 7, and distortion content is seen to consist of minute amounts of 2nd and 3rd order harmonic signals, each more than 75-dB below the desired 1 kHz output. Total range of the mid-range tone control is plotted in Fig. 8. **R-E**

new products

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

FET MULTIMETER. The *LEM-75* is a battery-operated full-sized FET multimeter that is both portable and AC operable. It offers wide range of use for most every electronic application, employs a large 4½ inch mirror scale and has an input impedance of 10 megohms. There are full scales of 0.3 V and 30 μA, AC and DC. Minimum sensitivities are 10 mV and 1 μV on both AC and DC for checking and servicing extremely sensitive low voltage and low current parameters of most advanced solid-state devices in use today. The *LEM-75* is supplied with an AC adapter for field or work bench use.



The unit features a ±DC polarity switch; 8 AC and DC current ranges; and peak-to-peak voltage from 0 to 2,800 Volts. The dB range is −15 to +62 dBm (0 dB=1 mV/600 ohms); and 7 ranges of resistance from 0.2 to 500 megohms. $149.95 complete with an *LPB-13* heavy-duty test probe and the *LPS-169* AC adapter. The optional, LP-05 thermistor probe ($21.00) is useful in measuring ambient temperatures in solid-state circuits from −50°C to 250°C.

The *LEM-75* measures 8¼ inches high by 6 inches wide by 5½ inches high. It also has a tilt viewing stand and weighs 5½ lbs.—**Leader Instruments Corp.,** 151 Dupont Street, Plainview, NY 11803.

Circle 31 on reader service card

BOOKSHELF SPEAKER SERIES. Consists of three models, available in both walnut and vinyl, features excellent dispersion, smooth frequency response, clean transient attack and good efficiency. A two-way system in a closed-box baffle, the driver package in each unit utilizes 2-inch aluminum-coned tweeters with frequency response to 40 kHz and a woofer system employing a conical aluminum dome to provide the extended range, improved transients and wide dispersion. In all models the woofer is driven full range.

The *H-80V* (Corinthian walnut vinyl) and *H-80W* (American walnut) use 8-inch woofer with the aluminum tweeter and a capacitor feed to the tweeter cutting in at 4.5 kHz; low-frequency cutoff is at 70 Hz. 17¼ × 11⅛ × 8 inches. Suggested list prices: H-80V—$72.00 each, H-80W—$87.00 each.

The *H-100V* and *H-120W* use a 12-inch woofer with two aluminum tweeters and a capacitor feed to the tweeters cutting in at 2.5 kHz; low-frequency cutoff is at 40 Hz. 25 × 14¼ × 11⅛ inches. A tweeter-level control on the rear panel permits adjustment for optimum balance in a particular room environment. *H-120V*—$135.00 each, *H-120W*—$156.00 each.—**Hegeman Laboratories, Inc.,** 555 Prospect Ave., East Orange, NJ 07017.

Circle 32 on reader service card

CAR STEREO COMPONENT SYSTEM, *Stamp 50*, consists of a separate power amplifier, an under-the-dash preamp/equalizer and a 2-way speaker system with crossover net-

works. The *Stamp 50* is a high-performance high-fidelity system designed to parallel the

(continued on page 80)

When you install a B-T Booster outside, you get a lot of new boosters inside.

The service technician's job is a tough one. Customers are always grumbling about the high cost of TV service calls. And they complain about poor reception—even when it's almost impossible to get a good signal.

But now and then a TV service technician wins one. And one of the products that can make him a winner, and create customer goodwill, is a Blonder-Tongue outdoor booster.

B-T Boosters can produce a dramatic improvement in picture quality, particularly on color and especially in difficult reception areas. After 25 years of making outdoor boosters, B-T is number one in sales, and enjoys the finest reputation for making products of highest performance and reliability. B-T Boosters do cost a bit more than competition, but they perform and last longer. And that's what makes satisfied customers.

The VAULTER, for example, is the number one outdoor booster today in the B-T line . . . *and* in the entire industry. This ultra-high performance, all-channel amplifier offers the ideal combination of lowest possible noise figure (4.6dB, VHF; 7.0dB, UHF) and high gain (15dB). While it can't make unusable, snowy pictures perfect, it *can* reduce fading, loss of color, overcome cable loss and reduce lead-in cable noise. It can even feed more than one TV set from the same antenna in fringe reception areas. It has separate U/V inputs and a coax output. Finally, it's specially designed for lightning prone areas.

The B-T line consists of 5 all-channel models (including the popular VOYAGER); 5 VHF models and 4 UHF boosters (the ABLE-U2b is a favorite).

See your B-T distributor for details. And see why you can count on boosters inside, when you install B-T Boosters outside. Blonder-Tongue Laboratories, Inc., One Jake Brown Road, Old Bridge, N.J. 08857.

25 BLONDER-TONGUE

Circle 26 on reader service card

NEW PRODUCTS

(continued from page 78)

performance quality of home stereo components. It can be installed in a car, van, boat or airplane.

The DC-coupled *Stamp 50* amplifier delivers 20-35 watts RMS per channel (40 to 70 watts in stereo). Distortion less than 0.3% THD, 20 Hz to 20 kHz at full output.

The *PEQ50* preamp/equalizer has separate high- and low-frequency controls level and LED indicator. The input accepts an FM/FM stereo signal source and all 8-track and cassette players. The 6¾-inch rear-mounting woofers are complemented by forward-placed hemispherical Mylar dome radiating tweeters.

Speaker grilles, all wiring, crossover components and owners' installation manual are included in the kit. $388.00.—**AudioMobile, Inc.,** 3625 McArthur Blvd., Santa Ana, CA 92704.

Circle 33 on reader service card

LIQUID CRYSTAL DISPLAYS. Standard digit sizes are 2, 4, 6, and 8 in., with large sizes up to 12 in. available on special order.

Single- and multi-digit assemblies are available with integral lighting or in a reflective-mode for external front lighting. The units are completely self-contained requiring only BCD inputs to generate numerics, and use less than 50 milliwatts of power per digit

exclusive of lighting. Excellent legibility with contrast ratios greater than 10 are achieved in ambients of up to 300 foot-candles with back lighting, and in any ambient, including direct sunlight, in the reflective mode.

Applications include message boards, process control "score boards", clocks, arrival/departure boards, and other uses requiring large numeric readouts—**North Hills Electronics, Inc.,** Glen Cove, NY 11542.

Circle 34 on reader service card

NEW SEMICONDUCTOR TESTER, the *model 520B*, features a new HI-LO Power Drive

system, is AC-powered and designed for maximum operating convenience for technicians at the service bench.

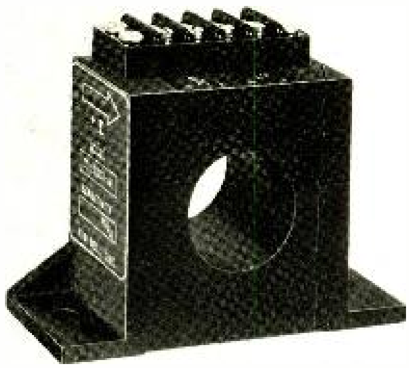
In LO Power Drive, the base, emitter, and collector leads of the device being tested are automatically identified. HI Power Drive enables a technician to perform accurate in-circuit gain tests on devices in circuits with shunt resistance as low as 10 ohms and shunt capacitance as high as 15 μF. An audible tone indicates proper operation, and LED indicator lamps identify the functioning device as PNP or NPN.

The *model 520B* can perform a complete in or out-of-circuit test in less than 10 seconds. The new unit also tests out-of-circuit leakage with an automatic identification of silicon or germanium semiconductor types. The polarity of diodes, FET's and SCR's also are indicated. $160.00.—**B&K-PRECISION** Division of Dynascan Corporation, 1801 W. Belle Plaine Ave., Chicago, IL 60613.

Circle 35 on reader service card

NON-CONTACT AC/DC CURRENT PICKUP. The *model ID-5001M* current sensor is designed to sense both AC and DC currents on one or more conductors passing through the sensing aperture. The device produces an output voltage proportional to the total current through the aperture.

This method of current sensing is unique in four main areas: (1) Non-contact operation provides complete isolation from the bus.



(2) Introduces a negligible power drain in the measured circuit. (3) The extremely low insertion impedance has a negligible effect upon a measured circuit performance. (4) The DC current capability allows the measurement of DC, AC or combination waveforms.

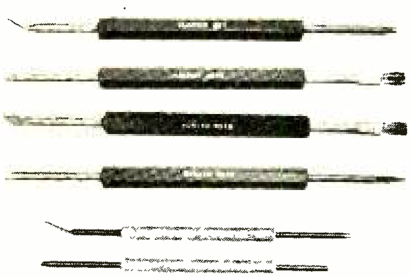
An optional electronic package is available with the *ID-5001M* sensor. This package contains the power supply for the control current and the output amplifier.—**F. W. Bell, Inc.,** 4949 Freeway Drive East, Columbus, OH 43229.

Circle 36 on reader service card

SOLDERING AIDS, designed with the production worker in mind, have non-magnetic steel blades to which solder won't adhere. Blades are set into black plastic handles that are hex-shaped so the aids won't roll off the workbench. Solder aids are available in the 8-inch standard size and the 6-inch version for micro work.

Models are available with a forked end that straddles wire for looping, bending or guiding; a reamer end that cleans and deburrs lug holes; the hook end probes for loose connections; the knife/scraper removes surplus solder and the brush cleans solder connections. The dual-ended regular models have an overall length of 8 inches. The hex handle is ⅜ × 4 inches, blades are 5/32 × 2 inches. Three models pair the fork with hook, brush and reamer. The fourth pairs the knife and brush. $1.39 each.

The *Micro* models are 6 inches overall. Handle is ¼ × 3 inches; blade ⅛ × 1½ inches. Available as fork/hook and fork/



reamer models at $1.79.—**Hunter Tools,** Marshall Industries, 9674 Telstar Ave., El Monte, CA 91731.

Circle 37 on reader service card

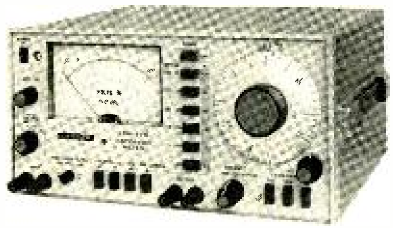
POCKET PORTABLE DVM as an analog

meter replacement. The *DVM35* is more accurate than most general-purpose analog instruments due to its 3-digit display, 1% DC voltage accuracy and 15-megohm input impedance. It measures more than most portable analog meters; including 1-ampere and 10-megohm capabilities, plus 2000 VDC measurements available when using the TIMES TWO button on the probe—thus doubling all voltage ranges and increasing the input impedance to 30 megohms. Measurements up to 50 KV are possible using the HP200 accessory high-voltage probe.

Long battery life is assured by using the TOUCH ON button on the probe. The *DVM35* is turned off between measurements, thus extending battery life. AC line operation is possible using the optional power adapter/recharger model PA 202. $124.00.—**Sencore, Inc.,** 3200 Sencore Drive, Sioux Falls, SD 57107.

Circle 38 on reader service card

DISTORTION METER. The *LDM-170* audio circuit distortion meter also measures signal-to-noise ratio and signal levels in all audio-frequency circuits. It has a balancing circuit to suppress the fundamental fre-



quency in the 20 Hz-20 kHz range while distortion products are fed to a stable, high-

Circle 70 on reader service card

gain amplifier for meter readout. Distortion may be measured as low as 0.1% while signal-to-noise ratio can be determined from 70 dB. Signal levels may be read from 100 μV to 300 V. The amplifier is effective to 200 kHz and measurements are possible up to and including the 10th harmonic of 20 kHz.

The *LDM-170* also features a high-pass filter with a cutoff at 500 Hz; plus 6dB octave attenuation. It also features output terminals for scope connection to observe waveforms or for use as a preamplifier in low-level circuitry. The *LDM-170* is 6½" H × 12½" W × 12" D and weighs 13 lbs. It operates on 115/230-V, 50/60-Hz power supply. $549.95.—**Leader Instruments Corp.**, 151 Dupont St., Plainview, NY 11803.

Circle 39 on reader service card

DIGITAL ELECTRONIC STOPWATCH, *model 1671,* is designed for use in simple start/stop and time in/time out applications, it is ideal for industrial time and motion studies, excellent for use in the research lab. You start,

stop and reset with one hand, and it times to 59 minutes, 59.9 seconds (with automatic recycle) in increments of 1/10 second. Fail-safe design means timing cannot be accidentally reset. Electronics are solid-state. Compact (4.45 × 2.46 × 1.46"), lightweight (6 oz.) and durable for use in the field or lab, the watch's bright 5-digit LED display gives excellent readability under most light conditions. Neck strap and replacement AA batteries are included. $49.95.

For under eighty dollars, you can get a watch (*model 1669*) with all the features detailed above, plus standard split-action for partial event times. You can freeze times on a partial event while you continue to measure total elapsed time (allows for timing of two "happenings" or participants in a single event). Rechargeable NiCad batteries, AC charger and leather carrying case are included. $79.95.

The deluxe *model 1653*, similar to above but with no recharger, comes with four replaceable alkaline batteries to provide 18 hours of continuous operation. It allows for a series of individual event times without losing total elapsed time. Its 6-digit display is bright neon orange with ±0.001% accuracy. $149.95. These three, and six other electronic digital stopwatches, are available by mail, postpaid.—**Edmund Scientific Co.,** 380 Edscorp Bldg., Barrington, NJ 08007.

Circle 40 on reader service card

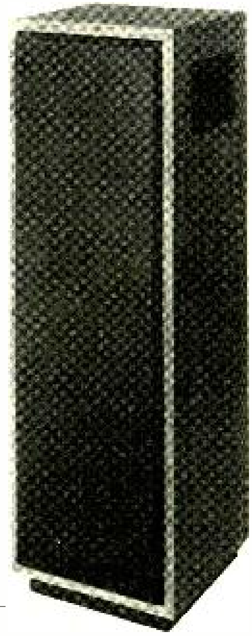
LAFAYETTE L-8 3-WAY PEDESTAL SPEAKER, the L-8 is a three-way design employing a 10-inch woofer with a massive 4-lb. magnet structure, a 1½-inch solid aluminum voice coil, and a 5-inch sealed-back mid-range speaker and four super tweeters positioned in front and either side to provide 270° sound dispension.

The columnar enclosure incorporates an internal tuned duct for high acoustic effi-

Circle 72 on reader service card

Circle 73 on reader service card

ciency and improved bass response. Frequency response of the *L-8* is 30—20,000 Hz. Nominal impedance is 8 ohms. Multistage RLC crossovers are used at frequencies of 2300 and 6000 Hz providing 12dB per octave. Mid- and high-frequency controls on rear



panel are used to adjust output for room acoustics. Power handling capacity is 30 watts RMS, 50 watts, program material. The cabinet is finished on four sides in a mar-proof walnut finished laminate over solid ¾-inch acoustic wood and has a removable

brown foam grille. It measures 37½ inches high × 12½ × 12½ inches cross-sectionally. $169.95—**Lafayette Radio Electronics Corp.,** 111 Jericho Turnpike. Syosset, NY 11791.

Circle 41 on reader service card

HOME MUSIC SYSTEM. The *model RH-606* 8-track record/playback, AM/FM stereo system is one of four in the Pioneer *Centrex Series* of seven having recording capabilities. Automatic or manual program change,

lighted program and recording indicators are among features. Unit has magnetic phono input jacks, 120-volt AC outlet, front-panel microphone and headphone jacks. The two-way acoustic suspension speakers have foam grilles. $280.—**Pioneer Electronics of America,** 1555 E. Del Amo Blvd., Carson, CA 90746.

Circle 42 on reader service card

MAGNETIC-MOUNT CB ANTENNAS. The 39-in. *Liberty series* are designed for fast attachment and removal that helps prevent thefts. The need for mounting holes or brackets is eliminated with these virtually theft-proof antennas that magnetically clamp to any 4 square-foot metallic surface on cars, trucks, RV's, or boats. (Not recommended for soft vinyl tops). The husky base magnet has

40 lb. holding power which prevents crawling or dislodgement and is ABS encapsulated to prevent surface scratches.

The *Liberty I (Model 10-275)* has a fiber glass whip, and the *Liberty II (Model 10-285)* features a weather-resistant stainless steel whip with base-load coils.

Both models have extra-distance radiation patterns and corrosion resistant stainless steel whip spring and marine-type hardware, 16 ft. coax transmission cable with a PL-259 plug, plus a capacitive impedance match that eliminates the need for matching transformers. $27.95.—**Breaker Corp.,** Marketing Dept., 1101 Great Southwest Parkway, Arlington, TX 76011.

Circle 43 on reader service card

HAND-HELD DIGITAL MULTIMETER measures capacitance along with AC and DC volts and resistance. Called the *model 21*, this palm-sized instrument has four DC voltage ranges with 1 mV resolution: Four AC voltage ranges with 1-mV resolution: Four resistance ranges with 1-ohm resolution and four capacitance ranges with pF resolution. Other features and specifications include: 0.27" LED displays 3½ digit readout (up to 2,000 counts); simplified five-step calibration.

Designed for field or bench operation, the *model 21* operates from 4 rechargeable Ni-Cad batteries. (An optional converter for line operation is also available). Inside the high-impact polycarbonate case, the *model 21* uses all components laid down to withstand impact and shock. Only standard compo-

(continued on page 86)

AUTOMOTIVE IGNITION SYSTEM
(continued from page 49)

the unit in the "bypass" position while setting the points.

Point contact wear is almost completely eliminated with the unit. Other point wear factors should be considered. The rubbing block surface of the points can wear. It is important to follow the car manufacturers instructions on lubricating the distributor cam surface during tune-up. Some cars have a lubricating wick; this should be replaced. On other cars, a *thin* layer of grease is put on the cam. If the rubbing block does wear, it will retard ignition timing somewhat. (The author has not experienced any rubbing block wear problems.)

Another possible source of failure is breakage of the points tension spring from age and fatigue. I have never seen this happen. However, it is probably good preventive maintenance to replace the points every 50,000 miles.

Due to the more positive spark from the unit, sparkplug life should be a little longer with this unit than with a standard ignition. **R-E**

Circle 79 on reader service card

Circle 80 on reader service card

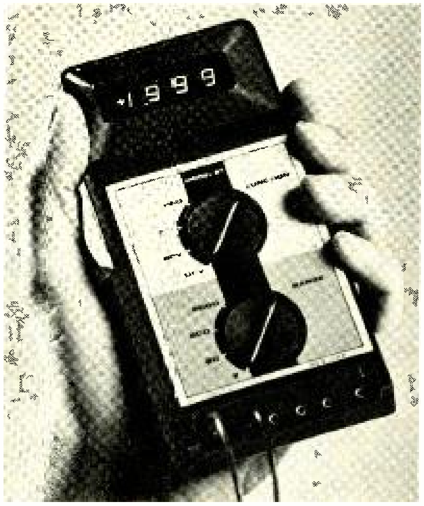
Circle 81 on reader service card

NEW PRODUCTS

(continued from page 84)

nents available off-the-shelf and a single PC board are used in the model 21.

To conserve battery charge life, the *model 21* has a push-to-read button on the side of the case. The unit remains off until the switch is depressed. For continuous operation, the push-to-read switch can be locked into the "on" position. An optional push-to-read probe is also available. $189.00, complete with battery charger and belt carrying case, batteries and test leads.—**Data Tech,** a Division of Penril Corp., 2700 South Fairview. Santa Ana, CA 92704. **R-E**



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new lit

All booklets, catalogs, charts, data sheets and other literature listed hee with a Reader Service number are free. Use the Reader Service Card inside the back cover.

SHORT-FORM CATALOG reviews the Wavetek line of test instruments. Included are function generators, phase meters, signal generators, sweep/signal generators, transmission test equipment, CATV test instruments, X-Y display oscilloscopes, attenuators, RF detectors and generator modules.—**Wavetek,** PO Box 651, San Diego, CA 92112 or PO Box 190, Beech Grove, IN 46107.

Circle 45 on reader service card

CRYSTAL GUIDE is a 68-page wealth of information listing replacement crystals for standard and synthesized CB rigs, monitor and scanner receivers and 2-meter amateur gear. All you need to know is the make and model number of the equipment or the manufacturers' part number of the desired crystal to select the correct replacement from the CTS Knights line.

Section I is a 26-page listing for standard CB rigs, Section II is an 18-page listing for synthesized equipment. Section II introduces the formulas needed to calculate the frequency of crystals needed to monitor specific channels. Section IV lists crystals for 2-meter amateur gear made by twelve manufacturers.—**CTS Knights, Inc.,** 400 Reimann Ave., Sandwich, IL 60548.

