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75¢ ■ JAN. 1976

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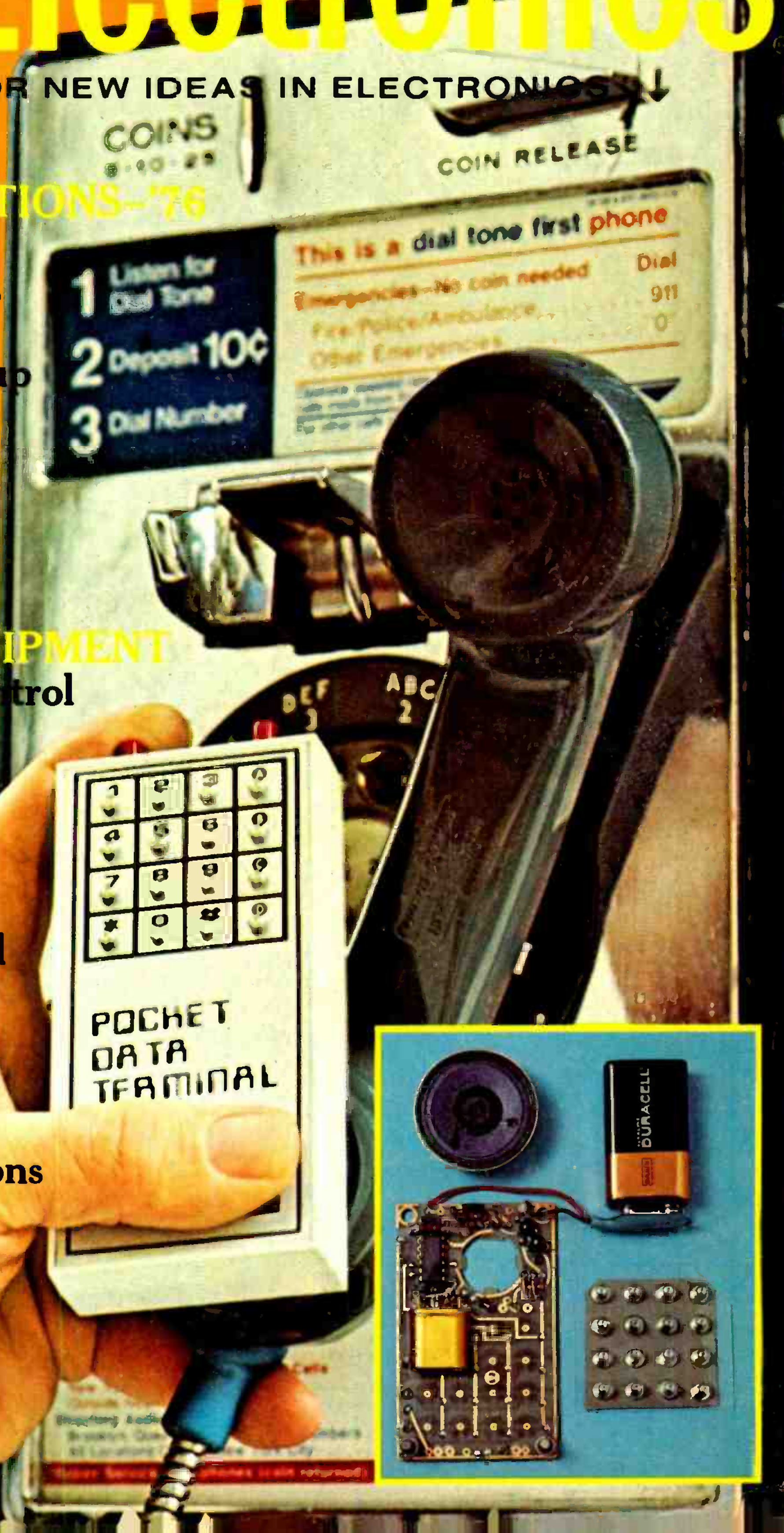

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JANUARY 1976 Vol. 47 No. 1

ON THE COVER
This phone booth is a computer terminal . . . as is any other phone booth when you're equipped with that little pocket-sized gadget. Want to own your own? Build it. Turn to page 29 now.

CB IS SWEEPING the country. Discover what's happening and the equipment that makes it happen. **. . . see page 33**

TURNTABLE DRIVE SYSTEMS have gone electronic. Find out what makes those platters go round. **. . . see page 49**

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looking ahead

Pay-TV via bird

Pay cable TV distributed by satellite is now a reality. The first see-for-fee program transmitted by satellite direct to cable systems was the Ali-Frazier championship fight from Manila September 30. The first systems to receive satellite programming via Western Union's Westar domestic satellite were in Vero Beach, FL, and Jackson, MS. The bout was transmitted from Manila to California via the Intelsat satellite, carried to New York by AT&T microwave, then to an earth station in Valley Forge, PA, where it was sent up to Westar. The image, which traveled about 92,500 miles, was of excellent quality. Regular transmissions of movies and other pay-TV fare by domestic satellite to cable systems has now begun, and new earth stations are being installed at many CATV systems.

No total recall

When a television-set model is "recalled" under government X-ray laws for inspection or modification, how many sets actually are located and inspected? A study by the Bureau of Radiological Health of the largest television recall to date showed that the percentage is shockingly low.

Under the federal X-radiation law, retailers who sell color sets or other products that potentially can emit radiation are required to keep files of names and addresses of purchasers or to turn the names of buyers over to the distributor or manufacturer so that owners may be located if necessary. The BRH took a look at the 1974 recall of 308,000 Panasonic sets to see how well the system is working—and decided it isn't.

Panasonic followed the government rules for locating these sets to ask their owners to bring them in for modification to eliminate the possibility of radiation above permissible limits. Some 68,000 sets were still unsold and remained in the hands of distributors and dealers. That left 240,000 to be located in consumer homes. From its own records and those kept by dealers and distributors, Panasonic was able to locate only half of these. Each of these 120,000 identified set owners was sent a letter telling him modifications would be made without charge. Only 80,000 sets were brought in for modification. The end result: Fewer than half of the sets were modified, including only one-third of those which were in consumers' homes.

BRH and Panasonic are still trying to find more names of set buyers, and BRH is notifying dealers that failure to keep records of sales or forward them to the manufacturer is a violation of the law. No really dangerous radiation was involved in the sets—the function of the radiation law is to hold X-rays down to the absolute minimum—but the failure to locate so many of the receivers is prompting government safety officials to try to develop more certain ways to trace set owners.

For watch-watchers

Remember when you didn't think you could afford an electronic calculator? Well, electronic digital watches are going to bite the dust, price-wise, in the same way, as a result of ferocious competition and new technology, according to a study by the market research firm of Frost & Sullivan. The study forecasts that the average retail price of an electronic watch will dip to $39 before 1976 is over and to $20 in 1977. By 1980, it is predicted that electronics will represent 26% of the total watch and clock market, rising to 50% by the mid-1980s. Some 78,000,000 digital watches will be sold in 1980 at nearly $3 billion. The study says that while light-emitting diode displays currently outnumber liquid crystals by 12 to 1, new work in LCDs and photochromic displays could well reverse the trend toward illuminated displays. The report sees integrated injection logic (I^2L) incorporating both timing and driving functions into same chip, reducing power requirements and resulting in increased speed.

CB vs. TV

The television business is in a slump, while there is more demand for Citizens-band radio equipment than industry can supply. So why not use idle TV factories to make CB gear? That idea occurred to the E. F. Johnson Co., probably the biggest manufacturer of CB equipment. After talking with several television manufacturers, it made a deal with Magnavox to produce 100,000 mobile CB units at the Morristown, TN, plant which normally turns out Magnavox television and stereo components. Production will be supervised by Johnson officials and the sets will be sold under Johnson's "Messenger" brandname.

Videodisc score

The two leading videodisc systems—The RCA capacitance and the Philips/MCA optical system—both are proceeding on schedule toward late-1976 introductions, according to their proponents. RCA is understood to have a number of hand-made prototypes installed in consumer homes, along with a selection of video records, to evaluate public response.

Officials of Philips and MCA say they're on target in their work toward complete interchangeability of optical discs—both flexible and rigid—so that any optical player will be able to read any optical disc. One of the biggest breakthroughs is the development of production facilities in the Netherlands to manufacture lasers at a cost of $10 to $15 each, in large quantities, with a second source in the United States (Spectra/Physics Co.). Neither Philips (whose players will be made and sold in the U.S. by its affiliate Magnavox) nor RCA anticipates that a large quantity of players will be sold in 1976, and both see the market gradually developing throughout 1977 and 1978 before the disc player can be called a mass-market item.

Five Japanese manufacturers have taken out patent licenses for the RCA system, but this doesn't mean they're committed to produce it. Under its licensing terms, RCA doesn't require any royalty payments until the player is actually on sale. So, in effect, taking out a license is just a good way to get a free look-see at the schematics.

FCC's game plan

The FCC is crying foul at some of those coin-operated video games which have become so popular lately. It seems some of them are creating serious radio interference problems. In one city, these arcade games are reported to have blacked out most police radio communications. The Commission is expected to isolate the radiating units and order them modified to eliminate interference.

Just as coin-op games are proliferating, so are home video game TV attachments—but these don't cause interference problems because they must be approved under the FCC's radiation rules before they can be put on the market. The first such game was Magnavox's Odyssey, which has been followed by five other brands, some using color and sophisticated on-screen scoring, some selling for as little as $65.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

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Power-line radiation may alter ionospheric reflecting layers

Radio-frequency oscillations from high-power electric transmission lines may have a controlling effect on the radiation belts around the planet, believes Dr. Robert Helliwell of Stanford University. The effect of this power-line action may be to cause the belts to dump some of their electrons into the upper atmosphere, altering the layers that make long-distance radio transmission possible.

This discovery, he believes, might open the way to ground-based manipulation of the radio-reflecting layers of the atmosphere to improve long-distance communication.

Dr. Helliwell has been studying the low-frequency emissions, called whistlers, for some 20 years. The study is conducted with the assistance of two 13-mile-long antennas, one in Antarctica and one in Quebec. The Antarctica antenna is used to produce synthetic whistlers—low-frequency radio waves—that are channeled to Quebec between the earth and the bottom of the ionosphere. Indications are, says Dr. Helliwell, that a high harmonic of the 60-Hz frequency of a Quebec power station, radiated by power lines between it and a large aluminum plant, is close to the frequency of the natural radiation. This produces resonance effect then increases the amplitude of the emissions fantastically to a point where electrons are knocked loose and drop into the upper atmosphere.

Are safety brakes dangerous?

A new Federal regulation, Motor Vehicle Safety Standard 121, requires electronic anti-lock brakes for new heavy tractor-trailer trucks. These are supposed to make it possible to use heavier and more powerful brakes than can be used otherwise. Without anti-lock devices, powerful brakes would simply lock the wheels of the vehicle in quick stops and send it out of control. Heavy-duty brakes with anti-lock systems can cut stopping distances almost in half, system supporters contend, while preventing skids and jackknifing.

The new brakes use mini-computers that compare the wheel speed with the ground speed. When the speed of the tire drops a pre-determined amount below that of the ground below it—indicating that the wheel is slipping—the brake releases, then is immediately reapplied, with quick releases and reapplications continuing until the vehicle stops. This tends to counteract any tendency to skid while increasing the efficiency of braking.

Many drivers are reacting to the supposed improvement with no enthusiasm, some referring to trucks so equipped as "death traps." Whether the objections are due to unfamiliarity with the action of the equipment (plus bugs in some of the units), normal resistance to change or inherent weaknesses in the anti-locking device is not clear. Brake manufacturers are understandably enthusiastic, as are some fleet owners. Drivers are almost totally pessimistic or downright hostile, one company's employees even threatening to strike if the brake problem is not resolved by winter.

The situation is further aggravated in some cases because new tractors with anti-locking devices are being used with old trailers without them. Thus the trucks can stop faster than the trailers, increasing instead of reducing the danger of jackknifing.

The National Highway Traffic Safety Administration is now carrying on tests with one of the trucks of the company whose drivers most strongly opposed the new brakes, and insists that the system will reduce the number and severity of accidents. The Teamsters Union, whose members have to drive the trucks, also favors the new standard. "The safety benefits of 121 far outweigh the problems we have had so far. If there are bugs, they will be ironed out," says R. V. Durham, the union's Health and Safety director.

The practical Dutch may solve the problem of city transport

The city of Amsterdam is choked with a surplus of cars on narrow streets not designed for them, often alongside deep canals where handling water traffic prevents building guard rails. A solution of the traffic problem now under experiment may well result in barring cars from her streets altogether. The small electric two-seat cars of the *Witkar* system, now being introduced in a testing program, seem to be working well and may in time entirely replace the larger gas-powered type on the city's streets.

The system was developed by one Luud Schimmelpennink, who in 1965 proposed that the city council buy 20,000 bicycles, paint them white and leave them all over the city for anyone to use. The white bicycle idea worked for a time, but was abandoned as the city withdrew financial support.

Citizens pay 25 guilders (about $5) for membership in the Witkar system. A further 25 guilders buys a one-year credit card that also serves as an "ignition key" for the cars. The cars are parked in stations where their batteries

(Continued on page 12)

THREE WITKARS await passengers in a typical charging station.

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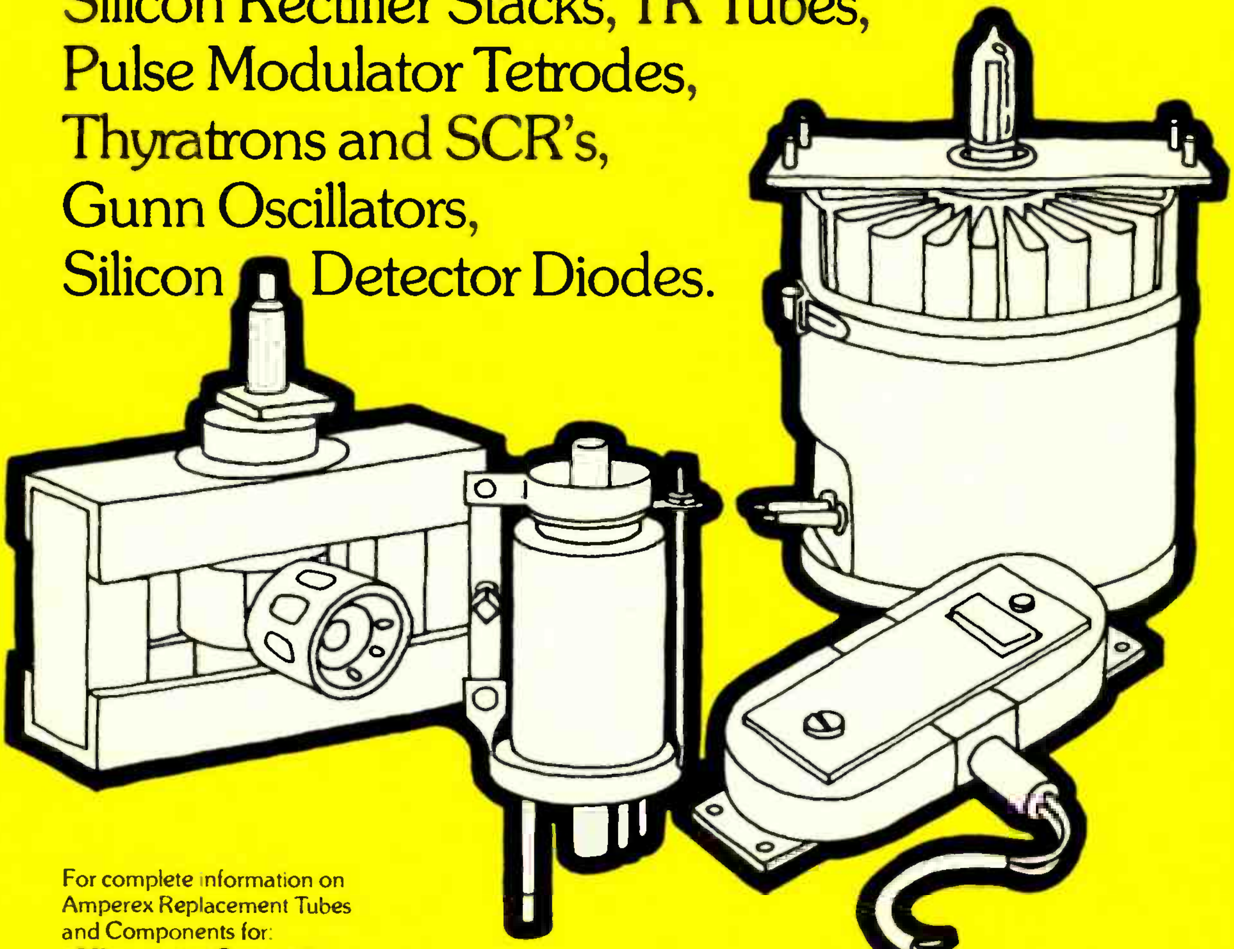

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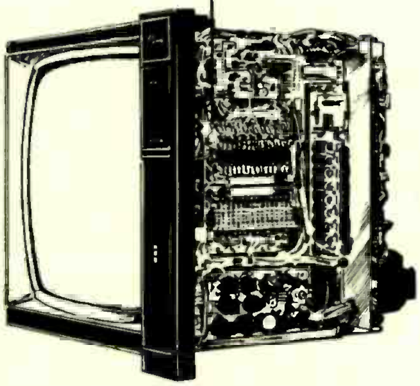

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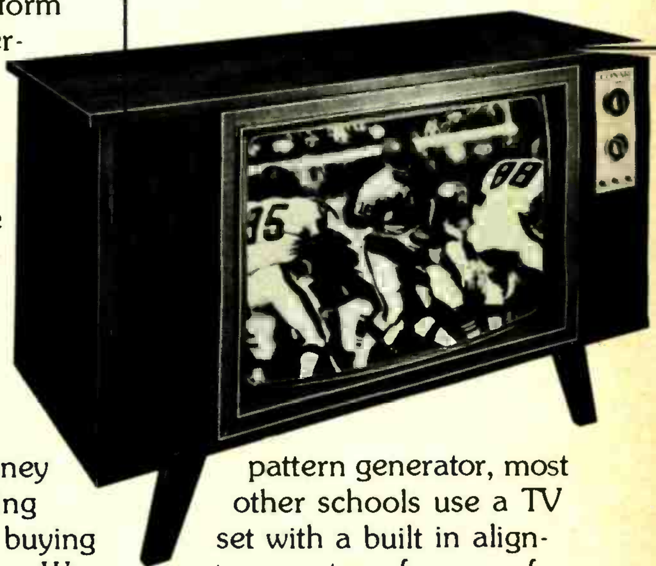

pattern generator, most other schools use a TV set with a built in alignment generator of no use for servicing other sets. Only NRI designs, engineers, and supplies training kits specifically for learning and professional use. You can pay hundreds of dollars more for a similar course and not get a nickel's worth more in training and equipment.

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new & timely (Continued from page 6)

are kept charged. A member inserts his card in a slot to "unlock" the car. He then drives to the station nearest his destination, parks and re-inserts his card to terminate the trip. During the time he is using the car, a charge of one cent per minute has been automatically recorded against his credit card.

It has been found that the average trip is between one and three miles. The present experimental setup consists of five stations and 35 cars, and trip distances may increase as the system spreads out over a larger area. (Expansion to 15 stations and 105 cars is under way.)

City planners from several countries have journeyed to Holland to see and evaluate the system and its possibilities. Meanwhile spokesmen for the city traffic department suggest that Amsterdam may become the world's first city to ban all forms of individual transportation other than the congestion-reducing and non-polluting electric cars—and, of course, bicycles!

TV manufacturer warns about possible line cord damage

Admiral's Home Entertainment Division reports that the line cord on about 500 of its color TV sets distributed since 1973 may have been damaged during manufacturing, to permit exposure of the conductor. Some of the damaged sets are believed to be in the hands of consumers.

A program to make repairs on sets in the hands of consumers, dealers and distributors is now under way. Any repairs necessary to correct the cords will be made at Admiral's expense.

Admiral states that it has heard of no incidents resulting from this problem, though under certain conditions it might be possible for a user to receive a shock from the line cord.

NESDA convention issues awards to individuals and firms

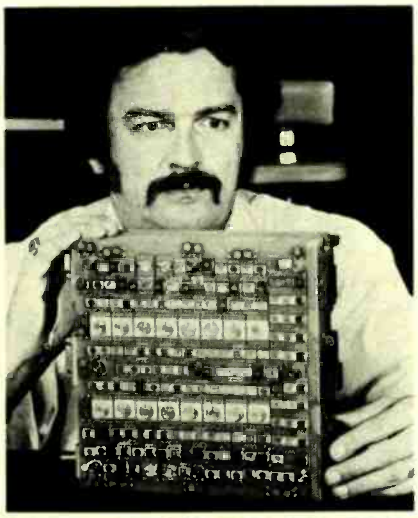
Larry Steckler, Editor of **Radio-Electronics** magazine, and during the past year chairman of the International Society of Certified Electronics Technicians (ISCET), was named Man of the Year by the National Electronic Service Dealers Association at its 1975 convention, held in Winston-Salem, NC.

The award, was "in appreciation for personal efforts and leadership to achieve the goals of NESDA and to further the interests of the nation's independent service dealers and technicians." **Radio-Electronics** magazine received a citation for "its support of the service industry yearbook and NESDA convention activities and for the support shown in its editor's involvement in service association activities as a member of the NESDA Executive Council and as chairman of ISCET during 1974-75."

Outstanding among the many other awards made at the Annual Convention was the Technician of the Year Award, made to Atahusian E. Emadi, CET, of Morefield Communications Co., Camp Hill, PA. He received a total score of 96 out of a possible 100 in the NESDA Tech of the Year grading system, which includes "proficiency in profession, industry involvement and community involvement." Coming from Uganda, Africa, in 1972, Mr. Atahusian overcame drastic changes in language, life style and employment to become well known in central Pennsylvania for his technical ability and for his efforts to improve the standards of technicians through education and the CET program. Mr. Atahusian received an engraved gold watch with his award. A silver watch, furnished by Gernsback Publications, was presented to the runner-up, Clarence Saatkamp of Milwaukee.

Other awards included plaques and certificates to outstanding associations, individuals, association publications, manufacturers and parts and product distributors.

DATA PROCESSING



GENERAL PURPOSE DATA PROCESSOR, held here by RCA technician Fred Schneider, is one of two that form the heart of a precise attitude control system that can guide a booster into orbit or supply spacecraft position information. The processor, using the latest semiconductor technology, weighs less than 8 pounds and uses only 5 watts of power.

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letters

QUESTION ON AUDIO POWER

I am writing to you concerning your article entitled "Radio-Electronics Tests Kenwood KR-5400" (August 1975 issue). While I found the article interesting, I object to the term "RMS power" that was used in the article. I claim that the term "RMS power" or (RMS watts) is a misleading term used by some vendors to misrepresent audio amplifier power capability to the technically unsophisticated consumer. Also some technical people use that term without defining it.

It is interesting to note that speakers are rated in terms of average power. What is the relationship between "RMS power" and average power (where average power is defined as the product of RMS voltage × RMS current × power factor, RMS current squared × resistance or RMS voltage squared divided by resistance)? To this day I have not seen "RMS power" defined in print. I am not aware of any instrument that responds to and indicates "RMS power." A conventional wattmeter (dynamometer type such as a Weston wattmeter) responds to and indicates average power. I must assume that "RMS power" is a parameter that is not measured directly but is arrived at by the use of some other measured parameter and some mathematical manipulation with some convenient fudge factor. According to the Federal Trade Commission, power output must be stated in terms of average power instead of "RMS power."

I am looking forward to your response to my comments.

STANLEY WALTER
Electronic Engineer
Simmonds Precision,
Instrument Systems Division
Vergennes, VT.

REPLY ON AUDIO POWER

I fully agree with you that the term "RMS power" is an unfortunately misused one. Nevertheless, the audio industry, through years of usage, can clearly define this term. It is simply the square of the RMS voltage (which is a legitimate term) read at the output of an amplifier, divided by the load resistance into which current from that amplifier is flowing. Average continuous power would be a better term, but the buying public has come to accept and expect a reference to "RMS power" and it is for that reason that we continue to use this term in our product test reports.

As for the FTC rule, I beg to disagree with you. I refer to a letter received from Mr. Aldhizer on August 1, 1974. In the letter, Mr. Aldhizer states specifically that "the designation minimum RMS may be used to indicate the rated minimum sine wave continuous average power output."

This is not the first contradiction the industry has encountered from the FTC. I am, in fact, hard at work now still trying to convince that Agency that preconditioning at ⅓ of rated power is an unrealistic requirement for amplifiers designed to operate in the class "B" mode. This arbitrarily conceived requirement is causing no end of grief to top manufacturers who cannot meet the requirement without de-rating the power output capability of their amplifiers or spending extra money for additional heat-sinking and/or blower fans.

Perhaps the FTC does not understand the true meaning of "RMS" either, but for the moment they are permitting its use. Also, if you will refer to the advertising copy of the most respected audio manufacturers in the world (who neither mathematically manipulate nor use "convenient fudge factors," you will find that the term RMS power is in very popular use. We are guided by industry practice, not purely by semantics.

If everyone understands RMS power to mean "average continuous sine-wave power" than that is what it means. When and if the industry drops this term, so will we. In the meanwhile, we feel our readers are better served by seeing terms which they can compare with advertised specifications.

LEONARD FELDMAN
Contributing High-Fidelity Editor

IDEAL BURGLAR ALARM

Regarding the request of Mr. David Blum, appearing in the August issue of **Radio-Electronics**, wherein he lists features of an alarm system as being the ideal burglar alarm system.

Let's be a little more up-to-date in our desires and have a system without under-rug pressure-pads, time-delay for entrance and exit doors, exposed reed-switches and magnets, window tapes, special alarm switches adjacent to entrance doors.

A more realistic "ideal burglar alarm system" for a residence should provide:

1. Concealed perimeter wiring for individual zones of windows, doors, underfloor entrances and roof entrances, detached garage or other structures, all coordinated into a dual-timed system.
2. A secreted control panel providing separate zonal on-off circuit continuity test with appropriately colored LED's indicating the zone alarm.
3. System should be powered with adequately rated Ni-Cads with automatic charging from the AC line.
4. Remotely located electromechanical controls providing:
   (a). Internal alarm adjustable to 90 seconds.
   (b). Very loud external alarm adjust-

(continued on page 16)

For the $400-class CB customer Realistic has what's really new and 4000 places to find it.

Reading time 48 seconds:

Not everyone has four C-notes to lay out for hobby or business equipment. But on the other hand, the new Realistic Navaho TRC-57 actually costs no more than a basic 35mm SLR camera. And for 399.95* you get an AM/SSB base/mobile transceiver with everything you'd expect — plus a lot you wouldn't. ✚ Digital phase-locked synthesizer and crystal lattice filter for unusual selectivity. ✚ Automatic modulation gain control for full power always, whether you talk loud or soft. ✚ ANL and blanker for chopping out noise. ✚ LED-indicator AM/USB/LSB mode lights. ✚ Separate SWR and S/RF power meters that turn red on transmit. ✚ Precise LED-readout clock switchable for 12 or 24-hour time. And of course it's FCC Type Accepted and UL listed. The new Navaho. You get something more by accepting nothing less!

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LETTERS

(continued from page 14)

able to 15 minutes.

(c). Automatic reset attempt at completion of each 15 minute period of external alarm.

(d). Sound operated controls energized only on complete shut-down.

5. Use of double-cylinder one-inch throw dead-bolt locking mechanisms on personnel entrance doors and:

(a). Immediate door-forced alarm.

(b). Provisions for exit or entry without deenergizing the zonal system.

6. Complete control with only one key.

F. IRBY
Ventura, CA.

UART MODIFICATION

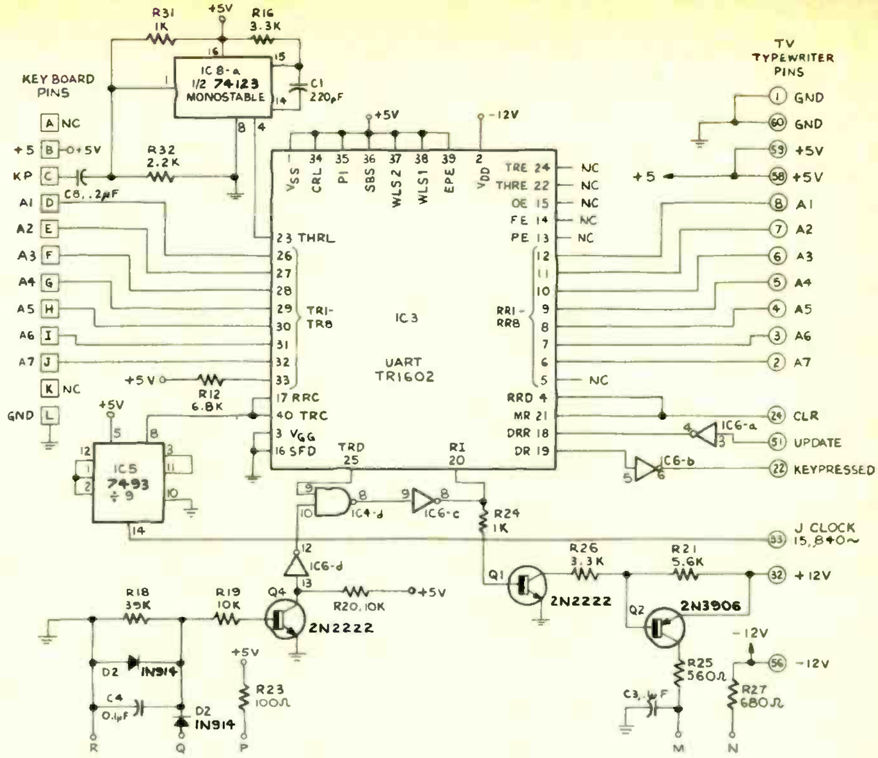
I wanted to use my TV Typewriter as a computer terminal, so I modified Roger L. Smith's UART board ("Add This UART To Your TV Typewriter," **R-E,** February 1975) as an I/O interface (schematic enclosed).

The transmitter output, receiver input and clock divider are identical to Mr. Smith's circuit. The transmitter input is connected directly to the keyboard, with the transmit load pulse coming from the keyboard keypressed-output through monostable IC8-a. The receiver output is wired to the TVT input bus, pins 2-8. The data received pulse drives TVT keypressed input through an inverter. Master reset and receive register disconnect come from TVT clear, pin 24. TVT update, pin 51, drives the data received reset through an inverter.

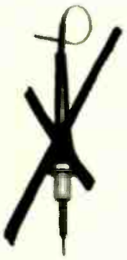
I used Western Digital's TR 1602 UART which is directly TTL compatible, thus eliminating the pullup and pulldown resistors. To save designing a new PC board, I used the one specified in the article, wiring jumpers as required. I used the same part reference numbers that Mr. Smith did wherever possible which accounts for some of the odd numbers on my schematic.

RAYMOND CRANDELL
Oakdale, CA.

R-E



Solder less. Design more.



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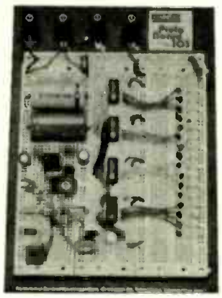

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we can fill them. For larger capacity, save time with our Proto-Board® series—660 to 3060 terminal points, with or without built-in regulated power supplies. For smaller applications, use 1 or more of our handy QT Sockets and Bus Strips, locking them together for infinite expandability, as you need it. Starting at $2.00.

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Circle 10 on reader service card

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"Pretty soon, they asked me to head up the air-conditioning department. I also picked up some business of my own on the side. That's what's helping to pay for the new house."

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Since 1890, millions of men and women around the world have turned to ICS for career training.

More than 70 of America's largest 100 corporations (including Gulf Oil, Bethlehem Steel, 3M, Westinghouse, and International Paper) use ICS training for their own employees.

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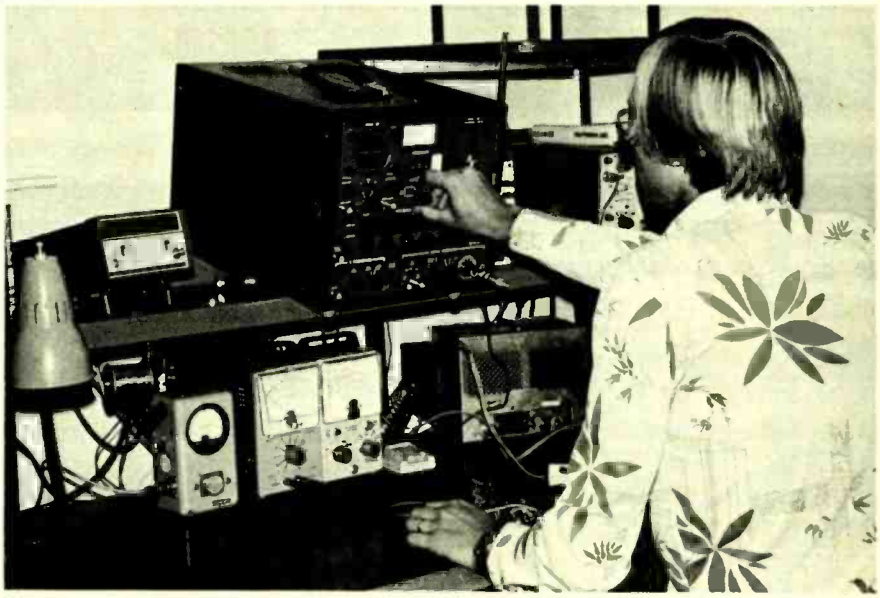
Soon, a new home built on a wooded lake site will give John and Cheryl Muirhead lots of room for their growing family. (Photo: Frank Cowan)

Getting Started in CB Servicing

CB operators demand the availability of quick and reliable service. What part will you play in the overall sales-and-service picture?



by LARRY STECKLER
EDITOR

CB IS BOOMING AND AS SALES INCREASE, the need for qualified repair agencies will also increase. You can get ready to handle the service end of the CB explosion now. And it is not difficult.

How do you get into CB and 2-way radio servicing? What equipment do you need; what training do your people need, and where can they get it? Deciding to do it is easy. Doing it is something else again.

If you're starting from scratch and want to do CB radio work only, you can get by with under $1,500 worth of new equipment: an inexpensive scope, a $500 frequency generator, a $50 multimeter, a dummy load, and a few other odds and ends are all you need for CB service. If you're already handling other electronic repairs you may need only the generator.

When you come to land mobile repair, we're talking an entirely different ball game. Here if you start from scratch, you must have a commercial monitor to start with and that costs $5,000 to $8,000 alone. As for the rest of the equipment, it has got to be better all the way down the line, so don't expect to get into land mobile radio repair for anything under $15,000 worth of equipment. In both cases you still need a shop to work out of; tools, parts and people.

Once you've made the decision to do servicing or if you're already involved in servicing, you know you will have a perpetual problem of getting competent, trained people to do the work. There is a shortage of trained service technicians in almost every field you can name, but nowhere is the shortage more critical than in electronics repair. As a result the specialized area of 2-way radio is facing an even more severe problem because of its sudden mushrooming growth.

One manufacturer has come up with a solution. At the moment it's available only to their authorized dealers (and on a space available basis to others who would like to participate). The company is E. F. Johnson and the school is run near their manufacturing facilities in Waseca, Minnesota.

I had the pleasure to visit the school recently. Daryl Thompson, the director of the school met me at the airport. I spent almost a full day there, touring the school, examining its facilities, speaking with its students, instructors, and Daryl.

One of my first questions was why E. F. Johnson decided to run a school for servicing 2-way gear in the first place. The answer was simple, "the manufacturer must provide trained people to service his product." With that introduction behind us, we went on to tour the facility and talk a bit about the various courses offered.

Remember, this is a resident school, and it offers several different courses of study. They are outlined elsewhere in this article. But let's review a few of

(continued on page 24)

CB SERVICE

(continued from page 22)

the highlights here. First, there's a one-week course for people who are already doing 2-way radio repair. It concentrates on a familiarization with E. F. Johnson equipment. Next, there is a two-week electronics repair course. It's intended for the man who is already doing electronics service work but is not familiar with 2-way equipment at all.

Then there is a six week course for the beginner. Daryl Thompson says

MR. DARYL F. THOMPSON oversees the training program for E. F. Johnson Co.

that this E. F. Johnson course will take a completely untrained individual and turn him into a competent technician capable of servicing 2-way radio gear. The school graduate does have less knowledge of theory than a two year vocational school grad, but the man will be able to work on and repair 2-way radio equipment under the supervision of an FCC licensed technician.

I asked Daryl if the course includes enough information to permit the student to pass the necessary FCC examinations. The answer is no; that the FCC license was beyond the scope of what the school was trying to cover. This is especially true since many of the questions asked on the FCC examination cover devices such as motor generators and vibrator power supplies that would be rarely seen in today's 2-way radio business.

The fees charged for the courses cover room and board for the student as well as tuition. The dealer must provide transportation to and from Waseca, plus take care of his normal salary obligations to his employee.

From my own observation, the classes are small but intensive and an awful lot is covered quite effectively in a very short time.

Like many other manufacturers, E. F. Johnson also conducts field training seminars. To enhance these seminars they have set up a complete video tape studio so that they can put the school and seminars on tape. Then the classroom is conveniently brought to dealers and their technicians in all parts of the country.

