Radio-Electronics

60¢ ■ FEB. 1974

FOR MEN WITH IDEAS IN ELECTRONICS

The Problems & The Promise Of DISCRETE CD-4 RECORDS

EXCLUSIVE TO R-E
Heathkit Builds A New Kind Of Color TV Kit

Tips For Experimenters IC's FOR ELECTRONIC MUSIC

Inductors Without Coils ALL ABOUT IC GYRATORS

IC Memories Are Fun WHAT IS A ROM?

PLUS

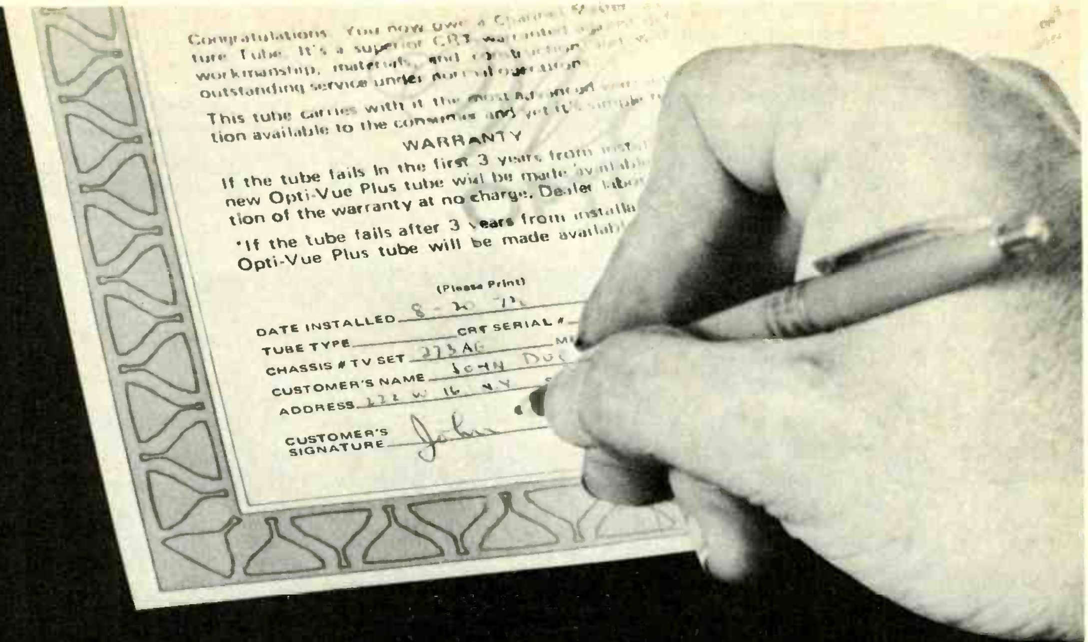
Appliance Clinic

Ja

R- uide

St oubleshooting

A GERNSBACK PUBLICATION



How to sign your customers up for life!

A lifetime of brighter, sharper color reception with the new Channel Master Opti-Vue Plus lifetime warranty CRT!

Opti-Vue Plus is the winner of a lifetime, because its warranted security makes it easier for you to step your customers up to a higher profit tube---then brings them back to you for all their other service needs---and for their new TV sets.

Opti-Vue Plus is the opportunity of a lifetime that the competition can't match, because its dynamic warranty provides: Free replacement for the first three years, and replacement at a guaranteed discount anytime thereafter for as long as the customer keeps his set. Labor not included.

Opti-Vue Plus is the most dramatic news in CRT's since the three year warranty. It's guaranteed to profit you---and your customers---for life!

CHANNEL MASTER

OPTI-VUE PLUS

WITH LIFETIME WARRANTY PROTECTION

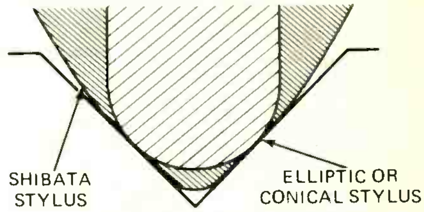
Circle 2 on reader service card

Radio-Electronics

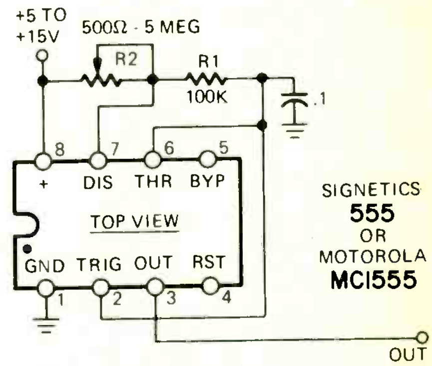
FOR MEN WITH IDEAS IN ELECTRONICS

More than 65 years of electronics publishing

FEBRUARY 1974



COMPARISON OF ELIPTICAL stylus to special Shibata stylus used to play CD-4 records.
. . . see page 42



RECTANGULAR WAVE GENERATOR made from a single IC. is one way to create electronic music.
. . . see page 48A

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looking ahead

Globalelectronics

Singapore—Once upon a time, you could tell where an electronic product was made by the tradename it bore. An American-brand item was made in the U.S. and a Japanese one was made in Japan. Today, an American stereo may have been made in Taiwan or Hong Kong and a Japanese TV set might have been born in the good old U.S.A.

American producers first moved plants to overseas havens to compete with the low wages paid by Japanese manufacturers. With the rapid rise in the Japanese economy, its inflation and revaluations, Japanese manufacturers have increasingly relocated plant facilities outside of Japan, some of them—such as Panasonic, Sony and Hitachi—building factories in the United States to compete with American manufacturers who were producing in Taiwan to compete with Japanese manufacturers.

No matter how roundabout it may seem, electronics manufacturers have now gone almost completely global. Japanese, American and European makers now have plants concentrated in Taiwan, Hong Kong, Singapore, Malaysia, South Korea and the Philippines as well as in their own home bases. Here on this small island of Singapore, for example, General Electric is making radios for the U.S. market as well as circuit modules for its color and monochrome TV sets. Dutch Philips is manufacturing radios, televisions and cassette recorders here for the world market. Hewlett-Packard is turning out its sophisticated pocket scientific and business calculators. Texas Instruments, Fairchild and National Semiconductor are making IC's and other semiconductors, Just to the north, in Malaysia, many Japanese manufacturers are making components. In Taiwan, Admiral, Motorola, Philco, RCA and Zenith have consumer electronics plants, as well as such major Japanese names as Toshiba and Hitachi.

In radio, brand names tend to get all mixed up. Sylvania has quit the radio business, right? In the U.S., that's true. But Sylvania Far East Ltd. in Hong Kong is stamping out radios as fast as it can—and they're labeled with such names as RCA, Zenith, Soundesign, Lloyd, Juliette, Realtone and Lafayette.

Black-and-white TV no longer comes mostly from the U.S. and Japan. In the third quarter of 1973, about 73½% of all monochrome sets sold in the U.S. were imports, although most of them bore American brandnames. And the majority of those with Japanese names came from countries other than Japan. Even in Japan, Japanese sets have been priced out of the market, and—like Mr. Jones in America—Mr. Suzuki in Japan is somewhat shocked to discover that his new monochrome set is marked "made in Taiwan."

Uniform audio standards

Expected momentarily is a government rule prescribing standards for audio power claims in advertising, which should—theoretically, at least—make it simple for a prospective purchaser to compare different brands and models. Subject to minor modifications, the Federal Trade Commission's new standards (which will apply whenever an ad makes claims for power output, frequency response, distortion or other power amplification qualities) will require advertisers to give the following information: (1) The rated minimum sine-wave continuous rms power output in watts per channel. (2) Load impedence, in ohms, for which the equipment is designed. (3) The rated frequency response. (4) The rated percentage of maximum total harmonic distortion at any power level from one fourth of a watt to the full rated power output.

Just to make certain that all manufacturers are speaking the same technical language, the FTC is expected to prescribe these test conditions: (1) Power-line voltage of 117 ac (rms), using a sinusoidal wave with less than 2% harmonic content, at 60-Hz frequency. (2) The amplifier is to be preconditioned by operating all channels simultaneously at one-third of the rated power output for one hour using a 1,000-Hz. sinusoidal wave. (3) All precoditioning and testing is to be conducted in still air at 77° F. (4) Input signals are to be applied continually at the auxiliary or phono input for at least five minutes at all frequencies within the rated power band.

In anticipation of the government ruling, many stereo equipment manufacturers during the last year have changed their claims to conform with these requirements. Thus the amplifier "horsepower race" has been considerably toned down; a four-channel amplifier which once could be described as having 250 watts "peak music power" (whatever that is) might now be reduced to something like 35 watts RMS per channel.

'Poor man's satellite'

That's what Westinghouse calls its novel new long-distance TV-communications system, now being tested over Freeport, Bahamas. Project is still hush-hush, but it's learned that transmissions are dispersed from a helium-filled baloon 10,000 to 15,000 feet above ground, secured to earth by a ⅝-inch line. The system, known as "Tethered Communications" (TCOM for short) uses gyro-stabilized directional antennas, picking up signals from Florida television stations and rebroadcasting them to the Bahamas. The system can receive TV signals from a distance of about 150 miles, covering a 125-mile radius with its rebroadcasts. The balloon is said to be able to lift a 3,500-pound load, withstand winds of higher than 100 miles an hour. In the current experiment, power is supplied by a gasoline generator at the balloon, with a spare balloon standing by for use while the other is being refueled. Future experiments will involve power sent from the ground via an ac line.

The system is designed principally for developing countries and the first order has been placed by the government of South Korea.

Cable TV's growth

One out of every eight American TV-equipped homes now receives its programming by cable, according to the annual CATV census made by the authoritative Television Factbook. As of midyear 1973, some 7,800,000 U.S. homes were tied in with 3,032 cable systems, an increase of 1,300,000 cable subscribers since Jan. 1, 1972. The average cable system has 2,723 subscribers, but the nation's largest system—in San Diego— connects more than 75,000 homes. Some 768 systems originate their own live, film or taped programming, in addition to relaying programs off-the-air. Another 1,000 carry "automatic originations"—news ticker readout, time, weather, stock market quotations, etc. Ten years ago there were 1,000 systems serving fewer than a million families.

Noble experiment

With the introduction of RCA's 1975 TV line, it will end a 3½-year-old program which permitted owners to take their sets to any technician for warranty repairs. In the future, the company will pay for service only by authorized RCA "Purchaser Satisfaction Centers." Reason given: To protect customers from being victimized by "some firms whose competence is questionable."

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

a cost breakthrough in distribution amplifier design!

Winegard's engineers have done themselves proud with this one — an amplifier that does the job at ⅔ the cost of competition* — and more importantly, without sacrificing all these important features:

HIGH OUTPUT LEVEL: 46 dbmv (200,000 microvolts) on each of 7 VHF channels at 0.5% cross modulation; 45 dbmv (178,000 microvolts) on each of 5 UHF channels at 0.5% cross modulation . . . enough to handle up to 48 taps without additional line amps.

HIGH INPUT LEVEL: Allows use in strong signal areas. 20 dbmv (10,000 uv) on each of 8 VHF channels, 22 dbmv (12,000 uv) on each of 5 UHF channels, both at 0.5% cross modulation.

HIGH GAIN: 26 db on VHF, 23 db on UHF for use in most reception areas.

LOW NOISE FIGURE: 3.6 db VHF, 6.0 db UHF for perfect color fidelity.

PASSES MID & SUPER BANDS (108-174 & 216-300 MHZ) — compatible with any CATV system.

LINE AMPLIFIER VOLTAGE to operate model L-213B or L-483B line amplifiers.

PLUS BUILT-IN FM TRAP, REGULATED POWER SUPPLY, LIGHTNING PROTECTION and more!

*Ask your distributor for full specs and prices, or write direct.

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Circle 4 on reader service card

new & timely

The cassette—10 years old

Philips celebrated the tenth birthday of the cassette tape recorder and player in late 1973, ten years after the first machine—the EL 3300—was introduced at the Berlin Radio Fair.

Just another tape machine at the time—albeit probably the smallest one to that date—the cassette has now become the standard. Recordings made on it can be sent anywhere with the assurance that the recipient will probably have a device to play them back on—something that was by no means the case ten years ago.

Why did the cassette take over? It was not the first machine—cartridge recorders dated back to the days of wire—and (let's face it) quality was not startlingly high compared to reel-to-reel machines of that time. Part of the reason was the compactness, convenience, and the

rapidly increasing audio quality over the first year or two. The other part was the decision by Philips not to license the machine, but to give the idea away to anyone who would agree to manufacture recorder-players that would meet the standards set up by Philips. Thus the research and engineering achievements of the developer were put at the disposal of all manufacturers, and a decisive step toward standardization was made.

New research and new techniques have kept the cassette in the forefront of progress during the decade. Dynamic noise limiters make it more useful for recording in circumstances where incoming sound cannot be controlled; new types of tape have made high-fidelity recording possible. Pre-recorded tapes—*Musicassettes*

—have appeared in a wide range of subjects and languages, and there is even —in Switzerland—an audio-visual magazine with the pictures printed on paper and the words on cassette.

REACT approves 224-225 MHz CB—wants emergency channel in band

Replying to an FCC request for comments, REACT, a voluntary organization of Citizens Band Operators for Emergency Communication, "heartily favors the allocation of additional spectrum for the purpose for which the Citizens Band was established originally," and therefore "favors the assignment of 224 to 225 MHz for 40 additional channels for a new Citizens Radio Service," a proposal which was the subject of an FCC hearing.

REACT is an organization of some 40,000 Citizens Banders divided into 800 teams throughout the country. They maintain a watch (an ear) on channel 9 of the Citizens Band, respond to emergency calls, provide two-way communications in local emergencies, and often offer direct physical assistance and take part in action to alleviate or avert effects of emergencies.

The communication to the FCC was the result of a mail canvass of the organization's 800 teams. A number of questions were asked, and among those replying, 93 per cent felt that a new additional emergency channel, similar to the present channel 9, be set aside for emergency communication on the proposed new band. More than 60% of the responding members favor automatic transmitter identification as an aid in enforcing proper on-the-air conduct and as a deterrent to illegal operation. As a further deterrent, REACT members favored licensing at point of sale. They also favor FM for the proposed new band, and use of repeater stations.

Signed by Henry B. Kreer, national director, and Gerald H. Reese, managing director of REACT, the comments conclude: "We view the allocation of this new Class E service as a progressive and justifiable recognition by the Commission of the right of individuals to utilize the radio spectrum, a natural resource, for individual, personal, and business communications."

Cool alternator spins at 100,000 rpm

A new record for low-temperature operation has been set by a miniature turbine-alternator, tested for three hours at 9.8°K (−442°F) at the General Electric Research and Development Center, Schenectady, N.Y. Rotating at 100,000 rpm throughout the test, it produced 13.2 watts.

The unit is a critical component in a super cold refrigerator that could be used for chilling superconducting motors and generators for ship or magnetically-levitated train propulsion, or for ac power generation.

The device is driven by helium gas and runs on frictionless helium-gas bearings.

SUPERCOLD TURBINE-ALTERNATOR spins at only 18 degrees (F) above absolute zero. Designer Duard B. Colyer of GE is seen in rear.

Optical fibers come of age—have their own U.S. laboratory

A new United States laboratory aimed solely at the development of optical fibers was announced last October at Roanoke, Va., by the Electro-Optical Products division of ITT. Division President John F.

(continued on page 12)

Another introductory offer to new members of the ELECTRONICS AND CONTROL ENGINEERS' BOOK CLUB

Save time and money by joining the Electronics and Control Engineers' Book Club

HERE is a professional club designed specifically to meet your day-to-day engineering needs by providing practical books in your field on a regular basis at below publisher prices.

How the Club operates: Basic to the Club's service is its publication, the *Electronics and Control Engineers' Book Club Bulletin*, which brings you news of books in your field. Sent to members without cost, it announces and describes in detail the Club's featured book of the month as well as alternate selections which are available at special members' prices.

When you want to examine the Club's feature of the month, you do nothing. The book will be mailed to you as a regular part of your Club service. If you prefer one of the alternate selections—or if you want no book at all for that month—you notify the Club by returning the convenient card enclosed with each *Bulletin*.

As a Club member, you agree only to the purchase of four books over a two-year period. Considering the many books published annually in your field, there will surely be at least four that you would want to own anyway. By joining the Club, you save both money and the trouble of searching for the best books.

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Write Code No. of bonus book here ______

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E33238

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When you train at home with NRI, you train with your hands as well as your head. You learn the WHY of Electronics, Communications, TV-Radio the NRI pioneering "3-Dimensional" way. NRI training is the result of more than half a century of simplifying, organizing, dramatizing subject matter, and providing personal services unique for a home study school. You get the kind of technical training that gives you priceless confidence as you gain experience equal to many, many months of training on the job.

NRI—The Leader in Electronics Training for more than Fifty Years

APPROVED UNDER NEW GI BILL If you served since January 31, 1955, or are in service, check GI line in postage-free card.

Earn $5 to $7 an hour spare or full time in

TV-RADIO SERVICING

Color television sales are soaring. And so is the demand for trained repairmen. If you can service TV sets, portable radios, tape recorders, hi-fi sets, phonographs and auto radios, you'll always be in demand. It's one of your best routes to spare-time earnings, a good paying job or a business of your own. NRI trains you quickly and expertly, showing you how to get started in servicing soon after you enroll, earning as you learn. NRI trains you in today's method of installing and repairing all electronic equipment for the home—including solid state Color TV. You even build, experiment with and keep to enjoy your own solid-state radio plus your choice of black-and-white or the new 25" diagonal solid state Color TV receiver NRI developed from the chassis up for training. Like thousands of others, you can soon be earning good money in your spare time . . . the easy NRI way.

There's money and success awaiting you in

COMMUNICATIONS

MOBILE RADIO & BROADCASTING

NRI training in Complete Communications equals as much as two years of training on the job. With NRI, you can train for a choice of careers ranging from mobile, marine and aviation radio to TV broadcasting and space communications. You learn how to install, maintain and operate today's remarkable transmitting and receiving equipment by actually *doing* it. You build and experiment with test equipment, like a TVOM you keep. You build and operate amplifier circuits, transmission line and antenna systems, even build and use a phone-cw transmitter suitable for transmission on the 80-meter amateur band. Whichever of these five intensely practical NRI Communications courses you choose, you prepare for your FCC License exams, and *you must pass your FCC exams or NRI refunds your tuition in full.*

Move ahead in America's fast growing industry as

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Ours is rapidly becoming the age of the computer . . . and NRI can train you to cash in on the opportunities in this field. Only NRI trains you at home on a real computer—not a simple logic trainer, but a complete, stored program digital computer using over 50 integrated circuits. As you build the NRI Computer, you explore all fundamental logic circuits, then how to combine them in a complete, stored program computer. You observe the "heart" of a real computer. You solve typical problems and learn how to locate faults with diagnostic programs. Bite-size texts make studying easier. Prove to yourself what nearly a million NRI students could tell you—that you get more for your money from NRI. Check the card and mail it today for your free NRI Color Catalog. NO SALESMAN WILL CALL. NRI Training, 3939 Wisconsin Ave., Washington, D.C. 20016.

YOU GET MORE FOR YOUR MONEY FROM NRI

NRI Kits and Equipment

Dollar for dollar, you get more value from NRI training kits, because they are designed as educational tools. In the TV-Radio Servicing Course, for instance, the end product is a superb 25" diagonal color TV your whole family will enjoy. The set is designed so that, while building it, you can introduce and correct defects . . . for trouble-shooting and hands-on experience in circuitry and servicing. The kits include, at no additional cost, a wide-band service type oscilloscope and color cross-hatch generator, and other valuable equipment that will let you start earning money in your spare time making repairs . . . even before the course is completed.

new & timely

(continued from page 6)

Johnson stated that 25 to 30 specialists would immediately initiate work in the United States on a transmission system invented in 1965 by an ITT scientist, Dr. Charles Kao, in a British laboratory.

By the 1980's, Mr. Johnson said much of the world's communications will be carried on optical fibers. As better fibers, lasers, and receivers are developed, he predicted, it will become possible to carry millions of voice channels or thousands of TV programs on a single beam. ITT has already—in 1971—demonstrated a model system with a capacity of 1,400 simultaneous voices on 17 simultaneous picturephone conversations.

ELECTRIC POWER FROM THE SUN?

STUDY PROGRAM INVESTIGATES the possibility of obtaining direct-current energy from solar cells on a satellite in position high above the earth and oriented to be in continuous sunlight. The dc would be converted to microwave energy and beamed to earth where giant arrays like the one in the photograph would receive the energy and convert it to usable electric power. Not at present economically competitive with present generating systems, the technique would have the advantage of not depleting fuel resources and would be pollution-free. In the photograph, scientist William C. Brown of Raytheon adjusts an antenna and diode in the receiving array.

Largest solid-state image sensor uses charge-coupling technique

A silicon chip about as big as a nickel is hailed as "a key milestone in the creation of a new generation of tubeless cameras." The sensor, a charge-coupled device (CCD), contains over 120,000 elements.

Not large from a layman's point of view, the nickel-size device was called a "key achievement" by Dr. Karl H. Zaininger of the RCA Laboratories, where it was developed. "Manufacturable CCD sensors of at least this size are essential if all-solid-state TV cameras are to have the resolution to satisfy a broad range of applications," he said, going on to state that TV cameras with CCD's could be made the size of a cigarette package or smaller. Such cameras would be especially useful in space exploration, military programs, surveillance systems, and a number of other applications requiring small dimensions or low weight.

J. E. Smith, founder of NRI dies at age 92

James Ernest (J.E.) Smith, of National Radio Institute, since 1914 one of the nation's foremost educators of radiomen, died at his Washington home September 30, 1973.

A native of New Hampshire, Mr. Smith was a graduate of the Worcester (Mass.) Polytechnic Institute. He went to Washington in 1907 as an electrical engineering instructor at McKinley High School, introducing wireless instruction in his courses. During World War I, he was director of radio instruction at Howard University, training radiomen for wartime service.

He founded the National Radio Institute, the country's and probably the world's first home study electronics school, in 1914 in a Washington bank building. During its 60 years of existence, it is said to have enrolled nearly a million students. Acting as president of the school till 1956, he then became chairman of the board. He retired in 1968, when the Institute was acquired by McGraw-Hill Co. and became part of its continuing education center.

Mr. Smith was a former chairman of the advisory board of the metropolitan Washington YMCA and president of the Round Table of Washington. He was a life member of the Radio Club of America (joining in 1930) and a life member of the IEEE. Among the numerous awards he received was the Robert H. Goddard Award for Outstanding Professional Achievement, the National Home Study Council Hall of Fame, the International Knight of Achievement award, a doctorate from the Worcester Polytechnic Institute, and several honorary degrees. **R-E**

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THE SONY SOUND LAB

Even if you can't afford it, you should know about it.

Knowing about a system like this gives you more than just a hook to hang your dreams on. It's also a benchmark that the system you have (or the one you plan to buy) can be measured against.

It exists because engineers dream, too. And because, at Sony, they turn their dreams into reality.

One dreamed of a turntable whose mechanical performance would approach an electronic circuit's level of perfection. The result was the PS-2251, in which electronic circuits perform the formerly mechanical functions of speed selection, speed regulation and pitch control. The single moving part...the turntable/servomotor assembly.

Other Sony engineers wouldn't settle for anything less than a tuner with absolute interference rejection. So they added to an already interference-free tuner, a circuit that could cut through even the most persistent impulse noises of men and machines.

More dreams: A preamplifier with the control flexibility of nearly 2,000 precisely repeatable response settings and precisely 42 levers, meters, knobs and jacks. A quadraphonic decoder with dual logic circuits that can make your system realize the full potential of four channel SQ discs and FM broadcasts, with decoder circuits for other matrix recordings, and a full complement of quadraphonic monitoring and control facilities. Plus power amplifiers so clean that they approach the maximum dynamic range of a live symphony orchestra while delivering 100 continuous watts of power per channel at all frequencies from 20 to 20,000 Hz, with less than 0.1% distortion.

Dreams, once. Realities, today.

And new realities to come. For after the dream levels of performance are achieved, our engineers re-scale their visions, asking: "What if we could adapt these new techniques, approach these levels of performance and sophistication, in less costly equipment?"

Some of the answers are on your Sony dealer's shelf already.

The complete Sony Sound Lab described above sells for $2,217.00: PS-2251L/A turntable, $299.50; ST-5130 tuner, $369.50; TA-2000F preamplifier, $579.50; SQD-2020 full logic SQ decoder, $229.50; (2) TA-3200F stereo amplifiers, $369.50 each. All prices suggested retail.

Sony Corporation of America, 9 West 57th Street, New York, N.Y. 10019.

SONY®

Circle 6 on reader service card

equipment report

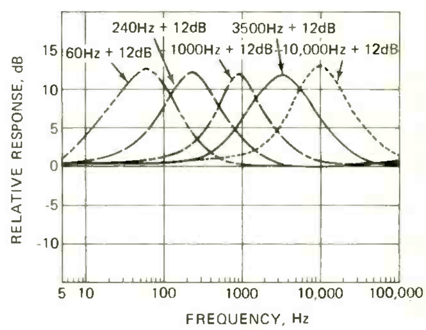
BSR Metrotec FEW-1 Graphic Stereo Frequency Equalizer

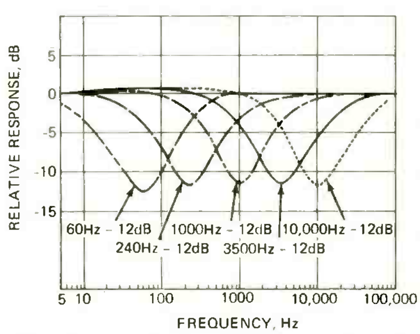
Circle 82 on reader service cards

THE FEW-1 FREQUENCY EQUALIZER IS an attempt to cure the ills of response deviation caused by the practical restraints of the stereo system's surroundings. Speaker location, room design, and furniture and drapery arrangement in the home is rarely dictated by good acoustical sense. There are also hearing losses to contend with, occurring at younger ages, due to high intensity sound and noise exposure. There are many of us who like effects such as emphasized bass despite what the hi-fi purists may have to say. The FEW-1 allows correction for these problems and desires by adjusting the frequency response in the regions of five frequencies: 60, 240, 1000, 3500 and 10,000 Hz.

In effect the Graphic Stereo Frequency Equalizer is a sophisticated tone control giving selective shaping of the resultant frequency response at the listener's ear. The system retains a great deal of flexibility because the effects are relatively narrowband without much overlap. Adjusting the 60-Hz control, for example, has no effect on the mid-band response. This is in large contrast to the conventional preamp and amplifier controls where there is considerable overlap of the bass and treble functions.

The responses centered around the five frequencies can be varied over a total range of ±12 dB. This is a substantial range and fairly gross response anomalies can be corrected. Both intermodulation and total harmonic distortion are specified at .05% maximum at 2 volts output. We measured a 1.8 dB voltage loss at the flat setting which is within the specified 0 to -2 dB. Hum and noise is called out at 80 dB below 1 volt with the input shorted. The input and output impedances are 75,000 and 10 ohms respectively. The recommended load impedance is 10,000 ohms or greater. This is lower than would be expected at the input to most amplifiers and is entirely adequate. The reason for the limit is a reminder that although the output impedance is in ohms, excessive loading can increase the distortion of the output emitter follower.





CONTROL RESPONSE PLOTS—boost curves in the top graph, attenuation in the lower.

With the controls centered we measured the response to be +.3, -.2 dB from 5 Hz to 100 kHz relative to 1 kHz which is well within the ±1 dB BSR specification. We were surprised at the accuracy to which this setting was obtained since it is dependent on the linearity and adjustment precision of the potentiometers.

The measured response with the individual controls in their extreme positions are plotted in the accom-

(continued on page 24)

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Energy shortages tell us we have to change our driving style. Now! It doesn't mean we have to go back to horse and buggy days. But it does mean we have to make every drop of gas give us the most go for our money. Anyone with horse sense knows that a well-tuned car gets better mileage, and in times of fuel shortages, better mileage means a lot.

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Circle 8 on reader service card

letters

BUILDS TV TYPEWRITER

I enjoyed, with great enthusiasm, build- and debugging the TV Typewriter. I am enclosing herewith a photo of a message transmitted on my TV.

Although I don't have a keyboard yet, I am able to test the unit with the switch set-up.

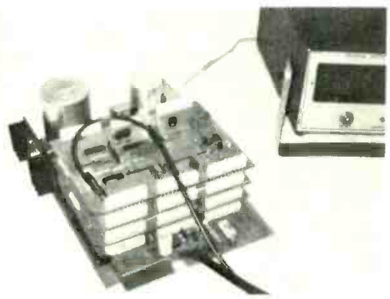
I have enjoyed your construction articles for many years and am looking forward to more of the same in the future.

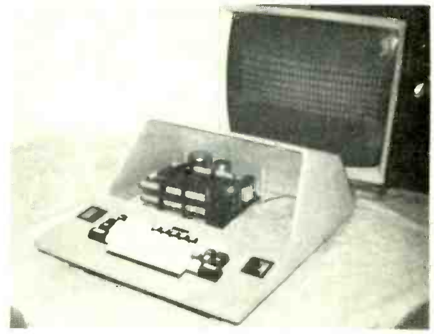
W.G. OBRINGER
Torrance, Calif.

ADD TO TV TYPEWRITER. PLEASE!

The purpose of this letter is twofold. One, to point out two small errors in the Timing board pattern, but most importantly, to add my vote to encourage you to forge ahead on add-on projects to extend the capabilities of the TV Typewriter. I would be particularly interested in seeing articles on:

1. A suitable MODEM for both phoneline and tape input/output.
2. Calculator capability.





3. Programming capability for the calculator.
4. Micro-computer/Processor development.

appearing perhaps in that order.

Enclosed you will find some photographs of the TV Typewriter I am building. As you can see, it is esentially complete except for a dedicated 9" TV that will mount in the surplus cabinet I bought

(continued on page 22)

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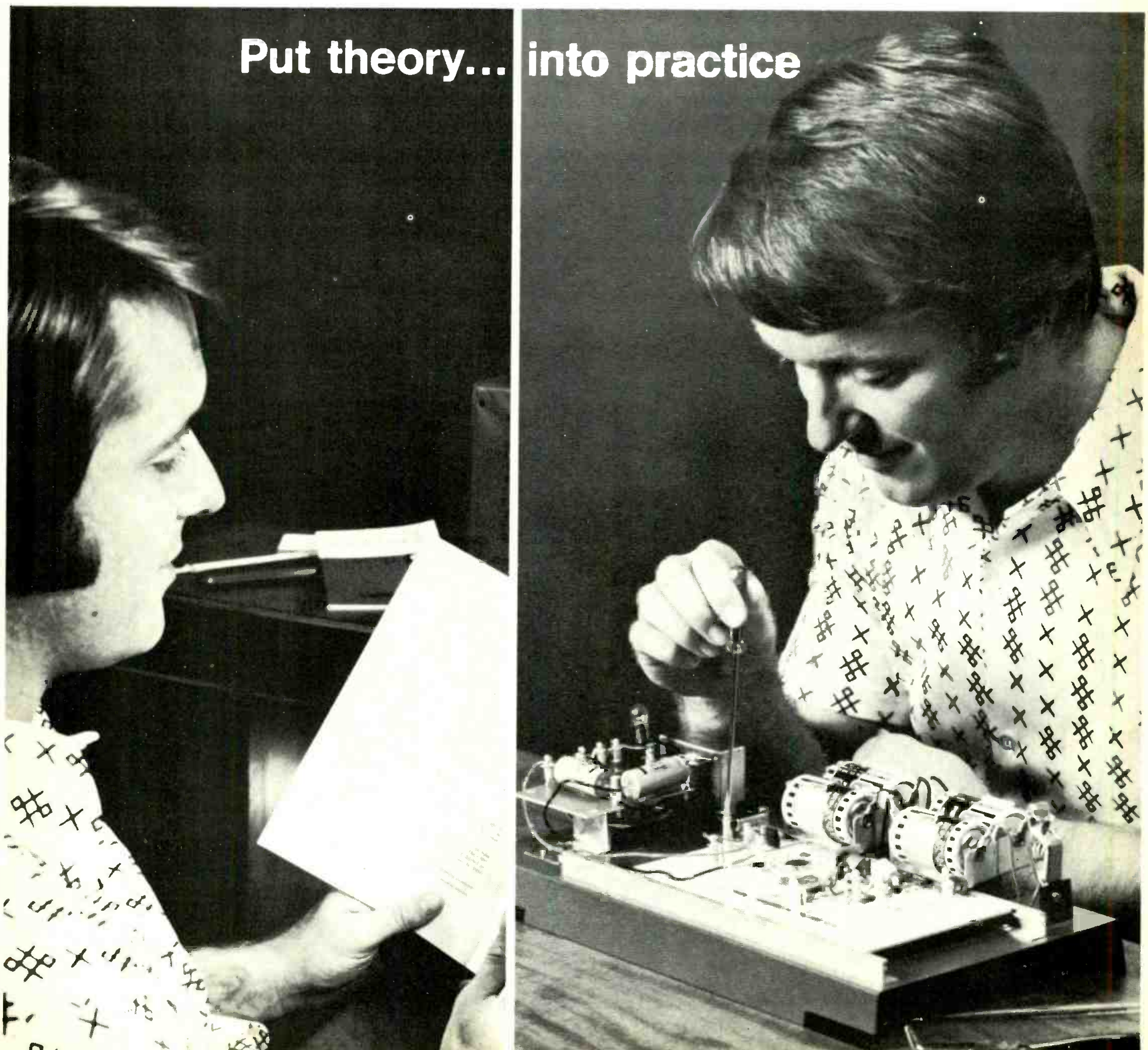


LETTERS

(continued from page 16)

with the keyboard.

Almost every module of the TV Typewriter has gone on-line without a hitch. I did, however, catch a short while reproducing the pattern between pins 5 and 6 of IC2 on the Timing board. The other error is an apparent connection between pin 11 of IC10 and Test Point R on the Timing board. This connection is also indicated in the Fig. 7 schematic. Hooked-up this way, of course, I got out 55 Hz at the end of the timing chain. A little "reasoned, logical testing" and a look at the timing of the inputs to this gate (IC10-c) with a dual trace scope showed we wanted the Q timing signal instead of the R timing signal. Works fine now (60 Hz out).

It is a pleasure to hear that the response to your TV Typewriter project has been so overwhelming (except that it sure made it hard to get a 2513). I hope all of this response will hasten the development of your add-on project plans.

M. PAUL FARR
San Pedro, Calif. 90731

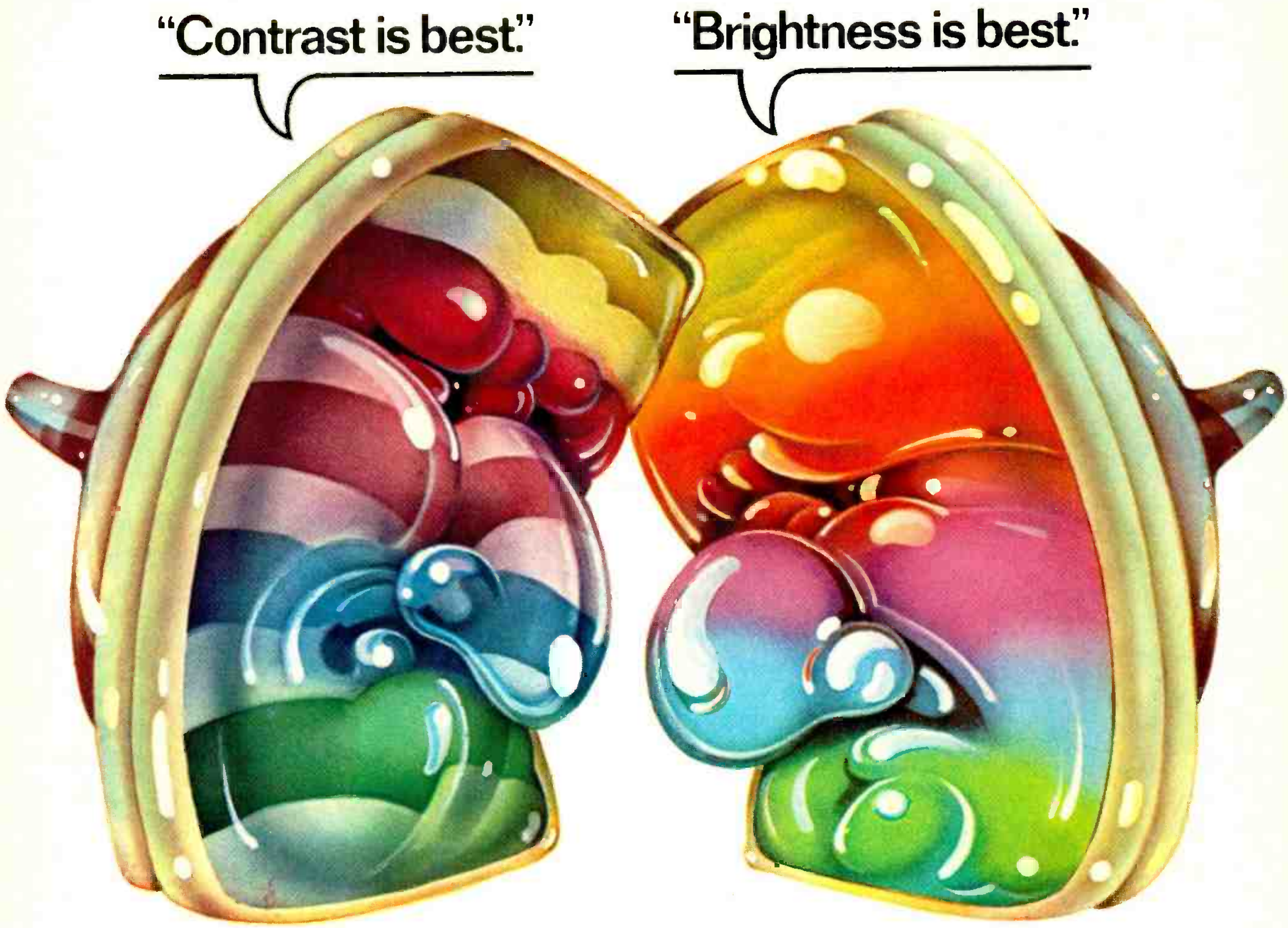
MORE ABOUT PHONE SENTRY

Some added confusion resulted from my comments in the "Letters" section of the September issue. The marked-up schematic of the Phone Sentry was omitted.

The correct change is: forget about adding the capacitor between pins 1 & 8 of IC2. Instead, cut the foil between pins 4 & 8 and add a 470K resistor between pins 4 & 8. Now, add a .1-µF capacitor between pin 4 and ground.

Another comment: in those states that permit you to record phone conversations, you can record with the Phone Sentry as follows: Turn OFF answer player unit 1; turn ON Phone Sentry and depress TEST button; turn ON the PLAYBACK switch. Be sure to restore all to normal when you're done recording.

ROGER L. SMITH
Phoenix, Arizona



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GTE SYLVANIA

EQUIPMENT REPORT

(continued from page 14)

panying figures. The response peaks are all within ±1 dB of 12 dB which again is quite good.

The equalizer uses two identical filter channels with ganged sliding potentiometers. This is the one place we think the design falls short of its intent. We would prefer to see each control split down the middle with separately color coded handles. In this way the true versatility needed to compensate for unsymmetrical speaker placement and hearing loss would be obtained.

The FEW-1 can be inserted between the preamplifier and amplifier or in series with the tape monitor circuit of a stereo receiver. Tape monitoring facility is still retained as an additional level of switching and phono jacks are included. In addition to the tone controls the front panel holds the on/off and tape monitor in/out switches and a pilot lamp.

We found the instrument quite useful in tape recording applications. It was a boon in recording live organ on a cassette deck. The bass was emphasized so that it could be heard on playback which was previously impossible. Other situations where it would be useful is where hum or noise is excessive. The 60-Hz frequency control has been judiciously chosen with this in mind.

Available in either wired or kit form the equalizer uses 8 transistors in the dual amplifier and 4 diodes for the transformer isolated power supply. All circuitry is on a single PC board with the exception of some of the filter components mounted with the sliding pots.

The equalizer measures 4⅝" high by 8⅜" wide by 5½" deep and draws 3 watts. Sheet metal construction is used with oiled walnut side blocks.

The FEW-1 would be a nice addition to an otherwise complete system and would be just great for the knob counter particularly because the added knobs really do a job. **R-E**

ONEIDA INSTANT-WELD ADHESIVE.

Circle 81 on reader service cards

IN ELECTRONICS REPAIR WORK, WE run into lots of things that must be put back together; metal, plastic, and ceramic, to name a few. So when we find a new product of modern chemical technology that can help us do hard jobs more easily, it's welcome.

The Oneida Electronic Mfg. Co., of Meadville, Pa., has come up with one of these. They call it "Instant-Weld", and that's about as appropriate as you could get. Its full name is "Alpha-cyanoacrylate industrial strength adhesive". Cyanoacrylate adhesives have been known for quite a while, but they had certain drawbacks. Oneida has overcome these.

This is a single compound; no mixing. It has amazing bond strength; one square inch will hold up to a 5,000 pound pull. It comes in a very small tube, but only a pinhead-size drop is all you need for the average radio-TV shop job. Also, it sets up *right now*. You apply the cement, put the pieces together, hold them for not more than three or four *seconds*, and there you are. In less than a minute, it's practically set up. (This can lead to problems, be *sure* whatever you're cementing is exactly *where* you want it.

I have a pet sweep-generator, that lives on a shelf over the bench. Part of it is a heavy 8-step attenuator (2 to 3 pounds) in a separate case, connected to the sweep with coax. I was always knocking it off the top, and breaking the cable. This annoyed me intensely, since I do not like to fix BNC connectors. So this would be a dandy project. I'd been meaning to bolt it to the sweep case for a long time.

Taking the four little plastic feet off, I put a wee dab of Instant Weld on each one, and stuck them on the bottom. This is where I learned about "put it where you want it!". I set one of them about ⅛ inch from the corner, then tried to slide it over; no slide. It was *there*.

Then, I put a wee dab of I-W on the bottom of each foot, and *very* carefully placed it where I wanted it. That's where it is, and it looks as if it'll stay. In less than a minute, I could pick up the whole thing by the attenuator case. No more broken coax.

A very detailed set of instructions comes with each tube. Follow them; they're simple. The only precaution you must take is to be sure you get the cap back on tightly.

Never having been able to refrain from a jape, I bonded a dime to the glass counter at the coffee shop. Two weeks later, it's still there, and it will probably stay. If some of *my* friends can't get it loose, it's tight. **R-E**

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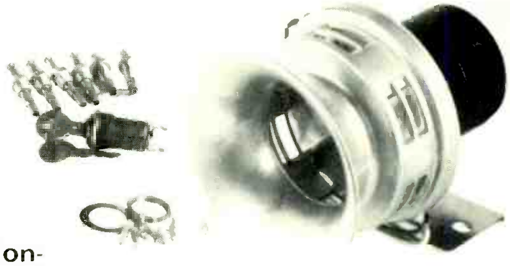

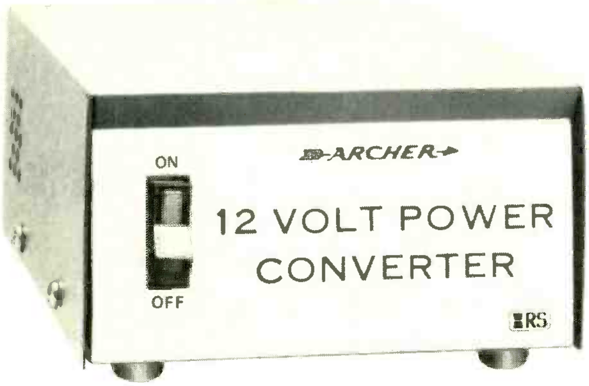

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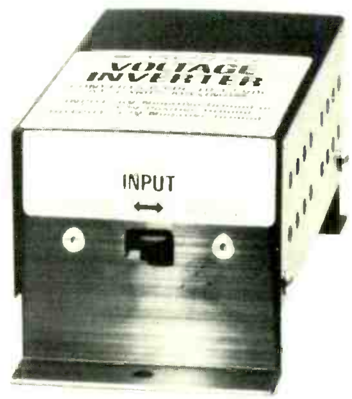

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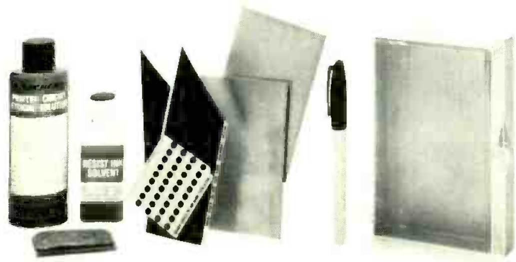

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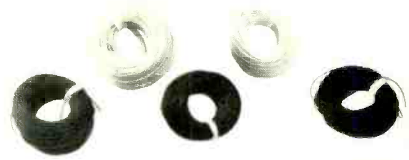

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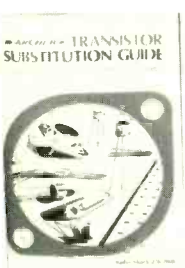

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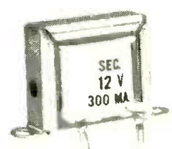

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LIMIT SWITCHES

by JACK DARR
SERVICE EDITOR

THERE'S ONE HANDY SAFETY DEVICE that you'll find on a lot of heating appliances. It should be used on all of them, really. This may look like an odd-shaped blob with several wires going into it. It's called a "limit switch". It *is* a switch, automatically operated by a thermal element, usually a bimetal blade. It's normally closed. When the temperature of the appliance heater reaches a certain level, the switch opens, to keep things from getting too hot. In some of the larger units, the bimetal blade may be in the form of a spiral or coil, instead of the familiar flat blade, but it works in the same way.

Many of these are adjustable. You will see a calibrated scale, marked in degrees F. A sliding pointer shows the cutoff temperature for which it is set. Note: some of these have locking screws: if the pointer can't be moved, look for a small screw that holds it in place. Loosen this, and then retighten it after adjusting the switch. Some types are preset: these open the switch at a certain temperature.

On a gas furnace or similar heater, with a fan to force air-flow, the limit switch may be a dual type. One section will control the fan-motor. This stays open until the plenum has reached a high temperature; this keeps the fan from blowing cold air up your pants-legs. (Plenum: heat-chamber on top of furnace.) The other section is the limit-switch. It is usually actuated by the same thermal element, but it is normally closed.

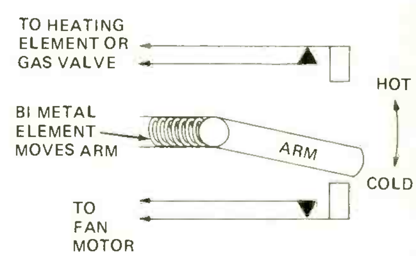
The power to the electrically-operated main gas valve flows through these contacts. If the temperature of the plenum goes too high, they open, and the gas-valve automatically closes. (All standard gas-valves are built so that when the power fails, they *close* automatically, see diagram.) This type of dual of switch will have two pointers; one sets the temperature at which the fan comes on, the other the temperature at which the burner is cut off.

Some of these switches use the familiar flat blades, with electrical contacts in an insulated mounting on the ends. In the heavy-duty types, such as those found on furnaces, the switch itself may be a "Mi roswitch" or similar unit. These take only a very small pressure to operate; they are tripped by an arm on the end of the thermal blade or spiral unit.

Other types can be found in the heating ducts of electric or gas clothes driers. These are generally preset, fixed types. Their purpose is to prevent the temperature in the duct from going too high. A typical unit might close at about 200 degrees and open at 300-350 degrees; this varies with different units. If a control shorts, or anything happens that would let the heating element stay on too long, this thermostat opens, breaking the supply circuit. A similar control can be used with gas heated driers. If the duct temperature goes too high, the limit switch shuts off the main gas-valve.

In most clothes driers, there will be another thermostat in series with the limit switch. This one works just like the limit switch, of course, but it will be adjustable for various temperatures, so that the drier can be used with different kinds of fabrics. Some models have as many as 6 different "heats".

The thermostats used for this purpose, in clothes driers, will look quite a bit different to the types found on furnaces, etc. They'll be small round-cased units, with lugs or push-on terminals. Many of these are of the "disc" type. They're bimetal, just like the blade, but made in the form of a "dished disc". When this gets hot, it will "snap" from one side to the other, just like the bottom of an oil-can! This operates the electrical contacts.



Checking and servicing

Finagle's First Law says that "If there is anything in there that can cause trouble, it certainly will!" So, if any kind of heating unit refuses to work, check the fuel supply first; gas or electricity. If this is present at the normal value, then check the gas burner or electric heating element. If you can read the full supply voltage across the terminals of an electric heating element, but it's stone cold, that's it. The element is open. Replace with an exact duplicate.

However, if your check at the terminals of the heating element shows zero voltage, then you've got another problem! *Something* between the line plug and the heating element is open. (Incidentally, one good thing to check here is to be *sure* that the thing is *turned on!* Check the timer, switch or whatever turns it on, normally.)