Circle 46 on reader service card

TAB BOOKS CATALOG. The latest edition lists the hundreds of books and booklets published under the *TAB* and *Gernsback Library* labels. The contents page breaks down the many listings into thirty categories for easy location of books on any desired subject.—**TAB Books,** Blue Ridge Summit, PA 17214.

Circle 47 on reader service card

MAGAZINE FOR ELECTRONIC MUSIC USERS, *Polyphony*, is a quarterly periodical primarily directed toward the user of electronic musical equipment rather than toward the designer. About one-third of the material in each issue will be contributed by readers. The current issue of *Polyphony* will be sent free upon request. Subscription price is $2.00 per year.—**Polyphony,** c/o PAIA Electronics, Inc., 1020 W. Wilshire Blvd., Oklahoma City, OK 73116. **R-E**

Circle 48 on reader service card

reader questions

LOSS OF VERTICAL SWEEP

I've got a black-and-white portable with no vertical sweep at all. I want to make a quick-check of the vertical output transformer and yoke. Can I use a separate 6.3 volt filament transformer to feed a signal into the output tube? This set has a series heater string.—J.G., Arlington, VA.

If you feed the test signal into the grid of the vertical output tube, OK. If you feed it directly to the plate, either disconnect the plate voltage or use a good-sized blocking capacitor (0.25 or 0.5 μF.)

TOO MUCH RIPPLE IN PICTURE

I wrote you before about checking the excessive ripple in the picture of a Gambles TV2-3701 black-and-white TV. You suggested checking ripple on the power-supply filters. That was it! I had to add 80 μF of extra capacitance to get rid of it! Works now. Thanks.—J.W., Hastings, MI.

Glad to hear I was right.

EXCESSIVE WIDTH

The raster in this Sylvania D05-14 is so wide that I can see only 8 vertical lines of a crosshatch pattern! All of the DC voltages seem to check out all right. I tried reducing the screen grid voltage of the horizontal output tube. That didn't work!—C.M., Diamond Bar, CA.

Well, there went one of my favorite ways of reducing excess width! So now what? In several cases this chassis has shown excessive width if that VDR from the pin-3 cathode of the 6CL8 high-voltage regulator tube to ground goes bad. This is part No. 38-15257-9. Replace with exact factory duplicate; couldn't find a listing on it. **R-E**

Circle 85 on reader service card

FUNCTION GENERATORS

(continued from page 42)

will decrease in output amplitude by as much as −2 dB when changed from the lowest to highest frequency. This −2 dB roll-off is due to filtering circuits used in the output amplifier to eliminate high-frequency discontinuities present in the synthesized sinewave.

Amplitude symmetry (DC offset)

As noted before, lack of time symmetry can cause an apparent DC offset in the output signal. The output signal may also have DC offset contributed by lack of symmetry in the limit detectors, and DC offset contributed by amplifying stages elsewhere in the generator. Amplitude symmetry is usually specified as a percentage match between the peak positive and negative amplitudes of a wave.

Output specifications

The output impedance, the maximum peak-to-peak output voltage, and the clipping level of the output voltage are all of interest to the potential user. The common output impedance of a function generator is 50 ohms. This value is chosen to permit driving low-impedance loads and to minimize reflections on the 50-ohm coaxial cables commonly used to connect the generator to a load. This is especially important when fast rise time square waves are used. Some lower-cost generators have sacrificed 50-ohm output impedance to reduce their price. These generators specify the 600-ohm output impedance common in the older sine/square oscillators.

The peak-to-peak output voltage of the generator is specified into the rated load impedance as well as into an open circuit. The open circuit voltage will be twice that of the loaded output voltage when the output impedance of the generator is the same as the rated load impedance. A common value of peak-to-peak output voltage is 10 volts minimum into the rated load. The value varies from manufacturer to manufacturer, and sometimes from model to model, and should be clearly noted when purchasing a function generator.

Frequently the sum of the peak output signal and the variable DC offset signal will exceed the peak limits of the output amplifier. When this condition occurs, the desired waveform may be clipped or otherwise distorted. Limit detectors are offered on some models of function generators. and a rare few offer an output amplifier with enough dynamic range to handle both the signal and the DC offset signal. The vast majority of function generator manufacturers expect the user to keep track of this condition.

Offset control

The offset control permits a variable amplitude/variable polarity DC bias to be applied to the output signal. This is usually a $\pm$ 5 volt offset signal. Generally, offset signals will not be attenuated with an increase in attenuation of the variable attenuator, but will be attenuated by the step attenuator. On some generators, offset may not be turned off, and some generators have switched position allowing the user to return to a signal symmetrical about zero volts. Offset is not available on all generators and is frequently deleted from low-cost units.

Attenuator

The amount of attenuation and the type of attenuators vary considerably from generator to generator as well as from manufacturer to manufacturer. The simplest attenuators are nothing more than a single variable control, offering as little as 20-dB attenuation and a maximum of 40 to 60 dB. Other function generators combine a variable control with 20-dB range with a step attenuator offering 10 or 20 dB per step. Step attenuations vary from one 20-dB section to six or seven 10-dB sections. Of course, the more attenuation sections available, the better. The maximum output voltage is usually known only to be greater than some specified value (say 10 volts) but not to be an exact voltage. For this reason, most attenuators are calibrated in decibels of attenuation rather than in voltage steps. The user interested in the exact signal voltage at the load should measure it separately.

Often the variable attenuator may appear to give more total attenuation than specified by the manufacturer. Use of the function generator at greater than specified attenuation levels may result in an output waveform with excessive distortion, resulting from high-frequency signals

(continued on page 92)

next month

JUNE 1976

- **Build Super-Pong & Bumper**

Two TV games that are fun to build and exciting to play. They connect into the video circuits of your TV set. IC circuitry. Complete plans and instructions start in this issue.

- **Video Discs & Tape**

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- **Ball Lightning And How To Make It**

You build a giant Tesla generator, of course, out in the desert and then. . . . But you'll have to read about this one for yourself. By the way have you ever seen 5- and 10-foot long electrical discharges?

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Jack Darr's Service Clinic

CHARTS & GRAPHS

(continued from page 62)

Log-log paper: Use for power functions—those involving "x" raised to a power, "n". This embraces all square-law equations, such as those connecting power and voltage or current. Example: Ln $P=I^2R$, I corresponds to "x", and "n" is 2. Plot I on the horizontal axis vs. P on the vertical axis. The plotted "curve" will then be a straight line.

Interestingly, log-log plots are also straight lines for reciprocal functions. Commonly-encountered reciprocal functions are the Ohm's law equations, $I=E/R$ and $R=E/I$. In the first equation, assume E is constant, then plot I on the vertical axis and R on the horizontal axis. In the second equation, assume E is constant, then plot R on the vertical axis and I on the horizontal axis.

Another reciprocal function is the equation connecting capacitive impedance or reactance, X_c with capacitance, C, and frequency, f. This equation is $X_c=\frac{1}{2\pi fC}$. Plot X_c on

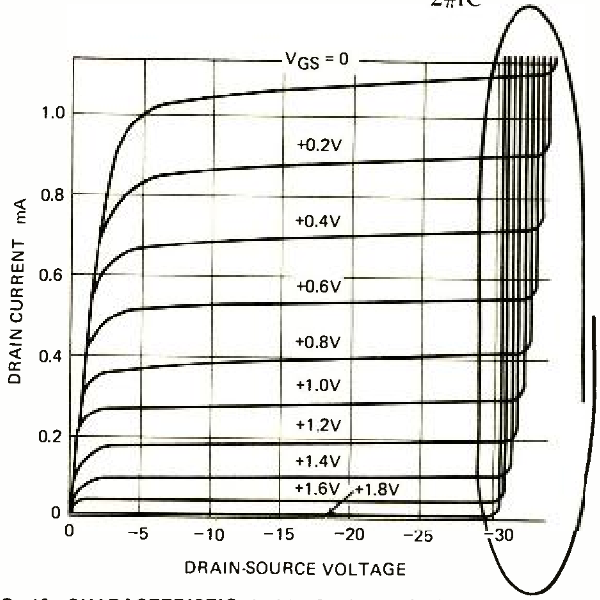

FIG. 10—CHARACTERISTIC CURVES of a typical junction FET. Circled portion is sometimes omitted.

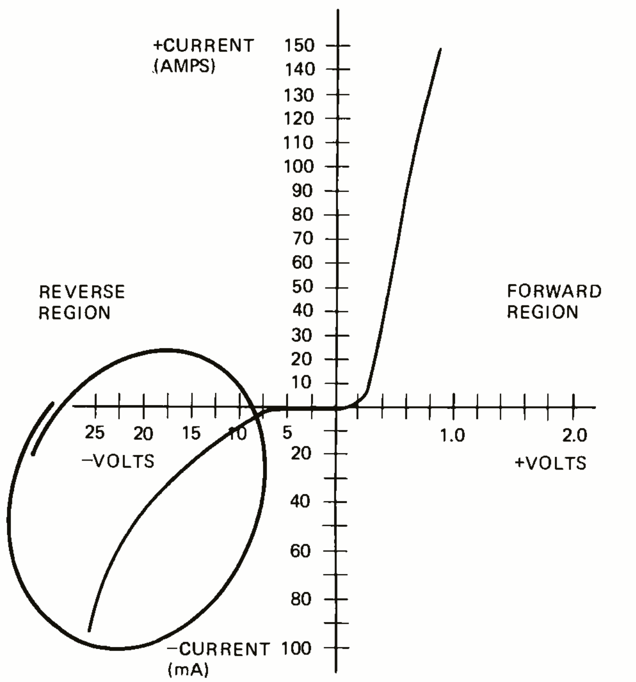

FIG. 11—BEHAVIOR of a Schottky diode. Circled portion is sometimes omitted.

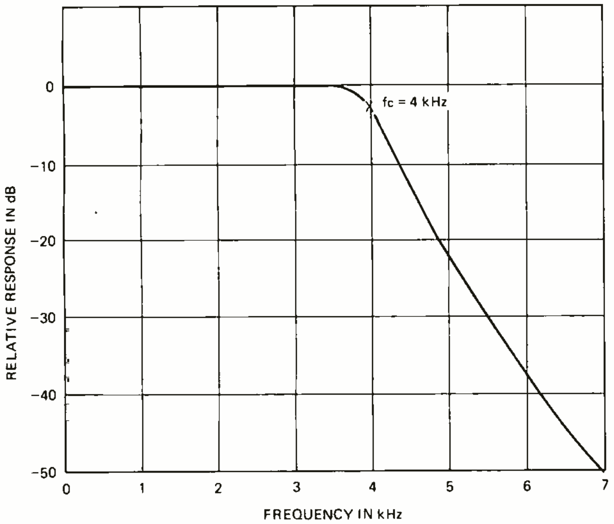

FIG. 12—RESPONSE of a 4-kHz low-pass filter plotted on conventional graph paper.

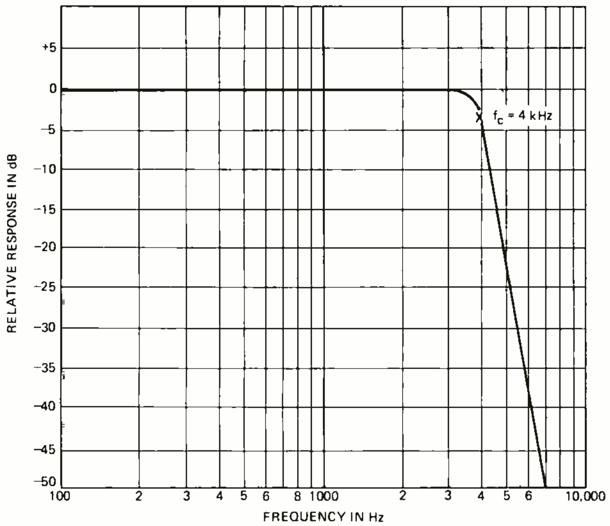

FIG. 13—SEMI-LOG GRAPH of response of same filter as in Fig. 12.

the vertical axis, and either f or C on the horizontal axis. (Actually, the reciprocal function is a power function in which the power of the exponent is −1. Thus, another way of writing the equation for capacitive impedance is $X_c = (2\pi fC)^{-1}$.)

Some graphical entrapments stem from incompleteness. Because of sales department specmanship or engineering department laziness, the encircled portions of the graphs in Figs. 10 and 11 are sometimes absent. This can lead to dire application results. There is nothing to warn us of the limits of allowable drain-source voltage for the FET. And unless you had reason to suspect otherwise, the inordinately low reverse avalanche voltage of the Schottky rectifier could lead to fireworks.

Graphs depicting the frequency response of tuned circuits, filters and other devices are often deceiving. Consider, as an example, the two plots of the same 4 kHz low-pass filter shown in Figs. 12 and 13. Both display the same information with respect to the "skirt". Yet, the semi-log plot of Fig. 13 appears to show much greater selectivity than is revealed by Fig. 12. Heightening the illusion, we see that the passband is geometrically longer in the semi-log plot than in the conventional plot. And that is despite the fact that a log scale has the ability to compress range! A filter maker would be guilty of no chicannery at all by showing the performance of his filters on semi-log plots. He would simply be putting his best foot forward! **R-E**

FUNCTION GENERATORS
(continued from page 88)

that capacitively bypass the attenuator and add to the desired signal.

Trigger output

A second output is frequently found on the function generator. This output is a square wave or a spike of a fixed level. The trigger signal is related to the leading edge of the square wave at the main output. This signal may be used to trigger such external devices as an oscilloscope, for example, in situations where the main output signal is attenuated below the point that would allow it to be used for this purpose. Often these trigger outputs are not 50-ohm amplifiers but are TTL outputs. Therefore, the user must remember that the waveform may not pass through zero volts, and may be of variable source impedance.

Other features

On the more exotic generators, features such as remote programmability, digital display of frequency, logarithmic frequency sweep, amplitude modulation, and variable symmetry control may be had, to mention a few of the more popular options. Most of these features will not be found on the low-cost function generators for a few years to come. Generators employing these features must be considered more than simple replacements for the sine/square oscillator. **R-E**

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The buyer must be provided with a cost-free device for this purpose such as a postpaid postcard or return envelope. If the buyer does not respond, it will be assumed that he has consented to an additional 30-day delay. For any longer delay, the customer's express consent must be gained; otherwise the money is to be refunded.

The rule also makes provision for indefinite delays if agreed to by the customer; though a refund must be made, if requested any time during the delay. It also requires sellers of mail-order merchandise to have a reasonable basis for any claims they make about shipping time.

Penalties are severe. The FCC can go to court to get an order for compliance by a company or they could have a company fined up to $10,000 for each day of non-compliance.

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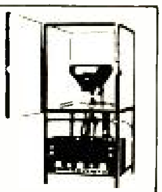

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7423	.31	7465	.35	74147	2.40	74185	2.19
7438	.35	7474	.35	74148	2.10	74190	1.30
7439	.41	7475	.59	74153	1 00	74196	1 29
7441	1.05	7480	.65	74154	1 30	74198	1 80
7442	.80	7483	.75	74155	1.04	74199	1 80
7444	.93	7485	1.08	74156	1.04	74200	5 60

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LM307	.30	LM380 8	1.05	3900	.55	550	.80
LM308	90	LM381	1.57	75451	39	555	75
LM309K	1.25	LM382	1.65	75452	39	556	1 35
LM310	1.13	A709	.32	75453	39	560	4.50
LM311	.95	A710	.45	75491	.75	561	4.50
LM319	1.24	A723	.65	75492	85	562	4.50
LM320K	1 30	A739	1.10	8038	4.25	563	2.95
LM324	1 54	A741	.35	8864	1 95	565	1.65
LM339	1 60	A747	.69	501	4 50	567	1.65

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2102	2.95	8223	3 00	2505	3.45	2529	5.80
5203	14 95	1101	1.75	2513	10 95	2532	4 95
5260	2.95	1103	3.25	2518	5.45	2533	7.75
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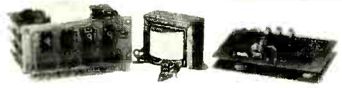

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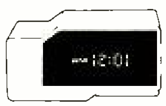

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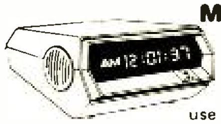

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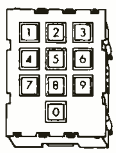

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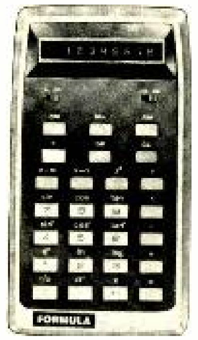

Kit Includes: Rockwell A4001 IC
HP 9 Digit LED Readouts
Complete Keyboard with Case
PC Board with all Electronic Parts
Instructions and Batteries

SPECIFICATION
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- 8 digits capacity for data entry or results
- (10^8 ~ 10^8)
- Full floating point
- Dome keyboard for excellent response and preventing double entry input

BASIC FUNCTION
- Algebraic mode operation
- Constant operations
- Repeat Operations
- Chain operations
- Change sign operation
- Display and Y register exchangeable
- One accumulating memory
- Display and memory exchangeable

SPECIAL FUNCTION
- Trigonometric functions (sin, cos, tan)
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AC adapter for the unit
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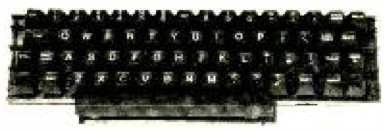

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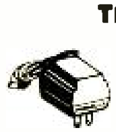

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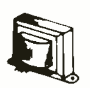

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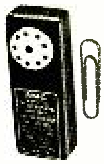

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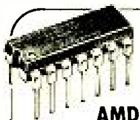

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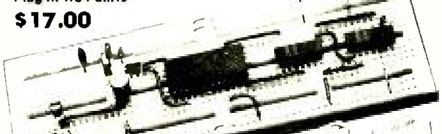
7401	.21	7474	.30	74175	.93	4002	.23	4075	.23
7402	.21	7475	49	74176	.79	4006	1.23	4081	.23
7403	.21	7476	.32	74177	.79	4007	.23	4082	.23
7404	.21	7480	.70	74180	.70	4008	.79	4502	.79
7405	.21	7482	.70	74181	2.15	4009	.44	4510	1.14
7406	.25	7483	.70	74182	.79	4010	.44	4511	1.05
7407	.25	7485	.89	74184	2.19	4011	.23	4514	2.80
7408	.21	7486	.28	74185	2.19	4012	.23	4515	2.80
7409	.21	7489	2.19	74188	3.50	4013	.40	4516	1.23
7410	.21	7490	.44	74189	3.50	4014	.96	4518	1.14
7411	.21	7491	.70	74190	1.23	4015	.96	4520	1.14
7412	.21	7492	.44	74191	1.23	4016	.40	4527	1.68
7413	.25	7493	.44	74192	.88	4017	1.05	4528	.88
7414	.89	7494	.70	74193	.88	4018	1.05	4585	1.23
7416	.25	7495	.70	74194	.88	4019	.23	LM309K	1.80
7417	.25	7496	.70	74195	.88	4020	1.14	LM324N	1.28
7420	.21	74100	1.28	74196	.88	4021	1.14	LM340T-5	1.25
7421	.25	74107	.30	74197	.88	4022	.96	LM340T-6	1.25
7423	.35	74109	.33	74198	1.49	4023	.23	LM340T-8	1.25
7425	.35	74121	.35	74199	1.49	4024	.84	LM340T-12	1.25
7426	.25	74122	.44	74251	1.09	4025	.23	LM340T-15	1.25
7427	.33	74123	.61	74279	.58	4026	1.68	LM340T-18	1.25
7428	.28	74125	.40	74365	.67	4027	.40	LM340T-24	1.25
7430	.21	74126	.40	74366	.67	4028	.89	LM3900N	.88
7432	.25	74132	.70	74367	.67	4029	1.14	NE536T	3.24
7433	.30	74141	.88	74368	.67	4030	.23	NE540L	2.04
7437	.25	74145	.70	75150	1.31	4033	1.51	NE555V	.48
7438	.25	74147	1.63	75450	.88	4034	3.50	NE556A	.88
7440	.21	74148	1.30	75451	.61	4035	1.14	NE560B	3.83
7441	.88	74150	1.16	75452	.61	4040	1.14	NE561B	3.83
7442	.53	74151	.70	75453	.61	4041	.79	NE562B	3.83
7443	.63	74153	.65	75454	.61	4042	.79	NE565A	1.25
7444	.63	74154	1.03	75491	.81	4043	.70	NE566V	1.28
7445	.70	74155	.70	75492	.84	4044	.70	NE567V	1.36
7446	.70	74156	.70	75493	1.09	4046	1.86	uA709CV	.44
7447	.70	74157	.70	75494	1.19	4049	.40	uA710CA	.44
7448	.70	74160	.88	8093	.40	4050	.40	uA711CA	.53
7450	.21	74161	.88	8094	.40	4051	1.26	uA723CA	.60
7453	.21	74162	.88	8095	.67	4052	1.26	uA741CV	.44
7454	.21	74163	.88	8096	.67	4053	.72	uA747CA	.70
7460	.21	74164	.96	8097	.67	4060	1.58	uA748CV	.49
7470	.30	74166	1.26	8098	.67	4066	.79	MC1458V	.53
7472	.30	74170	2.64	82S25	2.19	4071	.23	2102	2.65
		74173	1.42	4000	.23	4072	.23	8080A	49.95



AP SUPER STRIP II—Universal Breadboarding Element with 840 Solderless Plug-In Tie-Points

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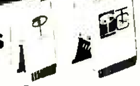

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All solderless plug-in tie-points

7 models for fast building and testing of circuits

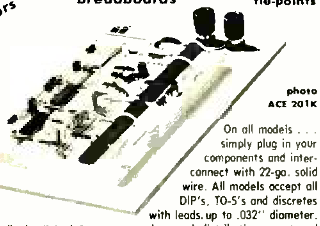

photo ACE 201K

On all models . . . simply plug in your components and interconnect with 22-ga. solid wire. All models accept all DIP's, TO-5's and discretes with leads up to .032" diameter.