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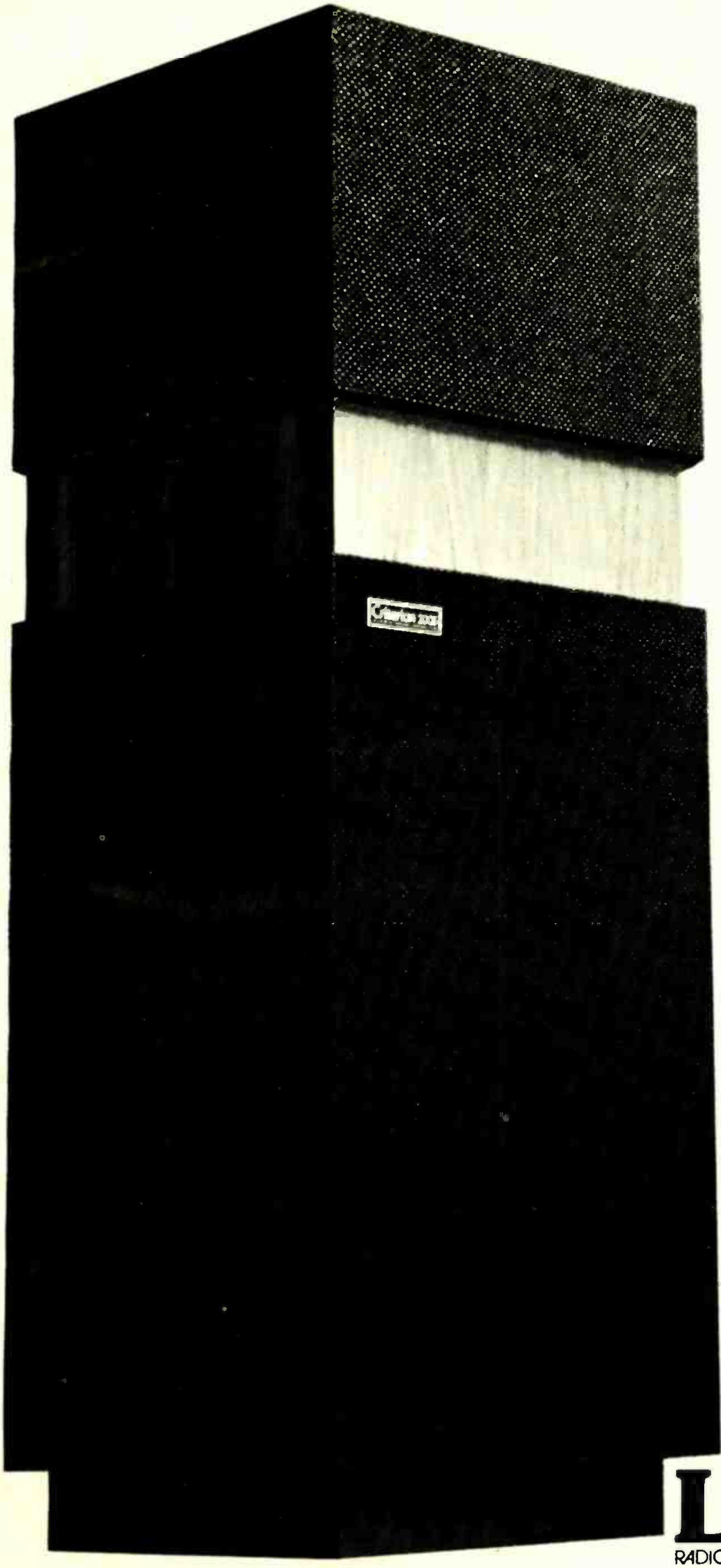

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HERE'S *A* PRESENT FROM THE FUTURE.

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CB SERVICE

(continued from page 24)

So if you are considering the question of servicing what you sell and do decide that it's a good idea, E. F. Johnson offers one possible solution to the question of getting trained technicians to do the job for you. They'll also be happy to give you data on what equipment you need to set up a shop to do this kind of work.

MR. LYNN ANDERSON, instructor, conducts class for Basic Technicians.

Field training seminars run by E. F. Johnson's Service Training Division, or as they call it, Technical Education Center, are held at regional locations to provide a quick and convenient way to become familiar with or refresh onesself on circuitry alignment procedures and trouble shooting hints that apply to E. F. Johnson Radios.

They also allow an exchange of information between dealers and factory personnel as well as among dealers themselves. Many retailers report that this is quite beneficial particularly swapping common solutions to problems. These seminars do not provide an opportunity to actually work on the equipment as the resident factory schools do. However they do provide interim training in a convenient way. They are also arranged to allow a participant the opportunity to select only those sessions that he particularly needs and skip those that he does not.

One item in the school course description is worth special mention. It reads: "any company that manufactures a product that must be serviced cannot ignore the necessity of providing education for those who must service that product. On the other side of the coin, those who service the products owe it to themselves and their customers to be as efficient and effective as possible. Service training is truly an investment in human capital that should be expected to pay a return. The E. F. Johnson company considers this mission of service to our warranty stations and customers one of high priority."

How to register

Advance registration for an E. F. Johnson class will normally insure you an opening in the class you plan to send an employee to. However, experience shows that the classes do fill quickly, so don't delay. Send company name, class requested and the date and number of employees you'd like to send, to E. F. Johnson company, Technical Education Center, Waseca, Minnesota 56093. A complete schedule of next year's classes are available from the same address.

Should you write to the school for information, please don't forget to let them know you read about it in **Radio-Electronics.** R-E

ADVANCED TECHNICIAN SCHOOL

Designed for one who is familiar with 2-way radio servicing but wants to learn the best techniques for servicing Johnson products. Also a good refresher for a "Johnson technician."

Land-Mobile

5 days	Tuition—$130.00
Equipment covered:	Fleetcom Transcom II Ultracom Handhelds

Repeaters

3 days	Tuition—$85.00
Equipment covered:	948/949 Repeater 770/780 Alpha Tone Panels Johnson Repeat-A-Guard

Citizens Radio

5 days	Tuition—$130.00
Equipment covered:	All E. F. Johnson manufactured CB radios —Duo-Scan & Mini-Scan

BASIC TECHNICIAN SCHOOL

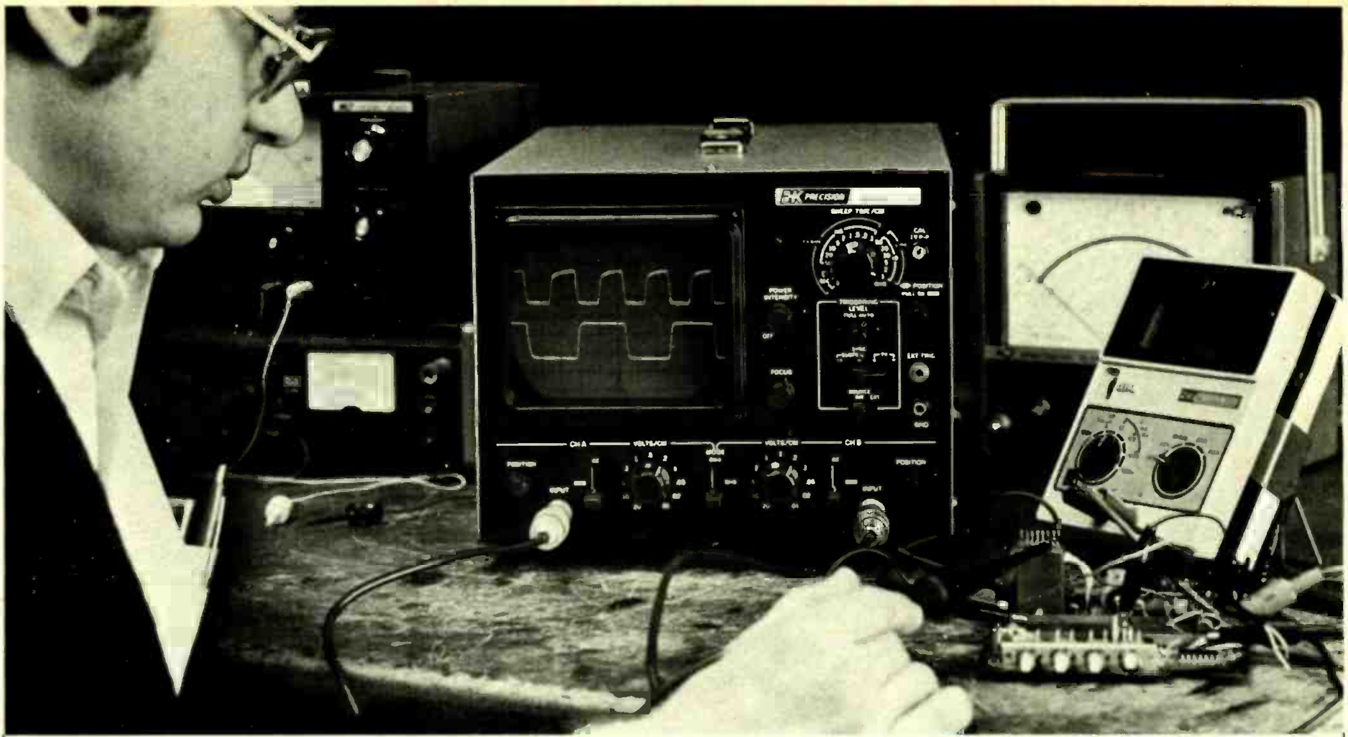
Designed for one who knows electronics but who feels a need for a firmer foundation or who, although previously involved in electronics, has not been involved in 2-way radio before. In addition to covering the products, the student will be refreshed on the basics of circuitry, problem analysis and test equipment usage. In addition, a heavy emphasis is placed on guided practical experience on the test bench to establish proper techniques.

Land-Mobile

10 days (plus one free weekend)	Tuition—$285.00
Equipment covered:	Fleetcom Transcom II Ultracom Handhelds

Citizens Radio

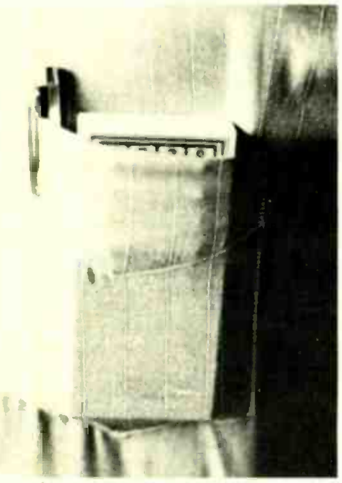
10 days (plus one free weekend)	Tuition—$285.00
Equipment covered:	All E. F. Johnson manufactured CB radios —Duo-Scan & Mini-Scan

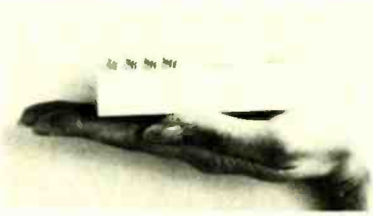


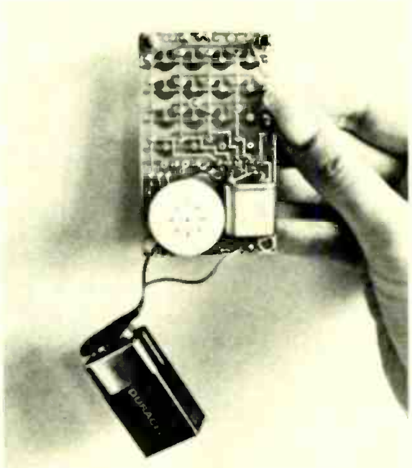
Circle 17 on reader service card

Use it to access a computer with a sound input, and with the optional plug-in memory, it can automatically dial a 7-digit telephone number.

Build This







Pocket Data Terminal

by CHARLES EDWARDS

THE POCKET DATA TERMINAL IS A HAND-sized unit that produces all the 16 digits of the standard *Touch-Tone** format. It generates, with a crystal controlled LSI integrated circuit, the eight *Touch-Tone* frequencies used by the telephone company. They are used, two frequencies at a time, to identify which one of 16 buttons (four more than on a standard *Touch-Tone* telephone) is being pressed.

Its uses as a telephone dialer or control unit are many—only a few of them can be described here. With the Auto-Dial plug-in memory—to be described next month—it can be used to dial any 7-digit telephone number automatically in less than one second, at the touch of a button. As more computers are adapted to sound input, it will become more useful as a means of computer access. (To operate as a true data terminal, the computer with which it is working must be equipped with a Synthetic Voice Generating Interface. These are around in only limited numbers today, so the PDT's main use along that line is in the future.)

The device does have many other uses that make it extremely valuable today. You can use it to dial any number (your telephone answering service for example) that you call frequently or in a hurry. If you are working with a computer that has to be dialed up every time you use the terminal, program the computer's number into the PDT's Auto-Dial memory to save time and distraction.

Give one to your elderly parents or grandparents so that in an emergency they can just hold it to the phone and call you without dialing, eliminating the possibility of a wrong number. (Make sure you try this ahead of time because not all phone lines are equipped to handle *Touch-Tone* dialing signals.) Older people whose eyesight may be poor and manual dexterity low will find it convenient and useful. Persons subject to heart attacks, strokes, epileptic seizures, etc., may find a PDT with the doctor's number programmed into it a life saver. (Tape a dime to the back of the unit for use in a phone booth.)

A store clerk could keep a Data Terminal handy, programmed with the number of the police department, to use in case of a holdup or similar emergency. The burglar alarm in your house or business can be connected to activate the PDT and call the police automatically.

Even without the Pocket Data Terminal's Auto-Dial option, the unit is handy to have around as a *Touch-Tone* generator. You can use it for a wide variety of

* Trademark of American Telephone and Telegraph Co.

applications, for instance, as an automatic and unduplicatable door key. Mount a small microphone at the point of entry and decode a series of tones to unlock the door. With proper decoders, the PDT can be used to operate a relay for almost any purpose. An example: to generate control tones to program a tape to control several slide projectors. Press 1, then press # to turn on a projector; press 2, then # to turn on projector 2. Press 1 then press * to turn off projector 2, etc.

Amateur radio operators will find it useful for controlling mountain-top repeaters. A series of tones from the keyboard could be used for repeater entry and for any function, from turning AC power on and off to switching antennas.

Besides the more obvious uses and remote control possibilities, an interesting case came up in the author's home. The *Touch-Tone* telephone quit working; it would receive calls OK but would not generate tones to dial out with. It took the phone company a week to get to the problem. In the meantime we dialed out without difficulty with the PDT, held to the handset microphone.

How it works

The Pocket Data Terminal (Fig. 1) consists of a two-of-eight coded keyboard, which drives the MOS *Touch-Tone* generating chip, IC1.

The output of IC1 goes to an audio amplifier, consisting of Q1 and Q2 (Fig. 2) which drive a small speaker. The two-of-eight code from the keyboard determines the divider mode of the programmable dividers in the tone generator chip. The on-chip oscillator is crystal controlled, generating very stable frequencies, accurate to ± ½%; well within the specification of

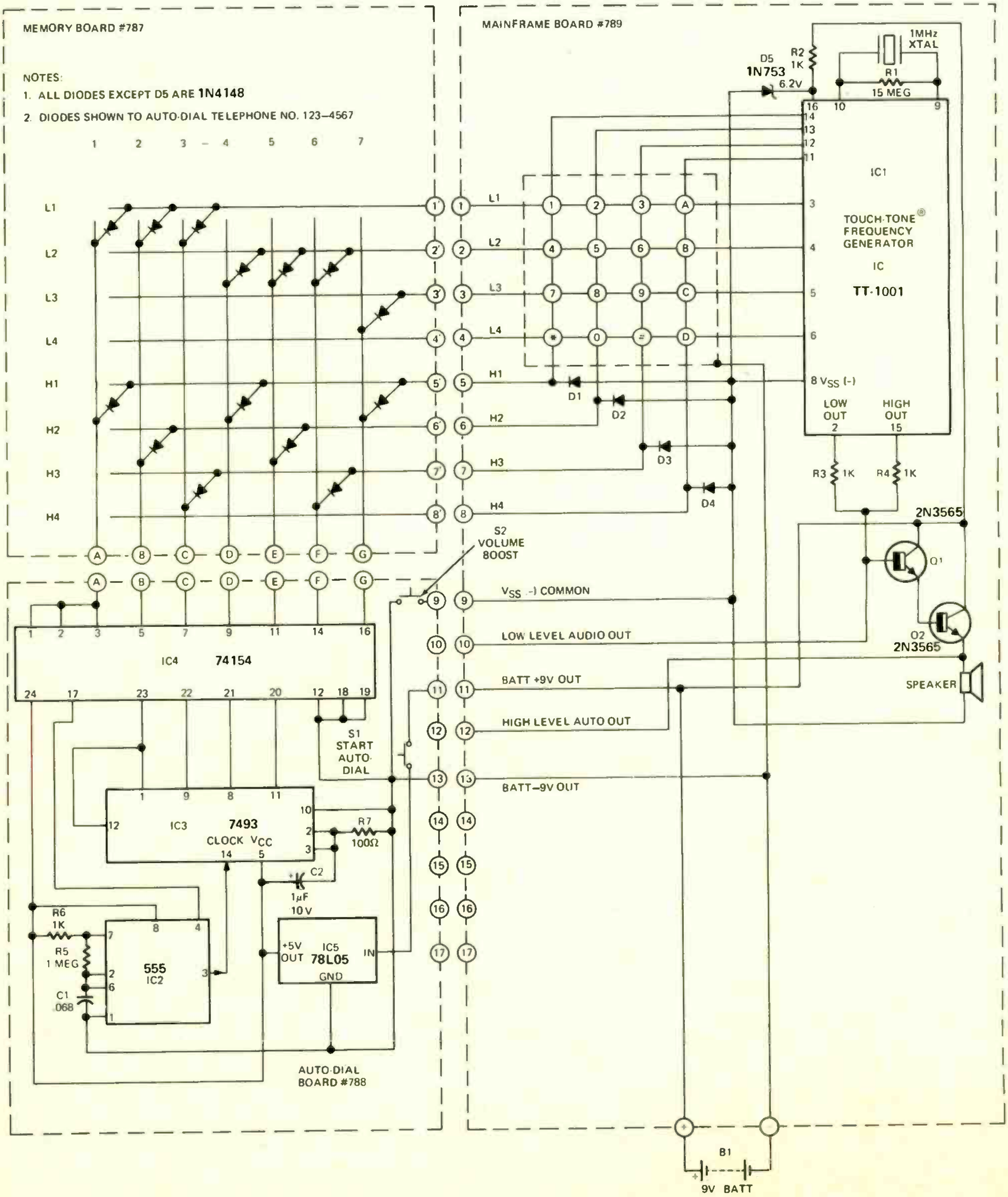
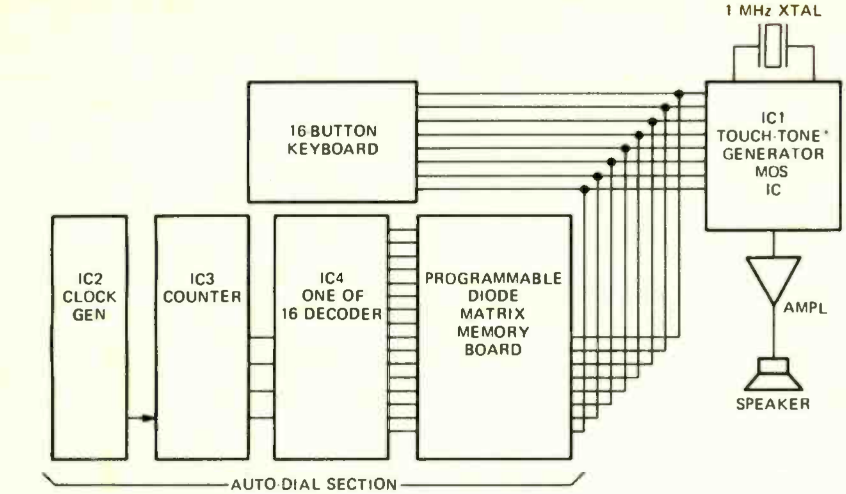
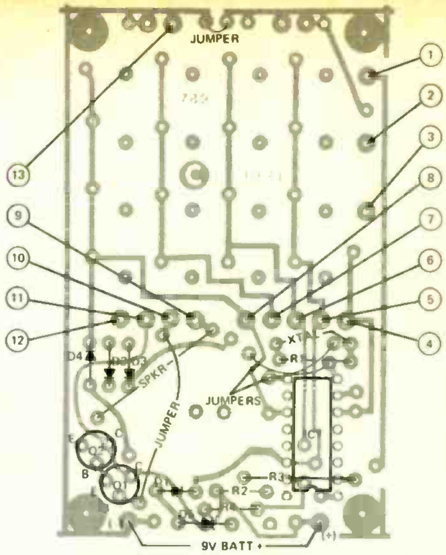


FIG. 2—POCKET DATA TERMINAL contains five IC's and three double-sided circuit boards.

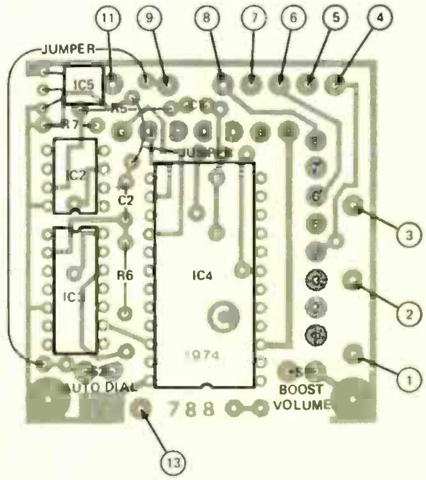


*TRADEMARK OF AMERICAN TELEPHONE AND TELEGRAPH CO.

FIG. 1—POCKET DATA TERMINAL uses a MOS Touch-Tone frequency generator IC.



COMPONENT PLACEMENT for the mainframe circuit board.



COMPONENT PLACEMENT for the Auto-Dial circuit board.

± 1.5% of most *Touch-Tone* receivers, including those used at the telephone company's main offices.

On the Auto-Dial option (board No. 788, Fig. 2) IC2, a 555 oscilator, is set to operate as a system clock with its frequency set by selecting R5. The output of IC2 clocks the input of IC3, a 4-bit binary-to-binary-coded decimal (BCD) output counter. The four-line BCD outputs of IC3 go to the inputs of IC4, a BCD to one-of-16 decoder. The outputs of IC4 go low one at a time, starting with pin 1, as the BCD information on the input of IC4 ascends in BCD value.

Only every other output of IC4 is used, which provides the required interdigit timing period. This is equal to the tone-on time, regardless of the frequency of IC2, the clock generator. IC2's frequency should be set so each output of IC4 is low for a period of a minimum of 40 milliseconds and could be typically set for 60-70 ms. At 70 ms, a complete 7-digit telephone number will still be outputed in less than one second.

Outputs 1, 2, and 3 of IC4 are tied together to provide a 180 to 240-ms first digit to make sure that a radio transmitter is up to full output when using the Pocket Data Terminal with a two-way radio. If a 40 to 70-ms long first digit is desired, simply cut the trace from pin 2 to 3 of IC4.

The outputs of IC4 are routed through board No. 3, the Memory plug-in card. The position of the diodes on the Memory card determine which of the two-of-eight inputs to the *Touch-Tone* generator chip IC1 will be pulled low in what order. IC1 is available for $11.00 postpaid within USA from Tel-Tek Electronics, P. O. Box 562, Belmont, California 94002. Order part No. TT-1001. (Refer to Part Two

All resistors are ¼ watt, 10% unless noted
R1—15 megohms
R2, R3, R4, R6—1,000 ohms
R5—1 megohm, 5%
R6—1,000 ohms

C1—.068 μF monolithic
C2—1 μF, 10 V electrolytic

IC1—TT-1001 *Touch-Tone** Frequency Generator Integrated Circuit available for $11.00 postpaid within USA from: Tel-Tek Electronics P. O. Box 562, Belmont, California 94002. Order Part TT-1001.
IC2—555 timer
IC3—7493 TTL
IC4—74154 TTL
IC5—78L05 Regulator

D1, D2, D3, D4, D6—D19—1N 4148
D5—IN753 6.2 V. Zener diode,
Q1, Q2—2N3565

XTAL—1.00 MHz Quartz crystal
MISC—pins, sockets, 9V alkaline battery, battery connector, speaker, PC boards, plastic case with keyboard, wire, solder

*Trademark of American Telephone and Telegraph Co.

The following parts may be ordered from: Executive Devices, 740 South Locan Avenue, Fresno, California 93727.

PC-789—Mainframe PC Board. Drilled epoxy-glass with plated-through holes. $5.95 postpaid within USA.

PC-788—Auto-Dial PC Board. Drilled epoxy-glass with plated-through holes. $5.95 postpaid within USA.

PC-787—Memory PC Board. Drilled epoxy-glass with plated-through holes. $5.95 postpaid within USA.

CA-700—Plastic Case for Pocket Data Terminal, including keyboard buttons and hardware. $7.95 postpaid within USA.

PDT-700K—Kit of all parts for basic Pocket Data Terminal. Includes all parts, TT-1001, IC, PC Board, speaker, XTAL, case and keyboard (less battery). Does not include any parts for Auto-Dial or Memory options. $39.95 postpaid within USA.

PDT-700—Above basic Pocket Data Terminal assembled and tested (less battery). $49.94 postpaid within USA.

ADO-700K—Kit of all parts for Auto-Dial option. Includes all parts, all IC's, PC board, smaller speaker, push button switches, pins and sockets. Does not include any parts for Memory board (required, see below). $24.95 postpaid within USA.

ADO-700—Above Auto-Dial option assembled and tested. $34.95 postpaid within USA.

MEM-700K—Kit of parts for Memory board. Includes PC board, pins for interconnection, all diodes. $6.95 postpaid within USA.

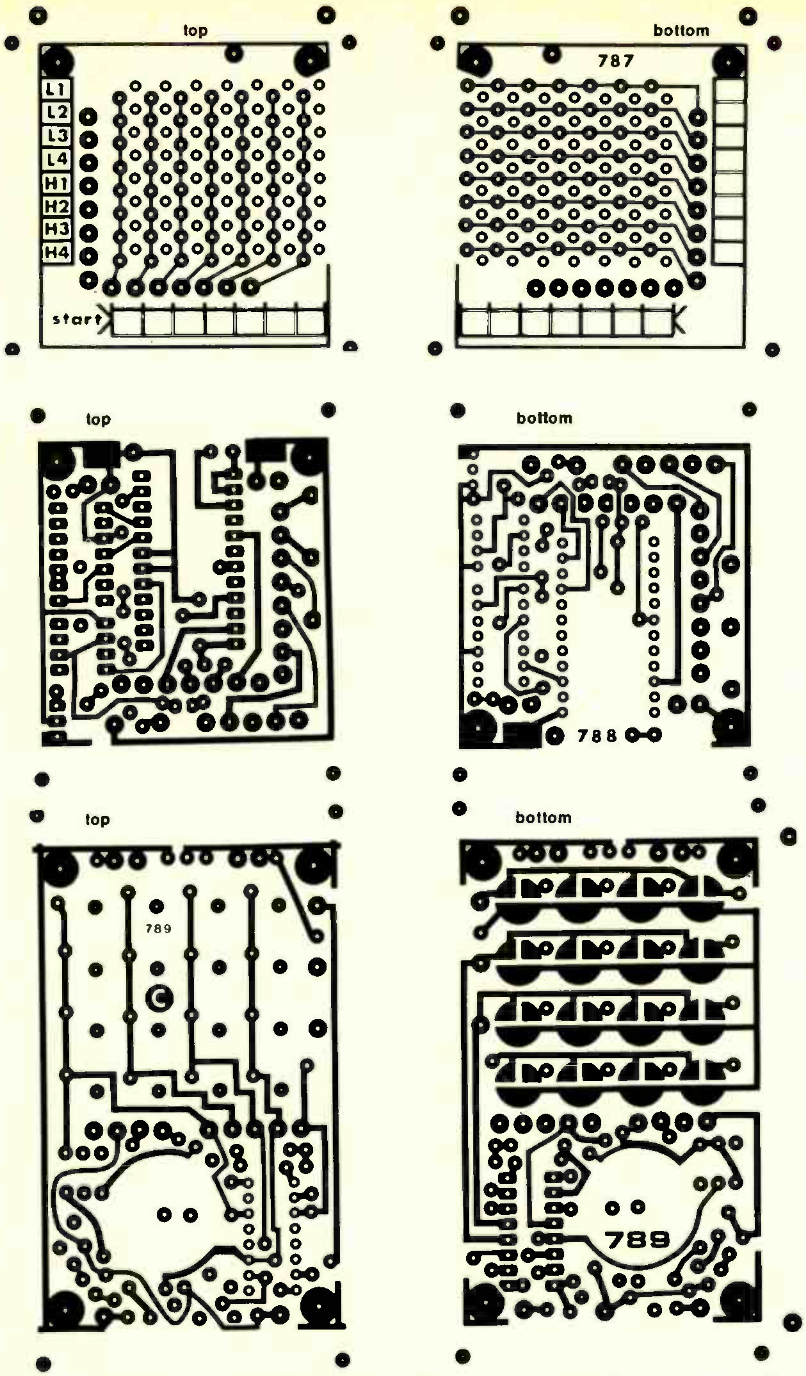
MEM-700—Above Memory board and programed for any 7-digit number. $9.95 postpaid within USA.

PDT-1000K—Kit of all parts and PC boards for basic Pocket Data Terminal including all parts and PC boards for Memory options (less battery). $69.96 postpaid within USA.

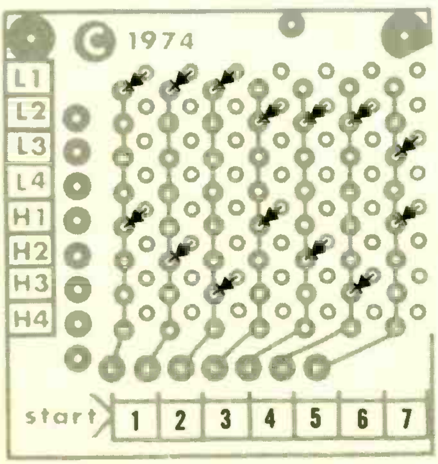
PDT-1000—Assembled basic Pocket Data Terminal including assembled Auto-Dial option and Memory option preprogramed to any 7-digit number (specify with order) (less battery). $89.95 postpaid within USA.

181-423—Heavy duty sewn-edge carrying case with belt loop. $5.95 postpaid within USA.

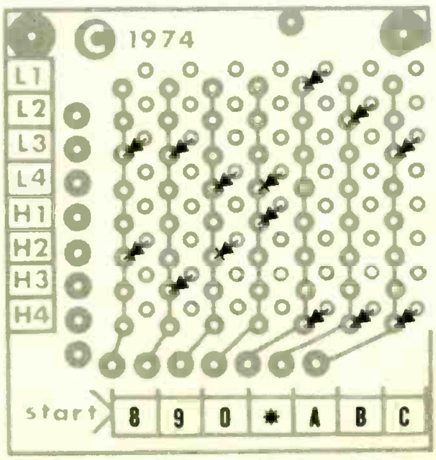
(California residents add sales tax)



FOIL PATTERNS of double-sided boards. Memory (top), Auto-Dial (center) and mainframe (above) boards are shown 80% full size.



MEMORY BOARD shown programmed to dial 1234567.



MEMORY BOARD shown programmed to dial 890*ABC.

next month for information on programming the Memory card.)

Switch S1 (Auto-Dial) is pressed and held during auto-dialing and supplies +5 volts to IC2, IC3 and IC4 via IC5, a 9V to 5V regulator. Switch S2 (volume boost) is used either during Auto-Dial or keyboard operation to boost the audio output level when required.

How to use it

Simply hold the Pocket Data Terminal up to the telephone or two-way radio microphone. To start the Auto-Dial, press the right button on top and hold it down; then press the left button and hold it down until the Auto-Dial has finished dialing (within one second it will have outputed all seven digits stored in memory). To use the keyboard for control or data entry purposes it is only necessary to press each button as required. Press firmly and listen to the tones produced as you use the keyboard.

If the data are not being received at the other end of the phone line, the level being transmitted may be low; check for maximum acoustic coupling to the microphone; be sure the nickel-plated eyelet on the rear of the Pocket Data Terminal is centered on and is in good contact with the handset microphone; be sure the unit is parallel with and flat against the microphone. If more audio level is required because of a bad or noisy telephone line, simply hold down the top right button while using the keyboard. This gives a boost in audio level output. No on-off switch is required, because there is no battery drain when no tones are being generated. The unit will work with any *Touch-Tone* telephone or any dial-type telephone that is connected on a *Touch-Tone* telephone line.

Because of the compactness of the unit and the fact that the keyboard contacts are etched into the main frame PC board, and since making double-sided plated-through holes is beyond the capabilities of most home constructors, it is recommended that the unit be built using only pre-fabricated PC boards. A set of PC boards, as well as a complete set of parts, is available from Executive Devices, 740 South Locan Avenue, Fresno, CA 93727. See the Parts List for information on ordering complete kits or parts or assembled units.

Next Month: Detailed construction information—how to build the plug-in Auto-Dial option that enables the Pocket Data Terminal to remember and automatically dial a 7-digit telephone in less than one second at the touch of a button.

NO DC VOLTAGE

I can't get any DC voltage on the plate of the video amplifier tube in this Bradford CMAT-89243. Nothing on the picture tube cathodes either.—S.E.

Its probably an open winding in the "service transformer" that feeds DC to both the video output plate and the picture-tube cathodes. Check this. If it is open, you can get an exact duplicate from the J.W. Miller Co. Something like their no. 7600 or no. 7602 ought to do very well.

JOHNSON Messenger 130A

CB Equipment Roundup

New features and new performance to meet the increased demand for CB.

PACE Sidetalk 1000B

PEARCE-SIMPSON Cougar 23B

by HERB FRIEDMAN

GOOD TIMES OR BAD, IF YOU HAVE A PRODuct that most everyone wants or needs—like the proverbial mousetrap—you have a hot item. Citizens band has proven, in just the last few months, to be the better mousetrap the electronics industry needed. With color TV sales way down and hi-fi equipment just sitting on shelves waiting for customers, the CB sales have kept many a store in business, not to forget a manufacturer or two. Fact is, some CB manufacturers are running six months behind in deliveries; in some parts of the country you go on a waiting list to get a specific type of mobile antenna, and some "hot" transceivers are just about unavailable if you don't have good relations with a local distributor.

What brought about the sudden surge in CB sales is a whole separate story concerning license fees, court decisions, unbelievable stupidity by the EIA regarding Class-E service, an insane FCC restructuring proposal for Class-D service, and the realization by many that it was now or never for them and CB—with or without a license. All these factors came together at the same time and when the smoke cleared, a whole new CB market emerged; a thundering herd rushing for CB licenses at the rate of 100,000+ applications a month.

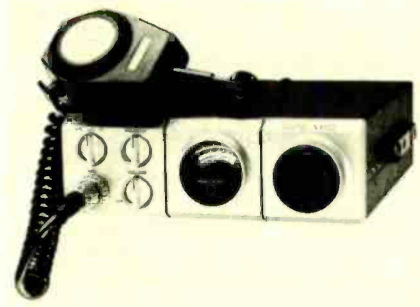
Equipment

There are so many people buying CB transceivers that the industry, which was moving towards the high-ticket "gold plated specials", has turned on a dime and settled on a more or less average price range of about $150 to $200, and most of the new equipment falls into this price range.

Of course, not everyone is producing two or three models for the "average price range". There are many lines from well known brands that range from basic budget-models with not too much in the way of features and performance to high-performance SSB/AM models with several steps in between. For example, Pearce-Simpson goes from a *Pussycat 23* at $170.95 to the deluxe *Guardian 23* at $379.95 in five steps—adding performance and features at each step. E. F. Johnson, Cobra (Dynascan), Lafayette and Radio Shack are just a few of other well known brands that offer progressively upgraded transceivers. And when you start to search for unusual features such as a modulation meter, or microphone gain control, you'll find other broadly-based feature/performance lines from Midland, Courier and Teaberry.

But if you look at both the broad lines, and the transceivers from manufacturers with just two or three models, you'll find most of what's available falls in the "average" $150 to $200 price range; and much of the performance will be similar. In many instances the price differential represents operating convenience features. In the "average" price range the models appear to be built on a basic package: a 23-channel transceiver with volume and squelch controls and moderate receiver selectivity. Generally, the only "extra" feature is a remote speaker jack.

As the model is upgraded, any or all of the following features might be added to the basic package: A PA speaker output and selector switch, a noise blanker, an S/RF-output meter, a tone control, a modulation meter, a microphone gain control, a speech compressor (talk power booster), etc., etc., etc. Rarely will you find one model with all possible features, but most of the standard brands will have at least one specific model with those features *you* consider most important. In addition to the previously mentioned brands, "average" priced models are also available from such well-known labels as E. F. Johnson, Royce, Pathcom, Browning, Hy-Gain, Robyn and Pace. And it seems that almost weekly a whole host of new brands and labels appear on the CB market.



CRAIG model 4104

The Johnnie-come-latelies are primarily in the "average" price area for that's where most of the sales are: few enter the low cost budget priced range close to $100 or the higher priced specialty and SSB/AM market. It's sort of like the early days of auto stereo tape players where every dealer stocked the best profit item for a given time: few gave any thought to repair parts for these here-today-gone-tomorrow brands. If it had the right "average" price it could be sold. CB is much like that today, and often you'll find an unknown "average" priced transceiver offers less performance and features than that of a similarly priced well known model.