In large appliances such as clothes driers, it's usually not too difficult to follow the wiring; it's visible. The thermostats, etc will be fairly easy to see. Take a voltage reading right across the terminals of the thermostats and switches. Full line voltage present across what should be a closed switch indicates trouble. One quick check for this is to turn it off, connect a jumper across the sus-

(continued on page 96)

SOUTHWEST TECHNICAL PRODUCTS CORPORATION

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February 1974

Dear R-E Readers,

Don't know how many of you have our new 1974 catalog, but it is out and you can get your copy by simply ripping out the "Bingo" card in the back of the magazine and circling our reader service number. This edition features our "Tigersaurus 250" amplifier on the cover, in case you are not sure which edition you have.

I'll bet that there are quite a few of you out there who are not aware of the various audio modules that we offer for constructing custom audio and PA systems. Not only do we offer preamplifier systems such as our "558" instrument preamp, but also mixers, reverbs, and basic power amplifiers. You can get a list for the asking of the various components that go into our #141 guitar amplifier system. Thus, if you want to build an amplifier with only one channel and no reverb you can do so, and save the cost of the other circuits in the standard kit. In addition to these kits, we now have available our new Ex-1 stereo expander-compressor kit. This expander-compressor uses a variable gain integrated circuit to obtain the expansion, or compression. This results in a fast acting low distortion system that is far superior to the commonly used lamp and photoresistor circuits. The expander not only can increase the dynamic range of your music, but will also enhance the stereo effects on many records. It is easily added to most systems by connecting it to the "tape monitor" jacks of the preamp.

I would like to offer a few comments on an idea that some of the other kit manufacturers are promoting lately. This one goes "you should not feel bad about paying as much, or more, for a kit than you would pay if you bought the thing assembled and ready to use from the store up the block." The idea being that you get all that fun and that you will be familiar with the device if it ever needs service. To all of this I say BULL. Any of you in the service business, or who have done any troubleshooting know better than this. You don't have to put the thing together to be able to quickly and effectively service it. All you need are proper instruments and a schematic for most things. There is no reason why a kit should cost as much or more than a comparable assembled product; be it a Hi-Fi, TV set or calculator. What it should cost is at least 20% less. If it doesn't then it is either badly engineered, or a rip-off. In addition to this you should expect to save even more if you are buying the kit by mail, directly from the manufacturer. If you really have nothing better to do with your time, or if you need a passtime and don't care what it costs then our competitors kits are just what you need. If your time is valuable and you want to get something for your effort we think you should take a close look at our products. I will be happy to send you a schematic, or additional information on any of them you might be interested in checking into.

We offer a full refund on any kit that you decide is not a bargain or not what you were led to expect; if it is returned to us unassembled and in original condition within two weeks of receipt. What have you got to lose?

Sincerely,

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Daniel Meyer

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Now you can build and keep a color television that's ahead of its time!

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But now comes a color television with features you've *never* seen before. Features now possible as a result of the new technology of digital electronics ... features that make Bell & Howell's new 25-inch diagonal digital color TV ahead of its time! Like...

Channel numbers that flash big and clear right on the screen. An on-screen digital clock that flashes the time in hours, minutes and seconds with just the push of a button. An automatic channel selector that you pre-set to skip over "dead" channels and go directly to the channels of your choice.

And, to insure highest quality performance, this new TV has all-electronic tuning, reliable integrated circuitry, and 100% solid-state chassis for a brighter, sharper picture with long life and dependability.

Perform fascinating experiments...test your new TV as you build it...with the exclusive Electro-Lab,® electronics training system. It's yours to build and keep!

Designed exclusively for our students, this new Bell & Howell Electro-Lab® features the most sophisticated and up-to-date "tools of the trade". Instruments you can use professionally after you finish the program.

A new digital multimeter that measures voltage, current and resistance and displays its findings in big, clear numbers. Far more accurate and readable than conventional "needle pointer" meters that require guesswork and interpretation.

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The design console is a valuable device for setting up and examining circuits without soldering! Features patented modular connectors, AC power supply and transistorized dual range DC power supply.

R TV IS HERE!

Build it yourself... the perfect way to learn all about the exciting new field of digital electronics!

Digital electronics is changing our lives!

There's a lot more to digital electronics than just the numbers! True, that's what you see on more and more products like digital calculators, clocks and watches. But behind the numbers lies a fantastic new technology that's creating higher standards of accuracy and dependability. The versatility of digital electronics has begun another industrial revolution. Its growth and applications are limitless, giving us new and better ways of doing things and spectacular products like this new Bell & Howell digital color TV!

It's a fascinating spare-time project you can enjoy at home!

Imagine spending your spare time actually building your own 25-inch diagonal digital color TV! It's a project you can enjoy working on right in your home. And you'll be amazed at the electronics knowledge you'll pick up in a relatively short period of time!

There's no travelling to classes, no lectures to attend, and you don't have to give up your job or paycheck just because you want to get ahead. When you finish this new Bell & Howell Schools program, you'll have the skills you need plus a great color TV to keep and enjoy for years!

You don't have to be an electronics expert to build it... we help you every step of the way.

One of the beauties of this TV is that you don't need previous electronics experience to build it! With a few simple household tools, our step-by-step instructions and the exclusive Electro-Lab®, you've got all the basics you need. Should you ever hit a 'snag', you're just a toll-free call away from one of our expert instructors who can help you solve it. You can also take advantage of our in-person "help sessions" held in major cities throughout the year where you can enjoy "talking shop" with instructors and fellow students.

Pick up valuable skills in digital electronics that could lead to extra income full or part time... or a business of your own!

Once you have your new TV, cash in on all that you learned from building it! This new Bell & Howell program employing digital electronics will help you gain valuable new skills that could easily lead to extra income, part time. A service or repair business of your own? Why not! We even show you how to get started with a complete volume on the basics of setting up a TV servicing business. Get the complete story on this exciting, learn-at-home program... the world's first color TV course employing digital electronics technology!

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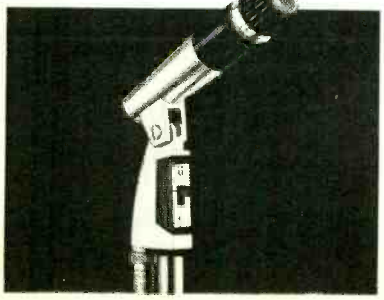
Microphones matter most.



Never have so few words said so much about sound system installations. The truth is that a carefully chosen, top-quality microphone makes a measurable difference in sound system quality—regardless of the other components in the system. It is false economy at its worst to be a microphone miser. Install *Shure Unidyne* or *Unisphere* microphones—for installations with a marked superiority in voice intelligibility (and fewer service calls due to microphone problems).

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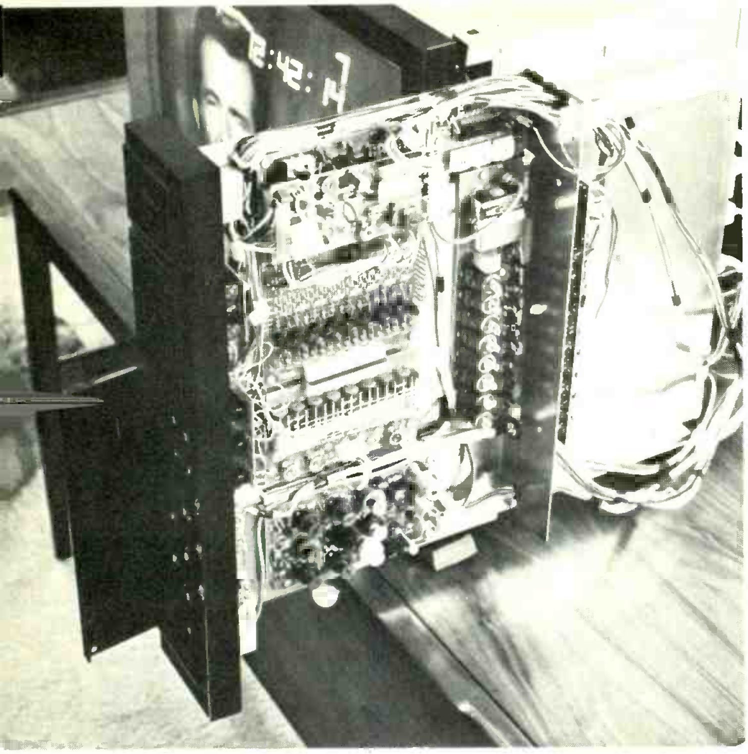


EXCLUSIVE!

Heathkit's new digital color TV

Digital design techniques produce unique features found in no other set

by LARRY STECKLER
EDITOR

STATE-OF-THE-ART! THESE FOUR WORDS are often associated with the space program, or the most recent developments in integrated circuits. But now they can be properly used to describe the brand new Heathkit GR-2000 color TV kit. In fact, this new set uses so much digital design and so many integrated circuits, that it can be said that it sets new standards for state-of-the-art in color TV.

At first glance it looks just like any other color TV. At second glance you start noticing the differences—there are no knobs on the front panel; and when you turn the set on, something remarkable happens—the channel number and the time (hours, minutes, and seconds) appear on the screen! And that's just the beginning.

There are many special design features built into this TV and we will be taking a close look at some of the most interesting ones. First, there are several features that must be labeled "unique." These are features that are not to be found in any other production color TV being sold in the U.S. There are six of these "unique" features in the GR-2000.

1. Silent, all-electronic tuning. It's done with uhf and vhf varactor diode tuners that are dc voltage-controlled. The tuners themselves are located right on the chassis, and are not attached to the front panel of the set. To change channels, the viewer taps either an up or down switch on the front panel of the set. We will explain how this circuit operates later.

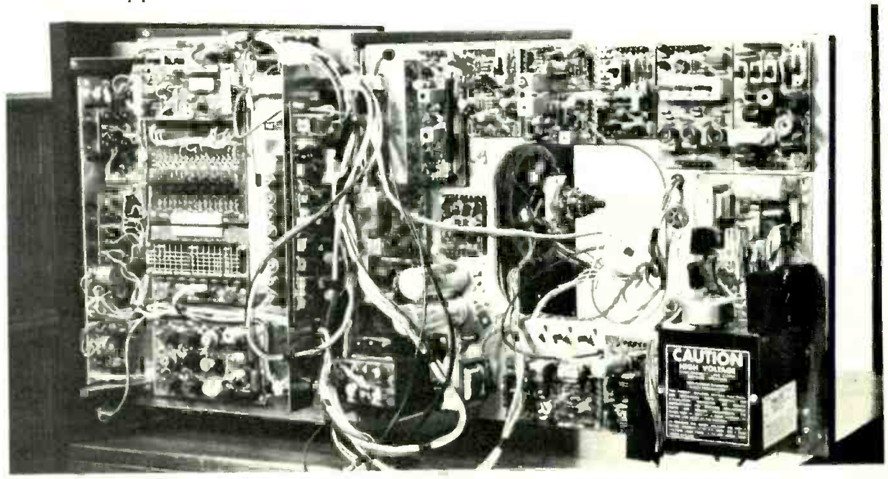
2. Touch-to-tune, reprogrammable, digital channel selection. You program up to 16 channels, uhf or vhf; and in whatever order you wish to arrange them. Great for switching from the football game on channel 2 to the football game on channel 7, without having to go through any other channels. And there's no need to ever tune to an unused channel. You don't program them, so they never appear.

3. Touch volume control. Again, there is no knob, when the remote control is used. Instead, there are two more touch switches to use to raise or lower the volume in small steps. More on this later.

4. On-screen electronic digital channel readout. This feature has been advertised by some set makers. Sharp offers one set with this feature. Hitachi is talking about it, and Blaupunkt sells one in Europe. In the GR-2000, the numbers appear on the screen each time you switch channels or touch the RECALL button. The length of time that they are visible is adjustable. For more details on this circuit, keep reading a bit longer.

5. On-screen electronic digital clock readout. This is an optional low-cost feature. It will display the time in 12- or 24-hour format, with your choice of hours and minutes, or hours, minutes and seconds. The clock is as accurate as the frequency of the 60-Hz ac line. The clock continues to run when the set is off. The readout appears on the screen whenever the channel number appears. We'll look at the clock curcuit a bit further on.

6. LC i.f. amplifier with fixed ten-section **LC i.f. bandpass filter** in the i.f. strip. This unit makes possible an unusually finei.f. response curve. Bandpass skirts offer fast, smooth rise and

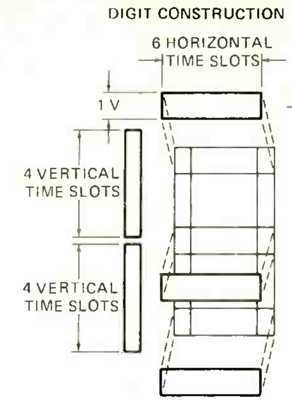


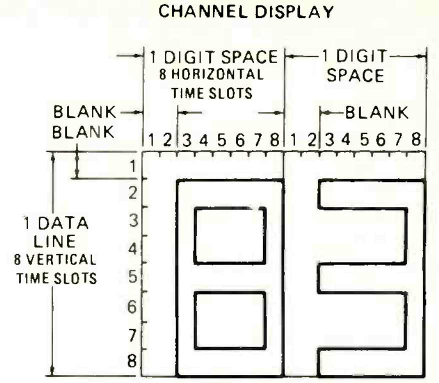
WITH THE REAR PANEL SWUNG OUT you can see just about all of the electronics inside the Heathkit GR-2000. Note all the IC's.

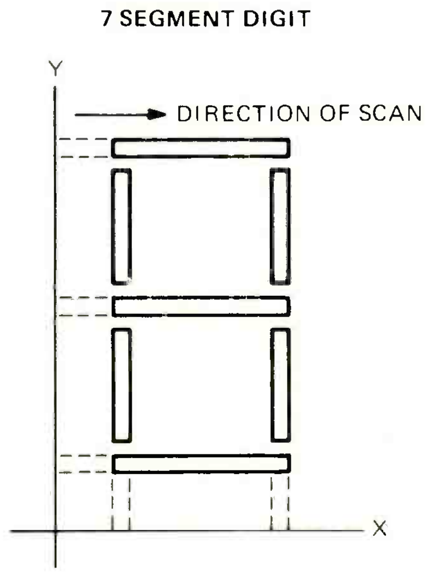
fall times. The filter eliminates the need for critically adjusted traps for eliminating adjacent-channel and in-channel carrier beats. No i.f. alignment is needed . . . ever. This is the first set we have seen that includes a filter-type i.f. It has several obvious advantages—not only in performance, but in assembly ease (no instrument alignment), and in longevity of its picture-quality excellence. More details further on.

There you have a rundown of the really special features that are built into the set. We will look at each of these circuits in much greater detail shortly. But first let's take a look at the other notable features of the GR-2000, and there are many of them.

The set is all solid state (with the exception of the picture tube, of course). Nineteen integrated circuits, including custom MOS designs, are used (plus another 13 IC's if you buy the optional remote control and yet another IC if you buy the optional clock). There are 71 transistors, all mounted in sockets for easy plug-in replacement. And a







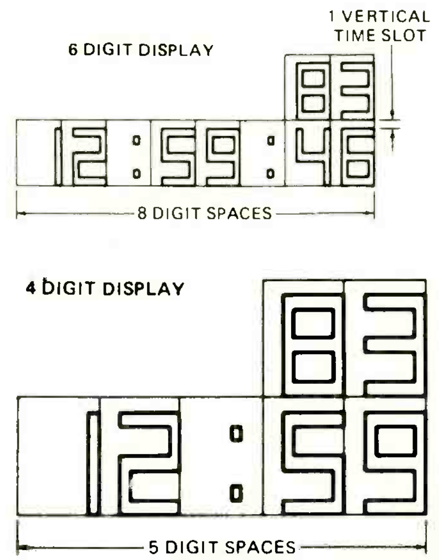


FIG. 1—(right top) HOW DIGITS are formed on the screen of the color set.

FIG. 2—(right) MODIFIED CHARACTER is used by Heath for earier reading.

FIG. 3—(far right) a—Channel number display. b — channel number with a six-digit time display. c—channel number with four-digit time display.

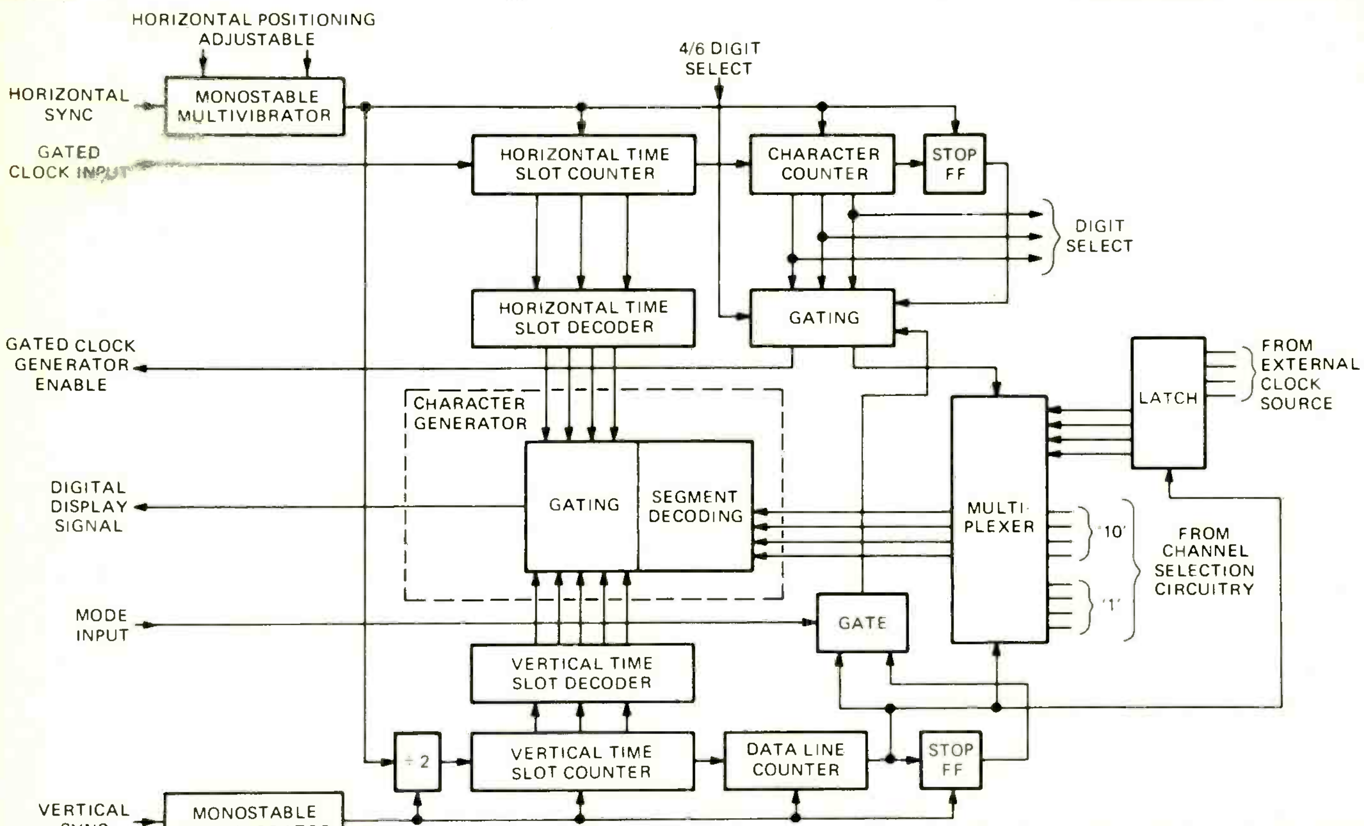


FIG. 4—BLOCK DIAGRAM OF CMOS display IC that forms the characters that appear on the screen of the set.

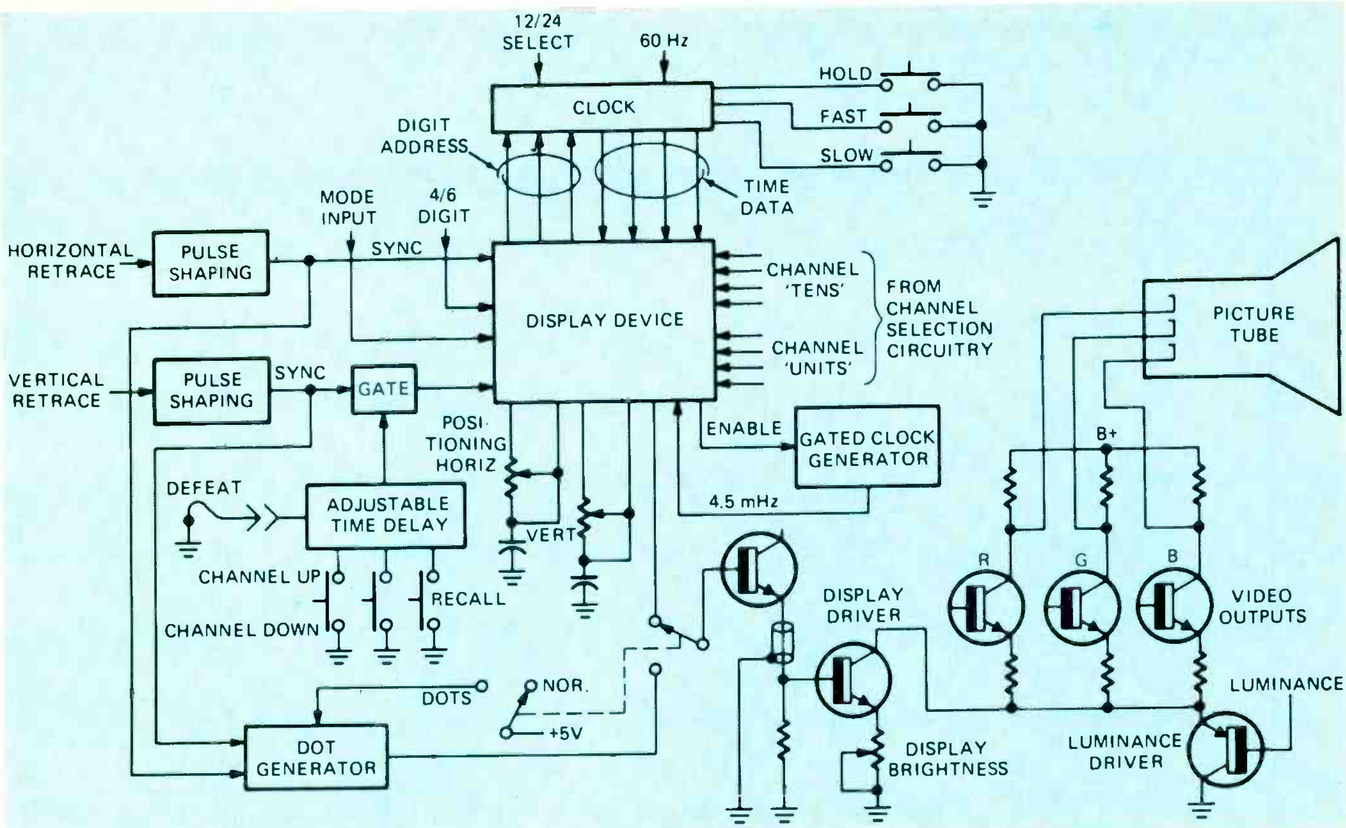


FIG. 5—THE ENTIRE DISPLAY SYSTEM in block diagram form. You'll note that it is far from a simple circuit.

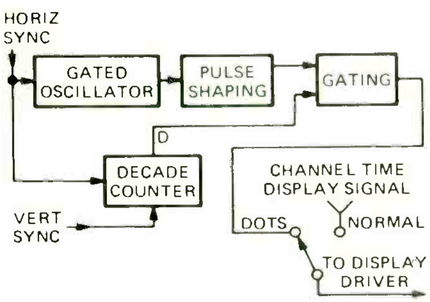


FIG. 6—THE DOT GENERATOR is built into the chassis. It's a single IC.

vast portion of the electronics, more than ever before, is mounted on 20 plug-in circuit modules. The special group of electronics that controls digital channel selection, the digital clock, readout positioning, and the convergence controls is located in a slide-out drawer for easy access. You can see this drawer on our cover.

Picture contrast is dc voltage controlled. There's an IC amplifier for better color rendition, improved color killer threshold performance and better dynamic range and sensitivity of the automatic chroma control.

A new vertical sweep circuit uses complementary power transistors, making it possible to eliminate the output transformer with its magnetic field and linearity problems. Interlace is near perfect.

There are some interesting service aids too. A true dot generator, built with IC's, is a part of the set. Both vertical and horizontal centering controls are provided. As in previous color TV kits, a test meter is included.

Even the color picture tube is new. It is the latest 25-inch diagonal black (negative) matrix picture tube. It offers fully illuminated and, therefore, brighter phosphor dots and an etched faceplate to reduce glare.

The set has a large number of modules, 20 plug-in circuit boards that both speed construction of the kit and make the finished set easier to service whenever service becomes necessary.

The readout system that generates positions and controls the numerical readout that appears on the picture-tube screen. To display a character on the screen, the electron beam must be turned on during the appropriate periods as it scans the face of the picture tube. In the GR-2000 a 7-segment digit is used.

The number of different time periods for which the electron beam must be turned on and off as each digit is formed determines the complexity of the character generator. For this reason Heathkit engineers selected the 7-segment digit shown in Fig. 1. Each segment in such a digit is a straight line that lies on either the horizontal or vertical axis (x or y). The four vertical

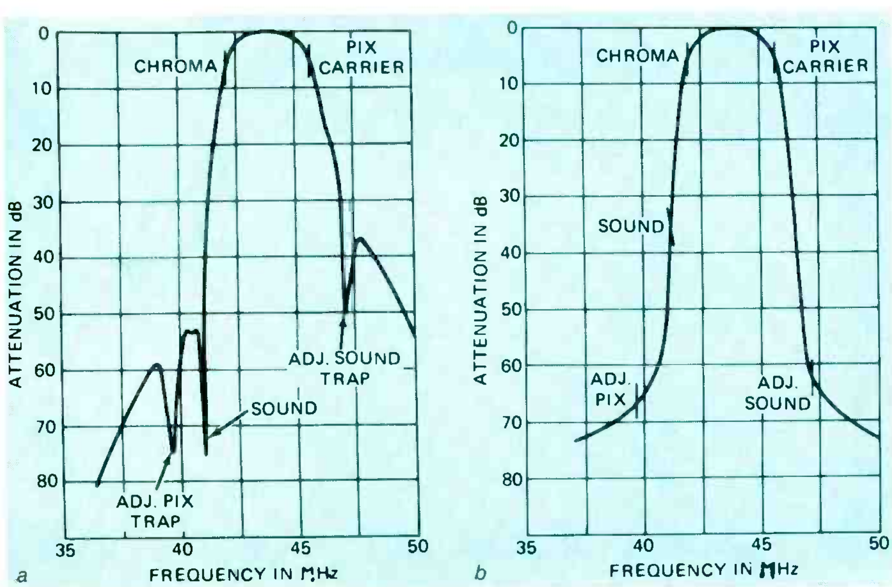


FIG.7—I. F. RESPONSE CURVES. a—this is the response curve of a modern conventional color set. b—this is the response curve of the Health LC-filter i.f. strip.

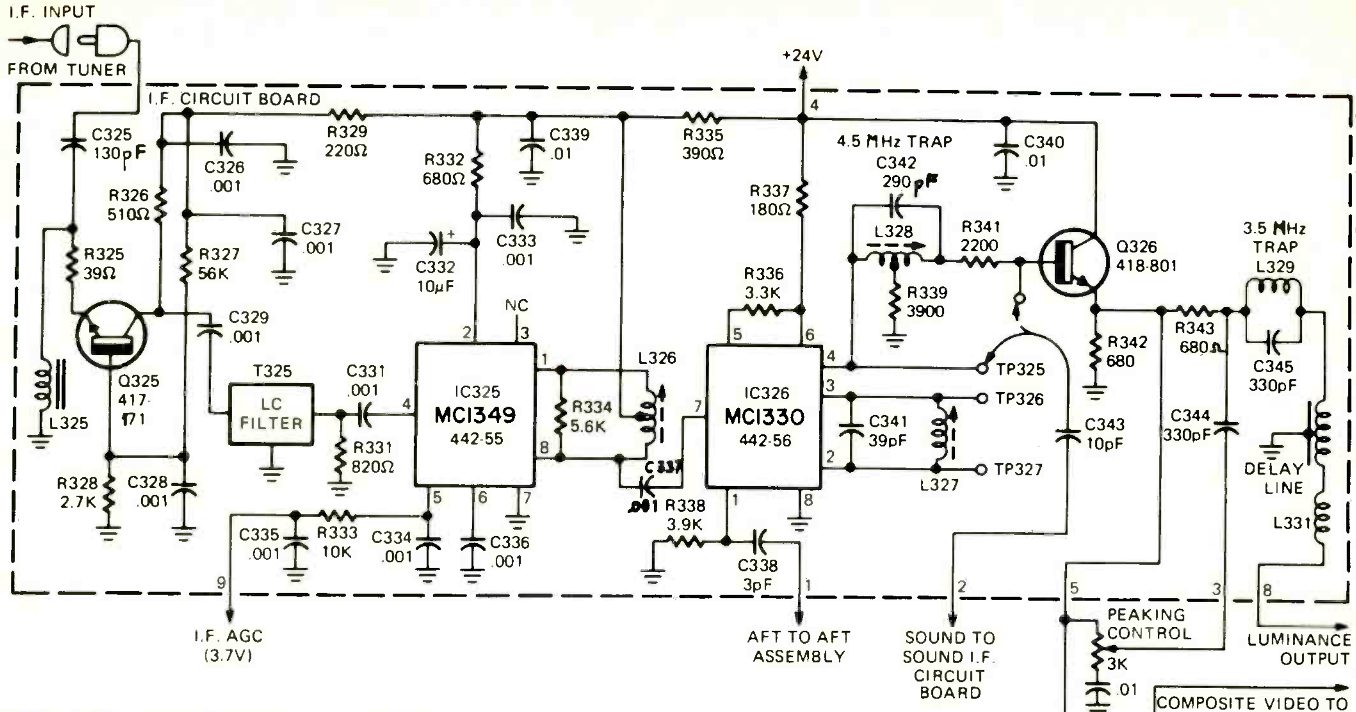


FIG. 8—COMPLETE CIRCUIT OF THE I.F. STRIP. The LC filter is a 10-section unit. Two IC's and two transistors are used.

segments occupy only two time periods during the horizontal scan which occur at the same time on each line. The three horizontal segments also occupy the same time periods on the horizontal scan.

By modifying the 7-segment digit of Fig. 1 slightly so the ends of each segment overlap the ends of each adjoining segment (see Fig. 2), they get a better-looking digit. The character generator decodes BCD (Binary Coded Decimal) input data into segment control lines. These lines control the output of the logic gates that turn the electron beam on and off when necessary. This type of character generator does not need a memory.

Figure 3-a shows how both the horizontal and vertical scanning times allotted for each igit are divided into eight time slots. Each vertical time slot consists of an even number of horizontal scan lines. The first two horizontal time slots and the first vertical time slot of each digit are always blank. The top, center and bottom horizontal segments occupy the third through the eighth horizontal time slots during the second, fifth, and eighth vertical time spots. The left and right vertical segments occupy the third, and eighth horizontal time slots. The left and right vertical segments occupy the second through the fifth and the fifth through the eighth vertical time slots, with overlap during the fifth time slot.

The display circuit was designed to also display the time-of-day along with the channel number. The time data is supplied from an external clock source (optional add-on to the GR-2000). As shown in Fig. 3-b, the time data fills eight digit spaces and is displayed as shown below the channel number. A

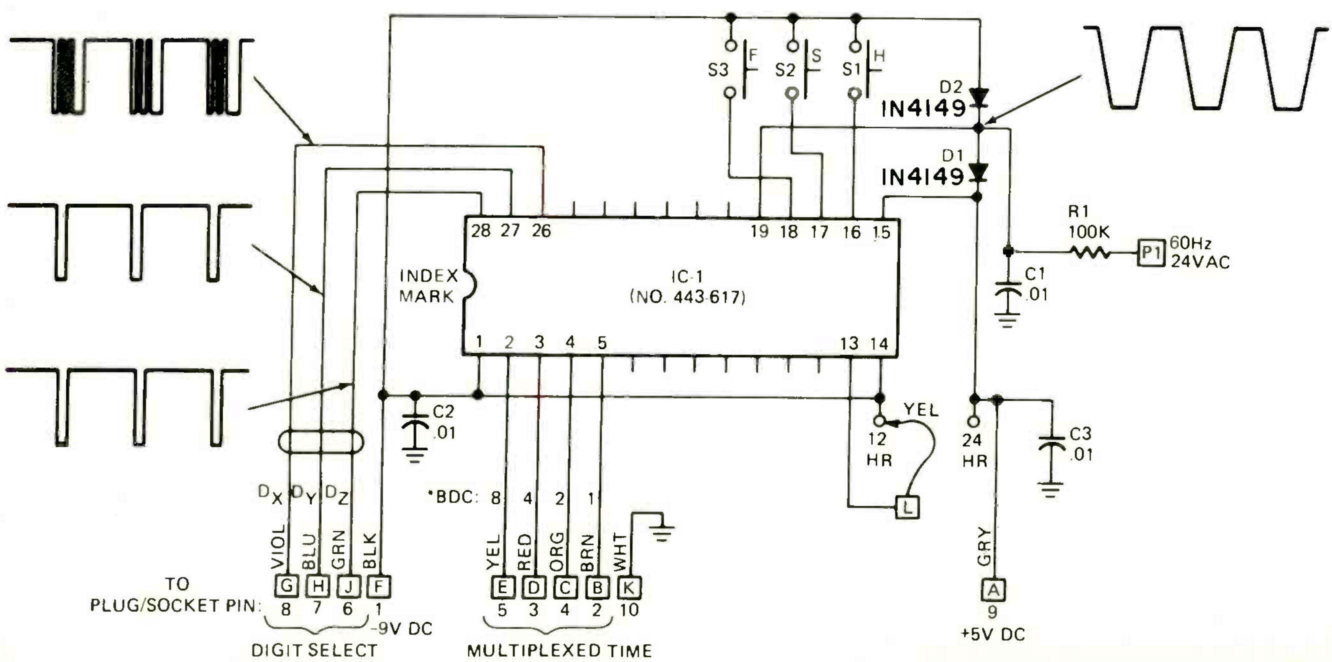


FIG. 10—THE DIGITAL CLOCK circuit is on a single IC.

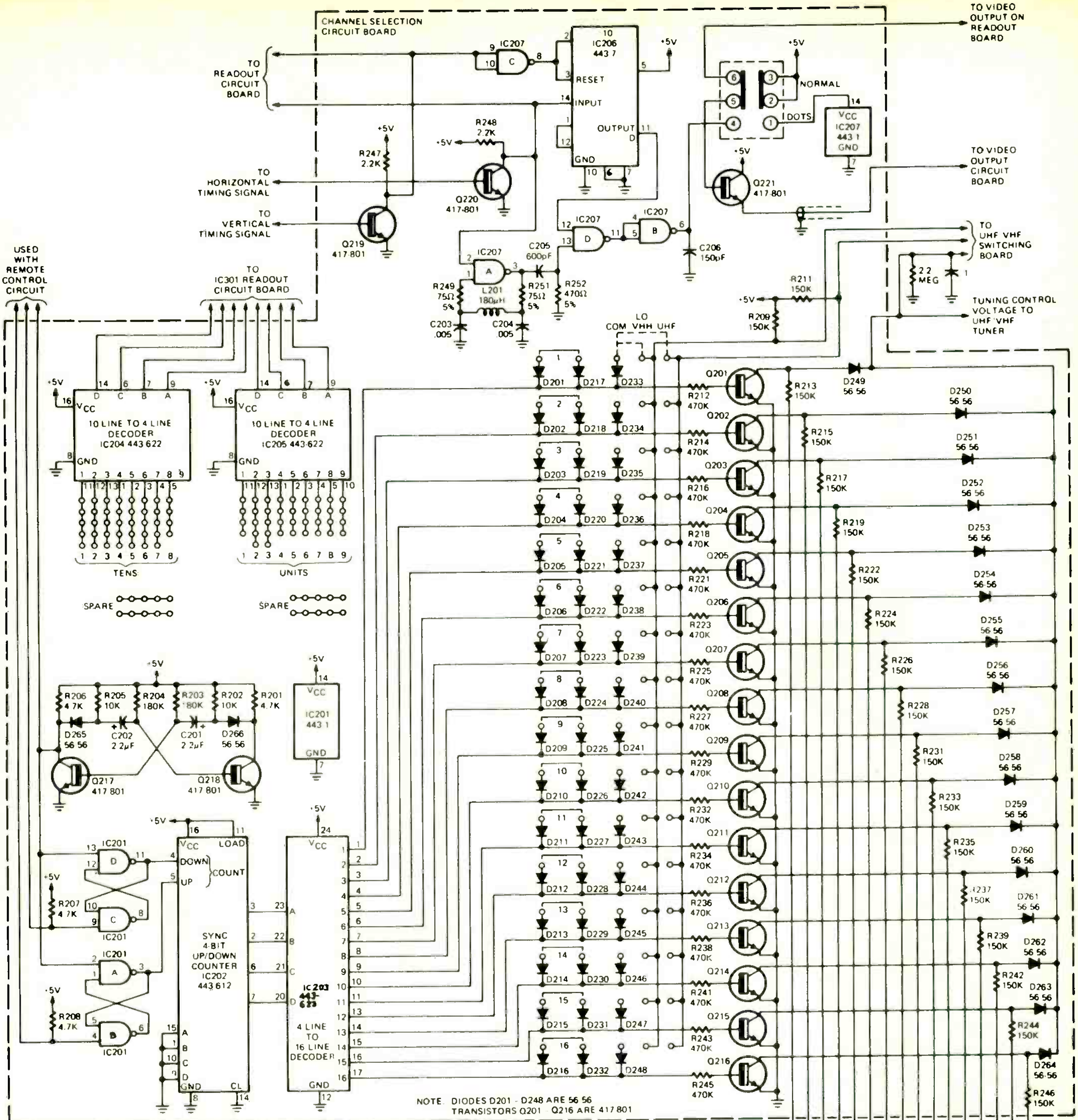


FIG. 9—ELECTRONIC SWITCHING CIRCUITS direct the tuners to change channels. They also control the channel number display.

four-digit time display mode is shown in Fig. 3-c.

A block diagram of the CMOS display IC used in the GR-2000 is shown in Fig. 4. Horizontal and vertical sync signals for the display circuit are derived from the horizontal and vertical retrace pulses of the TV receiver. Display position is determined by the adjustable multivibrators, which are triggered by the horizontal and vertical sync signals. The set owner can position the display to any part of the screen by varying the delay periods with two potentiometers.

Fig. 5 is a block diagram of the entire display system including the clock and showing the connections to the TV receiver. The display circuit which is made up of the 28-pin CMOS IC and its associated circuitry is mounted on a single-sided printed circuit board. The 28-pin clock chip and its associated circuitry plus time-set switches requires only a few more square inches of space.

The sync vertical pulses are gated into the display circuit for an adjustable period of time that is variable from several seconds to as much as half a minute or more each time the channel is changed or when the recall switch (part of the volume-control curcuit) is activated.

The digital output signal from the display circuit is coupled to a display driver transistor amplifier which parallels the luminance driver stage. The display signal thus enters the video stages as a luminance or black-and-white signal that forms a white display on the screen. Display driver current is adjustable, controlling display brightness without affecting the program. The display is superimposed over the video signal.

A dot pattern for use when converging the color receiver can be substituted for the display signal by throwing a switch in front of the display driver stage (NORMAL-DOTS). The dot generator itself, shown in Fig. 6, uses the same

(continued on page 78)

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CD-4 RECORDS

Phonograph records and playback equipment have re- but their specifications have become more Requirements for discrete 4-channel CD-4

BY LEN FELDMAN
CONTRIBUTING HIGH-FIDELITY EDITOR

THE DISCRETE FOUR-CHANNEL record has arrived upon the hi-fi scene and one manufacturer after another is offering hardware with which to reproduce these records in home music systems. At last count, nearly a score of receivers have built-in CD-4 demodulator circuitry or at least a pocket or slot into which such circuitry can be added in the form of a plug-in module. Early claims of phono cartridge manufacturers to the effect that "their" best stereo pickups could successfully track the complex groove information in CD-4 discs have largely been abandoned, and a new generation of "special" CD-4 cartridges is already on dealers' shelves. At least a half dozen separate CD-4 demodulator accessory boxes (self-powered and "easily connected" to existing equipment are also available.

It was the instruction manual that accompanied one of these demodulators that prompted me to investigate some of the limitations and special requirements of the new medium. The booklet that accompanies JVC's model 4DD-5 demodulator states:

1. In connecting turntable to demodulator, low-capacitance cords must be used. These cords are normally supplied with the demodulator . . . Proper four-channel performance cannot be guaranteed if another type of cord is used.

Other literature we had read concerning this subject generally settled in on a value of 100 pF as the maximum capacitance of the cable that could be tolerated in a CD-4 set-up. The cables supplied with the JVC unit were measured and found to have a total capacitance (per side) of 45 pF. The length of these connecting cables is just over 1 meter, or about 40 inches, which means that it has a capacitance of 13.5 pF per foot. This is an extremely low value of capacitance compared with ordinary shielded cable normally used for connecting between turntable jacks and preamplifier input. Typical values of such cable run anywhere from 25 pF to 50 pF per foot. In the case of a three-foot cable having the higher capacitance value, that means that its capacitance would exceed the recommended "maximum" of 100 pF.

The fact is that not everyone will use a separate demodulator for discrete disc playback as demodulator circuitry becomes an integral part of receivers and amplifiers, and ordinary shielded cable is likely to be used. If no consideration is given to the total capacitive load seen by the phono cartridge, results obtained by the listener may prove totally unsatisfactory.

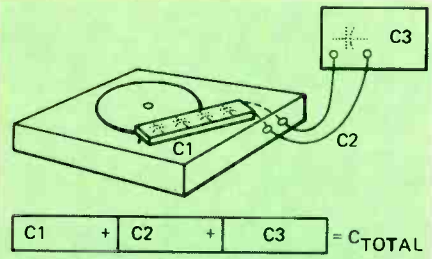

FIG. 1—TOTAL CAPACITANCE loading a CD-4 cartridge consists of three separate capacitive components.

Other loading effects

While some stress has been placed on cable capacitance by many manufacturers, little or nothing has been said about other parameters which govern overall frequency response and input level—as applied to the actual input of the demodulator circuitry. The diagram of Fig. 1 shows at least three separate capacitive loading effects that can affect performance. The internal wiring from the terminals of the changer or turntable (up through the pickup arm and to the cartridge terminals) also has measurable parallel capacitance, as does the input circuitry of the demodulator itself.

We measured the internal wiring capacitance of three popular automatic turntables (all of them selling for around $200.00 or more) and found that internal wiring capacitance ranged from a low of 23 pF per channel to a high of 135 pF per channel. In theory, at least, the changer having the 135 pF internal capacitance would not be expected to work with CD-4 no matter how short the external shielded cables! In fact, this did not prove to be the case.

Equivalent circuit

A magnetic cartridge can be viewed as the equivalent circuit shown in Fig. 2. While this schematic is a simplified representation of the electrical equivalent circuit of a magnetic pickup, it illustrates the action of the loading capacitance in altering frequency response. With capacitance of the

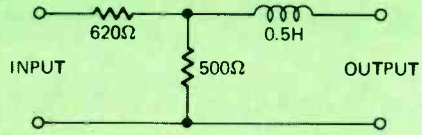

FIG. 2—ELECTRICAL EQUIVALENT of a magnetic phono cartridge.

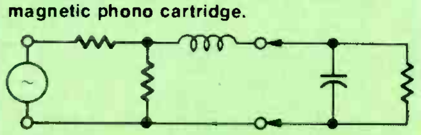

FIG. 3—EXTERNAL LOAD on cartridge acts as a half-section low-pass filter.

three contributing components added, as shown in Fig. 3, a familiar half-section low-pass filter is formed, consisting of the inductance of the cartridge and the external capacitances. Frequency response of this "filter" will depend in part upon the terminating load resistance and the source resistance.

Most of the new CD-4 cartridges are designed to be loaded by a resistive value of from 47 K-ohms to 100 K-ohms. If we presume that the new stylus assemblies and physical parameters of the new cartridges result in a frequency response which is essentially "flat" to 45 kHz or higher (a requirement of the new CD-4 discs), any "roll-off" in response experienced in actual use must be a function of the loading capacitance in the circuit of Fig. 3.

In setting up a CD-4 playback system there are, of course, other variables. For example, not all of the new cartridges produce the same nominal output for a given stylus velocity at 45 kHz (or for that matter, even at mid-band audio frequencies). If a given cartridge has a nominal output of 3 mV and is used with a demodulator having a *carrier* sensitivity of 1 mV, frequency attenuation could be as much as 10 dB at 45 kHz and perfect results might still be obtained. On the other hand, a cartridge having a nominal output of only 1.5 mV might be down only 4 dB from that nominal output and already be below the sensitivity threshold of the given demodulator circuitry.

JVC, the originators of the CD-4 record, make a series of frequency test records. We used them to determine performance characteristics of four different CD-4 cartridges, using two different record changer set-ups. The first record changer used had an internal capacitance (per channel) of only 23 pF. To this, we added the special low-capacitance cable supplied with the separate JVC demodulator. The second record changer was one which had an internal wiring capacitance of about 135 pF. To make matters still worse, we added to this a typical four-foot cable having a total capacitance of 130 pF. The total capacitance loading the cartridges (exclusive of the input capacitance of the demodulator circuitry) was therefore 265 pF—an extreme case, to be sure. The first cartridge to be checked was JVC's own model 4MD-20X. Its nominal frequency response is plotted in Fig. 4 and is seen to be essentially flat to about 50 kHz. Nominal output for 3.54 cm/sec stylus velocity at 1 kHz was measured as 1.9 mV. With the low-capacitance set-up, output at 40 kHz had dropped to 0.76 mV, a drop of approximately 8 dB. Using the inordinately high-capacitive loading, a total drop of 13

the problems and the promise

mained outwardly much the same through the years
stringent with each technical advancement.
players are especially rigorous as you'll see

dB was noted, resulting in an output of 0.42 mV at 40 kHz. Overall frequency response for these conditions is plotted in Fig. 5.

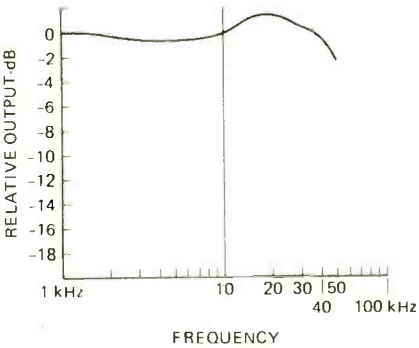

FIG. 4—UNLOADED FREQUENCY RESPONSE of JVC model 4MD-20X CD-4 cartridge.

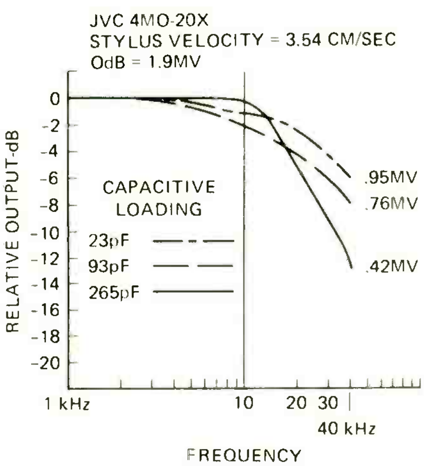

FIG. 5—EFFECT OF DIFFERENT capacitive loading on JVC cartridge.

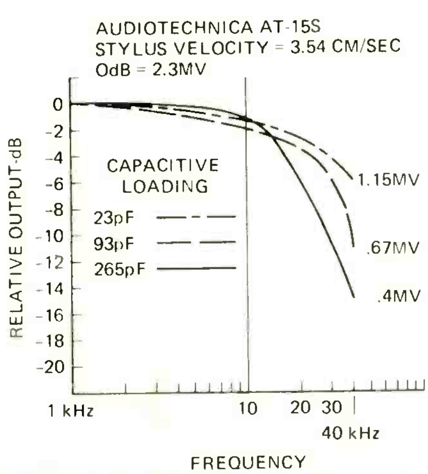

FIG. 6—EFFECT OF DIFFERENT capacitive loading on Audio Techinca cartridge.

CD-4 calibration record

JVC supplies a 45-rpm, 7" test record with all its demodulators. In addition to providing two bands of warble tone for left and right separation adjustment, there is a band of high-modulation 400 Hz with superimposed 30 kHz carrier frequencies designed to help you adjust the "carrier level" control which comes with every demodulator circuit (whether separate or built in). The theory here is that the circuit's 30 kHz carrier gain must be variable to optimize results for different cartridges and their outputs.

Instructions tell the user to choose that setting which results in least distortion in the audibly reproduced 400 Hz tone. The instructions further state that even if distortion cannot be eliminated entirely, this does not preclude proper reproduction of quadradiscs since their modulation is not likely to be as great as that deliberately cut into the test band. In the case of the JVC cartridge (and the similarly constructed Audio Technical model AT-15S, whose responses under both sets of test conditions are plotted in Fig. 6), distortion could be eliminated with the low-capacitance changer and cable setup, and reproduction was fine when playing an assortment of CD-4 musical records. The same held true for the Pickering model UV-15/2400Q CD-4 cartridge (whose outputs are plotted in Fig. 7) and an experimental model received from Shure Brothers (not yet released as a production cartridge) whose outputs are plotted in Fig. 8.