Multiple buses can easily be linked for power and ground distribution, reset and clock lines, shift command, etc. Bases: gold-anodized aluminum. Terminals: non-corrosive nickel-silver. Four rubber feet included.

ACE Model No.	Tie Points	DIP Capacity	No. Buses	No. Posts	Board Size (Inches)	Price Each
200-K (kit)	728	8 (16's)	2	2	4-9/16x5-9/16	$18.95
208 (assem.)	872	8 (16's)	8	2	4-9/16x5-9/16	28.95
201-K (kit)	1032	12 (14's)	2	2	4-9/16x7	24.95
212 (assem.)	1224	12 (14's)	8	2	4-9/16x7	34.95
218 (assem.)	1760	18 (14's)	10	2	6-1/2x7 1/8	46.95
227 (assem.)	2712	27 (14's)	28	4	8x9-1/4	59.95
236 (assem.)	3648	36 (14's)	36	4	10-1/4x9-1/4	79.95

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14 Pin Solder Tab	.20
16 Pin Solder Tab	.22
18 Pin Solder Tab	.29
24 Pin Solder Tab	.38
28 Pin Solder Tab	.45
40 Pin Solder Tab	63
8 Pin Wire-Wrap	.24
14 Pin Wire-Wrap	.26
16 Pin Wire-Wrap	.30
18 Pin Wire-Wrap	.60
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1N4001	.64/10	5.50/C	1N4005	.82/10	7.05/C
1N4002	.66/10	5.60/C	1N4006	.90/10	7.75/C
1N4003	.68/10	5.80/C	1N4007	.99/10	8.60/C

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— Radial Lead —			— Axial Lead —			— Axial Lead —		
1uf/50v	.08	.65/10	1uf/50v	.11	.90/10	47uf/25v	.17	1.30/10
2.2uf/50v	.08	.65/10	2.2uf/50v	.12	.90/10	100uf/16v	.17	1.30/10
3.3uf/50v	.08	.65/10	3.3uf/35v	.12	.95/10	100uf/25v	.20	1.55/10
4.7uf/25v	.08	.65/10	3.3uf/50v	.12	1.00/10	100uf/50v	.29	2.30/10
4.7uf/50v	.08	.70/10	4.7uf/25v	.11	.90/10	220uf/16v	.20	1.55/10
10uf/25v	.08	.65/10	4.7uf/35v	.12	.95/10	220uf/25v	.29	2.35/10
10uf/50v	.10	.75/10	10uf/16v	.11	.90/10	330uf/16v	.29	2.35/10
22uf/25v	.09	.70/10	10uf/25v	.12	1.00/10	330uf/25v	.32	2.55/10
22uf/50v	.12	1.00/10	10uf/50v	.14	1.15.10	470uf/16v	.32	2.55/10
100uf/6.3v	.09	.75/10	22uf/16v	.12	1.00/10	470uf/25v	.37	3.00/10
100uf/16v	.11	.85/10	22uf/25v	.13	1.05/10	1000uf/16v	.39	3.15/10
100uf/25v	.13	1.10/10	33uf/16v	.12	1.00.10	1000uf/25v	.56	4.50/10
			33uf/25v	.14	1.15/10	2200uf/16v	.62	4.95/10
			47uf/16v	.14	1.15/10			

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2-56 ½ Screw	.99/C	7.65/M
4-40 ¼ Screw	.55/C	3.60/M
4-40 ½ Screw	.60/C	4.05/M
6-32 ¼ Screw	.65/C	4.40/M
6-32 ½ Screw	.75/C	4.85/M
8-32 3/8 Screw	.90/C	5.85/M
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4-40 Hext Nut	.55/C	3.75/M
6-32 Hex Nut	.60/C	4.00/M
8-32 Hex Nut	.60/C	4.15/M
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2200pf/500v	.04	.37/10
4700pf/500v	.04	.32/10
.01ufd/500v	.06	.50/10
.01ufd/50v	.03	.24/10
.022ufd/25v	.03	.28/10
.047ufd/25v	.05	.42/10
.1ufd/25v	.08	.62/10

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1N5231B	5.1v	.15	$11/C	1N5241B	11v	.15	$11/C
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RL20	.48
RL20-02	.48
RL20-03	.48
RL20-04	.48
RL21	.42
RL21-02	.42
RL21-04	.42
RL50	.28
RL50-D1	.28
RL50-02	.28
RL50-03	.28
RL54	.21
RL55	.29
RL55-5	.21
RL209	.29
RL-2000	.39
RL-4403	.32
RL-4415	.55
RL-4484	.19
RL-4850	.19
RL-5054-1	.27
RL-5054-2	.52
RL-5054-5	.19
GL-56	.60
GL-4484	.75
GL-4850	.75
DL-30	.33
OL-31	.30
RLC-200	.54
RLC-201	.54
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TIL223	.49
TIL302	4.95
TIL303	4.95
TIL304	4.95
TIL305	7.95
TIL306	8.95
TIL308	8.95
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TIL311	11.95
TIL312	1.70
TIL313	1.70
TIL32	.90
TIL63	.75
TIL78	.60
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FCD802	.65
FCD806	.70
FCD820A	.80
FLV117	.18
FLV310	.55
FLV410	.55
FND357	1.75
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FNS700	.60
FPT100	.70

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AY5-1013P	7.75		8 Bit UART
AY5-2376	19.95		88 x 3 x 9 Keyboard Encoder
MF1101AP	3.50		MOS RAM 256 Bit
MF11D3-P	3.95		MOS RAM 1024 Bit
MF1403AT	3.25		Dual 512 Dynamic Shift Register
MF1404AT	3.00		1024 x 1 Dynamic Shift Register
MF1702AR	15.50		Static 256 x 8 PROM
MF2102P	3.50		1D24 x 1 Static RAM 500 NS
MF8008R	17.95		MOS 8 Bit CPU 50D KHZ
MM6300J-1	5.95		256 x 4 PROM (open collector)
MM6301J-1	5.95		256 x 4 PROM Tristate
MM6305J-1	11.95		512 x 4 PROM (open collector)
MM6306J-1	11.95		512 x 4 PROM Tristate
MM6701D	34.95		4 Bit Expandable Bipolar C.P.U.
COM2D17	8.95		8 Bit UART
CDM2502	8.50		8 Bit UART
COM2601	23.50		Universal Synchronous Receiver Transmitter
TMS3112NC	6.00		Hex 32 Bit Static Shift Register
TMS3113NC	6.00		Dual 133 Bit Static Shift Register
TMS3133NC	7.50		1024 Bit Static Shift Register
TMS3409NC	4.95		Quad 8 Bit Dynamic Shift Register
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TMS4030JL	16.95	(22 PIN)	4K Dynamic RAM Ceramic 300 NS
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TMS8080NC	29.95		
TMS5501JL	29.95		
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3342PC	5.50		Quad 64 Bit Static Shift Register
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93427PC	4.95		Tri-State 256 x 4 PROM
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LM301AN-8 (Mini Dip)	.39	General Purpose Operational Amplifier
LM304H	.75	Precision Voltage Negative Regulator
LM305H	.78	Positive Voltage Regulator
LM307H	.28	Operational Amplifier
LM307 N-8 (Mini Dip)	.28	Operational Amplifier
LM308H	1.25	Precision Operational Amplifier
LM308AN	2.75	Precision Operational Amplifier
LM309H	.75	Five Volt Regulator
LM309K (TO3)	1.34	Five Volt Regulator
LM310H	1.09	Voltage Follower
LM311H	1.40	Voltage Comparator
LM318H	1.50	Precision High Speed Operational Amplifier
LM323K	7.50	3 Amp 5 volt Regulator
LM324N	1.10	Quad op amp
LM339N	1.20	Quad Comparator
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LM556N-14	.99	Dual Timer
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LM7D9CH	.29	Operational Amplifier
LM710CH	.95	Differential Comparator
LM711CH	.50	Dual Channel Differential Comparator with strobes
LM720CN-14	1.50	Dual Differential Comparator
LM723CH	.52	Voltage Regulator
LM723CN-14	.52	Voltage Regulator
LM733CN-14	1.40	Differential Video Amp
LM739CN-14	1.25	Dual Stereo Pre-amp
LM741CH	.29	Operational Amplifier
LM741CN-14	.29	Operational Amplifier
LM741CN-8 (Mini Dip)	.28	Operational Amplifier
LM747CN-14	.75	Dual Operational Amplifier
LM747CH	.65	Dual Operational Amplifier
LM748CN-14	.45	Operational Amplifier
LM748CN-8 (Mini Dip)	.29	Operational Amplifier
LM748CH	.45	Operational Amplifier
LM1436CH	1.95	High voltage op amp
LM1458H	.65	Dual Operational Amplifier
LM1458N-8 (Mini Dip)	.79	Dual Operational Amplifier
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LM1488D	1.98	Quad Line Driver
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LM1489AD	2.45	Quad Line Receiver VT plus equals 1.75V
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LM3046N-14	.85	Transistor Array
LM3086	.63	Transistor Array
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LM3900N	.60	Quad op Amplifier
LM4136N	2.25	Quad op Amplifier
LM7800 Series TO-3	2.25	Positive Voltage Regulators 5, 6, 8, 12, 15, 18, 24 volts
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LM78L00 AWC Series TO-92	.45	Positive Voltage Regulators 70 MA 2, 5, 6, 12, 15, 26, 62, 82 Volts
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LM7900 Series TO-220	1.87	Negative Voltage Regulators, 1 amp 5, 6, 8, 12, 15, 18, 24 Volts
LM79M00 Series TO-5	1.80	Negative Voltage Regulators, ½ amp 5, 6, 8, 12, 15, 20, 24 Volts
LM79M00 Series TO-220	1.60	Negative Voltage Regulators, ½ amp 5, 6, 8, 12, 15, 20, 24 Volts
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79GU1 TO-220	1.75	1 Amp Adjustable Negative Voltage Regulator
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SN74LS04N	.35	SN74LS91N	1.25	SN74LS192N	2.50
SN74LS05N	.35	SN74LS92N	1.15	SN74LS193N	2.50
SN74LS08N	.29	SN74LS93BN	1.15	SN74LS194AN	1.45
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SN74LS10N	.29	SN74LS96N	1.75	SN74LS196N	1.45
SN74LS11N	.29	SN74LS107N	.59	SN74LS197N	1.45
SN74LS12N	.29	SN74LS109N	.59	SN74LS221N	1.35
SN74LS13N	.75	SN74LS112N	.59	SN74LS247N	1.30
SN74LS14N	1.48	SN74LS113N	.59	SN74LS248N	1.30
SN74LS15N	.29	SN74LS114N	.59	SN74LS249N	1.30
SN74LS20N	.29	SN74LS122N	.90	SN74LS251N	1.60
SN74LS21N	.29	SN74LS123N	1.10	SN74LS253N	1.60
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SN74LS27N	.35	SN74LS126N	.75	SN74LS261N	2.95
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SN74LS33N	.40	SN74LS139N	1.68	SN74LS290N	1.35
SN74LS37N	.40	SN74LS145N	1.35	SN74LS293N	1.35
SN74LS38N	.40	SN74LS151N	1.30	SN74LS295AN	1.75
SN74LS40N	.35	SN74LS153N	1.30	SN74LS298N	1.75
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SN74LS47A	1.20	SN74LS156N	1.45	SN74LS352N	1.45
SU74LS48N	1.20	SN74LS157N	1.35	SN74LS353N	1.70
SN74LS49N	1.20	SN74LS158N	1.25	SN74LS365N	.75
SN74LS51N	.29	SN74LS160N	2.25	SN74LS366N	.75
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LM304H	1.00	LM380CN	1.05	LM1556V	1.85
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Y - YELLOW
O - ORANGE

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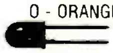
XC209R	5/$1
XC209G	4/$1
XC209Y	4/$1
XC209O	4/$1

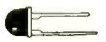
.185" dia.

XC526R	5/$1
XC526G	4/$1
XC526Y	4/$1
XC526O	4/$1



.190" dia.

XC111R	5/$1
XC111G	4/$1
XC111Y	4/$1
XC111O	4/$1



.200" dia.

XC22R	5/$1
XC22G	4/$1
XC22Y	4/$1
XC22O	4/$1

.200" dia.

XC556R	5/$1
XC556G	4/$1
XC556Y	4/$1
XC556O	4/$1

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MV50
.085" dia. Micro red led
6/$1

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MAN 4	COMMON CATHODE	187	1.95	DL750	COMMON CATHODE	600	2.49
MAN 7	COMMON ANODE	300	1.50	DL338	COMMON CATHODE	110	1.25
MAN 7G	COMMON ANODE-GREEN	300	2.50	FND70	COMMON CATHODE	250	.50
MAN 7Y	COMMON ANODE-YELLOW	300	2.50	FND500	COMMON CATHODE	500	1.75
MAN 72	COMMON ANODE	300	1.50	FND507	COMMON ANODE	500	1.75

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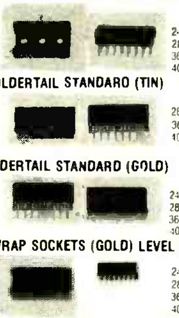

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.17	16	15	24 pin	$.38	37	36
14 pin	20	.19	18	28 pin	45	44	.43
16 pin	22	.21	20	36 pin	60	.59	.58
18 pin	29	28	27	40 pin	.63	.62	61
22 pin	37	36	35				

SOLDERTAIL STANDARD (TIN)

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

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.30	27	.24	24 pin	$.70	63	.57
14 pin	.35	32	.29	28 pin	1.10	1.00	90
16 pin	.38	35	32	36 pin	1.75	1.40	1.26
				40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
10 pin	$.45	41	37	24 pin	$1.05	.95	85
14 pin	39	38	37	28 pin	1.40	1.25	1.10
16 pin	43	.42	.41	36 pin	1.59	1.45	1.30
18 pin	75	.68	.62	40 pin	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

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

ALL OTHER RESISTORS FROM 2.2 OHMS - 5.6M AVAILABLE IN MULTIPLES OF 5 ea 5-25 PCS .05 ea. 30-95 PCS. .04 ea 100-495 PCS .03 ea 500-995 .027 ea

14 PCS. POTENTIOMETER ASSORTMENTS

ASST. A 2 ea: 10 OHM-20 OHM-50 OHM-100 OHM-200 OHM-250 OHM-500 OHM
ASST. B 2 ea: 1K, 2K, 2.5K, 10K, 20K, 25K, 50K
ASST. C 2 ea: 50K, 100K, 200K, 250K, 500K, 1M, 2M

$9.95 Per Asst.

Each assortment contains 14 pcs of 10 turn pots. All pots are available in single unit quantities. $.99 ea.

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California Residents — Add 6% Sales Tax — Data Sheets 25c each
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PHONE ORDERS — (415) 592-8097

74LS00 TTL

74LS00	.39	74LS55	.39	74LS151	1.55
74LS02	.39	74LS73	.65	74LS153	1.89
74LS03	.39	74LS74	.65	74LS157	1.55
74LS04	.45	74LS75	.79	74LS162	2.25
74LS05	.45	74LS76	.65	74LS163	2.25
74LS08	.39	74LS83	2.19	74LS164	2.25
74LS10	.39	74LS86	.65	74LS181	3.69
74LS13	.79	74LS90	1.25	74LS190	2.85
74LS14	2.19	74LS92	1.25	74LS191	2.85
74LS20	.39	74LS93	1.25	74LS192	2.85
74LS26	.49	74LS95	2.19	74LS193	2.85
74LS27	.45	74LS96	1.89	74LS194	2.25
74LS28	.49	74LS107	.65	74LS195	2.25
74LS30	.39	74LS112	.65	74LS257	1.89
74LS32	.45	74LS132	1.55	74LS260	.55
74LS40	.49	74LS136	.65	74LS279	.79
74LS51	.39	74LS138	1.89	74LS670	5.95

DIP SWITCH
These switches feature four SPST Rocker switches in a molded dip. They are ideally suited for microprocessor applications. $1.95

MINATURE TOGGLE

DPDT				JMT	1	2-9	10-29	30-99
	ON	OFF	ON	221	3.05	2.66	1.97	1.78
	ON	NONE	ON	223	2.85	2.26	1.88	1.51
	ON	OFF	ON	121	2.35	1.95	1.43	1.30
	ON	NONE	ON	123	2.05	1.65	1.21	1.10

PUSH BUTTON

SPDT — SERIES PB, PB1

	Model Number	1 Each	Quanity net prices 2-9	10-29	30-99
Maintained Action Switch. Push To Make Contact And Push Again To Reserve Action	PB-123	$2.35	$1.95	$1.47	$1.30
Momentary Action Switch. Normally Open or Normally Closed (For N.C. circuit use terminals 2 & 1; for N.O. 2 & 3; for N.C. and N.O. 1, 2, & 3)	PB-126	$2.35	$1.95	$1.47	$1.30

5 AMP RATINGS

THUMBWHEEL SWITCHES

THUMBWHEEL SWITCH ONLY
SF - Front Mount SR - Rear Mount

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.

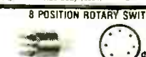
ACCESSORIES

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 Plates (pair)	$.50
SR DP	Divider Plate (each)	40
SR BB	Blank Body (each)	40
SR HB	Half Body (each)	40

8 POSITION ROTARY SWITCH



$.79

These switches are a 7 position, one position open rotary switch enclosed in a TO-5 can. They have a standard 8 pin configuration and will mount perfectly on printed circuit board.

ZENERS—DIODES—RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4005*	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006*	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007*	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N965B	15	400m	4/1.00	1N4154	35	10m	12/1.00
1N5232	5.6	500m	28	1N4734	5.6	1w	28
1N5234	6.2	500m	28	1N4735	6.2	1w	28
1N5235	6.8	500m	28	1N4736	6.8	1w	28
1N5236	7.5	500m	28	1N4738	8.2	1w	28
1N456	25	40m	6/1.00	1N4742	12	1w	28
1N458	150	7m	6/1.00	1N4744	15	1w	28
1N485A	180	10m	5/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4003	200 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00
1N4004	400 PIV	1 AMP	12/1.00				

TRANSISTORS

MPS A05	5/$1.00			PN4249	4/$1.00
MPS A06	5/$1.00	PN3567	3/$1.00	PN4250	4/$1.00
2N2219A	3/$1.00	PN3568	4/$1.00	2N4400	4/$1.00
2N2221	4/$1.00	PN3569	4/$1.00	2N4401	4/$1.00
2N2222A	5/$1.00	2N3704	5/$1.00	2N4402	4/$1.00
2N2369	5/$1.00	2N3705	5/$1.00	2N4403	4/$1.00
2N2369A	4/$1.00	2N3706	5/$1.00	2N4409	5/$1.00
FN2415	5/$1.00	2N3707	5/$1.00	2N5086	4/$1.00
2N2484	4/$1.00	2N3711	5/$1.00	2N5087	4/$1.00
2N2906A	4/$1.00	2N3724	$.65	2N5088	4/$1.00
2N2907A	5/$1.00	2N3725	$1.00	2N5089	4/$1.00
2N2925	5/$1.00	2N3903	5/$1.00	2N5129	5/$1.00
2N3053	2/$1.00	2N3904	4/$1.00	2N5138	5/$1.00
2N3055	$.89	2N3905	4/$1.00	2N5139	5/$1.00
MJE3055	$1.00	2N3906	4/$1.00	2N5209	5/$1.00
MJE2955	$1.25	2N4013	3/$1.00	2N5951	5/$1.00
2N3392	5/$1.00	2N4014	3/$1.00	C106B1SCR	2/$1.00
2N3398	5/$1.00			2N5432	$2.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	.05	.04	.03	.001µF	.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

	1-9	10-49	50-100		1-9	10-49	50-100
.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

	1-9	10-49	50-100		1-9	10-49	50-100
.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	1-9	10-49	50-100	Radial Lead	1-9	10-49	50-100
.47 50V	.15	.13	.10	.47 25V	.15	.13	.10
1.0 50V	.16	.14	.11	.47 50V	.16	.14	.11
3.3 50V	.15	.13	.10	1.0 16V	.15	.13	.10
4.7 25V	.16	.14	.12	1.0 25V	.16	.14	.11
10 25V	.15	.13	.10	1.0 50V	.16	.14	.11
10 50V	.16	.14	.12	4.7 16V	.15	.13	.10
22 25V	.17	.15	.12	4.7 25V	.15	.13	.10
22 50V	.24	.20	.18	4.7 50V	.16	.14	.11
47 25V	.19	.17	.15	10 16V	.14	.12	.09
47 50V	.25	.21	.19	10 25V	.15	.13	.10
100 25V	.24	.20	.18	10 50V	.16	.14	.12
100 50V	.35	.30	.28	47 50V	.24	.21	.19
220 25V	.32	.28	.25	100 16V	.19	.15	.14
220 50V	.45	.41	.38	100 25V	.24	.20	.18
470 25V	.33	.29	.27	100 50V	.35	.30	.28
1000 16V	.55	.50	.45	220 16V	.23	.17	.16
2200 16V	.70	.62	.55	470 25V	.31	.28	.26

Circle 106 on reader service card

Circle 107 on reader service card

AT LAST!