It is presently impossible to state that so-many dollars will purchase so-much performance and this-many features. The market just doesn't work that way anymore. In the "average" price range of about $150 to $200 there are many convenience trade-offs to make a particular feature available at a popular price. For example, and we are now talking *quality equipment* in terms of electrical performance—receiver sensitivity, selectivity, RF power output, etc.—the same amount of money might purchase a true RF noise blanker in one model (for those with real bad impulse noise problems), a modulation meter and microphone gain control in another model, or an S/RF-output/SWR meter in yet a third model. Of course, it is possible to get one model with all these features, but not for the "average" price. In short, within a given price range and a given level of electrical performance, the average CB'er can find a transceiver having only those features he needs.

If you look at some of the features now offered in moderate priced equipment, you wonder how it was done, for many of the now generally available features were formally found only in the most highest priced models. The secret to success was in cutting costs on circuits through new technologies so user-desired features could be offered at moderate prices with no essential change in performance. For example, crystal synthesizers usually require two receiving mixers, thereby providing double conversion. Lafayette, however, now uses a simple diode for the second mixer, and the substantial savings in circuit components and assembly has helped keep the cost of this year's full-feature models down at last year's levels.

On the other hand, many solid-state transceivers have suffered from cross-modulation caused by very strong received signals. Normally, the cross-modulation is caused by the protection diodes on the input to the RF amplifier. The problem can be alleviated by a more expensive FET front-end design, but a less expensive way to avoid the problem is a distant-local switch such as used by Robyn. Where the user wants to avoid throwing a switch there are new overload-immune FET front-ends such as used in Courier's *Redball* transceiver. In fact, with the proliferation of CB into almost every other street the overload and cross-modulation by "down-the-block" signals can only get worse and we can expect to see more FET front-ends as new transceiver models are introduced later this year.

Above the approximate $200 price level we start to get some new features and performance-oriented circuits that we used to expect only on the highest priced lines. For example, E. F. Johnson now has a model with a string of LED lamps substituting for an S/RF-output meter (the lights are easier to "read" in a car); six LED's indicate the received signal strength to 20-over-S9 and RF-output on an 0 to 5 scale. Even further above $200, Johnson has a new transceiver with cascaded crystal filters for steep-skirt razor-sharp selectivity, as well as an RF-side-chain type of noise blanker such as Lafayette uses in their top-of-the-line AM transceivers.

At the $200 price level we also start to see many features desired by hobbyists—and remember, the latest CB rules permit hobby-type operations. While the S/RF meter is just about standard on most transceivers priced from $150 up, more models, such as the Teaberry *T-Control*, now also provide SWR metering while Cobra and Pearce-Simpson have added models with independent modulation meters.

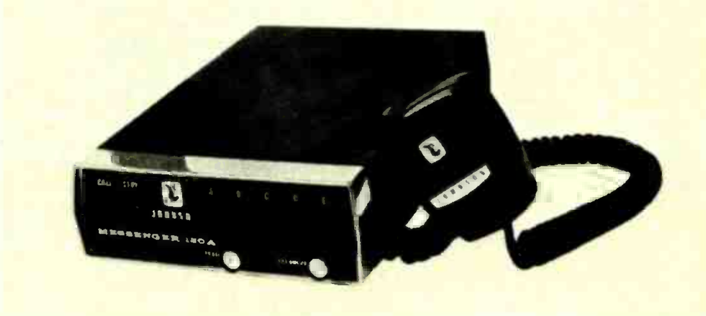
For special public service monitoring applications, there are still a few transceivers with dual-receive capability, such as Lafayette's *Telsat 925*, that monitors Channel-9 while you work a different channel. A signal appearing on Channel-9 will over-ride the received signal or indicate its presence by a panel lamp.

A feature for both the public service and hobbyist CB'er is the normally open and closed transmit/receive relay accessory contacts on the Kriss model XL-23 transceiver. These contacts can be used to switch accessory equipment, signal devices, etc. through the microphone's push-to-talk switch. The XL-23 also has connections for a remote signal strength indicator (S-meter, etc.).

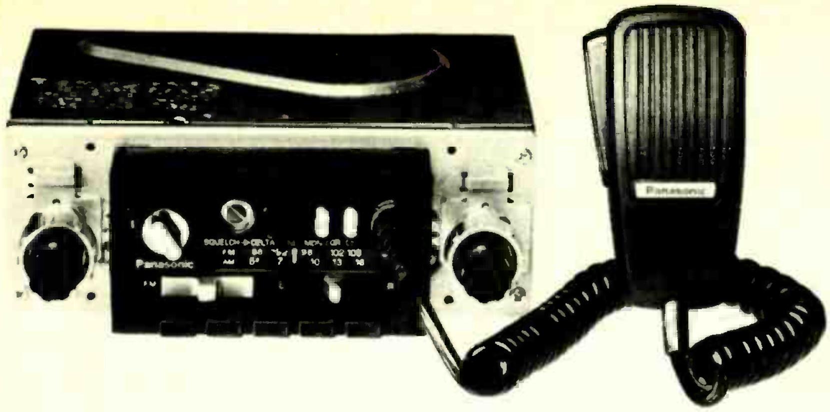
For the CB'er active in rescue or community service, there's the Craig model 4102 with a quick release mobile mount having automatic make/break terminals for remote and PA speakers.

Another specialized rig is Midland's model 13-861: a complete 23-channel mini-sized mobile having a leather case with built in battery compartment and an accessory telescopic antenna. Basically, the complete unit is a high powered walkie-talkie, but a mobile bracket allows the unit to be quickly secured with the usual two screws under a car or truck's dash. Plug in the power and antenna con-

KRIS model XL-23


JOHNSON Messenger 120A

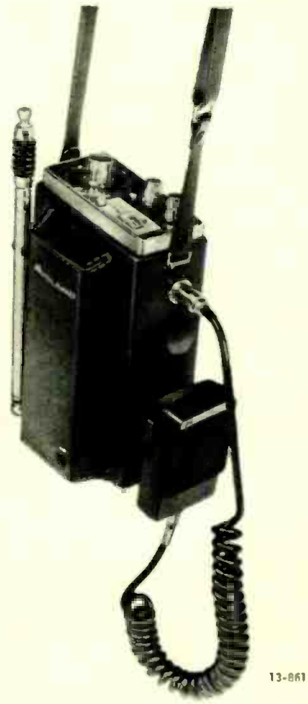

PACE Sidetalk 1000M



PANASONIC model CR-B1717

REGENCY Micro-com u12

REGENCY Micro-com 24s



MIDLAND model 13-861

nectors and the walkie-talkie becomes a standard mobile rig. If you have no need for a faster-than-the-eye-can-follow mobile to portable conversion, the unit can be removed from its case and used as a straight mobile.

The mobile telephone appearance pioneered by Johnson has really caught on and you'll find other mobilephone rigs in the Lafayette and Radio Shack lines. Also, E. F. Johnson has added an executive-phone styled base station.

In many instances you'll ask "Where have I seen that rig before?", for several brands use the quality mobile model as the basic base-station unit. They simply install the mobile in a new and larger cabinet containing a line-powered DC source, and perhaps a digital clock. PAL Electronics carries this idea one step further with their *Roadrunner 23* by providing a cabinet with forward facing speakers that plug into the basic mobile package.

An attractive idea, particularly for the boating enthusiast, is the PACE model CB-145, a 23-channel CB transceiver with a built in weather monitor for the two national weather frequencies.

With the exception of the "gold-plated/high-performance" transceivers and transmitter-receiver systems such as the Tram model D201 and Browning *Eagle*, most AM/SSB transceivers range in price from about $250 to $500. At the lower end of the price scale are the no-frills/no extra feature mobile models such as the Lafayette *Telsat SSB-75*, though the typical SSB/AM model with the most common features such as an S/RF-output meter go for somewhat more than $300. When you get to the feature and performance packed base station SSB/AM models, figure you're in the $500 class, but this kind of money gets you a Pearce-Simpson *Simba SSB* that features everything from variable microphone gain to a desk mike.

For those who dig high styling—clocks, meters, and a space-age appearance—combined with high performance SSB/AM, there's the Cobra equipment; while Siltronix, Tram, Browning, and Johnson, among others, still specialize in high performance SSB/AM equipment that can take an endless pounding on highway chuck holes.

Finally, we must acknowledge that CB has moved into the area of general interest, where it can be simply another feature in some form of "electronic entertainment center". We already find CB equipment sharing the same shelf space as hi-fi systems in many audio showrooms; and a substantial number of "auto sound shops" specializing in mobile tape player sales and installation now stock and install CB transceivers. To carry it to the final conclusion, the Xtal model XCB-28 has tied it all together with a combination AM/FM/FM stereo/8-track/23-channel CB "entertainment/communications center priced somewhat under $300. Other companies have announced similar applications such as cassette/CB, AM/FM/CB and 8-track/CB, but as of the time this article is being prepared the Xtal model XCB-28 appears to be the only multi-purpose model actually available.

Future

Whether it's simply a renewal of interest in CB, or old timers upgrading their stations to beat possible restructuring of Class-D CB, the fact of the matter is CB is the hottest thing going in consumer electronics. A conservative estimate is a million legitimate new licenses in the next 12 months, and an untold number of unlicensed operators; and each single CB'er represents a minimum of one transceiver purchase. With a market of this size, you can expect to see new models with new features and new technology appearing monthly, or even weekly. **R-E**

What are your opportunities in the electronics field? Here are some eye opening facts from ETI.

Q. What about the job market in electronics?

A. It's good. In fact, it seems to be one of the few fields that stays relatively steady in bad times. Today, for example, estimates indicate that several thousand jobs will be opening up for electronics technicians each year, for years to come. One reason for this is the fact that electronics are the basis of almost all communications, and this is a communications-oriented nation.

Q. What kind of jobs are you talking about?

A. For example, there are jobs available in electronic/industrial automation, electronic equipment repair and servicing, in the broadcast and radio telephone communications field, at airports, and even in medicine and in hospitals, where electronics is rapidly increasing in importance. And there are hundreds of other jobs opening up as electronics continues to make great strides, in new ideas and developments.

It's a growing field, and you can grow with it through Electronics Technical Institute.

Q. Can such a complicated subject as electronics be successfully taught by the home-study method?

A. Of course it can. ETI has proven that beyond a shadow of a doubt. Our graduates are working in practically every phase of electronics. This is largely due to the kind of instruction provided by ETI. For example, while learning the Fundamentals of Electronics, the student advances rapidly through the use of an exclusive teaching system called *Autotext*. And throughout all courses the student is thoroughly monitored and carefully guided by a licensed instructor, whose professional and personal interest is to see that he masters every bit of information presented to him. Of course, we must give a lot of the credit to our students themselves. They know that no matter how good the instructor may be, *they* have to make it work. So most of them apply themselves diligently, and they find the more they learn, the more they *want* to learn.

Q. But I have a job, and as much as I would like to get into electronics, I can't afford to take time off. How do I get around that?

A. You don't have to take time off from your job. You study at home, in your free time. We do advise, however, that you set aside a certain time for your study schedule and stick to it, even if it's only a couple of hours a day. The beauty of the ETI way of learning is that you work at your own pace, making sure you've completed your assignment thoroughly and completely. We think you'll find, as you go along, that learning the ETI way can be fun.

Q. How do my assignments come to me?

A. They are sent to you one at a time. You work on each in the comfort of your home, at a pace that is comfortable and convenient to you. If you feel you need more time, you can go back over the material until you've mastered every point of information. Then you take a brief exam, which helps you to fix the information even more firmly in your mind. This exam is mailed back to ETI, where your instructor reviews it, and makes comments and suggestions that will be particularly valuable when you take up your next assignment.

Q. How long does all this take?

A. If your instructor receives your examination in the morning, in most cases he will have graded it, added his comments and have it on the way back to you that same afternoon. Service like this helps speed up your learning process—keeps your interest high—and puts you closer to your goal, the coveted ETI diploma.

Q. But I was never very big on books and study. I like to work with my hands.

A. With your ETI course, you'll get plenty of work with your hands. In fact, the ETI system of teaching combines hands-on work with study, so that you actually learn by doing. As you move along developing your technical knowledge, you will use, in many phases, specially developed Project Kits. So you apply your knowledge in logical, hands-on sequences, from the first step through completion of basic units.

Q. It all sounds very interesting and inviting. But I wouldn't want to commit myself before knowing more.

A. We wouldn't want you to. In fact, we insist that you check it out first. All you do is fill out the card or coupon and mail it to us. We'll send you a colorful new 48-page ETI Career Book that will give you the facts and the many opportunities ETI can open up for you. If you like electronics, you'll enjoy reading this book.

Q. Do I obligate myself in any way by sending for your book?

A. Absolutely not. The ETI Career Book is free, and it involves no responsibility on your part, nor will a salesman call on you. All we want to do is to be sure you have all the facts about ETI and what it can mean to your future. And you can get these facts and complete information about ETI's 16 different courses and programs in electronics by filling out and mailing the card or coupon to us today. We'll send you ETI's Career Book by return mail. We think it will be a real eye-opener for you.
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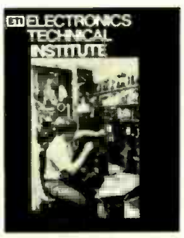

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Circle 18 on reader service card

Radio-Electronics

1

Tests Marantz Model CD-400B

by LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

WHILE MANY QUADRIPHONIC RECEIVERS marketed in the last year or two include built-in demodulators for playing CD-4 quadradiscs, Marantz's line of 4-channel receivers are supplied without this circuitry (See test report of Marantz 4400 receiver). Accordingly, that company offers an add-on CD-4 demodulator that will work with any 4-channel receiver or amplifier that is equipped with discrete inputs (such as AUX) for all four channels of a quadriphonic receiver. A front panel view of the demodulator is in Fig. 1. Besides the power ON/OFF pushbutton, there is a pushbutton selector switch that chooses 2-channel or automatic 4-channel operation and a centrally located pushbutton that selects PHONO or AUX operation. The reason for this choice of program sources will be explained when we examine the rear panel. A tiny light at the upper right of the panel becomes illuminated whenever a CD-4 record is being played.

The rear panel, shown in Fig. 2 has the expected pair of phono inputs and four jacks for the demodulated 4-channel outputs. In addition, there are four jacks for connecting any high-level 4-channel program source (such as tape, or even the decoded outputs of a separate matrix decoder). In this way, if your receiver has only one quartet of AUX (high level) inputs that must now be used for the CD-400B's outputs, the AUX input is repeated on this unit and selected by the previously mentioned front panel pushbutton switch.

2

There is also a pair of jacks labelled "direct output" and a slide switch that connects these jacks to the phono inputs without going through any of the electronics of the unit. These might be used to connect from your cartridge directly to a matrix decoder, for example, since CD-4 cartridges will work just fine with either stereo or matrixed 4-channel discs. The switch must be left in the "off" position when using the CD-400B for its primary purpose, the demodulation of discrete 4-channel discs, so it does not load down the CD-4 cartridge with the extra cable capacitance that would result if these additional connections are made. A pair of separation controls (which are adjusted during initial set-up to match the characteristics of a particular cartridge) and a chassis ground terminal complete the back panel layout.

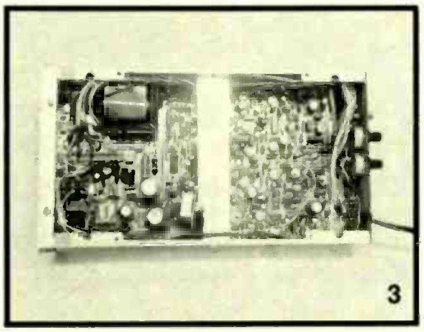

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Figure 3 shows the internal circuitry of the demodulator, which is contained on a single circuit board that occupies the entire surface dimensions of the unit. The small power transformer is mounted on the metal flanges of the chassis, rather than on the printed-circuit module. A block diagram of the CD-400B is in Fig. 4, illustrating signal paths for the left composite channel only. The phono cartridge signal is equalized (low frequency only) by block "A", amplified and passed on to the main and sub-channel systems. Low-pass filter (B) attenuates sub-channel frequencies and, bias separation adjust control (C) sends the main-channel signal to amplifier (D).

High-pass filter (E) passes only frequencies above 15 kHz on to the phase-lock-loop detection circuit (a single IC) that demodulates the FM difference signal (front minus back). Signals from the PLL circuit (F) also pass through a band-pass filter (G) that permits only 30-kHz signals to be amplified. Lock range control (H) alters the gain of the phase-lock-loop circuit to accommodate different levels of 30-kHz signals and the signal rectified at (H) also operates a Schmitt trigger circuit that turns on and off the muting and indicator lamp circuits.

Low-pass filter (K) eliminates any residual 30 kHz components. The block labelled FM/PM equalizer restores the preemphasis characteristics of the sub-channel audio signal for flat frequency response reproduction. Several of the additional blocks shown have to do with the ANRS circuit that is an inherent part of the CD-4 disc system. Much like other frequency/level dependent noise reduction systems, ANRS is a variable gain system which depends upon signal level and frequency content of program material. Matrixing of the sum-signal and recovered difference signal takes place in block (T) to produce separate front and back audio signals.

Laboratory Measurements

Without having available the equivalent of a CD-4 "encoder" (used to make CD-4 discs in the first place), there are only two types of measurements that can be made for a CD-4 demodulator. You can use any of the several test records made available for this purpose. But in doing so you are limited by the performance characteristics of the CD-4 cartridge used in making the tests. You can also "create" fixed difference signals, consisting of frequency modulated 30-kHz carriers, using an SCA

MANUFACTURERS SPECIFICATIONS:

SUM SIGNAL

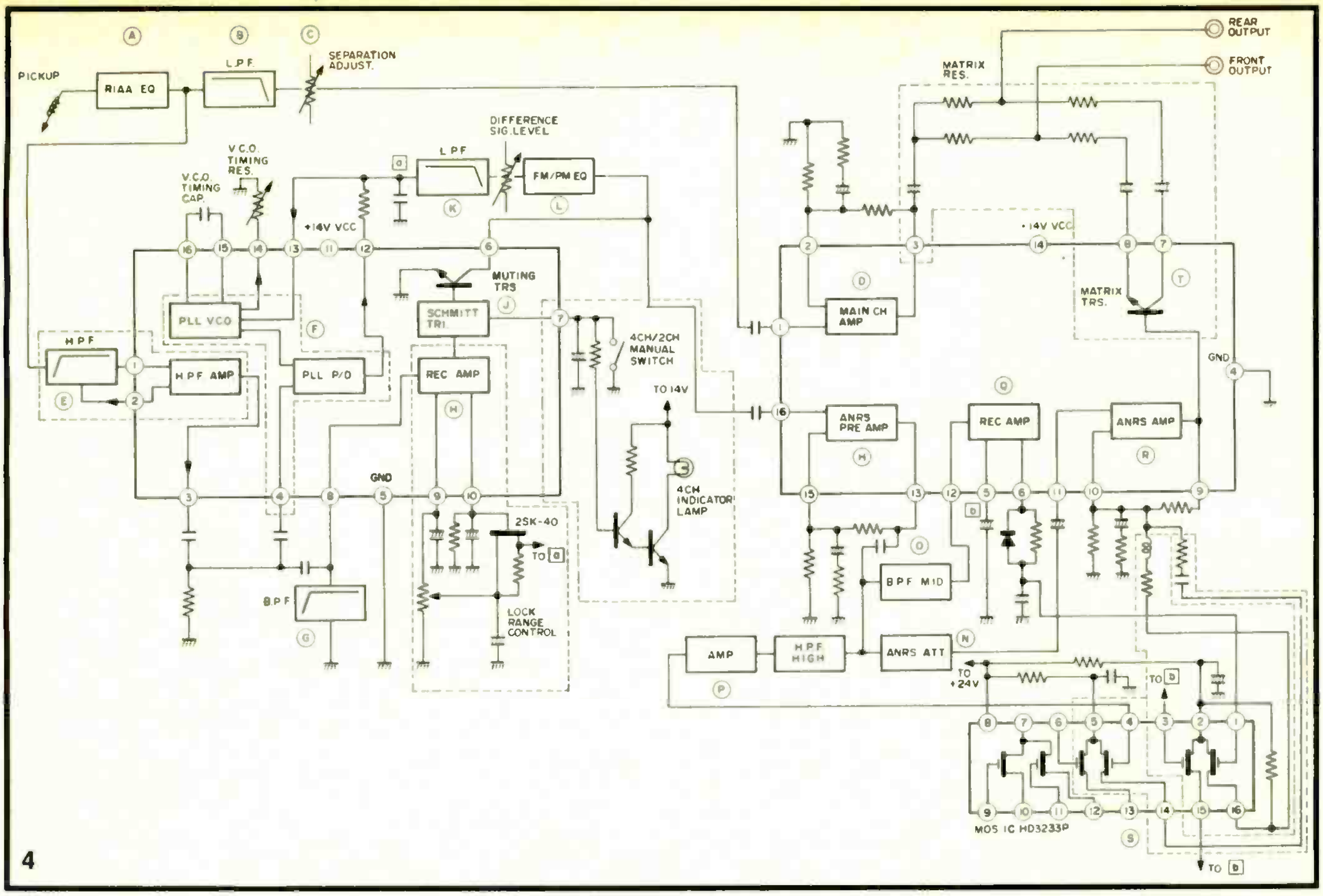
Frequency Response: RIAA ±1 dB from 40 Hz to 12 kHz. **Total Harmonic Distortion at 1 kHz** 0.1%. **Input Impedance:** 100,000 ohms. **Output Impedance:** 5,000 ohms.

DIFFERENCE SIGNAL

Total Harmonic Distortion at 1 kHz: 1.0%. **Signal-to-Noise Level:**—60 dB. **Muting Level:** —68 dB. **Input level for ±4 kHz lock-in range:** —53 dB. **Channel separation:** Greater than 20 dB.

GENERAL SPECIFICATIONS

Power Requirements: 120 VAC, 50/60 Hz, 10 watts. **Dimensions:** 8¼" wide × 4" high × 12-11/16" deep. **Net weight:** 5.9 lbs. **Suggested retail price:** $139.95.



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(subsidiary communications authorization) signal generator such as is used in transmitting background music over the sub-carrier facilities of FM radio stations. While such SCA generators are generally designed to operate at either 42 kHz or 67 kHz, it is no great problem to alter circuit constants so that the "carrier" frequency is shifted to the required 30 kHz.

In our lab tests, we used some of both techniques. For separation measurements, we used several of the 7-inch discs that are supplied with most demodulators. They are cut by JVC and are intended to help you set up your CD-4 playback system through audible tests alone. By metering the outputs of each channel we were able to measure 26 dB of separation from front-left to front-right channels, and just over 20 dB from either front channel to its corresponding back channel, using a Bang and Olufsen Model MMC-6000 cartridge.

Standard FM deviation for the difference signal stated by the manufacturer is 1.3-kHz deviation of 30 kHz by a 1-kHz signal. Under these conditions, output level (using only a "difference" signal was approximately 100 mV and THD at 1 kHz measured 0.5%. Using a "sum" signal, THD was much lower, measuring only 0.07% for the same equivalent output level. Again, using a sum signal only, frequency response of the system was within 1 dB of RIAA from 20 Hz to 10 kHz, rolling off to −3 dB at around 14.5 kHz. Response of a difference signal (equalized to RIAA) was within 3 dB of the prescribed response from 20 Hz to 11 kHz. At 1 kHz, output levels reached in excess of 0.5 volts before the total harmonic distortion reached 1.0%, using the SCA generator difference signal as an input. The B & O MMC-6000 cartridge has somewhat lower output than some competitive units, but lock-in of the PLL circuit was positive even with this cartridge when playing test records and when listening to musically recorded CD-4 examples in our subsequent listening tests. R-E

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Marantz** Model: **CD-400B**

OVERALL PRODUCT ANALYSIS

Retail Price	**$139.95**
Price Category	**Medium**
Price/Performance Ratio	**Very good**
Styling and Appearance	**Excellent**
Sound Quality	**Good**
Mechanical Performance	**Very good**

Comments: The final judgment regarding the effectiveness of any accessory product such as a CD-4 add-on demodulator must be made on the basis of listening tests. Unfortunately, early reaction to CD-4 discs generally was negative not so much because the discs were that bad or that noisy, but rather because the first generation of CD-4 demodulators offered to the public were not capable of demodulating the complex signal contained in the grooves of these records in a satisfactory manner. The Marantz CD-400B is definitely a "second generation" design, and as such, we found it capable of demodulating CD-4 records (both older releases and newer ones) in a manner which does justice to the complex CD-4 format. The use of phase-lock-loop circuitry makes the difference, and, while it does add to the overall cost of the demodulator it is well worth the difference. Adjustment of the unit was simple and took just a few moments with the test record supplied. Only separation adjustments need be made by the user, since the carrier level adjustments are internal and factory pre-set.

With its seven IC's, ten transistors, two FET's, sixteen diodes and literally hundreds of resistors, capacitors, chokes and miscellaneous parts, it is easy to understand why a demodulator of this advanced design would be difficult to "build-in" to an all in one receiver. As a separate CD-4 demodulator, the Marantz CD-400B is one of the best we have tested.

This is the sixth consecutive issue of Radio-Electronics that contains in-depth test reports on high-fidelity equipment. By now our readers should be familiar enough with these reports to have formed opinions.

We would like to hear your opinions, comments and criticism concerning these reports:

Please address them to:
High-Fidelity Test Reports
Radio-Electronics
200 Park Ave. South
New York, NY 10003

Luxman Model L-100


1

LUX AUDIO OF AMERICA IS PERHAPS A NEW name to most readers of **R-E** and to the high-fidelity fraternity in this country. Indeed, the company appeared upon the U.S. scene in mid-summer of 1975, surprising the experts with the introduction of no fewer than fourteen high-priced components. Obviously, the parent company of this fledgling U.S. subsidiary has been around for some time in its home territory of Japan (for nearly 50 years, in fact) and is, according to our information, highly regarded by Japanese audiophiles as well as by Europeans and in other Asian countries where the line has enjoyed distribution for some time.

Of all the products introduced here, we decided to check out a high-powered integrated amplifier which seemed to look interesting and had a few features we had never seen before. At just under $1000.00, our attitude intially was one of doubt. The L-100 would really have to be something special to justify that kind of money. Well, it is.

An overall view of the three-dimensional heavy bronze-colored front panel is shown in Fig. 1. Most striking is a massive master VOLUME control knob, shown up close in Fig. 2. The knob has a metal insert in its face and another metal collar around its rim and this trim is more than decorative. After applying power by means of the pushbutton switch just be-


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TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer **Lux Audio of America** Model **L-100 Integrated Amplifier**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPACITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	140	Excellent
RMS power/channel, 8-ohms, 20 Hz (watts)	123	Good
RMS power/channel, 8-ohms, 20 kHz (watts)	120	Very good
RMS power/channel, 4-ohms, 1 kHz (watts)	....	Excellent
RMS power/channel, 4-ohms, 20 Hz (watts)	....	Good
RMS power/channel, 4-ohms, 20 kHz (watts)	....	Good
Frequency limits for rated output (Hz-kHz)	17-35	Very good
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.005	Superb
Intermodulation distortion, rated output (%)	0.035	Excellent
Harmonic distortion at 1 watt output, 1 kHz (%)	0.005	Very good
Intermodulation distortion at 1 watt output (%)	0.024	Very good
DAMPING FACTOR, AT 8 OHMS	50	Excellent
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ± ___ dB)	0.2	Excellent
Maximum input before overload (mV)	460	Superb
Hum/noise referred to full output (dB) (at rated input sensitivity)	68	Very good
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ± ___ dB)	5-50, -1	Excellent
Hum/noise referred to full output (dB)	87	Very good
Residual hum/noise (min. volume) (dB)	98	Very good
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. 8	Superb
Action of secondary tone controls	See Fig. 10	Excellent
Action of low frequency filter(s)	See Fig. 9	Good
Action of high frequency (filter(s)	See Fig. 9	Good
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.8/2.8	
Input sensitivity, auxiliary input(s) (mV)	177	
Input sensitivity, tape input(s) (mV)	177	
Output level, tape output(s) (mV)	177	
Output level, headphone jack(s) (V or mW)	0.39V; 20mW (8 ohms)	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		Excellent
Adequacy of input facilities		Excellent
Arrangement of controls (panel layout)		Very good
Action of controls and switches		Excellent
Design and construction		Very good
Ease of servicing		Good
OVERALL AMPLIFIER PERFORMANCE RATING		Excellent

MANUFACTURER'S LISTED SPECIFICATIONS:

POWER AMPLIFIER SECTION:

Power Output: 110 watts minimum continuous power per channel, 8-ohm loads, 20 Hz to 20,000 Hz at no more than 0.05% total harmonic distortion. **IM Distortion:** 0.05% at rated output. **Frequency Response:** 5 Hz to 50,000 Hz ±1 dB. **Input Sensitivity:** 910 millivolts for full output. **Input Impedance:** 33,000 ohms. **Residual Hum and Noise:** −90 dB below rated output. **Damping Factor:** 50 (at 8 ohms).

PREAMPLIFIER SECTION:

Output Voltage: typically 910 mV; maximum 12 volts. **Frequency Response:** 5 Hz to 50,000 Hz, −1 dB. **Total Harmonic Distortion:** 0.007% at 1 kHz, 1-volt output. **Input Sensitivity:** Phono; 3 mV (variable ±5 dB). High Level; 180 mV. **S/N Ratio** (Phono): Better than 65 dB. **Phono Overload:** 450 mV. **RIAA Equalization:** ±0.2 dB. **Residual Hum and Noise:** Less than 40 μV. **Cross-talk:** Better than −60 dB.

GENERAL SPECIFICATIONS:

Power Consumption: Maximum, 400 watts at 120 volts 60 Hz. **Dimensions:** 19⅛" wide by 6⅞" high by 13¾" deep, including cabinet supplied. **Net Weight:** 42 lbs. **Suggested Retail Price:** $995.00.

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer **Lux Audio of America, Ltd.** Model **L-100**

OVERALL PRODUCT ANALYSIS

Retail Price	**$995.00**
Price Category	**High**
Price/Performance Ratio	**Excellent**
Styling and Appearance	**Excellent**
Sound Quality	**Superb**
Mechanical Performance	**Excellent**

Comments: Were it not for those massive heat-sinks at the rear of the Lux L-100, we would have thought for all the world that this elegantly styled unit is a most sophisticated preamplifier rather than an all-in-one integrated amp. In fact, Lux does carry a preamp in its line whose front panel has every single one of the features of the L-100. Since that model sells for only $100.00 less than the tested L-100, we feel that the L-100 offers better value unless you actually need much more than 110 watts-per-channel of audio power—and very few people actually do. Every control has a precision feel to it and while at first we thought the "touch mute" feature was a needless (and expensive) frill, we were surprised at how often we found ourselves using it during the course of our listening tests. The "Linear Equalizer" circuit, though subtle in its audible action, is a unique compensator that does for recordings what no tone control (not even those multi-turnover ones on this model) can do and we found that it improved reproduction on many of our records whose recording technicians must have disagreed with our ears.

Lux makes a statement regarding its design philosophy which, briefly, suggests that there is more to a good sounding high-fidelity amplifier than measured specifications. We must agree, since we heard a clarity and effortless power capability that is hard to describe in words but definitely is audible, even if you are not using the most expensive loudspeakers in the world. Obviously, one cannot hear 0.05% harmonic distortion, but we have listened to other amplifiers in the same power class that do not sound as clean, or as lifelike in their reproduction of music, and yet measure as low in distortion. There is much we still don't know about what makes one amplifier sound better than another—but Lux seems to have found some of the answers, at least.

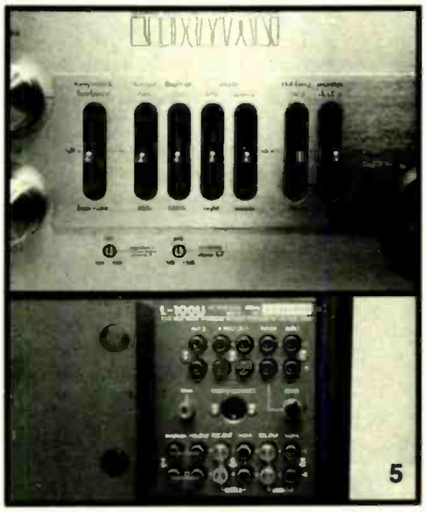
low the VOLUME control knob, the indicator light (just above the control labelled BALANCE in Fig. 2) flashes for a few brief seconds and no sound is heard during this standby condition regardless of volume control settings. Suddenly, the flashing stops and sound comes from your speakers with nary a "pop" or a bang.

Touch the front insert of the VOLUME knob, and the sound level drops magically by some 16 dB—a feature that Lux calls "touch mute". After your interruption is over (answering the phone, or a doorbell), touch the rim trim of the knob and sound is instantly restored to its previous level.

The master VOLUME control itself operates in tiny discrete steps. Each worth a couple of dB, so there's another attenuator knob concentric with the balance lever. This knob has a total active range of about 18 dB for "fine tuning" desired program levels. This section of the panel also contains the usual headphone output jack and two tiny pushbuttons that select main or remote speakers.

The left section of the front panel, shown in Fig. 3 features a large INPUT selector knob (there are two AUX and two PHONO choices as well as TUNER), BASS and TREBLE controls and three-position turnover switches for each of the tone controls which we will have more to say about later. Below the program selector is a five-position switch called a LINEAR EQUALIZER which will also be discussed shortly.

The center of the panel (see Fig. 4)



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contains seven three-position toggle switches. The feel of these switches has got to be tried to be believed. Smooth, yet positive and noiseless. These switches take care of tone defeat, tone control operation, or tone control operation with a fixed bass-boost below 70 Hz; low- and high-cut filters (each with two frequencies of cut-off), left or right program to both speakers; stereo, mono or reverse-channel listening; dubbing from one tape deck to another (or vice versa) and tape monitoring (of either of two tape decks connected to the amplifier). Two small screwdriver-adjustable controls below the toggle switches are used to set phono input impedance for the phono-1 input and to set input sensitivity for both phono input pairs to match cartridge outputs.

The low-level input and output section of the rear panel is shown in Fig. 5. Speaker connection terminals for main and remote sets of speakers are at the opposite end of the rear panel (not shown), and are of the push, spring-loaded type that require only simple insertion of the stripped speaker wire ends into tiny holes. The section of the rear panel shown in Fig. 5 contains the usual PHONO and AUX input jacks, an input LEVEL control for the tuner inputs, RECORD-OUT and MONITOR-IN jacks for two tape decks (the second of which may be connected via a multiple pin DIN connector as well) and a GROUND terminal. There are also jacks for PREAMP-OUT and MAIN-AMP IN which come supplied with jumpers that can be removed

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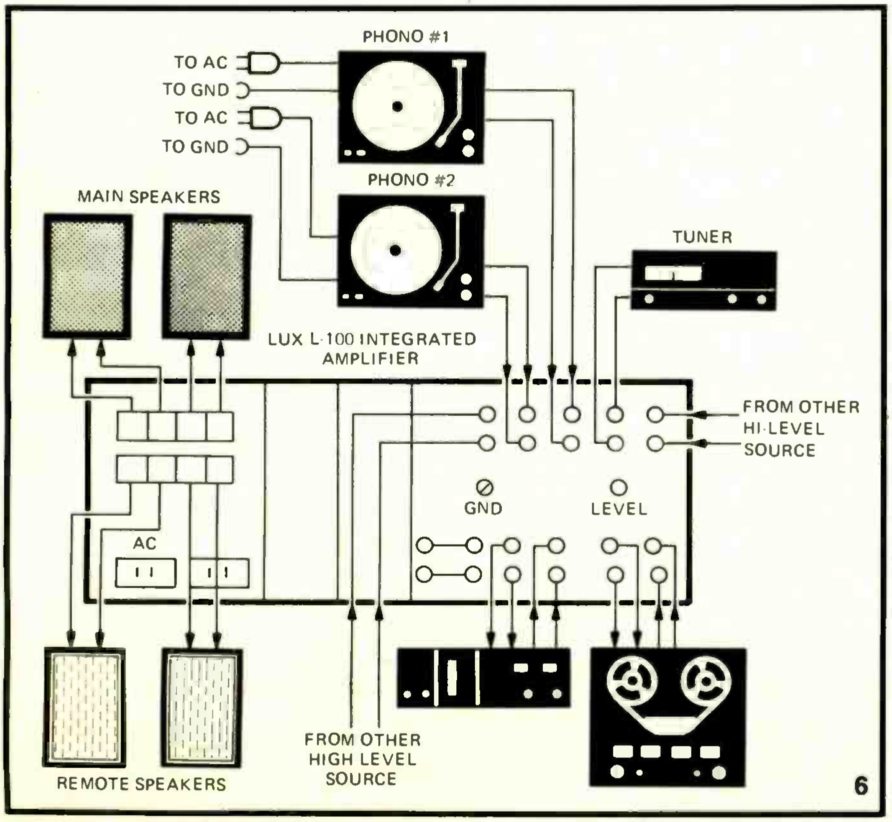


6

ALL ABOUT PROBES

Test leads, transmission lines, terminators and probes are as much a part of a measurement system as the test equipment itself.

by CHARLES GILMORE*

IT IS DIFFICULT TO DEFINE A THREE-FOOT length of RG-58/U cable as an instrument, but it is more difficult to use any instrument if there are no probes, cables, connectors, terminators, etc. As the theory, specifications, and operating techniques are the same for these devices when used with any instrument discussed in this series of articles, they deserve a thorough discussion of their potential.