Note, however, that the output of these last two cartridges at 40 kHz was significantly lower than that obtained with the JVC and Audio Technica models. When conventional cables (about 70 pF) were substituted for the special low-capacitance cables, the Pickering could no longer be adjusted for "no distortion" reproduction of the test tone on the JVC test record. Nevertheless, reproduced music from typically recorded quadradiscs still sounded fine under these conditions.

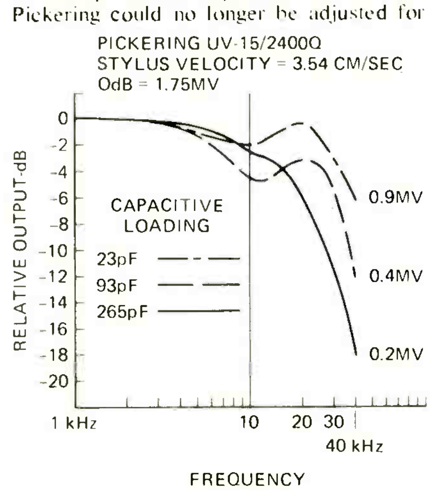

FIG. 7—USING A PICKERING cartridge here you can see the effect of different capacitive loads.

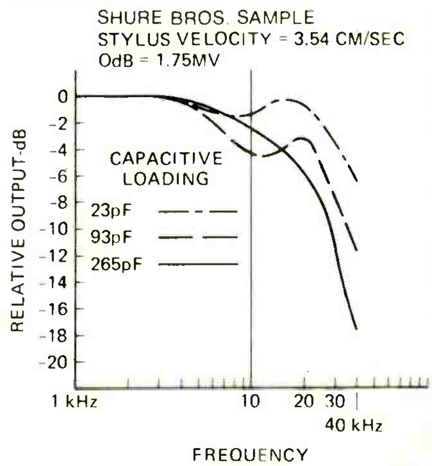

FIG. 8—EXPERIMENT SHURE CARTRIDGE is also affected by changes in capacitive load, as shown here.

When the extreme conditions of leading capacitance were substituted, none of the four cartridges could reproduce the 400 Hz tone from the test record with "no distortion." Under these conditions, however, the JVC cartridge continued to play acceptably while the other three began to exhibit break-up caused by "carrier drop-out." Based upon the curves obtained for all four cartridges, this would indicate that the *least* amplitude of carrier signal (at 40 kHz) required by the JVC demodulator, when set for maximum carrier gain, is something more than 0.4 mV. The other three cartridges had outputs of 0.2 mV, 0.2 mV and 0.4 mV at 40 kHz under these high-capacitance loading conditions. Of course, all the tests were conducted using the same JVC separate demodulator. Other later designs may well have a lower input sensitivity requirement and might therefore be less subject to the carrier drop-out experienced in our deliberately severe tests.

On the other hand, many records may contain higher orders of audio modulation than did our few musical examples and such records may well cause audible distortion of reproduced programs, if not actual drop-outs and reversion to "two channel" operation.

The conclusions that can be reached from all these measurements are:

1. **Factors determining maximum permissible** external cable capacitance include internal changer wiring capacitance, cartridge output level, and input sensitivity of the particular demodulator.

2. **The nominal "maximum" capacitance** of 100 pF suggested by many manufacturers of CD-4 hardware seems a bit conservative, probably deliberately so to provide some margin for error.
3. **In any event,** all other things being equal, users should strive for *minimum* cable capacitance—even if this means shorter distances between the turntable and the demodulator input—a small price to pay for proper reproduction of this new breed of four-channel disc.

Tracking force

All of the cartridges tested in our experiments tracked best at forces of 2 grams or even slightly higher. If this tends to upset the audiophile who has been conditioned to tracking forces of 1 gram, and even less with the best of the stereo pickups, a moment's reflection (and a glance at the cross-section diagrams of Fig. 9) should put all fears to

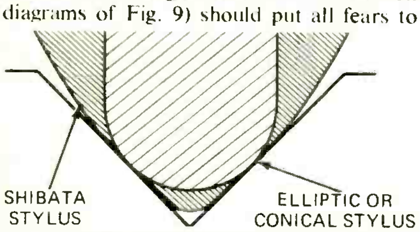

FIG. 9—SHIBATA SHAPED STYLUS engages more surface area of record groove wall, reducing tracking pressure.

rest. The stylus tip shape used in *all* of the new CD-4 cartridges is neither elliptical nor conical. Whether you call it a Shibata stylus (as most Japanese manufacturers do) or a Quadrahedral shape (a name coined by Pickering), the principles involved are the same. Surface contact between the stylus edges and the two groove walls is greatly increased compared with the surface contact achieved with conical or even elliptical styli. Record wear is a function of stylus *pressure* (measured in grams or pounds per square inch), *not* overall downward *force* (measured simply in grams or pounds or ounces). If the surface dimension engaged by the new-shaped styli is double that of earlier types (and it almost is), that would mean that the *pressure* per surface area is *one fourth* its previous value. In other words, 2 grams of tracking force with a Shibata stylus creates no more pressure than a conventional stylus with 0.5 grams downward force applied.

Anti-skating and vertical alignment

In the past, many experimenters have "written off" anti-skating adjustments on automatic turntables as a refinement which may perhaps reduce record wear over the long term, but which produce no audible improvement regardless of correct adjustment, incorrect adjustment or complete absence from the scene. The experiments with the few CD-4 cartridges outlined above certainly disprove this generalization when it comes to discrete discs. Incorrect anti-skating adjustment or no compensation for the inward pull of the tone arm resulted in very audible distortion and even loss of decoding during certain musical passages of some of the records we played. If you have ever doubted the need for this calibration on your record changer or turntable, try doing without this feature when you listen to your first CD-4 records and you'll quickly become convinced of its importance.

In stereo record reproduction, angular displacement of the stylus from true perpendicular resulted in rapid loss of channel separation (or increase in cross-talk). A 5-degree error in verticality of the cartridge and stylus results in separation which is reduced to about 12 dB at 1 kHz. Many people ignored this critical adjustment, probably because 12 dB of stereo separation actually sounds like pretty good stereo. In the case of discrete four-channel records, departure from verticality of the stylus assembly—even by a few degrees—will lead to complete failure of the demodulator to properly decode one groove wall. Thus, left-front and left-back channels may still sound right while all right information is combined in the right-front speaker or vice-versa. In really extreme cases of misalignment, you may lose decoding altogether and the disc will be reproduced like a conventional stereo record.

The promise

If all of what we've said so far tends to discourage your "conversion" to the discrete record format, take heart! The situation is not unlike that which prevailed when stereo FM was first introduced. (The technology is really quite similar, what with "main channel" information and super-audible carrier information all mixed together both in the stereo FM composite signal and in the groove modulation of a CD-4 record.) Early stereo FM decoders provided poor separation, tended to drift out of adjustment and reproduced stereo FM programs with more noise than the system justified. Yet today, we take the stereo multiplex circuits in our tuners and receivers pretty much for granted and expect them to work as well as other parts of our hi-fi systems—and they do.

Demodulators *will* become more sensitive and less critical to adjust. (Already announced is a new IC chip, developed by inventor Lou Dorren and about to be distributed by Panasonic for manufacturers' general use in CD-4 equipment.) The software is getting better all the time, too, with lower noise levels, increased playing time and higher output levels showing up on late releases. Cartridges will get better, too, just as they did when stereo discs first appeared. In the meanwhile, if you've got the urge to hear this latest sonic miracle, a bit of care in the areas we've discussed will result in a discrete four-channel system of which you can be justly proud. **R-E**

REACT approves 224-225 MHz CB—wants emergency channel in band

Replying to an FCC request for comments, REACT, a voluntary organization of Citizens band operators for Emergency Communication, "heartily favors the allocation of additional spectrum for the purpose for which the Citizens band was established originally," and therefore "favors the assignment of 224 to 225 MHz for 40 additional channels for a new Citizens Radio Service," a proposal which was the subject of an FCC hearing.

REACT is an organization of some 40,000 Citizens Banders divided into 800 teams throughout the country. They maintain a watch (an ear) on channel 9 of the Citizens band, respond to emergency calls, provide two-way communications in local emergencies, and often offer direct physical assistance and take part in action to alleviate or avert effects of emergencies.

The communication to the FCC was the result of a mail canvass of the organization's 800 teams. A number of questions were asked, and among those replying, 93 per cent felt that a new additional emergency channel, similar to the present channel 9, should be set aside for emergency communication on the proposed new band.

Signed by Henry B. Kreer, National Director, and Gerald H. Reese, Managing Director of REACT, the comments conclude: "We view the allocation of this new Class E service as a progressive and justifiable recognition by the Commission of the right of individuals to utilize the radio spectrum, a natural resource, for individual, personal, and business communications."

JACK KELLY, C.E.T. (left), president of the Arizona State Electronics Association, receives the "Outstanding State Association President" plaque from NEA Awards Chairman Everett Pershing (center) at the Kansas City Convention. His wife, Wanda Kelly (right) received an NEA Special Recognition Award for her help on State and National schools and with the Arizona State Association.

WITH SPECIAL ELECTRONIC EQUIPMENT to track down and solve problems of auto radio reception, this GMC Vantura is being sent by Delco Electronics to areas where poor or spotty reception has been reported. In New York, it was first driven near the Empire State Building, from which 15 radio signals are broadcast. The strength of each signal was measured with a spectrum analyzer that has a range extending from below the broadcast band to 1.2 GHz. The van was then driven to various spots in the city (such as the one in the photo) and the signal strengths compared with the ones previously measured. At the same time, a four-channel tape recorder records the actual sounds on two of its channels. The spectrum analyzer display is recorded on the other two, one of which receives its input from the vertical, and the other from the horizontal, outputs of the analyzer. The recordings are taken to Delco headquarters at Kokomo, for analysis.

THE GYRATOR - an IC inductor

Until the fairly recent development of this simulated inductor, the inherent bulk of even the smallest inductor has excluded inductance from all microelectronics except hybrid LSI's.

by STEVE LECKERTS

THERE IS A SEALED CONTAINER, THE MYTHical black box, sitting in front of us with two terminals coming out of the top. Our problem is to nondestructively determine what electrical component is inside. When we connect a constant-amplitude current source to the terminals and varying the frequency we find that as the frequency increases the voltage across the terminals decreases with a mathematical pattern. The voltage decreases exactly inversely with frequency. To complete the characterization we compare the phases of the input and output currents and see that the phase of the voltage lags the current by 90° irrespective of frequency. Our observations can be summed up by the mathematical expression $Z_1 = V_1/I_1 = 1/2\pi jfK$ where K is a positive constant and j is a mathematical ruse to show the 90° phase shift. If K is replaced by a C the expression is the same as the impedance of a capacitor of value C and we identify the hidden component as a capacitor.

Now take a second black box with two sets of terminals and connect the output terminals to those of the first box. The second box contains an active transistor circuit. It does not hold any energy-storing components, specifically capacitors and inductors. The box transforms the output current to input voltage and the output voltage to input current. Looking into the input terminals we expect to see the response of the first box with the roles of voltage and current interchanged. We repeat our measurements and find that now the voltage increases directly with frequency. Also the phase relationship has reversed with the voltage now leading the current by 90°. The expression for this measurement is written

$Z_2 = Vin2/Iin2 = 2\pi jfC$,

where C is the value of the capacitor in the first black box. Well this new two-box hookup behaves exactly like an inductor. The only thing unusual about the expression is that in place of the L that would normally be found is the value of the real capacitor C.

Note that we end up with $Z_2 = 1/Z_1$ which is not too surprising since impedance is the ratio of voltage to current and we have reversed them. By interchanging the roles of current and voltage we have simulated an inductor. This second black box is a gyrator, so called because it is electrically analagous to the mechanical gyroscope.

The gyrator

Fig. 1 shows the basic form of the gyrator with two transconductance amplifiers in a negative feedback loop. The amplifiers have both high input and output impedances. For a voltage input of v_{in} amplifier 1 has a current output i_1 equal to $g_m v_1$. We use the familiar transconductance notation gm since it is the ratio of current to voltage. Likewise the output of amplifier 2, i_{in} is $g_m v_2$.

This amplifier has a negative sign in front of its current gain indicating a phase reversal or 180° phase shift through it. If we load the output of amplifier 1 with a capacitor we have a situation where the input current i_{in} is transformed into the capacitor voltage v_2 and the input voltage v_1 is transformed into the capacitor current i_2. As we have explained this is precisely what we want and will result in an indictive looking input impedance. For those of you who would like to indulge in some algebra follow the next few equations:

$i_{in} = g_m v_2 = g_m v_c$

$i_{out} = -g_m v_{in} = i_c$ or $v_{in} = -i_c/g_m$

now $i_c = v_c/Z_c = v_c/(½\pi jfC) = -2\pi jf v_c$

and the input impedance $Z_{in} = v_{in}/i_{in} =$

$$\frac{-i_c/g_m}{g_m v_c} = \frac{2\pi jfCv_c/g_m}{g_m v_c} = \frac{2\pi jfC}{g_m^2}$$

The input impedance therefore looks like an inductor with a simulated inductance equal to C/g_m^2. We have assumed the gm of both amplifiers to be identical in magnitude. If they are not the expression would be $C/g_{m1}g_{m2}$.

A circuit proposed[1] to realize this basic gyrator configuration on an IC is drawn in Fig. 2. Each transconductance amplifier has two FET's and two bipolar transistors. High input impedance and circuit Q is assured by the input p-channel junction FET and the high output impedance results since the output is at the junction of a FET drain and bipolar collector. The circuit shown in Fig. 3 is interesting[2] because it is balanced using two differential amplifiers. One amplifier uses npn's and the other pnp's making the biasing easy, using direct connections between the corresponding output collectors and input bases.

This circuit is particularly convenient since it simulates a floating inductance completely unrestrained by a ground connection. If desired, either one of the input terminals can be grounded.

Next, Fig. 4 is an extremely simple circuit[3] that uses an RC combination and a single FET to simulate inductance. The FET corresponds directly to amplifier 1 in the original scheme of Fig. 1. Instead of the second amplifier a pseudo-current source is created using a large resistor R. Of course this is an approximation to a higher impedance active current source and we must expect a compromise in the Q of the resulting

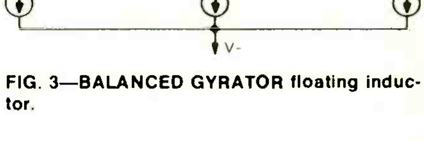

FIG. 3—BALANCED GYRATOR floating inductor.

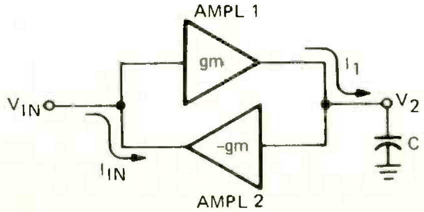

FIG. 1—BASIC GYRATOR uses two transconductance amplifiers as shown.

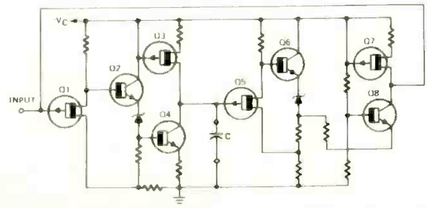

FIG. 2—IC GYRATOR CIRCUIT has p-channel junction FET's for high Q.

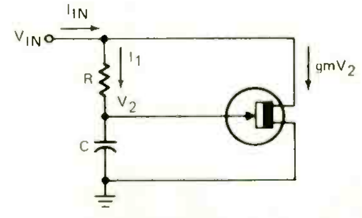

FIG. 4—SIMPLE GYRATOR uses high resistance to approximate transconductance amplifier.

inductance. In Fig. 5 transconductance amplifiers[4] are constructed by combining voltage and current amplifiers. The gain blocks are either a positive or negative unity gain current amplifier driven by unity gain voltage amplifiers. The current and voltage amplifiers are interconnected with a series resistor which sets the transconductance equal to the inverse of the resistor. Presenting an essentially zero input resistance, the

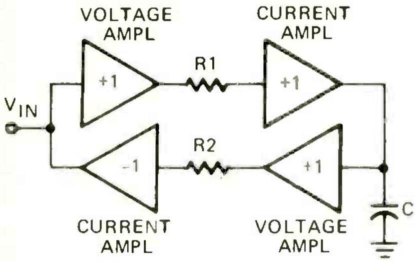

FIG. 5—GYRATOR WITH UNITY GAIN. Voltage and current amplifiers combined to form transconductance amplifiers.

current amplifier conducts equal input and output currents. These two currents are then equal to the input voltage divided by the resistance.

Other impedance converters

A Japanese manufacturer has recently announced an integrated circuit which is different from the pure gyrators we have been describing. Not only does its input impedance look inductive but it also generates a negative resistance component. Positive feedback in the manner of a Q multiplier must be added to the negative feedback used for impedance transformation. Mitsumi says the small chip it has named Semicon L is a replacement for the large coils used in radio and TV receivers.

Figure 6 is the schematic for the device which is further simplified by replacing Q2 and Q3 with a single pnp transistor. The composite configuration of Q2 and Q3 is commonly used by IC manufacturers to compensate for the low beta of the lateral pnp's they can produce compatable with their normal npn processing. The collector current of Q2 feeds Q3's base producing a beta roughly equal to the product of the two individual device betas. Q3's collector returned to Q2's emitter completes a negative feedback path lowering the impedance at this composite emitter terminal. The emitter of Q3 acts as the collector of the composite device: Q2's base as the base, and the emitter-base junction as the emitter.

While the simplified schematic of Fig. 7

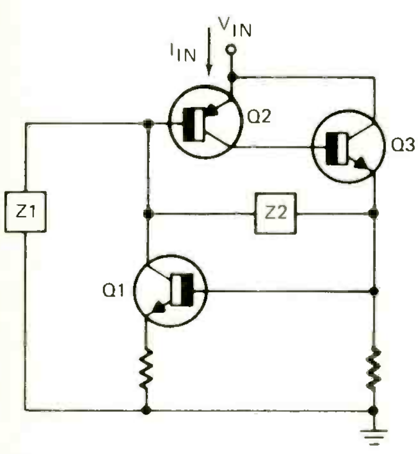

FIG. 6—MITSUMI'S SEMICON L impedance converter is diffused onto a small monolythic integrated circuit.

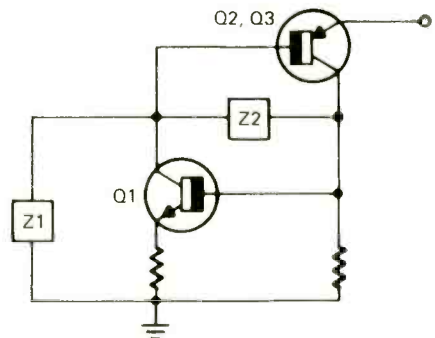

FIG. 7—SIMPLIFICATION OF FIG. 6 by redrawing composite Q2, Q3 configuration as single equivalent device.

appears elementary, it is actually quite difficult to analyze and very careful assumptions must be made to produce meaningful results.

Each of the two transistors in Fig. 7 has its collector connected to the other device's base. The two 180° base to collector phase shifts add to give 360° or 0° around the loop, which is positive feedback. The input impedance is of the form $Z_{in} = -AZ_1 + B/Z_2$ where A and B are real positive numbers. Z_1 is a resistor and Z_2 a capacitor giving an input impedance that is a negative resistance in series with an inductance. Inductance values in the range of 1 MH to 5H with Q's between 50 and 100 are claimed with frequency capability to 15 MHz.

Besides synthesizing inductors with gyrators, complete filter designs can be based around them. Figure 8 is the design of such a low pass filter. It is a fifth-degree Chebyschev type[5] with a 0.2 dB in band ripple and a cutoff frequency of 3.4 kHz. Fig. 9 is the schematic of a gyrator suggested by the proponent of this filter technique. Q1, Q2 and Q5, Q6 are Darlington connected amplifiers for high input impedance by virtue of the multiplication of the device betas. Q4 and Q8 are constant-current sources which combine with Q3 and Q7 respectively to form high impedance current outputs. The constant-current source enables current to flow into or out of the gyrator terminals

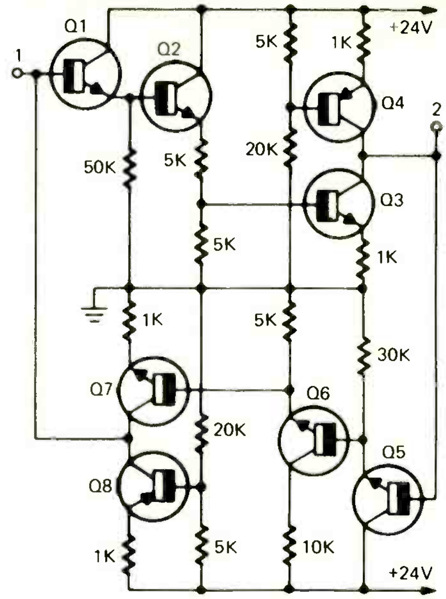

FIG. 9—GYRATOR WITH BIDIRECTIONAL current output.

which is necessary to charge or discharge circuit capacitances. When Q3 is cutoff current will flow out of terminal 2 from constant current source Q4. When Q3 conducts a current equal to that flowing in Q4 there will be a net zero output current from terminal 2. If Q3 conducts a larger current than can be supplied by Q4 there must be a net current flow into the terminal.

Some engineers say that making a negative impedance converter to synthesize negative capacitors is easier than building a stable usable gyrator. Not only are we concerned with the synthesis of inductance or inductive circuitry but important secondary criteria must be carefully examined. Whenever transistor circuitry replaces passive devices additional noise sources are injected. The added noise has to be kept at a minimum so the product performance is not degraded. Dynamic range is another key specification. Active circuitry has finite signal excursions that can be handled before overloading takes place, generally at a level considerably lower than could be handled by the physical counterpart. Temperature stability is also a vital consideration. In the final analysis the secondary characteristics are what makes one design superior to another.

Fig. 10 shows how a negative capacitance can be generated using a differential amplifier. The negative capacitance seen at the terminals is of value $2/fC_1R_3$. The design of a 104 to 108 kHz telephone channel bandpass filter[6] using negative capacitance is given in Fig. 11.

We have demonstrated how inductive networks can be simulated with resistors and capacitors combined with feedback amplifiers. With careful use of integrated cir-

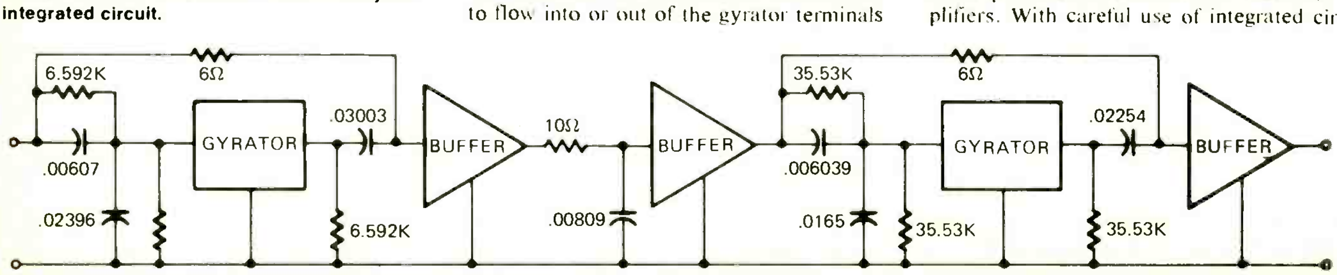

FIG. 8—FIFTH DEGREE CHEBYSCHEV lowpass gyrator filter.

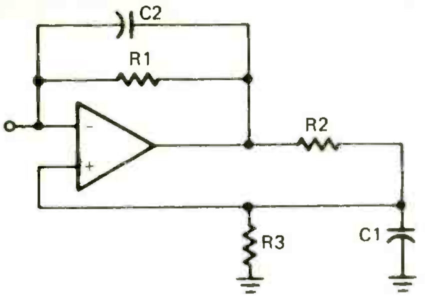

FIG. 10—NEGATIVE IMPEDANCE CONVERTER looks like negative capacitor.

cuits and thick film techniques practical circuits can be put together. Products designed using gyrators and negative impedance converters (NIC's) may soon appear in our homes. As we found with the tunnel diode any one technique is not a panacea but another tool to be added to our stockpile. The gyrator simulated inductor will eventually replace those components where space is at a premium or where there will be a savings in cost either by a physical reduction in parts count or by easing circuit adjustment using computer controlled laser or abrasive trimming. **R-E**

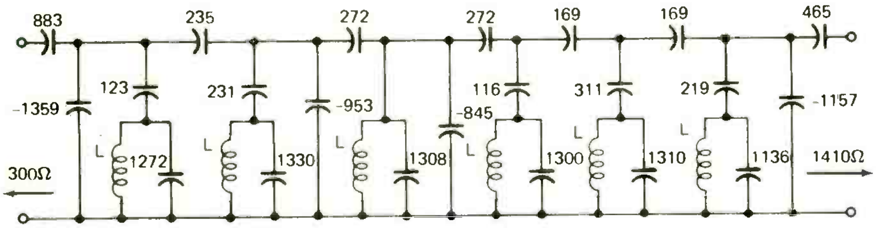

FIG. 11—TELEPHONE CHANNEL bandpass filter L=1.523 mH. Capacitors in pF.

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equipment report

Pioneer R500 Speaker System

Circle 90 on reader service card

THE R500 IS THE MIDDLE SPEAKER system in Pioneer's R for reflex speaker line. In a bookshelf cabinet 13 25/32 inches wide by 24 1/32 inches high by 12 1/16 inches deep this 8-ohm speaker system gives really impressive performance. It is an omen that speaker engineers are getting down to careful precise design using their drudgery reducing calculators and minicomputers and beginning to move out of the accoustic suspension age.

Rather than using the response smoothing and broadening techniques used in accoustically-loaded designs, the bass reflex is more analagous to a stagger-tuned amplifier where careful tuning of the entire system contributes to the performance of the final product. The speaker system is a mechanical network with mechanical reactances and resistances. Converted to analagous electrical quantities the system can be analyzed by using highly developed electrical circuit analysis methods.

Mechanical phase shifts must be appreciated such as the elemental fact that the air in front and rear of the speaker cone or diaphragm is driven 180° out of phase. This is simply because the air in front of the membrane is being compressed as the air behind it is expanded. The resonances of the cabinet structures and partitions along with the effects of ducting common to the bass reflex, when combined with the responses of the speaker elements themselves produce a multi-pole tuning. Only perfected components combined with meticulous system and cabinet considerations can produce the performance level we have learned to expect. The composition of the sound deadening material lining the inner cabinet walls, must be given careful consideration since it will affect the time stability of the system's response. This all leads to a design which has a singular advantage—efficiency. It is not necessary to specify minimum power ratings in excess of ten watts to drive the system.

While we are not generally preoccupied with efficiency per se, there are a substantial number of high-grade limited-power amplifier owners to whom the bass reflex is obviously attractive. If a high-quality speaker system can be produced in a smaller than traditional volume, as is done here, we have a workable concept.

Pioneer's attempt to bring the reflex back to prominence in a bookshelf sized system is a great success. A 10-inch cone woofer, 5-inch midrange cone speaker and a horn tweeter are combined with crossover frequencies at 800 and 5200 Hz. For wide dispersion the speakers are not recessed but are flush mounted. Woofer design pivots around a FB (free-beating) cone paper with minimized coil inductance to reduce distortion and improve transient response. A concave center pole design is used with large ferrite magnets covered with pure copper caps.

The midrange cone is also an FB type where the fibers are beaten rather than cut to give a light strong structure. An aluminum metalized polyester resin diaphragm is used in the aluminum die-cast horn tweeter replacing the more conventional cone and dome tweeters. These highlights cannot be expected to reveal the esoteric considerations that result in the system's true worth, but the proof is in the listening.

By now you are aware of the deficiencies of looking at speakers by simply studying their response curves, but we will still give a few points for perspective. The response has a 4 dB peak around 500 Hz compared to 1 kHz. Response is down 25 dB at 20 Hz, 10 dB at 50 Hz, 0 dB at 10 kHz and 12 dB at 20 kHz.

Rated at 60 watts maximum input power and with a sensitivity of 91 dB/W the R500 weighs 38 lb 9 oz. The oiled walnut enclosure is faced with an unusual split two-tone blue and black grill cloth. **R-E**

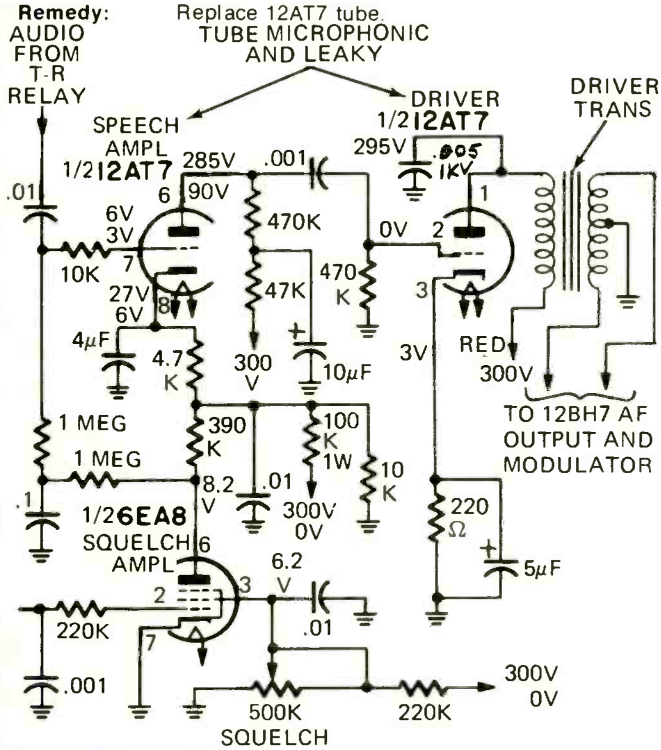
CB CASEBOOK

by ANDREW J. MUELLER

Case 1: Speaker crackles when unit is squelched.

Common to: Sonar **FS-23**

Remedy: Replace 12AT7 tube.

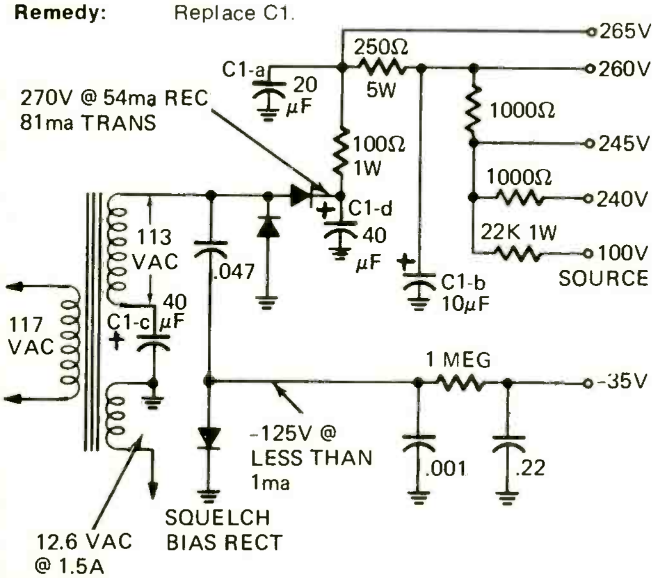


Reasoning: When the audio amplifier tube is cut off under squelched conditions, any noise due to microphonics, shorts, leakage, etc., that is generated in it can be clearly heard through the speaker. The tube was checked and found to be OK but direct replacement solved the trouble.

Case 2: Radio lights up the does not transmit or receive.

Common to: Metroteck **Mustang**

Remedy: Replace C1.

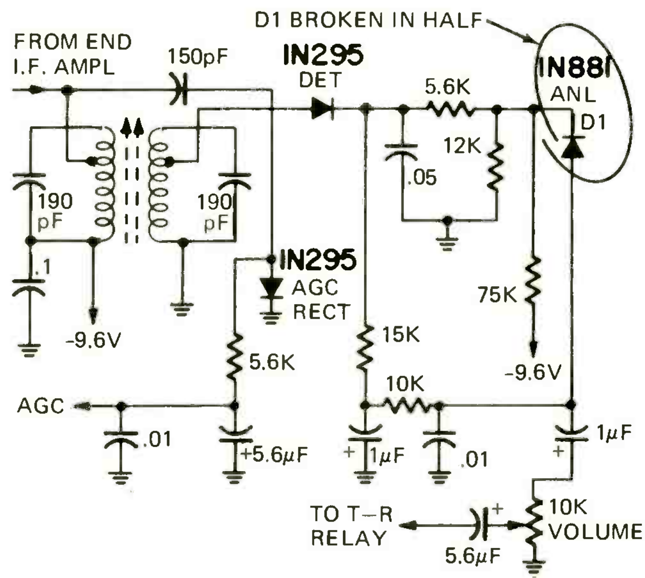


Reasoning: C1, the power supply electrolytic was found dried out. This caused the power supply to deliver only one half of the rated voltage. Replacement of C1 restored the unit to normal operation.

Case 3: Receive is weak and distorted.

Common to: Jonson **110**

Remedy: Replace D1.

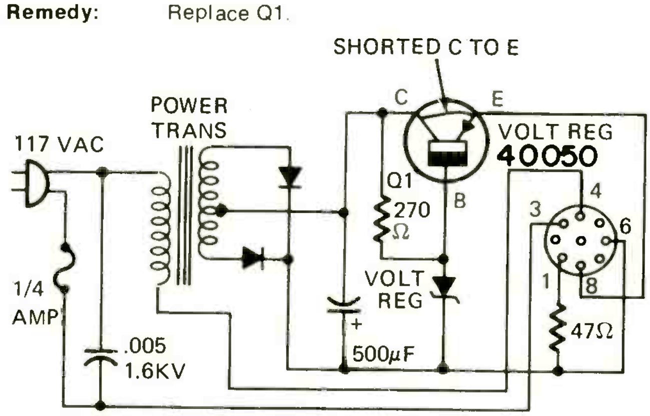


Reasoning: D1, the anl diode was found to have broken in half due to fatigue. This broke the path of receiver audio from the detector to the af amplifier. A little audio did feed through due to circuit capacitance but it was distorted.

Case 4: Unit hums on receive and transmit when operated from 117 vac.

Common to: Heathkit **GW-14.**

Remedy: Replace Q1.



Reasoning: Q1, the power supply regulator transistor is shorted. This feeds about 25 volts instead of 12 volts to the radio. In addition, there is very little filtering being done so all of the power supply ripple is fed to the radio. This results in the ac hum that is heard on both transmit and receive.

IC's for electronic music

Electronic music is a fast-growing field with the synthesizer arousing the most interest among the avant-garde. Regardless of what you want in electronic music, IC's will simplify design and ease construction.

SUPPOSE YOU WERE GOING TO DESIGN AND build an electronic music synthesizer, a pitch reference, an electronic organ, a composer, a timbre generator, or some entirely new instrument. What devices would you use? Where would you go for help?

While there are a few integrated circuits that are obviously and specifically intended for music use, these are rare, usually expensive in small quantities, and often hard to impossible to get. On the other hand, there are great heaping piles of different IC's available that don't even hint they are good for music use. These, or at least some of them, are widely available, cheap, and, best of all, many of the latest dramatically simplify things, doing as good and sometimes much better a job than older circuits did. In fact, some circuits are now available that are almost hard to believe—a very stable sine, square, triangle VCO for $3, a *hex* voltage-controlled amplifier for $1.80; a tracking "glider" phase-lock-loop that works over a 2000:1 frequency range without harmonic locking and costs under $5; a *single IC* to generate all the equally tempered notes of one octave; and switches that handle analog or digital, one to N or N to one reversibly, for under $2.

Here's my selection of a few dozen or so integrated circuits that are (1) cheap, (2) widely available, (3) applicable to electronic music, and (4) do a job far simpler or cheaper than older approaches. Table 1 lists all the manufacturers and their addresses. All prices are approximate. Be sure to have good data sheets and application notes on hand before you try to use *any* integrated circuit.

One IC top octave generator

Most music is arranged into twelve-note *equally tempered* note groupings (take a look at a piano keyboard). As you go up in frequency one *octave*, you double frequency on the *thirteenth* note. The note spacing is NOT linear, it is exponential. Each note is spaced from its neighbor by $\sqrt[12]{2}$ or approximately 6%. There is no reasonable way to exactly generate an irrational number such as $\sqrt[12]{2}$, so you have to *approximate* it the best way you can. Usually you start with a 1 or 2 *megahertz* crystal and then divide down by some "magic" optimum series of numbers (often 239 - 253 - 268 - 284 - 301 - 319 - 338 - 358 - 379 - 402 - 426 - 451) to get a good enough approximation to the highest octave you care to generate. From here you pick up the rest of the notes with a simple string of binary dividers.

The circuitry that handles the top octave is called a *top-octave generator*. Many of these circuits had been based on the GEM555 and GEM556 a pair of hard-to-use, harder-to-get IC's that are now essentially obsolete.

The *Mostek* MK5024P/AA is a one-chip,

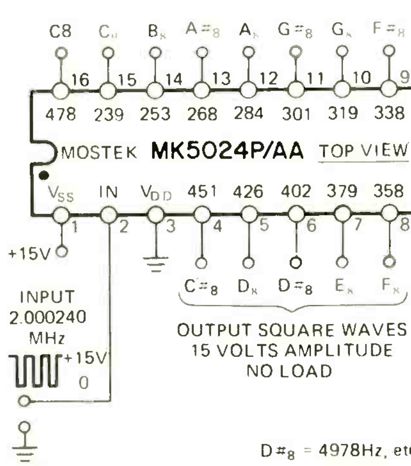
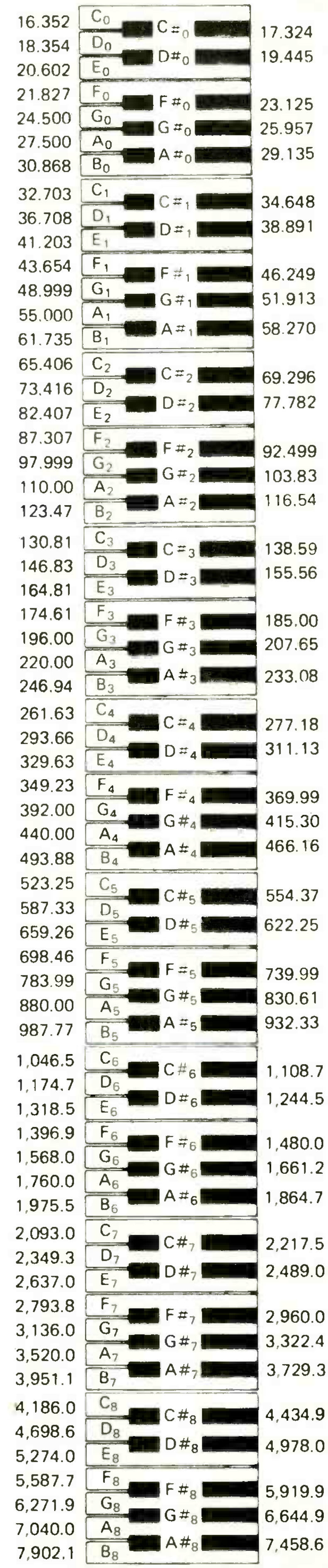


FIG. 1—SINGLE IC top octave synthesizer.



single 15-volt supply top-octave generator. Hook it up as in Fig. 1. You input a 2.000240 megahertz squarewave or sinewave of 15 volts amplitude, obtained from a crystal oscillator (for permanent tuning) or a variable oscillator (for vibrato, glides, or tuning to another instrument). You get thirteen outputs, appearing as square waves from C8 at 4186.01 hertz to C9 at 8369.2 hertz. Cost is under $12. This is admittedly a bit steep, but it is by far the cheapest route to go if you want all the notes at once.

If you only want one octave at a time, you can place a single binary divider between the oscillator and the top octave generator, rather than using 12 separate dividers.

Seven octaves at once

Once you have the top octave, you add binary dividers to get the rest. Again, there are several "music-only" divider IC's available, but none is as good, as easy to use, or as cheap as the RCA CD4024 or Motorola MC14024 CMOS 7-stage dividers. Cost is around $3.50. One IC is needed to produce seven octaves of a single note. Thus a top octave generator IC and twelve of the CD4024's will generate simultaneously all eight octaves or a total of 97 notes.

Figure 2 shows the connections. Simply apply a voltage from +3 to +18 (best results with +15) and input the top octave output. You get out seven new notes in octave steps. For instance, input A#8 (A sharp, 8th octave), and you get out A #7, A#6, A#5, A#4, A#3, A#2, and A#1. The outputs will all be square waves. Square waves only have odd harmonics present. You can convert these to sawtooth waveforms with virtually all harmonics present with a few resistors as shown as in Fig. 2-b. While the stairstep may not *look* quite like a sawtooth, analyze it and you'll find the first missing harmonic is the 16th, followed by the 32nd and the 48th, etc. . . . Otherwise it is absolutely identical to a linear ramp. Filtering is used to convert either the square or sawtooth outputs into familiar tone colors. For instance, the square waves are often used for clarinet and stopped organ sounds; the sawtooth by itself has a good string sound, while bandpass filtering is easily added to a sawtooth to get a horn or reed output.

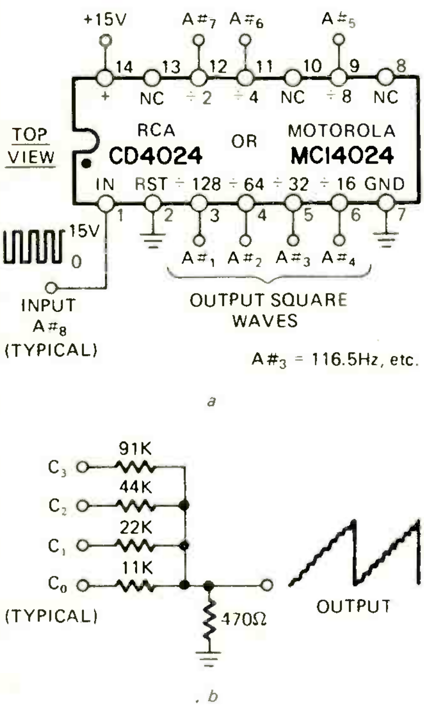


FIG. 2—DIVIDE BY 128 provides lower octaves for any note. a—Circuit for square waves. b—Adding resistors for sawtooth.

A tempo generator

How do you get a stable, cheap, wide-range square wave oscillator that's good enough as a monophonic note generator, but also is useful for rhythm and clocking, and easily drives TTL and CMOS to boot? With the *Signetics* 555 or *Motorola* MC1555 of course. This $1 IC can't be beat as a stable oscillator. Figure 3-a shows details. You can vary the resistance from 1K to 3.3 megohms, and make the capacitance anything you want above 500 pF or so. Output is usually a rectangular wave. If you need a square wave, make R2 much bigger than R1 or else add a binary divider to square it up. Figure 3-b shows how you can build a triggerable monostable or pulse generator out of the same circuit. This is useful for synthesizer envelope generation.

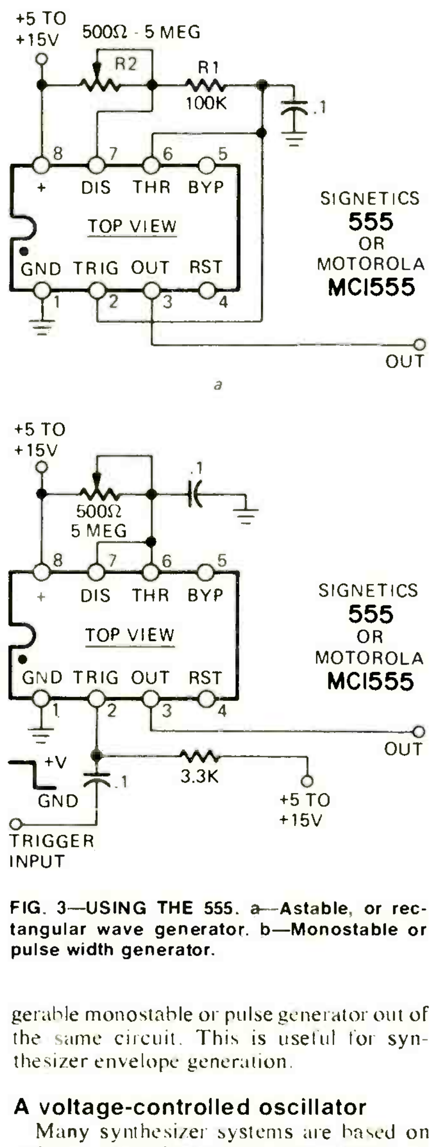


FIG. 3—USING THE 555. a—Astable, or rectangular wave generator. b—Monostable or pulse width generator.

A voltage-controlled oscillator

Many synthesizer systems are based on *voltage controlled oscillators*. Apply an input or control voltage, and you get an output frequency which you use as a tone source. Music VCO's have to be very stable to be useful. They also have to have a wide range. Ideally, they should respond in a log manner, but a log converter is more often added to the input of the VCO as a separate circuit. VCO's also should be able to put out a good looking sinewave for flute-like tones, as well as a square or triangle output. The *Intersil* 8038 does the whole job for under $3. A "baseline" circuit is shown in Fig. 4 that should get you started. Control voltage ranges from the positive supply to three volts or so *less*. The sinewave can be adjusted to below 0.5% distortion easily.

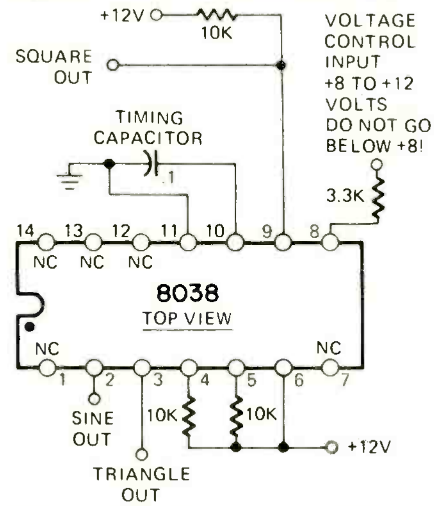


FIG. 4—SIMPLE VCO using Intersil 8038.

A dual operational amplifier

A good "741" style op-amp is essential for any electronic music circuit. An operational amplifier does at least three good things for you—it gives you controllable gain; it eliminates interaction and coupling between multiple inputs; and it gives you a versatile system gain block for active bandpass filters and things like this.

The *Motorola* MC1458 and the *Signetics* 5558 are typical dual "741" type circuits. Cost is around a dollar. The 5558 is in an easy-to-use 8-pin minidip package.

Figure 5-a shows the voltage follower connection. It gives you unity gain, a very high input impedance, a low output impedance and does not invert the signal. Figure 5-b is a voltage follower with gain. Figure 5-c shows the inverting amplifier and mixer. The gain of each input is the ratio of its own input resistor to the feedback resistor. The input impedance equals the input resistor for any input, and the summing point may be considered to be a *virtual ground*. There is no interaction between inputs or crosstalk problems possible in this circuit; further, you can *scale* or individually adjust each and every input to its own signal level inde-

ITT TCA350 ANALOG SHIFT REGISTER is 185-stage bucket-brigade af delay line.

pendently, while the feedback resistor can be varied as a master gain control. Figure 5-d shows a good, high-Q bandpass filter circuit you can use to independently control

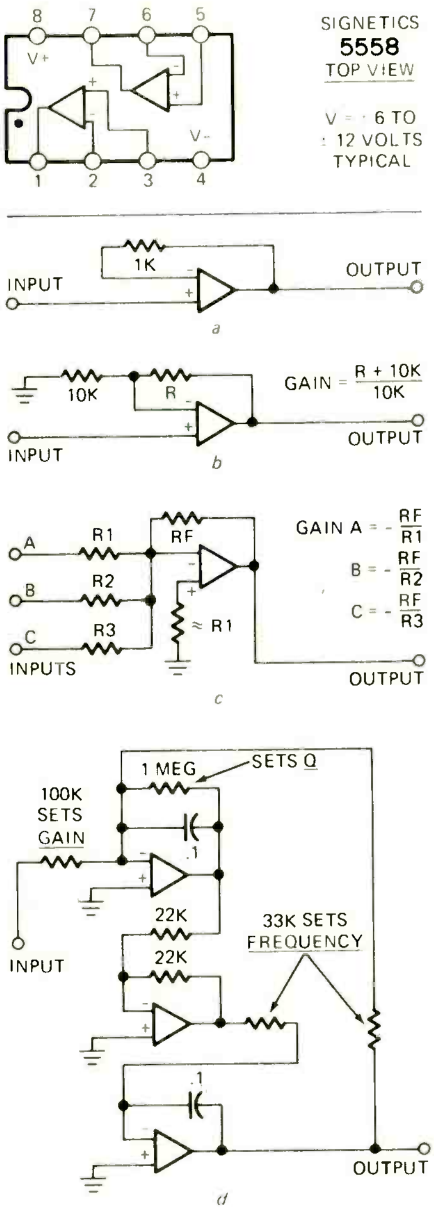


FIG. 5—A DUAL 741 STYLE OP AMP. a—voltage follower (high input Z, noninverting). b—Voltage follower with gain (high input Z, non inverting). c—Current summer or mixer —input is at virtual ground, no crosstalk is possible). d—High-Q bandpass filter.

the Q (to 500!), the gain, and the center frequency on. Use this for formant voicing circuits, sinewave recovery, and anywhere else you might like to emphasize a narrow frequency band.