4 & 6 DIGIT PC BOARDS

PC Board for 4 digit display MAN series or DL707	$1.75
PC Board for 6 digit display MAN series or DL707	$2.25
PC Board for 4 digit display FND503	$2.00
PC Board for 6 digit display FND503	$3.00
PC Board for 4 digit display DL747	$2.50
PC Board for 6 digit display DL747	$3.00
PC Board for 4 digit display DL727	$2.25
PC Board for 6 digit display DL727	$3.00
PC Board for 4 digit display FND70	$1.75

All PC display Boards are multiplexed for adding additional digits.

DL747
Jumbo .6 in. high, and only 20mA per segment.
$2.75

DL727
One of our best readouts .5 in. high, 20 mA per segment. Common anode.
$3.75

DL707
Red, .30 in. high 15 mA per segment. Common anode $1.25

DL33
If you like an array of displays, we have it. 10mA per segment. Common Cathode.
$1.45

HP7730
.33 in. high, red very bright readout. 25mA per segment. Common anode.
$1.20

MAN 5 GREEN
MAN 7 RED
MAN 8 YELLOW
Why not make a clock in 3 diff. colors. .27 in. high. Common anode. $1.25

BURROUGHS 12 DIGIT
.25 in. high orange digit. 160V DC. Free skt. $3.25

FND503
$1.60
5 for $7.50
New .5 in. display by Fairchild. Common Cathode.

LEDs

Mini red	.12
Jumbo red	.15
Jumbo green	.20
Jumbo yellow	.25

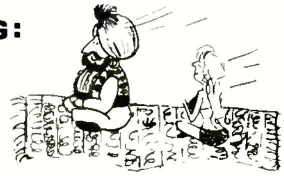
DISPLAY SPECIAL $1.30

Fully multiplexed, common cathode. Goldplated. Ideal fo. mini 6 digit clock.

THE KING OF ALTAJ

INTRODUCING: FATIMA

FOUR DIGIT TEMPERATURE KIT



FATIMA, the first in a series of time sharing kits to interface with THE KING.

FATIMA – FEATURES: $19.95

1) 4-digit temperature display
2) Farenheit or Centigrade
3) Temperature 10 sec. display; time 20 sec. display
4) Complete C-Mos application
5) Kit uses 7002 4-digit counter

Kit includes all components, PC Board and instructions for interfacing with THE KING 6-digit alarm clock.

Watch next issue for yet another addition!

THE KING – FEATURES:

1) 6 digit, 12 hr. 60 cycle or 24 hr. 50 cycle alarm clock
2) Time sharing capability for display of additional information.
3) Built-in alarm generator and automatic output for intensity control of LEDs.
4) Single 12v. supply and a minimum of interface components.
5) AM-PM and automatic power failure indications.
6) 10 minute snooze
7) Complete data and construction manual enclosed.

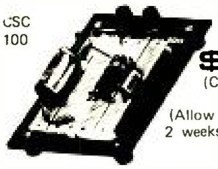
THE KING $23.50

Kit No. 70250-1R (Red readouts)
Kit No. 70250-1G (Green readouts)
Kit No. 70250-1Y (Yellow readouts)
Kit No. 70250-2R (DL727 readouts) $28.50
Kit No. 70250-3R (DL747 readouts) $28.50

All kits include Components, PC Boards, Transformer, and Case.

CSC 100

NEW Proto Board $19.95



(Complete Kit)

(Allow 2 weeks for Delivery)

We now offer a full line of Continental Specialties Proto Boards, Clips, Monitors, etc.

LOOK!

From Altaj to you, a special offer.

Power Supply Kit ; 5Volt 1Amp. Reg.
Line regulation .005%
Load regulation 50mV

Kit includes Components, PC board, Transf., Fuse
Pilot Light
Nothing else to buy: $5.50

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7438	.35
7440	.16
7442	.69
7447	.89
7448	.89
7453	.16
7473	.37
7474	.37
7475	.65
7476	.39
7483	.85
7490	.69
7492	.75
7493	.75
7495	.75
7496	.75
74121	.38
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CD4017	1.29
CD4018	1.49
CD4019	.59
CD4020	1.59
CD4021	1.49
CD4022	1.19
CD4023	.24
CD4024	.99
CD4025	.24
CD4026	1.49
CD4027	.59
CD4028	.99
CD4029	1.39
CD4030	.49
CD4032	.24
CD4033	1.49
CD4034	3.25
CD4035	1.39
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CD4040	1.59
CD4041	.89
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CD4044	.59
CD4047	.59
CD4049	.59
CD4050	.59
CD4066	.99
CD4077	.39
74C02	.29
74C04	.29
74C107	1.29

$ DOLLAR DAYS $

FORD SOLID STATE MODULES
Module contains 2 transistors plus other components. Used as audio pre amps. With specs 4/$1

TANTALUM CAPS
4.7 MFD 10VDC. Axial. 10/$1

ELECTROLYTIC CAPS
220 MFD 25 VDC. PC type 5/$1

DUAL ELECTROLYTIC CAPS
1500 MFD + 2000 MFD 30VDC. Metal can, twist lock. 2/$1

CERAMIC DISC CAPS
.01 MFD 50 VDC 20/$1
68 MFD 50 VDC 20/$1

12 VDC REED RELAY
Coil is 500 OHM. SPST-NO. Sub-mini. EA. $1

PUSH BUTTON SWITCHES
Miniature momentary switches 4/$1

POLAROID FILTERS
Pale green in color. 2.3 x 12 in. Use with various readouts 2/$1

TRANSFORMER SPECIAL NO.1
Mini. size, 8 VAC 400 MA under load $1

CPU

8008	8 bit parallel CPU	19.50
2102	1K Static RAM for 8008	2.25
MM5203	2K UV eraseable PROM	12.25

LED DRIVERS

75491 Seg. .35
75492 Dig. .45

6 Function Calculator Chip
Chip No. 7020 with direct segment drive. 8 digit.

Priced to sell: $2.25

TRANSISTORS

2N3055 NPN 115W TO3 Power	0.85
RCA200V 115W TO5 Power NPN	1.25
GE D40C1 NPN Darl. Cut Lead	0.25
2N4443 SCR 400V 8Amp TO220	0.65
2N2222 NPN Gen. Ampl.	0.20
2N3904 NPN Driver	0.15
2N3906 PNP Complim. 2N3904	0.15
2N4400 NPN Low level noise	0.20
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GE Transistor Assortment
TO98 cased Darling., SCRs, NPN, PNP, etc. Tests show very high yield.
50 for $0.95
100 for $1.75
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Satisfaction Guaranteed.

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60 Watt COLOR ORGAN

Completely self-contained unit, with 120 volt power cord included.

$1.50

TTL BOARDS

MEMOREX computer boards with TTL's Diodes and Transistors, etc.

5 Boards containing 150-250 IC's. $3.95

FM Transformer Asst.
Includes FORD 19 KHZ, 38 KHZ, Osc. coils, etc. Used in AM FM car radios. All new 10 PC. ASSMT.
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1N746	3.3Zen.	4 for 1.00
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555 Timer Mini dip.	0.45
8038 Functional generator	4.25
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565 Phase Lock Loop	0.95
567V Tone Decoder	1.50
LM723 Pos. Volt. Reg.	0.55
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Circle 112 on Reader Service Card

Circle 113 on Reader Service Card

Circle 114 on Reader Service Card

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ALARM CLOCK KIT SIX DIGIT LED

Thousands of hobbyists have bought and built our original clock kit and were completely satisfied. But we have received many requests for an alarm clock kit with the same value and quality that you have come to expect from S.D. So, here it is!

THE KIT INCLUDES:

1 Mostek 50252 Alarm Clock Chip
6 Hewlett Packard .30 in. common cathode readouts.
15 NPN Driver Transistors
1 Etched and Drilled P.C. Board set
1 Step Down Transformer
2 Switches for time set
2 Slide Switches for alarm set and enable
1 Filter Cap
4 IN4002 Rectifiers
1 IN914 Diode
1 .01 Disc Cap
15 Resistors
1 Speaker for alarm
1 LED lamp for PM indicator.

$16.50
(COMPLETE KIT)

Why pay MORE MONEY for our competitor's clock that has LESS DIGITS that are SMALLER in size?

Please take note that we use only first run parts in our kits and include ALL the necessary parts. Not like some of our competitors who use retested readouts and chips or who may not even include switches in their kits.

60 Hz. Crystal Time Base

FOR DIGITAL CLOCKS $5.95

S. D. SALES EXCLUSIVE!

The kit you have been waiting for is here **NOW**, and at an unbelievable price! Thanks to S.D. Sales you can turn that digital clock of yours into a superbly accurate, DC operated, time piece.

KIT FEATURES:

A. 60 Hz output with accuracy comparable to a digital watch.
B. Directly interfaces with all MOS clock chips.
C. Super low power consumption (1.5 Ma typ.)
D. Uses latest MOS 17 stage divider IC.
E. Eliminates forever the problem of AC line glitches.
F. Perfect for cars, boats, campers, or even for portable clocks at ham field days.
G. Small size, can be used in existing enclosures.

BUY TWO FOR $10.00

Kit includes crystal, divider IC, P.C. Board plus all other necessary parts and specs.

2102 1K RAM's - 8 FOR $12.95

New units ——— We bought a load on a super deal, hence this fantastic price. Units tested for 500NS Speed.

INTEL 1702A 2K ERASEABLE PROM'S $6.95

We tell it like it is. We could have said these were factory new, but here is the straight scoop. We bought a load of new computer gear that contained a quantity of 1702A's in sockets. We carefully removed the parts, verified their quality, and are offering them on one heck of a deal. First come, first served. Satisfaction guaranteed.

MV-50 TYPE LED's by *LITRONIX* **10 for $1** *Factory Prime!*

3 DIGIT LED ARRAY — 75c by *LITRONIX*
DL33MMB. 3 MAN-3 Size Readouts in one package. These are factory prime, not retested rejects as sold by others. compare this price! 75c 3 for $2.

SALE ON CUT LEAD SEMICONDUCTORS

Leads were cut for PCB insertion. Still very useable.

1N914/1N4148	100/$2
1N4002 1 Amp 100 PIV	40/$1
1N4745A 16V 1W Zener	20/$1
EN2222 NPN Transistor	25/$1
EN2907 PNP Transistor	25/$1
2N3904 NPN Driver Xstr.	25/$1
2N3392 GE Pre-amp Xstr.	25/$1
C103Y SCR. 800MA. 60V	10/$1

ALL NEW. UNUSED. SOME ARE HOUSE #

SLIDE SWITCH ASSORTMENT

Our best seller. Includes miniature and standard sizes, single and multi-position units. All new, first quality, name brand switches. Try one package and you'll reorder more. *Special — 12 for $1* (Assortment)

DISC CAP ASSORTMENT

PC leads. At least 10 different values. Includes .001, .01, .05, plus other standard values.
60 FOR $1

UPRIGHT ELECTROLYTIC CAPS

47 mfd 35 V-10/$1 68 mfd 25V-8/$1
Brand new by Sprague. PC leads.

RESISTOR ASSORTMENT

1/4 W 5% and 10%. PC leads.
A good mix of values. 200/$2

1000 MFD FILTER CAPS

Rated 35 WVDC. Upright style with P.C. leads. Most popular value for hobbyists. Compare at up to $1.19 each from franchise type electronic parts stores. *S.D. Special 4 for $1*

FAIRCHILD BIG LED READOUTS

A big .50 inch easy to read character. Now available in either common anode or common cathode. Take your pick. Super low current drain, only 5 MA per segment typical.

FND - 510 Common Anode
FND - 503 Common Cathode
YOUR CHOICE $1.50 ea. 6 for $7.50

DUAL 741C (5558) OP AMPS

Mini dip. New house numbered units by RAYTHEON.
4 FOR $1

FET'S BY TEXAS INSTRUMENTS — SPECIAL 5 for $1

#TIS-75 but with an internal house number. TO-92 plastic case. N. Channel, Junction type FET.

We do not sell junk. Money back guarantee on every item. No C.O.D. Texas Res. add 5% tax. Postage rates went up 30%! Please add 5% of your total order to help cover shipping.

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P.O. BOX 28810
DALLAS, TEXAS 75228

Circle 115 on reader service card

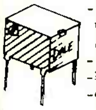
Spring-Pac super SALE! Each pac only $1.98

All pacs are first quality (no fallout), tested and guaranteed.

Memory pac 4 MM5016 MOS TO-5 512 BIT shift registers from NATIONAL - with data **$1.98**	**Flip-Flop pac** 10 assorted Flip-Flops, Dual JK's, RST's, and low power FF's, with data **$1.98**	**Comparator pac** 5 assorted DIP's-- LM311, 710, 711, with data **$1.98**
TTL Gates 15 assorted DIP's 7400 series-7420, 7430, 7440, etc...All prime, marked parts, with data **$1.98**	**LED pac** 10 assorted discrete LED's-green, red, and infra-red, with data. **$1.98**	**Transistor pac** 40 assorted TO-92 plastic transistors-- PNP's and NPN's, mostly Fairchild house marked. **$1.98**
Regulators 4 LM723 DIP variable regulators, 2-40V, with data **$1.98**	**Diodes** 100 Germanium computer signal diodes with leads trimmed for PCB mounting. **$1.98**	**Resistors** 100 ¼ watt 5% resistors of any single standard value from 2.7 ohm to 1M ohm **$1.98**
Linear pac 8 assorted linears in mini-DIP or TO-5*741 op amp, LM307 op amp, LM 703 RF-IF amp, with data and circuits **$1.98**	**DIP RC Network** 50 assorted 14 and 16 pin IC packages containing precision resistors and capacitors-no data available **$1.98**	**Switches** 8 SPST momentary contact push button N.O. Red button fits in approx. ¼" panel, with lock washer and mounting nut. **$1.98**
LED Display pac 2 DL33 - 3 digits each, approximately .1" magnified digits in a 12 pin DIP, with data **$1.98**	Buy 5 pacs for $9.90 and pic-a-pac for 10¢	The above are special offerings from Babylon Electronics, and will be shipped third class. See bottom of ad for ordering instructions.

Specials

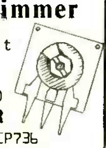
DIP TRIMMER



-12 turn trimpots which plug into a DIP socket
-5K and 200K
-¼" x ¼" x ¼"
-4 leads spaced .3" x .2"

Each $.65 10 for $4.95

25K Trimmer



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

TRANSISTOR

2N3904 - HEP736
TO92 PLASTIC - NPN
300 MW - 60V - β100-300
NEW - FAIRCHILD - MARKED
EACH $ .15 10 FOR $1.00

1 AMP RECTIFIER

1N4007 SALE EACH $ .13 10/ $1.00

NPN TO3 POWER TRANSISTORS

2N3055: PD-115W; VCE-60V; HFE-50; FT-30K.
Each $ .90 10 for $6.95
410 (RCA) 200V-10A
2N3772 70V-30A (max.)
Each $1.75 10 for $15.00

CMOS

CD4001	$ .29	CD4023	.29
CD4002	.29	CD4024	1.50
CD4009	.59	CD4025	.34
CD4010	.59	CD4030	.65
CD4011	.29	74C20	.65
CD4013	.69	74C42	2.0D
CD4015	1.98	74C157	2.50
CD4016	.69	74C195	1.D0
CD4019	.69		

2102-2 MOS 1024 BIT MEMORY

14 PIN DIP ON CARRIERS
Each $3.00 10 for $27.00

1 Amp OP AMP

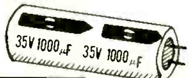
Similar to National LH0021 General purpose operational amplifier in a TO-3 package. Capable of large output currents.

$4.50 each 5/$20.00

Capacitors

PCB vertical mount electrolytic capacitors. 2" long, 3/4" dia.

59¢ ea. 10 for $5.00



TTL

7400	$ .20	74L54	$ .25
74H00	.25	74L55	.25
7401	.14	7460	.16
74H01	.25	74L71	.20
7402	.25	7472	.40
7404	.25	74L72	.60
74H04	.30	7473	.35
7405	.30	74L73	.75
7406	.40	7474	.45
7408	.30	74H74	.75
7410	.12	7475	.8-
7413	.75	7476	.35
7417	.40	74L78	.70
7420	.12	7480	.50
74L20	.25	7483	.7D
74H20	.18	7489	2.00
74H22	.30	7490	.70
7430	.10	7492	.35
74H30	.30	7493	1.00
74L30	.30	7495	.65
7440	.10	74L95	1.00
74H40	.22	74107	.25
7442	1.00	74123	.75
7447	1.50	74145	1.25
7450	.10	74155	.90
74H50	.30	74174	1.00
7451	.10	74180	1.00
74H51	.25	74192	.70
7453	.10	74193	1.00
7454	.20	75492	1.00

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1702-2048 BIT PROM. 2K static units. Ultra-violet light erasable.
EACH $9.95

SPACE AGE CLOCK KIT

Instructions & parts - 12 or 24 hour format.
Four digit clock kit includes all parts for complete clock: 3¼"x 2":
-FND 70 readouts
-MM5314 clock chip & all transistors, etc.
-extruded aluminum case
-cord with transformer plug

$16.95

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All IC's are new and fully tested. Leads are plated with gold or solder. Due to increased costs, orders under $7.00 add $1.00 postage and handling. Residents of California add sales tax. Orders are shipped within 2 workdays-kits are shipped within 10 days. $10 minimum order on C.O.D.'s.

Circle 116 on reader service card

NEW! Low-cost, full feature 4kx8 kit! ECONORAM™ $89.95

Other manufacturers have picked up on our buffered addresses and data outputs...and they've started using hysteresis on the data in lines, too...and static operation...but we've got the recipe on keeping the price down. ALTAIR 8800 PLUG-IN COMPATIBLE. Onboard regulation, sockets for all ICs, lots of bypassing, low power consumption (1A typ), double sided, industrial quality board, instructions. Like Bill says, "the only thing we skimped on was the price".

Software in a kit for 8080s: $159.95

The "ECONOROM" is 4k bytes of erasable ROM, pre-programmed with editor, assembler, and monitor routines for the 8080. Or order the board unprogrammed...and put your own software into a memory that does not forget. LOW POWER OPERATION...ALTAIR 8800 PLUG-IN COMPATIBLE. Comes with quality parts, instructions, and software listing. Listing available separately for $2.95.

Microcomputer Power Supply

$44.95 brings you 5V at 5 Amps, +12V at ½A, -12V at ½A, and an adjustable negative bias supply. Foldback current limiting and crowbar overvoltage protection. 1% regulation on the 5 volt line guaranteed. Same size as the JOLT power supply card. With chassis & hardware but no line cord. For 117VAC, 60 Hz. ADD 8 LBS SHIPPING

4kx8 at a bargain: NAKED RAM $79.95

A general purpose board designed for JOLT systems, but it's also at home with any bi-directional buss system. If you don't need the on-board regulation or buffers of our ECONORAM 4k x 8 board, then this is the way to implement cost-effective memory. Low power: under 750 ma. With instructions and all parts except edge connector.

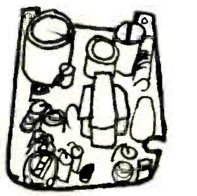
Do you know how to get our FLYER? It's EASY!

GODBOUT CIRCLE THE READER SERVICE # BELOW.