Devices which interconnect instruments may be divided into three categories: test leads, transmission lines, and probes. Each of these categories will be examined in this article so that the fundamental concepts are clear and the basic dividing lines between one type of interconnection device and another are established.

Test leads

Test leads are the simplest form of interconnection possible. In many cases they consist of nothing more than a single-wire conductor for the signal and a second such wire for the return. Such leads are common on DC voltmeters and AC voltmeters used to measure low-frequency signals. Frequently, only one wire is apparent because the common ground system between the instruments acts as the return path. This system is quite acceptable so long as the signals are of high amplitude, low frequency, and are from low impedance sources.

It is important to remember that the return path is always necessary. Often when using high-frequency circuits, a single lead will appear to be the only point of connection. Don't be misled; electricity is still electricity, and return paths are required. The path taken for the return signal may change the measured signal considerably. It is always wise to determine just what the return path is.

When the source impedance is high or the signal amplitudes are low, interference may develop on a simple open-wire test lead. The solution to this problem may be a twisted cable. Interference on the simple open-wire test lead may be caused by the signal and common wire being subjected to uneven electrical fields (see Fig. 1). One of the advantages of the twisted cable is that the electric fields will have an equal effect on both conductors and therefore cancel out. As shown in Fig. 2, the capacitive divider between the interfering source and the signal wire will develop an interfering signal.

If the signal wire were completely surrounded by a second conductor at ground potential, a different situation develops (see Fig. 3). There can be no capacitive divider from the interfering source to the center conductor to ground if the shielding of the outer conductor is perfect. If there is no capacitive divider, there will be no interfering signal coupled to the center conductor. Most shields are not perfect, so there will be some signal coupled to the center conductor of the shielded cable. However, the amount coupled to the center conductor will be considerably less than without a shield.

Transmission lines

The transmission line and the shielded cable are similar in nature and often confused. Both the transmission line and the shielded cable frequently use a cable which has a single center conductor surrounded by a woven braid. Such a cable is commonly called a coaxial cable. When a coaxial cable is used as a transmission line rather than as a shielded cable, the ability to deliver power and the characteristic impedance of the cable become of great importance.

If AC electrical energy is applied to a transmission line, that energy will assume a particular voltage/current ratio as the energy is propagated through the length of the line. This effect is caused by the distributed capacitance and inductance of the cable. The distributed capacitance and inductance are determined by the mechanical dimensions of the line. As a voltage/current ratio has units of resistance, this natural voltage/current ratio of the transmission line is referred to as the characteristic impedance.

If a coaxial transmission line is terminated in a resistive load that will maintain the same voltage/current ratio caused by the characteristic impedance of the line, all the transmitted power will be absorbed by the load. If, however, the resistance of the load differs from the characteristic impedance of the transmission line, some of the power will be reflected back along the line. Reflected power results in standing waves that occur when the reflected signal adds and subtracets with the transmitted signal. Voltage and current maximas and minimas occur at wavelength multiples along the line.

One of the most frequent effects on instrumentation of standing waves is an apparent signal loss. If a voltage minimum occurs at a point where an instrument is connected to the cable, a voltage

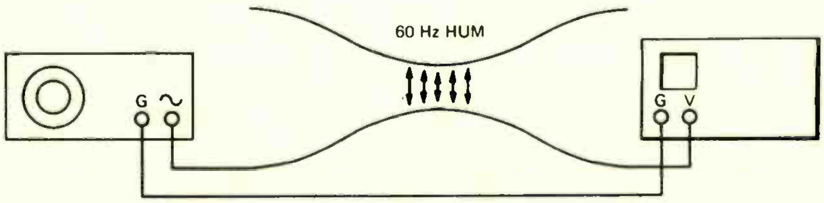


FIG. 1—INTERFERENCE is generated on one of a pair of test leads. This effect can be reduced to some extent by bringing the two test leads into close proximity.

of much less amplitude than intended is presented to the instrument, which then appears to lack sensitivity.

The opposite can also happen, and too great a signal may be applied to the instrument. Neither of these conditions would have occurred if the line was flat; i.e., terminated in a resistance equal to its characteristic impedance.

Another problem occurs when the coaxial transmission line is being driven with a square wave or some other form of pulse. If the line is not terminated in its characteristic impedance, the reflections may produce additional pulses on the line. If an instrument such as a frequency counter is connected to this line, it may count these extra pulses resulting in an erroneously high measurement.

If the transmission line is not driven by a *source* having an output impedance equal to the characteristic impedance of the transmission line, two problems may occur. First, there will not be maximum power transfer to the line nor, therefore, to the load. For example, a 600-ohm

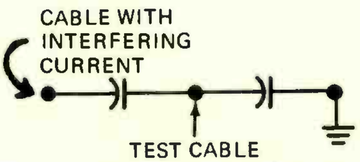


FIG. 2—A CAPACITIVE DIVIDER can be formed between a cable or other source of interference and a test cable.

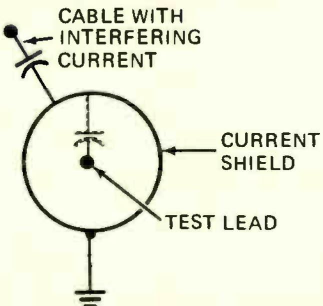


FIG. 3—PLACING A SHIELD around a test cable cancels the capacitive-divider effect that once existed from the interfering source to the test cable to ground.

*Design Engineer Health Company, Benton Harbor, Mich.

generator cannot supply maximum power to a 50-ohm system. Second, reflections will occur. These reflections will be propagated back to the generating source. If the generating source does not present an impedance equal to the characteristic impedance of the line, the reflected power will not be absorbed at the generating end and further reflections will occur. This effect will increase the standing waves and the probability of measurement error.

The problem of power transmission in a coaxial cable is important where voltage is the parameter of interest. The coaxial cable must be properly terminated in order to prevent error causing reflections and a low impedance system will be necessary. This impedance will usually lie between 50 and 93 ohms. If for example, a 1-volt signal is to be transmitted from one location to another, this 1 volt must be maintained across 50 ohms. By the formula for power, $P=E^2/R$, we can see that 20 milliwatts of power is involved. Compared to the power involved on a 1-megohm system (one microwatt), considerable power is involved. To maintain this 1 volt throughout the system, 20 milliwatts of power must be maintained. In order to supply a 1-volt signal, the generator must have at least 20 milliwatts of power generating capability. If we desire 10 volts on a 50-ohm system, the generator must be capable of $10^2/50$, or 2 watts of power.

Equipment probes

At first probes were nothing more than a simple method of attaching a test lead to a circuit. The classic test probe supplied with a VOM still retains this original simplicity. As measurement techniques have improved, the simple probe proved to be no longer effective in certain measurement applications.

One of the most ineffective cases was that of the simple probe attached to the end of a shielded cable. This combination served as a convenient method of transmitting interference free signals from the point of measurement to the instrument. At low frequencies, such a system was quite acceptabe. As the measured frequency increased however, the capacitance of the cable began to have a serious loading effect on the circuits being measured.

For example, consider a simple measurement where a source with an effective impedance of 1000 ohms and a frequency of 1 MHz is to be measured. A 3-foot length of RG-58/U coaxial cable is used in conjunction with an oscilloscope having an input impedance of 1 megohm shunted by 30 pF. The total capacitance at the source will be 30 pF from the oscilloscope plus an additional 85.5 pF from the RG-58/U (28.5 pF-per-foot). If the effects of the capacitance are not taken into account, the loading caused by the 1 megohm oscilloscope on the 1000-ohm source impedance of the generator will cause less than 0.1% error. See Fig. 4.

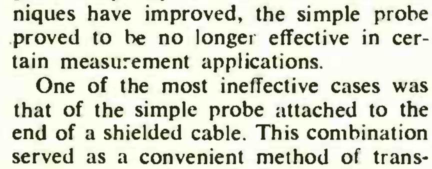


FIG. 4—THE ERROR caused by a 1M ohm load placed on a generator with a 1K ohm source impedance is 0.1%.

However, this ideal situation is not the case. The total shunt capacitance is 115.5 pF (see Fig. 5). At 1 megahertz this has

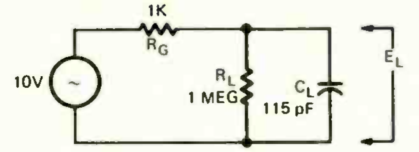


FIG. 5—THE ERROR caused by a 1M ohm load shunted by 115.5 pF placed on a generator with a 1K ohm source impedance is 19%.

an impedance of 1378 ohms. The 1 megohm of the scope is so dwarfed by the low capacitive reactance that it may be left out of the picture entirely. Simple calculation shows us a resistive/capacitive voltage divider has been formed, and the 10 volt signal at the generator is now presented to the ascilloscope as a signal of 8.1 volts, phase shifted by 39°. All this at only 1 megahertz.

If the signal frequency is increased to 10 MHz, the cable capacitive reactance is now 138 ohms. The voltage presented to the oscilloscope is reduced from the actual 10 volts of the source to less than 1.4 volts by loading of the source impedance with the cable capacitance. In other words, the amplitude error at one megahertz is 19% and at 10 megahertz it is greater than 86% in error.

Obviously such a large error cannot be tolerated. It is also obvious that all the capacitance in the system cannot be elminated, nor can all the source impedance be eliminated. One method of combating such error is to attempt to measure the signal at known low impedance points. This is not always possible, and as the measurement frequency increases, even low impedance sources will be affected by capacitive loading.

The passive probe is employed to reduce the measurement capacitance. Placing two capacitors in series results in a total capacitance lower than the smaller capacitance of the two. Figure 6 shows the passive

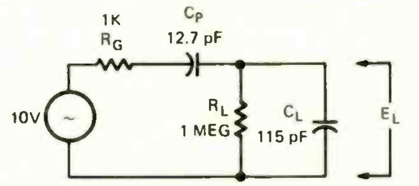


FIG. 6—THE INSERTION of a probe series capacitor at the probe tip reduces the measurement capacitance. This probe capacitance results in a smaller load capacitance being placed on the generator.

probe. A second capacitor (C_P) that is one ninth the total capacitance of the cable and the oscilloscope combined (C_L) is placed in series with the signal being supplied to the cable. The results of this added capacitor are three fold. First, the capacitive loading on the source is now less than one tenth the value of the cable and scope alone. Second, the two capacitors act as a ten-to-one voltage divider with a division ratio that is constant at all frequencies so long as the ratio of the two capacitors remains the same and the effects of the 1-megohm shunt resistance is negligible. Third, the probe is no longer useful at DC.

For the final reason, the oscilloscope probe is modified as shown in Fig. 7. Here

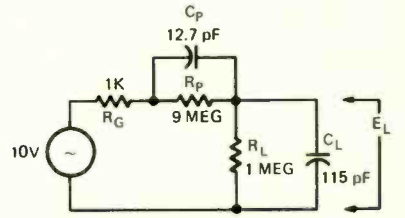


FIG. 7—THE PASSIVE low capacitance probe. The voltage division is constant for all frequencies, including DC.

a resistor (R_P) has been added in parallel with the series capacitor. This resistor and the 1-megohm resistance of the oscilloscope form a low-frequency DC voltage divider having exactly the same ratio as the capacitive divider. A variable shunt capacitor is usually added across the probe output so the capacitive division ratio may be adjusted to exactly match the fixed resistive division ratio. This permits one probe to match instruments with different input capacitances. To further complicate the design of such a passive probe, the center conductor of the cable is usually made of a resistive material. The resistive center conductor dampens ringing associated with a coaxial cable that is not properly terminated in its characteristic impedance.

Passive probes usually come as decade dividers. The ×10 probe is by far the most popular. Occasionally a ×100 is desired as input capacitance is further reduced and a 100-megohm input impedance is achieved. Of course this is accompanied by an attenuation factor of 100, which tends to desensitize all but the most sensitive measurement equipment. Occasionally a division factor of 50 will be found on a passive probe. Note that while the probe acts as a voltage divider, the name is given as a multiplier (e.g. a ×10 probe *divides* the input signal voltage by a factor of 10). The ×10 term indicates the *multiplication* factor that must be applied to a displayed signal in order to achieve the correct amplitude.

Other forms of probes other than the low-capacitance probe are available for special use. The RF and the demodulator probe have a great deal in common. Both of these are specialized probes using diode circuits to rectify RF signals. The simple RF probe will be similar to the one shown in Fig. 8. Radio-frequency signals present

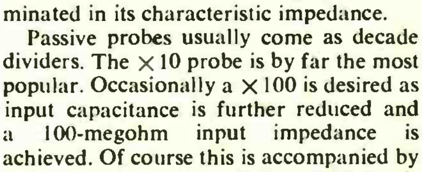


FIG. 8—TYPICAL RF PROBE designed for use with a VTVM having a 11-Megohm input impedance.

at the input of the probe are rectified by the diode. The resultant DC voltage is filtered by the capacitor. The probe may also contain some series resistance which will,

(continued on page 67)

For Special Music Effects

BUILD A PORTABLE SYNTHESIZER

Connect this to a high-fidelity amplifier to create your own unusual and special music effects.

by JOHN S. SIMONTON, JR.

THE LAST TWO PARTS OF THIS ARTICLE (November and December 1975 issues) covered synthesizer fundamentals, a detailed description of the GNOME and the construction details.

This third and concluding part is a short tutorial on synthesizers.

A short tutorial on synthesizers

Before we get into the operation of the GNOME's controls, a short discussion of synthesizers in general is in order for those whose exposure has been limited.

Every natural sound producing system can be broken down into several separate elements. Ordinarily, the first element in the chain is an energy source. A violin draws energy from the bowing action of the performer, a guitar from the deforming force of the fingers on the strings, and wind and reed instruments from the breath of the musician.

The second element is some means of converting the energy added to the system into periodic oscillations of a pre-determined frequency. In a guitar, the elasticity of the strings cause them to vibrate when deformed and released. In a saxophone the reed converts the steady breath of the musician into a series of pulses.

The last element is some means of coupling the oscillations that are occuring in the instrument into the air so that they can be heard. In a guitar, the function is performed by the body of the instrument. In a piano, this is accomplished by the sounding board. The individual characteristics of each of these elements interact to determine how the instrument will sound to a listener.

Dynamics

If the energy is added to the system in a single pulse—as in picking a guitar string or striking the keys of a piano—the instrument is of the percussion family, and all such instruments have the common characteristic of sound intensity at its highest level immediately after the striking action. The period during which the sound output of an instrument is building to its maximum is known as "attack" and this instantaneous rise to a peak is called "percussive attack." In natural percussion instruments, the attack is immediately followed by a "decay" period during which the instrument dissipates the energy that was added by the striking force. During the decay, the sound level falls to zero from the peak it reached during the attack. The decay period may be of short duration as it is in drums or a long duration as it is in pianos. The decay is again a function of the instrument.

If the energy is added in a continuous flow, the attack and decay may be separated by a sustain interval during which time the output of the instrument can be relatively constant. As long as a violinist bows the instrument, sound comes out. As long as the musician's breath holds out he can get a sustained note from his piccolo.

Figure 12 shows an attack/decay and

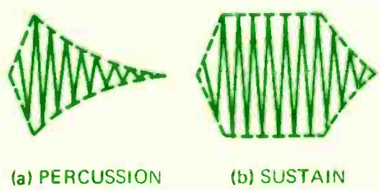


FIG. 12—SOUND ENVELOPES. Percussion envelope is shown in a while sustain envelope is shown in b.

an attack/sustain/decay envelope ("envelope" is a term that designates the behavior of the peak amplitude of the sound). Figure 12-a would be typical of a percussion instrument while Fig. 12-b is the envelope that you would find in wind or brass instruments. Taken together, attack, sustain and decay are known as dynamics and the dynamics of an instrument make by far the largest contribution to how that instrument will be perceived by a listener.

Timbre

But, all instruments that are capable of sustain intervals don't sound alike—a trumpet doesn't sound anything like a flute—so there are obviously other differences as well. Timbre is the term ordinarily used as a label for some of these differences.

The individual timbral characteristics of instruments are the result of two interacting phenomena. First, the "waveshape" of the oscillations produced by the vibrating element and secondly, the resonant characteristics of the coupling device that transfers the energy from the vibrating element to the air.

Not everything vibrates the same way and Fig. 13 shows four examples of the

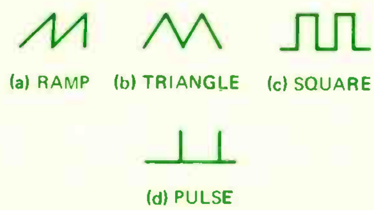


FIG. 13—EXCITATION WAVEFORMS. Ramp waveform shown in a is produced by bowed instruments. Triangle waveform shown in b, square wave shown in c and pulse wave shown in d are produced by wind instruments.

waveforms produced by the "oscillators" in natural instruments. Figure 13-a is typical of the waveform produced by most bowed instruments. This generally is known as a ramp waveform. In a violin, for example, it is caused by the bow grasping a string and deflecting it until the friction of the rosin on the bow is overcome and the string snaps back and is grasped again. Figure 13-b shows a triangle waveform that is typical of the back and forth oscillatory motion of the body of air within a flute. Figure 13-c shows a square wave that is usually produced when one or more reeds alternately open and close to allow bursts of the musicians breath to pass into the instrument. Figure 13-d shows a pulse waveform that is often the result of a performer's compressed lips on the mouthpiece of instruments in the brass family. Do not be confused and think that these waveshapes represent the sound of the instrument. These diagrams represent only the way that the vibrating element is behaving, the actual sound results from these waveshapes as modified by the instrument's natural resonator.

Figure 14 shows a sine wave. A sine

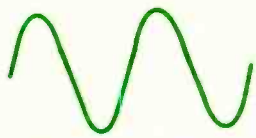


FIG. 14—SINE WAVE contains no harmonics and is a pure tone. It is not produced by natural instruments.

wave is sort of a strange beast because while there are almost no natural instruments that produce it, it is the only pure tone and all of the waveforms shown in Fig. 13 (in fact any periodic waveform) can be broken down into sine wave components. The number, amplitude, frequency and phase of the various sine waves required to produce non-sinusoidal complex waveforms are ordinarily called the harmonic structure of the waveform. Harmonic structure is a concept that is critical to complete understanding of sound synthesis but in the interest of brevity cannot be covered here.

Every physical object that exists will vibrate when exposed to an energy source. Every physical object has certain frequencies at which it tends to vibrate better than others. The object is said to be "resonant" at these frequencies. If the energy applied to the system is the same as one of the resonant frequencies of the object, then the object will vibrate more energetically than when the energy source is not at one of the resonant frequencies.

The body of the musical instrument contains resonant chambers that filter out the non-resonant frequencies. Because of this filtering property, waveshapes consisting of various sine-wave harmonic-content go into one end of an instrument and come out the other with the sine wave frequencies of the waveshape accentuated if at resonance and attenuated if off resonance. Because the amplitude of the sine wace components are altered, the waveshape is altered. Square waves go into one end of a saxophone and a "ringing" waveform such as the one represented in Fig. 15 comes out (Note: Fig. 15 is an exaggeration for illustration purposes only, the output of a saxophone is much more

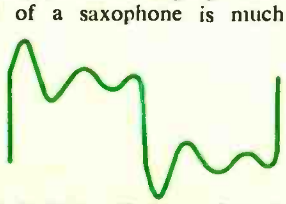


FIG. 15—RINGING WAVEFORM produced by a saxophone excited by a square wave.

subtle than that shown). In some instruments, the characteristics of the resonant chamber are constant, as in stringed instruments. In other instruments—wind and brass instruments for example—the parameters of the resonators must be altered to even closely approximate an equally tempered musical scale.

Synthesizers

Now that we have some idea of how the mechanical properties of a musical instrument determines the reproduced sound, we will look at how electronic circuits can be used to create those mechanical properties.

The electronic equivalent of vibrating strings, reeds, etc., is the oscillator. Just as the different types of vibrating elements in natural instruments can produce a variety of waveforms, so can the electronic oscillators in synthesizers. Must synthesizer oscillators are capable of producing at least ramp, triangle and pulse waveforms with the added capability of making the pulse so broad that it becomes a square wave. Many synthesizer oscillators can also produce a sine wave, but since a pure tone doesn't appear very often in natural instruments, a sine wave from a single oscillator isn't very interesting in electronic music. In any case, a triangle wave is very close to the same sound as a sine wave.

The pitch of natural instruments is determined by the length of the vibrating string, the pressure on the reeds or the configuration of the musicians lips and

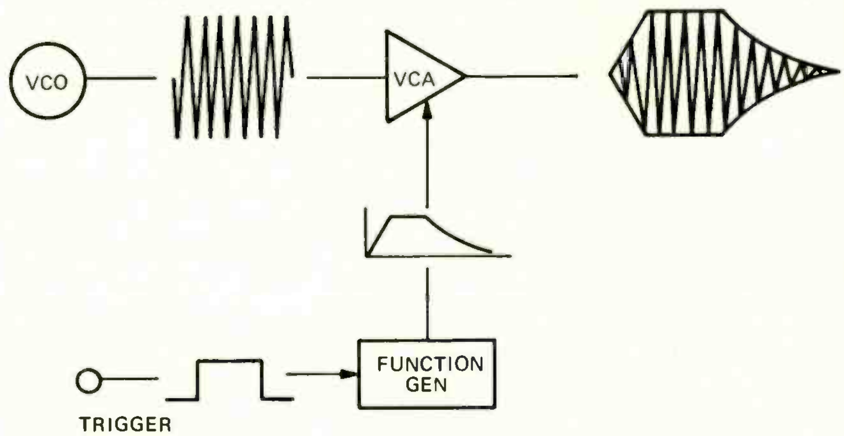


FIG. 16—INSTRUMENT DYNAMICS are simulated by a function generator and a VCA.

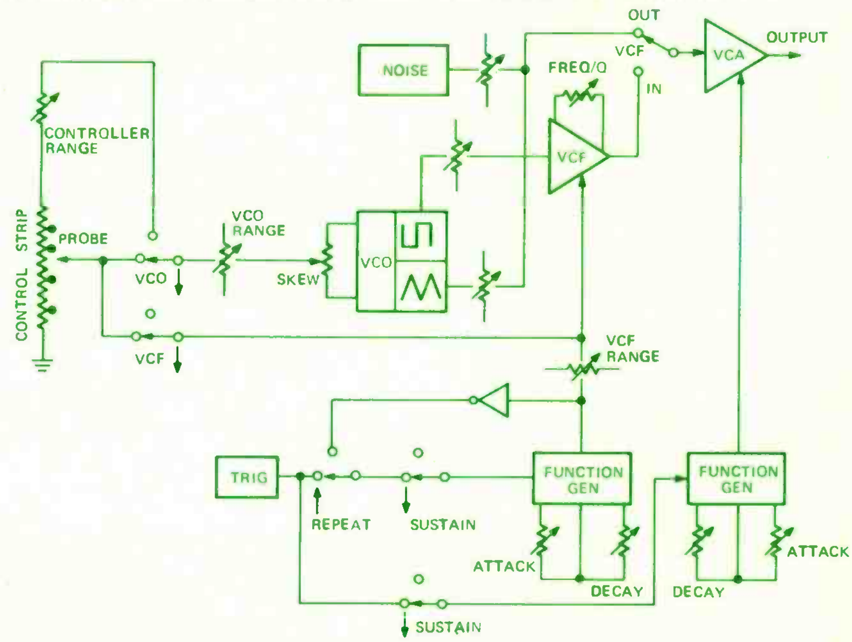


FIG. 17—SIGNAL AND CONTROL PATHS in THE GNOME.

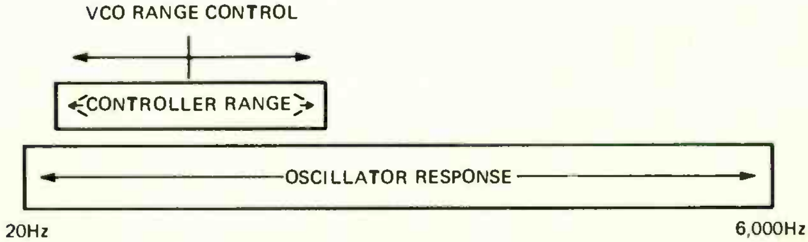
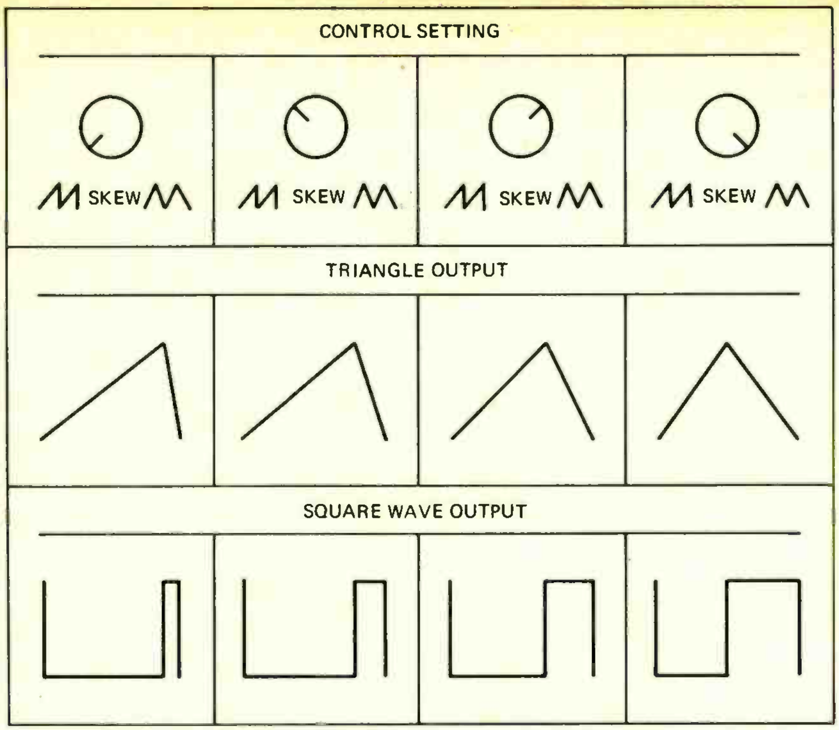


FIG. 18—CONTROLLER CIRCUIT controls the operation of the oscillator.



CONDITION	RESPONSE	COMMENTS
REPEAT SUSTAIN	PERCUSSION	Normal percussion output. Attack and decay at the rate set by these controls.
REPEAT SUSTAIN	SUSTAIN	Normal sustain output. Attack and decay at rate set by those controls. Output voltage holds high (sustains) while trigger button is held down.
REPEAT SUSTAIN	MUTE	Similar to percussion (no sustain). Attack and decay at rate set by those controls except when trigger button is released generator by-passes decay time and re-sets to zero.
REPEAT SUSTAIN	REPEAT	Function generator serves as its own trigger source and output oscillates from low level to high level. Rise time set by attack, fall time set by decay.

CONDITION	RESPONSE	COMMENTS
SUSTAIN	PERCUSSION	Hold Trigger for standard percussion response.
SUSTAIN	MUTE	Percussion with muting when Trigger released. Attack cycle need not finish before muting.
SUSTAIN	SUSTAIN	Normal sustain response. Attack cycle will always finish before decay begins.

FIG. 19 (top left)—EFFECTS of varying the skew control.

FIG. 20 (middle left)—EFFECTS of the sustain and repeat switches.

FIG. 21 (bottom left)—EFFECTS of the sustain.

properties of the resonant chamber. In synthesizers, the pitch (frequency) of the oscillator is determined by the magnitude of a control voltage applied to a voltage-controlled oscillator (VCO).

Control voltages can be derived from a number of possible sources including strip controllers (as with the GNOME), keyboards, programmable sources of various types (sequencers, function generators, etc), foot pedals and so on. All of these controllers have in common the fact that some action on the part of the operator produces predictable changes in the controller's output voltage.

In the simulation of an instrument's dynamics, synthesizers diverge slightly from their counterpart mechanical systems. It would be natural to assume that the oscillator is "keyed" or "triggered" in some sort of way to make its attack and decay simulate the natural instrument equivalent. In fact, the output of the oscillator is constant and the building up and dying away of the sound is implemented by varying the gain of an amplifier. As you can imagine, it would be at best cumbersome to twiddle the knob of an amplifier fast enough to simulate percussive attack but here again voltage control comes to the rescue in the form of a voltage-controlled amplifier (VCA).

In synthesizers, the gain of the amplifier is made proportional to the magnitude of a control voltage and in most cases this controlling voltage is generated by a programmable function generator.

A function generator is simply an electronic circuit that in response to a triggering signal produces a voltage that rises to pre-set level in an amount of time set by one control knob (ATTACK) and then falls back to zero in an amount of time set by a second knob (DECAY). Sustain is ordinarily handled by keeping the triggering signal on for the desired sustain interval.

Figure 16 shows a typical example of an oscillator feeding a VCA that is being controlled by a function generator to produce a desired envelope.

This leaves us with only one of the most basic natural properties to simulate—timbre. As with mechanical instruments, many of the timbral properties of a sound are the result of the excitation waveform produced by the vibrating element in the instrument and the remainder of the timbral properties are the result of the characteristics of the resonator that couples those vibrations to the air. Earlier we discussed the filtering characteristics of natural resonators because we were leading up to the use of an electronic filter as an equivalent circuit for this mechanical property.

The type of electronic filter used in the GNOME is the bandpass filter. A sine-wave applied to the input of bandpass filter will pass through relatively unchanged if it is at this center frequency of the filter but will be attenuated if at some other frequency. Similarly, the sine

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Turntable Drive Systems

The idler-wheel, belt drive and direct drive systems are examined along with their effects on rumble and wow-and-flutter.

by LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

SEVERAL MONTHS AGO WE EXAMINED THE various ways in which turntable rumble can be specified. (See "Signal-to-Noise—What Does It Mean," Len Feldman, Sept. 1975 issue.) Aside from rumble and vibration (which determines the signal-to-noise capabilities of a turntable system), the only other performance specification that is relevant to record reproduction is the speed accuracy and consistency of turntable rotation. Speed accuracy is usually stated in maximum percentage deviation from the desired speed (usually 33⅓ or 45 RPM), while periodic or cyclical variation above and below true speed (also expressed in percent) is referred to as wow and flutter. Wow is a slow repetitive speed change, generally occurring at a rate of less than 10 Hz, while flutter is any periodic variation in speed which occurs at a rate of more than 10 Hz.

Both rumble and wow-and-flutter are directly related to the type and quality of drive system used to rotate the turntable. In recent years, manufacturers have begun to stress the sophistication and perfection of their turntable drive systems. They have gone into great detail about motor type and construction, method of coupling rotational energy from motor to the turntable itself, and generally tried to prove (verbally) that their particular choice of drive system is superior to everyone else's. Actually, there are only three basic ways that a phonograph turntable can be made to revolve. These are indirect pulley/idler-wheel drive, belt drive, and direct drive.

Idler-wheel drive

A simplified diagram of pulley/idler-wheel drive is shown in Fig. 1. A high-speed motor (generally having a rotational speed of 1800 RPM) is equipped with a precision machined multi-step pulley permanently mounted to its shaft. An intermediate idler wheel, generally constructed of hard rubber or similar non-metallic material, presses simultaneously against the motor pulley and against the inner rim of the turntable itself. Since rotation of the typical motor is much faster than the required turntable speed, it is necessary to "step down" the speed of rotation. This is done by establishing precise diameters on the motor pulley. These diameters are approximately 0.0185 as great as the inner turntable diameter for 33⅓ RPM, and 0.025 as great as the inner diameter of the turntable rim for 45 RPM. As an example, if the inside rim of a turntable is machined to a diameter of 10 inches, the 33⅓ RPM "step" on the motor pulley will be 0.185 inches in diameter and the 45 RPM "step" will be machined to 0.25 or ¼-inch diameter.

The purpose of the idler wheel is twofold. First, because it is made of slightly compressible material, it tends to absorb some of the vibration produced by the high speed revolving motor. This same compressibility also tends to smooth out some of the speed variations which might be introduced by minor eccentricities of the motor pulley diameter and of the turntable inner rim diameter. Secondly, the idler wheel serves as a convenient means for changing speeds in a multi-speed turntable system. The idler wheel is coupled mechanically to a speed-changing lever which causes it to move up and down and to engage the appropriate diameter on the motor pulley.

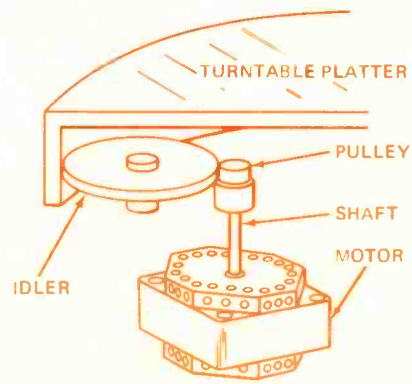

FIG. 1—PULLEY/IDLER-WHEEL turntable drive system.

Drive motors used in this type of drive system are either induction types or synchronous motors. Since induction AC motors are subject to speed variations based upon fluctuating supply voltages, better turntable systems use synchronous motors, whose speed is dependent only upon power-line frequency (60 Hz in the U.S., 50 Hz in most other parts of the world). Many manufacturers of record players that use the pulley/idler-wheel drive system will supply alternate motor-shaft pulleys (and sometimes alternate idler wheels to match) for conversion from 60 Hz to 50 Hz operation.

Speed accuracy and adjustment

The speed consistancy of a synchronous motor has led many people to believe that any turntable that uses this type of motor will, of necessity, rotate at the correct speed. It should be obvious from the discussion above that this is not true. Such turntables will rotate at a *consistent* speed that may or may not be exactly 33⅓ or 45 RPM. This depends upon the precision with which the motor shaft pulley, idler wheel and turntable rim have been fabricated. Since motor speed is constant, however, the only way to provide for speed adjustment on units using this system is to include some means for varying the diameter relationships which determine ultimate turntable speed.

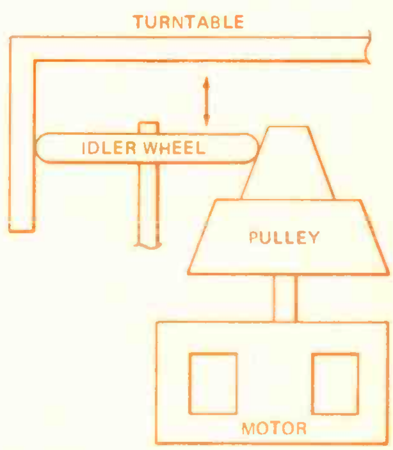

FIG. 2—MINOR SPEED ADJUSTMENTS in a pulley/idler-wheel drive system is accomplished by moving the idler wheel up and down along tapered sections of the motor pulley.

A simple way to do this is shown in Fig. 2. Here, the motor shaft pulley steps are tapered and a means is provided for having the vertical position of the idler-wheel up and down the surface of the motor pulley so that it engages varying diameters. As the idler moves up, turntable speed will decrease, while downward motion causes the rotation to speed up.

The "trouble" frequencies of idler drive

There are several problem frequencies involved in this kind of drive system that can produce periodic variation of speed (wow and flutter) as well as vibration which shows up as audible rumble. First, of course, the fundamental motor rotation at 1800 RPM is the same as 30 Hz (1800/60), so that speed variation and vibration can be introduced at a once-per-motor revolution rate of 30 Hz. Then, there is the speed of rotation of the idler wheel itself, which may vary from design to design.

If the idler wheel diameter is eight times that of the motor pulley, a new once-per-revolution frequency of just under 4 Hz is introduced. Any irregularities on the surface of the idler, or any uneven friction in its bearing surface which occurs at one point-per-revolution will introduce wow at a 4-Hz rate. Unhappily, this is the "wow" rate which seems most audible to listeners. Finally, there is always the possibility that the turntable itself may be eccentric, so that a speed variation that occurs at 2 Hz (1/33.3) may be sensed by the listener.

The motor itself, though rotating at 1800 RPM, is usually a 4-pole motor and in poorly designed motors there may be torque pulses which occur at twice or even four times the rotation rate, leading to rumble and flutter frequencies of 60 and even 120 Hz. It should be pointed out, however, that a well designed idler-drive system need not have any of these problems. It all depends upon the precision of the machining, materials used, and overall quality of motor and associated drive parts. Most record changers use this drive system. A typical turntable system employing the idler-drive is shown in Fig. 3.

FIG. 3—DUAL 1229Q top-of-the-line multiple-play turntable uses the pulley/idler-wheel drive system.

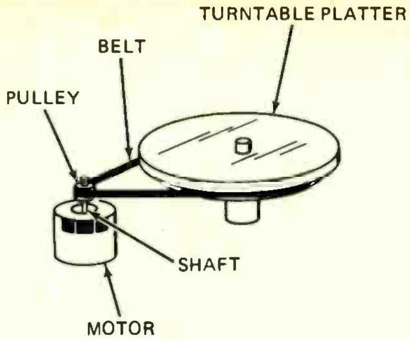

FIG. 4—BELT-DRIVE turntable system.

Belt drive systems

The intermediate idler wheel can be eliminated if a belt (made of rubber, neoprene or a similar compound) is used to translate rotational torque of a motor directly to an inner rim on the underside of the turntable itself, as illustrated in Fig. 4. Proponents of this approach claim that the intervening belt absorbs motor vibration more completely and that greater precision of rotation is possible using this drive system. Until recently, this drive system was used exclusively in single-play turntables, since it was deemed difficult to combine the belt-drive principle with the record-changing mechanism required in multiple-play units.