By the way, if you are working at high frequency and high gain, the 741 style devices might not have enough bandwidth to do the job. If you need only a little bit more, try the Motorola MC1741S; for a whole bunch more bandwidth, go to the more expensive *National* LM318.

Six keyers at once

At the very least, music notes must be smoothly turned off and on without any key clicks or thumps. It's even better to be able to instantly vary the gain of the note so you can have complete control of attack, fallback, sustain, decay, snubbing, and perhaps even an echo. To do this, you need something that will behave as an electrically variable resistor. The circuit is called a *keyer*, an *analog gate*, or a *voltage-controlled amplifier*.

There are lots of bad ways to do this job. What you have is some circuit that is essentially *transparent* to the notes fed through it—it simply varies gain and nothing more. You must control the gain smoothly and do so equally well on the positive and negative portions of the envelope. Above all, you cannot let any portion of the envelope or control signal appear as an output, for this gives you a loud thumping.

Diodes have traditionally been used in organ circuits, but they thump, introduce distortion, and have a limited dynamic range.

An obvious choice is an integrated circuit four-quadrant multiplier—see below—, but these are far too expensive to use dozens at a time. Another possibility is an electronically controlled gain block such as the *Motorola* MFC6040, but it has too much gain for many applications.

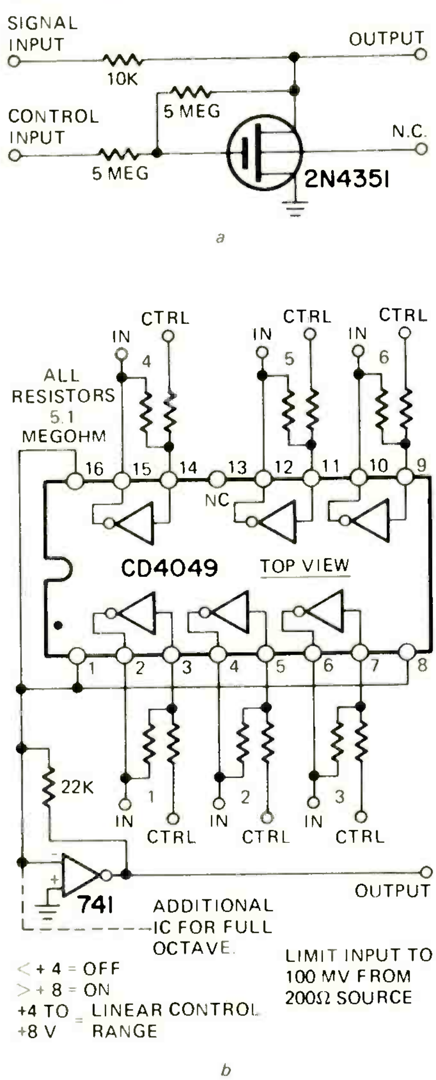


FIG. 6—HIGH-QUALITY HIGH-PERFORMANCE hex keyer or VCA costs only 30¢ per note. a—n-channel transistor as electrically variable gain control or keyer. b—CD4049 converted to six n-channel transistors.

The simplest *good* envelope keyer you can use is a single N-channel MOS transistor with some drain-to-gate feedback resistance. Figure 6-a shows the circuit. This gives you a linearly variable resistor, electronically controllable, and smoothly handles up to 10 volts of analog signal in either direction if the substrate lead is floated. Control voltage ranges from 4 or less for full off, up to 8 or more for full on; in between you get a good linear control range. For envelope and audio frequencies, there is absolutely zero feedthrough of the control signal. As a bonus, the control input looks into a high impedance that lets you use a small capacitor for the decay portion of the cycle. One typical discrete device is the *Motorola* 2N4351. At $2 or so, the cost is far cheaper than a multiplier, but still a bit steep if you use 97 of them at once.

Once again, it's digital CMOS logic to the rescue. A very few CMOS IC's can have their supply shorted to ground and thus disabling all the P-type transistors in the package. This leaves you with a block of N-channel MOS transistors that are ideal for gain control. You can get two and possibly three in the CD4007 (RCA) or the MC14007 (Motorola) devices in a dollar package. Most of the other devices, particularly the CD4009 and CD4010, have protective diodes arranged in such a way that you can't do this. The diodes are differently arranged in a new device—CD4049 (RCA) and MC14049 (Motorola). With this package, you get *six* voltage controlled amplifiers in a single integrated circuit. Cost now is around 35¢ per amplifier, but this will drop to around 10¢ per amplifer shortly.

Figure 6-b shows a full proportional control system with complete, thump free, control of attack, sustain, and decay.

Note that in both circuits, the package *ground* and *positive* terminals are tied *together* and form the *output*. The traditional inverter "outputs" are the signal or timbre input and the traditional inverter "inputs" receive the envelope commands. 3 volts or less is off; above 6 volts is on; in-between you get a smooth control range. Best input signals are less than 100 millivolts high and from a 300-ohm or less source impedance. The op-amp builds this back up to a volt or two output, eliminates crosstalk, and prevents negative feedback from reaching the gate circuit.

An analog quad switch and sample-hold

While you are looking at CMOS, check out the RCA CD4016 or the Motorola MC14016. Either of these has four separate analog off-on switches that you can apply up to ten volts of peak-to-peak signal to. You use the same circuit digitally, frontwards as a one line to four line distributor, backwards as a four line to one line selector, or as four separate switches. Unlike virtually all other IC logic families, the signals can go through the switch in *either* direction.

Figure 7-a shows the IC. Figure 7-b is a digital or analog one-to-four distributor. Figure 7-c is a digital or analog four-to-one selector. Finally Fig. 7-d shows how you can build a *sample-hold* amplifier with one quarter of this package, a good Mylar capacitor, and an operational amplifier. Sample-holds are useful in synthesizers for remembering what frequency a note was after a key is released so the decay cycle can

C

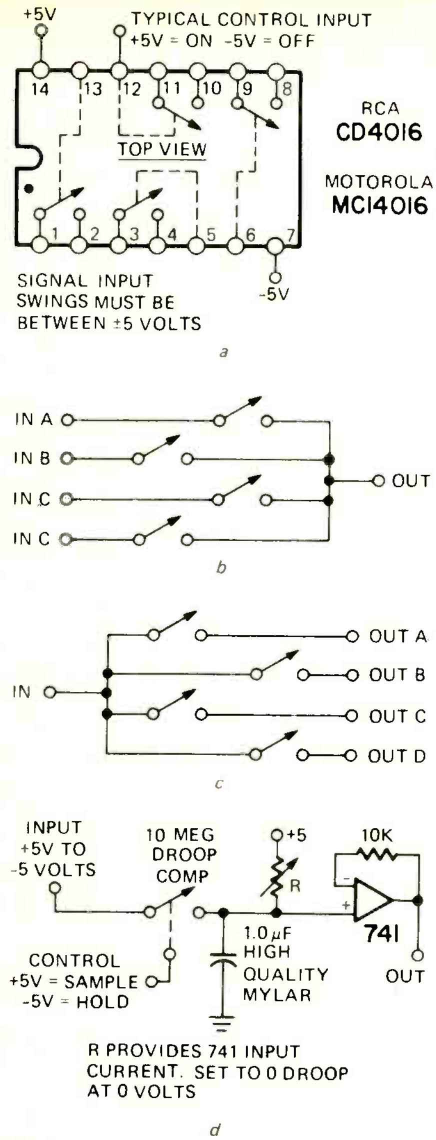


FIG. 7—A DIGITAL OR ANALOG quad switch. a—Circuit. b—Data selector—analog or digital. c—Data distributor—analog or digital. d—Low cost sample-hold.

be completed. The 4016 costs around $1.50. A complete sample-hold can be built for less than a dollar, since you need ¼ of this package, ½ of a dual op-amp and a capacitor. As with other CMOS circuits, the input control signal works into an open circuit. −5V is OFF; +5V is ON.

A tracker or gliding VCO

One of the biggest problems in any synthesizer is doing glides, sweeps, and trombone effects on a keyboard instrument. A circuit originally used by Olsen in the pioneer RCA synthesizer work to do this was called a *glider*. Today, it's called a phase-lock-loop tracker, and it is available as the RCA CD4046 or Motorola MC14046.

What the circuit does is this. You send it a frequency. It grabs onto that frequency from the one it is already at. You can control *how fast* the grabbing takes place. It can be nearly instantaneous, or it can provide a glide or sweep.

The circuit has an internal oscillator that compares its frequency against an input and then provides an error correction signal. You add a capacitor to slow down the response time to "errors".

Now, there're bunches of phase-lock loops available and you probably have already tried a few. The hangup here is that the IC you use must have at least a 1000:1 voltage controlled frequency range and must *NOT* be harmonic sensitive. This leaves out everybody but the MC4046. (The usual "565" type of PLL has only a 3:1 frequency range and is harmonic sensitive.)

One experimental circuit is shown in Fig. 8. Your input frequency can be a sine, square, or triangle or sawtooth wave. If you

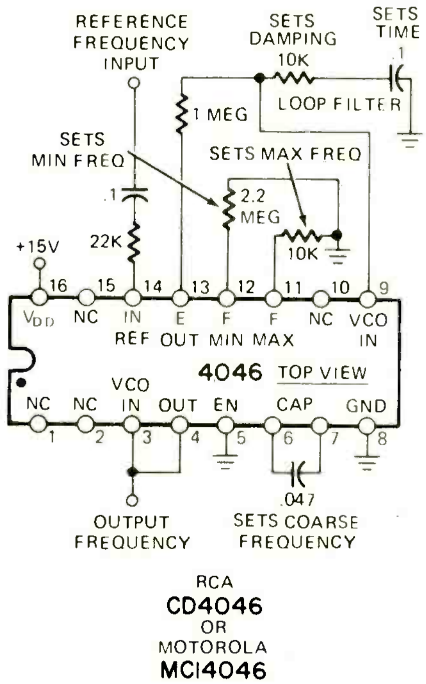


FIG. 8—PHASE-LOCK-LOOP tracker does glides and portamento from keyboard control.

are trying to follow a more complex waveform, filter it *thoroughly* to recover mostly the fundamental, or use a comparator circuit for conditioning. The capacitor sets the glide time, while the bottom resistor sets the *damping* or the overshoot. Make this resistor too *small*, and you get wild "Bounce" effects.

Cost is under $5. The normal output is a square wave, but you can easily break the loop and put in a binary divider and sawteeth resistors. You can also divide the input as well, perhaps to follow a fifth above or below, an octave above, and so on. The potential is fantastic. Use several together for chorus effects. Add external "noise" to the error signal for vibrato, chorus, or randomness.

And some others . . .

Let's take a quick look at a bunch of other devices that you may want to use in music circuits. These are a bit more specialized, but can solve some unusual music problems fast:

Motorola MC1408-6 and MC1408-8. Six and Eight-Bit Digital to Analog Converters. Input a digital sequence and get notes out. Multiplying but not truly bilateral. An output amplifier is needed. Under $5.

American Microsystems Inc. has a whole line of MOS music products. These include older top octave systems, rhythm generators, rhythm counters, and newer devices that combine functions. The S2566 Rhythm Generator provides a complete bandbox-on-a-chip when combined with a counter. Around $18.

Analog Multipliers. Analog multipliers are true four quadrant multipliers. They can be used for precision keyer and VCA applications or for *ring modulators*, where you combine two tones and get only the sum and difference out, or where you shift the frequency of a tone to compress or expand its harmonic spectra. These are still a bit steep in price to use on each and every note, but in a synthesizer system, one or two of them is certainly worth the price. Costs run from $15 upwards. Typical devices are the *Motorola MC1494* and *MC1495*, the *Signetics* 5596, and the *Analog Devices* AD532J.

Besides the CMOS we've talked about, check out the plain old CD4001 (MC14001) quad gate. What better way to expand the contacts on a keyboard for coupling, translation, and transposition. It takes three IC's per new contact per octave, or ¼th of an IC per contact per key. It's the cheapest CMOS device, well under a dollar surplus.

—by Don Lancaster

TABLE 1
Some Manufacturers
(Be sure and specify *specific* devices; the majority of these circuits were designed for *non-music* applications.)

AMERICAN MICROSYSTEMS INC. 3800 Homestead Road Santa, Clara, Calif. 95051	MOTOROLA SEMICONDUCTOR Box 20912 Phoenix, Ariz. 85036
ANALOG DEVICES Norwood, Mass. 02062	NATIONAL SEMICONDUCTOR 2900 Semiconductor Drive Santa Clara, Calif. 95051
INTERSIL MEMORY CORPORATION 10900 North Tantau Avenue Cupertine, Calif. 95014	RCA SOLID STATE Box 3200 Somerville, N.J. 08876
ITT SEMICONDUCTOR 3301 Electronics Way Palm Beach, Fla. 33407	SIGNETICS 811 East Arques Avenue Sunnyvale, Calif. 94086
MOSTEK INC. 1215 West Crosby Road Carrollton, Tex. 75006	TEXAS INSTRUMENTS PO Box 5012 Dallas, Tex. 75222

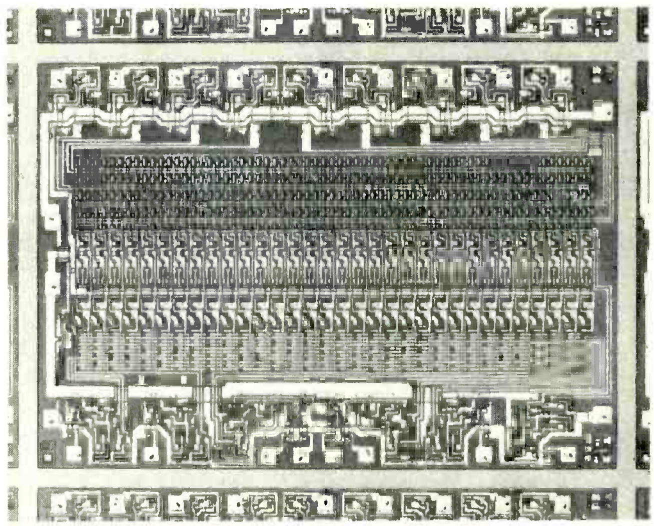
what is a ROM?

ROM's have a fantastic number of uses and are widely available as you-build-it and factory-builds-it types. Here's what ROM's are and what they are good for.

HOW WOULD YOU LIKE TO BUILD YOUR OWN INTEGRATED CIRCUIT, perhaps to do a job you can't find some catalog item for? This used to cost $15,000 or so and take months of work. Today you can do it for $5 in minutes, with surplus units, and under $20 with first-run parts. The trick is to use an extremely versatile integrated circuit called a Read Only Memory or ROM for short. Let's take a closer look at this exciting integrated circuit and see what it is and how you can use it.

Actually, it would be much better if a ROM were called something else, for its name implies it's only good for computers. Worse yet, its name says there is something "wrong" or incomplete with the device. It would be best to call a ROM a "universal code, state, logic, or sequence converter", for this name at least hints at the thousands of different things you can do with the same basic device, custom-programmed to do a specific job. Since ROM is easier to say than "UCSLOSC", we'll go along with the original name.

Figure 1 shows the important parts of a ROM. There are a number of *input* lines, a series of *output* lines, some power connections, and



INSIDE AN ROM you'll find a labyrinth of individual memory cells. Remember, actual size of this assembly is about .02 inch wide.

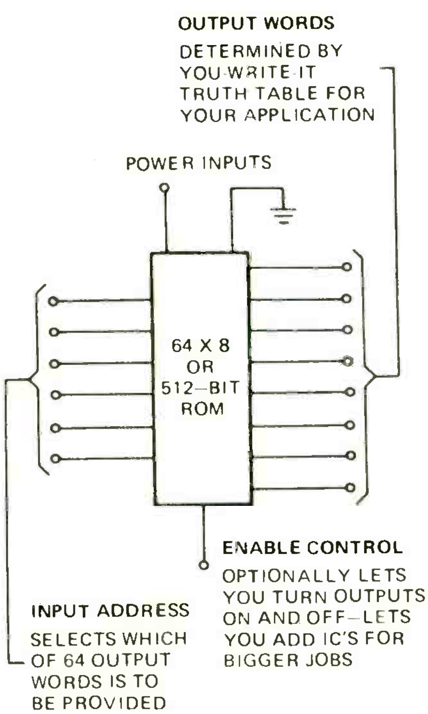


FIG. 1—ESSENTIAL PARTS of a typical ROM. This example is medium-sized and stores 512 bits of custom-programmed decisions by providing 64 possible 8-bit words at the outputs.

an *enable* control that optionally lets you turn the outputs on or off or combine them with other ROM outputs in other packages. As you've probably suspected, a ROM is a *digital* device, meaning it accepts yesses and no's or 1's and 0's or positive voltage and ground as two-state input signals. It provides similar 1s and 0's as two-state output levels. ROM's are available in most every logic family, including TTL, PMOS, CMOS, and ECL.

For each and every unique combination of input ones and zeros, a code word appears on the outputs. What this code word is or what it does in the rest of the circuit is *yours* to decide, for you can *teach* a ROM to do any one specific job for you.

For instance, if a ROM has six input lines, there are 64 (2^6) possible combinations of ones and zeros on the inputs, ranging from 000000, 000001, 000010, through 111110 and 111111. For each of these possible 64 conditions, you can select *any* output word you like, its maximum length determined by the number of available output leads. If you have eight output leads, each of the 64 words you select can be up to 8 bits long. Since we have 64 possible 8-bit words, we apparently have an internal ROM "decision" or "training" capability of 512 (8×64) *bits*. Each of the 512 locations can be a one or a zero per your choice, so there are apparently 2^{512} or *billions upon billions* of *different* things you can teach one IC to do.

The arrangement of the ones and zeros you want is usually shown on a *truth table*, a state-by-state listing of all possible input combinations and the desired outputs you want.

How is this teaching done? There are several basic ways. If you need a lot of identical ROM's and are sure of what you want, you use a *mask-programmable* ROM. Here a final metal overlay connection pattern is set up for your particular program. All the ROM's made are identical up to this step. Your mask then customizes your order to the particular truth table you need.

More popular is the *field-programmable* ROM. You use these if you only need one or two, or aren't sure if your truth table will work, or suspect you will have to change things later. Some field-programmable ROM's arrive from the factory with a fuse at *each* possible location in the memory. Before you use the ROM, you go through a *programming* procedure that selectively blows out the fuses you don't want, leaving you with a custom pattern of ones and zeros that matches your truth table. You do the programming one bit at a time, usually applying a current of several hundred mA at a programming input. The current is increased till the fuse opens, and you then go on to the next fuse you want to open.

All this really takes is a variable power supply with a meter, but the "zero defects" nature of this work and its "up the wall" aspects make programming services very desirable.

Many electronic distributors offer nominal or free programming services and guarantee the results—provided, of course, that you wrote the truth table down correctly! Programming machines are also available that ease the problem. These cost several hundred to several thousand dollars, but speed up the programming tremendously and eliminate many error possibilities.

Other field-programmable ROM's use buried charge (electret style) layers or silicon bridges instead of nichrome fuses, but the result is the same. The ROM fresh from the factory is either all ones or all zeros, and you do something—usually by applying an excessive voltage or current to remove or implant something at every memory location—that changes the ones to zeros or vice versa. You then end up with the truth table you want.

Once programmed, the majority of ROM's are *permanent*; hence the name *read only*. If you made a mistake, you throw the IC away and start on a new one. On the other hand, since the programming is mechanical, it's forever independent of supply power. Turn your ROM off for a year and reapply power—and the truth table is still inside. A few newer ROM's are erasable by removing part of the lid and applying intense ultraviolet light. These are expensive and not too common yet.

Building your own read only memory

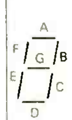
Let's build a "semi-discrete" ROM and see what it can show us about how the real ones work. Outside of doing it once as an exercise or to learn more about the process, going this route is complex and expensive compared to using the real thing.

Suppose we need a way of converting a 4-bit *hexadecimal* number into a 7-segment display so we can display the numbers 0, 1, 2, 3 . . . 9, A, B, C, D, E, and finally F with the letters handling states 10 through 15 and the numbers representing their own binary equivalents. A quick check of catalogs will turn up lots of different decoder/driver integrated circuits. This particular one seems to be rare, so let's pretend it doesn't exist at all. We have to use a ROM to build it.

Note that we'd go up the wall trying to build this out of simple gate packages—it would take a bunch of them and the design would take hours. With a ROM, the design only takes minutes, and a one-package solution almost always results.

We start by generating a *truth table* (Fig. 2). Our four input lines have 16 possible states (0000, 0001 . . . through 1111). We need

INPUT				OUTPUT								PATTERN
D	C	B	A	A	B	C	D	E	F	G	H	
0	0	0	0	1	1	1	1	1	1	0	0	
0	0	0	1	0	1	1	0	0	0	0	1	
0	0	1	0	1	1	0	1	1	0	1	1	
0	0	1	1	1	1	1	1	0	0	1	1	
0	1	0	0	0	1	1	0	0	1	1	1	
0	1	0	1	1	0	1	1	0	1	1	1	
0	1	1	0	1	0	1	1	1	1	1	1	
0	1	1	1	1	1	1	0	0	0	0	1	
1	0	0	0	1	1	1	1	1	1	1	1	
1	0	0	1	1	1	1	1	0	1	1	1	
1	0	1	0	1	1	1	1	1	0	1	1	
1	0	1	1	0	0	1	1	1	1	1	1	
1	1	0	0	0	0	0	1	1	0	1	1	
1	1	0	1	0	1	1	1	1	0	1	1	
1	1	1	0	1	1	0	1	1	1	1	1	
1	1	1	1	0	0	0	0	1	1	1	1	



+ = LIT SEGMENT

FIG. 2—THE TRUTH TABLE WE NEED to build a 7-segment decoder/driver with a ROM. Its four input lines have 16 possible states. Each of its seven output lines drives one segment of a 7-segment display device.

seven output lines—one for each segment of the display. Let's provide eight to round things out and put a "count zero" detector on the eighth line. Each output line lights a display segment if it is positive and puts out a display segment if it is grounded.

For instance, we could connect our output lines to a MAN3 or MAN4 common-cathode LED readout. Positive current lights a segment. Voltage near ground puts it out. The segments are labeled A through G in the usual clockwise from the top manner.

To build the actual ROM, we use a bunch of diodes and a 74154 4-line-to-16-line decoder. This particular IC converts the four input lines into a one-down-out-of-sixteen pattern on our *intermediate output* lines, so that a 0000 input grounds the top intermediate output, a 0001 the next one down, and so on down to 1111 which grounds the bottom intermediate output line. Only one output line is grounded at a time; the rest remain positive. Figure 3 shows the circuitry.

Going to our truth table, 0000 should give us an output 0, lighting

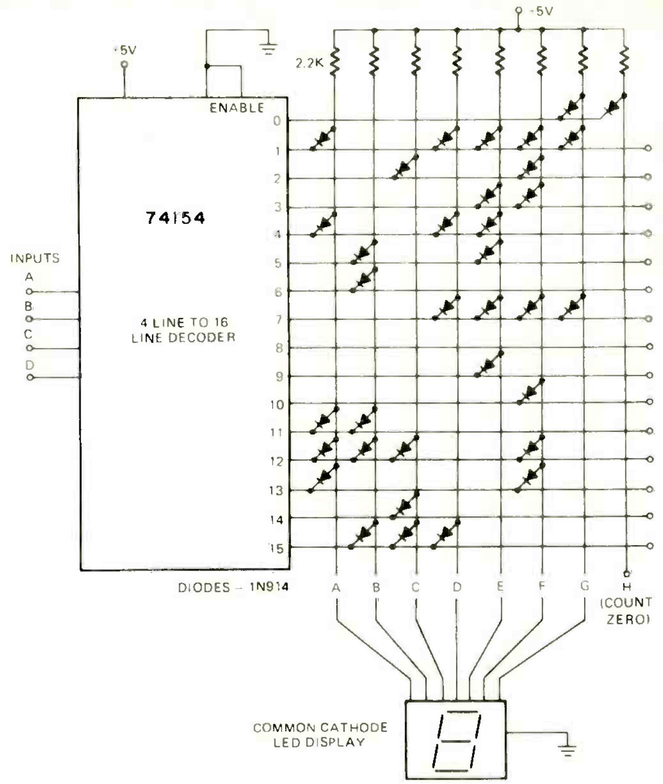


FIG. 3—OUR "FAKE" ROM is made from a 74154 4-line to 16-line decoder and a diode matrix to turn on and off the segments of a cold-cathode or LED 7-segment display device.

every segment but G, so we put a diode between line G and the 0000 decoded output. This diode conducts only on count 0000 and puts out this segment only at that time. On 0001, we only want to light B and C, so we evidently have to put zeros and diodes on A, D, E, F, and G. On 0010, to get a 2 lit, we put diodes on C and F. And so on, down the truth table.

We mathematically generate the truth table by placing a 0 everywhere we want a segment out and a 1 everywhere we want a segment lit. We physically program our ROM by putting a diode everywhere we want a 0 and leaving a diode off everywhere we want a 1. And this completes our decoder/driver.

To get fancy, we can use the eighth output lines as a state 0 decoder that might be useful for blanking or somewhere else in the system. All this takes is a new diode on the 0 line. We can use the output enable on the 74154 to drive all the outputs high for a lamp test, and we can blank the display either by breaking ground or removing the supply power.

We used diodes to teach our ROM to do one specific thing. There are 128 possible memory locations in our simple ROM. Each of these locations can be given a 1 (no diode) or a 0 (diode) per your choice, so there are apparently 2^{128} *different* truth tables you can write. (My math book stops at 2^{101} = 2,535,301,200,456,458,802,934,406,410,752. 2^{128} could be 134,317,728 *times* as large as this—you figure it out.)

Obviously we have a bunch of different truth tables we can write—A great heaping bunch. We can teach the ROM anything we like, consistent with the available number of inputs and outputs.

For instance, we could tell the ROM to subtract 3 from each input. Or multiply by 6.2. Or take the square root of it. Or we could tell it to decode and combine only certain states. We could make it play music. We can change codes or number systems. We can generate waveforms. There doesn't have to be any clear cut rhyme or reason relationship between inputs and outputs. If you can draw a truth table, the ROM will do the job for you—quickly and in a single package.

The *organization* of this particular ROM is called 16×8 or 16-8-bit words. Its potential memory locations are 128, so it is also called a 128 *bit* ROM.

ROM design is philosophically very different than older logic designs. The name of the game used to be a thing called "minimization", where you tried to get the logic equations in their simplest form and then build up a pile of gates to realize the "simplest" possible form. With ROM's you use *redundancy* instead. You take one logic block in one integrated circuit package with an incredible amount of redundancy—it can realize the "minimum" equivalent of *any* and *all* possible equations you could care to write consistent with the available inputs and outputs. You *ignore* the math and the simplifications! Instead, you just write down the truth table you want and program the ROM.

The benefits of redundant circuit design are overwhelming. The old way, you got a "minimum" logic design that took a dozen packages and took hours to design and debug. It was essentially unchangeable after design, particularly once it was locked into a PC board. The new way takes only seconds. Write your program, program the ROM and plug it in. The new way always works without any worry about glitches, races, disallowed conditions, sub-routines, and similar horrors. Changes? Simple. Just take out the old single IC that does the job and put a new one in its place. For everyday logic use, the textbook "minimization" techniques are an inexcusible waste of time and money once you get past a two- or three-package gate complexity. All they "minimize" is profits and the probability of success.

Commercial availability

Table I lists the commercial sources of programmable ROM's, one source of programmers, and one distributor that does programming. Table 2 lists a number of common ROM's and their organizations.

TABLE I

Some sources of ROM's and services:

CIRCUITS

Harris Semiconductor
Box 883
Melbourne, Florida, 32901

Motorola Semiconductor Products
Box 20912
Phoenix, Arizona, 85036

Intel Corp.
3065 Bowers Avenue
Santa Clara, California, 95051

National Semiconductor Corp.
2900 Semiconductor Drive
Santa Clara, California, 95051

Intersil, Inc.
10900 N. Tantau Avenue
Cupertino, California, 95014

Signetics
811 East Arques Avenue
Sunnyvale, California, 94086

Microsystems International
Box 3529 Station C
Ottawa, Canada

Solitron Devices
8808 Balboa Avenue
San Diego, California, 94086

Monolithic Memories, Inc.
1165 East Arques Avenue
Sunnyvale, California, 94086

Texas Instruments Inc.
Box 1443, Station 612
Houston, Texas, 77001

PROGRAMMING MACHINES

Spectrum Dynamics
2300 East Oakland Park Blvd.
Ft. Lauderdale, Florida

PROGRAMMING SERVICES

Semiconductor Specialists
Box 66125 OHare Airport
Chicago, Illinois, 60666

TABLE II

Here are a few currently popular programmable ROM's:

Part Number	Manufacturer	Organization	Bits
HROM-1-0512	Harris	64×8	512
HROM-1-1256	"	256×1	256
HROM-1-8256	"	32×8	256
HROM-1-1024	"	256×4	1024
HROM-1-2048	"	512×4	2048
IM5610	Intersil	32×8	256
IM5623	"	256×4	1024
MCM5003	Motorola	64×8	512
MCM5005	"	256×4	1024
MCM10139	"	32×8	256
MCM10149	"	256×4	1024
N8223	Signetics	32×8	256
N82S26	"	256×4	1024
SN74186	Texas Insts.	64×8	512
SN74188	"	32×8	256

One programmable ROM that's showing up quite a bit in the surplus market recently is the Signetics 8223. Costs have gone as low as $5 each. It is shown in Fig. 4. It's a bipolar device. DTL and TTL

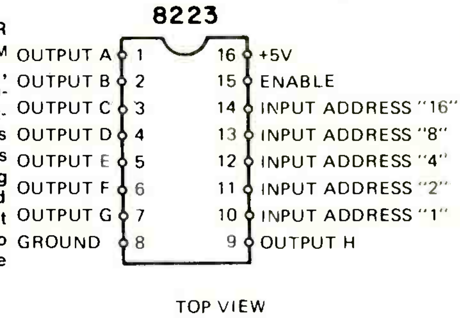


FIG. 4—A POPULAR PROGRAMMABLE ROM that is inexpensive, readily available, bipolar, and TTL compatible. Supply voltage is +8 V supply current is 65 mA. Connecting "enable" to ground provides an output code. Connection to +volts floats the output.

compatible and works with a single +5-volt supply. Operating speed is a fraction of a microsecond.

By the way—*preprogrammed* ROM's available surplus are only useful if you know *exactly* what they are and what they can do for you—a random or unknown program is totally worthless and essentially impossible to decode.

When do you use a ROM?

You use a ROM anytime you want a group of input numbers to be somehow related to a second group of output numbers, especially when you can't find a stock IC to do the job. ROM's become particularly attractive if the job seems hopelessly complex for construction using gate packages.

There are several different ways to use your input numbers. If you feed your ROM one number and then get a new one out on a random basis, you are using the system for *code conversion* or *table lookup*. If you sequentially go through your inputs, you have a *waveform generator*. Here the outputs provide an orderly progression of state changes, perhaps to generate a sinewave or a music note. If you use your inputs as separate logic inputs instead of feeding them a whole word at a time, you have a *programmable logic array*. Similarly, if you route your outputs to separate and distinct places, you have a *sequencer*, a *controller*, a timing generator, or a rhythm generator.

To really get fancy, you can let a ROM control *itself*. To do this, you store or latch the outputs each cycle and use the *last* output to

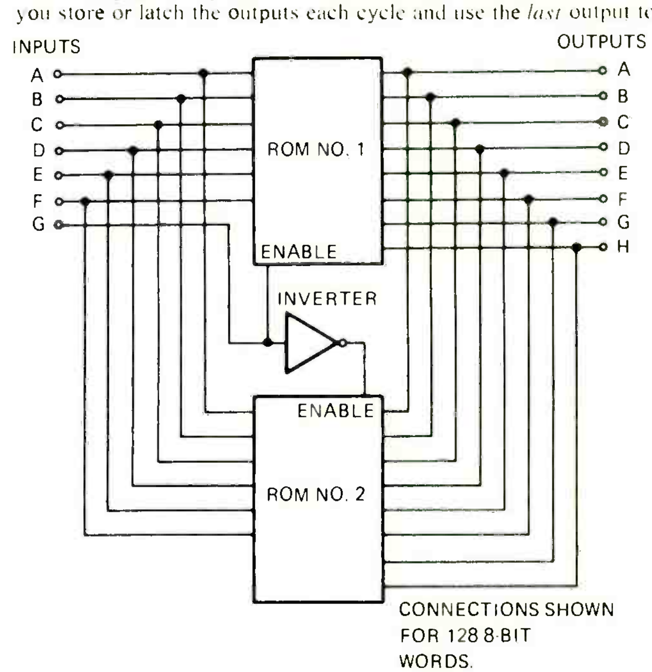


FIG. 5—HOW TO EXPAND ROM's by using several of them. Note that the doubled storage only offers one new input lead.

provide the *next input* address. This way, the ROM marches through its truth table in a prescribed and controlled way. You use this for unusual length *counters* and computer *microprogramming*.

ROM design is easy. First, you make sure you really need one and that nothing is available commercially to do the job. Then you write your truth table. Then you find a ROM that fits it. Then you program the ROM.

If your truth table seems hopelessly large, you try to *minimize* it through several tricks of the trade. These include removing mirror images (such as generating only one quadrant of a sinewave), putting easy-to-realize functions *outside* the main ROM, using multiple trips through the ROM, factoring, rearranging to fit ROM organizations, eliminating "don't care" states, and so on. Virtually *every* truth table can be minimized in a complex system. If you have reduced things as far as possible and you still can't fit it in, you go to a larger ROM or several ROM's combined with input steering and output enables.

Note that you don't double the inputs when you add a second ROM to a first one—all you gain is one extra input. Since you only doubled the memory capacity, your addressing has only increased by one power of two. Seven lines have twice the storage capability of six. If you are using 6-input (64-word) ROM's, it takes *two* of them for seven inputs (128 words), *four* of them for eight inputs (256 words), *eight* of them for nine inputs, (512 words), and so on. Figure 5 shows how you combine ROM's with their enables.

There are several stock organizations of ROM's 16×8, 256×1, 64×8, and 128×4 being common smaller ones. Sometimes you can rearrange things with a latch or a data selector to change the organization if you want to. For instance, if your particular ROM has eight output leads, and you only need a 4-output word, you can use a 4-pole double-throw data selector (74157) to pick either the top or bottom four bits. This *doubles* the number of words you have available. On the other hand, you can provide two 8-bit latches on the output and enable them on *alternate* addresses. If you look at all 16 outputs at the right time, you get a 16-bit output word. Of course, to

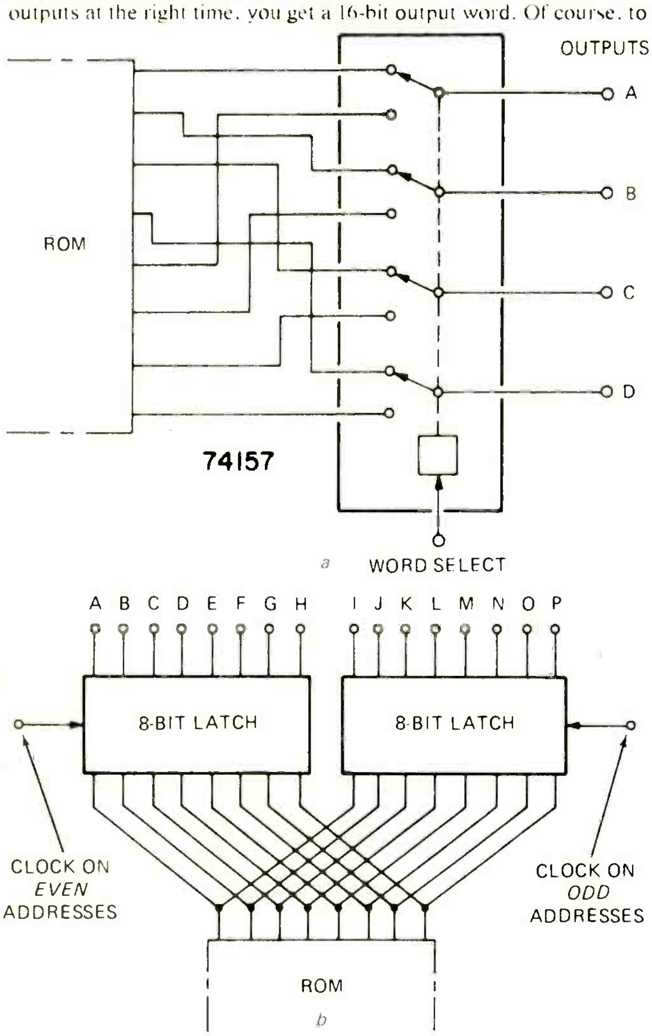


FIG. 6—THE DATA SELECTOR at (a) gives you twice as many output words of half the normal length. Using the setup at (b), the odd addresses are saved until even an address arrives. Output is half as many output words of twice the normal length.

get this, you've cut the number of words in half and reduced the possible operating speed at the same time. Figure 6 shows how you can change the organization of a ROM to fit your needs.

Sometimes a special custom organization will help. This was done for the time-zone-converting ROM on the *Radio-Electronics* Superclock (July 1972), where a 384×6 MOS ROM was used with a simple external OR gate to convert 2400-hour time to any timezone in the world. "Non-binary" organizations normally cost quite a bit of money and are not available in field programmable units.

Even if you are planning on using a bunch of identical ROM's, you first use programmable ones, and then later go on to the cheaper mask-programmable versions. The breakeven point is typically several hundred identical units. A few dozen identical ROM's are easily copied or duplicated on a small programming machine. If you do go to mask-programmed units, ROM-PROM pairs make the changeover easy.

Stock read-only memories

Besides custom patterns, you can get stock pattern ROM's preprogrammed and ready to use. There is no masking charge for these, since they are a popular enough pattern that lots of them can be sold. Very common examples are the character generators such as we used in the *Radio-Electronics* TV Typewriter (September 73) and the TV Time Display (scheduled for a forthcoming issue).

There are several types of character generators. Most of them accept a 6-bit ASCII standard computer code on one set of inputs and some system timing on some remaining outputs. A *row* output character generator is designed to work with TV sets. It puts out a bunch of dots or *undots* on its output lines. These go to a TTL shift register and are then clocked out as video. A *column* output character generator works sideways and puts out a vertical group of dots and undots useful for moving message signs and strip printers. Either type costs around $12, but a bunch of support circuitry is needed.

Other stock ROM's include code converters, particularly to get from the specialized SELECTRIC and EBCDIC codes to ASCII and back again. Trig tables for sine and cosine generation are also fairly common, although still a bit steep in price. A vastly different stock ROM is the American Microsystems S2566 Rhythm Generator used to generate the accompaniment beats (waltz, tango, etc.) on an electronic organ.

In addition, many ordinary IC's are really ROM's in disguise, for the semiconductor people long ago found out that it's easier to design one redundant ROM pattern and then change the metallization overlay than to relay out and make separate IC's for each and every special function. The Motorola MC4000 series of TTL uses several ROM functions.

Applications

We've already seen that a ROM can be used anywhere you want to convert one group of digital words to a second group of words, either on a one-at-a-time, a sequential, or a let-the-first-one-decide-the-next-one basis. The wilder or the more unusual the relationship between the input and output, the better a ROM will work, for you work directly with the truth table. Competing systems require deriving all the individual logic relationships between input and output, and cannot normally be done in a single IC.

So far, we've talked about display decoder drivers, character generators, sinewave generators, electronic music, time-zone converters, and code converters. Let's take a quick look at some other possibilities.

Frequency synthesizers and digital programmers often use thumbwheel switches. The numbers of the switches indicate a channel number or a frequency, but the circuitry inside may take entirely different numbers to operate. Rather than use an expensive special switch, a ROM performs the internal conversion—the operator sees his number and the circuitry sees the number it needs at the same time.

Sinewaves are easy to generate by taking a counter and a sine-lookup ROM. Add a D/A converter for a low-distortion sinewave oscillator of constant amplitude that can go down to ultra-low frequencies without any large parts.

ROM's are used in cathode ray tube display systems for pincushion correction, dynamic focus and convergence, and so on. Besides generating dot-matrix characters, ROM's can store and generate whole messages as well. Often you generate the fixed portions of a message in a ROM and add the changing part to it. You can also scramble or unscramble data with ROM's, throwing away what you don't want and rearranging things to get a needed format.

Any logic equation you can write in truth-table form is also easily handled by ROM's. The one-package solution and instant design are top advantages. Besides, the circuit is trivially easy to change—you simply replace the ROM. Compare this with a traditional "minimum" logic design of several dozen packages and locked-in interconnections.

SIMPLE SCOPE SERVICING

by JACK DARR
SERVICE EDITOR

THE CATHODE-RAY OSCILLOSCOPE IS THE fastest, most accurate, and *simplest* test instrument in a TV shop! We've been telling you guys that for too many years now. There are still entirely too many of you who persist in thinking of it as a very complicated, hard to use, scientific instrument. It is *not*! It's the best, fastest and simplest instrument in the place for giving you the answers to questions that can't be answered in any other way. The most common of these, and the most useful, is, "Is it there or isn't it?"

Typical instance: The set wiggles, bends, rolls and acts up, along with other symptoms. This kind of multiple symptom thing generally means that you have a feedback loop somewhere, causing cancellation of sync, assorted oscillations, and other things. How to find out? Pick up the scope probe and jab it on each of the *filter capacitors*, one at a time.

What should you see on each of these test points? *Absolutely NOTHING*. Nice straight line on scope-screen, indicating "pure dc". The dc power supply should have zero impendance to ground. If it doesn't, you'll have a beautiful feedback path through the dc power supply, which is the only thing common to *every* stage in the set. So if you see any "signal" when you scope the filter capacitors, something is darn well wrong. It almost has to be some fault in a filter capacitor; either open or low in capacitance. They are supposed to take out *all* signal from the dc power supply lines.

Double-check; leave the scope on the capacitor and bridge a good one across it. If the signals disapper and the symptoms clear up, there you are. By actual time-tests, this can be done in less than *30 seconds*. How fast can you get?

What do we mean "signal" in this test? *ANYTHING*. Set the scope for a reasonable vertical gain (the heater supply of your tube-tester is a handy source for rough voltage calibration. Voltage rms times 2.8 gives you the peak-to-peak reading. Never mind the horizontal sweep frequency! Jab the probe to the filter terminals, and if you see *ANY* vertical deflection at all you've got trouble! If you insist on fooling around, you can adjust the sweep and find out what frequency it is, but this is immaterial. Anything you see there is "ac" and means trouble.

More: this time you've got a dead amplifier. What kind? Any kind; rf, i.f., video, color. You know that signal is going into it, but it isn't coming out. How do you know you've got a signal going in? Because you can *feed* it in or rely on a known air signal. This can be checked with the scope, too. Example; hit the video detector output of a TV set. If you see about 1 to 2 volts p-p video at this point, but there's no picture on the screen, the video amplifier has a normal input but no output.

The "signal-path" in ALL amplifiers is a *series circuit*. If it is going in but not coming out, the path is broken somewhere. You must find out where. Start at the input and follow it. In a tube set, this would be grid-plate-grid-plate and so on. Transistors: base-collector-base-collector, etc. When you go through an amplifier stage, you'll see a voltage gain, in tube circuits. In transistors, you may not see much voltage gain, but you will have output. If you get out about as much as you put in, OK.

Somewhere along the line, you'll find a stage which has input but no output. There you are. On one occasion, I traced out an audio amplifier and located an open coupling capacitor between the second and third stages in a little less than 65 seconds! (Of course, I had the service data!) Even cold-turkey, you can usually follow the signal path, since you *can* identify the input and go from there.

In stereo amplifiers with one dead channel, you can tie the inputs together and "A-B" or cross-check between the same points in each channel. This will tell you exactly where you're losing the signal. It'll also tell you where distortion starts, if that's what you're looking for.

A lot of you have problems with color TV. Here again, the scope will give you fast, accurate answers that you can not get with any other test instrument. A series of "bang-bang" tests like those I just mentioned will check out a color bandpass amplifier, demodulator and color-difference amplifier stages quicker than you can say "Complementary symmetry integrated circuits". ((Speaking of that, the scope is the *only* way to go in any IC circuitry. If you have good signal in and no signal out of an IC, and dc voltage supply is normal, the chances are that the IC is bad!)

By feeding a color-bar signal into a color TV set, and tracing the unmistakable patterns through the bandpass, demods and diff-amps, you can identify any kind of color trouble. For loss of color, it will tell you where the color signals stop in the bandpass amplifier; if you see the characteristic "rocker" or Lazy-S pattern on the diff-amp grids, the demodulator *and* 3.58-MHz oscillator are working. If you see a flat-topped comb pattern on the differential-amplifier grid, the 3.58-MHz oscillator is dead. Instant identification of problem.

Let's kill another old superstition while we're at it. You do *not* have to have a 20-MHz, dual-trace, triggered-sweep scope, at about two grand a copy, to do this! They're very nice. But—you can make every one of the tests mentioned above with a narrow band recurrent sweep scope in good working order! You won't see the exact waveforms, maybe, but you will get the *information* that you must have, from the Is it there or isn't it?" test!

One more and then I'll go. "Odd Color" problems. This often means that one of the bypass capacitors in the color stages is open, once again allowing a feedback loop to set up. Test: scope each bypass capacitor in the circuit. If yo see any *signal*, this is the bad one; that's what the bypass was put there for!

So: here you have an instrument which can do *more* for you than any other in the shop, by making your test and diagnosis time far shorter. So, why the heck don't you *use it*? I'm not talking to those of you who do use the scope, but to the guys who have one and leave it sitting in a corner gathering dust instead of gelt! Don't be afraid of it; it won't hurt you, and it won't hurt the sets; it *will* help you to diagnose any kind of problem in electronic equipment much faster and more accurately. So Use it! Use it! **R-E**

Clocked logic where the ROM output sets the next input address offer all sorts of possibilities for unique counter sequences and minicomputer microprogramming. You normally initialize your sequence with a latch reset or the enable. Loops are done by returning to the same address and branching is handled by creative use of a new input, or an Exclusive ORing change of an output word.

In fact, *anywhere* you want to change one set of numbers into another set, or anywhere you want to change what the signals on one bunch of leads are doing, you can use a ROM. And at last, the prices and availability are good enough that you can seriously consider using your own custom IC as a routine solution to a wide variety of digital problems.

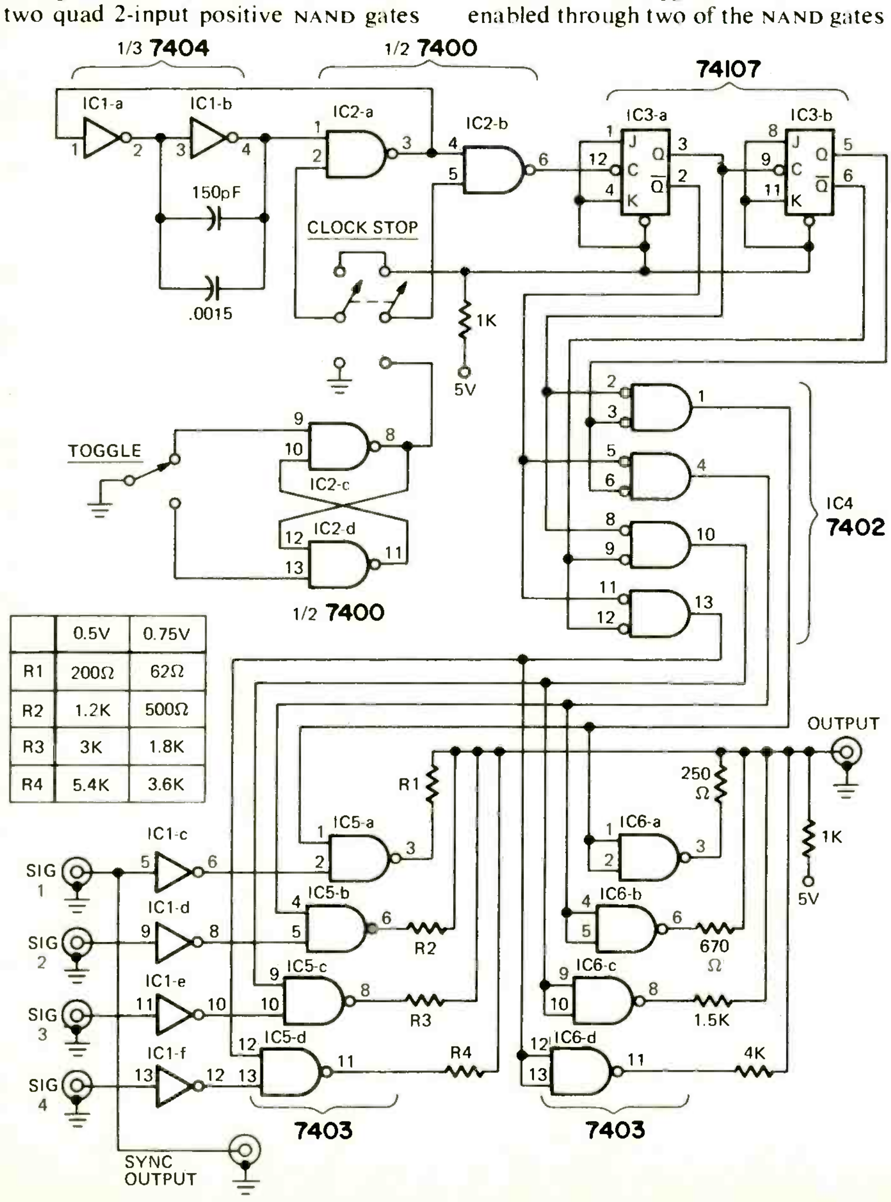
4-CHANNEL MULTIPLEXER FOR LOGIC EXPERIMENTS

When experimenting with digital circuits, some form of multiple scope trace is necessary if we wish to observe or compare the instantaneous states of various stages. Here is a circuit that you can assemble for about $3.00 and use to multiplex four DTL or TTL signals on to a single-trace scope. Here is how it works:

Two inverters and one NAND gate in a loop form the circuit clock. The capacitor in the loop across one inverter can be any one of a wide range of values, depending on the capabilities of the scope being used. A value of 0.05 μF will allow signals up to 8 kHz to be viewed without having the chopping of the circuit interfere with the display. A smaller capacitor will allow faster signals to be seen but may exceed the rise-time capability of the scope.