BILL GODBOUT ELECTRONICS***BOX 2355***OAKLAND AIRPORT, CA 94614.
Terms: Add 50¢ to orders under $10. Add shipping where shown. Cal res add tax. Mastercharge®/Bankamericard®: (415) 357-7007, 24 hrs.

Circle 127 on reader service card

ELECTRONIC STROBE CIRCUIT BOARD

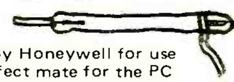


This circuit board is the heart of of a portable electronic strobe, made by a well known camera maker. It has a DC to DC converter to charge a cap to 370v from a 3v battery, and the the trigger transformer to fire the strobe tube. It is complete except for the tube, storage cap & battery. The boards that we have are pre-inspection boards; that is, we find that about 50% are operable as-is. The others just have solder splashes to be removed or bent leads. We provide the PC layout and schematic.

This board is the basis for a portable strobe light, using the strobe tube below. By adding the Light Activated SCR, below, it can be used as a slave strobe. By using a smaller storage cap, a strobe-tach for psychedelic effects can be made, with a max. flash rate of about 20 per second. Also handy for a portable emergency light. It is a very compact 2" x 2" x 1" high.

STOCK NO. R6311 $3.95 each, 2/6.00

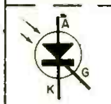
FLASH TUBE



A Krypton/Xenon flash tube made by Honeywell for use in their portable strobe units. A perfect mate for the PC board above. Energy input: 50 watt-sec, Max flash voltage: 400v, trigger voltage: 4kv, life: 100,000 flashes. 2" long, .18" diameter.

STOCK NO. R9244 $2.50 each, 2/4.50

SPECIAL! flash tube & PC board $6.00 a set, 2 sets/$11.00



LIGHT ACTIVATED SCR, triggered by light falling on a lens which acts as the gate. 200v rating. Use with above board or any flash to make a slave strobe. With reprint from PE/ Elec. Exp. Handbook on "Light Activated Slave Strobe Trigger".

STOCK NO. R4118 $1.50 each, 2/2.50
LASCR, flash tube, & PC board $7.50/set, 2 sets/14.00

Send for our free catalog. Phone orders welcome, MASTERCHARGE & BANKAMERICARD accepted. ALL numbers must be included to process order. Minimum order $5. Include sufficient postage; excess will be refunded.

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P.O. BOX 2, AMESBURY, MASS. 01913
Phone (617) 388-4705

Circle 117 on reader service card

Poly Pak's $1,000,000 SALE

BUY 'EM FROM THE "BARREL" AND SAVE!
100'S OF BARRELS PURCHASED!

Your choice of any kit $1.98

EXCLUSIVE 'BARREL'

Every kit carries money back guarantee.

THE BIGGEST INFLATION-FIGHTING VALUE EVER! TEST 'EM YOURSELF 'N SAVE!

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!

NEVER BEFORE!

U-TEST EM-N-CHOOSE EM IC'S

Order by Cat. No. and Type No.

NEW FACTORY ARRANGEMENTS! Why mix 'em? They decided to "bag" same types, then throw bags into barrels. WE DON'T TEST! You test 'em yourself. Buy types of your choice at BARREL PRICES!

7400 SERIES

Cat. No. 5R3170

Type	Sale
☐ SN7400	50 for $1.98
☐ SN7402	50 for 1.98
☐ SN7404	40 for 1.98
☐ SN7410	50 for 1.98
☐ SN7413	25 for 1.98
☐ SN7420	50 for 1.98
☐ SN7440	50 for 1.98
☐ SN7442	25 for 1.98
☐ SN7452	50 for 1.98
☐ SN7474	40 for 1.98
☐ SN7475	30 for 1.98
☐ SN7476	30 for 1.98
☐ SN7483	40 for 1.98
☐ SN7486	40 for 1.98
☐ SN7490	25 for 1.98
☐ SN7493	30 for 1.98
☐ SN7495	30 for 1.98
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☐ SN74112	40 for 1.98
☐ SN74123	30 for 1.98
☐ SN74125	40 for 1.98
☐ SN74150	30 for 1.98
☐ SN74157	30 for 1.98
☐ SN74164	30 for 1.98
☐ SN74173	30 for 1.98
☐ SN74192	30 for 1.98
☐ SN74193	30 for 1.98
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MONEY BACK GUARANTEE PER PAK!

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☐ LM324N	30 for 1.98
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☐ LM380N	30 for 1.98
☐ LM380V*	30 for 1.98
☐ LM381N	30 for 1.98
☐ LM382N	30 for 1.98
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☐ LM1458V	30 for 1.98
☐ LM1810N	30 for 1.98
☐ LM1902N	30 for 1.98
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☐ LM7535N	40 for 1.98
☐ LM7538N	40 for 1.98
☐ LM75451V*	40 for 1.98
☐ LM75491N	30 for 1.98
☐ LM75492N	30 for 1.98

*Mini †TO-5

BARREL KIT #1 SN7400 DIP IC'S 75 for $1.98
Marked 14 and/or with 16 pin dips, may include gates, registers, flip flops, counters. Who knows! GUARANTEED SATISFACTION! Cat.No. 5R2415 Untested.

BARREL KIT #2 LINEAR OP AMPS, DIPS Untested 75 for $1.98
May include 709's, 741's, 703's, 560 series, 555 includes marked and unmarked. Cat.No.5R2416

BARREL KIT #3 1N4148/914 SWITCHING DIODES 100 for $1.98
You never saw this before. Imagine famous switching diodes at these prices! Cat.No. 5R2418 Untested.

BARREL KIT #4 "4000" RECTIFIERS 100 for $1.98 Untested.
These are the famous micro miniature rectifiers of the 1N4000 series. May include 25, 50, 100, 200, 400, 600, 800 and 1000 volters. Cat.No. 5R2417

BARREL KIT #5 SCRS, TRIACS, QUADRACS 40 for $1.98
All the famous plastic power tab type. Raw factory stock! All the 10 amp types. Cat.No.5R 2419 Untested.

BARREL KIT #7 VOLUME CONTROL BONANZA! 40 for $1.98 100% good
Singles, duals, variety of values, styles, big ones — small ones. Cat.No. 5R 2421

BARREL KIT #8 SUBMINIATURE IF TRANSFORMERS 100% good. 100 for $1.98
Amazing, includes 455kcs, osc, antenna, who knows? From transistor radio manufacturers. Cat.No. 5R 2422

BARREL KIT #10 ROMS-REGISTERS 50 for $1.98 Untested
28 to 40 pin devices, marked, internal factory numbers, etc Cat.No.5R2424

BARREL KIT #12 POWER TAB TRANSISTORS 40 for $1.98
PNP, plastic TO220 type. Assorted 2N numbers. Cat.No.5R2426 Untested.

BARREL KIT #13 RESISTOR NETWORKS 60 for $1.98 Untested.
By Corning Glass, in 14-pin dip paks. Cat.No.5R 2427

BARREL KIT #15 MOSFET TRANSISTORS 60 for $1.98
All 4 leaders TO-18 case, includes UHF transistors too! Cat.No.5R2429

BARREL KIT #17 LINEAR & 7400 DIPS Untested 100 for $1.98
Marked and unmarked, internal numbers of raw factory stock. Cat.No.5R2431

BARREL KIT #19 DIPPED MYLARS 60 for $1.98
Finest capacitors made, shiny finish. Imagine factory dumping 'em in barrels. Cat.No.5R2597 100% good.

BARREL KIT #20 LONG LEAD DISCS 150 for $1.98
Factory distributor stock "auction sale". Prime, marked only. Long leads Cat.No 5R2598 100% good

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

BARREL KIT #26 PLASTIC TRANSISTORS 100 for $1.98 Untested.
Type TO-92 (TO-18), all manufacturers, variety of 2N #'s. Cat.No.5R 2604

BARREL KIT #30 PREFORMED RESISTORS 250 for $1.98
We got barrels of 1/4 and 1/2" watters for pc use. You'll get even amount. 100: 1/4, 100 1/2" watters. Cat.No.5R2608 100% good

BARREL KIT #31 METALLIC RESISTORS 100 for $1.98 100% good.
Made mostly by Corning, the finest resistor made. Mostly 1/2 watters. 1% to 5% tol. & a barrel of values. Cat.No.5R2609

BARREL KIT #32 TRANSISTORS WITH A HOLE IN IT 50 for $1.98
Cat.No. 5R2610 Untested. Can't name factory but we bought barrels of 25 watters with mtg. hole in middle. PNP'S and NPN'S.

BARREL KIT #35 NEON LAMPS 40 for $1.98 100% good.
Famous NE-2's. All prime, but factory made millions and barrel'ed 'em. Your advantage Cat.No.5R2613

BARREL KIT #36 GERMANIUM DIODES 200 for $1.98 Untested
Famous maker, popular item. Never grows old. But this is the way the RE-TESTERS buy 'em from the factories. Cat.No.5R2614

BARREL KIT #37 1 AMP "BULLETT" RECTIFIERS Untested. 100 for $1.98
Famous style, asstd. voltages, silicon, axial includes all types of voltages to 1KV. Cat.No.5R 2615

BARREL KIT #38 2 AMP RECTIFIERS 75 for $1.98 Untested.
"CYLINDER" type, silicon. Mallory, includes all voltages up to 1KV. Axial leads. Cat.No.5R2616

BARREL KIT #39 2N3055 HOBBY TRANSISTORS 15 for $1.98 100% good.
From factory to you, these fallouts of the famous 2N3055. We have 10 barrels. Cat.No.5R2617

BARREL KIT #40 PNP HIGH-POWER TRANSISTORS 20 for $1.98
Popular germanium TO-3 case units, now available at "good ole barrel" prices. Cat.No.5R2618 100% good.

BARREL KIT #46 G.E. 3.5 WATT AMPLIFIERS 25 for $1.98 Untested.
Hobby type, factory fallouts, we purchased them in barrels. These are unknowns. Cat.No.5R 2624

BARREL KIT #50 SIGNAL SILICON DIODES 200 for $1.98
Includes many, many types of switching, signal silicon types, all axial leads. Some may be zeners. Cat.No. 5R2628 Untested.

BARREL KIT #51 HOBBY OPTO COUPLERS Untested. 40 for $1.98
We bot 1,000's unknown both the sensor or transmitter may be good, or both. WE DON'T KNOW! We don't know the types. 1500V isolation. Cat.No. 5R2629

BARREL KIT #52 DISCS! 500 for $1.98
Cat.No.5R2630 100% good
The bargain of a lifetime! First time ever offered by Poly Paks for the economy-minded bargain hunters.

BARREL KIT #53 JUMBO RESISTOR PAK 100-pc. $1.98
Cat.No.5R2721 Assortm metal films, precisions, carbons, metal oxide powers, from 1/8 watt to 7 watts. Color coded & 100% good. Worth $10.

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.5R 2726 100% good.

BARREL KIT #59 POWER TRANSISTORS 40 for $1.98
15 watt Bendix B-5000 pellet transistors, npn, all good, purchased from a pretester, have millions of 100% good Cat.No. 5R2727

BARREL KIT #60 DTL'S IC'S 75 for $1.98 Untested.
This is prime barrel material. Who wants DTL's? 930, 936, 946's. Your gain is our loss. They're marked too. Cat.No.5R 2728

BARREL KIT #61 POLYSTYRENE CAPS 100% good 100 for $1.98
Finest caps made. As a gamble we bought 10 barrels from factory, mixed values; all good. Cat.No. 5R 2729

BARREL KIT #65 MIXED READOUTS 15 for $1.98
Factory returns — such numbers as MAN-4's, MAN-7's, MAN-3's, 11 barrels & no time to separate. Cat.No. 5R2733 Untested.

BARREL KIT #68 2 WATTERS 100 for $1.98 100% good.
Nobody seems to want 'em! So many suppliers don't count, but throw 'em in the barrel. It's a li'l gold mine All marked. Cat.No.5R2735

BARREL KIT #71 CAPACITOR SPECIAL 100 pcs. $1.98
Emptied stockrooms into barrels of mylars, poly's, micas, moldeds, plastics, ceramics, discs, etc. Nifty 100% good. Cat.No.5R 2738

BARREL KIT #73 TRANSISTOR ELECTROS 50 for $1.98
It "bugs" us why the factories dump 'em in barrels. We don't wish to separate wide asst voltages & values up to 300 mf. Cat. 5R2747

BARREL KIT #75 400MW ZENERS 100 for $1.98
Factory out of biz! Amazing offer: 6, 8, 10, 12 to 15V. You test. Hermetically sealed glass pak. Double plug. Cat.No.5R2740

BARREL KIT #76 1-WATT ZENERS 100 for $1.98 Untested.
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BARREL KIT #78 "RED" BODY TRANSISTORS 40 for $1.98
D-42 series. You test—go into your own biz! High current, hi-V, NPN. Cat.No.5R2743 Untested

BARREL KIT #81 SUBMINI RESISTORS 200 for $1.98 100% good.
PC, upright type, color coded, 1/8 watt. Asst values. Came to us in a barrel. Cat.No. 5R2746

BARREL KIT #83 15 for $1.98 LM-340T VOLTAGE REGULATORS Untested
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BARREL KIT #87 NATIONAL IC BONANZA 100 for $1.98
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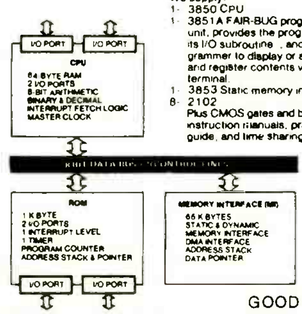

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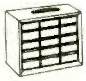

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RESISTOR ASSORTMENT
R (OHMS)

R	QTY	R	QTY	R	QTY	R	QTY	R	QTY	R	QTY
1.5	5	68	5	1.0K	20	10K	20	100K	20	1.5M	5
3.3	5	100	10	1.5K	10	15K	10	150K	10	2.2M	5
6.8	5	150	10	2.2K	20	22K	10	220K	10	3.3M	5
10	10	220	10	2.7K	10	27K	10	270K	5	4.7M	5
15	5	270	5	3.3K	10	33K	20	330K	10		
22	5	330	10	3.9K	10	39K	10	470K	10		
33	5	470	20	4.7K	20	47K	10	680K	10		
47	10	680	10	6.8K	10	68K	10	1.0M	20		

TTL

		7451	.17	74154	1.25
7400	$ .14	7453	.17	74155	1.07
7401	.16	7454	.17	74156	1.07
7402	.15	7460	.17	74157	.99
7403	.16	7464	.35	74158	1.79
7404	.19	7465	.35	74160	1.39
7405	.19	7470	.30	74161	1.25
7406	.35	7472	.30	74162	1.49
7407	.35	7473	.35	74163	1.39
7408	.18	7474	.35	74164	1.59
7409	.19	7475	.57	74165	1.59
7410	.16	7476	.39	74166	1.49
7411	.25	7483	.79	74170	2.30
7413	.55	7485	1.10	74173	1.49
7416	.35	7486	.40	74174	1.62
7417	.35	7489	2.48	74175	1.39
7420	.16	7490	.59	74176	.89
7422	.26	7491	.97	74177	.84
7423	.29	7492	.71	74180	.90
7425	.27	7493	.60	74181	2.98
7426	.26	7494	.94	74182	.79
7427	.29	7495	.79	74184	2.29
7430	.20	7496	.79	74185	2.29
7432	.23	74100	1.30	74187	5.95
7437	.35	74105	.44	74190	1.35
7438	.35	74107	.40	74191	1.35
7440	.17	74121	.42	74192	1.25
7441	.98	74122	.45	74193	1.19
7442	.77	74123	.85	74194	1.25
7443	.87	74125	.54	74195	.89
7444	.87	74126	.63	74196	1.25
7445	.89	74141	1.04	74197	.89
7446	.93	74145	1.04	74198	1.79
7447	.89	74150	.97	74199	1.79
7448	1.04	74151	.79	74200	5.90
7450	.17	74153	.99		

LOW POWER TTL

74L00	$ .25	74L51	$ .29	74L90	$1.49
74L02	.25	74L55	.33	74L91	1.45
74L03	.25	74L71	.25	74L93	1.69
74L04	.25	74L72	.39	74L95	1.69
74L06	.25	74L73	.49	74L98	2.79
74L10	.25	74L74	.49	74L164	2.79
74L20	.33	74L78	.79	74L165	2.79
74L30	.33	74L85	1.25		
74L42	1.49	74L86	.69		

HIGH SPEED TTL

74H00	$ .25	74H21	$ .25	74H55	$ .25
74H01	.25	74H22	.25	74H60	.25
74H04	.25	74H30	.25	74H61	.25
74H08	.25	74H40	.25	74H62	.25
74H10	.25	74H50	.25	74H72	.39
74H11	.25	74H52	.25	74H74	.39
74H20	.25	74H53	.25	74H76	.49

8000 SERIES

8091	$ .53	8214	$1.49	8811	$ .59
8092	.53	8220	1.49	8812	.89
8095	1.25	8230	2.19	8822	2.19
8121	.80	8520	1.16	8830	2.19
8123	1.43	8551	1.39	8831	2.19
8130	1.97	8552	2.19	8836	.25
8200	2.33	8554	2.19	8880	1.19
8210	2.79	8810	.69	8263	5.79
				8267	2.59

9000 SERIES

9002	$ .35	9309	$ .79	9601	$ .89
9301	1.03	9312	.79	9602	.79

CMOS

		4016A	.56	4050A	.59
4000A	$ .26	4017A	1.19	4066A	.89
4001A	.25	4020A	1.49	4068A	.44
4002A	.25	4021A	1.39	4069A	.44
4006A	1.35	4022A	1.10	4071A	.26
4007A	.26	4023A	.25	4072A	.35
4008A	1.79	4024A	.89	4073A	.39
4009A	.57	4025A	.25	4075A	.39
4010A	.54	4027A	.59	4078A	.39
4011A	.29	4028A	.98	4081A	.26
4012A	.25	4030A	.44	4082A	.35
4013A	.45	4035A	1.27	4528A	1.60
4014A	1.49	4042A	1.47	4585A	2.10
4015A	1.49	4049A	.59		

74C00	$ .22	74C74	$1.04	74C162	$2.93
74C02	.26	74C76	1.34	74C163	2.66
74C04	.44	74C107	1.13	74C164	2.66
74C08	.68	74C151	2.61	74C173	2.61
74C10	.35	74C154	3.15	74C195	2.66
74C20	.35	74C157	1.76	80C95	1.35
74C42	1.61	74C160	2.48	80C97	1.13
74C73	1.04	74C161	2.93		

NEW ITEMS

TTL

74132	$ .89
74H101	.58
74H102	.58
74H103	.63
74H106	.63
74H108	.63

SCHOTTKY

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

LOW POWER SCHOTTKY

74LS00	$ .36
74LS02	.36
74LS04	.36
74LS08	.38
74LS10	.36
74LS20	.36
74LS32	.38
74LS40	.45
74LS74	.59
74LS90	1.30
74LS93	1.30
74LS95	2.09
74LS107	.59
74LS164	2.20
74LS193	2.50

METAL FILM RESISTORS
±1% ¼ WATT

QTY	PRICE EACH	PRICE MINIMUM 10 PER VALUE	PRICE MINIMUM 100 PER VALUE
0 - 10	$.20		
10 - 100	.20	$.15	
100 - 1000		.10	$.09
1000 -		.10	.08

RESISTANCE (OHMS)

22.6	71.5	182	887	11.8K	40.2K
23.7	78.7	187	1.15K	13.0K	45.3K
25.5	84.5	191	1.5 K	15.0K	48.7K
30.9	105	205	2.49K	18.2K	54.9K
34.8	110	232	3.57K	19.1K	60.4K
40.2	115	243	4.75K	19.6K	64.9K
45.3	137	499	5.49K	22.6K	69.8K
51.1	147	604	6.04K	24.9K	84.5K
61.9	158	715	7.15K	28.0K	
64.9	178	806	8.25K	37.4K	

TANATLUM CAPACITORS SOLID-DIPPED ±20%

.1 mfd	35V	.25 ea.	6.8 mfd	6V	.30 ea.
.33 mfd	35V	.25 ea.	6.8 mfd	50V	.40 ea.
1 mfd	35V	.25 ea.	10 mfd	25V	.40 ea.
2.2 mfd	20V	.25 ea.	15 mfd	10V	.40 ea.
2.2 mfd	35V	.30 ea.	33 mfd	10V	.40 ea.
4.7 mfd	16V	.30 ea.	47 mfd	6V	.40 ea.