The B.I.C. turntables, recently introduced by British Industries Company, have apparently solved that problem and have successfully combined the advantages of belt-drive with multiple-record handling facilities. A photo of one of their two available models is shown in Fig. 5.

FIG. 5—B.I.C. MODEL 980 by British Industries Company uses the belt-drive system in this multiple-play turntable. This unit also features electronic motor-drive and speed adjustment.

While basic motor requirements remain the same whether a belt drive or an idler wheel system is used, there has been a growing tendency to use slower speed motors in belt drive systems. By increasing the number of poles in a synchronous motor, speed of rotation is reduced. Thus, the 24-pole synchronous motor used in the B.I.C. units (and more recently in the single-play Stanton 8004 turntable shown in Fig. 6) rotate at a fundamental speed

FIG. 6—STANTON'S MODEL 8004 single-play turntable also uses belt-drive system. Turntable is magnetically suspended, eliminating vertical friction at bearing.

of 300 RPM. A second, internal rim on the underside of the turntable is cast and machined to a much smaller diameter than the inside of the outer turntable rim so that speed step-down is correct for the required 33⅓ and 45 RPM turntable speeds.

While in theory a properly designed belt drive system should be "quieter" than an idler-system, much depends upon the quality of the belt itself. If it is at all lumpy or bumpy along its surface, these variations in thickness can impart their own vibrations and speed variations to the driven turntable. For this reason, many belts are precision ground after molding to insure perfectly smooth surfaces.

As for the multi-pole slower speed drive motors, a 300 RPM motor will, of course, have a fundamental once-per-revolution frequency of 5 Hz (300/60). Since this frequency is well below the audible limits of human hearing, its effect in the overall "rumble" picture should be less audible. Essentially, this is true, but there are qualifications to consider. Even though the predominant rumble frequency may be only 5 Hz, if your amplifier is direct-coupled (and has good response down to that low frequency), enough 5 Hz rumble may cause your speaker system's woofer cone to undulate wildly at that low, low frequency.

While the 5 Hz itself is not audible, if the speaker cone is forced out of its linear operating region because of this energy, musical frequencies that are being reproduced simultaneously may become highly distorted. A good check for this is to remove the speaker grille while auditioning one of these turntables equipped with slower speed motors and watch what happens with the volume turned up fairly high during a quiet passage on the record. If the speaker cone is waving wildly in the breeze, reach for the low-cut rumble (sub-sonic) filter on your amplifier panel, or choose another turntable system!

Remember, too, that sub-multiples and multiples of the basic 60-Hz power line frequency can also find their way into these systems (30 Hz, 60 Hz, 120 Hz etc.), though usually their amplitude will be lower in these slow-speed motors.

We mentioned before that the only way to adjust speed on any turntable using a synchronous motor is by mechanically changing diameter relationships between the motor pulley and the turntable drive rim. That is true, so long as the motor is driven directly from the utility power line. It is possible, however, to drive a synchronous motor by internally generated AC voltages, produced by built-in 60-Hz oscillators. That is exactly what is done in the B.I.C. model 980, which uses a low-voltage AC 24-pole synchronous motor that operates from about 6 volts. An electronic circuit incorporates a Wein bridge oscillator (one of the most stable oscillators known) that in turn drives a small power amplifier, producing the needed few watts of 60 Hz power to drive the low voltage motor.

Since the *frequency* of a Wien bridge oscillator can be easily varied by means of a variable resistor in the oscillator's feedback circuit, all that's needed for speed adjustment is a customer-accessible control knob which adjusts this resistance value. Increase the oscillator frequency to 61.2 Hz or reduce it to 58.8 Hz and you have a ±2% speed adjustment capability without having to change any pulley diameters. In theory, at least, even the change from 33⅓ to 45 RPM could be accomplished in this way, although B.I.C. chose to retain the two-step pulley in their design.

Direct-drive turntables

Long ago, transcription turntables used in broadcast studios were called direct-drive turntables because the motor shaft pulley made direct contact with the inner (or, in some cases, even the outer) rim of the large turntables that were used in such applications. Today's direct-drive units, such as the Technics by Panasonic model SP-10 shown in Fig. 7, operate on

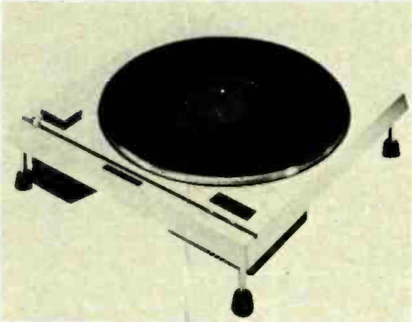

FIG. 7—TECHNICS BY PANASONIC MODEL SP-10 features direct drive, slow speed DC servo-controlled motor. Pickup arm must be purchased separately.

entirely different principles. In the first place, the motors used in today's units rotate at the actual, low speed of the turntable itself (33⅓ RPM or 45 RPM). Their shafts, therefore, have the turntable directly affixed to them with the center-hole spindle forming a part of the shaft assembly.

The motors used in these direct-drive turntables are primarily DC motors, driven by electronic circuitry which is built into the turntable system. In the case of the turntable shown, a DC brushless motor is powered by a servo-controlled electronic power source which automatically varies the amount of voltage fed to the motor whenever speed of rotation varies, regardless of the cause. A block diagram of the electronic speed control system is shown in Fig. 8. Many alternative forms of speed regulation and control have been applied to these new direct-drive turntables.

Some, such as Dual's model 701, use two Hall-effect generators to drive four switching transistors that produce a rotating magnetic field in the motor's field coils. This causes the four magnetic pairs on the rotor to be pushed and pulled continuously. A voltage which is a function of motor speed is fed to an electronic regulating circuit and is compared to a constant standard voltage derived from a regulated power supply. Any difference between these two voltages causes an immediate change in the motor speed.

Other methods of speed regulation have been devised by other manufacturers, but all depend upon some form of electronic feedback circuitry to keep that speed constant.

The generalization that direct-drive turntable systems are confined to single-play turntables was shattered recently when Technics by Panasonic startled the industry by delivering a new direct-drive system that was also capable of handling multiple records (a "record changer"—if that company and our more sophisticated readers will excuse the use of that much disparaged term). This new entry is shown in Fig. 9.

FIG. 9—DIRECT-DRIVE SYSTEM can even be applied to multiple-play turntables, as demonstrated by this new model SL-1350 from Technics by Panasonic.

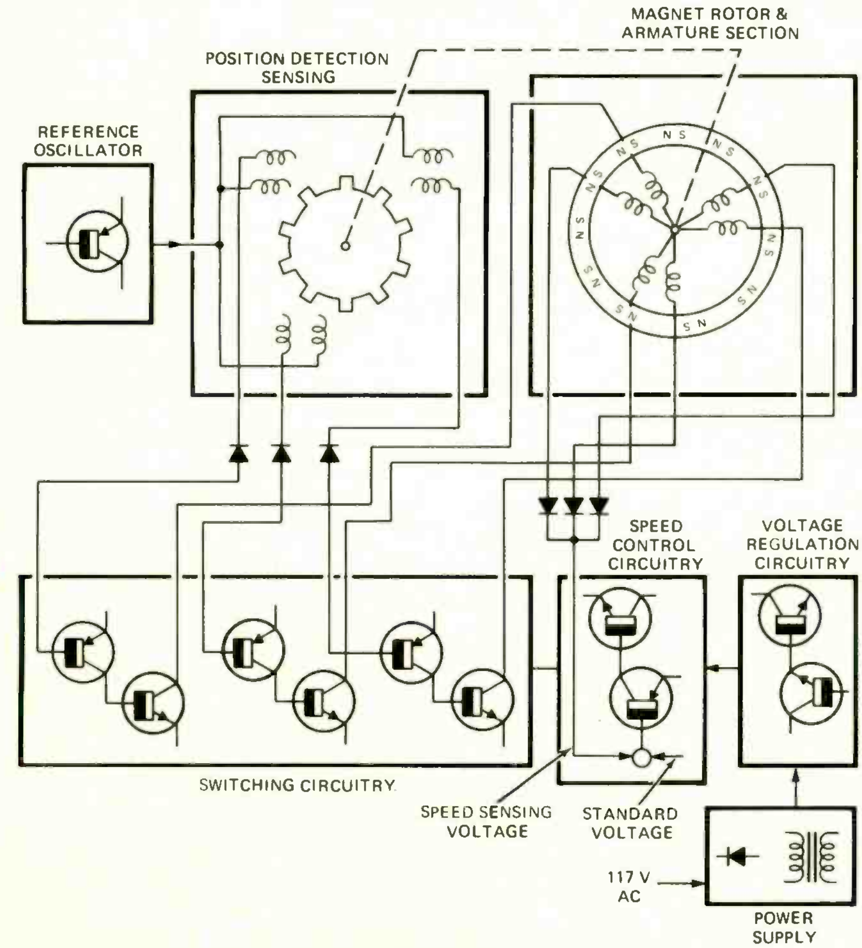

FIG. 8—BLOCK DIAGRAM of electronic drive and speed regulation system, Technics by Panasonic model SP-10 turntable.

Thus we see that the type of drive system used in a turntable is no longer a function of whether it is a single-play manual, semi-automatic single play, or fully automatic multiple play turntable system. Again, in theory, the direct drive approach should yield the best or lowest "rumble" figures of all—and indeed many of the newer and more expensive turntables now available for home use do boast figures as high as 70 dB or so (DIN "B" weighted). It is clear, too, that a DC motor will not impart vibration frequencies that are harmonically related to the incoming power line frequency, since no sinusoidal powering voltages are involved in the direct-drive system. Nevertheless, a poorly designed direct-drive system can have other sources of vibration, at other random frequencies, that can cause audible rumble that is no less severe than that caused by the more commonly encountered 30 Hz, 60 Hz, etc.

In the final analysis, then, the choice of a good turntable system still depends upon those three primary performance factors we mentioned at the outset; signal-to-noise ratio (rumble), speed accuracy, and speed consistency (low wow-and-flutter). So long as manufacturers quote these specifications in meaningful and easily understood terms, the *type* of drive system used remains a function of manufacturer's preference—and yours. **R-E**

"Putting a jumper from terminal 'D' over to point 'X' didn't work . . . any other suggestions?"

Selecting CB Antennas

The antenna is perhaps the weakest link in the equipment chain in a CB radio installation. Selecting the correct type depends on its usage and on the desired coverage. Here are some selection guides.

by ROBERT F. SCOTT
TECHNICAL EDITOR

WHETHER OR NOT A MOBILE CB UNIT can maintain reliable contacts with its base station depends largely on the types of base and mobile antennas and how they are installed. This is particularly true of the antenna on the mobile unit.

The *basic* or fundamental antenna is a length of wire one-half wavelength long and broken in the center by an insulator. The antenna—called a *half-wave dipole*—is fed in the center by a two-wire transmission line. The resistance of the antenna at the feedpoint is approximately 70 ohms. The overall length of a dipole for the 27-MHz Citizens band is approximately 108 inches long.

It would be highly impractical to install an antenna of this length on the average vehicle so mobile radio designers quickly adopted the Marconi or *ground-plane* type vertical antenna as being the simplest and most practical for vehicular installations. Since transmission and reception is best between stations using antennas of the same polarity, vertical antennas are most often used at base stations whose main contacts are with mobile units.

This antenna is half the length of a dipole or one-quarter wavelength long —about 9 feet at 27 MHz. If a quarter-wave antenna is to operate properly and most efficiently with a low angle of radiation for maximum ground-wave range, it must work against a good earth ground. When this is not possible, as when it is mounted on a building or on a vehicle, it must work against a *ground plane* which is a substitute for a good earth ground.

Ideally, the ground plane is a square or round metal plate or wire mesh. The minimum radius of the circle or half the diagonal of a square ground plane should be one-quarter wavelength or equal to the *electrical* length of the radiator. The ground plane, in effect, acts as a mirror that simulates the additional quarter-wave section that would be required if the antenna were not working against ground. The most common ground plane for VHF antennas consists of a number of stiff wires or rods extending from the base of the radiator. The most common type of quarter-wavelength vertical antenna is mounted on an insulator in the center of the ground plane. The center or core of a coaxial cable connects to the base of the antenna radiator and the coaxial shield connects to the ground plane. The impedance at the base of a quarter-wave radiator is about 35 ohms—half that of a half-wave dipole. This is not a perfect match for 50—52-ohm coaxial transmission lines but it is sufficient to yield a SWR of 2.5:1 or better.

(In the case of a base station antenna mounted on a tower or a mast, the ground plane may consist of three or four radials sloping downward at a 45° angle. Now, the feed-point impedance approaches 50 ohms so it is a nearly perfect match for 50-ohm coax.)

Vehicular installations

The ideal location for a vertical antenna on an automobile or other vehicle is in the center of a metal roof. But, a 9-foot whip can be quite unwieldy when mounted on the roof of the family car so it is usually mounted on a bumper or fender. In this case, the radiation pattern is distorted from the circular (ideal) configuration to one that is decidedly directional due to the close proximity to body metal.

Many CB'ers object to the 120—108-inch whip designed for mobile operation so several shortened forms have been developed. By using a *loading coil* at the base, in the center, above the center or at the top of a physically short radiator, the *effective electrical* quarter wavelength can be attained.

When a vertical radiator is shortened to less than a quarter wavelength, it presents a capacitive reactance and a lower radiation resistance to the source. To compensate, a loading coil is used to provide enough effective inductance to compensate for the physical shortening. When the loading coil is at the base of the antenna, the coaxial transmission line is usually tapped on to the coil at a point that provides a good impedance match between the two.

A coil-loaded shortened antenna is less efficient than a full-length quarter-wave whip. But, when it is installed in the center of a vehicle's metal roof, its radiation pattern suffers less distortion than that of a full-wave whip mounted on the car's rear bumper, on the cowl of a truck or on the side of a motorhome.

The placement of the loading coil in a shortened vertical radiator depends on several design factors and on how and where the antenna is to be used. The efficiency of the antenna is directly related to its height above ground and on the distribution of the RF current along its length. Naturally, the ideal is the full-length quarter-wave antenna.

In this case, the current distribution resembles one-quarter (ninety degrees) of a sinewave with minimum current at the top and maximum current at the base. Figure 1, from material supplied

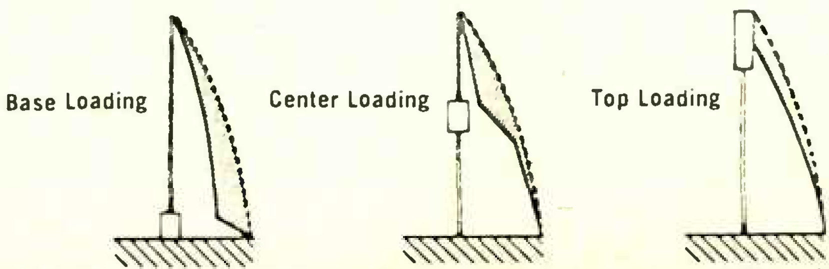

FIG. 1—LOADING COILS compensate for physical length in a shortened antenna. The position of the coil in a vertical antenna affects its overall performance.

by Hy-Gain, compares the current distribution of a full-length quarter-wave radiator with base-loaded, center-loaded and top-loaded radiators. The solid lines represent the current distribution in a short loaded antenna and the dashed lines the current in full quarter-wave antennas. The shaded areas represent loss in radiation efficiency.

Note how current distribution and efficiency vary with the position of the loading coil. Obviously, the top-loaded provides performance quite like that of a full-length radiator. However, you have to consider installation and use. Top-loaded radiators perform a little better than base-loaded types but they are difficult to match and their characteristics tend to change rapidly with any movement that varies the position of the loading coil with respect to the ground plane.

Furthermore, the loading coil on the top of an antenna cannot take physical abuse as when struck by trees and other low obstructions. On the other hand, in a base-loaded antenna, the loading coil is pretty firmly fixed in relation to the ground plane so antenna detuning with movement is minimized. The tip of the whip can be made of spring steel or other material that can take battering by trees and low overpasses.

Radiation patterns

Every antenna has vertical and horizontal radiation patterns. The horizontal shows the relative amounts of power radiated to the 360 degrees of the compass and the vertical pattern shows the angle at which maximum power is radiated with respect to the horizon.

The radiation pattern of a vertical antenna is (ideally) circular—radiating equally to all points of the compass. The pattern resembles a doughnut with the radiator passing through the hold in its center. Slicing through the doughnut, we may find its cross-section to be circular, elliptical with its long axis pointing skyward or it may be squashed nearly flat so its greatest dimension is parallel to the earth's surface. See Fig. 2.

A quarter-wave radiator squirts a considerable amount of the transmitter power upward where it is wasted in the atmosphere. As the radiator is lengthened to a half wavelength and longer (Fig. 3), the available power is concentrated in a lower, more extended lobe to provide a stronger signal over a greater distance.

The quarter-wave radiator is the standard against which all other verticals are measured. It is said to have an amplification factor of *unity* or zero dB gain. (An antenna is a passive device so it cannot amplify the signal fed to it by a transmitter or picked up from a distant station. Instead, it derives its *apparent* power gain by concentrating more of the transmitter power at lower angles to the horizon.)

Stepping up from the quarter-wave radiator, we have half-wavelength, five-eighths wavelength and 0.64-wavelength verticals. These provide approximate gains of 1.8, 3.4 and 4+ dB over a reference quarter-wave radiator.

Some of the more impressive vertical base station antennas based on two or more *electrical* half-wavelength radiators operated in phase. The average CB colinear is a full-wave vertical whose electrical length is around three-quarter wavelength. The transmission line connects to a 52-ohm point on a matching coil or to a shunt-feed arrangement. A capacitance "top hat" consisting of a few radials or a wagon-wheel type configuration shapes the current distribution for best operation and also serves to minimize static electricity build-ups that cause interference with reception. Typical colinear antennas are the CLR series by Hy-Gain, the Hustler Jam Ram model 27 Jr by New-Tronics Corp. and Mosley's Devant.

Directivity

In many cases, it is desired to radiate maximum power in only one direction. This is particularly true in installations where all communications are between two fixed stations, as between a ranch house and a stock pen or an oil well and pumping station. Some directional antennas concentrate their radiated power in directions 180 degrees apart; these are *bidirectional*. Antennas that pour all of their radiated power in one direction are *unidirectional*. Some unidirectional antennas are mounted on rotators so they can be aimed in the desired direction. Others are fixed arrays of two or three quarter-wave radiators whose pattern can be rotated electrically by changing the method of feeding and the phase of the current in the radiators. Beams for CB use will be covered later. **R-E**

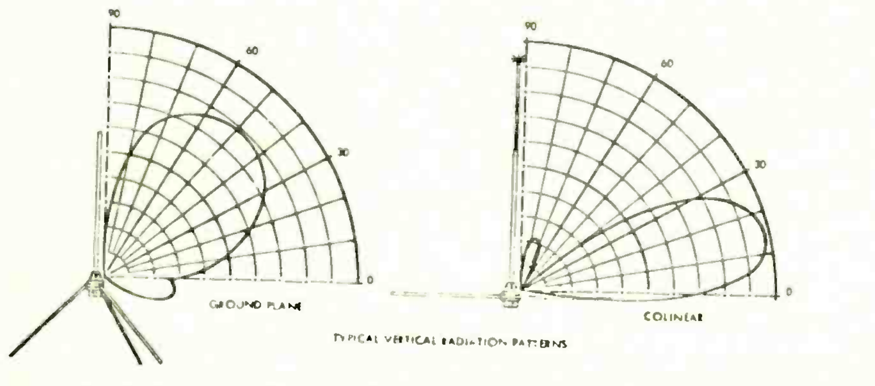

FIG. 2—VERTICAL RADIATION PATTERNS of ground-plane and colinear antennas. The apparent gain of the latter is due to its lower angle of radiation.

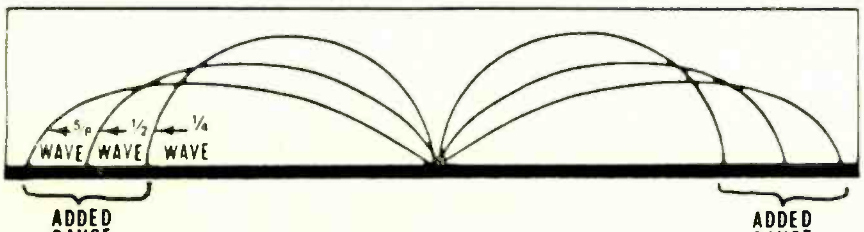

FIG. 3—CB COVERAGE ALONG THE GROUND increased as the antenna is lengthened beyond one-quarter wavelength.

POOR FOCUS

This Silvertone 4267 has a focus problem. The focus control has no effect. High-voltage is good, but I'm reading only 3.5 kV on the focus, and it won't vary. I can reduce the high-voltage and get better focus. What's going on?—D.F., Lyndhurst, OH.

Your focus voltage is too low. For proper focus, you must have approximately 20% of the high voltage; that's why you can reduce the high voltage and get a focused raster. Since you replaced the focus rectifier without result, the problem should be in the focus transformer. (The pulse that drives the focus rectifier comes from the horizontal output tube plate. If this is low, your high voltage, boost and sweep would also be down.)

Try this. Disconnect the two leads from the focus transformer to the flyback. This should bring your focus voltage back to slightly above normal. This type of adjustment is a "variable-loss" thing like the old width coils. If this brings it back, replace the focus transformer.

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new digital Remote Control

It's a new kind of remote control system for a color TV. The most noticeable thing about it is that there are no controls at all on the TV itself.

by MARVIN WILSON

SOME MODELS OF THE NEW RCA CTC-81 and CTC-74 color TV chassis use a unique remote control system that features on-screen display of the selected channel number and the time-of-day.

In addition, the set owner, selects channels by punching out two-digit numbers on a calculator-like keyboard. This is a direct-access system that permits the customer to go directly from any channel to any other channel. For more information on similar systems see "Star—A New Kind Of TV Tuning System" **Radio-Electronics**, December 1974; also see "Omega Tuning System", **Radio-Electronics**, December 1975.

Other features of this new control system include remote control of volume, color, tint and chassis power.

The control unit (it's the only way to control the set, there are no controls on the receiver itself) is an ultrasonic transmitter that RCA calls an XL-100 control center.

What the unit controls

To turn the chassis on, the customer simply punches out the desired channel (01 through 83). If an active channel has been selected, program audio and video appear immediately after the second digit is entered. To turn the chassis off, the user enters two zeros (00).

When the set is turned on, and each time a new channel is selected, the channel number appears in white in the lower right hand corner of the screen. The time appears on the lower left hand side of screen and shows hours, minutes and seconds. The channel number and time of day remain visible for five seconds and then turn off. They can be recalled at any time by making a new channel selection or by tapping the "C" or "T" buttons. If recalled by using the "C" button, the display appears in red. If you use the "T" button the display appears in green. If for any reason the set owner wants the display on all the time, he flips a switch on the rear of the set.

Actually, power is applied to the chassis as soon as the first digit is entered. However, if the second digit is not entered within 25 seconds, the set turns itself off. This feature prevents accidental triggering of the system when no one is home.

To control volume, the UP botton on the control keyboard is depressed to increase the volume and the DOWN button to decrease volume. These switches are marked with arrows to indicate up and down.

To adjust color, the user depresses the "C" button and then the up or down buttons. Tint is controlled in a similar fashion. First you depress the "T" button and then either the up or down button.

What Makes It Work

Now let's take a look at the electronic systems that make this electronic magic possible.

Physically, the complete address tun-

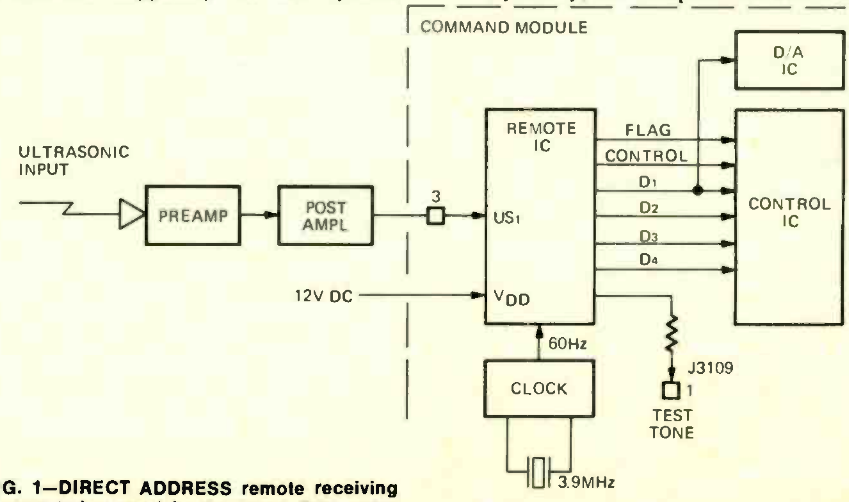


FIG. 1—DIRECT ADDRESS remote receiving system being used in the latest RCA color TV chassis. It does an interesting job.

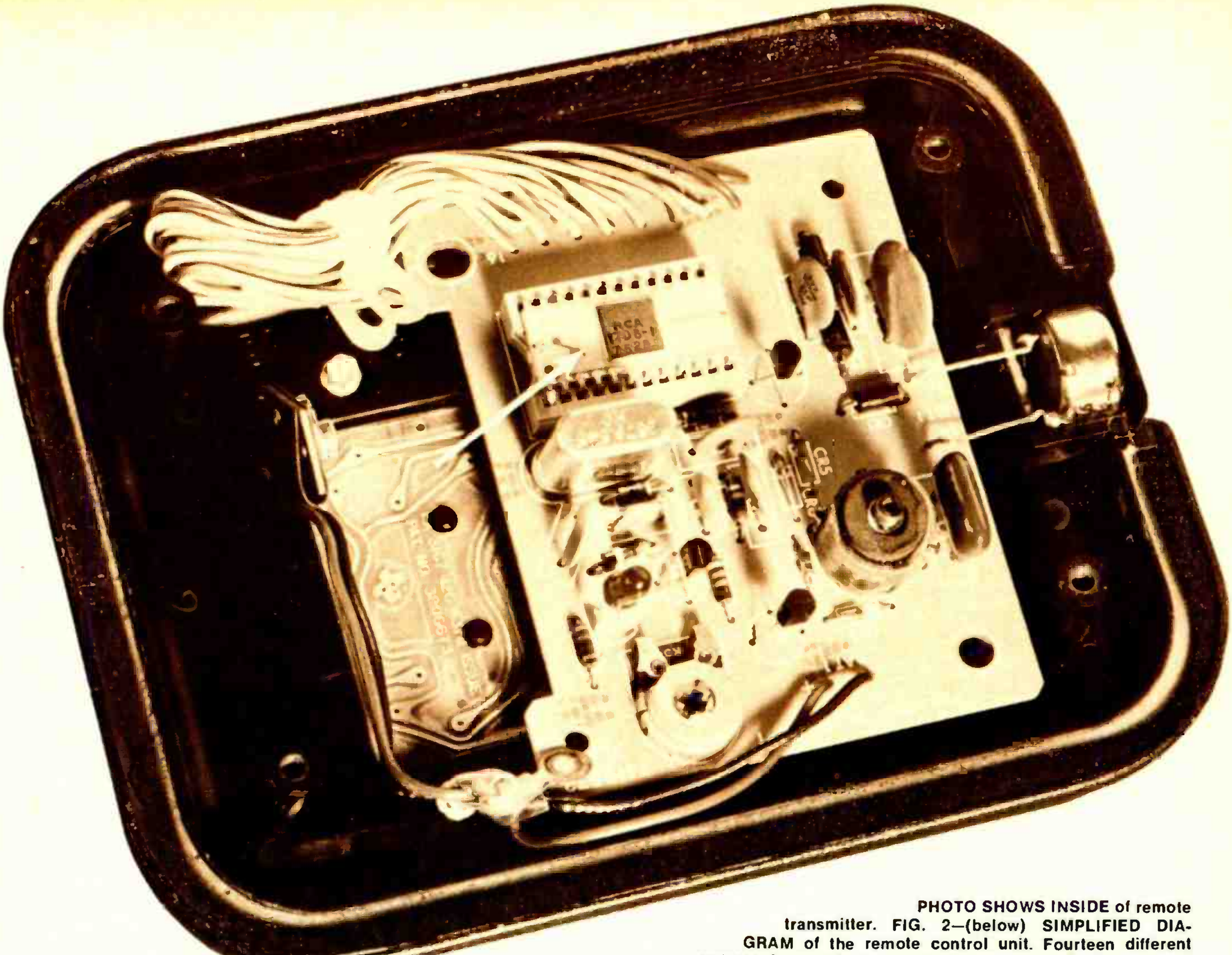
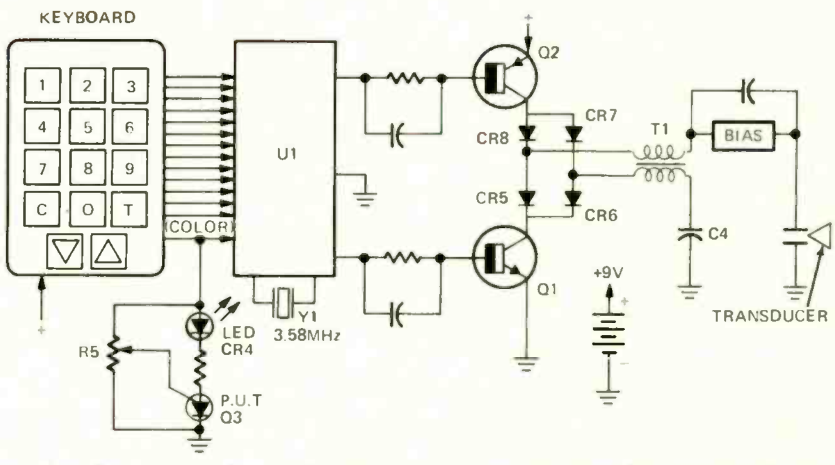


PHOTO SHOWS INSIDE of remote transmitter. **FIG. 2**—(below) **SIMPLIFIED DIAGRAM** of the remote control unit. Fourteen different untrasonic signals are produced and transmitted.

ing system consists of a 14-frequency ultrasonic transmitter (see schematic in Fig. 2). Inside the TV there is an ultrasonic decoding and function command system called the Direct Address Package (DAP). It is shown in block diagram form as a part of Fig. 4. Then there's an ultrasonic preamp and post amplifier (they are shown in both Fig. 3 and Fig. 4). There's also a five-module receiving, decoding and command assembly that includes the UHF and VHF tuners (see Fig. 3). The last section is the time-set pushbutton switch assembly that also includes the VHF offset potentiometers.



As you can see in Figures 3 and 4, ultrasonic signals from the control center are received and amplified by the preamplifier. From here the signal goes to the post amplifier that amplifies and amplitude-limits the incoming ultrasonic energy before applying it to the command module. The command module (Fig. 3) converts the 14 possible ultrasonic frequencies into digital codes that control the desired functions (on-off, channel select, volume, color and tint). The same digital codes are applied to the display module. It converts the channel number codes into video information that is displayed as channel numbers on the screen. The display module also contains an electronic clock that supplys time-of-day information to the display circuits.

The channel-select codes are applied to the VHF tuning and UHF tuning modules. These modules select the appropriate analog voltage for the varactor tuner operation. They also provide the respective tuners with the proper power and bandswitching voltages.

A separate power supply module (not shown) provides the DC voltages needed to operate the direct address system. Standby voltages as well as some operational voltages are derived from the AC line input via a module mounted transformer and rectifier circuit. The rest of the required voltages are taken off the set's 175-volt DC and 38-volt DC supplies.

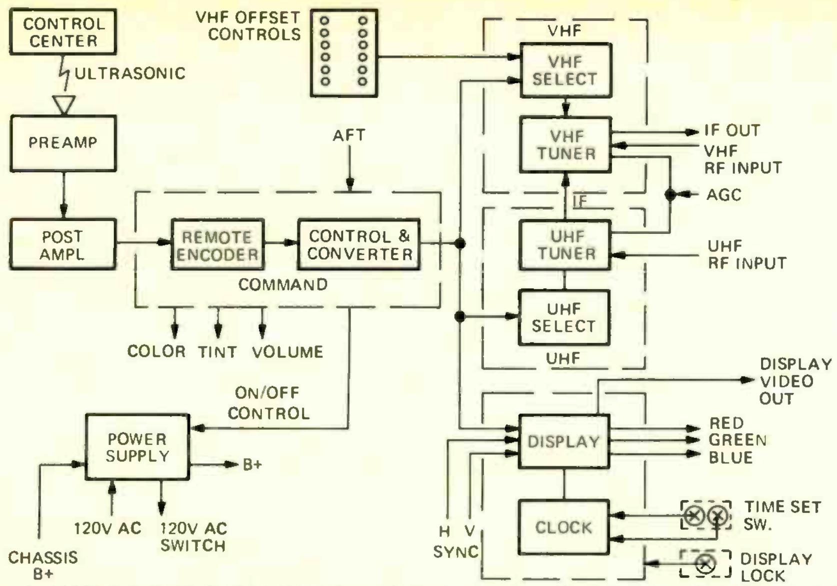


FIG. 3—MAJOR SUBSYSTEMS in the direct address package are shown here in block diagram form. Note that the tuners are part of the system.

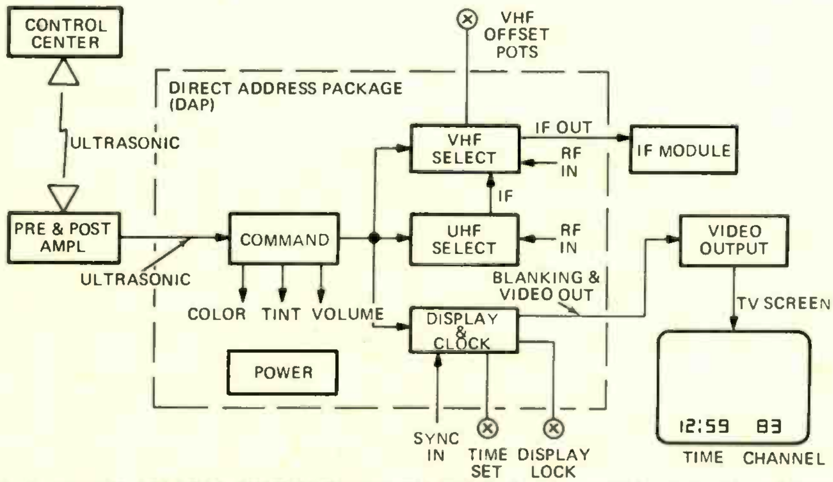


FIG. 4—DIRECT ADDRESS SYSTEM BLOCK DIAGRAM shows everything from the ultrasonic remote transmitter through the display on the color TV screen.

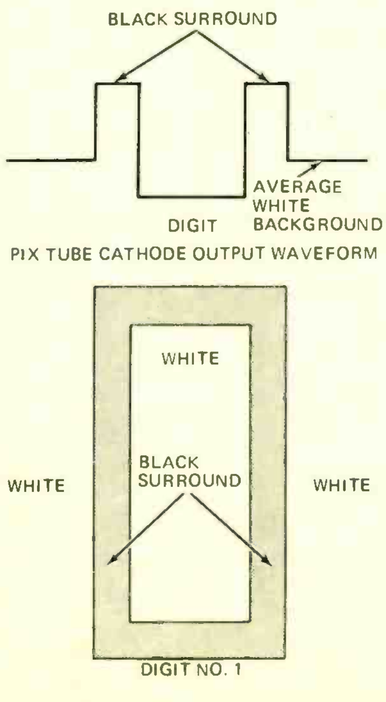


FIG. 5—COMPARISON OF WHITE numeral "1" digit to the output waveform that produces it. Note the black outline around the numeral.

The transmitter

A simplified schematic of the remote transmitter is shown in Fig. 2. Integrated circuit U1 consists of a crystal controlled oscillator and dividers that supply ultrasonic energy to the transducer at one of the 14 selected frequencies.

When the user pushes the keyboard switches, the switch supplies a positive DC output to the oscillator on the proper input terminal. The output pulse train at the selected frequency appears simultaneously on the bases of transistors Q1 and Q2. They drive the transducer through transformer T1.

The transformer secondary is tuned to resonate with the capacitance of the transducer beyond the highest selectable ultrasonic frequency. By charging capacitor C4, the transformer primary provides extra driving power for the transducer.

Diodes CR5, CR6, CR7 and CR8 prevent output current reversal, allowing T1 and its associated circuitry to ring when pulsed. A voltage tripler rectifies the 150 volt peak-to-peak output AC to provide the DC bias for the transducer.

The transmitter has a unique battery condition indicator. It consists of an LED and a PUT. When the "C" button is pushed, the battery voltage that appears at the oscillator color frequency input is applied across the LED (CR4). The LED cathode returns to ground through Q3, a programmable unijunction transistor (PUT). The gate voltage on the PUT (Q3) is set by R5 to maintain transistor conduction with battery voltages higher than 6.5 volts. When the battery drops below 6.5 volts Q3 no longer conducts and the LED will not light.

The receiver

As shown in Fig. 1, ultrasonic energy from the control center (remote transmitter) is preamplified by the MCY preamplifier module. The preamplifier is tuned to accept a spectrum of ultrasonic frequencies from approximately 30 kHz to 60 kHz, and to provide a voltage gain of approximately 60 dB. Power for the preamplifier is supplied from the direct address power supply module.