The clock is divided into four phases by the two 74107 J-K flip-flops. Each of these phases is picked off by one of the NOR gates in IC4, the 7402. IC4 drives two quad 2-input positive NAND gates with open-collector output a (IC5 and IC6). The gates in IC6 are signal-level generators. The signal consists of a staircase with levels at 1, 2, 3 and 4 volts. Each level is present for one clock time or phase. Since this is much faster than the signal, it should appear as four traces on the scope. IC5 presents the signal on each level. It does this by gating the signal with the phase. If the phase is high the signal will be put on the line. If the signal is also high, it appears as low to the gate and the 1, 2, 3 or 4 trace level is undisturbed. If, however, the signal is low, it appears as high to the 7403 gates, and turns it on, thus paralleling a resistor across the trace-level resistor and thus lowering the trace. The resistor values in the box give the R values for 0.5-or 0.75-volt drops. I personally prefer 0.5-volt steps. The external sync is always taken off of channel 1.

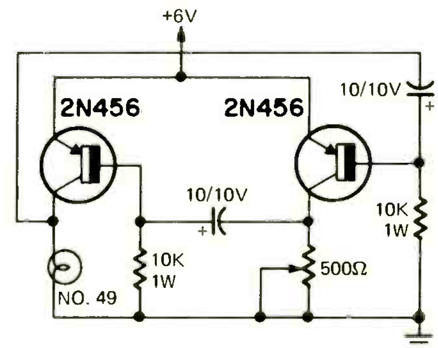
In the second mode of operation the CLOCK STOP switch is turned on and the clock feedback is disabled, stopping the clock. The toggle switch circuit is enabled through two of the NAND gates in the 7400 to the J-K flip-flops. The TOGGLE switch provides a de-bounced signal which toggles the scope through its traces. This mode can be used with external sync on channel 1 or sync to itself using internal sync on the scope.—*Robert Corson*



	0.5V	0.75V
R1	200Ω	62Ω
R2	1.2K	500Ω
R3	3K	1.8K
R4	5.4K	3.6K

MINIATURE STROBOSCOPE

Here is a simple low-cost stroboscope that operates on four D-cells in series and uses a No. 49 pilot lamp as the flash tube. It can be calibrated in



rpm's and used to measure the speed of rotating or reciprocating objects. Q1 and Q2 are 2N456 or similar pnp power transistor.

Two 30-μF units were used for a flash-rate ranging from about twice per second to 10 times per second. You can use larger or smaller capacitors, depending on your application; but remember that if the capacitors are too small, the lamp's filament will not get a chance to cool between pulses and the lamp will appear to remain on.

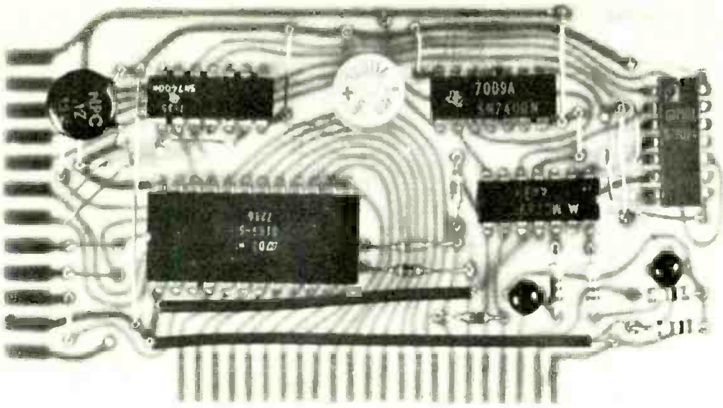
The device can be built into a small plastic case. No heat sink is required for the two transistors if the strobe is used for only a few minutes at a time. However, for constant duty (as in a store window display) it is advisable to heat-sink the transistors, making sure that they are electrically isolated from each other. If you use a metal case, you can use it as a heat sink.—*Geroge A. Devencenzi*

ADMIRAL M20 CHASSIS

Complaints of excessive brightness, washed-out video and no control of brightness have been traced to a **blown fuse** in the 400-volt B+ circuit.

Fuse F904 (0.5A pigtail, part 84A7-16) on the power supply module is in the secondary of the power transformer supplying ac to the 400-volt B+ circuit. Because of the power supply configuration, 285 volts remains on the 400-volt line when F904 is open. This reduced voltage appears on the picture-tube cathodes and causes excessive brightness.

Check the circuits supplied by the 400-volt line and components in the 400-volt supply for the cause of the blown fuse. Make the necessary repairs and then replace the fuse. —*Admiral Service News Letter*



BUILD Improved ASCII Encoder

by DON LANCASTER

Simplified circuit lets you convert virtually any surplus keyboard into the proper code to talk to a computer or the Radio-Electronics TV Typewriter

THE ORIGINAL RADIO-ELECTRONICS ASCII keyboard encoder (**Radio-Electronics,** April, 1973) was designed to convert the single-make contacts of the Low Cost Keyboard (**Radio-Electronics,** February, 1973) into the proper ACSII computer code for talking to either a computer or the TV Typewriter (**Radio-Electronics,** September 73). Here's a greatly improved version of the same circuit.

It's much smaller, uses far fewer parts, has true TTL compatible outputs, provides an optional "there's two keys down" output and is designed to exactly fit one end of the currently popular "keypunch" type of surplus keyboards. Costs are about the same as the original but no kits are sold. It works with any keyboard that has one isolated pair of spst contacts that are normally open per key. The contacts may be mechanical, reed switches, contacts, or resistive elastomeric pads. For low impedance contacts, you need a single +5-volt supply. For resistive contacts up to 1000 ohms, you need a second +12-volt supply at low current.

In its present form, it will encode all the upper case alphabet, most punctuation, all the numbers, a spacebar, a carriage return, a shift key to shift from numbers to punctuation, and a control key for transparent or machine commands. Additional keys are easily added if needed. A slight modification of the pre-encoder matrix on the **Radio-Electronics** low-cost keyboard (February 1973) is needed to use the new unit.

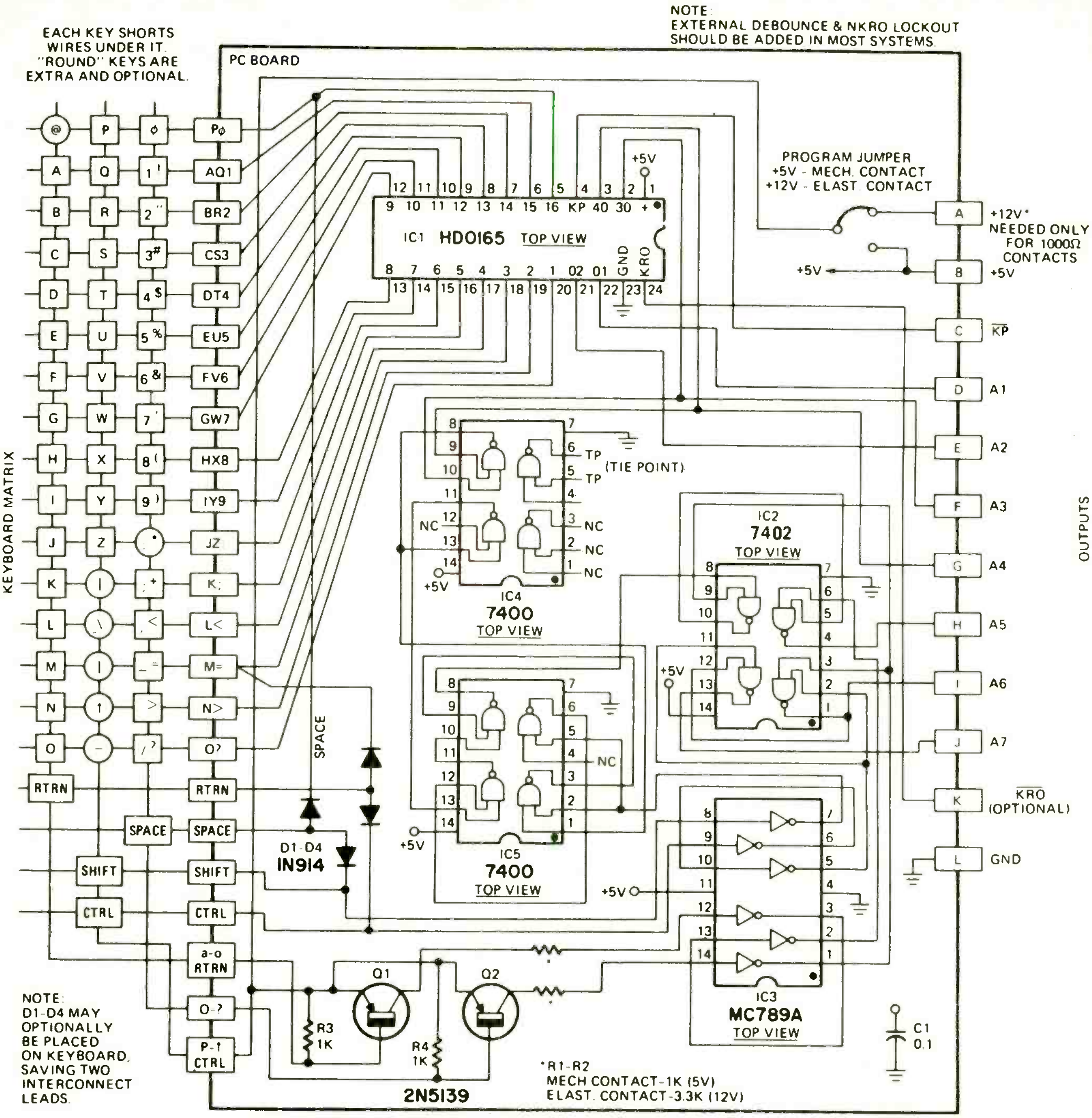
More on ASCII

The standard computer code in use today is called ASCII, short for American Standard Code for Information Interchange. The complete ASCII code is shown in Table I. While there are 128 possible entries to the code, we are only interested in the first six columns of these. Columns 0 and 1 are the transparent or machine commands. Things that don't end up in print or as part of a message, but instead return carriages, start and stop equipment, indicate beginnings and endings, and so on. Column 2 is the most popular punctuation, while column 3 is the numbers and more punctuation. In this encoder, we get from column 2 to column 3 by using a *shift* key. Thus, a capital "1" becomes a !, and so on. Finally Columns 4 and 5 are the alphabet and some lesser used punctuation.

We can get by with a basic assembly of 48 keys less a few if we're willing to do away with [,/,],↑ and ___. With a Control or CTRL key, we can shift any column 2 or 4

TABLE I
THE INDUSTRY STANDARD ASC11 COMPUTER CODE

Bits				b7 →	0	0	0	0	1	1	1	1
				b6 →	0	0	1	1	0	0	1	1
				b5 →	0	1	0	1	0	1	0	1
b4	b3	b2	b1	Column / Row	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP	[illegible]	@	P	[illegible]	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	[illegible]	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	\	l	/
1	1	0	1	13	CR	GS	—	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	[illegible]
1	1	1	1	15	SI	US	/	?	O	—	o	DEL



1PARTS LIST

C1—0.1-μF disc ceramic, Mount *flat*.
D1, D2, D3, D4—1N914 or equivalent silicon computer diode
IC1—HD0165 Encoder (Harris)
IC2—7402 TTL Quad NOR gate
IC3—MC789AP Hex Inverter, RTL, do not substitute
IC4, IC5—7400 TTL Quad NAND gate
Q1, Q2—2N5139, silicon pnp
R1, R2—Varies with keyboard, 1000 ohms for mechanical contacts and +5 supply; 3300 ohms for elastomeric high resistance contacts and +12 supply.
R3, R4—1000 ohms, ¼-watt carbon

MISC: PC Board, Solder; No.24 Soldereeze wire, 20 feet for keyboard wiring, sleeving, No.24 solid wire jumpers.

NOTE: The following is available from Southwest Technical Products, 219 West Rhapsody, San Antonio, Texas, 78216

PC Board, etched and drilled: $5.75.

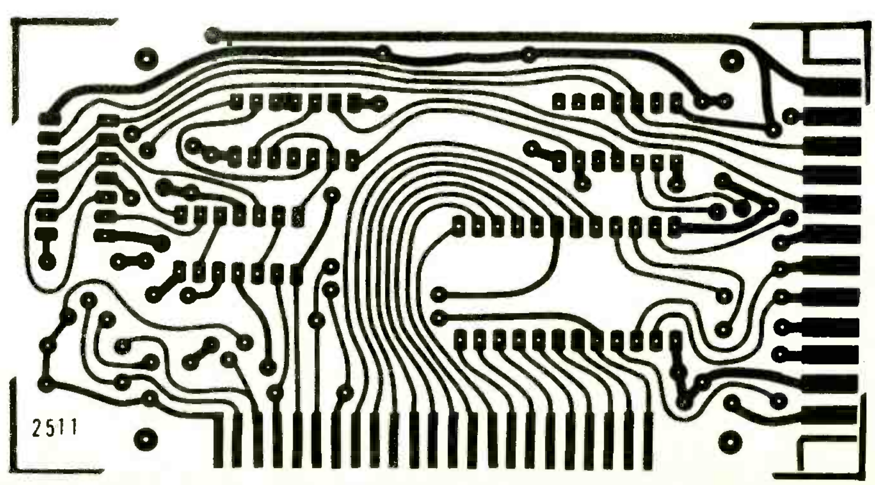
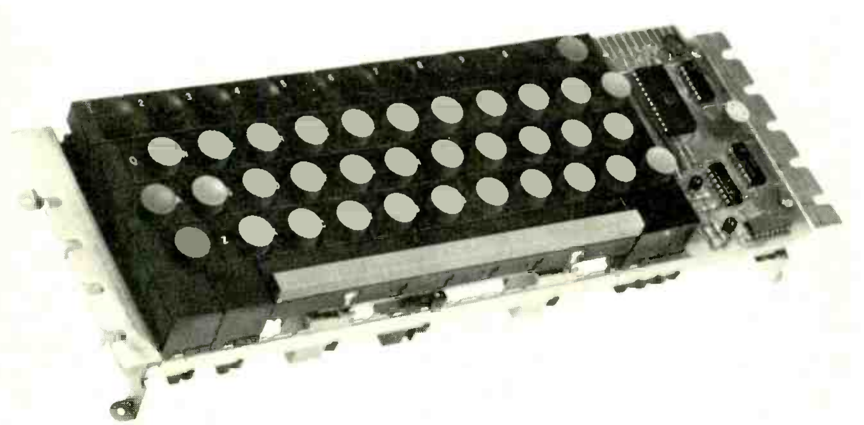


FIG. 1—ASCII ENCODER CIRCUIT (top) is easy to build. FULL SIZE FOIL PATTERN (above) is for the circuit board. PARTS LAYOUT (right) shows where to mount the components on the circuit board.

code into a column 0 code, and any column 3 or 5 code into a column 1 code. Thus, we need no new keys for the control commands, unless we are really going to use that command often. CARRIAGE RETURN is often used, so, it's handy to have a special key that *simultaneously* gives us a CONTROL and a M command. Similarly, we can get a spacebar by simultaneously giving a SHIFT and a 0 command. Other special functions (DELETE, ESCAPE, ALT MODE, etc. . . .) are easily added in the same way.

To decide when a code is sent, a keypressed command is given when a key is pressed, telling things on the other end that something new is happening. We *do NOT deliver* a keypressed command for the shift or control key, for they are always used in conjunction with another key. And, in our circuit, we get a free "there's two keys pressed!" output that can be used to tell whatever is on the other end that the typist is running too fast or just made a mistake and please ignore what just arrived. One final, and slightly messy detail involves the > = < and ? keys. Normally, we like to type commas, dashes, periods, and slashes *without* shifting, and save the question, equals, greater than, and less than for *shifted* commands. This is clearly backwards from the standard code. So if we are going to go along with the standard code (often we are forced to because of the keytops on the keyboard we're going to use), we have to arrange the shift key so that it operates *backwards* on these four keys. All this takes are two 21¢ IC's, but this is a complex and painful little detail to resolve.

The output of the code consists of seven bits in *parallel*, or all-at-once form. An eighth *parity* bit can optionally be added for error detection, or the seventh bit can optionally be dropped to get the 10-bit code that has only alphanumerics to run a character generator. Should we want to talk to a computer or a phone line, we have to convert this code to a *serial* form, easily done with either the circuit shown in the original article or with a new MOS terminal transmitter/receiver chip. Depending on the type of keyboard and the debouncing in the rest of the system, we may have to add a contact conditioning and debouncing system as well.



TYPICAL KEYBOARD WITH ENCODER. The small encoder board is mounted at the right end of the keyboard.

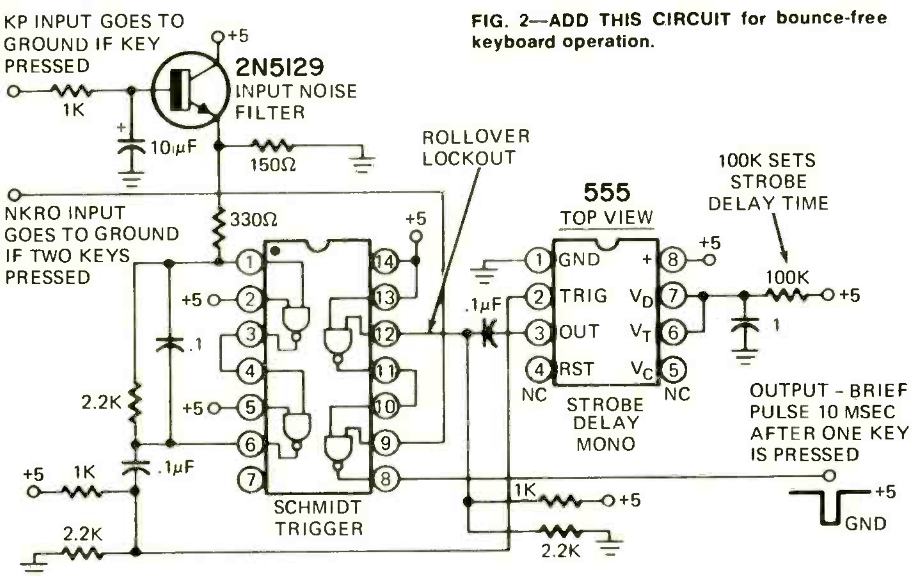
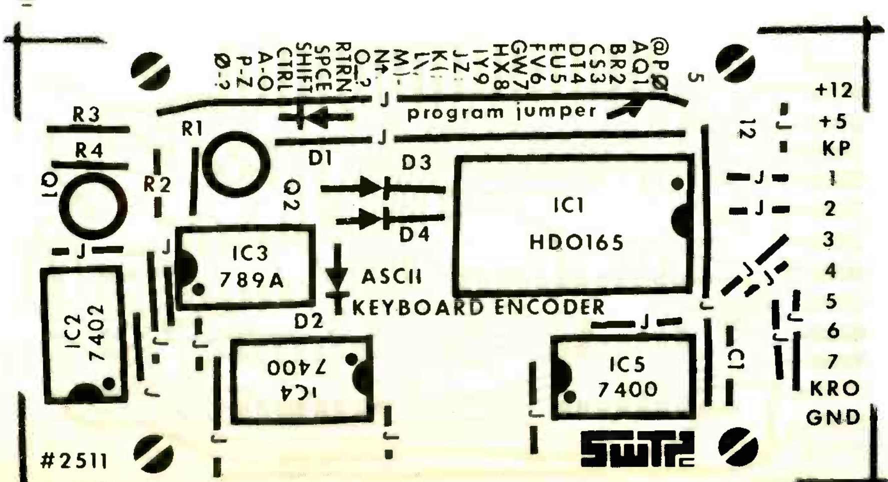


FIG. 2—ADD THIS CIRCUIT for bounce-free keyboard operation.



About the new circuit

The new circuit is shown in Fig. 1. Except for IC1 (presently around $7.50), all the remaining parts are nickel and dime stuff, and there are only 19 components in all. Just like the code of Table I, we can split the problem into two parts, for the lower four bits couldn't care less what the upper three are doing, so long as everything ends up right. Thus a lower four bits 1101 code could be a carriage return, a group seperator (a very rare machine command), a dash or minus, an equals, a M, or a large unbracket. IC1 singlehandedly takes care of the lower four bits for us. It has sixteen input lines and four output lines. If you make any *one* (only one!) input line positive, it gives the binary equivalent to that code. Thus the third line generates a 0011, the eighth line a 1000, and so on.

The inputs are RTL style and simply need an impedance path to +5 or +12 to serve as an input command. Whatever *else* the input current flows through on the way to set up the upper three bits is of no concern to IC1, so long as the current gets there when it is needed. IC1 also generates a keypressed output that's high if all the inputs are low and goes low if any key is pressed. It also produces an optional output that goes low if two keys or more are simultaneously pressed. This is called a NKRO output, short for N-key-rollover.

It only takes about +3.5 volts to turn on an IC1 input. Since the input is current operated, we can either get our current from a low impedance (mechanical or reed) contact and a +5 supply, or from a higher impedance (elastomeric or foam) contact and a +12 supply. Around two milliamperes are needed, but it can handle much more than that safely. Thus, we can use virtually any kind of keyboard contact simply by picking one optional low current supply voltage.

So much for the lower four bits. The upper three bits are generated by responding to *what* the IC1 input current is routed through on the way down from the positive supply. If it goes through nothing, we set up P-Z. If it goes through Q1, we set up A-O, and if it goes through Q2, we set up zero through 9 and the related punctuation. The

(continued on page 92)

Step-by-step TV Troubleshooters Guide

by STAN PRENTISS

A smeary picture can be due to misalignment or defective agc. Think you can spot the cause right away? If not, here's how you can.

OUR FATED INTRODUCTION TO THIS CTC 39X RCA was at an RCA distributor's. It had been deposited by a local TV repair shop. The basic complaint was smeary picture . . . with Fig. 1 as positive evidence. This wave/form was taken with the usual 10X low-capacitance probe at TP201 (Fig. 2, the i.f.-agc schematic), following the video detector, and registered just over 2V p-p, as RCA specified. The sync portion could be adjusted to some 30 percent of the waveform at full modulation as shown, since the envelope has the same amplitude as the station-supplied negative-going pulse reference.

However, there were buckets of spurious frequency "fill" in the sync portion between the top of the blanking pedestal and the tip of the vertical sync pulses that are always transmitted during each vertical field blanking interval of 1.4 milliseconds. But there is a black peak level just below the blanking level, and so this smear would not reproduce in the visible picture *unless* it also extended below the black peak and into the video.

A close look at the photograph will show that such, indeed, is our problem. Although there does not seem to be a full smear extension, the 15.2-milliseecond *on* time trace does indicate higher-frequency problems just below black peak since low-frequency problems show up as ripple, while high frequencies appear as smear.

Reflections or agc?

Having our good oscilloscope handy—but *no* demodulator probe—we had to approach this problem somewhat from the rear by continuing stage-by-stage down the video amplifier chain all the way through the 3rd video amplifier. We found that the condition was faithfully amplified directly into the picture tube. Even a tube pull or two and a disconnect of the 800-nanosecond luminance delay line failed to show that such interference originated from reflections, but rather confirmed that the problem lay among the intermediate frequency amplifiers or in the agc.

Why pick on agc—there's no sync compression? Because we had not yet verified whether the agc i.f. control would drive the video i.f's and amplifiers from saturation to cutoff, with "resting" dc i.f. drive voltage approximately at mechanical control midpoint. Approaching saturation, of course, the 30-percent sync pedestal first begins to disappear, followed by the video portion; while in cutoff, video fades initially, followed by sync—all seen on an oscilloscope *after* the video detector, naturally.

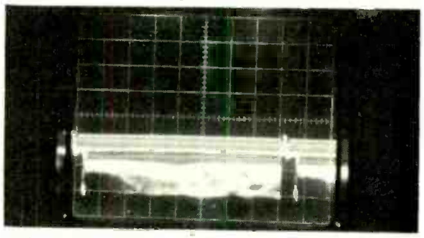


FIG. 1—VIDEO WAVEFORM shows smeary picture at output of video detector.

Can agc induce smear? Certainly, if its dc control is unbalanced, coupled with leakage from 63.5-microsecond line sweep filtering through the RC time constants to the video i.f.'s. How do you tell? First, check cutoff and saturation characteristics. Then, if these are good, put your scope's vertical amplifiers on ac and switch the attenuator to about 20 millivolts/div. Any 15,734-Hz flyback pulse leakage will show up in detail at the base or grid of the 1st i.f. In this case, there was only a little, and added shunt filtering made absolutely no difference in the picture. Therefore, any agc source problems were eliminated—at least for now.

Can alignment help?

Alignment can often help a tuned circuit condition to a certain extent, and if the trouble points to problems in the intermediate frequency video amplifiers, then there's every advantage in trying . . . especially with all the new, excellent alignment equipment now available.

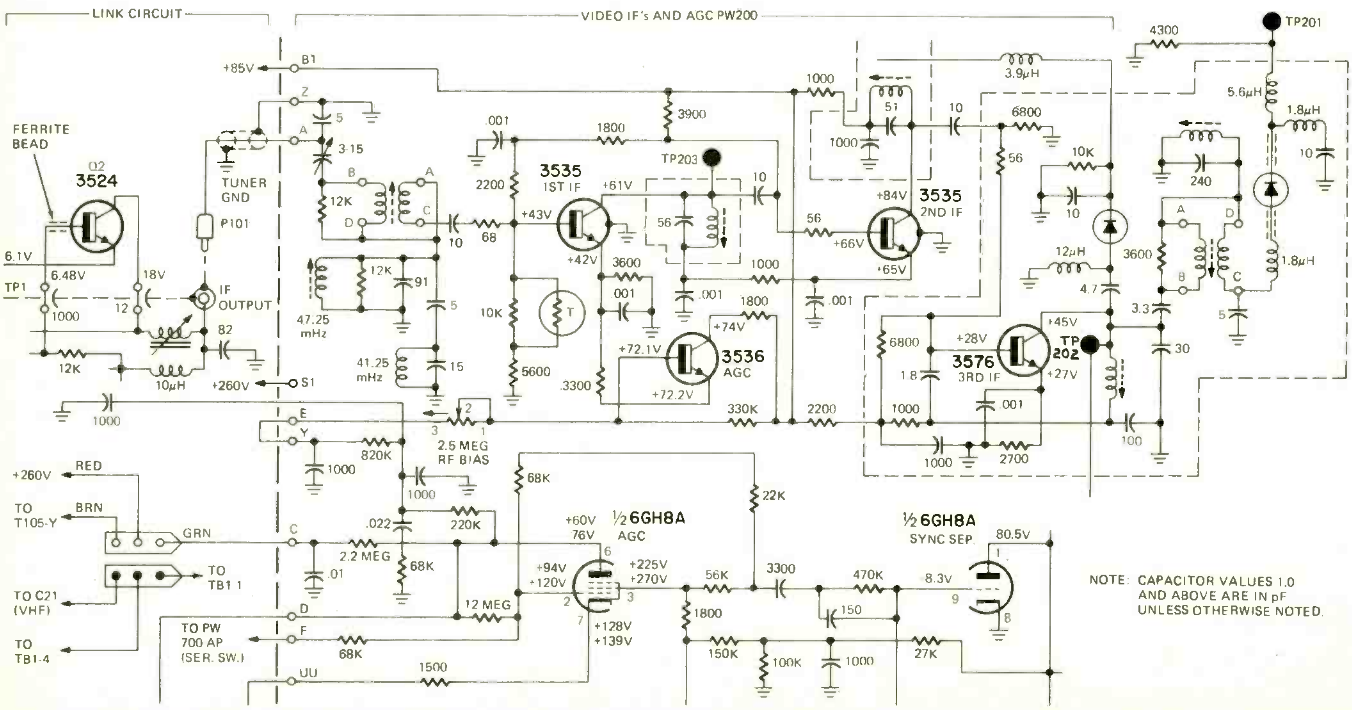


FIG. 2—VIDEO I.F. AND AGC CIRCUITS of the RCA CTC 39 color TV receiver. The video detector output circuit is greatly simplified.

condition to a certain extent, and if the trouble points to problems in the intermediate frequency video amplifiers, then there's every advantage in trying . . . especially with all the new, excellent alignment equipment now available.

But do be careful, because there's a special *link* circuit in this CTC 39X that won't respond satisfactorily to just any old (or young) input impedance, and the quadrupler detector RCA requires at the TP203 test point is a *must*: we know, we've been there before! This *link* includes a transistor amplifier (Q2, Fig. 2), along with the usual coaxial cable, and supplies a midpoint 44-MHz bandpass directly to P101 and the i.f. amplifiers.

You can try (using terminations supplied by the sweep equipment manufacturers) to get by with a response curve such as the one in Fig.3, but such flattopped response with video and chroma markers on top of the curve simply won't work. They *must* look like Fig. 4 at 75 percent on either slope of the curve, with the 41.25-MHz sound carrier and the 47.25-MHz lower adjacent channel sound carrier traps set at the bottom of the skirts along the baseline.

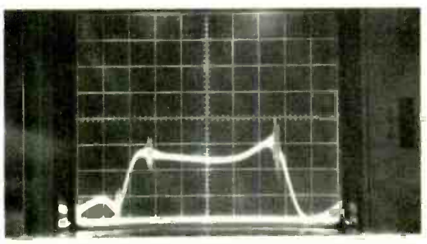


FIG. 3—RESPONSE CURVE has flat top due to incorrect sweep generator impedance.

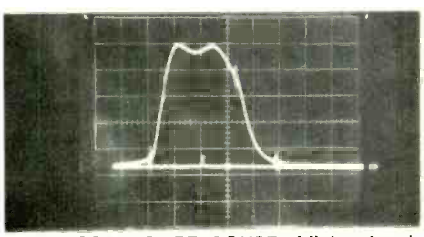


FIG. 4—CORRECT RESPONSE of link network has markers 75% up on each slope.

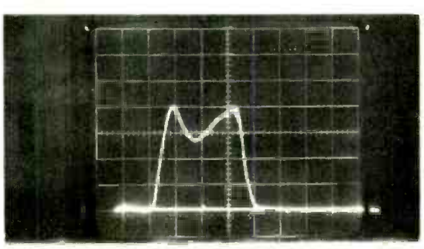


FIG. 5—OVERALL I.F. RESPONSE at the video detector before complete alignment.

Present such traps first by tuning a sinewave generator modulated by 400 Hz or 1,000 Hz to their resonant frequencies and scoping for minimum trap amplitude setting before beginning the link alignment. But once through the link alignment, let both the link and traps alone *forever!*

The overall response at the video detector after link alignment will probably look like Fig. 5, but don't worry. Other i.f. adjustments will bring it in as illustrated in Fig. 6. Here, on the left, you start with the 41.25-MHz sound trap, then 42.17-MHz chroma at just about 50 percent on the left slope, 45.75-MHz video carrier near 50 percent on the right slope, and the 47.25-MHz lower adjacent channel sound trap on the right baseline—the blip in the center is a simple transient. So there's your CTC 39X video i.f. sweep alignment. Not complex at all—*if* you have the right swep generator terminations.

But should you try and "diddle" the link and the remainder of the i.f. transformers and traps to conform to the conventional curve (Fig. 7), then your troubles have just begun. All the frequency markers described for Fig. 6 are still there, including a 44.25-MHz (off) center frequency at the top. But you should have seen the unmanageable, negative, touchy picture it produced! Peak-to-peak amplitude for the link, by the way, is 100 millivolts, while the overall i.f. alignment response is set for 2.5 V p-p.

Troubles over?

Hardly they've really just begun. Unfortunately, many components of this particular i.f. strip had been removed and replaced previously, including at least three or more sets of transistors—so here is where things became sticky. Having procured an acceptable demodulator probe for a 30-pF, 1-MHz scope—just any one won't do—we proceeded from the video detector back up the i.f. strip. Distortion increased until we reached the collector of the 1st i.f. amplifier, then disappeared. This posititively proved two things:that signal from the tuner was both clean and adequate, and the agc itself could not be offering interference, since agc is applied only to the 1st i.f. and any distortion would have been both visible and obviously amplified. The 2nd i.f. amplifier, however, was a mess, and it was immediately changed for the fourth time.

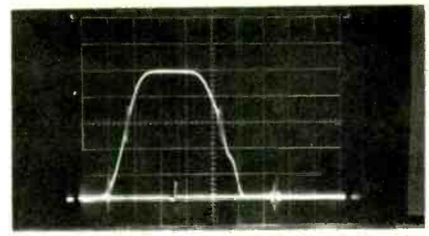


FIG. 6—AFTER FINAL ADJUSTMENTS, the overall curve should look much like this.

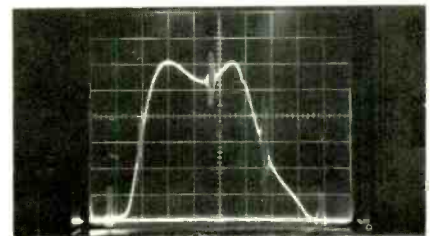


FIG. 7—THIS UNHAPPY ALIGNMENT was based on link response curve in Fig. 3.

MONOCHROME AND COLOR ALIGNMENT

MAYBE

When a poor picture is not caused by a bad tuner, old antenna, faulty agc or other routine problem. But don't attempt alignment unless your markers are crystal controlled!

DO

1. When fine tuning affects definition and perhaps contrast.
2. Poor monochrome pix and no color —possibly sound bars.
3. If new tuner is installed and i.f. bandpass is inadequate.
4. On test pattern where either high or low signals are weaker than the other end and induce trails or phase reversal.
5. With grainy pix, touchy vertical and horizontal sync.
6. When sweep gen with linear output can't produce correct tuner and video-chroma i.f. responses.
7. At the point when chroma is smeary and indistinct—bandpass amplifier is usually out of alignment.
8. With monochrome picture smear and sound bars.
9. When the 3.58-MHz color sync transformer becomes detuned and there is poor color lock or phase shift (coil or oscillator).
10. On occasions where hue (tint) control will not produce 30-degree phase shifts on either side of mechanical center (burst amp.)
11. On appearance of the color barber pole showing 3.58-MHz oscillator out of sync.
12. In older receivers when fine slanting lines indicate 3.58-MHz traps are detuned.

DON'T

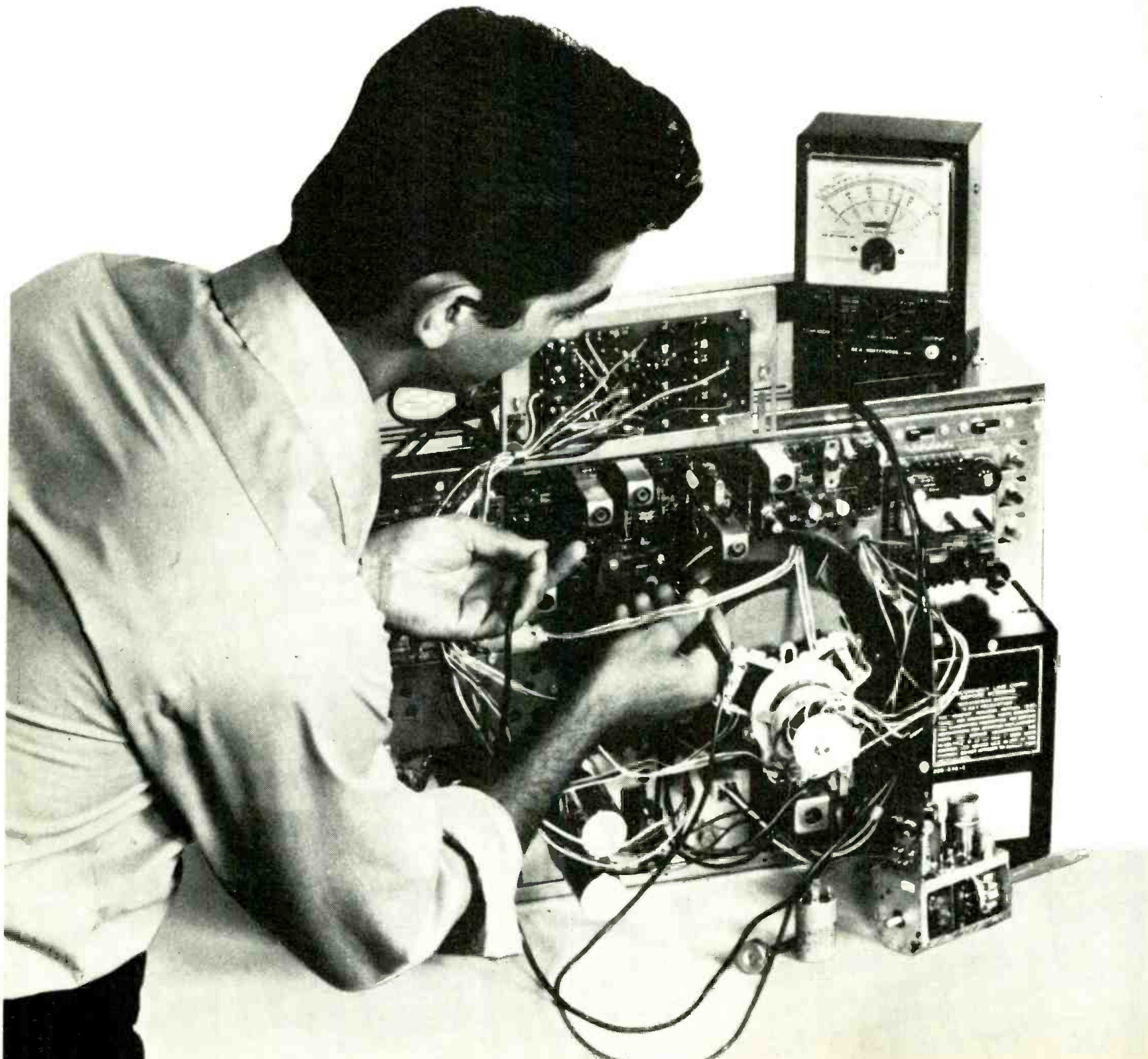
1. When a bad peaking coil or defective load resistor reduces definition in a video amplifier.
2. If multiple images or vertical bars are produced by poorly damped deflection yokes or horizontal-output-produced transients.
3. With a weak picture, but good detail and no smear.
4. When fine tuning has little effect on the picture and overall quality is poor.
5. With some channels poor, others OK.
6. When fine lines cross the picture but don't affect sound—definition remains sharp.
7. Poor vertical or horizontal sync but fair to good picture.
8. Good monochrome, but no color.
9. When video is too weak or too contrasty (investigate agc).
10. With weak but distinct color (try bandpass amplifier or output).
11. When colors are clean but misplaced. (This is a phase problem only.)
12. With one or more colors missing. (Check demods or output amplifiers.)

The above 12 good rules for both alternatives can save hours of time and frustration. And do be careful never to add excessive agc or too much generator rf! Either distorts the response curve.

(continued on page 68)

Why a Sylvania home training program may be

your best investment for a rewarding career in electronics



We had noticed that the demodulator probe had some detuning affect around the video detector, but with another i.f. change, almost any point in the i.f. strip that was touched by the probe would wipe out the picture. (If you haven't had this happen, it's a nasty experience!) Should you wish to make the time, you can now begin checking and or substituting each coil and capacitor—we had previously shunted all bypasses—until you find whatever's oscillating. Or, you can simply replace the printed circuit board.

Replace the PW200?

As a *last* resort, of course, you *should* replace the entire PW200 board. Naturally, this is a rather expensive procedure for the receiver owner, but any halfway measure on a set that's been virtually butchered invites catastrophe. These PC boards will stand just so much abuse, then cracks appear, foil peels back, grounds loosen, and components become "unglued." This is especially true for any boards subject to tube heat or heavy current flow—often the same end difference in terms of thermal dissipation. And if a $30 or $50 board can save a $700 set, the effort and money are well spent, if this is the real solution to your (their) problems.

When such a replacement *is* made, a spot i.f. alignment recheck is needed to see if markers are where they should be, the tuner response matches, and traps are at their appointed places along the baseline. Remember, a transformer or coil shapes the bandpass, but a trap anchors it! Obviously, you should also check the composite video signal from a broadcast program, agc cutoff-to-saturation operation, and have a quick look at the chroma bandpass amplifiers to see if the new i.f. board has changed their tilt. This, however, can more easily be done with a clean color bar generator and vectorscopoe—a subject we'll discuss much later in the future when certain equipment now in design and development reaches the market

Answering questions

If you're sharp, you should have at least one penetrating question: Why wouldn't the response curve have been affected by this obvious high-frequency oscillation? The answer is, that our problem child had to be somewhere in the frequency spectrum above 50 MHz since 41 MHz to 47 MHz is, roughly, the bandpass intermediate frequency. Would a demodulator probe have shown the fault? A poorly designed one would not, nor are the vertical amplifiers of an inexpensive oscilloscope linear enough to produce true crt representations accurately much past the 3rd video i.f. If you want to look successively at *all* the i.f.'s and tuner output, you'll need a scope with at least a 10-millivolt vertical deflection factor to handle the average diode demodulator probe. My own D66 has an extended vertical range of 1 millivolt/div. and it does come in handy on critical occasions.

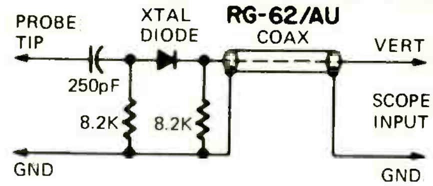


FIG. 8—PRACTICAL DEMOD PROBE for your scope. Use full shielding and a short ground.

A useful demodulator probe

Since this column is written to inform, not amaze, a schematic of an old Precision Apparatus demodulator probe I am currently using appears in Fig. 8. Remember, it's fully shielded and has a RG-62 A/U coaxial test equipment cable of approximately three feet between probe body and the BNC-coupled scope input. It's not perfect—a full-wave demodulator is, of course, more desirable, but this one will have to do until we can persuade some good test equipment manufacturer to design one that's more predictable, with better linearity, and less attenuation. How about it RCA, Sencore, B & K, Tektronix, Hewlett-Packard, EICO, and all the rest? For a good demodulator probe, the TV service industry needs *YOU!* **R-E**

Tests show Caruso's voice could have shattered goblet

A demonstration at the recent Audio Engineering Society convention indicates that it may indeed be possible to shatter a goblet by singing at it. Legend has it that the great Caruso was indeed able to break a glass with his voice, but the failure of many experiments has caused the story to be regarded with doubt.

Peter W. Tappan, of Bolt, Beranek and Newman, described to the convention a project that had been undertaken for a television commercial. Two singers, one after the other, demonstrated to the television public how their (amplified) voices could break a goblet by singing a steady note at the glass's resonant frequency. Then the advertiser's tape used the singers' recorded voices to repeat the effect.

The goblet was placed in front of a speaker of 100-watt capability. The speaker was mounted in an ordinary small enclosure, with the hole in the baffle board ahead of the speaker reduced to a diameter of two inches, thus concentrating all the energy into a small beam. The top of the goblet was directly ahead of the hole and about two inches from the grille cloth. The greatest difficulty was, Mr. Tappan stated, in getting the singers to produce a note free of vibrato, which reduces the power at the actual resonant frequency.

Tests showed that some types of glasses could be broken at an audio level ranging from 142 to 148 decibels. Two singers were able to produce sound levels up to about 140 dB without amplification. Therefore, admitting that Caruso probably had a great deal more vocal ability than the average singer (and that he had good luck in selecting a goblet) it is quite possible that he may have been able to shatter a goblet with his unaided voice.

North Carolina technicians hold successful convention

The North Carolina Electronic Technicians Association held its 1973 convention at Wrightsville this summer, with excellent participation and a noteworthy attendance of out-of-state NEA guests, manufacturers, distributors and technical representatives. Notable guests were NEA president Charles Couch, CET, from Gainesville, FL; NEA executive vice president Dick Glass, CET, from Indianapolis; John McPherson, CET, VEA president, from Yorktown, VA; Jesse Leach and Walter Cook, CET's, NEA first and second region vice presidents, from Hampton, VA, and Linthicum, MD, respectively, and William Rivers, CET, from Columbia, SC.

Paul Cartrette, CET, Winston-Salem, was elected president; Greg Hoger, CET, Conover, vice president; Earl Todd, CET, Yadkinville, secretary, and Earl Todd, Sr., CET, Whitsett, treasurer.

Awards were presented to James Heath, CET, as Outstanding Local President; Greg Hoger, CET, for his unselfish service as convention chairman, and to Sonny Adkins, CET, for his leadership as State President 1972-1973. The Association reports one new chapter since the convention—the Metrolina ETA of the Charlotte area.

R-E's Substitution guide for replacement transistors

PART XII

compiled by

ROBERT & ELIZABETH SCOTT

ARCH—Indicates the Archer brand of semiconductors sold only by Radio Shack and Allied Radio stores. Allied Radio Shack, 2725 W. 7th St., Ft. Worth, Texas 76107

DM—D. M. Semiconductor Co., P.O. Box 131, Melrose, Mass. 02176

GE—General Electric Co., Tube Product Div., Owensboro, Ky. 42301

ICC—International Components, 10 Daniel Street, Farmingdale, N.Y. 11735

IR—International Rectifier, Semiconductor Div., 233 Kansas St., El Segundo, Calif. 90245

MAL—Mallory Distributor Products Co., 101 S. Parker, Indianapolis, Ind. 46201

MOT—Motorola Semiconductors, Box 2963, Phoenix, Ariz. 85036

RCA—RCA Electronic Components, Harrison, N.J. 07029

SPR—Sprague Products Co., 65 Marshall St., North Adams, Mass. 01247

SYL—Sylvania Electric Corp., 100 1st Ave., Waltham, Mass. 02154

WOR—Workman Electronic Products, Inc., Box 3828, Sarasota, Fla. 33578

ZEN—Zenith Sales Co., 5600 W. Jarvis Ave., Chicago, Ill. 60648

Radio-Electronics has done its utmost to insure that the listings in this directory are as accurate and reliable as possible; however, no responsibility is assumed by Radio-Electronics for its use. We have used the latest manufacturers material available to us and have asked each manufacturer covered in the listing to check its accuracy. Where we have been supplied with corrections, we have updated the listing to include them. The first part of this Guide appeared in March 1973.