MISC. DEVICES

546	AM radio receiver subst. DIP	$ .75
2513	64 x 8 x 5 character generator	$11.00
CA3046	Transistor array 14 pin DIP	.89

LED's

MV10B	Red TO 18	$ .22
MV50	Axial leads	.18
MV5020	Jumbo Vis. Red (Red Dome)	.22
	Jumbo Vis. Red (Clear Dome)	.22
ME4	Infra red diff. dome	.54
MAN1	Red 7 seg. .270"	2.19
MAN2	Red alpha num .32"	4.39
MAN4	Red 7 seg. .190"	1.95
MAN5	Green 7 seg. .270"	3.45
MAN6	.6" high solid seg.	4.25
MAN7	Red 7 seg. .270"	1.19
MAN3	Red 7 seg. .127" straight pins	.29
MAN8	Yellow 7 seg. .270"	3.45
MAN66	.6" high spaced seg.	3.75
MCT2	Opto-iso transistor	.61

MEMORIES

1101	256 bit RAM MOS	$ 1.50
1103	1024 bit RAM MOS	3.95
1702A	2048 bit static PROM UV eras.	17.95
2102-2	1024 bit static RAM	4.25
5203	2048 bit UV eras PROM	17.95
5260	1024 bit RAM	2.49
5261	1024 bit RAM	2.69
5262	2048 bit RAM	5.95
7489	64 bit ROM TTL	2.48
82S23	Programmable ROM	3.69
74200	256 bit RAM tri-state	5.90
F93410	256 bit bipolar RAM	2.19

MULTIPLE DISPLAYS

NSN33	3 digit .12" red led 12 pin fits IC skt.	$1.79
HP45082 7405	5 digit .11 led magn. lens com. cath	3.49
HP5082 7414	4 digit .11 LED magn. lens comm. cath.	3.25
FNA37	9 digit 7 seg led RH dec clr. magn. lens	4.95
SP-425-09	9 digit .25" neon direct interface with MOS/LSI, 180 VDC, 7 seg.	1.79

CALCULATOR & CLOCK CHIPS

5001	12 DIG 4 funct fix dec	$2.49
5002	Same as 5001 exc btry power	2.79
5005	12 DIG 4 fuct w/mem	2.99
MM5725	8 DIG 4 funct chain & dec	1.98
MM5736	18 pin 6 DIG 4 funct	4.45
MM5738	8 DIG 5 funct K & mem	5.35
MM5739	9 DIG 4 funct (btry sur)	5.35
MM5311	28 pin BCD 6 dig mux	4.45
MM5312	24 pin 1 pps BCD 4 dig mux	3.95
MM5313	28 pin 1 pps BCD 6 dig mux	4.45
MM5314	24 pin 6 dig mux	4.45
MM5316	40 pin alarm 4 dig	5.39

SHIFT REGISTERS

MM5013	1024 bit accum. dynamic mDIP	$1.75
MM5016	500/512 bit dynamic mDIP	1.59
SL5-4025	QUAD 25 bit	1.29

DTL

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

Data sheets on request. With order add $.30 for items less than $1.00 ea.

LINEAR CIRCUITS

L100	Red LED	.15
L101	Red LED	.15
300	Pos V Reg (super 723) TO-5	$ .71
301	Hi Perf Op Amp mDIP TO-5	.29
302	Volt follower TO-5	.53
304	Neg V Reg TO-5	.97
305	Pos V Reg TO-5	.71
307	Op AMP (super 741) mDIP TO-5	.26
308	Mciro Pwr Op Amp mDIP TO-5	.89
309K	5V 1A regulator TO-3	1.35
310	V Follower Op Amp mDIP	1.07
311	Hi perf V Comp mDIP TO-5	.95
319	Hi Speed Dual Comp DIP	1.13
320T	Neg Reg 5, 12, 15, TO-3	$1.39
320K	Neg Reg 5.2, 12 TO-3	1.39
322	Precision Timer DIP	1.70
324	Quad Op Amp DIP	1.52
339	Quad Comparator DIP	1.58
340K	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-3	1.69
340T	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-220	1.49
372	AF-IF Strip detector DIP	2.93
376	Pos V Reg mDIP	2.42
380	2w Audio Amp DIP	1.13
380-8	.6w Audio Amp mDIP	1.52
381	Lo Noise Dual preamp DIP	1.52
382	Lo Noise Dual preamp DIP	.71
550	Prec V Reg DIP	.89
555	Timer mDIP	.89
556A	Dual 555 Timer DIP	1.49
560	Phase Locked Loop DIP	3.95
562	Phase Locked Loop DIP	3.95
565	Phase Locked Loop DIP TO-5	2.38
566	Function Gen mDIP TO-5	2.25
567	Tone Decoder mDIP	2.66
703	RF IF AMP mDIP	.45
709	Operational AMP TO-5 or DIP	.26
710	Hi Speed Volt Comp DIP	.35
711	Dual Difference Compar DIP	.26
723	V Reg DIP	.62
733	Diff. video AMPL TO-5	.89
739	Dual Hi Perf Op Amp DIP	1.07
741	Comp Op Amp mDIP TO-5	.32
747	741 Dual Op Amp DIP or TO-5	.71
748	Freq Adj 741 mDIP	.35
1304	FM Mulpx Stereo Demod DIP	1.07
1307	FM Mulpx Stereo Demod DIP	.74
5556/ MC1456	Int. compensated Op Amp mDIP	1.59
1458	Dual Comp Op Amp mDIP	.62
1800	Stereo multiplexer DIP	2.48
LH2111	Dual LM 211 V Comp DIP	1.70
3900	Quad Amplifier DIP	.35
MV5020	Jumbo green	.22
7524	Core Mem Sense AMPL DIP	.71
7525	Dual core mem. sense AMPL DIP	.98
8038	Voltage contr. osc. DIP	4.25
8864	9 DIG Led Cath Drvr DIP	2.25
75150	Dual Line Driver DIP	1.75
75451	Dual Perepheral Driver mDIP	.35
75452	Dual Peripheral Driver mDIP	.35
75453	(351) Dual Periph Driver mDIP	.35
75491	Quad Seq Driver for LED DIP	.71
75492	Hex Digit driver DIP	.80

Satisfaction guaranteed. Shipment will be made via first class mail in U.S., Canada and Mexico within 5 days from receipt of order. Add $.75 to cover shipping and handling for orders under $25.00. Minimum order $5.00. California residents add sales tax.

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Circle 120 on reader service card

ZENER DIODES 500 mW – 5%

	V	1-9	10up		V	1-9	10up
IN5223B	2.7	.45	.40	IN5246B	16	.45	.40
IN5224B	2.8	.45	.40	IN52478	17	.45	.40
IN5225B	3.0	.45	.40	IN5248B	18	.45	.40
IN5226B	3.3	.45	.40	IN5249B	19	.45	.40
IN5227B	3.6	.45	.40	IN5250B	20	.45	.40
IN5228B	3.9	.45	.40	IN5251B	22	.45	.40
IN5229B	4.3	.45	.40	IN5252B	24	.45	.40
IN5230B	4.7	.45	.40	IN5253B	25	.45	.40
IN5231B	5.1	.45	.40	IN5254B	27	.45	.40
IN5232B	5.6	.45	.40	IN5255B	28	.45	.40
IN5233B	6.0	.45	.40	IN5256B	30	.45	.40
IN5234B	6.2	.45	.40	IN5257B	33	.45	.40
IN5235B	6.8	.45	.40	IN52588	36	.45	.40
IN5236B	7.5	.45	.40	IN5259B	39	.45	.40
IN5237B	8.2	.45	.40	IN52608	43	.45	.40
IN5238B	8.7	.45	.40	IN5261B	47	.45	.40
IN5239B	9.1	.45	.40	IN5262B	51	.45	.40
IN5240B	10	.45	.40	IN5263B	56	.55	.50
IN5241B	11	.45	.40	IN5264B	60	.55	.50
IN5242B	12	.45	.40	IN5265B	62	.55	.50
IN5243B	13	.45	.40	IN5266B	68	.55	.50
IN5244B	14	.45	.40	IN52678	75	.55	.50
IN5245B	15	.45	.40				

LINEAR IC's

H=TO-5 N=DIP M=MINI-DIP D=CER-DIP K=TO-3

LM105H	3.90	LM311H	1.20	LM710CH	.90
LM108H	4.90	LM311D	.90	LM710CN	.90
LM114H	3.00	LM311M	1.75	LM711CH	.90
LM300H	1.20	LM312N	1.75	LM711CN	.90
LM300N	1.20	LM318H	1.50	LM715CH	3.50
LM301AH	.50	LM318M	2.40	LM715CD	4.60
LM301AM	.80	LM324N	1.90	LM723CH	.60
LM301AN	1.10	LM331N	1.25	LM723CN	.65
LM301M	.95	LM336K	2.40	LM725CH	1.50
LM302N	1.30	LM339N	2.20	LM725CD	5.00
LM302H	1.40	LM320-5K	2.90	LM733CH	1.40
LM304H	1.20	LM320-5T	2.50	LM733CD	3.50
LM305H	.85	LM320-12K	2.90	LM733CN	1.30
LM305AH	1.05	LM320-12T	2.50	LM741CH	.40
LM305N	1.00	LM340-5K	2.60	LM741CD	1.25
LM306N	.95	LM340-6K	2.60	LM741CM	.39
LM307H	.60	LM340-8K	2.60	LM747CH	.75
LM307M	1.50	LM340-12K	2.60	LM747CN	.90
LM308H	.85	LM340-15K	2.60	LM748CM	.55
LM308AH	5.00	LM340-18K	2.60	LM777CH	2.15
LM308D	2.25	LM340-24K	2.60	LM777CM	2.10
LM308M	1.00	LM555CM	.70	LM3046CN	.95
LM309H	1.75	LM556CM	1.30	LM3054CN	1.50
LM309K	1.50	LM567CM	1.70	SG4501T	2.40
LM310H	1.50	LM709CH	.75	SG4501N	2.40
LM310M	1.80	LM709CN	.75	LM5000K	7.60

MICROPROCESSOR SPECIAL

8080A $34.90

MICROPROCESSOR COMPONENTS

RAM'S

	1-9	10up
P1101A	2.20	2.10
P1101A1	3.50	3.30
P1103	2.90	2.70
P2101	5.00	4.80
P2101-1	5.10	4.85
p2101-2	5.20	4.90
P2102	2.48	2.30
P2102-1	2.80	2.65
P2102-2	2.70	2.60
P2102A	2.90	2.70
P2102A-2	3.00	2.80
P2102A-4	2.95	2.75
P2111	5.70	5.50
P2111-1	5.80	5.60
P2111-2	5.90	5.70
P2112	5.90	4.70
P2112-2	6.00	4.80
P2401	9.90	9.80
P2405	8.80	8.00
26028	2.48	2.30
2602-18	2.80	2.65
2602-2B	2.70	2.60
IM7552CPE	2.48	2.30
IM7552-1CPE	2.80	2.65
IM7552-2CPE	2.70	2.60
TMS4035NL	2.48	2.30
TMS4034NL	2.70	2.60
P8101	5.00	4.80
P8101-2	5.20	4.90
P8102	2.48	2.30
P8102-2	2.70	2.60
P8111	5.70	5.50
P8111-2	5.90	5.70
AM9101APC	3.50	3.30
AM9101BPC	3.90	3.80
AM9101CPC	5.50	5.30
AM9101DPC	7.80	7.00
AM9102PC	2.70	2.60
AM9102APC	3.00	2.80
AM9102BPC	4.90	4.50
AM9102CPC	6.20	6.00
AM9102DPC	7.80	7.00

LOW POWER RAM'S

AM91L02PC	2.75	2.70
AM91L02APC	3.90	3.70
AM91L02BPC	5.00	4.40
AM91L02CPC	7.00	6.00

PROMS

	1-9	10up
1702A	15.95	14.50

SHIFT REGISTER

	1-9	10up
P2401	23.00	19.00
P2405	10.85	9.90
P2505K	3.70	3.30
2512K	4.30	4.05
2521V	2.50	2.20
2524V	2.40	2.20
2525V	3.60	3.50
2533V	10.50	8.50
AM2802PC	4.40	3.50
AM2803PC	4.40	3.50
AM2804PC	4.40	3.50
AM2805HC	3.70	3.30
AM2806HC	7.00	5.60
AM2807PC	2.40	2.20
AM2808PC	3.60	3.50
AM2809PC	2.50	2.20
AM2810DC	10.00	8.00
AM2812ADC	24.00	19.20
AM2812DC	21.00	16.80
AM2813ADC	24.00	19.20
AM2813DC	21.00	16.80
AM2814DC	12.45	9.15
AM2825PC	18.75	15.00
AM2826DC	22.50	18.00
AM2827PC	18.75	15.00
AM2833PC	10.85	8.70
AM2841APC	10.50	8.40

SHIFT REGISTER

	1-9	10up
AM2841PC	8.25	6.55
AM2847PC	5.00	4.50
AM2855PC	7.15	5.75
AM2856PC	7.15	5.75
AM2857PC	7.15	5.75
AM2896PC	5.00	4.50
AM3341PC	8.25	6.50
AM3347PC	6.40	5.10
AM4025D	73.00	58.40

AMD-MSI

AM2501DC	9.00
AM2502PC	9.50
AM2503PC	9.50
AM2504PC	16.05
AM2505PC	15.00
AM2506PC	8.80
AM25L02PC	10.70
AM25I03PC	10.70
AM25L04PC	16.05
AM25L05PC	15.00
AM25L06PC	8.80
AM25S05PC	19.00
AM25S07PC	3.78
AM25508PC	3.51
AM25S09PC	5.40
AM25S10PC	4.50
AM25S18PC	5.40
AM25LS07PC	2.79
AM25LS08PC	2.76
AM25LS09PC	3.49
AM25LS14PC	31.00
AM25LS15PC	2.14
AM25LS138PC	2.12
AM25LS139PC	2.12
AM25LS151PC	2.14
AM25LS153PC	2.14
AM25LS157PC	1.54
AM25LS158PC	1.54
AM25LS160PC	2.94
AM25LS161PC	2.94
AM25LS162PC	2.94
AM25LS163PC	2.94
AM25LS174PC	3.10
AM25LS175PC	2.76
AM25LS181PC	8.00
AM25LS190PC	3.87
AM25LS191PC	3.87
AM25LS194APC	2.62
AM25LS195APC	1.77
AM25LS251PC	2.66
AM25LS253PC	2.66
AM25LS257PC	2.00

COMPUTER INTERFACE

DM8820N	2.40
DM8820AN	6.90
DM8830N	2.40
DM8831N	5.20
DM8832N	6.00
N8T26B	4.40
9600PC	1.30
9601PC	1.20
9602PC	1.95
9614PC	2.30
9615PC	2.40
9616PC	5.00
9617PC	3.50
9620PC	4.00
9621PC	4.00

75107

75107BN	2.60
75108BN	2.30
75109N	2.20
75110N	2.20
75115N	2.25
75138N	2.95
75150N	3.10
75154N	4.10

75107

75208N	2.70
75234N	2.50
75450N	1.25
75451N	1.00
75452N	1.00
75453N	1.00

7520 SERIES SENSE AMPS

7520N	4.00
7521N	2.00
7522N	4.25
7523N	1.75
7524N	2.00
7525N	4.50

TWO-PHASE MOS CLOCK DRIVER

MH0026CN	5.50

MM

MM404H	12.00
MM405H	23.00
MM406H	6.50
MM407H	6.50
MM451H	11.40
MM454F	18.00
MM500H	2.00
MM506H	3.20
MM507H	3.20
MM550H	5.90
MM551H	5.60
MM555H	5.60

MOS-LSI

1402AN	3.80
1403AH	4.00
1403AN	3.80
1404AH	4.50
1404AN	2.90
1405A	4.00
1406	8.40
1407	8.40
1506	3.00
1507	3.00
1602	33.00
TMS3114J	9.40
TMS3120JC	7.00
TMS3120NC	6.00
TMS3133NC	7.50
3341ADC	8.00
3341APC	7.00
3347DC	5.80
3347PC	4.60
4102	4.95
7552	4.95
7552-1	5.40
7552-2	5.50
MM4055D	12.00
MM4056H	9.70
MM4057D	13.00
MM5025N	20.00
MM5026N	20.00
MM5027N	20.00
MM5055N	5.50
MM5056N	5.50
MM5057N	5.50
MM5058N	5.50

BIPOLAR MEMORY

C3101	6.50
P3101	4.90
C3101A	7.30
P3101A	5.80
IM5501CDE	7.30
IM5501CPE	5.80
MM5560D	7.30
MM5560N	5.80
DM8599N	5.80
93403PC	5.80

7400N TTL

	1-9	10up		1-9	10up		1-9	10up
7400N	.14	.13	7470N	.40	.30	74152N	1.04	.94
7401N	.18	.16	7472N	.40	.30	74153N	.85	.75
7402N	.18	.16	7473N	.42	.38	74154N	1.08	.94
7403N	.18	.16	7474N	.44	.40	74155N	1.02	.92
7404N	.21	.19	7475N	.55	.50	74156N	1.02	.92
7405N	.20	.19	7476N	.44	.40	74157N	.90	.80
7406N	.36	.28	7480N	.80	.72	74158N	1.50	1.30
7407N	.36	.28	7481N	1.30	1.25	74160N	1.02	.92
7408N	.24	.21	7482N	.98	.96	74161N	1.10	1.00
7409N	.28	.21	7483N	.82	.76	74162N	1.40	1.30
7410N	.22	.19	7484N	1.80	1.70	74163N	1.00	.90
7411N	.26	.20	7485N	1.20	1.08	74164N	1.16	1.05
7412N	.34	.32	7486N	.44	.40	74165N	1.20	1.10
7413N	.45	.42	7489N	2.20	2.10	74166N	1.20	1.10
7414N	.98	.95	7490N	.56	.51	74167N	5.00	4.50
7416N	.35	.32	7491N	.84	.76	74170N	2.00	1.80
7417N	.35	.32	7492N	.56	.50	74173N	1.66	1.50
7418N	.30	.27	7493N	.62	.56	74174N	1.00	.90
7420N	.15	.14	7494N	.88	.80	74175N	.98	.90
7421N	.30	.26	7495N	.80	.72	74176N	1.08	1.00
7422N	.50	.45	7496N	.75	.68	74177N	1.08	1.00
7423N	.37	.36	7497N	5.00	4.50	74178N	1.42	1.30
7425N	.30	.23	74100N	1.10	1.00	74179N	1.80	1.70
7426N	.28	.26	74104N	1.00	.90	74180N	1.12	1.02
7427N	.28	.25	74105N	1.00	.90	74181N	3.00	2.70
7428N	.40	.33	74107N	.40	.36	74182N	1.00	.90
7430N	.26	.20	74109N	.40	.36	74184N	2.80	2.50
7432N	.32	.30	74110N	1.00	.90	74185N	3.00	2.70
7433N	.44	.40	74111N	1.00	.90	74188N	5.00	4.80
7437N	.29	.20	74116N	2.00	1.80	74190N	1.20	1.10
7438N	.29	.27	74118N	2.20	2.00	74191N	1.20	1.10
7439N	.44	.40	74119N	4.00	3.60	74192N	.98	.90
7440N	.17	.16	74121N	.60	.54	74193N	.92	.88
7441N	.85	.83	74122N	.48	.43	74194N	1.36	1.23
7442N	.40	.39	74123N	.68	.62	74195N	.75	.70
7443N	.72	.65	74125N	.50	.45	74196N	1.40	1.30
7444N	.72	.65	74126N	.50	.45	74197N	1.40	1.30
7445N	.90	.81	74128N	.50	.45	74198N	1.40	1.30
7446N	.90	.81	74132N	.92	.85	74199N	1.40	1.30
7447N	.98	.90	74136N	.80	.72	74200N	9.00	8.00
7448N	.98	.90	74141N	1.70	1.50	74221N	1.36	1.25
7450N	.14	.13	74145N	1.10	1.00	74247N	2.40	2.20
7451N	.14	.13	74147N	1.90	1.70	74251N	1.90	1.80
7453N	.14	.13	74148N	1.50	1.35	74278N	2.90	2.50
7454N	.14	.13	74150N	1.52	1.40	74279N	.66	.60
7459N	.20	.18	74151N	1.02	.92	74298N	2.00	1.80
7460N	.14	.13						

HIGH SPEED TTL

74H00N	.33	74H20N	.33	74H52N	.36	74H73N	.80
74H01N	.25	74H21N	.33	74H53N	.36	74H74N	.80
74H04N	.33	74H22N	.33	74H54N	.36	74H76N	.75
74H05N	.33	74H30N	.33	74H55N	.36	74H102N	.75
74H08N	.40	74H40N	.36	74H60N	.36	74H103N	.90
74H10N	.33	74H50N	.36	74H71N	.75	74H106N	.95
74H11N	.33	74H51N	.36	74H72N	.75		

LOW POWER TTL

74L00N	.24	74L10N	.24	74L51N	.34	74L90N	1.62
74L02N	.24	74L20N	.33	74L73N	.43	74L93N	1.51
74L03N	.39	74L42N	1.33	74L74N	.90	74L95N	1.62
74L04N	.33						