From the preamp, the band-limited and simplified ultrasonic energy is coupled to the post-amplifier module. It supplies an additional 60 dB of voltage gain and provides a square wave output limited to a value of 12V p-p.

The remote receiver and decoder functions take place in a unique large scale integrated circuit (LSI) located on the command module. This "remote" IC consists of a frequency counter and decoder which converts each of the 14 possible input ultrasonic frequencies into a binary code. The ultrasonic frequency corresponding to each of the ten transmitted digits, 0 through 9, is converted into the respective binary number on output terminals D1 through D4. In addition, the "up," "down," color ("C") and tint ("T") functions each produce a binary number plus an output on the "control" terminal. These remote IC outputs are decoded by the "control" IC which generates the appropriate function command signals.

Because a high degree of immunity from undesired inputs is a prime requisite for the reliable operation of the digital address system, the remote IC only reacts to valid, legitimate ultrasonic inputs. Each ultrasonic input is sampled at a 120 sample-per-second

(continued on page 86)

REACT—What's It All About

Citizens Band group keeps perpetual watch on channel 9, supplies information and aid to motorists and helps in emergencies.

by FRED SHUNAMAN

A SUDDEN CATASTROPHE ERUPTS—FLOOD, earthquake, tornado, or a forest fire that wipes out a village. The authorities are out with emergency gear, evacuating people in danger, supplying food for the hungry, lodging for the homeless, and emergency medical and hospital service for the injured.

Emergency communications services are vital at such a time. Wires are usually down; power is often out, normal communications facilities may be entirely disrupted. Traditionally the amateur has moved in, setting up his portable equipment and preparing to handle messages into and out of the stricken area.

But today a new agent—the Citizens-band communicator—is in the center of the emergency as soon as it appears. No need for him to set up equipment—his is in his car—or in his hand. Highly mobile, he can report on rapidly changing conditions even while they are changing, and can maintain contact between various groups working on the same emergency as no other service can.

In many cases this work is done by local Citizens-band groups. But by far, the greater number of effective workers are banded together in a national organization called REACT—*R*adio *E*mergency *A*ssociated *C*itizens *T*eams. Organized in the late 1950's by Hallicrafters, the Association is now sponsored by the Research and Development department of General Motors as an aid to highway travelers.

Even though REACT'ers have made a glorious record in emergency activities, probably REACT's most valuable work is to help motorists on the road. They respond to calls for assistance, giving information and referring calls to agencies able to handle them, as well as engage in life-saving activities in road accidents. CB Radio means more than just a sales boom. Used effectively and in an organized manner, CB communications can provide a necessary and valuable community service. And aside from community service, organized CB communications can create new marketing opportunities in your region. But how can CB help a community?

Other activities, such as assistance to police during parades and celebrations, maintaining communications during searches for lost children, and even participating in an "annual rattlesnake hunt" are reported on with some enthusiasm in the association's organ, *The National REACTER*. Their central activity is to keep a continuous watch on CB channel 9, recognizing that many motorists have CB equipment, which can be completely useful to them only if they are able to contact help at any time.

REACT has its heroes

REACT'ers nevertheless point with pride to their work in severe emergencies, where they already have an honor roll of members lost in the service of the public. In the Rapid City (South Dakota) flood of 1972, five REACT members were among the victims. Herb Whiting, his wife Phyllis, Marv Pepper and Blake Thornton of Black Hills C-276 REACT and Otis Mathews of Rushmore 2158 REACT were instructed to take positions in the flood areas and were cut off by waters that rose faster and farther than expected. At least two other Black Hills members were trapped for several hours, one in a tree and the other in a water-filled car.

More recently David Bryant, past president of the Hale County (Texas) REACT, was killed on tornado watch duty. Alerted by the local REACT coordinator, he took his regular spotter's post. His wife was with him in the car ("I wouldn't want us to get separated if Plainview gets hit.") The tornado touched down close to Bryant's car and a police vehicle also on tornado watch duty. Bryant's last transmission was: "The wind is trying to lift us up!" His body was found in a field about 60 feet from the car. His wife, in the car, was injured. The police car was also shaken up, one of the officers receiving lacerations.

A full week's work

A more recent example was given by Xenia, OH, where two tornados (some say three) joined to destroy the southern third of the city. The Miami Valley REACT, headquartered in Dayton, has a special group called Redicom, trained under the Red Cross and Civil Defense in first-aid, survey and disaster work. When the Sheriff's radio announced; "A tornado has touched down in Xenia. Send all available police, ambulances and first-aiders," the Redicom unit was ordered out by the Red Cross and CD.

Their first duty was to carry the injured to ambulances. Then for several days they carried on a combination of communications and legwork. Mobiles assigned to explore the partly devastated streets found heart patients without phones or necessary medicines, some without food. Others, who were in normal physical condition, were afraid to leave their homes for fear of looters. The CB mobiles called the information back to base, and runners were sent with food or other necessary supplies or aid.

One detachment was joined by Red Cross nurses with PA's. The REACT vehicle toured while the nurse announced the availability of medicine and vaccines, and asked that people come to the car for medical aid. Calling on other CB'ers for assistance, the original Redicom group was joined by REACT teams and other CB clubs from Greene, Clarke, Fairfield and Franklin counties. It was only after eight days, "spending ten to 16 hours a day in Xenia," that the last REACT team was discharged from a job well done.

These dramatic incidents, and dozens of others in which REACT'ers have risked life and limb in the service of the community, are just a few of the thousands of times REACT'ers have been of service to the motoring public—all the way from telling a driver where he made a wrong turn and the best way to get to his destination, to a two-car accident where ambulances were called and first aid given to the injured till they arrived.

In this continuing activity they have had some special successes. During the energy shortage in early 1974, CB'ers not only relayed distress calls from motorists who were out of gas, but were able to direct others to stations that had supplies at the moment. In many cases, they used their local knowledge to give information on the shortest and most economical route to a given destination.

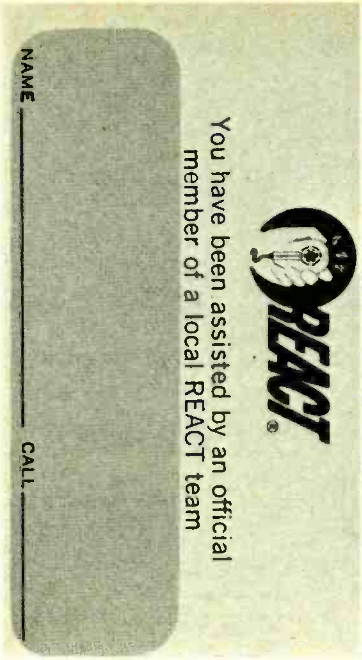
WHAT IS REACT—HOW DOES IT WORK?

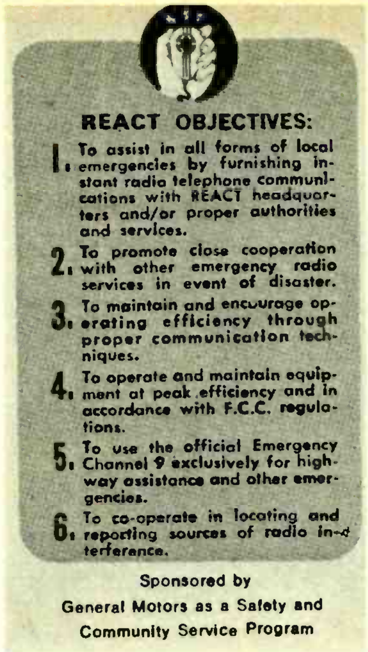
Any five or more persons may apply to REACT National Headquarters, 11 E. Wacker Drive, Chicago, IL 60601, for a charter to form a local REACT team. If there is already a REACT team in the community, applicants will be referred to it.

There are three simple requirements:

1. Establish an effective REACT monitor system, guarding the official emergency channel 9, 24 hours per day, 7 days a week.
2. Maintain an active membership of at least five Class-D Citizens Radio operators.
3. Operate at all times in accordance with FCC rules and all Federal, State and local regulations.

(It might seem that REACT service would be useful only to motorists with Citizens Radio. It really is much broader—a REACT member or often an ordinary Citizen bander passing a disabled car or an accident will immediately put out a call on channel 9, informing the nearest monitor of the situation. Some teams even patrol the highways, though National REACT does not endorse such projects, pointing out that criminals sometimes pose as disabled motorists to lure good Samaritans into their reach. In any case, the services of REACT reach a much broader group than owners of CB radios.)





OFFICIAL REACT CALLING CARD is handed out to people that have been assisted by a REACT member.

COL. ROBERT CHIARAMONTE, who was responsible for integrating the efforts of Citizens-band radio teams and the Ohio State Police to improve conditions of highway travel.

Organized aid to travellers

The State of Ohio, whose State Highway Patrol Superintendent, Colonel Robert Chiarmonte, has been an ardent supporter of CB from its earliest days, is a particularly excellent example. All 57 Ohio State Patrol posts are equipped with CB base units, donated by REACT teams and other CB clubs, that monitor channel-9 twenty-four hours a day. In 1970, the Patrol engaged in a two-year test program with REACT. It included not only road tests but such activities as planning meetings where Highway Patrol personnel, REACT teams and local CB clubs as well as representatives of other interested public services, were involved. A number of problems were investigated and some educational work accomplished. One somewhat unexpected result is that in Ohio, "non-emergency use of channel 9 is very limited."

In some of the tests, CB mobile units were placed in patrol cars for a given period of time and their traffic logged. In one ten-day period during one officer's regular duty tour, he received three accident calls, one report of a car on fire, twelve disabled motorists, one "driving under the influence of alcohol" complaint, two runaway teen-age girls, and three excessive speed complaints. A tribute to the CB discipline on the Ohio highways is that there were no false alarms—all the messages were legitimate.

The growth of Citizen band use in Ohio, says Col. Chiaramonte, is incredible. Other states throughout the nation, keeping a close watch on Ohio's progress in CB emergency use, have expressed interest in building a similar climate of cooperation between law enforcement agencies and the CB user population.

"Infinite positive results," says Col. Chiaramonte, "could come from the development of a nationwide highway emergency communications system as described here. The day is coming when it may be said that help for the person in trouble is truly as close as his microphone." **R-E**

R-E's Service Clinic

The open short

When is an open a short?

by JACK DARR
SERVICE EDITOR

THIS IS THE TALE OF A FAIRLY TYPICAL tough-dog service job. The fault itself isn't at all unusual. We've all seen it many times. However, I thought it might be educational to follow the analysis through all of the various tests (and see how many times I was led astray by not interpreting test reactions *correctly*!) When you see this (*!*), it marks one of the points where a different interpretation of the symptoms would have led me to the solution much faster.

The TV set was a new Zenith 19DC-12Z. It had been sold, but developed a nasty habit of blowing the damper fuse about every three weeks. When taken back to the dealer's shop, it played perfectly. After about three trips, it was replaced by another set and put aside. After quite a while, I inherited it.

On my bench, it played for quite a while, and then the fault showed up and stayed. Replacing all of the tubes did nothing. Checking for grounds in the B+ and boost circuits clearly showed no grounds (*!*).[1] Grid drive on the 6LF6 horizontal output was good, but the cathode current slowly increased to 400 mA (at which point I pulled the plug. Disconnecting the tripler didn't help. The flyback and yoke showed no shorts on a flybacker test.

Rechecking the horizontal windings of the deflection yoke showed no shorts. Ohmmeter tests also showed infinity. Substituting another horizontal yoke winding and using only the ends of the winding hooked to the flyback brought back the boost and high-voltage. The cathode current of the horizontal output tube dropped to normal. Hmm. Must be a high-voltage breakdown in the horizontal deflection yoke winding. (*!*).[2]

Order new exact-replacement deflection yoke. Plug it in. Retest. Oh, boy! Same thing. The cathode current of the horizontal output tube increased to above 400 mA and no boost voltage. (Get red in the face.) Try the substitute yoke again. Everything normal. Notice that I had used only the ends of the winding, leaving the horizontal yoke center tap open. Hook this up. Hmm.

Current jumps back up and the yoke *smokes*. The smoke turns out to be the 4.7K resistor in the center-tap. Check original yoke; this resistor completely open. Check replacement yoke; open here too. Also in my test yoke. Replace all of them. New we're ready to try again.

Using my test yoke because it would be easier to replace the 4.7K resistor, I pull the set-yoke plug and clip mine in. Without the center-tap hooked up, I get normal current, lots of high-voltage and 1,000 volts of boost. Discover that the last one is due to connecting the top of the yoke to terminal 9 on the flyback instead of terminal 8 where it should have been. Correct this and boost is now normal.

Stop and sit. Try thinking. Everything is now out of the circuit except the pincushion transformer. As you can see in Fig. 1, this is actually between

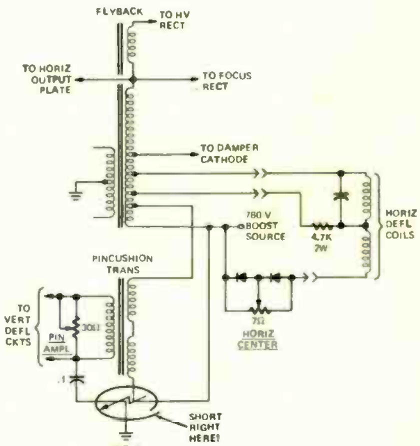


FIG. 1

the two halves of the horizontal winding, so it has boost on it. Check for shorts from boost terminals to ground, B+ and everywhere else. Nothing. Completely open circuit. Actually, about 3.0 megohms, which ought to be all right. (*!*)[3]. Monitoring the boost with the pin-transformer still in the circuit shows that the boost voltage rises and holds momentarily before dropping drastically. Cathode current rises at the same time.

It's easy to unhook the boost winding of the pincushion transformer, one end actually plugs in. Disconnect this and connect the ends of the horizontal yoke winding with jumper lead. Cross fingers and turn on the set again. Everything normal! Boost, high-voltage and current all OK. Reconnect center-tap lead. Still OK. Disconnect test yoke and plug original yoke back in. Still normal. (Look sheepishly at brand-new deflection yoke lying on bench!)

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.

Now, apparently we have a shorted pincushion transformer. Reconnecting it to the boost momentarily with a clip lead shows the short. Recheck for short to ground or B+ from boost winding of pin transformer; nothing. Open circuit (*!*)[4]. Hmm. Examine pincushion transformer very closely. No burnt spots, all windings check out at precisely the correct resistance.

Scratch head. By now the nature of the fault is becoming apparent, even to me. It has to be an *arc-over* (*!*)[5]. But where? Can't hear it pop or see it or smell it. Eventually, a very close examination of the connections to the boost winding of the transformer shows it up. There is a spaghetti-covered lead going to the boost terminal on the mounting plate. This is *crossing* the grounded lead to a capacitor in the other windings. Moving the spaghetti covered lead reveals a tiny spot! It had accidentally been dressed closely over the grounded lead, and the heat of soldering had weakened it. Moving the hot lead about ¼-inch away from the other cleared up the whole problem.

Analyzing the analysis!

Now, let's see what happened.

1. One of the early tests showed very plainly that this was not an "ordinary short" either to ground or B+. That should have been remembered later.
2. This was getting closer. However, I ran right over the key fact in this series; that I *could* get both boost and high-voltage with no overload using the substitute yoke. This should have been pursued further, for there were more things than the deflection yoke in that circuit!
3. This is a repeat of a test that I had made at least three times. Every time it told me the same thing, that this *was* definitely an arc-over or high voltage breakdown. Only two things in there, the horizontal winding of the yoke and the pincushion transformer.
4. Now, we're getting better. At least I had sense enough to start *eliminating* things.
5. Ho-hum. There he goes with that ohmmeter again. Monotonous, ain't it? Anyhow, by now ol' Dum-Dum has pinned it down to the right part! Actually, I came very close to ordering a new pincushion transformer, but didn't.

So there you have it. As you can see, on too many occasions I ran right over the key fact in this case. The "open short" definitely points to only one kind of fault, and that is a high-voltage breakdown due to just exactly what I found. A place that had no readable leakage with the low voltage of an ohmmeter, but which broke down instantly when the boost hit it. The yoke-sub test was correct. This pinned the trouble down to the *area* of the deflection yoke and pincushion transformer. The correct method here is the one I eventually used; taking the pincushion transformer out of the circuit (simply because it was easier to do this) and checking out the deflection yoke. The moral of this is "stop and think." When you see something that isn't right, take the thing apart and check it a piece at a time and you'll find the cause a lot faster! **R-E**

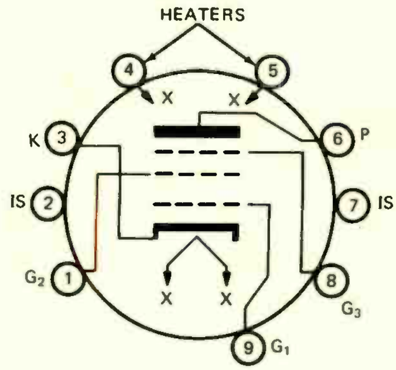
reader questions

REPLACEMENT FOR UF86 TUBE?

I need a replacement for a type UF86 tube. Found it in an old stereo amplifier brought in. I can't find this in any of the interchangeable tube manuals. Do you know where I can get this tube, or if there is a replacement?—V.S., Canoga Park, CA.

There is no direct substitution for this type. It's made by Mullard, in England. It's a "low-noise audio amplifier pentode." The problem is in the basing (see diagram). There is no direct replacement for a base like this.

The closest thing you could get to the spec's of the tube itself would be



UF86
("B9A")

something like a 12BY7. The socket will have to be rewired to match. There are other 9-pin types that would also work, if you want to look them up, but the 12BY7 ought to be good.

REPLACEMENT OUTPUT TRANSISTOR

I need a replacement for the output transistors in a Fisher 440T amplifier. They have the numbers 36642 and E65265J and RCA on them. Also, what is the little black thing marked 0.5 and 5%WL connected to them? No one around here can get a replacement.—J.B., Las Vegas, NV.

The 36642 is an RCA Device number. Both transistors in this stage are NPN's. From the voltages used, and the spec's (Sams 1094-SED), something like an RCA SK-3027 ought to do nicely. You can get matched pairs of SK-3027's under the number SK-3029. The "little black gadget" is an emitter resistor, 0.5 ohms, 5%. It is connected from the emitter of one transistor to the collector of the other. Check it, or replace it. If the originals shorted out, it probably damaged this resistor. Also, be sure to check the driver transistors. Since these are direct coupled, they will affect the output transistors!

ODD COLOR SYNC PROBLEM

After other repairs, an odd color drift problem showed up in a Magnavox U45 chassis. Not the usual breakout with 6 or 7 color stripes, only one and a half. This showed up only on a TV signal; very steady on a color bar generator. Trying a bias-box on the oscillator control test point showed that the color could be controlled at that point by varying the DC voltage. The reactance coil would change the DC voltage, showing that it was *trying* to hold the frequency.

This led me to the power supply; local AC line, 60 Hz, TV vertical 59.94 Hz. Scoping different points showed about 5 volts of AC hum on the screen grid of the burst amplifier! Replacing the 80-μF electrolytic (C2-b) on this point cured the color problem. Apparently, the variation of the screen voltage of the burst amplifier, due to the hum, was dropping the burst level and letting it fall out of sync, only to pull back when the voltage rose on the next cycle!
—Monty Huckle, CET, Tahoe City TV, Lake Tahoe, CA.

NO HORIZONTAL SYNC

The picture slips sideways on this Philco 19P22. Sometimes it runs pretty fast. I've checked all of the tubes and changed the AFC diodes. Now What?—J.T., Norlina, NC.

Now run a complete setup procedure on the horizontal oscillator! Shunt the stabilizer coil with a cliplead, and ground the AFC. Adjust the horizontal hold control for a *single* straight-sided picture. This will float from side to side; no sync.

Next, take the shunt off the stabilizer coil and adjust it for a straight-sided floating picture. If it'll do this, your oscillator is capable of running on-frequency. Now take the short off the AFC. If the picture falls *out* of sync, you've got AFC problems.

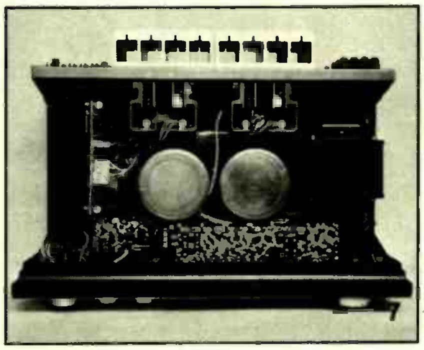
If you can lock the picture with the hold control but it has no range at all, picture falls out as soon as you move the control just a hair, you are NOT getting horizontal sync to the AFC circuitry. Check for break in foil on PC board. **R-E**

HI-FI LAB TEST
(continued from page 43)

for separate use of the two circuit sections of the L-100. Some idea of the number of components that can be connected to this amplifier and their method of connection is shown in the diagram of Fig. 6.

Circuitry and construction

An internal view of the L-100 chassis with the cabinet removed is shown in Fig. 7. Those giant electrolytic filters are 15,-000 μF each. The L-100 is so new that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Lux Audio of America does not as yet have English versions of the service manual and so we could not study a schematic diagram of the unit. An attempt at circuit description is given in the temporary brochure describing the product and, though it is a poor translation from the original Japanese, we will summarize it briefly.

The preamp-equalizer has a differential direct-coupled amplifier with a cascode circuit, followed by a Darlington push-pull Class-A inverter circuit. Voltage and tone amplifiers also employ direct-coupled cascode circuitry. The main power amplifier section uses a two-stage differential amplifier input and direct-coupled complementary output circuitry. Since early stages operate in Class-A while output stages are Class-B, Lux has actually constructed a power transformer with separate windings for powering the Class-A and Class-B circuitry. They claim that this reduces intermodulation distortion that might otherwise result from a common power supply impedance between the fluctuating Class-B currents and the less irregular Class-A circuit currents.

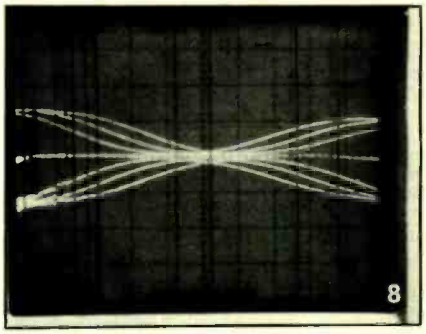
A complex group of circuits is included for protection of the output stages and loudspeakers, and the muting action that delays turn-on for those first few seconds is relay operated.

Power and distortion measurements

A summary of all of our laboratory measurements can be found in Table I, together with our evaluation of each specification measured in relation to claims and in terms of the price category of the L-100. The unit is very conservatively rated, delivering 140 watts of power at its rated distortion figure of 0.05% at mid frequencies and over 120 watts-per-channel for the same distortion at the high-frequency and low-frequency extremes. In fact, if one limits output power to the rated 110 watts, the distortion measured at that power level (at mid frequencies) is an incredibly low 0.005%.

Preamplifier and control measurements

RIAA equalization was measured and found to be within 0.2 dB of exact requirements at all frequencies when the LINEAR EQUALIZER switch is set to its mid-position Tone control range of the BASS and TREBLE controls is shown in the spectrum analyzer scope display shown in Fig. 8. This display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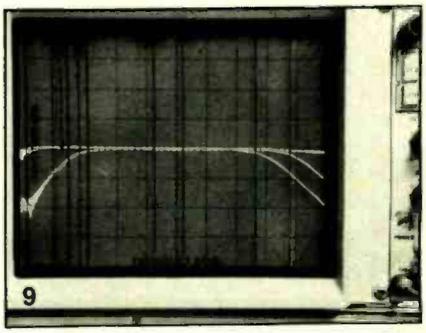
clearly shows how changing the bass and treble turnover points affects overall range and hinge points of both of these controls. Each vertical major division on the scope graticule is equal to 10 dB of amplitude change. High-filter and low-filter action is similarly shown in Fig. 9. While both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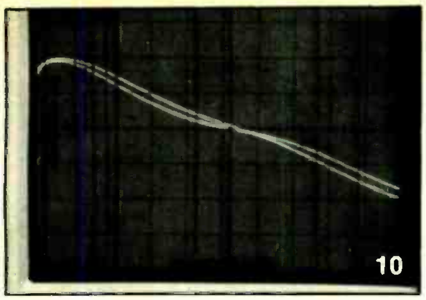
high-end cut-off curves show up clearly (the cut-off points are 7 kHz and 12 kHz), only the 70 Hz cut-off of the low-filter shows up significantly in the scope traces because the second cut-off position is set to 10 Hz (for sub-sonic rumble attenuation) and our scope/spectrum analyzer combination sweeps only from 20 Hz to 20,000 Hz in the required logarithmic mode.

Phono sensitivity measured 2.8 millivolts for full output with the front panel sensitivity controls set to their mid-points. As mentioned earlier, cartridges with different output levels can be matched in gain to other program sources by adjusting these controls for a maximum of ±5 dB on either side of the nominal 3.0 millivolt sensitivity.

Hum and noise in phono (referred to actual input sensitivity and full output) was 68 dB. For those who prefer a 10 mV input signal reference, that would be equivalent to a signal-to-noise ratio of 79 dB below rated output. Overload capability measured an impressive 460 mV against 450 mV claimed.

To illustrate the action of the linear equalizer, we displayed the RIAA equalization afforded by the preamp section with the linear equalizer set first to one extreme and then to the other. Results are shown in the photo of Fig. 10. Note that the shape of the overall curve does not change with these settings—it is simply "tilted" up-



ward or downward (unlike what tone controls might do, even if used minimally). While the range of adjustment seems small indeed, bear in mind that each vertical box in the scope display is equivalent to 10 dB of change. Certainly, the effect of the linear equalizer is rather subtle, but it is audible enough for an astute listener to be able to choose that setting which sounds "just right" for a given recording in a given listening environment—and that is just what it is intended to do.

A summary of our overall opinion of the Lux L-100 will be found in Table II together with our comments concerning the listenability of the unit and its control features as they impressed us during actual use and listening tests. **R-E**

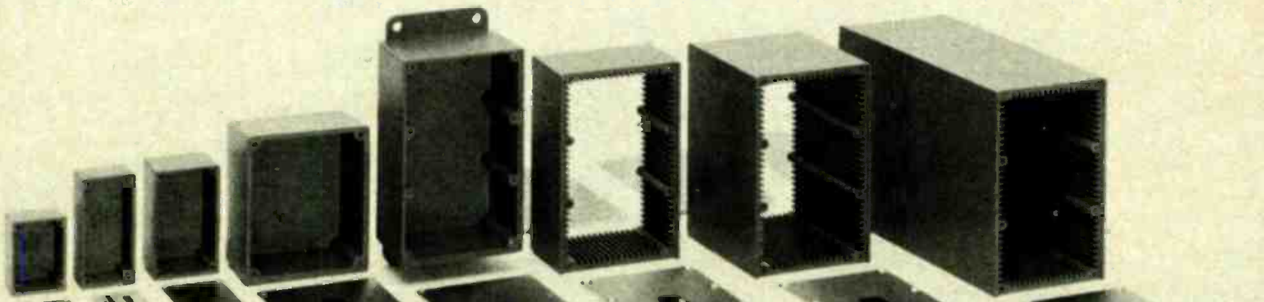
PROBES

(continued from page 45)

when the probe is used with a meter of known input resistance, create a voltage divider. This voltage divider will divide the voltage stored on the capacitor (which will be equal to the peak value of the RF signal) by 1.414 to yield a meter deflection that may be read as RMS voltage. Additional diodes may be connected in series to increase the reverse breakdown voltage of the diode, and therefore the maximum operating voltage of the probe. Placing additional diodes in series also increases the minimum voltage that can be measured.

The demodulator probe is similar in design to the RF probe, but usually differs in its intended use and its output time constant. Demodulator probes, as their name would imply, are designed to recover ampliture modulated information on an RF signal. These probes are frequently used in analyzing television signals in such places as the IF strip, and recovering signals created by a sweep generator. Signals from a sweep generator often obtain modulation from the amplitude vs. frequency characteristics of the circuit being swept. Demodulator probes are primarily used with oscilloscopes. RF probes are used with voltmeters.

Other types of specialty probes include those that are used to measure current, active probes containing amplifiers to achieve high impedance at no sacrifice in gain, logic probes (which are really miniature instruments rather than probes) for detecting highs and lows in logic circuits and specially built high-voltage probes containing series multiplier resistors to permit extremely high DC voltage measurements with ordinary meters such as VTVM's and VOM's. **R-E**



Future of CB

More channels and maybe even a Class-E service.

by HERB FRIEDMAN

THINK BACK TO LAST SPRING. WOULD YOU really have believed anyone who predicted the FCC would permit hobby-type operations on the Class-D 27-MHz Citizens band? Fact is, it would have been next to impossible to find anyone to make such a prediction because the future of CB looked about as black as a coal bin at midnight—during a power failure.

At the time, the FCC was talking about restructuring Class D, which put very simply meant eventual SSB-only operations except for channels 9 and 11. Reading further between the lines, heavy restrictions were ahead for antenna systems. Add to all this the seemingly endless list of CB'ers being hit with heavy monetary fines for hobby-type operations and it appeared the FCC had finally decided to crack down—very hard.

At the same time it appeared the EIA's proposal for Class-E CB was going to get the go-ahead; whether it was a well thought out proposal or not made no difference for the electronics industry needed the anticipated sales. Unfortunately, someone proposed Class-E right in the middle of the 220-MHz amateur band, and the howls to every politician in sight made a handsome profit for the postal service.

Funny about the Hams, for they were the key to relaxation of the CB rules allowing hobby communications. Concurrent with the FCC proposals for Class-D restructuring were assorted dockets for restructuring the amateur radio licenses. Among the sane and insane ideas was a "Communicator's License" that would permit entry-level-skilled "Communicators" to use the amateur 2-meter band FM frequencies. This new "Communicators License" would have no code speed requirement and a simplified written test. Trouble was even the FCC didn't seem to know what the "simplified test" would contain. Most informed sources implied a "ten-easy-true-or-false on simplified theory and/or regulations."

The Hams read the "Communicators License" to be a legal CB hobby license and envisioned a thundering herd of CB'ers filling their FM repeater frequencies. The howl from the Hams to their elected representatives almost equalled their complaints about giving up part of their 220-MHz band to Class-E CB. Basically, the Hams were making everyone edgy as they were showing a lot more muscle than anyone thought they had.

Meanwhile, the politicians who set telecommunications policy get the wrong message. They actually believe Class-E CB is all that's needed to boost the consumer electronics industry and they announce "they favor" a Class-E CB in the 220 MHz Ham band. (When a White House agency says "they favor," you read the signal right or look for a new job.) Now it's out in the open, the Hams will really lose part of their 220-MHz band, and every amateur radio club mounts a letter writing campaign to Washington—showing even more muscle.

Word gets out that both the CB and amateur restructuring will be postponed (until someone figures out who has the right ideas).

Suddenly, someone in authority actually listens to Class-D CB and takes two deep breaths at what he hears: Where did all those stations come from? CB was known for ten layers on each channel but now there were twenty layers. In urban areas it was virtually impossible to get 100% copy across on a single transmission.

It seems that in the few months since the license fee had been reduced to $4, something like an average of 100,000+ applications for a CB license poured into the FCC every month. The FCC was literally tied up and nothing was getting done. Amateur licenses were running months behind; commercial license (operator) renewals were getting lost, and even CB licenses were taking so long the bootleg CB operator was taking over the band—there were more stations using "handles" than call letters. Class-D CB was running out of control; the hobbyist had taken over CB and the manufacturers and the amateurs were showing as much muscle as they could to fight restructuring, so the FCC bailed out: they simply removed the restrictions against hobbying and turned Class-D CB into a "Communicators Band." Simultaneously, a "spokesman" announced that Class-E CB was now being considered for 218 to 220 MHz, outside the amateur band. This took the amateurs off everyone's back.

As for the CB manufacturers, they couldn't have been happier. With the hobby restrictions removed from Class D, CB took off. Everyone, but everyone got into CB: the department stores, the discount houses, the auto supply stores, the tape player specialty shops, even the local auto service centers. (CB was and is booming, and no one along the way really tells the equipment buyer he needs a license.) Some of the best known brands of CB transceivers are running six months on back order. In several stores of a large national electronics chain you must get on a waiting list to get a transceiver and antenna equipment. For some of the best known hi-performance transceivers you actually have to be on friendly terms with the local dealer to even get moved up on the waiting list.

Of course, almost 100% of the CB sales and activity are to hobbyists today, and the small business and personal user for whom CB was originally intended is being squeezed out. No one can expect a small store, taxi service or personal user to use CB if every transmission is cut to ribbons —or *walked on* as the CB'ers would term it. What is needed now is a rational expansion of the Citizens Radio Service.

Looking ahead

If at the time you are reading this article the FCC has gone ahead with part, or all of their restructuring proposal(s) there will not be much of a change in Class-D CB from what we have now, for the extra channels won't be worth a burnt out tube if they are SSB-only. SSB is too expensive for the average CB'er and there are not sufficient sales to maintain a viable consumer industry. For the small business user, a standard VHF or UHF, or even mobilephone, will cost less than an SSB CB system. For the personal user, SSB is entirely too expensive and complex. At worst, the hobbyists will creep up into the new channels. They got what they wanted by violating the rules the first time around; why be any different the second time?

We'll get back to Class D later. Right now, let's move on to Class-E CB, where the real future of CB lies. With the present Class D turned over to the hobbyists Class E is not only needed for the business and personal user, if offers the only area that can resist encroachment by the hobbyist, thereby providing for a true citizens radio service. The ideal frequencies for Class E are about 218 to 220 MHz because the present technology and equipment—used by radio amateurs—can be instantly ap-

(turn page)

plied to CB; there are no development costs to be written off near 220 MHz. The same FM equipment used by hams can be "tweaked" on the assembly line to cover Class-E CB. For this reason alone the future looks bright for Class E below 220 MHz.

Assuming we will see Class E in the near future, if it is not already approved by the time you read this article, figure the FCC will not make the same mistake twice, and Class E will be exactly what was originally intended for Class D: *hobbying will be out*. It is most likely that Class-E stations will be permitted contacts only with stations under the same license (except for emergencies), and it is also likely Class-E equipment will have built in identifiers that will transmit—probably when the transmitter is keyed—a code sequence filed with the F.C.C. Licensing will probably be done at the point-of-purchase through the dealer, who will file the proper papers with the F.C.C. The cost of licensing will probably be built into the cost of the transceiver. Violations will be easy to detect if the identifier is coded to the license, so a transmitter can communicate only to another transmitting station with the same identifier code. Keying in the code at the time of purchase is slightly ahead of what we can expect from a CB dealer, so the first system will probably have an individual identification. The FCC will probably refer to the codes only when there is an apparent violation.

Automatic identification will make it difficult to resell the rig as the identifier will be yours. Assume some provisions will be made to transfer the license with the coded identifier, much as we do with automobile title papers in some states.

Since every Class-E transceiver will be licensed at the time of purchase, the only way a hobbyist could get by is either by stealing the equipment or going through some complicated conspiracy at the time of purchase to conceal his or her true identity. (And this would be carrying hobbying too far—into the area of a felony.)

The proven success of the amateur radio repeaters on 144 and 220 MHz has led many to speculate on the use of commercial repeaters for Class-E CB. The idea is certain frequencies would be set aside for repeater use, and the user would pay a fee for each "call" through a repeater. This all looks very good, except we are getting into the realm of the common carrier, and Ma Bell wouldn't stand still one second for this idea. If you think the Hams and CB'ers have clout in Washington, they're not even newborn infants compared to A. T. & T.

Finally, let's examine the cost of a Class-E CB system. Since it will be the same equipment the Hams use, only with increased production and sales, the CB unit will cost even less than a modern amateur radio FM transceiver. A typical Class-E unit might have 10 to 25 watts RF output, 10 channel selection, and a price tag well under $200. The antenna equipment is not much more than a piece of stiff wire in a lightweight body mount, so figure maybe $15 as an average. That's about the same if not a little less than a decent Class-D system would cost. Dollar for dollar, Class E is the same as Class D. If we allow for the capture effect of FM so that interference from distant stations is non-existant with FM, Class E pulls ahead. And when we add in a complete absence of hobbyists, Class E is obviously the future of CB.

Class D, however, will still be around, for there is no present way to change or eliminate what has become a legal "unlicensed amateur band". (If you object to calling CB'ers "amateurs" let's call it a "licensed communicator's band".)

Unlike other electronic hobbyists such as the general experimenter and traditional radio amateur, the CB hobbyist doesn't give two hoots or a holler about electronic experimentation. He might purchase some add-on transceiver accessory in the quest for more talk-power, or a directional antenna to produce a rock-crushing signal at the receiving station, but how it all works or why couldn't interest him less, for the end purpose of his hobby is *to talk* to someone else.