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2N2600	NA	T-708	GE21	NA	NA	PTC 127	NA	SK 3114	RT-115	ECG 159	WEP 717	NA
2N2601	RS276-2023	T-52	GE-21	ICC-52	TR-88	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP 717	NA
2N2602	RS276-2023	T-52	GE-21	ICC-52	TR-88	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP 717	NA
2N2603	RS276-2023	T-52	GE-21	ICC-52	TR-88	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP 717	NA
2N2604	RS276-2023	T-52	GE-21	ICC-52	TR-88	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP 717	NA
2N2605	RS276-2023	T-52	GE-67	ICC-52	NA	PTC 127	HEP-52	SK 3114	RT-115	ECG 159	WEP 717	NA
2N2606	NA	NA	NA	NA	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N2607	NA	NA	NA	NA	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N2608	NA	NA	NA	NA	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N2609	NA	NA	NA	NA	NA	NA	HEP-807	NA	NA	NA	NA	NA
2N2610	RS276-2009	T-53	GE-61	ICC-53	IRTR-51	PTC 132	HEP-53	SK 3122	RT-102	ECG 123A	WEP 735	ZEN 102
2N2611	NA	T-706	GE-27	NA	NA	PTC 144	HEP-714	NA	NA	NA	NA	NA
2N2612	NA	T-230	GE-3	NA	TR-01	PTC 105	HEP-625	SK 3009	RT-124	ECG 104	WEP-634	NA
2N2613	RS276-2003	T-632	GE-2	ICC-632	IRTR-05	PTC 102	HEP-632	SK 3004	RT-121	ECF 102A	WEP 250	ZEN 308
2N2614	RS276-2003	T-632	GE-2	ICC-632	TR-35	PTC 102	HEP-632	SK 3004	RT-121	ECG 102A	WEP 250	ZEN 308
2N2615	NA	T-718	GE-61	NA	NA	PTC 121	HEP-720	SK 3018	NA	NA	NA	NA
2N2616	RS276-2011	T-56	GE-61	ICC-56	NA	PTC 133	HEP-56	SK 3019	RT-113	ECG 108	WEP 56	ZEN 104
2N2617	RS276-2023	T-52	GE-62	ICC-52	IRTR-51	PTC 115	HEP-52	SK 3004	RT-102	ECG 123A	WEP 735	NA
2N2618	RS276-2009	T-713	GE-63	ICC-713	NA	PTC 136	HEP-713	SK 3045	RT-110	ECG 154	WEP 712	ZEN 100
2N2619	NA	NA	NA	NA	NA	NA	NA	NA	NA	ECG 5476	NA	NA
2N2621	NA	T-50	GE-2	ICC-2	TR-17	PTC 102	HEP-2	SK 3123	NA	ECG 160	WEP-637	ZEN 300
2N2622	NA	T-2	GE-2	ICC-2	TR-17	PTC 102	HEP-2	SK 3123	NA	ECG 160	WEP-637	ZEN 300
2N2623	NA	T-2	GE-2	ICC-2	TR-17	PTC 102	HEP-2	SK 3123	NA	ECG 160	WEP-637	ZEN 300
2N2624	NA	T-2	GE-2	ICC-2	TR-17	PTC 102	HEP-2	SK 3123	NA	ECG 160	WEP-637	ZEN 300
2N2625	NA	T-2	GE-2	ICC-2	TR-17	PTC 102	HEP-2	SK 3123	NA	ECG 160	WEP 637	ZEN 300
2N2626	NA	T-2	GE-2	ICC-2	TR-17	PTC 102	HEP-2	SK 3123	NA	ECG 160	WEP-637	ZEN 300
2N2627	NA	T-2	GE-2	ICC-2	TR-17	PTC 102	HEP-2	SK 3123	NA	ECG 160	WEP-637	ZEN 300
2N2628	NA	T-2	GE-2	ICC-2	TR-17	PTC 102	HEP-2	SK 3123	NA	ECG 160	WEP-637	ZEN 300
2N2629	NA	T-2	GE-2	ICC-2	TR-17	PTC 102	HEP-2	SK 3123	NA	ECG 160	WEP-637	ZEN 300
2N2630	RS276-2003	T-3	GE-2	ICC-3	TR-17	PTC 102	HEP-3	SK 3123	NA	ECG 160	WEP-637	ZEN 300
2N2631	NA	NA	NA	ICC-S3010	NA	NA	HEP-S3010	NA	NA	NA	NA	ZEN 301
2N2632	NA	TS-3020	GE-66	NA	NA	NA	HEP-S5004	NA	NA	NA	NA	ZEN 207
2N2635	RS276-2003	T-3	GE-53	ICC-3	IRTR-85	PTC 109	HEP-3	NA	NA	ECG 160	WEP-637	ZEN 301
2N2636	NA	T-236	NA	NA	TR-01	NA	HEP-236	SK 3009	RT-147	ECG 179	WEP-WG6001	NA
2N2637	NA	T-236	NA	ICC-236	NA	NA	HEP-236	SK 3009	RT-147	ECG 179	WEP-WG6001	ZEN 301
2N2638	NA	T-236	NA	ICC-236	NA	NA	HEP-236	NA	RT-147	ECG 179	WEP-WG6001	NA
2N2639*	NA	T-729	GE-61	ICC-729	NA	PTC 121	HEP-729	SK 3039	RT-113	ECG 108	WEP-56	NA
2N2640*	NA	T-729	GE-61	ICC-729	NA	PTC 121	HEP-729	SK 3039	NA	ECG 108	WEP-56	ZEN 115
2N2641*	NA	T-729	GE-61	ICC-729	NA	PTC 121	HEP-729	SK 3039	RT-113	ECG 108	WEP-56	ZEN 115
2N2642*	NA	T-728	GE-61	ICC-728	NA	PTC 121	HEP-728	SK 3039	RT-113	ECG 108	WEP-56	ZEN 114
2N2643*	NA	T-728	GE-61	ICC-728	NA	PTC 121	HEP-728	SK 3039	RT-113	ECG 108	WEP-56	ZEN 114
2N2644*	NA	T-728	GE-61	ICC-728	NA	PTC 121	HEP-728	SK 3039	RT-113	ECG 108	WEP-56	ZEN 114
2N2645	NA	T-714	GE-18	NA	NA	PTC 121	NA	NA	NA	NA	NA	NA
2N2646	RS276-2029	T-310	NA	ICC-310	NA	NA	HEP-310	NA	NA	ECG 6401	NA	ZEN 129
2N2647	RS276-2029	T-310	NA	ICC-310	NA	NA	HEP-310	NA	NA	ECG 6409	NA	ZEN 129
2N2648	NA	T-2	GE-2	ICC-2	NA	NA	HEP-2	NA	RT-127	ECG 176	WEP-238	ZEN 300
2N2649	NA	NA	NA	NA	NA	NA	HEP-S3001	NA	NA	NA	NA	NA
2N2651	NA	T-56	GE-20	ICC-56	NA	PTC 136	HEP-56	SK 3039	RT-113	ECG 108	WEP-56	ZEN 104
2N2652*	NA	T-714	GE-18	NA	NA	PTC 123	HEP-S3001	NA	NA	NA	NA	NA
2N2654	RS276-2005	T-636	GE-9	ICC-636	TR-17	PTC 107	HEP-636	SK 3006	NA	ECG 160	WEP-637	ZEN 312
2N2656	RS276-2009	T-50	GE-20	ICC-50	IRTR-51	PTC 136	HEP-50	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 100
2N2657	NA	TS-3020	GE-66	NA	NA	NA	HEP-S3002	NA	NA	NA	NA	NA
2N2658	NA	NA	NA	NA	NA	NA	HEP-S3302	NA	NA	NA	NA	NA
2N2659	NA	T-238	NA	ICC-238	NA	NA	HEP-238	NA	NA	NA	NA	ZEN 329
2N2660	NA	T-239	NA	ICC-239	NA	NA	HEP-239	NA	NA	NA	NA	NA
2N2661	NA	T-239	NA	ICC-239	NA	NA	HEP-239	NA	NA	NA	NA	NA
2N2662	NA	T-238	NA	ICC-238	NA	NA	HEP-238	NA	NA	NA	NA	ZEN 239
2N2663	NA	T-239	NA	ICC-239	NA	NA	HEP-239	NA	NA	NA	NA	NA
2N2664	NA	T-239	NA	ICC-239	NA	NA	HEP-239	NA	NA	NA	NA	NA
2N2665	NA	T-238	NA	ICC-238	NA	NA	HEP-238	NA	NA	NA	NA	ZEN 329
2N2666	NA	T-239	NA	ICC-239	NA	NA	HEP-239	NA	NA	NA	NA	NA
2N2667	NA	T-239	NA	ICC-239	NA	NA	HEP-239	NA	NA	NA	NA	NA
2N2671	RS276-2003	T-3	GE-9	ICC-3	NA	PTC 107	HEP-3	SK 3006	NA	ECG 160	WEP-637	ZEN 301
2N2672	RS276-2003	T-635	GE-9	ICC-635	NA	PTC 107	HEP-635	SK 3006	NA	ECG 160	WEP-637	ZEN 311
2N2673	RS276-2009	T-50	GE-61	ICC-50	IRTR-51	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 100
2N2674	RS276-2023	T-52	GE-61	ICC-52	IRTR-51	PTC 121	HEP-52	SK 3122	RT-102	ECG 123A	WEP-735	NA
2N2675	RS276-2009	T-50	GE-61	ICC-50	IRTR-51	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 100
2N2676	RS276-2009	T-50	GE-61	ICC-50	IRTR-51	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 100
2N2677	RS276-2009	T-50	GE-61	ICC-50	IRTR-51	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 100
2N2678	RS276-2009	T-50	GE-61	ICC-50	IRTR-51	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 100

NA=NOT AVAILABLE

(turn page)

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2N2691	NA	T-232	NA	NA	NA	NA	NA	NA	RT-147	ECG 179	WEP-WG6001	NA
2N2692	RS276-2009	T-50	GE-62	ICC-50	IRTR-21	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 100
2N2693	RS276-2009	T-50	GE-61	ICC-50	IRTR-21	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 100
2N2694	NA	T-718	GE-61	NA	IRTR-21	PTC 121	HEP-729	NA	NA	NA	NA	NA
2N2695	RS276-2023	T-52	GE-22	ICC-52	NA	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP-717	NA
2N2696	RS276-2023	T-52	GE-22	ICC-52	NA	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP-717	NA
2N2697	NA	NA	NA	NA	NA	NA	HEP-S5000	NA	NA	NA	NA	NA
2N2698	NA	NA	NA	NA	NA	NA	HEP-S5000	NA	NA	NA	NA	NA
2N2699	RS276-2001	T-641	GE-66	ICC-641	TR-08	PTC 103	HEP-641	SK 3011	RT-119	ECG 101	WEP-641	ZEN 315
2N2706	RS276-2003	T-632	GE-53	ICC-632	IRTR-85	PTC 135	HEP-632	SK 3004	NA	ECG 158	WEP-630	ZEN 308
2N2707	NA	T-255	GE-59	NA	TR-08	PTC 108	HEP-632&641	SK 3010	NA	ECG 158	WEP-630	NA
2N2708	RS276-2011	T-56	GE-17	ICC-56	NA	PTC 133	HEP-56	SK 3019	RT-113	ECG 108	WEP-56	ZEN 104
2N2709	RS276-2021	T-51	GE-21	ICC-51	NA	PTC 103	HEP-51	SK 3114	RT-115	ECG 159	WEP-717	ZEN 101
2N2710	RS276-2011	T-56	NA	ICC-56	NA	PTC 133	HEP-56	SK 3039	RT-113	ECG 108	WEP-56	ZEN 104
2N2711	RS276-2009	T-722	GE-10	ICC-722	NA	PTC 121	HEP-722	SK 3124	RT-113	ECG 108	WEP-56	ZEN 110
2N2712	RS276-2009	T-724	GE-17	ICC-724	NA	PTC 121	HEP-724	SK 3124	RT-113	ECG 108	WEP-56	ZEN 112
2N2713	RS276-2016	T-54	GE-20	ICC-54	IRTR-33	PTC 123	HEP-54	SK 3124	RT-102	ECG 123A	WEP-735	NA
2N2714	RS276-2016	T-54	GE-20	ICC-54	IRTR-33	PTC 123	HEP-54	SK 3124	RT-102	ECG 123A	WEP-735	NA
2N2715	RS276-2009	T-722	GE-60	ICC-722	IRTR-33	PTC 126	HEP-722	SK 3124	RT-113	ECG 108	WEP-56	ZEN 110
2N2716	RS276-2009	T-724	GE-61	ICC-724	IRTR-33	PTC 121	HEP-724	SK 3124	RT-113	ECG 108	WEP-56	ZEN 112
2N2717	RS276-2003	T-3	GE-9	ICC-3	TR-17	PTC 107	HEP-3	NA	NA	ECG 160	WEP-637	ZEN 301
2N2719	RS276-2009	T-50	GE-20	ICC-50	IRTR-51	PTC 136	HEP-50	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 100
2N2720*	NA	T-53	GE-20	NA	NA	PTC 136	HEP-S0007	NA	NA	NA	NA	NA
2N2721*	NA	T-53	GE-20	NA	NA	PTC 136	HEP-S0007	NA	NA	NA	NA	NA
2N2722*	NA	T-53	GE-20	NA	NA	PTC 136	HEP-729	NA	NA	NA	NA	NA
2N2726	NA	TS-3021	GE-27	ICC-S3021	NA	PTC 117	HEP-S3021	NA	NA	NA	NA	ZEN 208
2N2727	NA	T-706	GE-27	NA	NA	NA	HEP-S3021	NA	NA	NA	NA	NA
2N2728	NA	T-231	GE-4	NA	NA	PTC 106	HEP-G6002	SK 3012	NA	ECG 105	WEP-233	NA
2N2729	RS276-2011	T-56	GE-61	ICC-56	NA	PTC 133	HEP-56	SK 3018	RT-113	ECG 108	WEP-56	ZEN 104
2N2730	NA	T-231	GE-4	NA	NA	PTC 106	NA	SK 3012	NA	ECG 105	WEP-233	NA
2N2731	NA	T-231	GE-4	NA	TR-03	PTC 106	HEP-G6002	SK 3012	NA	ECG 105	WEP-233	NA
2N2732	NA	T-231	GE-4	NA	TR-03	PTC 106	HEP-G6002	SK 3012	NA	ECG 105	WEP-233	NA
2N2781	NA	NA	NA	NA	NA	NA	HEP-S3021	NA	NA	NA	NA	NA
2N2782	NA	NA	NA	NA	NA	NA	HEP-S3021	NA	NA	NA	NA	NA
2N2783	NA	T-251	NA	NA	TR-12	NA	HEP-S3021	NA	NA	ECG 126	WEP-635	NA
2N2784	RS276-2011	T-56	GE-17	ICC-56	TR-24	PTC 133	HEP-56	SK 3039	RT-113	ECG 108	WEP-56	ZEN 104
2N2786	NA	T-2	NA	ICC-2	TR-17	PTC 107	HEP-2	NA	NA	ECG 160	WEP-637	ZEN 300
2N2787	NA	T-53	GE-20	NA	NA	PTC 136	HEP-S3011	NA	NA	NA	NA	NA
2N2788	NA	T-714	GE-18	NA	NA	NA	HEP-S3011	NA	NA	NA	NA	NA
2N2789	NA	T-714	GE-18	NA	NA	NA	HEP-S3011	NA	NA	NA	NA	NA
2N2790	NA	T-53	GE-20	NA	NA	PTC 136	HEP-S3001	NA	NA	NA	NA	NA
2N2791	NA	T-53	GE-20	NA	NA	PTC 136	HEP-S3001	NA	NA	NA	NA	NA
2N2792	NA	T-53	GE-20	NA	NA	PTC 136	HEP-S3001	NA	NA	NA	NA	NA
2N2793	NA	T-231	GE-4	NA	TR-03	PTC 106	HEP-G6002	SK 3012	NA	ECG 105	WEP-233	NA
2N2795	RS276-2003	T-3	GE-51	ICC-3	TR-17	PTC 107	HEP-3	NA	NA	ECG 160	WEP-637	ZEN 301
2N2796	RS276-2003	T-3	GE-51	ICC-3	TR-17	PTC 107	HEP-3	NA	NA	ECG 160	WEP-637	ZEN 301
2N2797	NA	T-2	GE-51	ICC-2	TR-17	PTC 107	HEP-2	NA	NA	ECG 160	WEP-637	ZEN 300
2N2798	NA	T-2	GE-51	ICC-2	TR-17	PTC 107	HEP-2	NA	NA	ECG 160	WEP-637	ZEN 300
2N2799	NA	T-2	GE-51	ICC-2	TR-17	PTC 107	HEP-2	NA	NA	ECG 160	WEP-637	ZEN 300
2N2800	RS276-2021	T-51	GE-67	ICC-51	TR-88	PTC 141	HEP-51	SK 3114	RT-115	ECG 159	WEP-717	ZEN 101
2N2801	RS276-2021	T-51	GE-67	ICC-51	TR-88	PTC 141	HEP-51	SK 3114	RT-115	ECG 159	WEP-717	ZEN 101
2N2802*	NA	T-715	GE-22	ICC-715	TR-20	PTC 131	HEP-715	SK 3118	RT-126	ECG 106	WEP-637	ZEN 106
2N2803*	NA	T-715	GE-22	ICC-715	TR-30	PTC 131	HEP-715	SK 3118	RT-126	ECG 106	WEP-637	ZEN 106
2N2804*	NA	T-715	GE-22	ICC-715	TR-20	PTC 131	HEP-715	SK 3118	RT-126	ECG 106	WEP-637	ZEN 106
2N2805*	NA	T-715	GE-22	ICC-715	TR-20	TC 131	HEP-715	SK 3118	RT-126	ECG 106	WEP-637	ZEN 106
2N2806*	NA	T-715	GE-22	ICC-715	TR-20	PTC 131	HEP-715	SK 3118	RT-126	ECG 106	WEP-637	ZEN 106
2N2807*	NA	T-715	GE-22	ICC-715	TR-20	PTC 131	HEP-715	SK 3118	RT-126	ECG 106	WEP-637	ZEN 106
2N2808	NA	NA	NA	NA	NA	NA	HEP-720	NA	NA	NA	NA	NA
2N2809	NA	NA	NA	NA	NA	NA	HEP-720	NA	NA	NA	NA	NA
2N2810	NA	NA	NA	NA	NA	NA	HEP-720	NA	NA	NA	NA	NA
2N2811	NA	NA	NA	NA	NA	NA	HEP-S5004	NA	NA	NA	NA	NA
2N2812	NA	NA	NA	NA	NA	NA	HEP-S5004	NA	NA	NA	NA	NA
2N2826	NA	NA	NA	NA	NA	NA	HEP-238	NA	NA	NA	NA	NA
2N2827	NA	NA	NA	NA	NA	NA	HEP-238	NA	NA	NA	NA	NA
2N2828	NA	TS-3020	GE-66	NA	NA	NA	HEP-S5000	NA	NA	NA	NA	NA
2N2829	NA	TS-3020	GE-66	NA	NA	NA	HEP-S5000	NA	NA	NA	NA	NA
2N2831	RS276-2009	T-50	GE-17	ICC-50	TR-21	PTC 136	HEP-50	SK 3024	RT-114	ECG 128	WEP-724	ZEN 100
2N2832	NA	T-626	NA	ICC-626	NA	PTC 136	HEP-626	NA	RT-127	ECG 121	WEP-232	NA
2N2833	NA	T-236	NA	ICC-236	NA	NA	HEP-236	NA	NA	NA	NA	NA
2N2834	NA	NA	NA	NA	NA	NA	HEP-642	NA	NA	NA	NA	NA

*Indicates a dual transistor for high-speed switching, diff amplifier etc. Likely to be a matched pair. Use two of the type specified, matching when necessary, on a curve tracer or lab-type transistor checker.

NA = NOT AVAILABLE

(continued next month)

R-E's Service Clinic

Aristotle and the Big Bottle

Or, no raster; Plenty high voltage

by JACK DARR
SERVICE EDITOR

ARISTOTLE WAS AN ANCIENT GREEK PHILosopher. One of a group that left us some valuable ideas. Their personal habits would get them an X-rating now, but their other ideas were pretty good. Aristotle's gave us a two-valued system of logic. This hung on for quite a while. Everything was either black or white, A or B, on or off—nothing in between. Sometimes this is good, sometimes bad. At any rate, it makes a good illustration of methods for dealing with one problem that has become a lot more common lately.

In far too many cases, we have a tendency to assume that only one thing can cause a given trouble. We overlook possible alternative causes. This particular problem was very rare; however, it is showing up more and more in the Clinic mail. So I thought it would be a very good idea to take a look at other solutions.

Here's the problem: a complete loss of raster. High voltage may be completely missing, or very low. Yet, when we check out the high-voltage supply, or change everything in it, we *still* have the same problem—no raster! So, the thing to do now is revise our original (and quite logical) conclusion, that there was trouble in the high-voltage supply, and look for *another* cause: "B", since "A" didn't work! Actually, of course, the high-voltage supply itself does provide most of these problems, but don't overlook B. It's still present.

The big bottle

The other possible cause is a defect in the *bias supply* of the picture tube! If the picture-tube bias isn't correct, the Big Bottle can draw so much *current* that it loads down the high-voltage to the point where it disappears. "So much current", in this cases, is a whopping 2-mA, or something in that area! That doesn't sound like a lot. However, *maximum* rated current for a standard 3-gun color picture tube is 1600-µA—0.0016 mA! In terms of power, where we multiply voltage by current, using 25,000 volts for "E" we have a very respectable amount of load indeed, at minute currents. So our high-voltage supply simply collapses under such a load, and the raster goes out.

Possible causes

There are several things that can cause this condition. Anything that upsets the dc voltages on the video amplifier will vary the picture tube cathode voltages; upset the dc voltages on the three color difference amplifiers, and you vary the voltage on the grids of the picture tube. This refers to the original circuit. The later "RGB" circuitry is subject to the same kind of troubles, though with different parts causing it.

In the original circuitry, we run the cathode at around +300 volts and grids at around +200 volts. (ballpark figures, of course) It doesn't take much of a change in the right direction to cause trouble. This Big Bottle is a plain old vacuum tube, after all. If its grid is made more positive, it draws more "plate current".

In this circuit, we have two possible variables; if we make the grids more positive, up goes the beam current. Also, if we make the cathodes *less* positive, we are actually making the grids more positive, since the grid voltage is referred to the cathode voltage! The actual bias is the *difference* between the grid and cathode voltages, regardless of what these voltages read to ground!

So: let's assume that something upsets the bias on all three of the differential amplifiers at once. (In many circuits, the horizontal *blanker* can do this) Suppose this causes their grids to go highly negative. Here, too, we can have a cathode problem; the blanking is fed to the common cathode; make the cathodes *more positive*, and you've made the grids more *negative*. So, the differential-amplifier tubes are cut off; their plate current goes down, and naturally, their plate *voltage* "goes up" (more positive). So does the grid voltages of the picture tube, since these are directly coupled to the differential-amplifier plates. Up goes the beam cur-

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, New York 10003.

rent of the picture tube and, in many cases, out goes the raster.

We can get the same thing in the video- amplifier stage. Let's have a fault, such as a short in the video amplifier tube, that makes it draw very high current. Its plate voltage goes "down" or more negative; so, the picture tube cathodes follow, leaving the picture tube grids much more positive! Same result. An open in the "video peaking transformer" used in a great many video output circuits can even leave the video amplifier with zero plate voltage, and Boom.

In some cases, where the fault isn't quite as severe as these, you will get a smaller change in picture tube bias. This will cause a "flare" symptom. The picture will get very bright, and the brightness control will have no effect on it. If the high-voltage supply happens to be in very good shape with a high reserve power rating, this can happen. In a few instances, this has been seen to cause flaring, with a small amount of raster pull-in on the sides. These seem to be contradictory symptoms, but looked at in this light, no.

The same thing can show up in the later model sets using RGB circuitry. In these, the grids are common, and generally tied together. Video and color signals all go to the three separate cathodes. But, you can still have this type of trouble. It may be from a different part, but the same thing can happen.

This is the major problem that seems to be getting the boys—they don't remember this! As I said before, this kind of trouble used to be quite rare. Lately, the Clinic mail is full of them, and I have run into at least a dozen on my own bench, this year! (I don't explain 'em, I just tell 'em.)

There's a quick check for this, thank goodness. When you have made the initial tests and substitutions (the easy ones), with no results, just pull the base off the picture tube and recheck for high voltage. In sets with series heaters, you'll have to pull the high-voltage lead off the tube. If the high-voltage jumps back up to normal, there you are. Go thou and check all of the bias voltages on the base of that picture tube!

The worst problem seems to be that we don't *suspect* this; or, we just plain don't rememer it! So, remember the first Ari., and his two-valued logic; there is always more than one cause for any kind of trouble. If you don't dig it out in the high-voltage supply itself, go chase some biases. **R-E**

reader questions

NO BRIGHTNESS CONTROL

I can't turn the brightness off in this Olympic CC3340. Even the kine bias switch has no effect. Picture tube OK, other tubes OK. I'd like a schematic on this, too; can't find one in Canada.—J.F., Montreal, Canada.

This particular model of Olympic uses an RCA CTC-15 chassis. You can use this, or write to Olympic International Ltd., 88-89 Union Turnpike, Ellendale N.Y. 11227.

Brightness control: Check the grey-scale adjustments, especially the setting of the screen controls on the picture tube. If someone has turned all three of these full up, you might not be able to turn the raster off.

If these are OK, then you have a *bias* problem. Read the cathode and grid voltages on the picture tube. Cathodes should be about +345 volts, grids about +160 volts. If the grids are "too positive" (high), or the cathodes "too negative" (low), the picture tube will be near to "zero-bias", and the control won't work.

ELECTROLYTIC BLOWS

The customer said there was a Bang, and this Truetone WEG-2297-A27 went out. When I turned it on, I got a weird raster, with a dark spot in the center. Opening it up, I found that a small electrolytic capacitor on the high-

voltage/sweep module had exploded. It's connected to the cathode of the 6GK6 horizontal output. I replaced it, and the new one exploded, too! I have no schematic on this set. What's causing this?—G.W., Waldron, Ark.

Schematic on this one is in Sams 1216-3. This capacitor is apparently used to bypass the horizontal output tube cathode. It returns to ground through a little heater in the *circuit breaker*. If this heater is open, the pulse voltage will blow this little capacitor: 100-μF, 10V. Check from pin 2 of the sweep module to ground for not more than 1.3 ohms.

NO RED

Everything else works, but I can't get any red in the picture on this RCA CTC-16XL. As you said, I checked all of the dc voltages. The blue and green grids on the picture tube are OK at +160 volts, but the red grid is down to +82 volts. The 6GU7 is OK, and the plate resistor (27,000 ohms) is OK. Only +82 volts on the plate of the R-Y amplifier. What goes now? F.C. Augusta, Ga.

Old saying: if plate voltage is low, tube and plate load resistor OK, then check cathode and grid circuits. (You're losing the red because the red gun of the picture tube is plain old cut off. A "drop" in bias from +160V. to +82V is enough to stop this gun from conducting.)

Cathode circuit of all three difference-amplifier tubes is common, but check it anyhow. Also check the grid circuit. I think you may find that little choke, L34, is open. This would upset the bias on this section of the 6GU7, which upsets the picture tube grid bias. (Feedback: that *was* it!)

REPLACEMENT TRANSISTOR

One of the output transistors is shorted in this Capitol SA-707T stereo record player. No data; transistor has "274 CV61" on it. What will replace it?—D.F., Pomfret, Conn.

Service data on this is in Sams 973-4. However, this transistor has only S-1570, no substitute given. From the voltages, etc., I'd try an RCA SK-3020. It's an npn, in a TO-5 case, with collector connected to case. (Don't forget the insulator and silicone grease on the heat-sink!)

PILOT LIGHTS OUT

An RCA RZC-275W radio came in. The only thing wrong with it is the pilot lights. I've checked the circuit, without a schematic, and can't figure it out.—P.L., St. Cloud, Minn.

The schematic for this is in Sams 1075-6 if you need it. The pilot-light circuit *is* a bit unusual in this set. This uses two 45-volt lamps which draw 55-mA apiece. These are shunted by a pair of 2200-ohm resistors and are in series with the tuning-meter lamp, a 12.6 volt 75-mA type. This whole string is across the 117-volt line, with a 220-ohm 2-watt resistor in series.

These are special lamps; the 45-volt types are RCA part No. 165296, and the 12.6-volt one is No. 165295. see your RCA parts distributor.

CRYSTALS? OSCILLATOR OR FILTER?

This isn't a regular question about a problem, but it's been bugging me for some time. Why isn't a crystal used alone in a color television set, instead of being used as an oscillator? I get different opinions from people that I ask—R.R., Dyess AFB, Tex.

A crystal, to simplify things, can be thought of as a very *sharp* resonant circuit. The "Q" (figure of merit) is tremendous. So, we can use one to lock the frequency of an oscillator, by substituting the crystal for the resonant circuit.

We can also use it as a very narrow *filter*, by putting it in series with the incoming signal. In quite a few sets, they pass the actual 3.58-MHz burst itself through the crystal, and then amplify it in the following stage.

With either method, we come out with what we must have: a signal which is locked to the station burst frequency for reference. **R-E**

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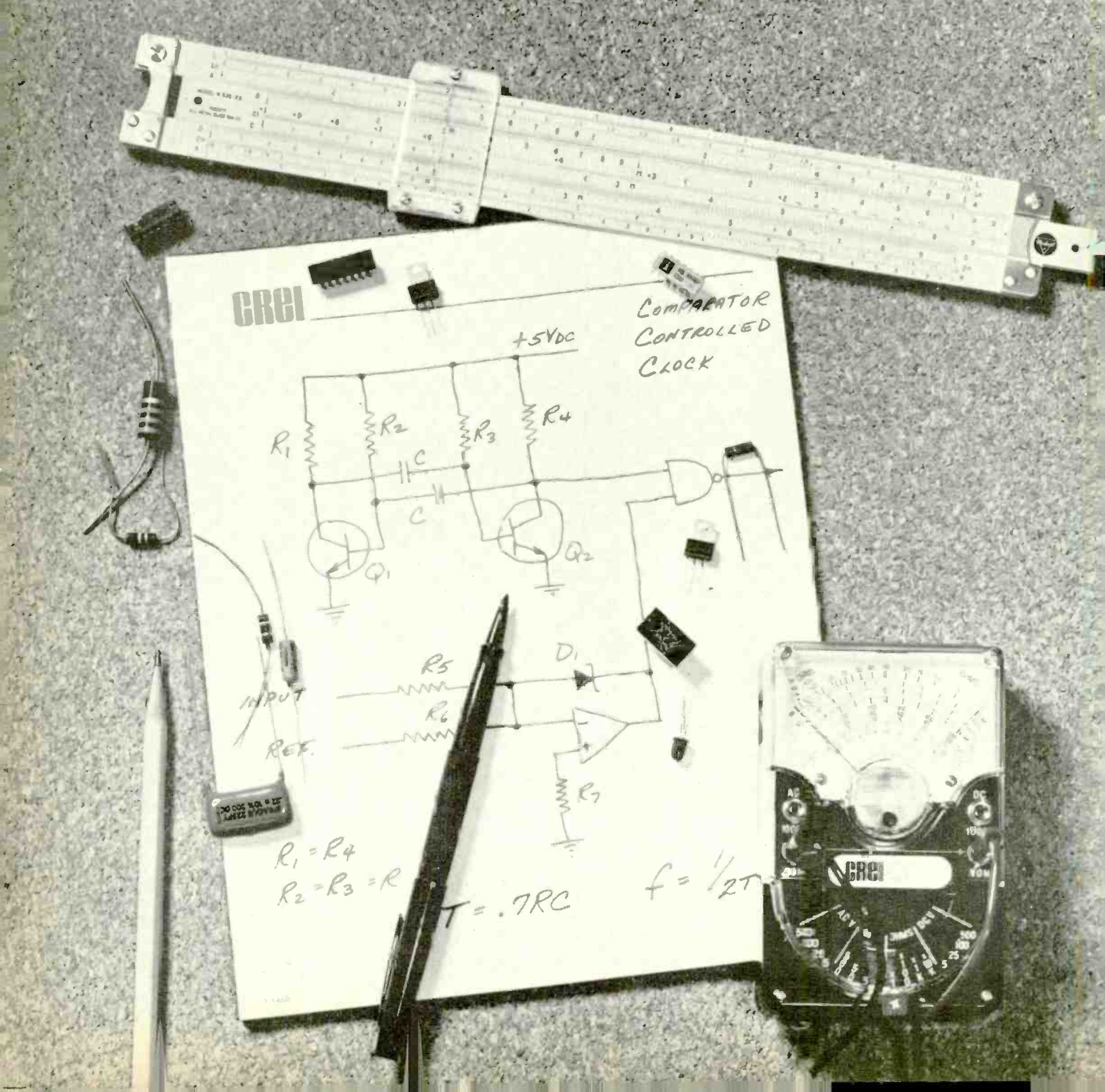

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Electronic circuit design—source of all new development in the application of electronics to new products and services. Without this skill, we would be unable to monitor the heartbeat of men in space. Without it, the computer revolution would never have occurred. And we would have yet to see our first TV show. *Yet, only CREI teaches electronic circuit design at home.*

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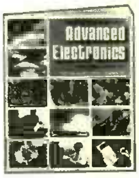

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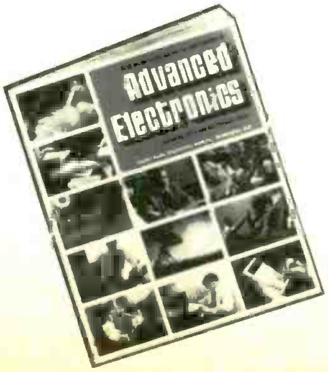

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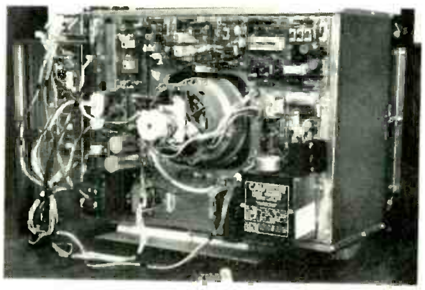
HEATHKIT COLOR TV

(continued from page 37)

horizontal and vertical sync pulses generated for the display sync. The digital output signal is coupled through the switch to the display driver in place of the channel/time display signal. The pattern that appears on the screen is an array of small, well-defined white dots.

LC bandpass filter for i.f. strip

Perhaps the most important function of the i.f. amplifier in a color television receiver is selectivity. Fig. 7-a shows the i.f. selectivity curve of a typical modern high-quality color TV. Transistor amplifiers provide the gain. Tuned LC circuits distributed through the amplifier handle the amplitude shaping. A very narrow trap tuned to 39.75 MHz rejects the picture carrier of the adjacent upper channel. In a similar way a trap tuned to 47.25 MHz rejects the sound carrier of the lower adjacent channel. The other adjacent channel frequencies are minimized by the normal skirt selectivity of the TV set.



LOOKING AT THE GR-2000 from the rear all the modules are visible. One has been unplugged.

The i.f. amplifier used in the GR-2000 is totally different. It uses a single bandpass filter as its sole response-shaping element. Figure 7-b shows the selectivity curve of this i.f. amplifier. Note the positions of the critical frequency points in the curve. Adjacent channel carriers are located a minimum of 60 dB down. The circuit of the amplifier as used in the GR-2000 is in Fig. 8.

Looking at Fig. 8 we see that the tuner's i.f. output is coupled to the filter through transistor Q325, a common-base circuit. This transistor provides some gain, and presents a constant impedance to both the tuner's output and the input to the filter. It also isolates these two stages.

The LC filter is positioned ahead of the 2-stage IC amplifier. These two IC's provide plenty of gain, a synchronous detector, an afc output, and a choice of high or low-impedance outputs for composite video. A broadly tuned transformer is used to couple these two IC stages. This makes the transformer easy to adjust and no special instruments are needed.

The 4.5-MHz sound output signal is taken from the low-impedance output of IC326. Coming off the same output is a 4.5-MHz trap that is coupled to Q326, an emitter-follower stage that is used to drive the agc and chroma.

The varactor tuner

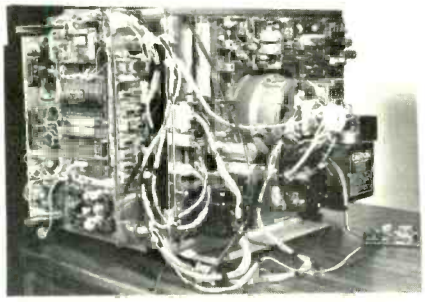
The uhf/vhf varactor tuner differs from conventional switch-type tuners visually, in that no mechanical tuning is used. Instead, the circuits are tuned by feeding preset dc voltages to them. Digital logic circuits are used to direct the preset tuning voltages to the tuner to select the desired channel.

A 4-bit up-down counter (see Fig. 9) IC202, can count from binary 0000 to binary 1111. A total of 16 different binary numbers can appear at its four output lines. When a negative-going pulse is applied to pin 5 of IC202 (the counter input), the counter will count up one binary number and remain there until another pulse is applied. In the same way, when a negative-going pulse is applied to the pin 4 of IC202 (the countdown input), the counter will count down one binary number and stay there.

When the counter reaches 1111 while counting up it starts over on the next pulse with 0000. In the same way when counting down if the counter reaches 0000, it starts over at 1111 on the next pulse.

The pulses to activate the counter are produced by a 2-Hz multivibrator made up of Q217 and Q218. They are applied to the counter when either S152, the up-channel switch; or S151, the down-channel switch, on the front of the set is depressed.

The 4-bit information at the outputs of the up-down counter is fed to the four input terminals of IC203, a 4-line to 16-line decoder. One of the 16 output lines is selected for each of the different 16 binary numbers applied to its four input lines.



FROM THE SIDE the digital programming circuitry becomes visible. Remote control and clock circuits are also here.

Each of these 16 output lines is connected to a transistor diode switch (Q201 through Q216 and D249 through D264) that will switch the tuning voltage from one of the 16 preset tuning controls to the tuner.

(turn page)

In any setting of the up-down counter one of IC203's 16 output lines is low while all of the others are high. The low output corresponds to the binary input of IC203. The 15 high outputs turn on their associated transistor switches, placing the collectors of these transistors at approximately ground (actually 0.3 volt), which shunts the tuning voltage to ground. The output that is low turns its respective transistor off and the tuning voltage passes through its isolation resistor and diode to the tuner and the desired channel is selected.

The digital clock

The complete circuit of the digital clock option for the Heathkit GR-2000 is shown in Fig. 9. The majority of the circuit is contained in a single IC, and MOS unit that contains all of the logic circuits required to provide 6-digit, 12 or 24-hour time data to the readout circuit of the receiver.

The clock operates from a 24-volt ac, 60-Hz signal that connects to pin P1. It is coupled by resistor R1 to pin 19 of IC1. Diode D1 clamps the positive half cycles to +5 volts dc and diode D2 clamps the negative half cycles to +9 volts dc. Capacitors C1, C2 and C3 are bypasses.

Three momentary switches are used to set the time. Physically they are mounted in the slide out chassis drawer for easy access. Pushbutton H (switch

S1) stops the clock to allow actual time to catch up to the display. Pushbutton S (switch S2) advances the minutes and pushbutton F (switch S3) advances the hours.

Either a 12 or 24-hour display mode can be selected by connecting pin 13 to pin 14 for a 12-hour display, or pin 13 to pin 15 for a 24-hour display.

The voltages that cause the digits to be selected and displayed by the readout circuit appear on wires G, H, and J. Multiplexed time data is fed back to the readout board on lines B, C, D.

The hand-held remote is completely self-contained and is powered by a 9-volt battery. It offers eleven control functions: TV on-off, volume up or down, tint green or red, color up or down, channel up or down, and the readout can be recalled by a touch of the volume-down button. The control frequencies generated by the oscillator in the remote range from 16 kHz to 22 kHz. These frequencies are doubled by the transducer so the actual signals transmitted to the set range from 32 kHz to 44 kHz.

Logic circuits control the actual functions in the receiver. The volume control is a good example and the color and tint circuitry is basically the same. Take a look at Fig. 10. A 4-bit up-down counter is used to provide 16 possible binary counts. The volume is raised or lowered by varying the current flow in the volume control line. The counter applies a logic 0 to one end of resistor R31 through R34 in binary sequency to provide 16 discrete levels of volume. Inverted IC4-a b, c, and e in series with each output line of the counter (IC3) provide logic inversion.

The volume control also turns the set on and off. The four output lines of IC3 are connected to a series of OR gates whose outputs controls relay driver transistor Q2. When the counter is set to 0000, the output at pin 11 of IC6-d is logic 0 and turns Q2 off. Then relay contacts 6 and 9 are open and contacts 1 and 7 are also open and the set is off. When the volume is advanced by increasing the count in IC3, output pin 11 of IC6-d goes to logic 1. This makes Q2 conduct through the relay coil and turns the set on.

Final comments

We could go on and on. A complete description of all the new circuits in the GR-2000 would fill this issue of Radio-Electronics. However, we have touched on the high points and as it is obvious from the circuits we have described, this TV kit is something to be reckoned with. It provides new circuits that haven't been seen before. It uses the latest in digital logic techniques in its operation. It is undoubtably one of the best designed color TV sets available today. It's a set you will want to own. **R-E**

new products

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

OPEN SESAME. *Automatic Speech Recognition System* operates on a new concept. A sound-operated switch, the A.S.R. responds only to the specific word or group of words spoken into it. The system consists of an analog-to-digital converter that converts the applied speech

waveforms into a digital format. This information is stored in a memory/logic system for speech pattern identification.

To set up the unit, it is necessary only to speak the desired word or words into the microphone while holding down the ENCODE button. The switch may now be activated at any time by depressing the ACCESS button and repeating the stored word(s). Additional modules permit a number of words to be stored.—**Shields Products, Inc.,** 1104 Prospect Ave., Cleveland, OH 44115.

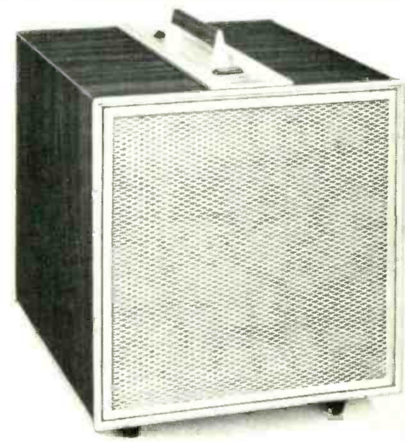
Circle 31 on reader service card

DIGITAL COLOR GENERATOR, *CG25 Little Huey* is portable and uses CMOS IC's. Produces all RCA licensed patterns with pushbutton operation. Low power drain; automatic shutoff. Operation from 120°F. to −20°F. Small size leaves

room inside for: adjustable output to cover low channels 2-6, color level control from 0-200°, adjustable dot size, all easily accessible screwdriver adjustments on bottom of unit. $99.00.—**Sencore, Inc.,** 3200 Sencore Drive, Sioux Falls, S.D. 57107.

Circle 32 on reader service card

ELECTRONIC AIR PURIFIER KIT, *GD-1003* removes up to 99% of all pollens and mold spores and up to 95% of all other airborne contaminants regardless of size or concentration. Two-stage cleaning cycle: 8,000-volt initial ionizing stage, followed by 4,000-volt collecting stage. Two-speed switch allows movement of



large volumes of air in high position and provides quiet continuous operation in low position.

To clean: just flip off rear grille screen, lift out collector cell and wash in plain detergent and water. Activated charcoal deodorant filters slip out for replacement when needed. 15″ × 13-½″ × 17-¾″; self-contained; plugs into any 120 Vac outlet. $139.95. — **Heath Company,** Benton Harbor, Mich. 49022.

Circle 100 on reader service card

METRIC CONVERTER, *model 941* features 35 conversions with the arithmetic functions plus percent for a total of 41 functions. Can be used

as calculator until operator initiates conversion operation. At any point in a problem, a conversion can be made (length, area, volume, liquid, mass, and temperature).

Features include: bright, 8-digit LED display, chain calculations, calculation with memory, full floating decimal, sign indicator, true credit balance, overflow indication, low battery indication, display blanking to conserve power, and more. Kit $129.95; assembled $149.95; both are handheld.—**MITS, Inc.**, 6328 Linn Avenue, N.E., Albuquerque, N.M. 87108.

Circle 33 on reader service card

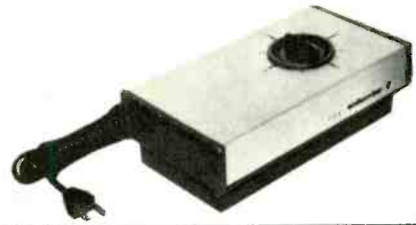
POCKET CALCULATOR, *EL-805* operates for more than 100 hours on a single penlight battery. Liquid crystal display and an improved CMOS IC. Display works on reflected light with

almost no battery drain. CMOS reduces power consumption to less than 1/20th of conventional (P-type) MOS.

In additon to four basic arithmetic functions, this model features 8-digit answers; chain and mixed calculations; minus indicator; zero suppression; automatic clearing; floating decimal and constant. Less than 8 oz.; 3-⅛" × 4-¾" × 13/16"; $109.95 — **Sharp Electronics Corp.**, 10 Keystone Place, Paramus, N.J. 07652.

Circle 34 on reader service card

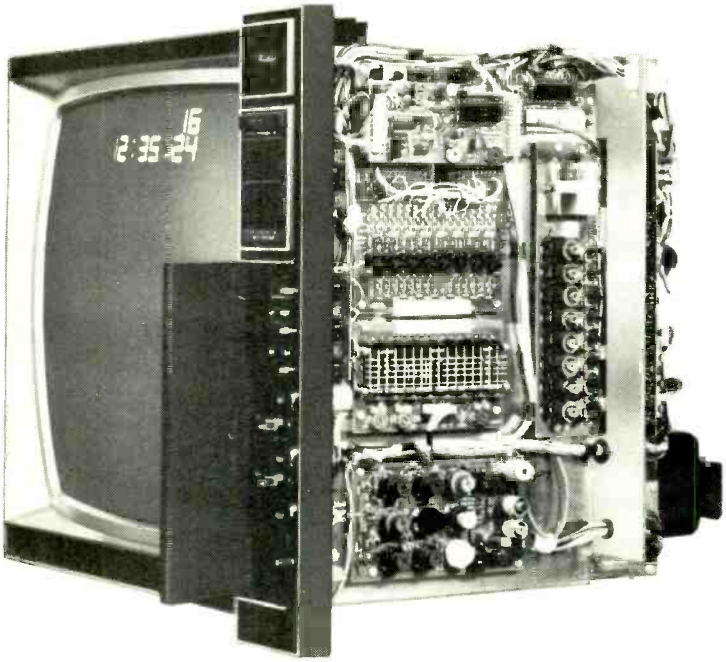
ANTENNA ROTOR, *model AR-40* has high stall torque, and on-off light that indicates when the system is operating. Roof-top portion can be rotated a full 360, and has an accuracy of 1%. Installation is simple because unit can be assembled on the ground first. Mast-clamp type mounting fits all color antennas.—**Cornell-Dubiller Electric,** 150 Avenue L, Newark, N.J. 07101.



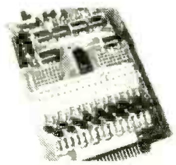
Circle 35 on reader service card

SOLDERING TWEEZER SYSTEM, *model CTP-20.* For working on small joints in closely-spaced areas and in applications where resis-

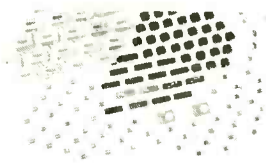
The all-new digital-design



It offers you these important advances in technology, quality, and performance:



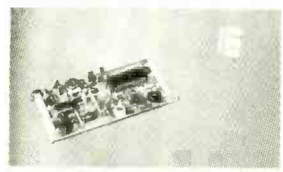
Programmable Channel Selection through digital up-down counter with computer-like programming board.



100% Solid-State Design — the picture is the only tube-type device.

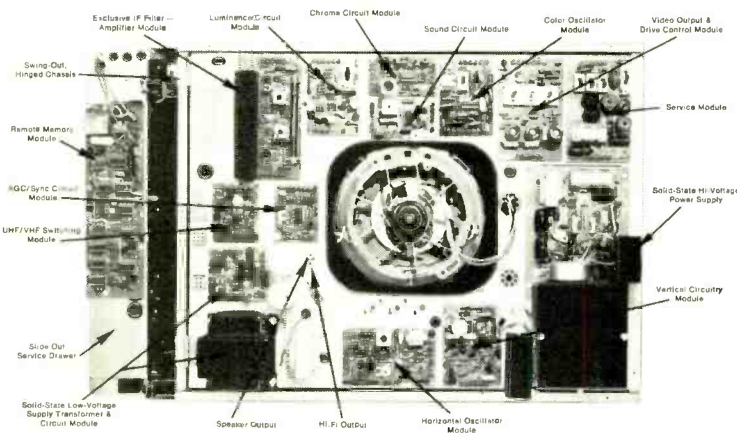
Silent All Electronic Tuning with new combination UHF/VHF Varactor Tuner located inside the chassis — completely shielded.

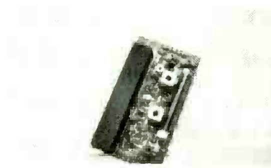
Touch Tuning at front panel (or remote) — touch to change channels up or down — hold in to sweep all channels.



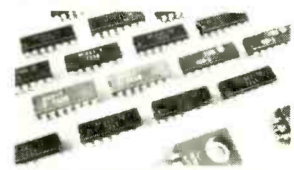
On-Screen Channel Readout — big, bright 1½" numerals for both UHF and VHF.

On-Screen Clock Readout gives time in 4 or 6-digit format, 12 or 24 hour time.

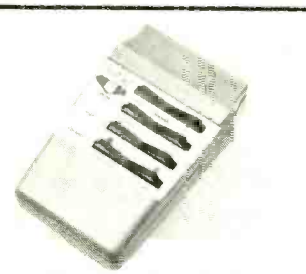


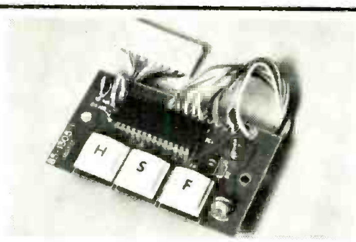


Fixed Filter IF totally eliminates instrument IF alignment forever.



19 Integrated Circuits simplify kit building and permit ultra-sophisticated technology with long-term reliability.





Eleven-Function Touch-Tune Remote Control for the Heathkit GR-2000 ... 79.95*

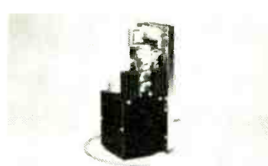
This all solid-state ultrasonic system utilizes 13 integrated circuits, 28 transistors to give you wireless armchair control of on and off, volume, VHF/UHF channel selection, up or down color intensity, and tint. Plus, a touch of the volume button automatically recalls the digital readout to the screen. Kit includes receiver for in-chassis mounting and hand-held transmitter. Operates from 20-feet away from set.