74LS00

	1-9	10up		1-9	10up		1-9	10up
74LS00N	.36	.35	74LS55N	.39	.38	74LS161N	3.00	2.70
74LS01N	.44	.40	74LS73N	.58	.55	74LS162N	3.06	2.80
74LS02N	.36	.35	74LS74N	.56	.54	74LS163N	3.00	2.70
74LS03N	.45	.43	74LS76N	.65	.64	74LS170N	5.80	5.30
74LS04N	.44	.40	74LS78N	.92	.90	74LS174N	2.20	2.00
74LS05N	.45	.44	74LS95N	2.08	2.00	74LS175N	2.40	2.20
74LS08N	.38	.37	74LS107N	.59	.58	74LS181N	3.69	3.68
74LS09N	.44	.40	74LS109N	.92	.86	74LS190N	2.85	2.70
74LS10N	.36	.35	74LS112N	.58	.55	74LS191N	2.85	2.70
74LS11N	.46	.42	74LS113N	.92	.85	74LS193N	2.50	2.40
74LS15N	.58	.54	74LS114N	.92	.85	74LS194N	2.25	2.20
74LS20N	.44	.20	74LS123N	1.60	1.50	74LS195AJ	2.40	2.20
74LS21N	.58	.54	74LS138N	1.89	1.80	74LS196AJ	2.76	2.50
74LS22N	.58	.54	74LS139N	2.00	1.80	74LS197AJ	2.20	2.10
74LS27N	.44	.40	74LS151N	1.68	1.50	74LS251AJ	2.08	1.90
74LS30N	.39	.38	74LS153N	1.80	1.79	74LS253AJ	2.42	2.20
74LS32N	.45	.44	74LS157N	1.55	1.54	74LS257AJ	1.89	1.80
74LS38N	.58	.53	74LS158N	1.68	1.60	74LS258AJ	2.06	1.90
74LS51N	.39	.38	74LS160N	3.00	2.70	74LS260AJ	.44	.40
74LS54N	.58	.54						

SCHOTTKY TTL

74S00	.44	74S32	.80	74S113	1.50	74S174	3.30
74S01	.76	74S40	.65	74S114	1.20	74S175	2.90
74S02	.60	74S50	.76	74S133	.80	74S181	6.00
74S03	.75	74S51	.80	74S138	2.20	74S189	4.40
74S04	.55	74S60	.80	74S139	2.20	74S194	3.30
74S05	.76	74S64	.80	74S140	.80	74S195	3.30
74S08	.80	74S65	.80	74S151	2.20	74S251	2.20
74S09	.76	74S74	.90	74S153	3.40	74S253	2.40
74S10	.55	74S76	1.15	74S157	2.40	74S257	2.40
74S11	.65	74S78	1.16	74S158	2.00	74S258	2.40
74S15	.76	74S85	6.10	74S160	3.90	74S260	1.20
74S20	.65	74S86	2.50	74S161	4.70	74S290	5.70
74S21	.76	74S112	1.00	74S172	6.00	74S289	4.00
74S30	.80						

9300 SERIES

9300PC	$1.00	9318PC	2.30	9366PC	1.75	93L18	3.50
9301PC	1.20	9321PC	1.20	93L00	1.50	93L21	1.50
9304PC	1.50	9322PC	1.30	93L01	1.60	93L22	1.80
9306PC	6.90	9324PC	2.00	93L08	3.20	93L24	2.80
9308PC	2.50	9328PC	2.50	93L09	1.80	93L28	3.70
9309PC	1.60	9334PC	2.95	93L10	2.80	93L34	4.00
9310PC	1.50	9338PC	3.30	93L11	4.20	93L38	4.20
9311PC	2.30	9340PC	5.00	93L12	1.80	93L40	6.50
9312PC	1.20	9341PC	4.10	93L14	1.70	93L41	6.50
9314PC	1.30	9342PC	1.15	93L16	3.20	93L60	3.00
9316PC	1.50	9360PC	1.75	93L18	3.50	93L66	2.70

C-MOS

P/N	1-9	10up	P/N	1-9	10up	P/N	1-9	10up
4000AE	.24	.23	4027AE	.55	.53	4070AE	.60	.59
4001AE	.24	.22	4028AE	.95	.88	4071AE	.25	.23
4002AE	.24	.22	4029AE	1.25	1.22	4072AE	.34	.31
4004AE	4.00	3.99	4030AE	.44	.40	4073AE	.38	.35
4006AE	1.30	1.20	4033AE	2.00	1.94	4075AE	.38	.35
4007AE	.24	.23	4035AE	1.25	1.14	4076AE	1.24	1.22
4008AE	1.79	1.65	4040AE	1.58	1.50	4077AE	.70	.69
4009AE	.59	.51	4041AE	1.82	1.75	4078AE	.38	.35
4010AE	.50	.49	4042AE	.78	.75	4081AE	.25	.23
4011AE	.24	.23	4043AE	.85	.80	4082AE	.34	.31
4012AE	.24	.22	4044AE	.80	.75	4095AE	2.00	1.99
4013AE	.45	.40	4047AE	2.75	2.70	4098AE	1.30	1.29
4014AE	1.45	1.34	4048AE	1.43	1.42	4099AE	2.90	2.89
4015AE	1.24	1.23	4049AE	.68	.53	4507AE	.60	.55
4016AE	.50	.49	4050AE	.58	.53	4508AE	2.20	2.19
4017AE	1.15	1.07	4051AE	1.49	1.48	4510AE	1.45	1.44
4018AE	1.24	1.23	4052AE	1.49	1.48	4514AE	5.00	4.99
4019AE	.50	.49	4053AE	1.49	1.48	4515AE	5.00	4.99
4020AE	1.45	1.34	4055AE	1.95	1.94	4516AE	1.75	1.74
4021AE	1.38	1.25	4056AE	1.99	1.98	4518AE	1.28	.98
4022AE	1.05	.99	4063AE	2.50	2.49	4520AE	1.28	.98
4023AE	.24	.22	4066AE	1.10	1.09	4528AE	1.59	1.45
4024AE	.88	.80	4068AE	.50	.49	4585AE	2.05	1.89
4025AE	.24	.22	4069AE	.44	.43	4901AE	.43	.36
						4911AE	.43	.36

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What is more important?
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or
PRICE?
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IC SOCKETS

WIRE-WRAP GOLD DIP

PIN	1-24	25	100
14	.45	.41	.37
16	.54	.49	.44

SOLDER · GOLD DIP

14	.34	.31	.28
16	.37	.34	.31

TEFLON TO-5

3 PIN	.55 EA
4 PIN	.65 EA
6 PIN	.90 EA
8 PIN	1.10 EA
10 PIN	1.40 EA

PLASTIC TO-5

8 PIN $.40

SOLDER-TIN DIP

	1-24	25	100
8	.21	.19	.17
14	.25	.22	.20
16	.28	.25	.23
18	.34	.31	.28
22	.37	.36	.35
24	.47	.43	.40
28	.88	.80	.70
36	1.09	.98	.89
40	1.24	1.12	.90

INTERSIL 8038 PRECISION WAVEFORM GENERATOR & VCO

For simultaneous sine, square and triangular waveforms <.001 Hz to 1MHz.

Part No.	1-9	10 up
8038CCPD	$3.90	$3.70

1-AMP RECTIFIERS

	10	100	1000
1N4001	1.00	7.00	60.00
1N4002	1.10	8.00	70.00
1N4003	1.20	9.00	80.00
1N4004	1.30	10.00	90.00
1N4005	1.40	11.00	100.00
1N4006	1.50	12.00	110.00
1N4007	1.60	13.00	120.00

HYBRID POWER AMPLIFIERS

SI-1010G	10W	$6.40
SI-1020G	20W	9.90
SI-1030G	30W	18.70
SI-1050E	50W	24.90
SI-1050G	50W	24.90

HIGH VOLTAGE TRANSISTORS

BU204	3A	1300V	$4.14
BU205	3A	1500V	4.95
BU206	3A	1700V	5.94
BU207	6A	1300V	5.85
BU208	6A	1500V	6.93
BU209	6A	1700V	8.64

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THE SMALLEST AC/DC POWER SUPPLY EVER!

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8	115
10	100
12	90
15	70
18	50
20	35
22	25
24	15

$39.80 each

POWER SUPPLIES

ADTECH

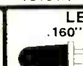
Model No.	Output Vdc	Output Amps	1-4	5 up
APS5-3	5	3.0	$29.95	$28.60
APS12-1.6	12	1.6		
APS15-1.5	15	1.5		
APS24-1	24	1.0		
APS28-0.8	28	0.8		
APS5-6	5	6	$48.45	$46.05
APS12-4	12	4		
APS15-3	15	3		
APS24-2.2	24	2.2		
APS28-2	28	2		
APS5-10	5	10	$72.25	$68.65
APS12-7	12	7		
APS15-6	15	6		
APS24-5	24	5		
APS28-4	28	4		

LEDs

.125" dia.

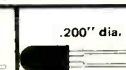
209	RED	$.25
209	YELLOW	.35
209	GREEN	.35

.160" dia.



216	RED	$.25
216	YELLOW	.30
216	GREEN	.30

.200" dia.



220	RED	$.25
220	YELLOW	.30
220	GREEN	.30

LOW PROFILE

.200" dia.

226	RED	$.25
226	YELLOW	.30
226	GREEN	.30
226	ORANGE	.30

.200" dia.

5053	RED	$.35
5053	YELLOW	.40
5053	GREEN	.40
5053	ORANGE	.40

MV50 RED $.30

216 = MV5024
5053 = MV5053

DISPLAYS

0.6" IN.

EP62R	RED	3.00
EP62G	GREEN	3.60
EP62Y	YELLOW	3.60

Data sheet for EP62 $.25

LARGE 1"

EP1000 RED	5.50
3 pcs EP1000	15.00
5 pcs EP1000	22.50

Data sheet for EP1000 $.25

XCITON

XAN72	RED	2.00
XAN52	GREEN	2.00
XAN82	YELLOW	2.00

LITRONIX

DL80	RED	6.00	DL44	RED	6.00
DL81	RED	6.00	DL402	RED	4.00
DL10	RED	6.00	DL701	RED	3.40
DL10A	RED	4.00	DL704	RED	2.25
DL101	RED	4.90	DL707	RED	2.35
DL57	RED	9.90	DL747	RED	2.50
DL61	RED	12.00			
DL33	RED	4.00			

WAVEFORM GENERATOR KIT

EXAR XR205K $25.00

Here's a highly versatile lab instrument at a fraction of the cost of conventional unit. Kit includes 2 XR205 IC's, data & applications, PC board (etched and drilled, ready for assembly) and detailed instructions.

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MONSANTO
MCT2 .60

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IL74	1.35
ILD74	1.00
ILQ74	3.40

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CMOS/LSI
FROM STANDARD MICROSYSTEMS

COM2502/H COM2017/H

Universal Asynchronous Receiver/Transmitter

Performs all receiving/transmitting functions of asynchronous data communications. Duplex mode, baud rate, data word length, parity mode, and number of stop bits are independently programmable. There may be 5,6,7, or 8 data bits, odd/even or no parity, and 1 or 2 stop bits or 1.5 stop bits when utilizing a 5-bit code from the COM2017/H. Operates in either the full or half duplex mode. Interfaces with all asynchronous peripherals. 250k baud, 200 ns strobes. **Prices:** COM2502, $13.20; COM2502P, $8.00; COM2502H, $14.20; COM2502HP, $9.00; COM2017, $13.20; COM2017P, $8.00; COM2017H, $14.20; COM2017HP, $9.00. (P = Plastic, H = High Speed)

COM2601

Universal Synchronous Receiver/Transmitter

Performs all the receiving and transmitting functions associated with synchronous (STR, BSC, Bi-Sync and interleaved bi-sync) data communications. TTL compatible, duplex mode, baud rate, data word length, parity mode, receiver sync character and transmitter sync character are independently programmable. Double buffered and generates the sync character received and sync character transmitted signals. Interfaces with all synchronous peripherals. **Price: $30.00.**

- High Speed Operation – 250K baud, 200nS strobes
- Hermetic Dip Package

COM5016 . . . . COM5016T

DUAL BAUD RATE GENERATOR . . . Programmable Divider

Generates 32 externally selectable frequencies, the full spectrum of 16 asynchronous/synchronous data communication frequencies externally selected by four address inputs. Internal re programmable ROM allows the generation of other frequencies from other crystal frequencies or input frequencies. The 4 address inputs on each divider section may be strobe (150ns) or DC loaded. Full duplex (independent receive and transmit frequencies) operation is possible. Divides any modulo up to (215–1). The COM5016 can be driven by either an external crystal or TTL logic level inputs; COM5016T is driven by TTL logic level inputs only. **Price:COM5016, $12.00;COM5016T, $11.70.**

- 18 pin ceramic DIP package
- On chip crystal oscillator or external frequency input
- Choice of 2 x 16 output frequencies
- 16 asynchronous/synchronous baud rates
- Direct UART/USRT compatibility
- Full duplex communication capability
- Re-programmable ROM allows generation of other frequencies
- TTL, MOS compatibility

KR2376-XX

Keyboard Encoder Read Only Memory

Contains all the logic necessary to encode single pole single throw keyboard closures into a usable 9-bit code. **Price: $20.00.**

- Outputs directly compatible with TTL/DTL or MOS logic arrays.
- External control provided for output polarity selection.
- External control provided for selection of odd or even parity.
- Two key roll-over operation.
- One integrated circuit required for complete keyboard assembly.
- Static charge protection on all input and output terminals.

Package: 40-Pin DIP

10 Channel Multiplexer NMX 5010

Ten (10) n-channel silicon-gate, low on-resistance, MOS enhancement-mode field-effect transistors fabricated on a single silicon chip. Source regions of the individual transistors are internally connected in such a way as to provide the user with maximum flexibility in switching applications. A separate substrate terminal is provided so as to enable one to choose the desired threshold voltage associated with the individual n-channel MOSFETs over a relatively wide range of values. The SMC NMX-5010 is assembled in a standard 24-lead ceramic dual-in-line package. **Price: $12.00.**

CAL 1022

Twelve Digit Printing Calculator

Contains all logic functions required to interface with a SEIKO 102/104 or equivalent printer. Performs functions consistant with a general-purpose business machine, including the basic four functions, one memory and percentage. One line of output buffering allows the 1022 to be calculating or accepting keyboard entries simultaneously with a print operation.**Price: $60.00.**

Package: 40-Pin Ceramic DIP

MM5316
DIGITAL ALARM CLOCK CIRCUIT

MM5316 utilizes line frequency (50 or 60 Hz) as its timing base, and provides a variety of timing functions suitable for a digital alarm clock, digital clock radio, and other applications. Four display modes are provided (hours and minutes, minutes and seconds, alarm, and sleep) . . . . . . 12 or 24 hour display format • 24 hour alarm setting • 9 minute snooze alarm • Presettable 59 minute sleep timer • AM/PM outputs (12 hr. format) • Flashing colon for seconds indication • All counters resettable • Power failure indication • Direct interface to fluorescent tubes or liquid crystal displays. Also operates with LEDs. • Alternate to AMI 1998. . . . . **Price. . . . . 1-4, $4.95 . . . . . 5 up, $4.50**

MATSUO
DIPPED TANTALUM CAPACITORS

MFD	WVDC	1-9	10up	50up	MFD	WVDC	1-9	10up	50up
.1	35	$.30	$.25	$.20					
.15	35	.30	.25	.20	4.7	35	$.40	$.32	$.26
.22	35	.30	.25	.20	6.8	35	.40	.32	.26
.33	35	.30	.25	.20	10.0	16	.38	.30	.24
.47	35	.30	.25	.20	10.0	35	.40	.32	.26
.68	35	.30	.25	.20	15.0	35	.95	.64	.56
1.0	35	.30	.25	.20	22.0	16	.40	.32	.26
1.5	35	.35	.28	.23	33.0	20	.95	.64	.56
2.2	20	.30	.25	.20	47.0	20	1.40	1.05	.90
3.3	35	.38	.30	.24	68.0	16	1.40	1.05	.90

XR FUNCTION GENERATOR

XR-2206KA ... SPECIAL ... $16.95. Includes monolithic function generator IC, PC board, and assembly instruction manual. **XR-2206KB ... SPECIAL ... $26.95.** Same as XR-2206KA and includes external components for PC board.

HIGH QUALITY CARBON FILM RESISTORS

From 10 ohm to 10 megohms. . . ¼ Watt 5% . . $1.69 per 100
Only in multiples of 100 per value • 150 different values in stock

OHM	OHM	OHM	OHM	OHM	OHM
10	100	1K	10K	100K	1M
11	110	1.1K	11K	110K	1.1M
12	120	1.2K	12K	120K	1.2M
13	130	1.3K	13K	130K	1.3M
15	150	1.5K	15K	150K	1.5M
16	160	1.6K	16K	160K	1.6M
18	180	1.8K	18K	180K	1.8M
20	200	2K	20K	200K	2M
22	220	2.2K	22K	220K	2.2M
24	240	2.4K	24K	240K	2.4M
27	270	2.7K	27K	270K	2.7M
30	300	3K	30K	300K	3M
33	330	3.3K	33K	330K	3.3M
36	360	3.6K	36K	360K	3.6M
39	390	3.9K	39K	390K	3.9M
43	430	4.3K	43K	430K	4.3M
47	470	4.7K	47K	470K	4.7M
51	510	5.1K	51K	510K	5.1M
56	560	5.6K	56K	560K	5.6M
62	620	6.2K	62K	620K	6.2M
68	680	6.8K	68K	680K	6.8M
82	820	8.2K	82K	820K	8.2M
91	910	9.1K	91K	910K	9.1M

PULSE GENERATOR

Interdesign 1101: 0.1Hz - 2MHz, 0.5V Output, var. width, line or battery operation **$159.00**

SPDT MINIATURE TOGGLE SWITCH

105D . . . . 115V . . . . 5A Rating . . . . **$.95**

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QT SOCKETS & BUS STRIPS

Plug in . . . wire. . . test . . modify . . . . build . . . . without soldering! Use the same components all the way from the "idea stage" to final design. Leads stay clean – not bent, twisted or loaded with solder. Expand or contract to meet your needs. Easily snapped on or off your breadboard. The fastest, most reliable way to try out new ideas or rejuvenate old ones.

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QT-47S $10.00

QT-59B...$2.50 QT-47B...$2.25 QT-35S...$8.50 QT-8S
QT-35B...$2.00 QT-18S...$4.75 QT-12S...$3.75 $3.25
QT-7S...$3.00

PROTO-BOARDS

QT Sockets and Strips combined into a variety of versatile ProtoBoards. Make all circuit and power interconnections with inexpensive solid #22 wire. Aluminum base plates offer solid, ground plane work surfaces. Rubber feet prevent scratching. 5-way binding posts tie into systems or power supply grounds. All are compatible with digital or linear ICs, in TO5s, DIP packs and discrete components.

PB-6 . . . . Lowest priced solderless breadboard kit on market today. 6 14-pin DIP IC capacity **$15.95**

PB-100 . . . . The popular mini-breadboard kit with 10 IC capacity and low, low price . . . . Complete kit **$19.95**

PB-101. A compact mini-breadboard at a mini-price, but with expanded 10 14-pin DIP capacity. **$29.95**

PB-102 . . . mid-size, mid-priced with 1,240 solderless tie points . . **$39.95**

PB-103 . . . . . . Everything you need. 2,250 solderless tie points at less than $.027 ea. Four 5-way binding posts; one grounded. 24 14-pin DIP capacity. 10 distribution buses; 2 horizontal with 40 contacts each, 8 vertical with 50 contacts each **$59.95**

PB-104 . . . . 3,060 solderless tie points at only $.026 ea. 32 14-pin DIP capacity to build an entire system, including power supplies. Four 5-way binding posts; one grounded, three floating. Rubber feet. 14 distribution buses; 4 horizontal with 50 contacts each, 10 vertical with 50 contacts each. **$79.95**

PB-203 & PB-203A . . . . with built-in regulated short-proof power supplies!