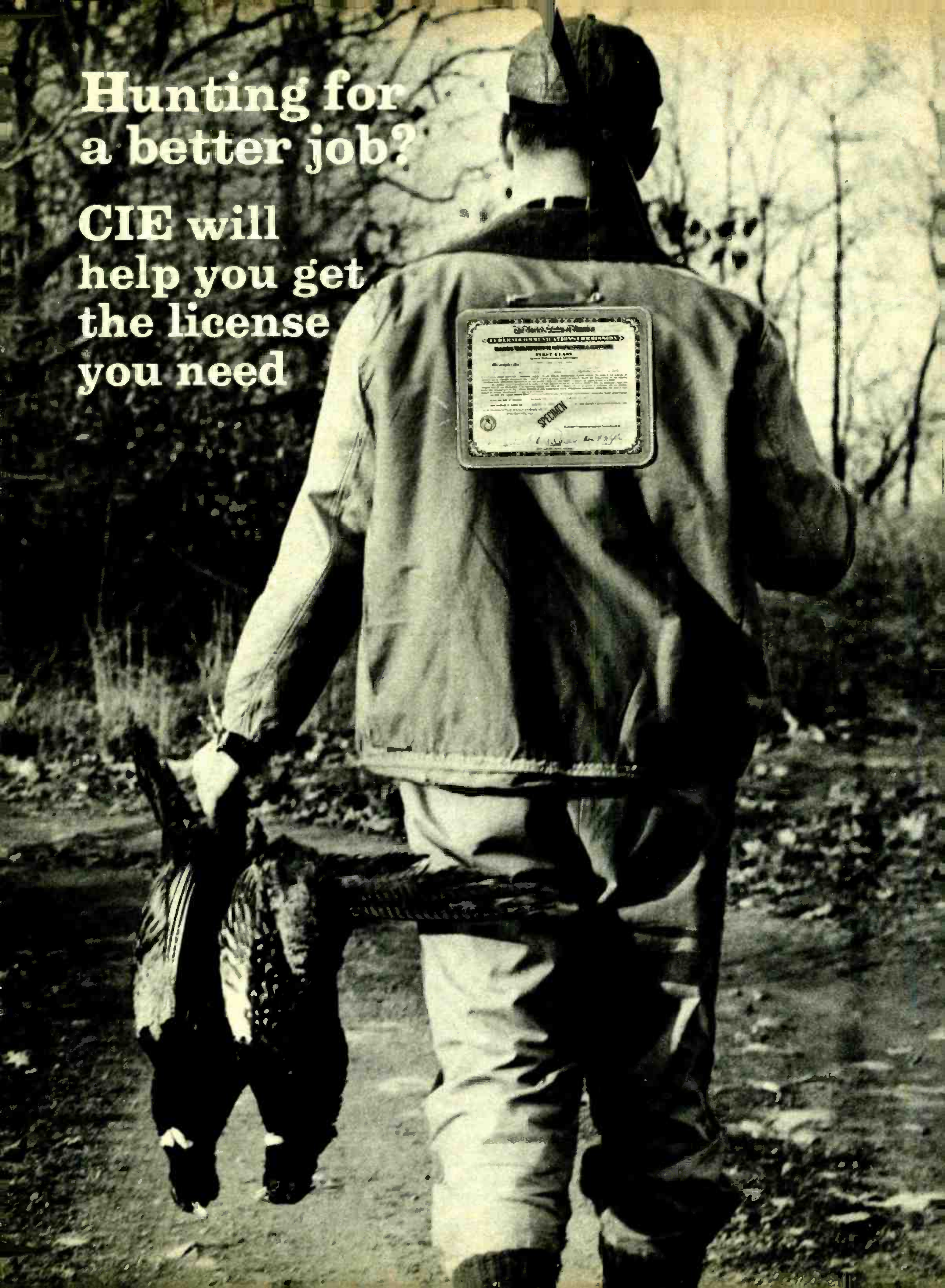
Since the equipment itself serves only as a means for the hobbyist CB'er to do something, and is not part and parcel of the hobby itself as the transmitter-receiver is to the typical amateur, there is no reason why hobbyist CB gear cannot be part of some other hobby, a natural being a mobile tape player or AM/FM radio. Fact is, that is precisely what we are starting to see: Combination tape player/CB transceivers and AM/FM radios combined with CB transceivers; even an AM/FM radio/tape player/CB transceiver is ready for distribution to dealers.

It is this combination of music and CB that shapes up as the next big development in Class-D CB. And it is with this tie-in that cars might come equipped with a CB transceiver, thereby providing the channel 9 emergency service the FCC and the CB manufacturers envisioned when Channel 9 was set aside for emergency calls. (A purely accidental benefit via the CB hobbyist).

Another aspect of hobby CB has been an increase in the availability of budget (low cost) CB transceivers. Until the past year there was a continuous upgrading of the *average* AM CB transceiver. In general, *selectivity*—the ability to reject interference from stations on adjacent channels—was the key to both the transceiver's overall quality and price; and both were edging upwards. Fewer and fewer basic, limited channel, transceivers were available each year.

But with the hobbyist explosion last March there was a similar explosion in low cost all-channel versions of basic transceivers: nothing great in selectivity, maybe prone to strong signal overload, enough modulation distortion to garble the message, but, and it's a BIG *but*, a price tag around $100 that's bringing in customers like lemmings on a death march to the sea. One hundred, or so, dollars is the *magic* figure for hobby CB—the price that gets the talkers: students, young children, etc. Almost all major newspapers now have half or full page ads from ex hi-fi and auto-aid dealers extolling and selling CB, and always the feature attraction is a transceiver in the $100 price range. It's that $100 price tag that's getting 'em on the hook, the more expensive high performance equipment will come later. Fact is, business should soon start

(continued on page 81)


Hunting for
a better job?
CIE will
help you get
the license
you need
FEDERAL COMMUNICATIONS COMMISSION
FIRST CLASS
SPECIMEN

new products

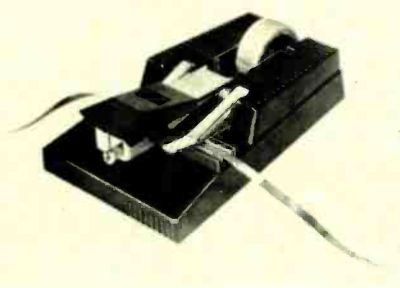
More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card inside the back cover.

PORTABLE DIGITAL MULTIMETER, *model 1455,* has ½ inch high, 7 segment planar 4½-digit display, 100% overranging and 21 function-range operation. DC volts are measured from 100 μV to 1000 V; AC volts from 100 μV to 500 V RMS; resistance from 100 milliohms to 20 megohms; current, both AC and DC, from 1 μA to 2 amps. Frequency response for AC current and voltage is from 30 Hz to 50 kHz. Basic accuracy on DVC is ±0.02% of reading ±0.01+ f.s., ±1 digit for

6 months. Overload protection of ±1000 volts on all DC ranges; 500 volts on AC voltage ranges; and 115 volts DC or AC on all resistance ranges. Current protected to 2 amperes with a rear panel mounted fuse. The 1455 comes with its own internal NiCad battery module and recharger so it can be both as bench-mounted lab unit or as a portable tester. When it is not AC connected, it is automatically operated from its batteries. Unit measures (W×H×D) 8½" × 3½" × 7¼". Comes with its own test leads, equipped with a combination carrying handle/tilt stand, internal battery pack and removable line cord. $355.—**Data Precision Corp.,** Audubon Rd., Wakefield, MA 01880

Circle 31 on reader service card

TAPE SPLICERS. Two new *Gibson Girl* models are the *R26038* for ¼-inch reel-to-reel and eight-track tapes and the *R33047* for cassette tapes. Their best known feature is a special trim along the edges of the spliced tape area to prevent adhesive from touching critical parts of the tape deck, reducing mal-



functions and prolonging service life. Other features include a knob with cut and trim positions, spring-loaded arms to hold the tape in position and cutting blades that are exposed only when actually splicing.

The model *R26038* and *R33047* both list for *$8.50*.—**Robins Industries Corp.,** 75 Austin Blvd., Commack, L.I., NY 11725

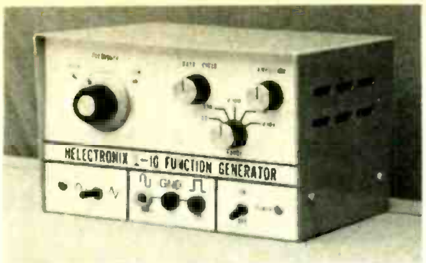
Circle 32 on reader service card

WIRELESS PA SPEAKER, the *SC-100 Sound Column* is a system featuring quick set-up and freedom from trailing microphone wires. The Sound Column consists of three 6 x 9 inch speakers, a receiver with built-in antenna and amplifier, a chrome stand and a nylon carrying case. The crystal-controlled *model SC-100* is available on three different frequencies. The manufacturers wireless microphones can be matched to the system.

The *SC-100* has separate bass and treble controls and may be AC or 12-volt DC operated. Three independent volume controls provide simultaneous control of a wireless microphone, recorder and turntable. The system provides wire-free communication on tennis courts, althletic fields, playgrounds, indoor and outdoor assemblies and emergency situations.—**Edcor,** 3030 Red Hill Ave., Costa Mesa, CA 92626

Circle 33 on reader service card

FUNCTION GENERATOR, *model L-10.* This kit has a pre-assembled, pre-tested circuit board. Remaining assembly is fast and easy. A schematic and easy to follow directions are included. All components are guaranteed for one year. Specifications include: Frequency range, 1 Hz to 100 kHz in 5 ranges. Constant amplitude ±0.5 dB over frequency range. Sine Output, variable amplitude up to 10V P-P into a 600 ohm load. Sine distortion less than 2%, 1 Hz to 100 kHz. Triangle output, variable amplitude up to 12V P-P into a 600 ohm load. Linearity 0.1% typ. Squarewave and pulse, fixed amplitude, TTL levels more than 3V. Rise and fall times less than 15ns. Variable duty-cycle pulse from 5 to 95% of full duty-cycle. Output will drive 30 gate loads. Unit measures 5" x 7" x 0.5", weighs approximately



2 lbs. Price; $69.95 plus $1.50 shipping. Assembled.—**Helectronix,** 8100 St. Clair Avenue, North Hollywood, CA 91605.

Circle 34 on reader service card

AIR-SUSPENSION SPEAKER, *model 69C10FECO,* for auto stereo and other hi-fi applications is a 6 x 9 inch model with a

3-inch tweeter. Voice-coil impedance is 8 ohms. List price is $24.75.—**Quam-Nichols** Co., 234 M. Marquette Road, Chicago, IL 60637

Circle 35 on reader service card

NEW CASSETTE TAPE. The new *Ferricobalt* tape, called Nakamichi *EX II*, is the outgrowth of a newly developed process whereby a crystal of cobalt ferrite is grown onto the surface of a gamma ferric oxide crystal. The resulting particle is more elongated and uniform in size and combines the most desirable properties of both compounds without any of their drawbacks. It permits extremely uniform coating and boasts superior magnetic orientation characteristics.

This means higher output, lower noise and lower distortion. Typically, *EX II* offers 4 dB more output at low and mid frequencies and up to 6 dB at high frequencies in comparison to other quality high-output, low-noise tapes. Noise level is improved by more than 1 dB and dynamic range is enhanced by a factor of 1.8. Best of all, biasing requirements are exactly the same as for the highly acclaimed Nakamichi EX tape.

The Nakamichi *EX II* cassette employs cassette housing that not only resists jamming, fouling and other mechanical difficulties, but also reduces tape skewing, a major cause of nonuniform output.

Nakamichi *EX II* is available in C-60 and C-90 lengths. The price of the C-60 cassette is $4.39, the C-90 is $5.79.—Ted Nakamichi, **Nakamichi Research (U.S.A.), Inc.,** 220 Westbury Ave., Carle Place, NY 11514.

Circle 36 on reader service card

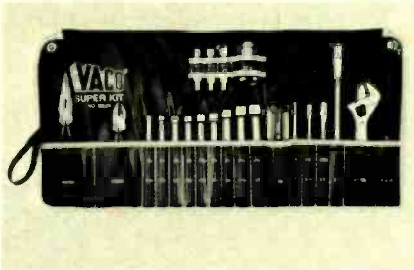
AUDIO GENERATOR, *LAG-120,* features pushbutton operation for easy switching of frequency ranges along with solid-state circuitry to hold distortion to 0.1%.

This sine/square generator, provides a means of quick, accurate testing of sensitive high-fidelity equipment and products and generates a wide range of sine and square waves from 10 Hz to 1 MHz. It offers external triggering through the use of the built-in trigger terminals and has a switchable output generator which ranges from 0 to 20 dB continuously variable with frequency accuracy at ±3% (+1 Hz). Input impedance is 10,000 ohms while the synchronization range is ±1% per volt.

Compact, portable and lightweight the *LAG-120* offers 115/230 V power supply; 50/60 Hz; and approx. 12 VA. Size is 5⅞"H x 5-3/16"W x 9-13/16"D; weight approx. 6.5 lbs. $219.95.—**Leader Instruments Corp.**, 151 Dupont St., Plainview, NY 11803.

Circle 37 on reader service card

COMPLETE TOOL KIT in a pouch, *Super Kit*, the newest addition to the *Vacombo* kit program offers the convenience of twenty of the most often used tools in a versatile roll-up pouch. The *Super Kit* contains a standard and a stubby type heavy-duty handle with snap-in interchangeable screwdriver and nutdriver blades, reamer and extension plus two pliers and an adjustable wrench. The screwdriver blades are 3/16" and ¼" slotted and



No. 1 Phillips types. The twelve nutdriver blades range in size from 3/16" to ½" including three stubby models. The reamer has a 5" body tapered from ½" in diameter to a point. The extension blade adds an additional 7" of working length to all of the nutdriver and screwdriver components. All of the blades will fit into either the standard or the stubby handles. The kit also contains a 6" long needle nose plier with the wire cutter, a 5" diagonal wire cutter and a 6¼" adjustable wrench.

The *Super Kit* (*Stock No. 99550*) measures 19⅝" wide and 19⅛" high. The blue pouch with yellow trim is made from top grade, durable vinyl. Pockets and dividers are double stitched. A matching blue dust cover keeps all components clean. The kit can be mounted on a wall or pegboard through brass eyelids, or it can be rolled up for convenient, compact storage in a drawer or a tool kit.—**Vaco Products Co.**, 510 N. Dearborn St., Chicago, IL 60610.

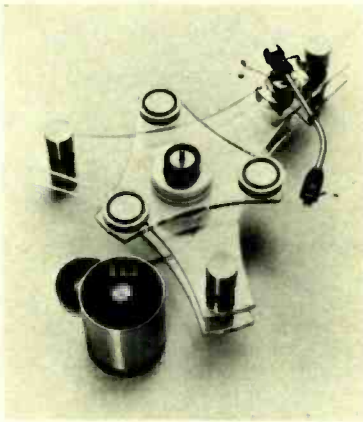
Circle 38 on reader service card

OPTICAL SERVO TURNTABLE, the *Gale GT2101* is totally different from any other turntable ever made . . . in appearance, materials used, motor design, speed control and monitoring, performance and price.

At first glance, the Gale is not easily recognizable as a turntable, as there is neither the conventional rectangular chassis nor round platter. Instead, one sees a highly modernistic Y-shaped sculpture of plexiglass and stainless steel. Only the pickup arm on the long end of the Y indicates that this is indeed a record playing device.

At the center there is a spindle for the record hole protruding from the motor underneath. The record itself is also supported by and rotated on a Y element.

The DC, brushless, servo motor is also unique. Its 10-pole, 3-phase skew-wound design minimizes peak-to-peak torque ripple. It is commutated optically instead of by the Hall-effect devices commonly used in other direct-drive systems. The rotating elements



rest on a magnetic field instead of the high-point-load mechanical bearings used in almost all turntables, which wear in time and cause the rumble figures to deteriorate appreciably. Unlike conventional permanent magnets such as the Alnico alloys or barium ferrite, the rare-earth magnetic material used to create the magnetic field will not degrade in time. The entire motor is housed in a cylinder, with the rotating portion made of stainless steel and the base of cast aluminum.

The electronic control circuitry is in a stainless steel cylinder connected to the turntable by a coiled cord and can be mounted up to three feet away. Speeds can be set either in a continuous range from 10 to 99 RPM, or locked in precisely at 33⅓. A green LED indicates 33⅓ to an absolute accuracy to within ten parts per million. Speed is monitored 600 times per revolution by reference to a 1.048-Hz quartz crystal. A three-digit LED read-out displays the actual rotation speed.

A mechanical suspension on the three extremeties of the unit provides near-total isolation from external shock and acoustical

Circle 66 on reader service card

Circle 67 on reader service card

feedback.

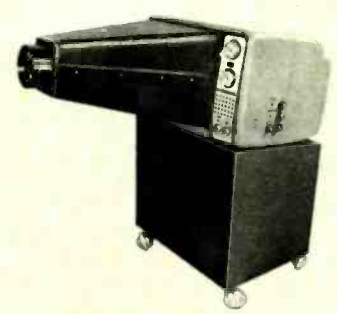
Gale does not manufacture pickup arms, but provides a model which includes an SME arm. Mounting plates for other arms are available.

The designer of the turntable claims that there is no current test equipment or method that can accurately measure any rumble or wow and flutter in this turntable. The 5-year guarantee not only covers defects in materials and workmanship, but any measurable change in performance.

The price: $1,875, less tonearm. Gale products (turntable and speaker systems) will be available in the U.S. through selected Audio specialists.—**Roth/Sindell**, Suite 102, 540 Kelton Ave., Los Angeles, CA 90024.

Circle 39 on reader service card

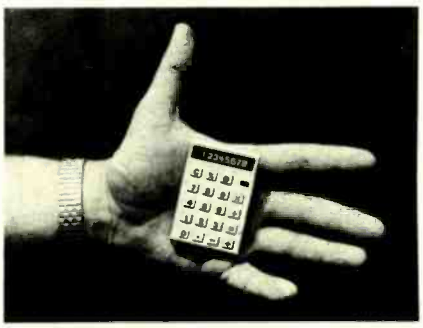
PROJECTION TELEVISION KIT that easily converts any color or black and white set to wall size projection with a 50" picture, consists of a specially designed TV projection lens and a high-efficiency screen. A



high-voltage intensifier for brighter pictures is also available. Complete instructions for converting the TV set and installing the necessary components are also furnished. A completely assembled projection TV set with a 13" color tube and an attractive stand is also available.—**Miami Projection TV**, 304 N.E. 79th Street, Miami, FL 33138.

Circle 40 on reader service card

SMALLEST ELECTRONIC CALCULATOR is only 2 x 2.8 x 0.4" (about one-third the size of a pack of cigarettes), and weighs just 2 ounces. This full-function electronic calculator with 8-digit readout does everything the big ones do. It features an automatic percentage key, floating decimal, constant key, lead zero suppression, and more. The tiny plastic unit operates on two 1.5-V Mallory PX 825 camera batteries or the equivalent. Batteries are included and replacements are available at any camera shop.



Small enough to comfortably fit in a pocket, the calculator provides plenty of room for most fingers. A natural for carrying to the office, plant, construction sites and on road trips, it's so small and light you'll hardly know it's there until you have to do some figuring. Then you'll have quick, timesaving answers at your fingertips.

Available only by mail (Stock No. 1945 . . . $19.95) from **Edmund Scientific Co.**, 380 Edscorp Bldg., Barrington, NJ 08007. **R-E**

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Circle 68 on reader service card

Circle 72 on reader service card

new lit

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

AUDIO PRODUCTS CATALOG, *No. 7502*, starts off with the best sellers in the *Robins* line of 230 different accessories used by professional as well as amateur hi-fi enthusiasts and tape recordists. The most interesting items—or at least those that the Robins customers buy most—are right up front, where they'll be easy to find.

Another feature of the catalog was to group, describe and illustrate products by type, rather than specific application. Thus all cleaners, splicers, bulk erasers, demagnetizers and other sound enhancers are listed as such.

According to the catalog listing, among the products are phono cleaners and kits, record and album covers and other phono accessories, tape and cassette cleaners and lubricants, head demagnetizers, bulk tape erasers, splicers, a variety of recording, splicing, leader and test tapes for all applications, and a melange ranging from carrying cases to mailers and from stereo speaker protectors to audio plugs, jacks and cables.—**Robins Industries Corp.**, 75 Austin Blvd. Commack, NY 11725.

Circle 42 on reader service card

PACKAGING PRODUCTS. A new 16-page catalog fully describes packaging products from A—Aluminum Cages to V—Vectorbords®. Organized to aid the designer, the catalog gives features and specifications for circuit boards, cages, card cases, sockets, terminals, Vectorbords and tools. Also included are a variety of breadboarding kits, patchboards, turrets, positive photosensitized boards and developer. The 398 products listed are the most popular items stocked by Vector and its AVID distributors.—**Vector Electronic Co., Inc.**, 12460 Gladstone Avenue, Sylmar, CA 91342.

Circle 43 on reader service card

CTS LOUDSPEAKER LINE. A total of 87 models are described in a 12-page catalog. This makes it easy for hi-fi stereo buffs to meet all of their speaker requirements from one quality product line . . . whether it be for new system construction or replacement of an existing hi-fi stereo, musical amplifier, automotive, public address or aircraft speaker. Among those offered in this newly expanded group are:

A full selection of 36 hi-fidelity speakers ranging from a 1¾ in. tweeter with a power rating of 2 watts maximum continuous and a response range of 2000—20,000 Hz, to the popular 10-watt, 4½ in. mid-range speaker rated at 400—10,000 Hz to the big 100-watt, 18 in. woofer with 20—1,500 Hz response range. New automotive stereo and rear deck speaker kits. Additional speakers are also available for public address, intercom, tape deck, sound column and numerous other applications.—**CTS of Paducah, Inc.**, 1565 N. 8th St. Paducah, KY 42001. **R-E**

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Circle 71 on reader service card

FUTURE OF CB

(continued from page 71)

picking up for the "gold plated specials"; those high-performance feature-loaded CB transceivers priced well upwards of $400 or $500. In any hobby there's always some who want to upgrade; the more hobbyists there are the more there are who want to break out of the general scheme of things and upgrade. While we can count the number of presently available "gold plated special" transceivers on one hand, the booming CB hobbyists should result in many more super-performance transceiver models in the next few months (just as soon as the manufacturers can move them off the assembly line).

Finally, we come to Class-D restructuring with its additional channels. In practical terms there is simply no future for them if they are SSB-only. Several years ago many a manufacturer took a "bath" by going into SSB when there was no market at all; a few magazines and promotors created the illusion of an SSB market and some really big names got hurt bad. Even if additional channels are approved, if they are SSB-only don't look for a thundering herd of users or manufacturers. For one thing, a total of 100 channels requires a bandwidth too wide for simplified transceiver design—*simplified* meaning the design technology presently being used in CB transceivers. With SSB, total equipment costs will be much too excessive for the small business and personal user. If the channels are added for the AM mode, and hobby operations permitted, that, of course, is a whole new ball game and you can figure CB will be even bigger than it is today: It would be totally impossible for the FCC to handle the licensing of all the people flocking to CB, and point-of-purchase licensing would be an absolute must.

The really ideal solution for CB, and one strongly favored by some of our largest CB manufacturers, dealers and users is additional AM channels reserved for the business and personal user—as originally intended by the FCC. Here, contacts would be only between stations of the same call (license), with built in identifiers and crack-down enforcement by the FCC insuring total freedom from CB hobbyists. (Without the identifiers and crack-down the hobbyists will simply slide up the band to the new channels). Of course, if the new channels are reserved for business and personal intrastation use, there is no point or justification for Class-E CB.

The future of CB will therefore be primarily determined by new channels or frequencies, and how they are finally used—not how they are initially set up. As we should have all learned by now, CB is some mystical force unlike any other established radio service; as the commercials for a well-known hamburger chain would put it. "The CB'er will have it *his way*." **R-E**

SYNTHESIZER

(continued from page 48)

wave components of a complex signal that are within the pass band of the filter will be unchanged while the components outside the pass band will be attenuated, thus producing a planned and controlled "distortion" of the complex waveform.

Since many natural instruments depend upon the characteristics their resonators being changed to produce different tones, there must also be some means of controlling at least the center frequency of a synthesizer's filter. As you might expect, voltage control is the answer.

Control voltages for a voltage controlled filter (VCF) can originate from basically the same sources as those that control the oscillators. If the center frequency of the filter is to change with the changing pitch of the oscillator, the same voltage that is controlling the oscillator can also be routed to the filter. For the "waa-waa's" that are characteristic of electronic music, the control can originate in a function generator.

Noise

So far in our analysis we have dealt exclusively with "pitched" sound sources—sources that have a readily discernable frequency and therefore an easily recognized musical pitch. There are also "unpitched" sources.

The concept of an unpitched musical sound may at first seem as esoteric as the sound of a clapping hand, but it is actually very easy to understand. The hiss that you hear from an FM radio that is tuned between stations is an unpitched sound and most synthesizers have provisions for a noise source that produces just this effect. From a technical standpoint, it is the result of summing together randomly varying amplitudes of all possible frequencies within a given frequency band.

The applications of noise are very broad. For example, the sound of the snares of a snare drum is noise with a percussive envelope. By processing noise through the proper filters, the sounds of the surf and wind are easily simulated.

So, now we know a little bit about how musical instruments work and how electronics can be used to simulate the properties of these instruments—let's look at the GNOME and begin applying some of these principles.

The GNOME

In the early days of synthesizers, each element of a system was a free-standing module and the specific electrical connections were made using patch cords. Patch cords allow great flexibility but the laborious task of setting up patches for each voice is a disadvantage to most performing musicians. In a small system that will not be expanded beyond a specific capability, a normalized connection (one in which a specific arrangement of elements is pre-wired) is definitely the way to go.

Figure 17 shows the signal and control paths through the GNOME. The VCO always feeds the input of the VCF and the VCA can get its input either directly from the VCO or from the output of the VCF. The control voltage for the VCA always comes from the function generator. The control voltage for the VCO can come either from the self-contained controller or the power supply and is adjustable with the VCO RANGE control. The VCF control voltages can come either from the function generator or the controller, or both. This is a fairly typical normalization scheme for small synthesizers and while it unquestionably limits the versatility of the machine, the limitations are minimal and entirely consistent with the inherent limitations of the simplified, low cost circuitry of the GNOME.

Controls

The front panel nomenclature of the GNOME is such that the controls are divided into six sections corresponding to the six major circuits that make up the unit. These sections are:

1. Controller
2. Trigger
3. Noise Source
4. Voltage Controlled Oscillator
5. Voltage Controlled Filter
6. Voltage Controlled Amplifier

Controller section

The built-in control strip is nothing more than an exposed resistance element that has one end grounded and a positive voltage applied to the other end. The sawtooth cuts on the resistance strip along with the paralleling resistors inside the case combine to produce a voltage distribution along the control strip that is exponential. If it were not for this exponential voltage distribution at the control strip, semi-tone intervals at the low end of the strip would seem to be bunched together while those at the top end of the strip would be spread apart. This relates back to the distribution of semi-tone intervals in the equally tempered musical scale.

The Controller RANGE potentiometer varies the voltage that appears across the control strip. At the maximum position of this control, the strip is a little less than 4 octaves long while at the minimum setting it is slightly more than ½ octave long. As we shall see later on in this article, the Controller and VCO RANGE controls interact to place the musical "length" of the controller at any desired position within the oscillator's 8 octave range.

The two slide switches within the controller section of the front panel connects the voltage that is picked off the control strip by the wiper probe to either the VCO or VCF, or both. Sliding the switch bat in the direction of the arrow connects the voltage to the element indicated.

Trigger

There is only one control within the trigger section of the front panel and that is the TRIGGER button. Whenever this button is pressed, a voltage is applied to the triggering inputs of the function generators associated with the VCF and VCA. Provisions have been made internally to reduce multiple triggering caused by "noisy" switch contacts, but a firm pressure on the button is needed to prevent contact bounce.

Noise source

The single control within the noise section of the front panel is a LEVEL control that determines the amount of white noise that will appear on the common audio bus. At the minimum position of this control, the noise source is isolated from the bus and the noise level increases with clockwise rotation toward maximum.

VCO

The RANGE control within the VCO section of the front panel is an attenuator on the control voltage input line of the oscillator. It is useful in a number of different ways. When the Controller VCO switch is off, a constant voltage is applied to the VCO RANGE control allowing the oscillator to be set to some constant pitch that is independent of the controller action.

When the Controller VCO switch is on, the VCO RANGE and Controller RANGE controls can be used together to set the highest and lowest pitches available from the control strip. Figure 18 illustrates this by using a bar to represent the total 8 octave range of the oscillator. The double ended arrow above the bar represents the range of the control strip. Rotating the Controller RANGE control toward maximum increases the length of the double ended arrow across the width of the bar. For example, with both controls set to maximum, the range of the controller is approximately from 600 Hz to 6500 Hz. If the Controller RANGE control remains at maximum, the controller will remain a little over three octaves long but reducing the VCO RANGE can cause these three octaves to run from 30 Hz to 350 Hz. **Note:** The same slight non-linearities that in most circumstances make the GNOME oscillator incompatible with keyboards will also make the length of the control strip variable depending on the setting of the VCO RANGE control, but under normal circumstances these errors will not be noticeable or objectionable.

At the minimum setting of the RANGE control, the oscillator is off regardless of the condition of the controller or the setting of the Controller VCO switch.

The SKEW control is a little unusual for synthesizers but it allows the GNOME's simple VCO to produce 4 basic waveforms (triangle, ramp, square wave and pulse) while also making available a wide range of waveforms in between the four. Figure 19 shows the effect of this control. Clockwise rotation changes the ramp wave to a triangle and the narrow pulse to a square wave. There is some shift in oscillator pitch associated with the rotation of this control from one end of its travel to the other. This deviation is maximum toward the center of the range of the control with the two extreme ends being within a semi-tone of the same pitch.

The triangle control determines the amount of ramp/triangle waveform applied to the common audio bus. The level

(turn page)

increases with a clockwise rotation of the control.

The square wave control determines the amount of pulse/square wave applied to the common audio bus. The level increases with a clockwise rotation of the control.

VCF

The voltage controlled filter may be eliminated from the audio path entirely by setting the IN-OUT switch to the OUT position.

There are four possible combinations of settings of the REPEAT and SUSTAIN switches and each of these combinations produces a different response. These combinations are most easily explained in tabular form as shown in Fig. 20.

The RANGE control within the VCF section of the front panel is an attenuator on the output of the VCF's function generator. It varies the amount of control voltage applied to the filter from the *function generator only*. Since the response of the filters will vary from one unit to the next, this control is designated so that rotation fully clockwise to MAX provides a control voltage greater than the maximum range of the filter. This assures that maximum range will be available on all units. Voltages originating from the controller when the Controller VCF switch is on are not connected through this RANGE control.

The ATTACK control within the VCF section of the front panel determines the time required for the filter's function generator output to rise to its peak. The range of this control is from .005 seconds at the minimum setting to a little over 1 second at maximum.

The DECAY control determines the time required for the output of the filter's function generator to fall from the attack peak back down to no output. The range of this control is the same as the ATTACK control.

The FREQ/Q control is the only control that actually makes some change to the filter itself. Clockwise rotation of this control raises the frequency of the filter while simultaneously decreasing the Q and increasing the loss of the filter. It is normal for the volume of the sound to decrease as the FREQ/Q control is rotated in a clockwise direction.

VCA

The SUSTAIN switch within the VCA section of the front panel serves roughly the same function as the SUSTAIN switch does for the VCF. With the SUSTAIN switch off (switch to the left), pressing the TRIGGER button will cause the VCA's function generator to attack and then immediately decay. As long as the TRIGGER button is held down, the attack and decay times will be as set by these controls. When the TRIGGER is released, a "muting" function takes over and quickly turns the VCA off.

Turning the SUSTAIN switch on (to the right) causes the function generator to hold at the peak level as long as the TRIGGER button is held down. Releasing the TRIGGER now causes the envelope to decay at the rate set by the DECAY control. These responses are tabulated in figure 21.

The ATTACK control determines the

amount of time required for the output of the amplifier to build to a peak. The range of this control is from .002 seconds at minimum to slightly more than one second at maximum.

The DECAY control determines the amount of time required for the amplifier to turn off. The range of the control is from .005 seconds at minimum to slightly more than one second at maximum.

There are two jacks on the back of the GNOME case. The miniature phone jack is the output and it requires a standard miniature phone plug for connections. Coaxial cable should always be used to connect the GNOME output to the input of the amplifier being used.

The black pin jack on the rear edge of the case is an external trigger input. For best operation, the trigger voltage applied to this jack should exceed 8 volts but trigger voltages greater than 4 volts will produce a triggering action (triggers less than 8 volts will not allow the function generators to go to their maximum level). External triggering voltages must be referenced to the GNOME case ground. **R-E**

REMOTE CONTROL

(continued from page 60)

rate and must be present for at least 16 consecutive sample periods before the remote circuitry will identify the input as valid. A valid input is identified by an output on the "data valid" (flag) terminal of the remote IC. This "flag" output causes the control IC to accept the remote IC outputs. The "flag" output goes to 0 when the no input has been received for 3 consecutive sample periods.

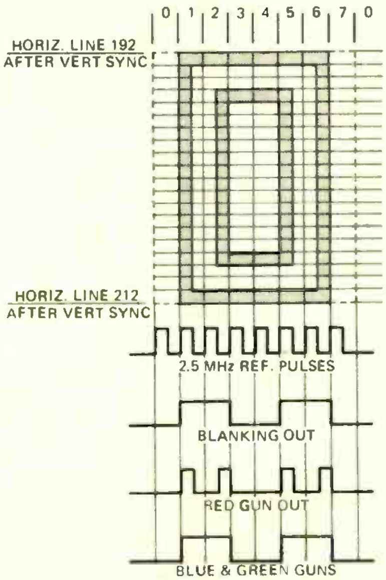

FIG. 6—DISPLAY FORMAT of red zero and the waveforms that generate it on the screen. It, too, has a black outline.

Clock and display

The clock and display circuits fill two basic functions:

1) Converts the channel number BCD code generated by the control IC to video signals, which allow the channel number to be displayed as decimal characters on the TV screen.

2) Generates and maintains time-of-day information in an hours and minutes digital format, which is also converted to video signals to be displayed on the TV screen simultaneous with the channel number.

The clock and display system also, in response to time out, half-entry, and CTS codes from the control IC, establishes the color of the display (white, red, or green) and the amount of time the display remains on the screen.

The clock IC receives 60-Hz clock pulses from the crystal controlled reference clock located on the command module. The clock IC converts both the channel number BCD code and clock information to a channel number and time-of-day display code for use by the display IC. The time-of-day may be updated by the customer via hours and minutes update push buttons located on the instrument front panel.

The display IC decodes the display code from the clock IC and the CTS code from the control IC to provide the proper series of color blanking and luminance drive pulses to the chassis video circuitry for character display on the TV

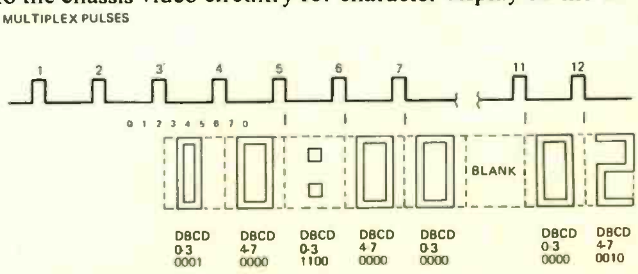

FIG. 7—CLOCK IC OUTPUTS are shown in their relationship to the display and MPX pulses.

screen. Auxiliary blanking is provided to both the luminance and chrominance circuitry to blank station video and color outputs during character display. Horizontal and vertical sync is also defeated during half-entry and non-assigned (illegitimate) channel entry to prevent noise from causing character display instability.

The display output interfacing circuits consist of emitter followers in the red, green, and blue blanking outputs, as well as the luminance and chrominance blanking outputs. The luminance drive is a transistor switch and resistor stage designed to provide the correct driver output current for properly saturated (white or colored) characters. For explanation purposes, the display waveforms generated are those for the character "1" as shown in Fig. 5. For this digit, the pulse shape applied to the red, green, and blue interfacing emitter followers is shown. Note that blanking is applied to the leading and trailing edges of the character. During these blanking intervals, current is diverted from the red, green, and blue output stages, causing a black area to surround the digit. This greatly enhances the sharpness and visibility of the character. (For illustration purposes, it is assumed that the video information surrounding the digit has an "average" white content.)

A luminance drive pulse is supplied to transistor Q5. It establishes the video output driving current for proper white saturation. If blanking were applied for the full character width to any combination of the R, G, and B blanking stages, along with luminance drive, the character would be produced in color. This is exemplified by the red "0" illustrated in Fig. 6. Of course, blanking applied to all three color blanking stages simultaneously would completely blank the video producing a black screen (muted video). This occurs during half entry or illegitimate channel input, except in those areas where the characters are displayed.

An auxiliary blanking pulse (which is the same as the luminance drive pulse) is applied to an auxiliary blanking emitter follower Q6. This stage cuts off the luminance output stage (Q5, on the MCL video module), preventing station video information from appearing on the screen during character display and provides a blanking pulse to IC2 on the chroma module which prevents station chroma input to the R, G, and B outputs.

Not shown are a series of low-pass, parasitic suppression filters in the outputs of the interfacing stages. These filters, in combination with the shields on both sides of the clock and display module, prevent spurious outputs from the display circuitry from coupling to the tuner RF inputs during character display.

Referring again to Fig. 6, note that the half-entry terminal is coupled to an electronic sync defeat "switch." This switch provides a positive voltage to the base of the PNP sync separator disabling this stage during half-entry and illegitimate channel selection. This defeat is necessary to limit vertical instability of the character display when no valid station sync information is received.

There you have it, a complete rundown on one of the newest remote control systems around. We thought you'd find it as interesting as we did. **R-E**

SERVICE NOTES

TOO MUCH HEIGHT

I have too much height in this Sylvania 19P08 TV. Can't reduce it with the controls. Also, I bought a Sams folder for it, and the tubes don't match the ones in this chassis. I'm confused.—G.S., Plainville, CT.