Kit GRA-2000-6, 4 lbs. **79.95***

Optional Digital Clock for your GR-2000

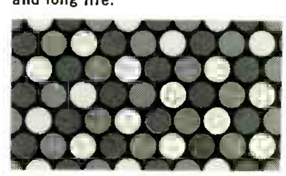
In just a couple hours' time you can build the GRA-2000-1 Digital Clock Accessory. Everything mounts on one small board that plugs into the readout board in the GR-2000 service drawer. That's all there is to it. Clock circuit board has slow, fast and hold pushbuttons for setting time, jumper wire for selecting 12 or 24-hour format. You set your on-screen display for hours and minutes, or hours, minutes and seconds using the programming circuitry on the channel readout board. Order with your GR-2000, or add it on later, if you prefer.

Kit GRA-2000-1, Digital Clock Accessory, 1 lb. **29.95***

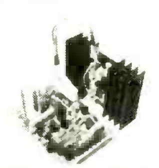


Solid-State Hi-Voltage Supply in tripler configuration for efficiency and long life.

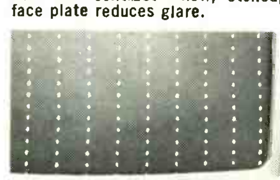
Solid-State Low-Voltage Supply has short-circuit proof integrated circuit regulators.



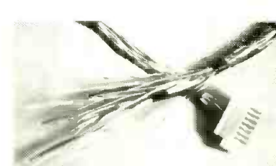
New Deluxe Black (Negative) Matrix Picture Tube — fully illuminated color dots with black background matrix for greater brightness and contrast — new, etched, face plate reduces glare.



New Vertical Sweep Design gives better picture interlace, improved picture detail; complementary power transistors eliminate output transformers for better linearity.



True Digital Design Dot Generator makes picture convergence easier and more precise.



Twelve Wiring Harnesses — prefabricated, connectors installed, pre-stripped, ready to solder — this TV is easier to build.

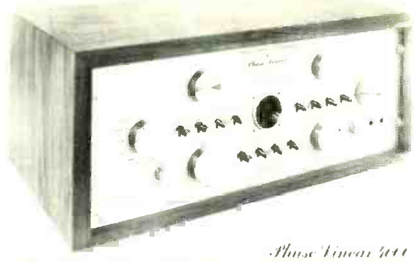
tance heating could damage circuit components. Operator grasps the lead (tweezer-like) and then performs the heating function with no danger of arcing or stray current generation.

Weighs less than 5 oz.; controlled heat allows temperature stabilizion of the leads during heating and cooldown; adjustable-temperature power supply. Foot switch on-off control. Adjustable tip gap opening to ¾"; replaceable tips; $149.00 — **Pace, Inc.**, 9329 Fraser Avenue, Silver Spring, Md. 20910.

Circle 36 on reader service card

STEREO PREAMPLIFIER, *model 4000* features the "auto correlator," a noise reduction system that makes record/tape hiss and FM broadcast noise virtually vanish without affecting muscial content.

Total distortion: less than .25°; typically .02%. Frequency response: phono—within ±1 dB of RIAA from 20 Hz to 20 kHz; high level—within ±1 dB from 20 Hz to 20 kHz. Power consumption: 40



Phase Linear 400

watts. 7" x 19" x 10"; 18 lbs.; $599.00.—**Phase Linear Corp.,** 405 Howell Way, Edmonds, Wash. 98020.

Circle 37 on reader service card

VOM, *model 120P* features 20,000 ohms-per-volt sensitivity and 2% accuracy on dc; offers a .25-Vdc range and a 50-μA direct current range. Resettable electronic overload protection cir-

cuit protects the instrument.

Ranges covered: direct volts—0 to 1000 in 8 ranges; direct current—0 to 10 A in 6 ranges; alternating volts—0 to 1000 with 3% accuracy and frequency response of ±1 dB to 100 kHz through 50V±to 20 kHz on 250V range; ac output volts—0 to 250 in 4 ranges; ohms—R×I, R× 100, R×10,000; also reads decibels. 5-¼" × 7" × 3-⅛"; 3 lbs.; $69.95 (test leads and batteries included).—**Dynascan Corp.,** 1801 West Belle Plaine Avenue, Chicago, Ill. 60613.

Circle 38 on reader service card

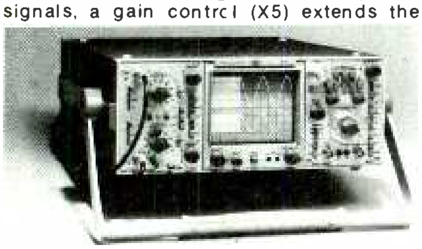
MICRO-COMPUTER, *model Root-8* features automatic square root key; can be used for squaring and reciprocal calculations. Features include: sign change (+ to -, - to +), automatic

floating decimal, underflow system that delivers the eight most significant digits of the answer, calculation with a constant in multiplication and division, automatic overflow check that locks calculator until cleared, automatic zero suppression, and true credit balance capabilities. Operates on ac or batteries; 1-½" x 7" x 3-⅜"; 14 oz. including batteries; $89.95.—**Casio, Inc.**, One World Trade Center, New York, N.Y. 10048.

Circle 39 on reader service card

DUAL TRACE OSCILLOSCOPE, *D75.* 6-½" CRT contains internal graticule for nonparallax measurement. 15-kV accelerating potential helps produce bright displays of low repetition rate signals in even high ambient light environment.

For low-amplitude measurements, the 50-MHz dual-channel, vertical amplifiers have deflection factors starting at 5 mV/div, accurate within 3%. For measuring even lower amplitude signals, a gain control (X5) extends the



minimum deflection factor to 1 mV/div with 15-MHz bandpass. For high resolution meas-

Circle 62 on reader service cards

UNTIL RECENTLY, THERE WERE OVER 22,500 TRANSISTOR PART NUMBERS TO WORRY ABOUT IN THE SERVICE BUSINESS.

Now, only 47 types put an end to the nightmare.

Sprague's concise but complete line of 47 replacement transistors (24 small-signal, 18 power, and 5 field effect) is designed to do the work of over 22,500 O.E.M. transistors. But don't just take our word for it. The 'Fantastic 47' are on the self-service Semiconductor Q-Mart at your Sprague distributor's, ready to help you now.

And here's more good news! To help you keep the most-frequently-used transistors handy in your shop, we've got a new KS-10 Transistor Assortment. The Keen 18 . . . 10 small-signal transistors and 8 power transistors . . . give you a working inventory that replaces thousands of the most popular domestic and foreign O.E.M. part numbers. They come in an attractive, blue, durable plastic cabinet . . . you pay for transistors *only* . . . cabinet is yours at no additional cost!

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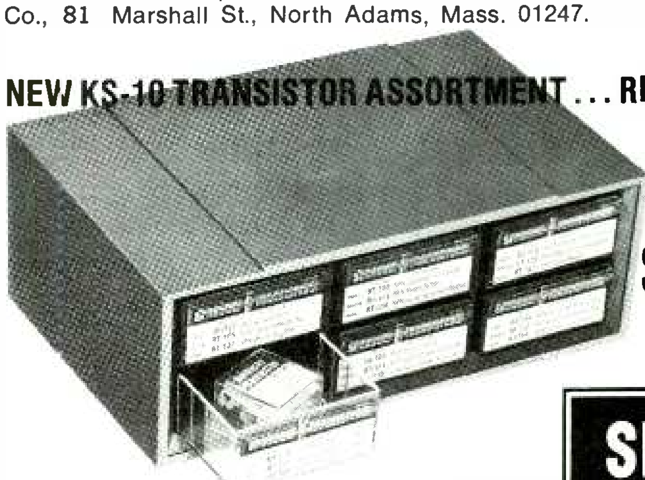

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Circle 63 on reader service cards

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MICROPHONE TRANSFORMER, *502CP* matches a Lo-Z mike line to Hi-Z input; matches low-impedance microphones to high-impedance inputs. Has flat 20 Hz to 15 kHz response; plug-in connectors; ¾" diameter.

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Circle 41 on reader service card

MARCH IS HI-FI MONTH

And R-E has some really special articles ready for you. Among them is a detailed look at the development of the SQ system from the basic matrix decoder, through the latest wave-matching full-logic decoder and on to a look at what is still to come.

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.

TOOLS FOR ELECTRONIC ASSEMBLY AND PRECISION MECHANICS. 96-page handbook describes over 1,900 items. Includes files, screwdrivers, wrenches, pliers, power tools, tool kits, relay tools, solders, microtools, test equipment, metalworking tools, wire strippers, etc. Four pages of technical data on tool selection include screwdriver selection, machine screw data, tool materials, temperature conversion, drill sizes and more. Contains glossary of terms of specific sections at beginning of that section.—**Jensen Tools and Alloys,** 4117 North 44th Street, Phoenix, Ariz. 85018.

Circle 42 on reader service card

1974 ELECTRONICS CATALOG, *No. 238.* 180-page booklet contains stereo and four-channel receivers, electronic calculators, automatic tape cartridge changer and DuoFone (telephone answering system for under $80). Includes complete line of Realistic home entertainment products, audio equipment, CB two-way radios and walkie-talkies and intercoms, Micronta test instruments, Archerkit and Science Fair automotive, electronic and hobby kits. Also includes tubes, transistors, cables, connectors and adapters; many illustrations and prices.—**Radio Shack,** Dept. R-24, 2617 West Seventh Street, Fort Worth, Tex. 76107.

Circle 43 on reader service card

NRI HOME TRAINING IN AIR CONDITIONING, REFRIGERATION AND HEATING. Outline of 45 lesson course covering servicing electric motors, refrigerant connections and servicing automotive heaters and air conditioners. Training units include circuit demonstrator (for learning fundamentals of electrical circuits) and control simulator (for learning electric controls). Each student receives a 5,000 BTU York window air conditioner to use as a practice unit and later for his personal use.—**NRI Training,** 3939 Wisconsin Avenue, N.W. Washington, D.C. 20016.

Circle 44 on reader service card

SOLDERING TOOLS CATALOG No. 523 features all purpose soldering kits from Standard, Princess, and Imperial lines. Illustrations and applications of the kits' adaptability are shown. Included is heater and kit selection guide as well as instructions for tip use and maintenance. Also featured are production aids, de-soldering equipment, and heat gun.—**Ungar,** 233 East Manville, Compton, Calif. 90220.

Circle 45 on reader service card

SIMPLIFIED SCIENCE ACTIVITIES is a 32-page catalog that contains step-by-step units on weather, ecology, plants and growing, nature, optical illusions, color, astronomy, microscopes, metric, and physical education. Many kits with illustrations and lessons. Also included are various materials, useful teaching aides.—**Edmund Scientific Co.,** 486 Edscorp Bldg., Barrington, N.J. 08007. **R-E**

Circle 46 on reader service card

next month

MARCH 1974

SPECIAL ISSUE
HIGH-FIDELITY SOUND

- **The SQ Generation**
  Contributing High-Fidelity Editor Len Feldman explores the development of the SQ matrix system from its earliest beginnings (3-dB front-to-back separation) to its current status with wave-matching and full logic.

- **Improving Room Acoustics**
  There are ways to make your hi-fi system sound better by improving the acoustics of your listening room. This article tells how to do it.

- **Flat Speaker Systems**
  There are two new speaker systems that produce a relatively flat speaker enclosure. One is from Magitran, the other from Fisher. Here's the inside story on how they work.

- **Installing Car Tape Decks**
  A complete guide to installing an add-on tape deck and speakers in a modern automobile. It's easy and can be profitable.

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Step-By-Step Troubleshooting Charts
Transistor Replacement Guide
Appliance Clinic
Service Clinic

IMPROVED ASCII ENCODER

(continued from page 61)

sensing is translated down to ground by IC3 and acted on by IC2 to get the proper three bit code. For instance, with no current through Q1 or Q2, the output code 101-XXXX is sent, corresponding to a character P through Z. Current through either other transistor sets up the numbers or lower alphabet code. And this gives us our basic 48 key encoding scheme.

Now, we add some refinements. The shift key acts on IC2 to change from punctuation to numbers or backwards. If a code from 0000 through 1011 is sent, this is recognized by IC5 as a number, a colon, or a semicolon. IC5 then tells IC4 to leave the shift command the way it was, and a *unshifted* key gets you a number, and a *shifted* key gets you the equivalent punctuation. On the other hand, if codes 1100 through 1111 are sent, IC5 detects this, and through the exclusive-or gate in IC4, compliments the shift line. Now, the shift key works *backwards*, putting the four problem punctuation keys back the way they belong. This is admittedly a bootstraps operation, but the time for the output to tell the input to shift is only a few nanoseconds, an utterly negligible time compared to most contact conditing and compliment-the-shift-if-12-or-greater circuit *only* affects the number keys. Any alphabet or punctuation key in columns IV or V are *not* affected by this circuit since Q2 is not sensing a "numbers" key.

Finally, the control key forces outputs 6 and 7 to ground regardless of anything else, automatically shifting from a alphanumeric command to a machine command. The spacebar is diode encoded to simultaneously provide a shift and a 0, or a "capital Ø", while the carriage return key uses two diodes to simultaneously give you a "control" and a "M" command. Other special keys are easily added, often by using two more diodes per key. If you need a DEL or delete key, the simplest way to do this is to break output line 6 with a SPDT key and route it to +5. The normal output of the encoder is 101-1111 when no key is in use. This changes it to 111-1111 or DEL. If you must have the lower case alphabet (make sure the other end of the system can handle or recognize it), you can leave the DEL key down to generate it.

Building it

A PC board is shown along with a parts list and notes on kit availability. We cannot tell you, now, what keyboards are available. Check the ads in the back of this issue for a guide. Before construction, you have to decide whether you are going to use mechanical contacts or resistive ones and place the program jumper accordingly, +5 for mechanical contacts or +12 for elastomeric ones. A 12-volt battery may also be used, as no input current is drawn unless a key is pressed, or you can tack a 6-volt battery on top of the +5-volt line for 11 volts. Resistors R1 and R2 also have to be changed, 1K for the +5-volt supply, or 3.3K for the +12-volt supply. If the encoder is to be used on a keypunch style keyboard, it easily mounts on one end of the unit by using four spacer blocks. A slight amount of filing may be

(continued on page 94)

new books

MATV Systems Handbook-Design, Installation & Maintenance by Allen Pawlowski. Tab Books, Monterey & Pinola Sts., Blue Ridge Summit, Pa. 17214. 176 pp. 8½" x 5½". Hardcover $7.95, Softcover $4.95.

A top-to-bottom look at MATV systems — from antenna basics down to TV filters and attenuators. The author presents a bedrock background for readers unfamiliar with technical terminology. He covers the various types of antennas for vhf and uhf, down-conversions, mixers, filters and traps, isolation and insertion loss, impedance matching and selectivity. The basics of master antennas, coax cables, splitters and couplers, taps and other terminating devices and matching transformers are covered in the early portion of the book. Then the reader is introduced to the ins and outs of designing complete systems. Must reading for the technician getting involved in MATV.

Selecting & Improving Your Hi-Fi System by Harvey F. Swearer. Tab Books, Monterey & Pinola Sts., Blue Ridge Summit, Pa. 17214. 224 pp. 8½" x 5½". $7.95.

Never before has the hi-fi buff had such a wide range of selection as he is currently offered. In this book the author explains what features each unit in the hi-fi system should provide and what the buyer should look for. He does not tell you the best system for you to buy simply because the best system for you is the one that fills your specific needs. Among the chapters in this book are: program sources, AM/FM receivers and amplifiers, 4-channel sound, stereo record players, tape recorders, connectors and cables, hi-fi speaker systems, speaker enclosures, and overall system checks.

Regulated Power Supplies by Irving M. Gottlieb. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, Ind. 46268. 160 pp. 8¼" x 5¼". Softcover $4.95 ($5.95 in Canada).

The regulated power supply has become a vital part of modern electronic devices. This kind of supply enables circuits powered by it to provide low distortion and stable operation under varying loads. The book starts off by showing the advantages of using regulated supplies, then goes on into the characteristics of their operation and continues into methods of using them. A final chapter discusses integrated circuits and monolithic modules used in today's regulated power supplies.

Introduction to Medical Electronics - For Electronics & Medical Personnel by Burton R. Klein. Tab Books, Monterey & Pinola Sts., Blue Ridge Summit, Pa. 17214. 271 pp. 8¼" x 5¼". Hardcover $9.95, Softcover $6.95.

This one book ties together medicine and electronics in a mannner that can be understood and easily digested by members of both professions. For non-medical personnel, a body is described in depth as an anatomical and physiological system. There is a continuing tie-in of physiological activities of the body with the equipment that is designed to detect, amplify and present data signals concerning the body. On the electronic end, the various categories of electromedical equipment are described as is maintenance, fault sensing, equipment management, and follow-up for preventive maintenance. A valuable text and reference in the field of medical electronics.

Transistor Specifications Manual, 6th Edition by the Howard W. Sams Engineering Staff. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, Ind. 46268. 160 pp. 10¾" x 8¼". Softcover $4.50 ($5.40 in Canada).

In the time since the first transistors were made available, the total number of types has increased tremendously. Many of these transistors are no longer on the market, many were produced with no type numbers, and others by manufacturers no longer producing transistors. When these types are encountered in older equipment, it is usually difficult, if not impossible, to locate transistor specifications. This manual contains three principal sections designed to provide maximum information about the transistor — a specification section, a LED identification section and an outline section. This newest, expanded version contains all the information you need to locate a proper replacement for more than 12,000 different transistor types.

1-2-3-4 Servicing Automobile Stereo, 2nd Edition by Forest H. Belt. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, Ind. 46268. 240 pp. 8¼" x 5¼". Softcover $4.95 ($5.95 in Canada).

This text outlines an effective troubleshooting system that results in a reduced call back rate since the system is so complete that it catches even borderline faults that are often overlooked. Follow the procedures diligently and as the author states: "You can't fall into the common fix-only-what's-obvious trap." Sets that you repair stay repaired. This is the second edition of this book and has been brought completely up-to-date with many new illustrations and updated additional text information.

KEYBOARD ENCODER

(continued from page 92)

necessary on these blocks, depending on your soldering on the circuit board to get things to lie flat. The bypass capacitor should be mounted *component* side, but with slightly long leads and bent flat. Otherwise interference between C1 and the metal case or rails holding the keyboard in your system may result.

There are 23 input leads. These are directly wired to the keys following the wiring matrix of figure one. (If you're using the **Radio-Electronics** Low-Cost Keyboard, rewire the jumper matrix to suit.) If you have to run through a connector or otherwise want to minimize the interconnect leads, the diodes D1 through D4 can be placed on the keyboard end, reducing you to 21 connections. Normally you mount the encoder integrally with your keyboard and this doesn't matter.

Note that whatever keyboard you use, the keytops must be ASCII ones. This means that the "capital 2" has to be a #, the capital colon a *, the capital semicolon a dash or minus, and so on. Otherwise, you have to remark the keyboards.

Using a keypunch keyboard

These are easily recognized by their bright blue keys and are now available from several surplus sources. More can possibly be expected since keypunch equipment is more or less headed to obsolescence. An unmodified one of these has the keys and keypairings all wrong, since they originally were EBCDIC coded, a non-standard and older code. Fortunately the callouts go where you can't reach them with a finger, and attractive stick-ons are easy to do, (see parts lists) as are instant transfer letters, or white ink fro the stationery store.

Various solvents (lacquer thinner, etc.) easily remove the old ink, or it may be carefully scraped off with an Xacto knife or a razor blade. Don't soak the keys in solvent as it may attack the plastic. Keyboards available from some sources are completely rebuilt for ASCII use. If you are doing your own instead, rearrange the parts so you have a rectangular block of keys with the black keys on top and the blue ones in the middle. Again, if you are rebuilding your own, you probably will end up short by at least two or three blue keys. These may be repainted as needed. ASCII modified keyboards come with everything the right color. Extra mounting blocks on one end support the encoder. The encoder may be mounted above or below the rails, although the lower position is much easier to wire. Output may be directly soldered, or connected with a standard 12-pin PC edge connector.

One way to simplify the wiring with this type of keyboard is to use *solderable* magnet wire—stuff that you can solder right through the insulation. Beldsol and Soldereeze are two types. This way, you loop the wire from terminal to terminal and then solder it in place without stripping. Stripping or at least pretinning is still recommended at the PC board end. It takes extra heat to solder through the insulation, but don't use so big an iron or gun that you melt the key assemblies or hurt the PC board. Heat the joint

(turn page)

KEYBOARD ENCODER

(continued from page 95)

first. After the insulation smokes, add a *minimum* amount of solder.

Testing the encoder

The obvious test is an acid test—connect it to the TV Typewriter or a terminal and see if it sends the right letters. A way that ties up less fancy equipment is to use a batch of IC driveable test lamps or LED's to *simultaneously* monitor *all* the outputs.

If some stickiness or reluctance is experienced with the spacebar and carriage return keys, raise the supply voltage slightly or replace D1 and D2 (the diodes that go to IC1) with metal barrier low-threshold diodes such as a MBD101 or something else with a 0.3 volt forward drop or less at 6-mA current. Of several IC1's tested, operation was satisfactory down to 4.7 volts. *Maximum* permissible voltage applied to the +5 terminal is 6.8 volts. A tightly regulated 5.1 or 5.2-volt supply should work with practically all units.

As with any keyboard system, some form of debouncing and noise elimination is *essential*. Normally, as in the TV typewriter, this is provided internally. If not, one possible circuit is shown in Fig. 2 that handles most any keyboard. An optional parity generator and parallel to serial converter were shown in the original article. These may be used as add-ons, or newer MOS asynchronous receiver-transmitter integrated circuits can be used for the same task. If enough readers need this sort of thing, we'll work up a project on it. **R-E**

APPLIANCE CLINIC

(continued from page 26)

pected switch, etc. and apply power. If the unit starts to heat, run, etc., turn it off, and replace that thermostat or switch.

In the plastic-cased thermostats, switches, etc., check the terminals. They should be clean, and tight in the body of the unit. In quite a few cases, the switch contacts can overheat, cause the body of the switch to char, and make the terminal come loose! This is a dandy cause of *intermittent* operation of the appliance. It will work perfectly one time, then refuse to go at all the next. Wiggle wiring, and check terminals, etc. Something is loose, not making good tight contact.

Careful attention to small details can help you find and fix some otherwise puzzling problems. Check everything! **R-E**

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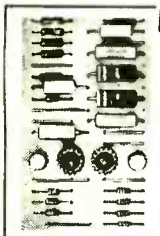

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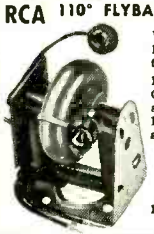

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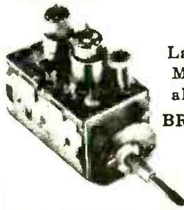

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- ☐ 20 — ASSORTED TV COILS I.F., VIDEO, sound, radio, etc. $1
- ☐ 1 — ELECTROLYTIC CONDENSERS 200/300/100/100 MFD — 25 V $1
- ☐ 1— ELECTROLYTIC CONDENSERS 100 MFD-400V $1
- ☐ 3 — ELECTROLYTIC CONDENSERS 20/20 MFD-450 V $1
- ☐ 5 — 9 VOLT MOTORS Excellent for hobbyist $1
- ☐ 6" PHILIPS "INVERTED CONE" SPEAKER Top quality . . . Thinline $2.29
- ☐ 1—6" x 9" HEAVY DUTY 10 OZ. SPEAKER Ceramic Type . . . 8 Ohm $3.95
- ☐ 10—ASSORTED DIODE CRYSTALS 1N34, 1N48, 1N60, 1N64, etc. $1
- ☐ 6— TOP BRAND SILICON RECTIFIERS 1 amp. 1000 PIV $1
- ☐ 5 — PNP TRANSISTOR general purpose, TO-5 case $1
- ☐ 5 — NPN TRANSISTORS general purpose, TO-5 case $1
- ☐ 50 — ASSORTED TRANSISTORS big factory scoop—sold as-is $1
- ☐ TV TWIN LEAD-IN 300 ohm 500' - $7 100' - $1.50, 50' $1
- ☐ 12—MINIATURE ELECTROLYTIC CONDENSERS For Transistor & miniature work $1
- ☐ CLARICON AM FM TUNER Solid state, walnut cabinet $59.95
- ☐ WEN SOLDER GUNS Model 225K $8.50 Model 288 $7.50 Model 250 $9.95 Model 100K $5.95
- ☐ 8 ELEMENT COLOR OUTDOOR ANTENNA Big shot Jr. List $11.95 $5.95
- ☐ 4 — POLARIZED CHEATER CORDS Grey $1
- ☐ ARISTO WIRELESS INTERCOM Walnut Cabinet, with buzzer call, AC operation $15.95
- ☐ 4—ELECTROLYTIC CONDENSERS 75/30mfd—150v $1

TEST EQUIPMENT SPECIAL DISCOUNT PRICES

B&K EICO Leader SENCORE

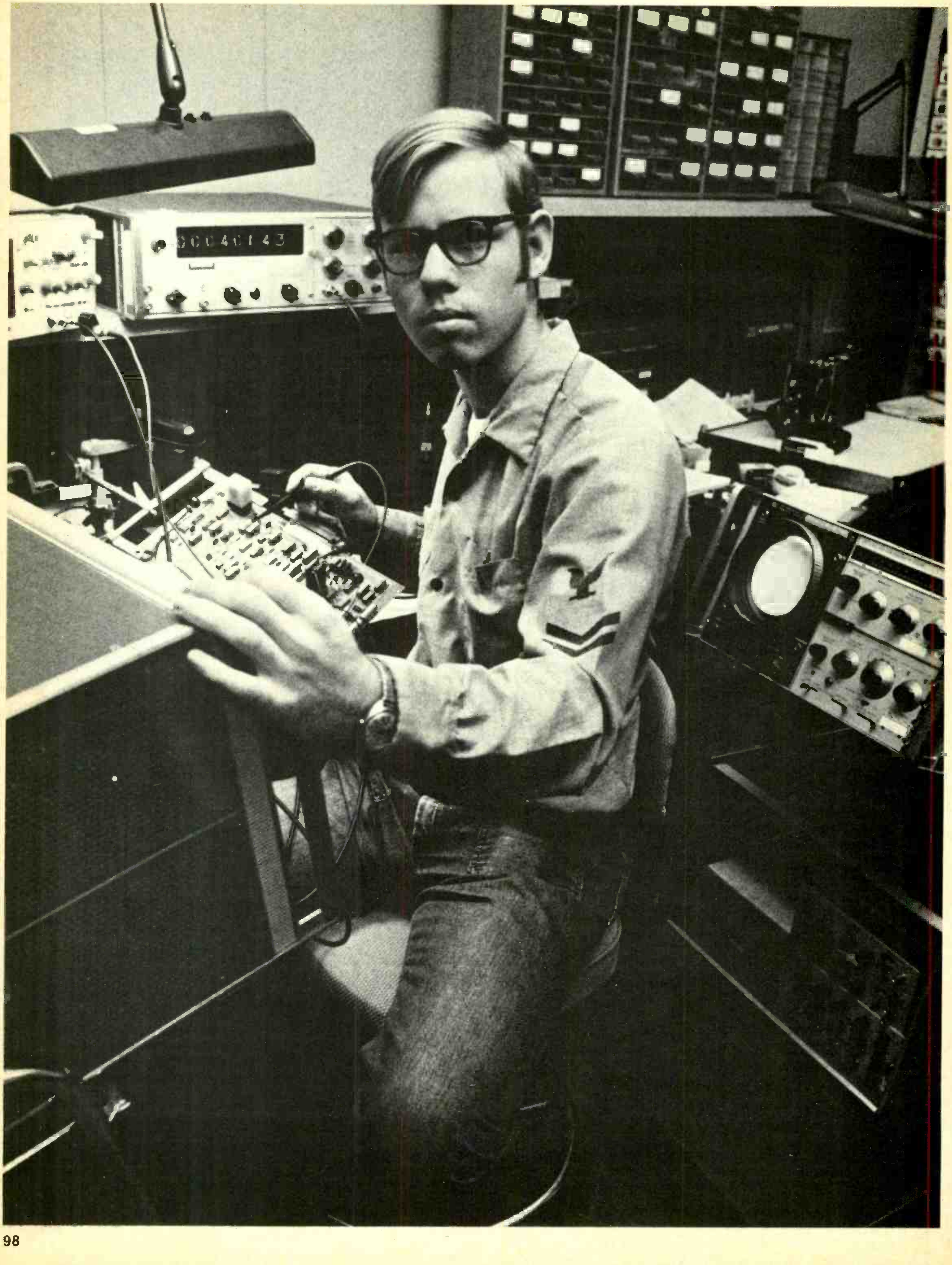
- ☐ 300 — ASSORTED HEX NUTS 2/56, 4/40, 5/40, 6/32, 8/32 $1
- ☐ 250 — ASST. SOLDERING LUGS best types and sizes $1
- ☐ 250 — ASST. WOOD SCREWS finest popular selection $1
- ☐ 250 — ASST. SELF TAPPING SCREWS #6, #8, etc. $1
- ☐ 150 — ASST. 6/32 SCREWS and 150 6/32 HEX NUTS $1
- ☐ 150 — ASST. 8/32 SCREWS and 150—8/32 HEX NUTS $1
- ☐ 150 — ASST. 2/56 SCREWS and 150—2/56 HEX NUTS $1
- ☐ 150 — ASST. 4/40 SCREWS and 150—4/40 HEX NUTS $1
- ☐ 150 — ASST. 5/40 SCREWS and 150—5/40 HEX NUTS $1
- ☐ 500 — ASSORTED RIVETS most useful selected sizes $1
- ☐ 300 ASSORTED WASHERS most useful selected sizes $1
- ☐ 100 — ASST. RUBBER BUMPERS for cabinet bottoms — other uses $1
- ☐ 100—ASSORTED RUBBER GROMMETS best sizes $1
- ☐ SIMPSON 2½" ROUND PANEL METERS Model 125 (0-100) DC Milliammeters $3.95
- ☐ 12" UNIVERSAL SPEAKER Top Quality . . . Large Magnet $4.89
- ☐ 10" PHILCO SPEAKER Top Quality Large Magnet $2.99
- ☐ 8" UNIVERSAL SPEAKER — Large Magnet—Special Buy $2.99
- ☐ 4" UNIVERSAL TWEETER 1 oz Magnet $1.29
- ☐ UNIVERSAL 4" PM SPEAKER Top Quality $1
- ☐ 2½" x 4" SPEAKER Special Buy 10 For $5— 69¢ Ea.
- ☐ 4" X 6" "QUAM" 16 OHM SPEAKER Large magnet . . . Special BUY (10 for $15.00) $1.79
- ☐ RONETTE STEREO CARTRIDGE latest dual sapphire flipover type $2
- ☐ STEREO HEADPHONES Hi-Fi Quality . . . Complete with Stereo plug $5.95
- ☐ 10 — STANDARD TRANSISTORS NPN & PNP 2N404, 2N414, etc. $1
- ☐ UTAH 8" — HEAVY DUTY 10 OZ. SPEAKER Ceramic Type - 8 Ohm $3.95
- ☐ 2—ELECTROLYTIC CONDENSERS UNECAP . . . 2000/1000 Mfd . . . 30 Volt $1
- ☐ 2—SPRAGUE ELEC. CONDENSERS 80/30/4 - Mfd. - 475 V $1
- ☐ 2 — ELECTROLYTIC CONDENSERS 200/30/4 mfd — 350V $1
- ☐ 8-TRACK TAPE PLAYBACK DECK Compact design fits anywhere $27.50
- ☐ 3—ELECTROLYTIC CONDENSERS 100 mfd.-100 V, 50 mfd—75 V $1
- ☐ 32" — TEST PROD WIRE DELUXE QUALITY, red & black $1
- ☐ SOLID STATE UHF CONVERTOR Channels 14-83, easy to install $17.95
- ☐ VARCO STEREO CARTRIDGE-CN-72 With mounting bracket, flipover needle $2.95
- ☐ ELECTROLYTIC CONDENSER 300 Mfd—200V $1
- ☐ CO-AX CABLE RG59U grey or black 250'—$9 100'—$3.69 50'— $2
- ☐ 15 — MINIATURE 456KC IF TRANSFORMERS PC ¼" X ¼"—good value $1
- ☐ 2 — 12BH7 RCA TUBES $1
- ☐ ELECTROLYTIC CONDENSERS 200/200 Mfd. — 200V $1.00
- ☐ 2 — ELECTROLYTIC CONDENSERS 1500 mfd — 35V $1
- ☐ 1 — 5" SPEAKER with output transformer $1.39
- ☐ MERCURY TUBE TESTER MODEL 990 Compact, latest model $39.95
- ☐ MIDLAND STEREO AMPLIFIER Model 26-002, 12 Watt, solid state $36.50
- ☐ MIDLAND STEREO AMPLIFIER Model 26-003, 25 Watt, Solid State $55.00
- ☐ — ELECTROLYTIC CONDENSERS 40 Mfd - 500V, 40 Mfd — 400V $1.00
- ☐ 2—ELECTROLYTIC CONDENSERS 50 Mfd X 50 Mfd. —400V $1
- ☐ TUBE & CONTINUITY CHECKER Model FT425 (Tests fuses, heaters, lamps, Etc.) $1.98

Minimum Order $3.00.

IMMEDIATE DELIVERY . . . Scientific light packing for safe delivery at minimum cost.
HANDY WAY TO ORDER . . . Send check or money order, add extra for shipping. Lists of new offers will be returned in your order.
Please specify refund on shipping overpayment desired: ☐ CHECK ☐ POSTAGE STAMPS ☐ MERCHANDISE (our choice) with advantage to customer

BROOKS RADIO & TV CORP., 487 Columbus Ave., New York, N. Y. 10024 212-874 5600 TELEPHONE

Circle 76 on reader service card



Circle 84 on reader service card

market center

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TTL

7400	$ .25	7446	$1.45	74121	$ .65
7401	.25	7447	1.45	74122	.55
7402	.25	7448	1.50	74123	1.15
7403	.25	7450	.29	74126	.95
7404	.29	7451	.32	74145	1.25
7405	.27	7453	.32	74150	
7506	.55	7454	.45	74151	1.05
7407	.53	7455	.32	74153	1.45
7408	.29	7460	.30	74154	1.75
7409	.29	7461	.30	74155	1.35
7410	.25	7464	.45	74156	1.50
7411	.35	7465	.45	74157	1.50
7413	.95	7470	.50	74161	1.65
7415	.50	7472	.45	74163	1.80
7416	.50	7473	.55	74164	2.95
7417	.50	7474	.55	74165	2.95
7420	.25	7475	.95	74166	1.95
7421	.32	7476	.55	74173	1.95
7422	.32	7478	.89	74175	1.95
7423	.37	7483	1.25	74176	.95
7425	.39	7485	1.20	74177	.95
7426	.35	7486	.55	74180	1.15
7427	.39	7489	3.25	74181	4.25
7430	.25	7490	1.25	74182	1.10
7432	.30	7491	1.40	74190	
7437	.50	7492	1.05	74192	1.65
7438	.55	7493	1.05	74193	1.65
7440	.25	7494	1.10	74194	1.65
7441	1.25	7495	1.05	74195	1.15
7442	1.15	7496	1.05	74196	1.35
7443	1.25	74100	1.65	74197	1.15
7444	1.30	74105	.55	74198	
7445	1.25	74107	.55	74199	2.50

Low Power TTL

74L00	$ .40	74L42	$1.75	74L85	$1.25
74L02	.40	74L45	1.45	74L86	.95
74L03	.40	74L51	.40	74L90	1.75
74L04	.40	74L71	.60	74L91	1.50
74L06	.40	74L72	.60	74L93	1.75
74L10	.40	74L73	.80	74L95	1.75
74L20	.40	74L74	.80	74L164	2.95
74L30	.40	74L78	.80		

8000 Series TTL

8054	$ .45	8123	$1.75	8570	$2.95
8060	.30	8182	1.75	8600	1.15
8091	.69	8214	1.95	8810	.95
8092	.69	8230	2.95	8812	1.25
8093	.69	8280	.95	8822	2.95
8094	.69	8288	1.05	8830	.69
8122	1.05	8520	1.45	8831	2.95

ALL DIP PKGS.

Specify spec. sheets required with order. Add $ .50 per spec sheet for items less than $1.00 ea.

Linear

LM309	Pos V Reg (super 723)	TO-5	$ .95 ea.
LM 301	Hi performance AMPL	TO-5 or MINI-DIP	.45 ea.
LM 302	Voltage Follower	TO-5	.95 ea.
LM 304	Negative Voltage Regulator	TO-5	1.25 ea.
LM 305	Positive Voltage Regulator	TO-5	1.25 ea.
LM 307	Op AMP (super 741)	TO-5 or MINI-DIP	.45 ea.
LM 308	Micro Power Op Amp	TO-5 or MINI-DIP	1.25 ea.
LM 309H	5 V Regulator	TO-5	1.25 ea.
LM 309K	5 V 1A Regulator	TO-3	1.95 ea.
LM 310	Voltage Follower Op Amp	TO-5	1.45 ea.
LM 311	Hi perf. Voltage Comparator	TO-5 or MINI-DIP	1.25 ea.
LM 319	Hi Speed Dual Comparator	DIP	1.65 ea.
LM 320	-5.2 V Negative Regulator	TO-3	1.95 ea.
LM 320	-12 V Negative Regulator	TO-3	1.95 ea.
LM 320	-15 V Negative Regulator	TO-3	1.95 ea.
LM 340T	Pnsitive Voltage Regulator (6V, 8V, 15V or 24V)	TO-220	2.25 ea.
LM 370	AGC/Squelch AMPL	TO-5 or DIP	1.29 ea.
LM 372	AF-IF Strip-detector	DIP	.85 ea.
LM 373	AM/FM/SSB Strip	DIP	3.60 ea.
LM 376	Pos. Volt Regulator	MINI DIP	.65 ea.
LM 380	2 Watt Audio Regulator	DIP	1.75 ea.
LM 382	Low Noise Dual Pre-Amp	DIP	2.25 ea.
LM 550	Precision Voltage Regulator	DIP	.95 ea.
LM 709	Operational AMPL	TO-5 or DIP	.39 ea.
LM 711	Dual Differential Comparator	DIP	.39 ea.
LM 723	Voltage Regulator	DIP	.75 ea.
LM 739	Dual Hi Performance Op AMP	DIP	1.25 ea.
LM 741	Comp. Op AMP	TO-5 or MINI-DIP	.45 ea.
LM 747	Dual 741 Op AMP	TO-5 or DIP	.95 ea.
LM 3900	Quad Amplifier	DIP	.50 ea.
LM 3905	Precision Timer	MINI-DIP	.75 ea.
LM 9601	Retriggerable One Shot	DIP	.95 ea.
LM 75451	Dual Peripheral Driver	MINI-DIP	.49 ea.
LM 75452	Dual Peripheral Driver	MINI-DIP	.49 ea.
LM 75453	(LM 351) Dual Peripheral Driver	MINI-OIP	.49 ea.

Specify TO-5, DIP or MINI-DIP Package

Specify Spec. Sheet Required with order. Add S .50 per spec sheet for items less than $1.00 ea.

Phase Locked Loops

NE 560	Phase Locked Loop	DIP	$2.95 ea.
NE 561	Phase Locked Loop	DIP	2.95 ea.
NE 562	Phase Locked Loop	DIP	2.95 ea.
NE 565	Phase Locked Loop	DIP	2.95 ea.
NE 566	Function Generator	MINI DIP OR TO-5	2.95 ea.
NE 567	Tone Decoder	MINI DIP OR TO-5	2.95 ea.

Specify TO-5, Dip or Mini-Dip Package

FEBRUARY SPECIALS

MM 74C00	Quad two-input NAND gate	$ .60 ea.
SN 74193	Up/down Binary Counter	1.39 ea.
MM 1101	256 Bit static random access memory	2.00 ea.
LM 385K	Similar to LM 309K except input voltage limited to 20 V – no current limiting – while they last	1.35 ea.
LM 739	Hi performance operational amplifier DIP	1.15 ea.
LM 741	Hi performance operational amplifier	5 for 2.00
MV 108	Visable red led TO-18	100 for $15.95
ME4	Infra red (invisable) diff. dome TO-18	10 for $3.95
MV5020	Jumbo clear dome visable red	100 for $19.95

MM5313 CLOCK CHIP WITH LED's

28 pin any readout
6 digit IPS BCD with
6 MAN 3M LED's
Complete with Data $17.50/set

FLAT PACK GRAB BAG

7400 Series – Assorted
Military Temp. Spec. Fall-Out
Electrically good . . . . 25 for $1.95

4000 Series – RCA Equivalent

CD 4001	$ .65	CD 4012	$ .65	CD 4023	$ .65
CD 4002	.65	CD 4013	1.50	CD 4025	.65
CD 4009	1.00	CD 4016	1.50	CD 4027	1.35
CD 4010	.65	CD 4017	2.95	CD 4030	.65
CD 4011	.65	CD 4019	1.35	CD 4035	2.85

CMOS

74C00	$ .65	74C76	$1.70	74C162	$3.25
74C02	.65	74C107	1.50	74C163	3.25
74C04	.95	74C151	2.90	74C164	3.50
74C10	.65	74C154	3.50	74C173	2.90
74C20	.65	74C157	2.25	74C192	3.25
74C42	2.15	74C160	3.30	74C195	3.00
74C73	1.70	74C161	3.25	80C97	1.50
74C74	1.50				

Calculator Chips

5001 LSI (40 pin) Add, subtract, multiply & divide 12 digit
Data supplied with chip . . . . $6.95 ea.
Data only-Refundable w/purchase . . . . . 1.00 ea.

5002 LSI Similar to 5001 except designed for battery power
Data supplied with chip . . . . $8.95 ea.
Data only-Refundable w/purchase . . . . . 1.00 ea.

5005 LSI (28 pin) Full four function memory. 12 digit display and calc. 7 segment multiplexed output
Data supplied with chip $10.95
Oata only-Refundable w/purchase . . . . 1.00 ea.

LED

MV10B Visible red SUPER SPECIAL		$ .25 ea.
MV50 type red emitting		.25 ea. 5/$1.00
MV5020 type Large red		.35 ea. 3/$1.00
ME4 Infra red TO18		.69 ea.
MAN 1 The original		3.95 ea.
MAN 3 type	1.95 ea. 3 or more	1.49 ea.
MAN 4 type	2.75 ea. 3 or more	2.50 ea.
Data-Lite 707 (MAN 1 repl)		3.25 ea.

Opto Isolators

MCA 2-30	Darlington	$ .95 ea.
MCD 2	Diodes	1.95 ea.
MCT 2	Translstor	1.45 ea.

Memories

1101	256 bit RAM MOS (2501)	$2.50 ea.
1103	1024 bit RAM MOS	7.95 ea.
7489	64 bit RAM TTL	3.25 ea.
8223	Programmable ROM	6.95 ea.

*** NEW ITEM ***

MM 5260	1024 bit RAM Second generation version of 1103 . . . Featuring 16 pin DIP rather than 18 pin . . . 30% less power consumption . . . Introductory Price . . .	9.95 ea.

Digital clock . . . on a Chip

MM 5311 (28 pin) Any readout 6 digit BCD with spec. sheet . . . $11.95 ea.
MM 5312 (24 pin) Any readout 4 digit ipps BCD with spec. sheet . . . 8.95 ea.
MM 5313 (28 pin) Any readout 6 digit ipps BCD with spec. sheet . . . 10.95 ea.
MM 5314 (24 pin) LED incandescent readout 6 digit with spec sheet . . . 10.95 ea.
MM 5316 (40 pin) Normal alarm, snooze alarm, sleep timer 12 or 24 hr. operation with spec. sheet . . . 15.95 ea.

MOS

MM1404	1024-bit dynamic shift register	$2.25 ea.
MM5013	1024 bit dynamic shift Register/Accumulator	2.25 ea.
MM5240	2560-bit static character generator	4.95 ea.
MM5241	3072-bit static read-only memory	7.95 ea.

Untested IC's

UNTESTED MOS

MM1403	1024-bit dynamic shift register	DIP	.65 ea.
MM1404	1024-bit dynamic shift register	DIP	.65 ea.
MM5013	1024 bit dynamic shift register/accum.	DIP-TO-5	.55 ea.
MM5016	512 bit dynamic shift register	DIP-TO-5	.25 ea.
MM5019	Dual 256 bit mask prog. shift register	TO-5	.25 ea.
MM5050	Dual 32-bit static shift register	TO-5	.35 ea.
MM5054	Dual 64/72/80-bit static shift register	DIP	.35 ea.

MOS Shift Registers 2500 Series
2502 2506 2509 2510 2511 2518 2519 2521 2522
Untested seconds 4/1.00

Grab Bag Specials
15 Assorted TTL's (dips) $1.00/bag
25 Assorted DTL's (dips) $1.00/bag

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Circle 85 on reader service card

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IBM COMPUTER POWER SUPPLY

• (ITEM #22-934-XYZ) Expensive, regulated unit. Fine for college labs, research co's., service shops, etc. Pure DC over a wide range of voltages. DC output voltages 6, 12, 48, etc. Wide range of AC voltages available.

• Finest transformers, filters, transistor load regulation system, independent of line voltage fluctuations. Contains five separate rectifier systems. Unit is furnished without small "regulating card" which can be easily made or can be by-passed. Data and circuit diagrams furnished. 30" x 12" x 10". (125 lbs.)

Cost Gov't Over $500.00 **$26.95**

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BURGLAR-FIRE ALARM SYSTEM

• (ITEM #1135-A) - - Dual alarm system gives warning of fire or break-in. Operates on 115-VAC. Control unit, 2-Kidde flash fire, 2-mercury column, 3-door window actuators, alarm bell, 100 ft. wire, instructions. 8½" x 7½" x 3". (7 lbs.)

$39.95

STANDARD DIAL TELEPHONE

• (ITEM #715) - - Standard, commercial telephone same as used throughout U.S.A. Attractive polished black, like new condition. Use as extension phone to private systems or connect several phones together for local intercom system. Full instructions are furnished. Wt. 9 lbs.

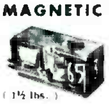
Original Cost $24.50 **$8.79**

STEP-BY-STEP TELEPHONE SWITCH

• (ITEM #738) - - Amazing "up-and-around" Switch. Great experimental item. When used with two-wire telephone dial will select any number from 0 to 100. Make intercom or private system. Use to turn on remote lights, start motors, etc. Complete with contact bank. 13" x 6" x 5". (16 lbs.) Cost Over $90.00 **$8.95**

• Telephone dial for use with above switch (when purchased at same time as switch). Order as (ITEM #700-X). Only **$1.97**

MAGNETIC DIGITAL COUNTER (12 to 18-VDC)



(1½ lbs.)

• (ITEM #21-959) - - Use to count electrically. Use to count number of times door is opened after business is closed, to show changing prices, laboratory uses, etc. Will count 1 for each pulse and will transfer 10th count to next unit. 4½" x 1¾" x 1½".

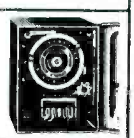
Orig. Cost Over $19.00 Each **$1.99** Three For **$4.99**

200 AMP., 50 VOLT, SILICON DIODE

• (ITEM #22-963) - - A Four Star Buy! New, leading make. Heavy duty units excellent for use in 12 or 24-volt fast chargers, high current power supply systems, etc. 2½" x 1½" x 1⅝". ¾"—16 SAE mounting threads. (1 lb.)

List Over $15.00 **$4.98**

AC PROGRAM TIMING CLOCK



• (ITEM #158) - - Zenith 115-VAC unit. Use for periodic signaling, work breaks, classes, turn on radio, etc. Adj. clips permit ON-OFF switching any time in 24-hour period. Also has "skip-a-day" feature. Can be multiple programmed. 15-amp. contacts. 8½" x 6½" x 4". (8 lbs.)

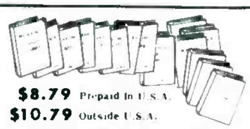
Cost Gov't Over $30.00 **$15.75**

SNAP AROUND VOLT-OHM-AMMETER

• (ITEM #21-944) - - Measures AC current without opening the line. Simply press handle and snap the probe around the conductor. Reads currents from .25 to 125-amps. Reads voltages to 300, reads ohms up to 500. Test motors, appliances, etc. Three current ranges, two voltage ranges. With case, test leads. 7½" x 3" x 1¼".

$39.95 (2 lbs.)

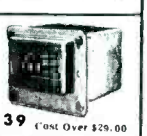
SPECIAL SALE Correspondence Course in ELECTRICAL ENGINEERING



$8.79 Prepaid In U.S.A.
$10.79 Outside U.S.A.

• (ITEM #9-181) - - Obtain technical training at low cost! Lincoln Engineering School has suspended its Correspondence Courses because of rising costs. A limited number of Electrical Engineering Courses are available, but without the examination grading service. The course consists of 15 lesson books, each with associated exams and standard answers. Book describing prize winning Home Experimental laboratory Bench furnished at no extra cost.