PB-203 . . 5V, 1AMP regulated power supply **$75.00**

PB-203A . . . . . 5V, 1AMP regulated power supply (same as PB-203), +15V, ½AMP regulated power supply, –15V, ½AMP regulated power supply **$120**

PROTO CLIPS

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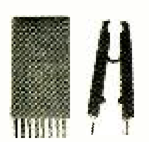
PC-16 (16-pin). . . . . **$4.75 ea.**
NEW! PC-24 (24-pin). . . . **$8.50 ea.**



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Check logic levels without an expensive scope. The Logic Monitor brings ICs to life ... as it tests DTL,TTL,HTL and CMOS **$84.95**

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DESIGN MATE 1. . . . with built-in, regulated, metered power supply to design unusual circuits fast. . **$49.95**

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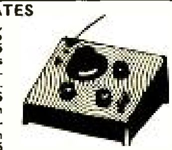

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2N293	.60	2N1543	3.40	2N2538	2.40
2N321	.50	2N1544	1.40	2N2600	7.00
2N324	.55	2N1549	1.80	2N2605	.49
2N336	1.00	2N1551	3.90	2N2605A	.58
2N338A	.82	2N1552	3.90	2N2606	3.60
2N388A	.82	2N1554	1.90	2N2608	2.05
2N389	8.90	2N1557	1.70	2N2646	1.00
2N393	3.70	2N1613	.40	2N2647	1.50
2N3988	1.00	2N16718	2.30	2N2648	3.90
2N404	.30	2N1693	13.90	2N2658	6.90
2N417	.85	2N1711	.40	2N2708	.30
2N456	1.30	2N1715	.70	2N2712	.30
2N491	4.90	2N1720	4.80	2N2713	.14
2N497	1.10	2N1893	.36	2N2714	.44
2N508A	.40	2N1907	4.80	2N2715	.10
2N611A	3.50	2N1924	1.25	2N2716	.20
2N5128	2.90	2N1934	9.30	2N2754	94.00
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2N681	2.80	2N2081A	2.50	2N2857	3.00
2N683	2.90	2N2100	2.90	2N2880	10.90
2N697	.25	2N2102	.45	2N2890	3.50
2N697A	.50	2N2143	1.50	2N2893	9.70
2N699	.66	2N2147	1.40	2N2894	.60
2N700	3.50	2N2148	.68	2N2895	1.00
2N705	.60	2N2152	3.00	2N2903	4.10
2N7068	.40	2N2192	.60	2N2904	.36
2N711	.34	2N2192A	.66	2N2904A	.38
2N7118	.60	2N2193	.44	2N2905	.36
2N718	.28	2N2197	2.40	2N2905A	.38
2N718A	.31	2N2217	.80	2N2906	.20
2N720A	.50	2N2218	.25	2N2906A	.21
2N741	2.80	2N2218A	.28	2N2907	.16
2N744	.35	2N2219	.29	2N2907A	.26
2N829	2.80	2N2219A	.36	2N2911	21.00
2N834	.35	2N2221	.24	2N2913	.89
2N859	7.90	2N2221A	.25	2N2925	.20
2N894	2.90	2N2222	.24	2N2926	.14
2N918	.40	2N2222A	.26	2N2947	14.40
2N929	.26	2N2259	1.10	2N2949	5.90
2N930	.28	2N2270	.40	2N2950	6.40
2N960	.45	2N2289	3.60	2N2958	1.90
2N962	.45	2N2290	5.90	2N2969	30.90
2N967	.48	2N2297	.95	2N3019	.50
2N976	1.70	2N2323A	2.00	2N3022	17.90
2N984	.95	2N2326	3.30	2N3053	.34
2N1035	1.80	2N2356	5.90	2N3054	.80
2N1132	.30	2N2356A	6.90	2N3055	.94
2N1136	1.40	2N2359	15.90	2N3060	2.95
2N1137A	1.80	2N2368	.28	2N3066A	1.19
2N1143	1.90	2N2369	.28	2N3107	.78
2N1168	.65	2N2369A	.28	2N3117	1.50
2N1204	1.40	2N2382	4.40	2N3130	4.90
2N1302	.50	2N2440	3.45	2N3202	15.90
2N1303	.60	2N2465	7.40	2N3209	.89
2N1305	.50	2N2468	1.00	2N3227	2.30
2N1307	.65	2N2475	.54	2N3239	2.90
2N1377	1.40	2N2476	.79	2N3247	3.80
2N1404	.48	2N2483	.28	2N3250	.49
2N1408	.50	2N2484	.25	2N3307	8.50
2N1420	.50	2N2492	4.00	2N3308	6.50
2N1485	2.60	2N2509	.95	2N3309	7.10
2N1521	4.80	2N2511	1.98	2N3323	1.15
2N1523	6.00	2N2518	5.90	2N3324	.80

2N3325	.70							2N4032	1.90
2N3368	.80	2N3565	.18	2N3693	.21	2N3824	1.00	2N4037	.70
2N3375	5.50	2N3567	.26	2N3694	.22	2N3851	7.40	2N4045	1.90
2N3390	.40	2N3568	.28	2N3702	.30	2N3856	.28	2N4058	.25
2N3391	.41	2N3569	.19	2N3705	.32	2N3858	.26	2N4059	.24
2N3391A	.20	2N3570	5.50	2N3706	.21	2N3859	.28	2N4060	.25
2N3392	.20	2N3571	3.90	2N3707	.18	2N3860	.29	2N4061	.25
2N3393	.20	2N3572	2.60	2N3708	.22	2N3866	1.25	2N4062	.25
2N3394	.22	2N3584	1.80	2N3709	.22	2N3877	.42	2N4093	1.05
2N3395	.24	2N3614	1.10	2N3710	.20	2N3900	.38	2N4123	.20
2N3396	.26	2N3616	1.24	2N3711	.18	2N3901	.30	2N4124	.20
2N3397	.28	2N3617	2.40	2N3713	1.20	2N3903	.20	2N4125	.25
2N3398	.25	2N3634	7.90	2N3721	.22	2N3904	.22	2N4126	.25
2N3414	.20	2N3638	.18	2N3725	.50	2N3905	.20	2N4141	.26
2N3415	.20	2N3640	.19	2N3730	1.80	2N3906	.22	2N4142	.17
2N3416	.20	2N3642	.19	2N3731	2.00	2N3909	.80	2N4143	.16
2N3417	.38	2N3643	.16	2N3732	2.25	2N3924	3.50	2N4220A	1.00
2N3436	1.60	2N3645	.16	2N3740	1.10	2N3925	4.75	2N4225	3.75
2N3440	.98	2N3645	.10	2N3741	1.60	2N3933	1.30	2N4226	3.90
2N3441	1.70	2N3649	4.70	2N3771	2.20	2N3945	.90	2N4227	.34
2N3442	2.15	2N3650	6.10	2N3772	2.30	2N3954	4.40	2N4228	.49
2N3445	4.90	2N3651	9.20	2N3773	3.30	2N3954A	5.80	2N4235	1.90
2N3467	1.46	2N3656	8.50	2N3789	3.00	2N3955	2.70	2N4237	1.20
2N3468	1.85	2N3657	9.90	2N3793	.25	2N3955A	3.20	2N4238	1.30
2N3478	2.00	2N3662	.42	2N3796	3.00	2N3956	2.90	2N4248	.17
2N3501	6.40	2N3663	.44	2N3799	3.15	2N3957	1.46	2N4249	.20
2N3506	7.40	2N3684	1.20	2N3804	8.00	2N3958	1.45	2N4250	.22
2N3554	3.90	2N3685	1.35	2N3805	10.40	2N3964	1.09	2N4256	.28
2N3546	2.90	2N3685A	1.75	2N3819	.30	2N3970	1.20	2N4258	.34
2N3553	1.80	2N3686	1.50	2N3821	1.35	2N3971	1.00	2N4289	.40
2N3563	.16	2N3687	1.60	2N3822	1.40	2N3972	1.39	2N4291	.35
2N3564	.14	2N3692	.20	2N3823	.69	2N4012	10.40	2N5157	9.85

2N4293	.50	2N5172	.14	2N5592	1.00
2N4303	.30	2N5190	.95	2N5637	26.90
2N4341	1.35	2N5191	1.00	2N5644	7.10
2N4347	1.60	2N5198	4.25	2N5655	.95
2N4348	2.10	2N5210	.22	2N5657	1.20
2N4352	2.00	2N5219	.16	2N5679	1.39
2N4395	1.25	2N5220	.28	2N5742	35.00
2N4400	.29	2N5221	.30	2N5777	.50
2N4401	.33	2N5222	.16	2N5778	.54
2N4402	.35	2N5223	.16	2N5779	.80
2N4409	.30	2N5224	.22	2N5780	.86
2N4416	.89	2N5225	.30	2N5810	.34
2N4424	.35	2N5226	.26	2N5811	.38
2N4425	.40	2N5227	.16	2N5812	.36
2N4427	1.30	2N5232	.22	2N5813	.42
2N4441	1.30	2N5232A	.24	2N5815	.36
2N4443	1.40	2N5249	.30	2N5816	.38
2N4852	.85	2N5249A	.31	2N5817	.38
2N4858	1.10	2N5294	.75	2N5818	.40
2N4859	1.20	2N5295	.60	2N5819	.42
2N4863	5.45	2N5296	.95	2N5821	.60
2N4870	.60	2N5298	1.00	2N5822	.56
2N4878	3.85	2N5306	.26	2N5823	.66
2N4890	.95	2N5306A	.40	2N5824	.24
2N4898	1.10	2N5307	.40	2N5825	.26
2N4901	2.70	2N5308	.44	2N5826	.28
2N4902	3.00	2N5309	.36	2N5827	.30
2N4903	3.90	2N5310	.40	2N5828	.32
2N4904	2.90	2N5311	.44	2N5828A	.38
2N4905	4.10	2N5322	.70	2N6000	.50
2N4906	4.30	2N5323	.66	2N6001	.52
2N4918	1.30	2N5354	.35	2N6002	.54
2N4919	1.35	2N5355	.35	2N6004	.54
2N4921	1.30	2N5365	.40	2N6010	.62
2N4922	1.00	2N5366	.40	2N6011	.64
2N4923	1.05	2N5367	.42	2N6014	.66
2N4983	.80	2N5368	.24	2N6015	.68
2N4984	1.10	2N5369	.25	2N6027	.50
2N4985	1.90	2N5370	.26	2N6028	.64
2N4986	.95	2N5371	.22	2N6076	.16
2N4987	.65	2N5373	.26	2N6099	1.00
2N4988	.95	2N5375	.25	2N6101	.95
2N4989	1.40	2N5380	.50	2N6103	.98
2N4990	.75	2N5381	.56	2N6107	1.90
2N4991	.75	2N5382	.50	2N6109	2.30
2N4992	1.10	2N5383	.56	2N6111	2.60
2N4993	1.60	2N5397	2.90	2N6114	4.50
2N4994	.25	2N5407	28.90	2N6115	2.10
2N4996	.26	2N5409	31.90	2N6218	.60
2N5016	12.70	2N5418	.30	2N6219	.59
2N5036	1.17	2N5419	.34	2N6220	.58
2N5064	.90	2N5420	.40	2N6221	.52
2N5088	.45	2N5447	.26	2N6222	.28
2N5089	.80	2N5448	.27	2N6223	.30
2N5105	3.05	2N5449	.26	2N6224	.32
2N5109	2.40	2N5450	.24	2N6225	.34
2N5127	.16	2N5451	.24	3N81	3.60
2N5130	.20	2N5453	5.35	3N82	5.00
2N5131	.20	2N5457	.65	3N83	1.70
2N5133	.17	2N5458	.50	3N84	1.68
2N5134	.18	2N5490	1.40	3N85	3.30
2N5135	.15	2N5491	.80	3N86	6.10
2N5137	.26	2N5492	1.45	3N153	1.05
2N5138	.24	2N5494	1.70	3N189	4.10
2N5154	7.05	2N5496	1.90	40290	1.70
2N5155	3.20	2N5562	12.40	40319	1.00
2N5161	2.60	2N5563	8.90	40346	.70

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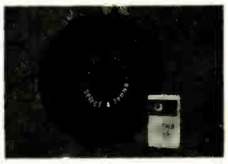
SUPER POWER FOR ANY AM RADIO



New antenna assist turns a tiny transistor into a tiger, has pulled in stations 1000* miles away! Just set beside radio (no wires, clips, grounding) and fine-tune Select-A-Tenna's dial to same frequency—"gangbusters"! Great for clearing weak signals in radio depressed areas, off-coast islands, crowded frequency stations. Solid state—uses no electricity, batts., tubes.

Stock No. 72,095 EH .... $15.95 Ppd.
Ultra Select-A-Tenna No. 72,147 EH
(*Over 1000 Mi.) .... $22.95 Ppd.

ACTUAL WORKING SEE-THRU LASER!

See the full lasing process *work*, why this technological break-through revolutionized optical field! Beautiful 0.5mW TEMoo HE-NE 6328A laser enclosed in completely safe clear acrylic housing. *Shows everything*—power supply to actual lasing action within plasma! Diffraction grating attchmt's. for multiple beam display. Converts to hologram viewing system (3 holograms included). Polished walnut base. Fantastic demonstrator/display. 2 year tube guar.

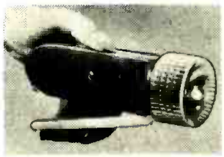
No. 79,089 EH (15½x6½x7½") .... $350.00 Ppd.

AN ALPHA MONITOR FOR $34.95?

Yes, because you built it! Use your ability to tune in your brainwaves, an aid to relaxation, concentration. Kit incls. everything you need (except 9v trans. batt.) to own a portable self-cont. BIOFEEDBACK unit for a pittance: steth. earphones, electrode headband, solid-state circuitry; 5 microvolt sensitivity, more! Compl. assembly instructions & op. manual. With basic electronics knowledge, you can do it!

No. 61,069 EH (KIT) .... $34.95 Ppd.
No. 71,809 EH (FULLY ASSEMBLED) .... $55.00 Ppd.

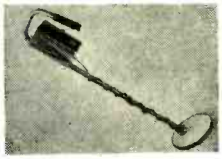
FLYWHEEL GENERATED FLASHLIGHT



Never needs batteries! Lights the way free by using flywheel energy. Each time you squeeze handle the alternator generator spins, flywheel disengages from the clutch, and your flashlight lights for about 2 seconds. By continuous squeezing (generating a soft hum), the light stays bright. Energy-saving 6-oz. flashlight pays for itself many times over. And demonstrates flywheel generator principle. Never buy flashlight batteries again!

No. 61,086 EH .... (2x5½") .... $14.95 Ppd.

WOW! TR METAL DETECTOR: $69.95



Super-sensitive transmitter/receiver unit at a never-before price, w/feats. of $150 types. Terrific selectivity—10-turn (not just 90°) metal/mineral tuner! 6" waterproof search coil finds a cent at 6"; telescoping adjust. shaft gives 44" lgth.; ¼" stereo earphone jack; all metal constr. Perfect balance & feather light, it incls. 8 "AA" batteries. Lifetime warranty!

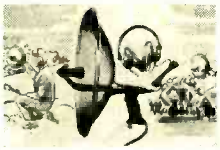
No. 80,251EH (JUST 38 OZ.!) .... $69.95 Ppd.
STARTERS' BFO CHALLENGER I (32 OZ.)
No. 80,222EH (ALUMINUM CONSTR.) .... $39.95 Ppd.

LOW-COST DIGITAL MULTIMETER

World's smallest, with accuracy of .1 to .3% of full scale! Measures up to 500V DC or AC: up to 10 megohms—3 digit LED reading seen 8 ft. away! Performance & acc. of a digital volt-ohm-meter; *very* high impedance better than most VTVM's, great for TV. 9-oz. "pocket" unit has 13 ranges (4V DC, 4V AC & 5 ohms), operates from 0-45°C. Overload indicator, more! Req. 3 AA batts.

No. 72,192EH (1.9x2.7x4") .... $115.00 Ppd.
WITH RECHARGEABLE BATTS. & RECHARGER
No. 72,179EH .... $129.95 Ppd.

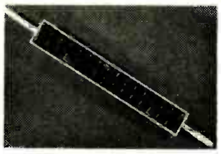
PRO ELECTRONIC SOUND CATCHER



Parabolic mike w/18¾" transparent reflecting shield & 2 I.C.'s in amplifier magnifies signals 100x that of omni-direction mikes. Catch sounds never before heard! Highest signal to noise ratio poss. Earphones, tape recorder output, tripod socket; req. two 9V trans. batt. (not incl.).

No. 1649EH (5½ LB.) .... $299.00 Ppd.
LOW COST MODEL: NO EARPHONES, ELECTR. CIRC.
No. 1665EH .... $149.95 Ppd.
LOWER SENSITIVITY ECON. MOD. W/O ELECTR.
No. 80,242EH .... $89.50 Ppd.

SOLAR CELL CONCENTRATOR PANEL



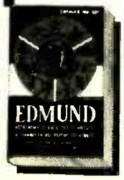
World's first! *Takes up to 10 suns* . . . without burning out (normal ones can't use over 3)! Specially designed panel (four 2x2cm super cells) delivers .125 amps @ 1.5V w/1 sun; over 1 amp @ 1.5V w/ ten! Requires concentration system (build Crab Eye or mount on std. telescope drive). Water-cooled, so it's also a hot water generator. Detailed instructions incl.

No. 61,103EH (6x2x¾") .... $175.00 Ppd.
LARGE CONCENTRATOR PANEL (19x2x¾")
No. 72,195EH (30 CELLS; 15w) .... $575.00 Ppd.

KNOW YOUR ALPHA FROM THETA!

For greater relaxation, concentration, monitor your Alpha/Theta brainwaves w/ audible or visible signal on Biosone II. Has 3 feedback modes, outputs to monitor logic signal, filter sel. feedback, broad sensitivity control; other professional feats. of $200-up units. Easily operated 4-lb. portable has total brainwave monitoring capability! Req. 2 9v tr. batteries.

No. 1668EH (9½x5⅝x4¼") .... $149.95 Ppd.
LOW COST STARTERS' UNIT (PORTABLE)
No. 71,809EH (4½x2¾x4¼") .... $ 55.00 Ppd.



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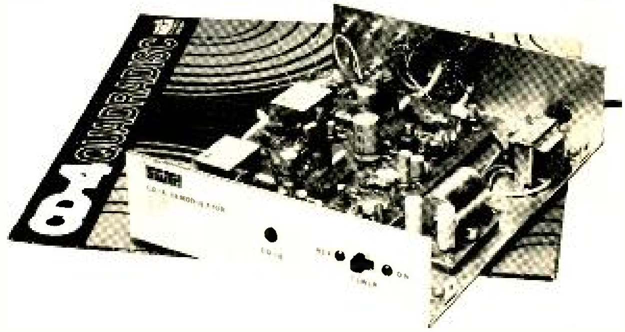
SWTPC

CD-4 DEMODULATOR



TRUE FOUR CHANNEL SOUND

Southwest Technical Products is proud to offer the most advanced CD-4 demodulator available. Our new CD-4 has characteristics superior to anything previously available thanks to the QSI-5022 integrated circuit used in the unit. This IC and the balance of the circuit was designed by Quadracast Systems Inc. under the direction of Mr. Lou Dorren. The QSI-5022 contains all the sub-system functions needed to demodulate a CD-4 disc, from the phono cartridge input to the output drive for the four power amplifiers. It may be used with either an RIAA equalized magnetic cartridge, or a semiconductor cartridge with flat equalization.

INEXPENSIVE

Now anyone can afford to add discrete true 4 channel sound to their system. You no longer need be satisfied with matrix techniques that produce acoustrical enhancement, but not true 4 channel sound. The Southwest Technical Products CD-4 demodulator when added to your system will produce four channel sound from a CD-4 encoded disc that will equal, or surpass anything you can buy—no matter what the price.

EASY INSTALLATION

The SWTPC demodulator connects between the cartridge and the volume-tone control portion of your system. If you did not want tone controls, actually all that would be needed in addition to our CD-4 demodulator would be volume controls for the front and rear amplifiers. The demodulator is self powered from any 115 Volt 60 Cycle line. When normal stereo discs are played on your system a muting system automatically turns off the rear channels. A manual override 2 or 4 channel selector switch is provided on the rear panel.

SIMPLE CONSTRUCTION

As shown in the photograph, the vast majority of the parts mount on the epoxy-fibreglass circuit board. Part numbers and package outlines printed on the top of the board make proper assembly quite simple. Anyone with a minimum of electronic experience should be able to assemble this project without any problems. A copy of the article describing the CD-4 demodulator and assembly instructions are supplied in the kit.

CD-4 Demodulator Kit............$50.00 ppd

CD-4 CARTRIDGE

For those who do not already own a CD-4 cartridge, we are offering the "Technics" EPC-451C semiconductor strain-gauge cartridge at a special low price when purchased with our new CD-4 demodulator kit. This cartridge features a Shibata-type stylus and excellent response out to 50 kHz. This eliminates any chance of "carrier drop-out", or "carrier crosstalk" which result in abnormal noise or distorted sound. The EPC-451C produces a high output (about 30 times that of an average magnetic cartridge) and does not pick up hum from magnetic, or electrostatic fields. Easily replaced stylus.

EPC-451C CD-4 Cartridge........$25.00 ppd

TEST RECORD

Lou Corren has recorded a special test record for Southwest Technical Products Corp. that will allow you to properly adjust your CD-4 demodulator for the best possible sound. This special test and demonstration record is yours for only $5.00 when purchased with the CD-4 demodulator kit.

CD-4 Test Record...................... $5.00 ppd

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