Welcome to The Club. There are several different chassis in this model. From the tube lineup, you have a 573 chassis; Sams Photofact 723-4. The crystal ball tells me that your height problem could be due to a bad thermistor that feeds the DC voltage to the vertical size control. The Sylvania part number on this is 38-11780-2, and it should read 1.0 megohm cold. There was a modification in this circuit; in some, they use a different thermistor with a 100K resistor in series to protect it against breakdown.

REVERSED GUNS IN PICTURE TUBE!

The last time I wrote you about the reversed blue and green convergence problems, in a Sears 7160, you said that it might be something wrong in the picture tube. I took it back to the rebuilder. He checked, and said that in a 16CYP22, the blue gun should be on the bottom; but in a 16CSP22, the blue gun should be on top. He ran the tube through again, and the convergence problem was solved. Thank you!—L.H., Detroit, MI.

When every possible alternative has been considered, the only one left has to be the right one!

HV REGULATOR; EXCESS CURRENT

This Curtis-Mathes CMC-33 chassis has a high-voltage regulator problem. If I take the 6BK4 plate-cap off, I can get 27kV. Put it back, and it drops to only about 10-11 kV. (Here he gave a list of DC voltages, including 6BK4, grid, +300 V, cathode +300 V.) Boosted boost, +1000 V; B+, +400 V; and all tubes good. There's no high voltage adjustment control on this chassis.—G.M., Whittier, CA.

This is almost one of those "Everything it fine but it won't work!" problems. However, there is a clue. Look at the *bias* voltage on that 6BK4. With +300 volts on both grid and cathode, this tube is at *zero-bias*. This makes it draw far too much cathode current. In this tube, about 1.5 *milliamperes* is "too much!"

This voltage is controlled by a voltage divider from the boost, to the 6BK4 grid through two 1.5-megohm resistors and the high-voltage adjust (which may have been replaced by a fixed resistor here). The cathode should be at the full B+ voltage (400 volts). The only thing in there that could drop this voltage would be the little 1K "metering resistor." See if this hasn't gone up to a high resistance. Also, check those grid resistors at the same time. Normal bias on this tube should be at least a −20 volts, or even more. Normal cathode current should never be more than about 1.0 mA.

MORE ON DUMONT 304 SCOPE

Howard A. Boltz, of the Lockheed Missiles & Space Co., Sunnyvale, CA, writes, "A friend showed me the item in the Feb. 1975 issue of **R-E** regarding the Dumont 304 scope. I had just finished repairing his Dumont 304-H with the same symptoms! However, the cause was different. Blanking capacitor C27, 0.05 μF 200 volts, was *leaky*. This leakage increased as the scope got hotter. The cathode of the CRT became more positive, cutting off the electron beam. If the scope is a Dumont 304-A, look at capacitor C401.

Thank you very much, sir. Note this in your files, Dumont scope owners!

R-E

next month

FEBRUARY 1976

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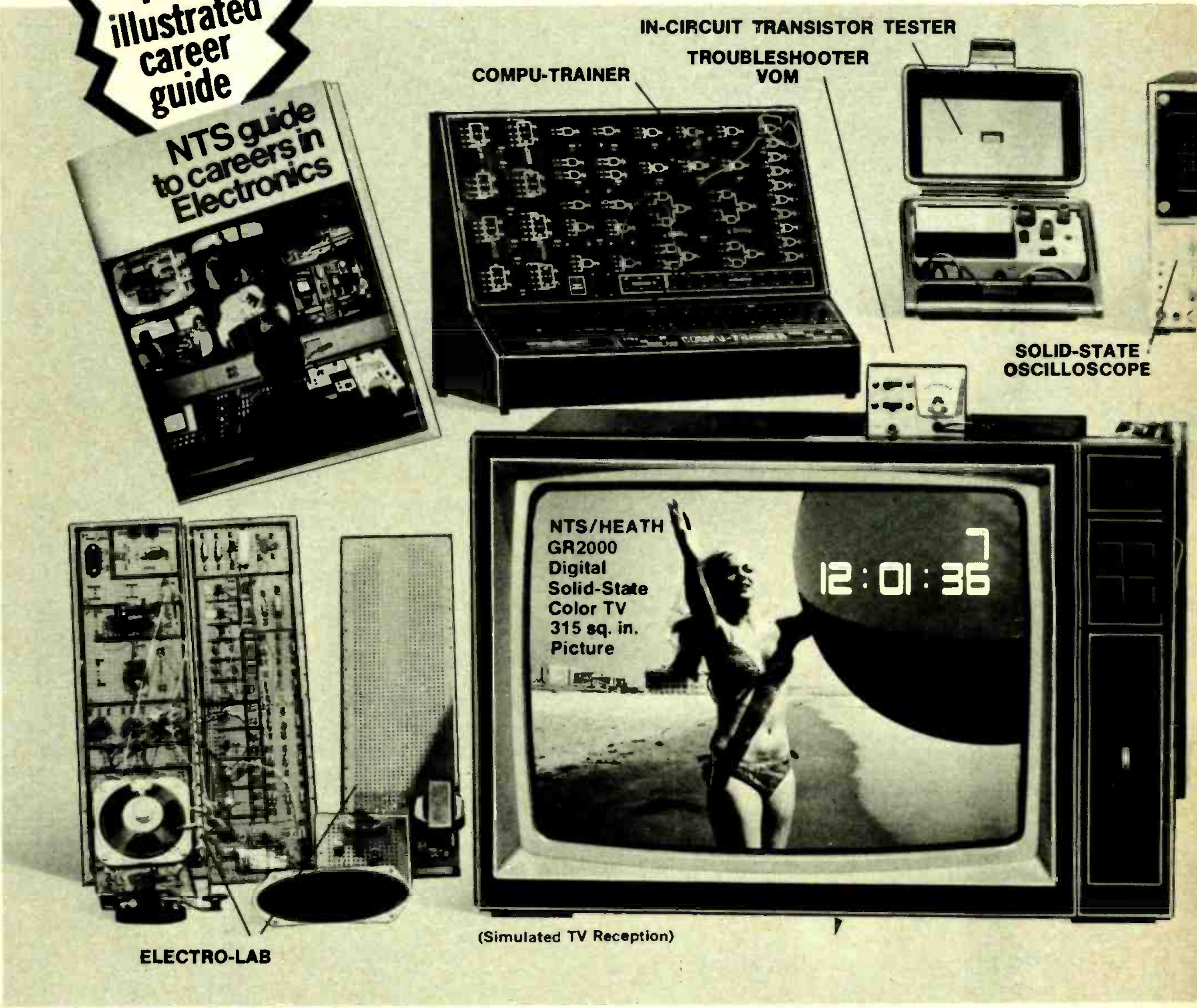

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2SA473	.75	2SB303	.65	2SC478	.80	2SC829	.75		
2SA483	1.95	2SB324	1.00	2SC491	2.50	2SC830	1.60	2SD30	.95
2SA489	.80	2SB337	2.10	2SC497	1.60	2SC839	.85	2SD45	2.00
2SA490	.70	2SB367	1.60	2SC515	.80	2SC945	.65	2SD65	.75
2SA505	.70	2SB370	.65	2SC535	.75	2SC1010	.80	2SD68	.90
2SA564	.50	2SB405	.85	2SC536	.65	2SC1012	.80	2SD72	1.00
2SA628	.65	2SB407	1.65	2SC537	.70	2SC1051	2.50	2SD88	1.50
2SA643	.85	2SB415	.85	2SC563	2.50	2SC1061	1.65	2SD151	2.25
2SA647	2.75	2SB461	1.25	2SC605	1.00	2SC1079	3.75	2SD170	2.00
2SA673	.85	2SB463	1.65	2SC620	.80	2SC1096	1.20	2SD180	2.75
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2SA699A	1.75	2SB481	2.10	2SC644	.70	2SC1170	4.00	2SD313	1.10
2SA705	.55	2SB492	1.25	2SC681	2.50	2SC1172B	4.25	2SD315	.75
2SA815	.85	2SB495	.95	2SC684	2.10	2SC1209	.55	2SD318	.95
2SA816	.85	2SB507	.90	2SC687	2.50	2SC1213	.75	2SD341	.95
		2SB511	.70	2SC696	2.35	2SC1226	1.25	2SD350	3.25
2SB22	.65			2SC712	.70	2SC1243	1.50	2SD352	.80
2SB54	.70	2SC206	1.00	2SC713	.70	2SC1293	.85	2SD380	5.70
2SB56	.70	2SC240	1.10	2SC732	.70	2SC1308	4.75	2SD389	.90
2SB77	.70	2SC261	.65	2SC733	.70	2SC1347	.80	2SD-390	.75
2SB128	2.25	2SC291	.65	2SC739	.70	2SC1383	.75	2SD437	5.50
2SB135	.95	2SC320	2.00	2SC715	1.75	2SC1409	1.25		
2SB152	4.50	2SC352	.75	2SC762	1.90	2SC1410	1.25		
2SB173	.55	2SC353	.75	2SC783	1.00	2SC1447	1.25		
2SB175	.55	2SC371	.70	2SC784	.70	2SC1448	1.25		
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		2N967	.50	2N2221A	.30	2N2916A	3.65	2N3772	1.90	2N4403	.20
2N173	1.75	2N1136	1.35	2N2222	.25	2N3019	.50	2N3773	3.00	2N4409	.20
2N178	.90	2N1142	2.25	2N2222A	.30	2N3053	.30	2N3819	.32	2N4410	.25
2N327A	1.15	2N1302	.25	2N2270	.40	2N3054	.70	2N3823	.70	2N4416	.75
2N334	1.20	2N1305	.30	2N2322	1.00	2N3055	.75	2N3856	.20	2N4441	.85
2N336	.90	2N1377	.75	2N2323	1.00	2N3227	1.00	2N3866	.85	2N4442	.90
2N338A	1.05	2N1420	.20	2N2324	1.35	2N3247	3.40	2N3903	.20	2N4443	1.20
2N398B	.90	2N1483	.95	2N2325	2.00	2N3250	.50	2N3904	.20	2N4852	.55
2N404	.30	2N1540	.90	2N2326	2.85	2N3375	6.50	2N3905	.20	2N5061	.30
2N443	1.75	2N1543	2.70	2N2327	3.80	2N3393	.20	2N3906	.25	2N5064	.50
2N456	1.10	2N1544	.80	2N2328	4.20	2N3394	.17	2N3925	3.75	2N5130	.20
2N501A	3.00	2N1549	1.25	2N2329	4.75	2N3414	.17	2N3954	3.50	2N5133	.15
2N508A	.45	2N1551	2.50	2N2368	.25	2N3415	.18	2N3954A	3.75	2N5138	.15
2N555	.45	2N1552	3.25	2N2369	.25	2N3416	.19	2N3955	2.45	2N5198	3.75
2N652A	.85	2N1554	1.25	2N2484	.32	2N3417	.20	2N3957	1.25	2N5294	.50
2N677C	6.00	2N1557	1.15	2N2712	.18	2N3442	1.85	2N3958	1.20	2N5296	.50
2N706	.25	2N1560	2.80	2N2894	.40	2N3553	1.50	2N4037	.60	2N5306	.20
2N706B	.40	2N1605	.35	2N2903	3.30	2N3563	.20	2N4093	.85	2N5354	.20
2N711	.50	2N1613	.30	2N2904	.25	2N3565	.20	2N4124	.20	2N5369	.20
2N711B	.60	2N1711	.30	2N2904A	.30	2N3638	.20	2N4126	.20	2N5400	.40
2N718	.25	2N1907	4.10	2N2905	.25	2N3642	.20	2N4141	.20	2N5401	.50
2N718A	.30	2N2060	1.85	2N2905A	.30	2N3643	.15	2N4142	.20	2N5457	.35
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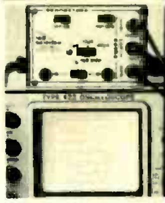

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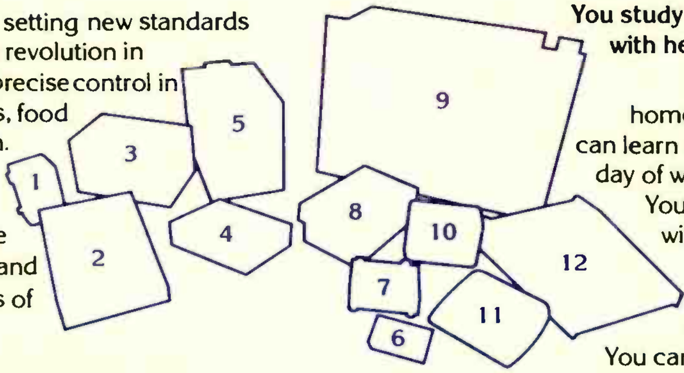

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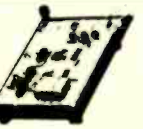

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PC-16, 16-pin Proto Clip, $4.75 ea.
PC-24, 24-pin Proto Clips, $8.50 ea.

CALCULATOR CHIPS AND DRIVERS

MM5725	8 DIGIT 4 FUNCTION	$1.98
DM75491	SEGMENT DRIVER	.79
MM5736	6 DIGIT 4 FUNCTION	1.95
DM75492	DRIVER FOR 5736	.89
MM5738	8 DIGIT 5 FUNCTION	2.95
DM8864	DRIVER TYPE 1	2.00
DM8865	DRIVER TYPE 2	1.00

CLOCK CHIPS

MM5311	6 DIGIT W/BCD	$4.95
MM5312	4 DIGIT W/BCD	4.95
MM5313	6 DIGIT W/BCD	4.95
MM5314	6 DIGIT CLOCK	3.95
MM5316	ALARM CLOCK	4.95
CT7001	CAL/CLOCK CHIP	5.95

DIGITAL WATCH READOUT

FOR USE WITH WATCHES, DVMS, COUNTERS, ETC. $1.95

HP-5082-7300

HP 5082-7300
.3" Dot Matrix type numeric readouts with decoder/driver/latch built on the chip. Only 8 bins (BCD in, DP Latch, +5v, ground).
HP 5082 7300 $5.95

HP 5082 7304
+1 version of 7300 4.95

1¼" x 1½" XFMERS P.C. Mount

That were designed for clock type applications. 110 Vac primary @ 60 Hz.
Secondaries: 8-10 Vac @ 300 mA-200 mA
50 Vac @ 30 mA-50 mA
Excellent for miniature power supplies & gas discharge displays

SPECIAL $.99

1/16 VECTOR BOARD

0.1" Hole Spacing P-Pattern

	Part No.	Length	Width	Price 1-19	Price 20-49
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 02XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44 062	4.50	6.50	2.07	1.86
	84P44 062	4.50	8.50	2.56	2.31
	169P44 062	4.50	17.00	5.04	4.53
	169P84 062	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062C1	4.50	17.00	6.80	6.12

VECTOR WRITING PENCIL

Vector Wiring Pencil P173 consists of a hand held featherweight (under one ounce) tool which is used to guide and wrap insulated wire, fed off a self-contained replaceable bobbin, onto component leads or terminals installed on pre-punched "P" Pattern Vectorbord®. Connections between the wrapped wire and component leads, pads or terminals are made by soldering. Complete with 250 FT of red wire. $9.50 ea.

REPLACEMENT WIRE — BOBBINS FOR WIRING PENCIL

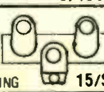
W36-3-A-Pkg. 3	(Green)	$2.40
W36-3-B-Pkg. 3	(Red)	$2.40
W36-3-C-Pkg. 3	(Clear)	$2.40
W36-3-D-Pkg. 3	(Blue)	$2.40

9V BATTERY CLIP

STANDARD CLIP FOR USE WITH 9V TRANSISTOR BATTERIES WITH 4" LEADS 9/.95

TERMINAL STRIPS

THREE TERMINAL STRIPS, WITH CENTER TERMINAL USED FOR MOUNTING 15/$1.00



AMP TERMINAL PINS

TERMINAL PINS FOR MOUNTING COMPONENTS ALSO PERFECT FOR USE WITH BOARD CONNECTORS AND SUBASSEMBLIES $1.00/100 PCS.

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JAMES ELECTRONICS IS PROUD TO ANNOUCE, FOR THE FIRST TIME EVER, TO THE ELECTRONIC HOBBIEST . . FROM AMERICAN MICRO DEVICES.

8080A $39.95

8080 AND 8008 SUPPORT COMPONENTS

8224 CLOCK GENERATOR USED TO GENERATE TWO PHASE CLOCK NEEDED BY THE 8080 $12.95

8228 SYSTEM CONTROLLER GENERATES A SYSTEM DATA BUS AND CONTROL SIGNALS FOR MEMORY $21.25

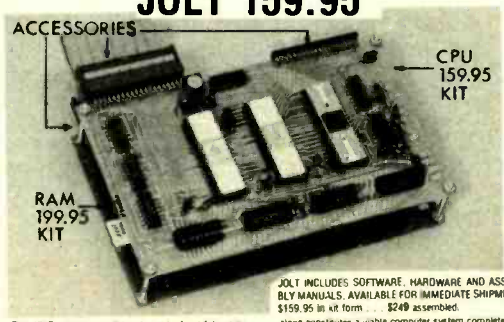
74LS138 DECODER PERFECT FOR DECODING THE THREE 8008 STATE LINES INTO 8 USEABLE LINES FOR ADDRESS LATCHING $3.95

8212 8 BIT INPUT OUTPUT PORT DIRECTLY INTERFACES WITH THE 8080 TO PROVIDE I/O INTERFACE $3.75

CPU'S		
8008	8 BIT CPU	$19.95
8080	SUPER 8008	39.95
4040	4 BIT 8080	39.95
SR'S		
2504	1024 DYNAMIC	$9.00
2518	HEX 32 BIT	7.00
2519	HEX 40 BIT	4.00
2524	512 DYNAMIC	3.50
2525	1024 DYNAMIC	6.00
2527	DUAL 256 BIT	3.95
2529	DUAL 512 BIT	4.00
2532	QUAD 80 BIT	3.95
2533	1024 STATIC	7.95
3341	FIFO	6.95
74LS670	16X4 REG.	3.95
UART'S		
AY-5-1013	20K BAUD	$6.95
ROM'S		
2513	CHAR. GEN.	11.00
7488	RANDOM BITS	3.50

RAM'S			
1101	256X1	STATIC	$2.25
1103	1024X1	DYNAMIC	6.95
2101	256X1	STATIC	6.95
2102	1024X1	STATIC	2.95
2107	4096X1	DYNAMIC	19.95
2111	256X4	STATIC	7.95
7010	1024X1	MNOS	29.95
7489	16X4	STATIC	2.49
8101	256X4	STATIC	7.95
8111	256X4	STATIC	7.95
8599	16X4	STATIC	3.49
91L02	1024X1	STATIC	2.95
74200	1024X1	STATIC	6.95
93410	256X1	STATIC	1.75
5262	2048X1	DYNAMIC	2.95
PROMS			
1702A	2048	FAMOS	15.95
5203	2048	FAMOS	14.95
8223	32X8	BIPOLAR	3.00
74S287	1024	STATIC	7.95

JOLT 159.95



The JOLT system consists of a set of modular microcomputer boards which can be used singly or tied together to produce any desired microcomputer system configuration. The minimum system is one CPU board, which alone constitutes a viable computer system complete with central processor, I/O, interrupts, timer, read write memory, and a complete software debug monitor in read only memory.

JOLT INCLUDES SOFTWARE, HARDWARE AND ASSEMBLY MANUALS. AVAILABLE FOR IMMEDIATE SHIPMENT. $159.95 in kit form . . . $249 assembled.

JOLT SYSTEM DESCRIPTION

JOLT RAM Card — Fully static 4,096 bytes of RAM with 1 microsecond access time and on-board decoding. Hardware and assembly manuals included. AVAILABLE FOR IMMEDIATE SHIPMENT. $199.95 kit . . . $285 assembled.

JOLT Power Supply — Operates at +5, +12 and −10 voltages. Supports JOLT CPU, 4k bytes of RAM and JOLT I/O card — or, CPU and 8 I/O cards. Manuals included. AVAILABLE FOR IMMEDIATE SHIPMENT. $99.95 kit. $145 assembled.

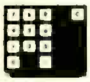
JOLT Accessory Bag — Contains enough hardware to connect one JOLT card to another. Such necessary items as flat cable, connectors, card spaces, hardware, etc. AVAILABLE FOR IMMEDIATE SHIPMENT. $39.95.

JOLT I/O Card (Peripheral Interface Adapter) — 2 PIA LSI chips, 32 I/O lines, four interrupt lines, on-board decoding and standard TTL drive. Fully programmable. Manuals included. AVAILABLE FOR IMMEDIATE SHIPMENT. $95.50 kit . . . $140 assembled.

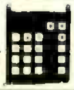
JOLT Universal Card — Same size (4¼" x 7"), same form factor as other JOLT cards. Completely blank, drilled to accept 14, 16, 24 or 40 pin sockets. Used for additional user memory or I/O control panels, TV interfaces, keyboards, LEDs, or other interface logic. AVAILABLE FOR IMMEDIATE SHIPMENT. $24.95

JOLT +5V Booster Option — Fits onto JOLT Power Supply card. Supports CPU, 16k bytes of RAM — or, CPU and 8k bytes RAM and 8 I/O cards — or, CPU and 4k bytes RAM and 16 I/O cards. Manuals included. AVAILABLE FOR IMMEDIATE SHIPMENT. $24.95

MULTIPURPOSE KEYBOARDS



MULTIPURPOSE KEYBOARDS
20 Keys — Touch Tone
No schematic needed. Calculator use or re-arrange (pop off) key tops. For touch tone or any control application. This unit may be cut apart for smaller units. $2.95



This unit was originally intended for calculator type applications but can be applied to a variety of other types of units such as microcomputer interface, digital channel controlling, digital input to a frequency synthesizer, and even touch tone applications. The unit is composed of 18 very low bounce keys of the SPST type and one SPST slide switch. Numbers are white. Clear and Decimal are blue and all other keys are orange on a black background. $2.49

WIRE WRAP WIRE

AWG	COLOR	25 FT. MIN.	50 FT.	100 FT.	1000 FT.
30 AWG	WHITE	$2.10	$2.75	$3.50	$24.00
30 AWG	YELLOW	2.10	2.75	3.50	24.00
30 AWG	RED	2.10	2.75	3.50	24.00
30 AWG	GREEN	2.10	2.75	3.50	24.00
30 AWG	BLUE	2.10	2.75	3.50	24.00
30 AWG	BLACK	2.10	2.75	3.50	24.00

STANDARD WIRE

AWG	COLOR	25 FT MIN	50 FT	AWG	COLOR	25 FT MIN	50 FT
16	RED	$3.80	$5.05	24	RED	$1.55	$2.05
18	GREEN	$3.25	$4.30	26	GREEN	$1.45	$1.90
20	WHITE	$7.55	$3.40	28	WHITE	$1.25	$1.65
22	BLACK	$1.90	$2.55	30	BLACK	$1.25	$1.65

TO ORDER: SPECIFY GUAGE COLOR AND FOOTAGE (25 FOOT MINIMUM)

6' 2 CONDUCTOR POWER CORDS 125V @ 5A 3/1$

THREE CONDUCTOR POWER SUPPLY CORDS

NUMBER	LENGTH	AWG	O.D.	RATING	COLOR	PRICE
17236	6	18(41X34)	.265	1250W 10A-125V	BLACK	Special .99 ea.
17237	6	18(41X35)	.253	1250W 10A-125V	GREY	1.25
17238	6	18(41X34)	.265	1250W 10A-125V	BLACK	Special .99 ea.
17239	8	18(41X34)	.253	1250W 10A-125V	GREY	1.30
17000	4	18(41X34)	.253	1250W 10A-125V	BLACK	.59

Satisfaction Guaranteed. $5.00 Min. Order. U.S. Funds.
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JE SERIES KITS

JE801 DVM

The JE801 is a three and one half digit, auto polarity digital voltmeter, in a kit form. It features several options not available in any commercial digital voltmeter. Its low cost is perhaps the most important feature, which is achieved by offering it in a kit form. A kit allows the unit to be used by small OEM's where cost effectiveness is an important factor, and by the hobbyist who has to be concerned with cost. The unit also features on card regulators, allowing it to be operated off a single plus and minus fifteen volt, unregulated power supply. The unit has a small size of three inches width, three and three quarters of an inch length, and one and a quarter inch height.

$39.95 Per Kit printed circuit board

JE803 PROBE

The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families: TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test, drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols: (HI) 1 (LOW) 0 (PULSE) P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.

$9.95 Per Kit

printed circuit board

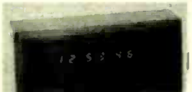
JE804, JE805 SUPPLIES

THE JE804 AND JE805 ARE POWER SUPPLIES MOUNTED ON A 1¾ x 3" PC BOARD. THEY ARE AVAILABLE IN ±5 @ 300 mA, ±6 @ 250 mA, ±12 @ 100 mA. SPECIFY VOLTAGE WHEN ORDERING.

JE804 IS A POSITIVE SUPPLY
JE805 IS A NEGATIVE SUPPLY

$9.95 per kit

JE700 CLOCK



The JE700 is a low cost digital clock, but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6" x 2½" x 1". It utilizes a MAN72 high brightness readout, and the MM5314 clock chip. $19.95

12 or 24 Hour
115 VAC—
$19.95 per kit.

WALL OR TV DIGITAL CLOCK

12 or 24 Hour 115 Vac
25' VIEWING DISTANCE

6 Digit
LED DISPLAY
(4) DL747 (2) MAN 7

WALNUT CASE
6" x 3" x 1"

KIT-All Comp. & Case $34.95
Wired & Assembled $39.95

JE010 CALC.

- 5 Functions
- 8 digit — business logic
- Floating decimal or fixed two-place add mode output (selectable)
- Automatic markup/discount on percentage calculation
- Automatic constant calculations
- General calculations
- Chain calculations
- Repeat operations
- True credit balance
- Addressable Memory

$12.95

OPTIONS:
115 VAC Transformer $4.95 each
6 each "N" Alkaline Batterys $2.50 lot

ELECTRONIC ROULETTE

Complete kit with all components case and transformer.

115 VAC

8" x 8" x 1"

A 56 page book on the facts of Roulette included. **$29.95 Per Kit**

ELECTRONIC CRAPS

Complete kit with all components case and transformer.

6½" x 3½" x 1"

115 VAC

A 56 page book on the facts of Craps included. **$19.95 Per Kit**

Circle 96 on reader service card

POTTER BRUMFIELD

Type KHP Relay
4 PDT 3A Contacts

24 VDC (650 coil) $1.50 Ea.
120 VAC (10.5 MA coil) $1.75 Ea.

RCA 2010

Numitron Digital Display Tube
Incandescent 5-volt 7-segment with .6" high numeral visible from 30 ft., standard 9-pin base (solderable), and left hand decimal point.
EACH $5.00 5 FOR $20.00

CMOS

CD4000	$ .29	CD4016	$ .69
CD4001	.29	CD4019	.69
CD4002	.29	CD4023	.29
CD4008	1.98	CD4024	1.50
CD4009	.59	CD4025	.34
CD4010	.59	CD4030	.65
CD4011	.29	74C20	.65
CD4012	.29	74C42	2.00
CD4013	.69	74C157	2.50
CD4015	1.98	74C195	2.00

Numeric Display

¼" Single Digit
GaAsP LED

SUPER SPECIAL $.59
TEN for $4.95

ACTUAL SIZE

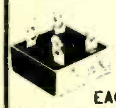
COMMON CATHODE WITH RH DECIMAL

Compact - 10 digits in 3" panel width
Highly legible - bright red ¼" character easily read within 10 feet over a wide viewing angle (140°)
Low power - 125 mw per digit at typical brightness

2102-2 MOS 1024 BIT MEMORY (DIP)

FULLY DECODED STATIC RANDOM ACCESS MEMORY
DIRECTLY TTL COMPATIBLE INPUTS AND OUTPUT
SINGLE 5V SUPPLY - - NO CLOCKS OR REFRESH
$4.00 EA. 8 FOR $27.95

NEW!



FULL WAVE BRIDGE RECTIFIERS
25 AMP 500 PIV
EACH $2.00 10 FOR $16.50

CD-2 COUNTER KIT

Unit includes board, 7490, 7475, quad latch, 7447 seven-segment driver, and RCA DR2010.

COMPLETE KIT $10.95
FULLY ASSEMBLED $15.00
Boards can be supplied separately at $2.50 per digit.

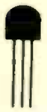
NPN TO3 POWER TRANSISTORS

410 (RCA) 200V - 10A
2N3772 70V - 30A (max.)
Each $1.75 10 for $15.00

2N3055: PD-115W: VCE-60V; HFE-50: FT-30K.
Each $ .90 10 for $6.95

TRANSISTOR

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



25K Trimmer

PRINTED CIRCUIT BOARD TYPE
EACH $ .20 10 FOR $1.50

TTL

7400	$ .20	7453	$ .15
74H00	.25	7454	.20
7401	.30	74L54	.25
74H01	.25	74L55	.25
7402	.25	7460	.16
7403	.25	74L71	.25
7404	.25	7472	.40
74H04	.30	74L72	.60
7405	.30	7473	.25
7406	.40	74L73	.75
7408	.30	7474	.45
7410	.15	74H74	.75
7413	.75	7475	.80
7417	.40	7476	.55
7420	.20	74L78	.70
74L20	.30	7480	.50
74H20	.30	7483	.70
74H22	.30	7489	3.00
7430	.15	7490	1.00
74H30	.30	7492	.45
74L30	.30	7493	1.00
7440	.20	7495	.65
74H40	.30	74L95	1.00
7442	1.00	74107	.25
7447	1.50	74145	1.25
7450	.15	74180	1.00
74H50	.30	74193	1.50
7451	.20	74195	.65
74H51	.25		

Specials

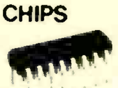
DIP TRIMMER

-12 turn trimpots which plug into a DIP socket
-5K and 200K
-¼" x ¼" x ⅛"
-4 leads spaced .3" x .2"

Each $.65 10 for $4.95

MEMORY CHIPS

8223 PROM
8 BIT-32 WORD MEMORY



$3.00 EACH 10 FOR $29.00
WE PROGRAM FOR $5.00 EACH

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1024 BIT-256/4
FIELD PROGRAMMABLE
{WE WILL NOT PROGRAM}
EACH $5.00 8 FOR $34.95

1702 PROM
2K - ULTRA VIOLET LIGHT ERASABLE STATIC UNITS
ONLY $9.95

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Circle 97 on reader service card

INTRODUCING VDM-1

Video Display Module

The VDM-1 is an ultra high-speed intelligent display on a single printed circuit card. The new card generates 16, 64 character lines of Alpha-numeric data in upper and lower case characters from a 1K Byte memory.

The VDM-1 configuration allows you to build a power terminal, with a standard video output into your Altair Processor.

Price: $160.00

SPECIAL FREE OFFER!

Scientific Notation Software Package with Formatted Output

With the purchase of (1) VDM-1 and (1) 4KRA Memory:
Just $299.00 (Offer expires 2-1-76)

The floating point math package features 12 decimal digits with exponents from +127 to —127; handles assigned and unassigned numbers. With it is a 5 function calculator package; + — X ÷ & sq. root. It includes 3 storage and 3 operating memories and will handle chain and column calculations.

Write for more details on these and other 8800 plug in compatible modules.

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Berkeley, Ca. 94710

Circle 98 on reader service card

For faster service

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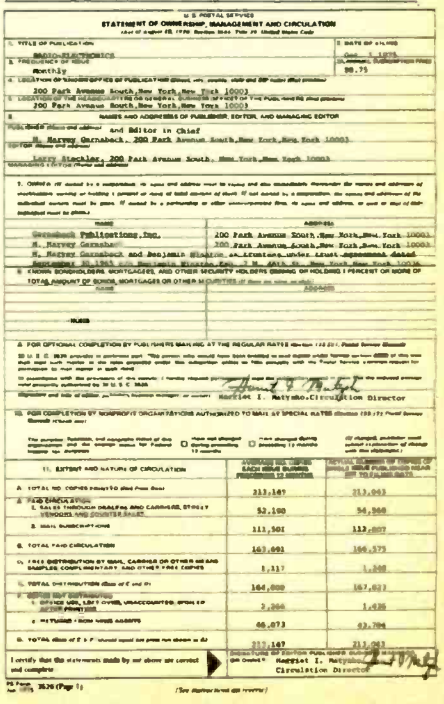
WANTED

QUICK cash . . . for electronic equipment, components, unused tubes. Send list now! **BARRY,** 512 Broadway, New York, NY 10012, 212 Walker 5-7000



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Harriet I. Matysko, Circulation Director

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A. TOTAL NO. COPIES PRINTED (Net Press Run)	213,147	213,063
B. PAID CIRCULATION 1. SALES THROUGH DEALERS AND CARRIERS, STREET VENDORS AND COUNTER SALES	52,100	54,960
2. MAIL SUBSCRIPTIONS	111,501	113,607
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G. TOTAL (Sum of E & F—should equal net press run shown in A)	213,147	213,063

I certify that the statements made by me above are correct and complete. Harriet I. Matysko, Circulation Director

PS Form 3526 (Page 1)

5% OFF ON ORDERS OVER $50.00
10% OFF ON ORDERS OVER $100.00
15% OFF ON ORDERS OVER $250.00

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DIGITAL

7447	BCD to 7 seg. decoder drvr.	$ .69
7483	4 bit binary full adder	.59
7490	Decade counter	.45
74151	8 channel multiplexer	.59
74153	Dual 4 input multiplexer	.79
74180	Parity generator checker	.79
74193	Binary up/down counter	.99
9602	Dual one shot .69	
75C00	Quad 2 input NAND gate (CMOS)	.12

LINEAR

301	Hi perf op amp	mDIP	.25
339	Quad comparator	DIP	1.29
320T	5V neg. V reg.	5V	1.39
320T	12V neg. V reg.	12V	1.39
340T	12V neg. V reg.	5V	1.39
340T	15V pos. V reg.	15V	1.39

MEMORIES

2102	$2.65
2102-1	2.75
2102-2	2.75
82S23	3.25
F93410	
256 bit RAM	2.19

CLOCK CHIPS

5311	$3.95
5312	2.95
5314	3.95
5316	4.15

CALCULATOR CHIPS

5005	$1.69

8038 FUNCTION GENERATOR

Voltage controlled oscillator — sine, square, triangular output. 16 pin DIP with data **$3.95**

7001 CLOCK CHIP

4-6 digit, 12-24 hr. alarm, timer and date circuits — with data **$6.95**

DVM CHIP 4½ DIGIT

MM5330 — P channel device provides all logic for 4½ digit volt meter. 16 pin DIP with data **$14.95**

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	75L90	$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

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9301	1.03	9312	.79	9602	.79

CMOS

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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		

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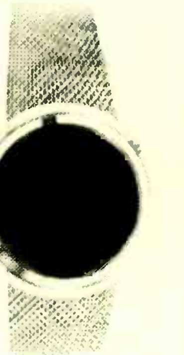

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301	Hi Perf Op Amp mDIP TO-5	.29
302	Volt follower TO-5	.53
304	Neg V Reg TO-5	.80
305	Pos V Reg TO-5	.71
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308	Mciro Pwr Op Amp mDIP TO-5	.89
309K	5V 1A regulator TO-3	1.35
310	V Follower Op Amp mDIP	1.07
311	Hi perf V Comp mDIP TO-5	.95
319	Hi Speed Dual Comp DIP	1.13
320	Neg Reg 5.2, 12, 15 TO-3	1.19
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
373	AM/FM/SSB Strip DIP	.53
376	Pos V Reg mDIP	2.42
377	2w Stereo amp DIP	1.16
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	2.48
562	Phase Locked Loop DIP	2.48
565	Phase Locked Loop DIP TO-5	2.38
566	Function Gen mDIP TO-5	2.25
567	Tone Decoder mDIP	2.66
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
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
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1307	FM Mulpx Stereo Demod DIP	.74
1458	Dual Comp Op Amp mDIP	.62
1800	Stereo multiplexer DIP	2.48
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8038	Voltage contr. osc. DIP	4.25
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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

LED's

MV108	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
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MAN4	Red 7 seg. .190"	1.95
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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

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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
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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

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MM5013	1024 bit accum. dynamic mDIP	$1.75
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SLS-4025	QUAD 25 bit	1.29

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932	.15	944	.15	962	.15
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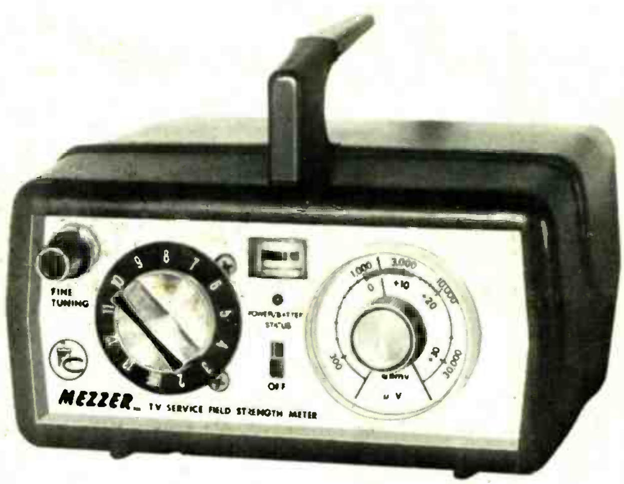

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