RUNNING TIME METER



• (ITEM #2188) - - Record number of operating hours of electric lights and electrical devices such as refrigerators, furnaces, etc. Records total hours, tenths and hundredths up to 9,999.99 hours. For 115-volt, 60-cycles. Size 4¾" x 3" x 2½". Shipping weight 2 lbs. **$4.39** Cost Over $29.00

COMPUTER TRANSISTORS ON HEAT SINKS

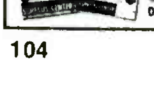
IBM Computer Quality Units

• (#22-928) - - Unit consists of one 150-watt power transistor on heavy, ribbed, aluminum heat sink. Many experimental uses. (1 lb.)

Cost Gov't Over $10.00 **$1.98**

• (#22-915) - - Unit consists of two 150-watt power transistors, 2 pots., several diodes, capacitors, resistors, etc. on heavy, ribbed aluminum heat sinks. Ideal for use as motor speed control. (4 lbs.)

Cost Gov't Over $35.00 **$4.91**



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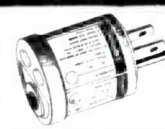

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JUNK KEYBOARDS as above, "as is" for parts $7.00

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Measures 12 × 7 × 1 inches. Utilizes TTL IC's. 10240 memory cores. 9 installed sense amps, addressed as 1024 locations. I/0 lines include 9 data-in, 9 data-out, 10 address-in, powering status and control. Only 40 systems on hand. Schematics included.

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With built-in stereo pre-amp, 115 volt drive motor, channel indicator lamps. Unused, original boxed, less cabinet. Customize your stereo music center with one of these tape decks.

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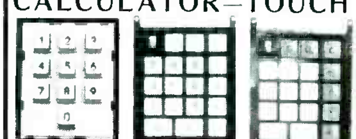
Circle 86 on reader service card

DIGITAL CLOCK PARTS KIT

Complete parts kit(except cabinet),to make a 6 digit clock. National Semi MM5314N chip and socket, 6 miniature LED readouts. All transisotrs, resistors, capacitors, diodes, switches and power supply parts. Value of chip and readouts alone is over $50.00. Overall dimensions of each 7 segment readout is 1/4"x3/16", so clock can be as small or lage as you want it. Complete with all data sheets.

STOCK NO.J5153 Digital Clock Kit $36.50 3/100.00

CALCULATOR—TOUCH TONE—DATA ENTRY KEYBOARDS



J5151 is a heavy duty 10 digit board, made by automatic Electric Co.(makes of phone equipment). Usefull for tone encoding, data entry etc. J5112 is a calculator board, made by Flex-Key. 10 digits, decimal, 4 arithmetic functions, equal sign, K & C keys,and on-off switch. J5155 is a calculator board, also made by Flex Key,10 digits,decmal point, 4 arithmetic functions, plus and minus,C,DE and D keys, and on off switch.

STOCK NO.J5151	2½"x3¼"	$9.75	2/18.00
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All above with data sheets One each of above $24.00

DIGIVAC 7 SEGMENT FLUORSCENT READOUT

Tung-Sol DT1704B, 9 pin, electricaly similar to G.E. Y4075. Blue-green color. We supply 9 pin socket. 1.2 volts Fil., 25 to 50 volts anode. Makes all digits and 14 letters.

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Circle 92 on reader service cards

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Mfgr's Type	Watts	Sale
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☐ SI-1025E	25	18.88
☐ SI-1050E	50	29.95

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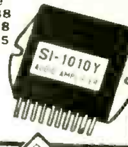

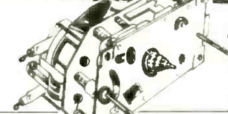

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Basic movement for all clock radios, by "Sessions" or "Telechron". Puts devices ON. Design your own "timing" eqpt. 0-to-24 hrs. 115/1/60 hz. Switch rated at 5 amps. With hookups.

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- ☐ 2 – 2N5296 35-WATT NPN PLASTIC TRANSISTORS, for NE-540 $1.
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- ☐ 5-SCRs 7-AMP TO220, 6-12-24 prv. power tab $1.
- ☐ 10-MOS FETS, 3N187, 3N200, 3N128, TO-18, Fairchild* $1.
- ☐ 5-SCRS & TRIACS up to 25 amps. 6-12-24 prv. studs too $1.
- ☐ 2 – 2N3819, Texas, N channel, 6500 umho TO-18 $1.
- ☐ 2 – 2N2646 UNIJUNCTIONS, plastic transistors, Texas $1.
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- ☐ 4 — PHOTO CELLS, Clairex, pancake, 30K-70 ohms $1

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- ☐ 5 – ER900 TRIGGER DIODES for SCRs & Triacs $1.
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- ☐ 10 – 1N914 fast switch diodes, silicon, 4 nanoseconds $1.
- ☐ 2 – 6 AMP TRIAC 200 PRV, TO-5 $1.
- ☐ 40 – ITT MICRO MINI RECTIFIERS silicon porcelain to 1KV* $1.
- ☐ 30 – WORLD'S SMALLEST RECT. & zeners, 1W, assorted volts* $1.
- ☐ 4 – 2N4269 Nixie tube driver transistors 100V, npn $1.
- ☐ 2 – PUTS, prog. uni-transistors, similar to GE-D13T $1.
- ☐ 2 – 6000 PIV 50 mil epoxy rectifiers, axial leads* $1
- ☐ 10 – BENDIX 25 WATT "pellet" power transistors, silicon* $1
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- ☐ 4 – 80 WATT, 2N1488, silicon, TO3, 60 Vco, npn $1
- ☐ 4 – 1000 HFE DARLINGTON Transistors, TO-18 case $1
- ☐ 1 – 2N5036 HI-PWR plastic trans 100 vceo, 7 amp 85 watts $1
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- ☐ 3 – 2N6109 HOBBY, 40 watts, plastic powers, PNP $1
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- ☐ 5 – PLASTIC 35W powers, pnp, silicon, hobby 2N6124 $1.
- ☐ 2 – MOS FETS, N channel 10K umos 3N128, TO-18, RCA $1.
- ☐ 2 – MOS FETS, DUAL GATE, N chan. 3N187, TO-18, RCA $1.
- ☐ 2 – MOS FETS, DUAL GATE, N chan. 3N140, TO-18, RCA $1.
- ☐ 4 – RCA 2N3600 NPN, UHF transistors, tv-fm, TO-18, 1000mc $1.
- ☐ 1 – 300V PLASTIC POWER TAB transistors, 6A $1.

I.C. & LED HOBBY-ONICS

- ☐ 3-1-WATT AUDIO AMPLIFIERS, Westinghouse, TO-5 $1.
- ☐ 15-709 FLAT PAK OP AMPS, 100% good $1.
- ☐ 50-710-711 flip flopCOMPARATORS, untested $1.
- ☐ 4-DUAL 709, dip pak, op amps, untested $1.
- ☐ 5-7474D triggered flip-flops, dip, no test $1.
- ☐ 2-1101 256 BIT ram special, dip, no test $1.
- ☐ 5-SN7447 7-Seg. decoder-driver fallouts $1.
- ☐ 10- TO-5 Case 536, 540, 565, 567, 741* $1.
- ☐ 5-MOS REGISTERS, 5013-17, mini dips, no-test $1.
- ☐ 5-MOS REGISTERS, 501-6, etc., TO-5, no-test $1.
- ☐ 5 – SN7441N, hobby, BCD-to-Nixie driver IC, DIP* $1.
- ☐ 10 – LINEAR AMPS, 709, 710, 711, 741, TO-5 $1.
- ☐ 10 – 709 LINEAR AMPS, 741's too, DIP'S* $1.
- ☐ 5 – HOBBY MEMORY CELLS, SN7481, up to 16-cell, DIP* $1.
- ☐ 10 – RCA CA-3000 OP AMPS, TO-5 case* $1.
- ☐ 5 – 723 VOLTAGE REGULATORS, TO-5* $1.
- ☐ 4 – PHASE LOCK LOOPS, hobby 565, 560, 561* $1.
- ☐ 10 – MINI DIPS phase lock loops, 709, 741, 301, 307, hobby* $1.
- ☐ 2 – VOLTAGE REGULATORS, LM309K, hobby, TO-3* $1.
- ☐ 10 -SIGNETIC OP AMP, 531, 533, 536, 550, 555, DIPs, TO-5* $1.
- ☐ 1 -5311-14 CLOCK ON A CHIP, 4-or-6 digit, 24-or-28-pin* $1.
- ☐ 1 -CALCULATOR ON A CHIP, hobby, exp. 40-pin, specs* $1.
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- ☐ 15 - NATIONAL & SIGNETIC TTL dip special, all marked* $1.
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- ☐ 20-SN7404 DIP, manufacturers' fallouts, u test 'em $1.
- ☐ 7-SN74121 DIP, multivibrator, fallout, u test 'em $1.
- ☐ 5-LM-300 Super 723, manufacturers' fallouts, u test 'em $1.
- ☐ 5-IBM IC's with pc board, many parts, from computors $1.
- ☐ 1-AM RADIO-ON-A-CHIP, by Sprague, DIP, u test 'em $1.
- ☐ 1-DUAL 2-WATT "Stereo-Amp-On-A-Chip", fallout Sprague, u test $1.
- ☐ 1-OPCOA SLA-11C, like MAN-5, green, seg missing $1.
- ☐ 4-SPERRY SP332, twin digit, factory rejects, .33" charac. no tes $1.
- ☐ 1-OPCOA SLA-11*, like MAN-5, green, 1-or-more segs gone. $1.
- ☐ 1-OPCOA SLA-3H*, 0.7 charac. readout, 1-or-more segs missing. $1.
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- ☐ 10-LED HOBBY SURPRIZE, asst. types, factory rejects, no test $1.
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- ☐ 2-MONSANTO MAN-4, .19" charac. 1-or-more segs missing, red $1.
- ☐ 5-MONSANTO MAN-3, .12" charac. red, 1 or more segs missing. $1.

*Reflective bar segments, while Monsanto all LED segments.

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☐ SN7404	.35	☐ SN7442	1.10	☐ SN7476	.65	☐ SN74122	.95	☐ SN74173	1.65
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☐ SN7406	.45	☐ SN7444	1.25	☐ SN7480	.65	☐ SN74125	.71	☐ SN74175	3.20
☐ SN7407	.55	☐ SN7445	1.19	☐ SN7481	1.25	☐ SN74126	.71	☐ SN74176	1.85
☐ SN7408	.35	☐ SN7446	1.40	☐ SN7482	.99	☐ SN74139	1.25	☐ SN74177	1.85
☐ SN7410	.30	☐ SN7447	1.40	☐ SN7483	1.19	☐ SN74140	1.25	☐ SN74179	2.10
☐ SN7411	.35	☐ SN7448	1.45	☐ SN7485	1.19	☐ SN74145	1.55	☐ SN74180	1.10
☐ SN7413	.85	☐ SN7450	.30	☐ SN7486	.50	☐ SN74148	4.50	☐ SN74181	4.25
☐ SN7415	.55	☐ SN7451	.30	☐ SN7489	3.25	☐ SN74150	1.19	☐ SN74182	1.05
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☐ SN7421	.55	☐ SN7460	.30	☐ SN7493	1.02	☐ SN74154	1.65	☐ SN74194	1.85
☐ SN7422	.32	☐ SN7461	.35	☐ SN7494	1.05	☐ SN74155	1.29	☐ SN74195	1.10
☐ SN7425	.50	☐ SN7462	.35	☐ SN7495	1.02	☐ SN74156	1.45	☐ SN74196	1.95
☐ SN7426	.36	☐ SN7464	.30	☐ SN7496	1.02	☐ SN74157	1.45	☐ SN74197	1.95
☐ SN7430	.30	☐ SN7465	.50	☐ SN74106	.95	☐ SN74158	1.55	☐ SN74198	2.65
☐ SN7432	.35	☐ SN7470	.50	☐ SN74107	.70	☐ SN74160	1.85		
		☐ SN7471	.55	☐ SN74108	.95	☐ SN74161	1.55		

"C-MOS" IC CIRCUITS

Type	Sale
☐ 74C00	$.95
☐ 74C02	.75
☐ 74C04	1.15
☐ 74C10	.95
☐ 74C73	1.79
☐ 74C74	1.59
☐ 74C76	1.79
☐ 74C157	2.50
☐ 74C160	3.50
☐ 74C161	3.50
☐ 74C162	3.50
☐ 74C163	3.50
☐ 74C195	4.50

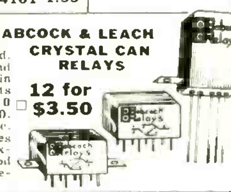
RCA TYPE "C-MOS" IC's

Type	Sale
☐ CD4001AE	$ .71
☐ CD4002AE	.71
☐ CD4009AE	1.69
☐ CD4011AE	.71
☐ CD4012AE	.71
☐ CD4013AE	1.62
☐ CD4016AE	1.62
☐ CD4023AE	.71
☐ CD4035AE	4.16

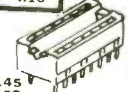
"AEROSPACE" BABCOCK & LEACH CRYSTAL CAN RELAYS

All hermetically sealed. Submini, 1/6, half, and full crystal can types in 6-12-24V in asst contacts up to 4PDT, 1 amp up 10 amps. Such types as BR40, 41, 10, 44, 16, 24, etc. Sorry, no choosing voltages or types. From factory mixtures . . . to you! Good asst. if you are space-minded, at low prices.

☐ **12 for $3.50**



INTEGRATED CIRCUIT SOCKETS



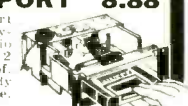
- ☐ 14-Pin, DIP $.45
- ☐ 14-Pin, Wire Wrap .59
- ☐ 14-Pin, Side Mount 1.00
- ☐ 16-Pin, DIP .50
- ☐ TO-5, 8 or 10-Pins .29

Buy Any 3 Take 10% Discount!

8-TRACK CAR RADIO STEREO TAPE TRANSPORT 8.88

3 for $24

8-Track tape transport with complete stereo playback system less audio amplifier. Operates off 12 VDC Wow & flutter proof. Use 739 preamp & ready to go. Uses 8-track tape. Wt. 3-lbs.



NATIONAL 'OP' AMPS

BUY ANY 3 — TAKE 10%

Type	Description	Sale
☐ LM-300	Super 723 V. reg.	$ .95
☐ LM-301	Hi-performance amp	.45
☐ LM-302	Voltage follower	.95
☐ LM-305	Pos. V. reg.	1.19
☐ LM-307	Super 741	.45
☐ LM-308	Hi-Q Fet Type Op Amp	1.25
☐ LM-309H	5V 200 mil V. reg.	1.00
☐ LM-309K	5V 1-amp V. reg.*	1.95
☐ LM-311	Comparator	1.25
☐ LM-320	Minus 5V 1-amp V.R.*	1.50
☐ LM-320	Minus 12V 1-amp V.R.*	1.50
☐ LM-320	Minus 15V 1-amp V.R.*	1.50
☐ LM-350	Dual peripheral driver	.59
☐ LM-370	AGC squelch op amp	1.25
☐ LM-371	R-F, I-F, op amp	.69
☐ LM-373	AM-FM, SSB, I.A.D.	3.75
☐ LM-374	AM-FM, SSB, IVAD	3.75
☐ LM-380	2-watt audio amplifier	1.69
☐ LM-3028	Differential RF/IF amp	1.50
☐ LM-3070	Chrome regenerator	1.50
☐ LM-3071	TV chroma IF amp	1.50

*TO-3 case, — others TO-5

"MEMORY LANE"

Buy Any 3 — Take 10%

☐ 1101	256 Bit RAM MOS	$2.50
☐ 1103	1024 Bit RAM MOS	7.50
☐ 2516	Character Gen. ROM	12.50
☐ 7489	64 Bit RAM TTL	3.25
☐ 8223	Programmable ROM	6.50
☐ MM5260	1024 Bit RAM	7.95
☐ MM5262	2048 Bit RAM	9.95

LINEAR Op Amps

• FACTORY GUARANTEED FACTORY TESTED • FACTORY MARKED

Buy Any 3 PAKS — Take 10% Discount

☐ 531	Hi slew rate op-amp (TO-5)	$2.50
☐ 532	Micro power 741 (TO-5)	2.50
☐ 533	Micro power 709 (TO-5)	2.50
☐ 536	FET input op amp (TO-5)	2.95
☐ 556	5 Times faster than 741C	2.10
☐ 558	Dual 741 (TO-5)	1.00
☐ 560	Phase lock loops (DIP)	2.95
☐ 561	Phase lock loops (DIP)	2.95
☐ 562	Phase lock loops (DIP)	2.95
☐ 565	Phase lock loops (A)	2.95
☐ 566	Function generator (TO-5)	2.95
☐ 567	Tone decoder (A)	2.95
☐ 702C	Hi-grain, DC amp (TO-5)	.49
☐ 703C	RF-IF, amp, 14 ckts (TO-5)	.69
☐ 704	TV sound IF system	1.50
☐ 709C	Operational amp (A)	.47
☐ 709CV	Op amp (mini DIP)	.47
☐ 710C	Differential amp (A)	.47
☐ 711C	Dual diff. comp (A)	.47
☐ 723C	Voltage regulator (A)	.75
☐ 733	Diff. Video Amp	1.75
☐ 741C	Frequency compensator 709 (A)	.49
☐ 741CV	Freq. comp 709 (Mini DIP)	.49
☐ 747C	Dual 741C (A)	.95
☐ 748C	Freq. adj. 741C (A)	.49
☐ 753	Gain Block	1.75
☐ 709-709	Dual 709C (DIP)	1.00
☐ 739-739	Dual stereo preamp	1.98
☐ 741-741	Dual 741C (A)	1.00
☐ PA265	5-Watt voltage regulator	1.95
☐ ULN2300M	Op amp with SCR	1.50
☐ CA3065	Video Audio system	1.05
☐ 75451	Dual peripheral driver	.88
☐ 75491	Quad seg driver for LED readouts	1.65
☐ 75492	Hex driver w/col. out 250 ma. For LED readouts	1.85

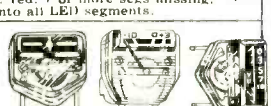
(A) TO-5 or DIP dual in line pak

HI-FI 1" SQUARE MINI METERS $1.49

3 for $3.75

* Plastic case * Red needle Indicators

- ☐ Balancing, stereo, tape, amps.
- ☐ VU, side mtg, plus 3 minus 20 db.
- ☐ VU, front mtg, plus 3 minus 20 db.

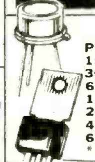


BRAND NEW LOWEST PRICES GENERAL ELECTRIC 3-WATT AUDIO AMP ☐ $2.50

3 FOR $6.00

Delivers 3 watts continuous, 10 watts peak. With heat sinks; micro-mini size: ¾x¼x½", 9 to 30V supply. High sensitivity, 8 to 16 ohms. For mono and stereo phonos, tape, FM, AM, TV, servo.

SILICON CONTROL RECTIFIERS



PRV	1A	3A	8A**	25A*	100A*	250A*
15	☐ $.15	—	—	—	—	—
30	☐ .25	☐ $.39	—	—	—	—
60	☐ .39	☐ .52	☐ $.55	☐ $.95	☐ $2.25	☐ $5.50
100	☐ .49	☐ .69	☐ .60	☐ 1.25	☐ 2.95	☐ 6.95
200	☐ .69	☐ .89	☐ .69	☐ 1.95	☐ 3.95	☐ 8.50
400	☐ .95	☐ 1.19	☐ 1.25	☐ 2.50	☐ 5.95	☐ 10.50
600	—	—	☐ 1.50	☐ 2.96	☐ 7.95	☐ 12.50

*Stud. **Plastic, power tab. Others TO-18,5.

HIGH POWER STUD RECTIFIERS

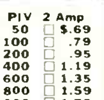
PIV	50A	250A
50	☐ $.69	☐ $4.50
100	☐ .85	☐ 6.50
200	☐ 1.19	☐ 8.25
400	☐ 1.45	☐ 9.95
600	☐ 1.75	☐ 10.50
800	☐ 2.25	☐ 11.50
1000	☐ 2.65	☐ 12.50

GI "GLASS AMP II" SPACEAGE FEATURES

Type	PIV	Sale
☐ 1N4245	200	$.14
☐ 1N4246	400	.22
☐ 1N4247	600	.39
☐ 1N4248	800	.49
☐ 1N4249	1000	.59

Meets critical JAN specs. A glass "ball of silicon strength" that meets JAN specs, high reliability, withstands avalance power surges to 1K watts. ONE amp ratings with 2 amp capabilities. Axial leads.

EPOXY FULL WAVE SILICON BRIDGE RECTIFIERS



PIV	2 Amp	6 Amp
50	☐ $.69	☐ $.88
100	☐ .79	☐ .99
200	☐ .95	☐ 1.25
400	☐ 1.19	☐ 1.50
600	☐ 1.35	☐ 1.75
800	☐ 1.59	☐ 1.95
1000	☐ 1.79	☐ 2.25

Code: 2 amp TO-5 case 6 Amp ½ x ½ x 3/16 sq

LOWEST PRICES EPOXY SILICON RECTIFIERS

PIV	2Amp •	2Amp	3Amp
50	☐ $.05	☐ $.05	☐ $.08
100	☐ .06	☐ .06	☐ .12
200	☐ .07	☐ .07	☐ .15
400	☐ .09	☐ .09	☐ .22
600	☐ .12	☐ .12	☐ .28
800	☐ .15	☐ .15	☐ .39
1000	☐ .18	☐ .18	☐ .45

STUD & TO-5 TRIACS

PRV	3A*	6A*	15A	25A
50	☐ $.25	☐ $.30	☐ $.75	☐ $.95
100	☐ .49	☐ .40	☐ .95	☐ 1.15
200	☐ .49	☐ .70	☐ 1.19	☐ 1.50
300	☐ .59	☐ .90	☐ 1.50	☐ 1.90
400	☐ .69	☐ 1.10	☐ 1.90	☐ 2.25
500	☐ .79	☐ 1.50	☐ 2.25	☐ 2.75
600	☐ .99	☐ 1.75	☐ 2.50	☐ 2.95

*In TO-5 case, others stud

Terms: add postage Rated: net 30
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☐ 15¢ CATALOG on Fiber Optics, 'ICs', Semi's, Parts

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Circle 87 on reader service cards

FOR SALE

LOGIC probes from $9.95. Free catalog. **ELECTRO INDUSTRIES,** 4201 Irving Park, Chicago, Ill. 60641

BURGLAR alarm system — Do it yourself. Installed in minutes. Free literature. **EMRAD CORPORATION,** P.O. Box 1341 Kokomo, Ind. 46901

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CONVERT any television to sensitive big-screen oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans $2.00. **RELCO**—A25, Box 10563, Houston, Tex. 77018

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DIGITAL electronics! Complete schematics, parts lists, theories—Discrete Component Digital Clock, $3.00. Increase technical competence, hobby skills —Complete course in Digital Electonics is highly effective, $10.00. Free literature. **DYNASIGN,** Box 60R2, Wayland, Mass. 01778

LOW noise resistors - ¼ W, 5%, carbon film for 3.5c each. Fifty of one value for $1.25. All 5% values from 10 to 3.3Meg ohms in stock. Specifications upon request. 75c postage and handling charge per order. Deduct 10% on orders over $50. **COMPONENTS CENTER,** P.O. Box 134, N.Y., N.Y. 10038

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RADIO & TV tubes 36c each. One year guaranteed. Plus many unusual electronic bargains. Free catalog. **CORNELL,** 4217-E University, San Diego, Calif. 92105

CANADIAN'S free catalog LED's, IC's, transistors, SCR's diodes, parts. **CORONET ELECTRONICS,** 649A Notre Dame West, Montreal 101, Que., Canada

EMPLOYMENT information - Electronic technicians - How to earn $15,000-20,000 yearly. Not field service. Not overseas. Work in U.S.A. Details $2.00. **WENDEL L. DANIELS CONTRACT ENGINEERING,** 8450 Anthony Wayne Ave., Cincinnati, Ohio 45216

NEW! Record, dub, edit, mix, fade, monitor. Eliminate "jungles" of tangled wires with Dubie Tape Aid control for 1 to 3 tape decks. **DUBIE TAPE AID CORP.,** Dept. D, 2305 N. Penn., Oklahoma City, Okla. 73107 (405) 524-858

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FREE kit catalog: Scramblers, tone encoders and decoders, alarms, sounders, automatic telephone recorder phone patch, IC kits and more. **KRYSTAL KITS,** 2202 S.E. 14th, Bentonville, Ark. 72712

CINCH connectors 22+22 **contacts.** 156 spacing $1.95 plus 25c postage. **WEST ASSOC.,** 95 Steuben Blvd., Lake Ronkonkoma, N.Y. 11779

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Opto Electronics Sale

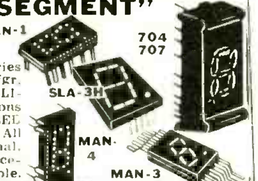
LIGHT EMITTING DIODE GaAs INDICATORS

☐ 2-MV1, amber, visible jumbo epoxy lens upright	$1.00
☐ 1-MV2, TO-18, dome, green, visible	1.00
☐ 1-MV2, green small dome, green diff. lite	1.00
☐ 1-MV2, clear small plastic dome, green diff. lite	1.00
☐ 1-MV3, micro-mini 'pin head' dome, TO-18, green lite	1.00
☐ 4-MV3, visible, "coax pin pak", red, mini dome lens	1.00
☐ 1-MV4, stud, high power, red, 2-watts	3.95
☐ 1-MV4H, stud, high power, hi-dome, red, 2-watts	3.95
☐ 4-MV10B, visible, red, clear dome lens TO-18	1.00
☐ 4-MV10C, visible, red, diffused, dome lens, TO-18	1.00
☐ 1-MV10D, diffused lens, green visible lite, TO-18	1.00
☐ 4-MV50, axial leads, micro-mini dome, clear, red, TO-18	1.00
☐ 1-MV52, micro-mini, axial green lens, green lite	1.00
☐ 1-MV53, micro-mini, axial yellow lens, yellow lite	1.00
☐ 4-MV54, micro-mini, axial leads, red lens, red lite	1.00
☐ 4-MV55, micro-mini, axial leads, red lens, red lite	1.00
☐ 4-MV5012, red small dome lens, red lite, TO-18	1.00
☐ 4-MV5013, sm. dome, 2 hi red dome, soft red diff. lite, TO-18	1.00
☐ 4-MV5020, jumbo clear dome, visible, red, TO-18	1.00
☐ 4-MV5021, jumbo red diffused lens, visible, lite, red	1.00
☐ 4-MV5022, jumbo red lens, visible red lite, spade, upright	1.00
☐ 4-MV5024, jumbo purple dome, purple flooded lite, TO-18	1.00
☐ 4-MV5026, jumbo red diffused lens, red lite, spade	1.00
☐ 1-MV5040, 4-LED red array, with 5-lead pak	1.49
☐ 4-MV5054, red jumbo dome lens, TO-18 red lite, upright	1.00
☐ 4-MV5080, TO-18, micro-mini red dome, red lite	1.00
☐ 4-MV5080, TO-18, micro-mini flat clear lens, red lite	1.00
☐ 4-MV5082, red clear flat lens, TO-18 red lite	1.00
☐ 1-MV5094, red bi-polar, solid state lamp V to 110-115VAC-DC	1.98
☐ 1-MV5222, green hi plastic dome, diffused green lite	1.00
☐ 1-MV5222, green hi dome, diff. green lite	1.00
☐ 1-MV5222, green jumbo dome, green lite, panel snap-in	1.49
☐ 1-MV5282, micro-mini, green lens TO-18, green lite	1.00
☐ 1-MV5322, yellow jumbo dome, yellow lite, panel snap-in	1.98
☐ 1-MV5491, jumbo, Tri-State, RED, GREEN, OFF, special	1.98
☐ 1-MV9000, cartridge panel lamp, sealed, red, clear lens	1.49
☐ 2-MT2, photo transistor, light sensor, TO-18	1.00
☐ 2-ME1, infra-red, parabolic lens, pin type	1.00
☐ 3-ME3, infra-red, invisible lite, "pinhead", single lead	1.00
☐ 3-ME4, infra-red "invisible", TO-18, diff. dome	1.00
☐ 3-ME60, infra-red, "invisible", axial, micro-mini	1.00

OPTO COUPLERS

☐ MCD1, 4000V isolation photo transistor	$2.95
☐ MCD2, 1500V isolation photo diode	1.00
☐ MCT1, 4000V isolation photo transistor	3.95
☐ MCT2, 1500V isolation photo transistor	1.00
☐ MCT5-10, 10,000V isolation photo transistor	3.95
☐ MCT5-25, 25,000V isolation photo transistor	2.95

LITRONIX-OPCOA-MAN "7-SEGMENT" LED Readouts



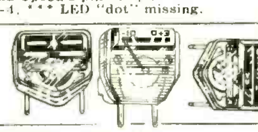
All fit 14-pin IC sockets. All 7-segments. MAN Series "all LED" and made by well-known West Coast mfgr. Others Reflective Bar type made by OPCOA and LITRONIX. The Reflective Bar types are low-cost versions of the MAN's except .33 character height! If one LED blows you lose a segment. MAN's you DO NOT! All readouts 0-to-9 numerals, plus letters and decimal. **Opcoa and Litronix products pin-for-pin replacements for MAN-1 MAN-4. All 5V TTL compatible.

ALL LED READOUTS — TYPE	character Size	Color Display	Decimal	Mils	Driver	Each	Special
☐ MAN-1 equal	.27	Red	Yes	20	SN7447	$4.50	3 for $12.
☐ MAN-1A equal*	.27	Red	Yes	20	SN7447	4.95	3 for $13.
☐ MAN-3 equal	.115	Red	Yes	10	SN7448	2.50	3 for $6.
☐ MAN-3A equal*	.115	Red	Yes	10	SN7448	2.50	3 for $6.
☐ MAN-3M equal*	.127	Red	Yes	10	SN7448	2.50	3 for $6.
☐ MAN-3 equal	.115	Red	***	10	SN7448	1.95	3 for $5.
☐ MAN-3M equal*	.127	Red	Yes***	10	SN7448	1.95	3 for $5.
☐ MAN-4 equal*	.190	Red	Yes	15	SN7448	3.25	3 for $9.
☐ MAN-4 equal*	.190	Red	Yes***	15	SN7448	2.75	3 for $8.
"REFLECTIVE LITE BAR" (Segment LED Readouts)							
☐ 707** (MAN-1)	.33	Red	Yes	20	SN7447	3.25	3 for $9.
☐ 704** (MAN-4)	.33	Red	Yes	20	SN7448	3.25	3 for $9.
☐ SLA-1** (MAN-1)	.33	Red	Yes	20	SN7447	3.25	3 for $9.
☐ SLA-2 + — 1	.33	Red	No	15	SN7447	3.25	3 for $9.
☐ SLA-3H Giant	.70	Red	Yes	20	SN7447	6.50	3 for $18.
☐ SLA-11C** (MAN-5	.33	Green	Yes	40	SN7447	5.95	3 for $15.
☐ SLA-12** ±1	.33	Green	No	40	SN7447	3.50	3 for $ 9.

* Red epoxy case, others clear. ** Litronix and Opcoa's pin-for-pin equals and electrical specs as MAN-1 or MAN-4. *** LED "dot" missing.

HI-FI 1" SQUARE MINI METERS

* Plastic case
* Red needle indicators



☐ Balancing, stereo, tape, amps.
☐ VU, side mtg, plus 3 minus 20 db.
☐ VU, front mtg, plus 3 minus 20 db.

3 for $3.75 **$1.49**

SPERRY "ORANGE" TWIN DIGIT ARRAY

Type SP332, each digit is individually controlled, operates off 180VDC. 100 ua, 200 mw. Color: ORANGE. 7-digits, glass protection over digits. Character height: 0.33. P.C. mounting. Size: 3/4" x 3/4". 9-pins per digit. Driver: SN7447.

☐ **$4.95** 3 for $12.

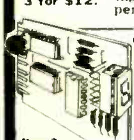
3 LED DIGITS ON A DIP

7-seg (MAN-3 type) and internally "multiplexed" and driven by one SN7448. Similar to DL-33 by Litronix ..... intended for calculators, clocks, test equipment, etc. Encapsulated in red transparent epoxy in 14-pin dip pak. With decimals. High brightness, character .12 x .077. 5V 10 mils.

☐ **$7.95** 3 for $21.

LED MITY DIGIT "DCM'S"

*Your choice of 5 red LED readouts!



Buy 3 — Take 10%

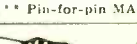
☐ Only **$9.99**

Scientific Devices "Digital Counting Modules" outperform any other DCM on the market today. More features than ever before! Not gaseous, not incandescents, not nixie but the modern LED. Choose from such famous manufacturers as Monsanto's MAN-1, MAN-4, Litronics 707 and 704, Opcoa's SLA-1 (the last 4 having character heights of 0.33 at no extra charge). Each kit includes 3x2" p.c board with fingers for a FREE edge connector, side-mounting dip socket, LED readout of your choice, resistors, 3 IC's, and Molex connectors (this ELIMINATES SOLDERING YOUR IC's), and booklet. **INCLUDES P.C. EDGE CONNECTOR — FREE!**

READOUT	Char.	Maker
☐ MAN-1	.27 h.	Monsanto
☐ MAN-4	.19 h.	Monsanto
☐ 707*	.33 h.	Litronics
☐ 704**	.33 h.	Litronics
☐ SLA-1*	.33 h.	Opcoa

* Pin-for-pin MAN-1, ** Pin-for-pin MAN-4, elec. char. same

100-PC. JUMBO CORNING "METAL OXIDE" RESISTOR KITS



☐ Only $2.50

KRONOS WITH "TIME BASE"*

CHOOSE YOUR READOUT

Cabinet is 6" x 5½" x 6".

$47. Any Type Clock less time-base

NEW FOR 1974!

• with TIME BASE $64.95

Type	LED	Charac.	Sale
☐ KR-101	MAN-3	.12	$47.
☐ KR-102	MAN-1	.27	47.
☐ KR-103	MAN-4	.19	47.
☐ KR-104	Nixie*	.45	47.
☐ KR-105	707†	.33	47.
☐ KR-106	704†	.33	47.
☐ KR-107	SLA-1†	.33	47.
☐ KR-108	Same as SLA-1 but GREEN, add $12.		

† "MAN" LED readouts are "all LEDs" but the Litronix 707 and Opcoa SLA-1, like the MAN-1, are of the reflective bar segment technique, the 704 is the reflective bar version of the MAN-4. *The Nixie tube is a 7-segment device as others.

- Now two clocks in one!
- For 12VDC* 110VAC!
- Now adaptable to boats, planes & cars too!
- One price for any LED!
- The only clock of its kind in USA today!
- Compare and see!
- 12 or 24-hr clock

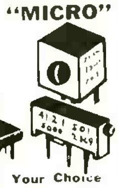
Scientific Devices introduces the new any LED Kronos digital clock. That's right, you can choose the "ALL-LED" Man-1, Man-3, and Man-4, and the new reflective bar types with the larger digits, at only one price, $47. This is a Scientific Device first! We even hav the GREEN LED readouts at a slightly extra cost. We have more . . . for $19.95 we have available as an (*) extra option to Naval Observatory your clock, or making it an all-purpose all-duty unit. For indoor and outdoor activity. This "TIME BASE" is the simplest on the market today with the help of one of the largest time base manufacturers for the famous digital wrist watches. Therefore, current drain is negligible, not like other cumbersome types. It's easy to construct, easy to slip into the Kronos of your choice and connect with easy instructions. Its overall design is simple and easy to construct. The kit is complete with famous black-and-white TEN-TEC cabinet, plus all accessories with booklets. Features include 3 setting controls, 1-hour per second, 1-minute per second, and hold button. KR100 series is a Scientific Device exclusive!

CRYSTAL TIME BASE FOR ANY KRONOS

☐ **$19.95**

Includes precision crystal, time-base IC, pc board & accessories with info.

SPECTROL CERMET "MICRO" POTS



Ohms: ☐ 10 ☐ 20 ☐ 50 ☐ 100 ☐ 200 ☐ 500 ☐ 1K ☐ 2K ☐ 5K ☐ 10K ☐ 20K ☐ 50K ☐ 100K ☐ 200K ☐ 500K ☐ 1 Meg

Your Choice **Any 2 for $1**

☐ Model No. 53-2-1 — 5/16" cube, single-turn, screw-adjust, front, ½ watt 20%.

☐ Model No. 41-2-1 — ½ x .3 x .160" rectangular, 15-turn, wedge-shaped pins, for easy pc work, ¾ watt 20%, screwdriver side.

☐ Model No. 53-1-1 — .343 dia. x 5/16" high, Single-turn, 3-leads, screwdriver top, ½ watt, TO-5 transistor size, fits transistor sockets.

CALCULATOR KEYBOARD SWITCH KITS

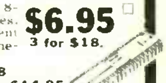
Kit of 17 for $7.50

Each switch made by Oak #415, SPST normally open, 24V 1 amp contacts. Kit includes 0-to-9 (10 switches white with black numerals) decimal, white with black dot, and CE, CL and 4 functions blue with white characters.

☐ 10-pc. kit, 0-to-9 only, same type as above. **3.50**

12-DIGIT "CALCULATOR CHIP"

CT5001 Chip ☐ **$6.95** 3 for $18.



Similar to Mostek 5001. Outperforms Texas 8-digit TMS1802. A 40-pin DIP. Adds, multiplies, subtracts, and divides. Use with 7-segment readouts, Nixies, and LED's. We include schematics, instructions to build calculator.

☐ CT5002-9 Volt version of above — $8.88
☐ CT5005-Same as above with MEMORY — $14.95

NATIONAL EQUALS ON "DIGITAL CLOCK on a CHIP"

Any "Chip" ☐ as Low as **$9.95**

*Money Back Guarantee!

Mfrs #	Description	Sale
☐ 5311	28-pin, ceramic, any readout, 6-digits: A-B-D	$12.88
☐ 5312	24-pin, ceramic, any readout, 4-digits: C-D	$ 9.95
☐ 5313	28-pin, ceramic, any readout, 6-digits: A-C	$ 9.95
☐ 5314	24-pin, plastic, LED and incandescent readouts, 6-digits: A-B	$12.88

Code: A—Hold Count. C—1 PPS Output. B—Output Strobe. D—BCD

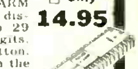
*With Spec Sheet

☐ 1-MM5316, DIGITAL ALARM CLOCK FACTORY FALLOUT — $1.49 EACH

NATIONAL MM5316 EQUAL 'ALARM CLOCK ON A CHIP'

☐ Only **14.95**

MOS 40-pin dip IC. Four display modes time, seconds, alarm and sleep, for a variety of digital clocks. Interfaces directly with 7-segment flourescent and liquid crystal displays. Requires single power supply. 12 or 24 alarm setting, featuring 9-minute SNOOZE ALARM and pre-settable 59-minute sleep timer. Low power dissipation only 32mw @ 8V. Operates from 8 to 29 volts. NO REGULATION REQUIRED! Only needs 4-digits. Has seconds provisions, with instant press of button. Has many, many features. The only ALARM CHIP on the market today at this low Poly Pak price. With 5 pages of tech. info, plus applications.

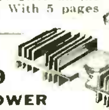


NIXIE COUNTING SYSTEM

$5.95 3 for $16.00

Includes SN7490, decade counter, SN7475 latch, SN7448 BCD decoder driver, 0-to-9 Nixie With socket.

HIGH POWER TRANSISTOR WITH HEAT SINK



Removed from new equipment! Includes popular 2N174 "doorknob" transistor TO-36, germanium, PNP, 150 watts, VCBO 80V, 15 amps, 40 hfe. For ignition, high power transmitters, etc. Mounted on heat sink 5 x 2½ x 1¼".

☐ **$1.49** 3 for $3

1-WATT FLANGELESS TOP HAT ZENERS

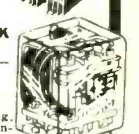
5 for $1

Type TK, Metal Case

Volts	Volts	
☐ 4.7	☐ 9.1	☐ 13.
☐ 6.3	☐ 10.	☐ 15.
☐ 8.2	☐ 12.	☐ 30.
		☐ 33.

Potter & Brumfield KAP RELAYS

Your choice 3 for $7.50 **$2.98**



Excellent for "HAM" use as antenna switching, latching, transmit, receive, etc., and 100's of commercial or industrial uses. Includes plastic dust-cover with diagram and hookup info, 11-pin plug-in base. Contacts movable gold flashed silver, stationary overlay, with silver cadmium oxide movables. All contacts 10 amp 3PDT. Coil data, 115VAC 2250 ohms, 17.5 ma, 12 VDC 21 mils 168 ohms. Size: 2¼" x 1 5/16". Wt. 4 ozs. Center pin missing. Comar Mfg. type equal too.

3PDT
☐ 12 VDC
☐ 115 VAC

MUX'D DIGITAL CLOCK PC BOARD

Your choice **$2.50**

☐ MAN-1 ☐ Litronics 707 (MAN-1*)
☐ MAN-3 ☐ Litronics 704 (MAN-4**)
☐ MAN-4 ☐ Opcoa SLA-1 (MAN-1*)
☐ 6-MAN-3A's for above board. $9.50.

* Elec char. same as MAN-1 or 4.

Each board properly multiplexed for 6 digits, to hold MAN-1's, MAN-3's, MAN-4's, Litronics 707 (MAN-1) and 704 (MAN-4), and Opcoa's SLA-1 (MAN-1). Board 6⅞" long with spec sheets.

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300	☐ 1.45	☐ 1.65
400	☐ 1.85	☐ 1.95
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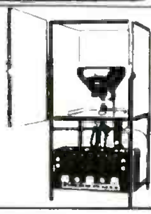

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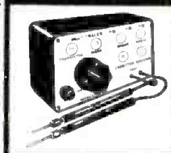

Use with your present Oscilloscope to trace Resistors, Capacitors, Transformers, Diodes, Transistors, Zeners, Trigistors, most Semiconductors, IC's, etc. • Also shows continuity, in-circuit and go/no go checks. • Complete with diagrams and instructions. No internal scope connections. • For medium or small production runs or for hobbyist, experimenter, engineer, or ham.

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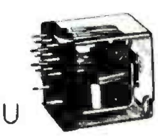

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COIL: 24 VDC - 650 OHMS.
CONTACTS: 4PDT @ 3 AMPS 30 VDC OR 120 VAC RESISTIVE.

SMALL, RUGGED DC RELAY WITH CLEAR POLYCARBONATE DUST COVER. CONTACT GOLD FLASHED SILVER. MOUNTS WITH STUD OR IN A SOCKET. SIZE: 1 5/16 HIGH X 1 WIDE X 13/16 DEEP.

PRICE $1.45 EA

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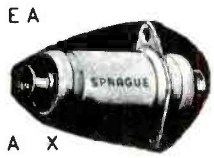

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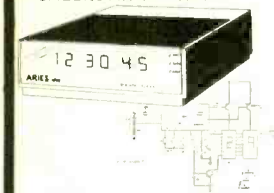
Circle 91 on reader service card

NEW LOW COST DIGITAL CLOCK/ALARM/ CALENDAR CLOCK KIT



This is an updated version of our popular low price clock kit. In addition to the former features which were a decorator walnut case, six digit blue-green display, the clock now features 28/30/31 day calendar, 12/24 hour clock and 24 hour alarm, snooze alarm, 50/60 Hz Operation, setting any counter (time, alarm, calendar, and clock radio) is quite easy, since a separate control of the hour and minutes digits has been provided. The setting of any counter does not affect the contents of any other counter.

☐ New Clock/Alarm/Calendar Clock Kit. Available Jan., 1974. Send $10.00 deposit to insure early shipment. Will be shipped C.O.D. for balance of $59.50 to make up full purchase price of $69.50.

☐ "OLD" Clock Kit. Uses 5311 Clock Chip does not have Alarm/Calendar features indicates hours, minutes, seconds. Available now $47.50

UNIVERSAL DIGITAL CLOCK – TIMER – STOPWATCH ALARM KIT

This new kit has so many features and applications, we hardly know where to start. To summarize the applications:

*The unit can be used as a conventional clock, either from internal batteries, or from the AC adapter. Makes an excellent travel clock.

*The alarm feature can be set at any time, and will generate a tone with an external speaker.

*The unit can be used as a stopwatch, either registering hours, minutes, or seconds, up to 23:59:59, or minutes, seconds, and 1/60 seconds up to 24 minutes, to an accuracy of 1/60 second.

*The unit can be used as a timer, to trigger an external device at a preset time.

☐ This unit will be available as a complete kit in Jan. 1974. To get one of the first, and take advantage of our lower pre-issue price, send $10.00 deposit, will be sent COD for balance. Total kit price will be $69.50 including pillow speaker as shown. AC power adapter $4.75 additional.

☐ Available now, all parts, but no circuit board or detailed instructions. $59.50

CLOCK CHIPS – INCLUDES NEW DIGITAL CLOCK/CALENDAR ALARM CHIP

These large scale integrated (LSI) chips eliminate literally thousands of components or hundreds of chips in the construction of a clock. For most applications only a single supply and a minimum of components are required.

☐ 7001 Chip – Features 28/30/31 day calendar, 12/24 hour clock, 24 hour clock, 24 hour alarm, snooze alarm, 6 digit display, direct drive to luminescent anode tubes or LED segments, single transistor interface with Sperry displays. Segment and digital outputs can be "wire or" D" to share calculator displays. $14.75

☐ MM5314 Chip – Features 6 digit seven segment output, operates from 50 or 60 Hz input, use for Minitrons LED's, Luminescent or Sperry displays. $9.75

☐ MM5311 Chip – Same as 5314 but with additional BCD outputs, ceramic pkg. $12.50

FUNCTION GENERATOR CHIP, TYPE 4038

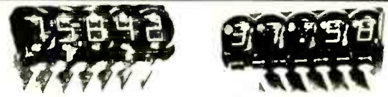
This chip gives simultaneous sine, square, sawtooth, and triangular outputs. Great for music synthesizers, or voltage controlled function generators and oscillators.

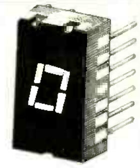
☐ Function Generator Chip $7.75

LUMINESCENT 7 SEGMENT NUMERIC READOUTS

Bright Blue-Green display Tube. Very pleasing to the eye. Tube exhibits fast display speed and easy to read characters of 0.57"H x 0.36"W, with decimal point. Complete with instructions to make a decade counting unit or a 6 Digit Clock. Tubes are manufactured by Tung-Sol, part number 1705.

☐ 7SDD-1705 READOUT $1.70
6 for $8.50
10 for $14.00





, one of the world's largest manufacturers, has sold us his surplus of multiple digit clusters with one bad digit per cluster. They were for use in the calculator, DVM, and other products. The remaining digits are guaranteed perfect in all respects and are intensity graded (marked on the back with letters A thru F) and matched, so that several strips can be combined and still result in a perfect match. These monolythic GaAsP displays require as little as 7 mW per digit, are highly readable at arm's length, and lend themselves well to hand-held portable applications.

Applications include hand-held calculators, digital thermometers, stopwatches, darkroom timers, DVM's, clocks and watches, or any other product requiring low cost, low power, long lifetime indicators.

The unit is common cathode, set up for multiplexed operation. Two decimal point styles are available; center decimal for PN 7804/05, and right decimal for PN 7814/15, as illustrated. The following configurations are available, where "8" represents a perfect digit, "X" a non-functioning digit:

X8888	7405-1 or 7415-1,	X888	7414-1
8X888	7405-2 or 7415-2,	8X88	7414-2
88X88	7405-3 or 7415-3,	88X8	7414-3
888X8	7405-4 or 7415-4,	888X	7414-4
8888X	7405-5 or 7415-5,	X88X	7556-1

All products are available at the following price rate:

1 – 24 digits . . . $1.875/digit
25 – 99 digits . . . $1.50/digit
100 – 499 digits . . . $1.25/digit

Higher quantity price on request.

For the following applications we recommend the following configurations:

Pocket calculators: 7405-1 & 7405-5, which results in X88888888X, eight consecutive perfect digits @ $1.875 = $15.00.

Recommended Calculator chips:

Nortec 4204 @ $19.75 ($15.00 when ordered with displays).
Caltex 5005 @ $9.75 ($7.50 when ordered with displays).

Clocks: 7405-3 & 7556-1, which results in 88X88X88X, six perfect digits at $1.875 = $11.25.

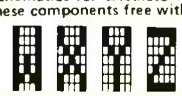
Recommended clock chips:

National MM5314 @ $9.75 ($7.50 ordered with displays).
National MM5316 @ $19.75, includes alarm, ($15.00 ordered with displays).

For only hours and minutes, order 7405-3 only.

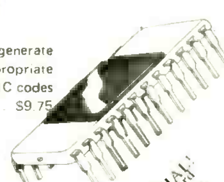
Digital thermometers, DVM's, stopwatches, darkroom timers, frequency counters, etc., order 7415-1 or 7415-5 for four digits ($7.50) or 7414-1 or 7414-4 for three digits ($5.60). Use Solitron CM 4102AE 3½ digit counter decoder @ $19.00, ($15.00 ordered with displays).

Schematics for calculators, clocks and counters using these components free with order.



ALPHANUMERIC DISPLAY

☐ This is a 5x7 (35 Dot) Dot Matrix which will generate alphanumeric characters when used with an appropriate generator such as the 2513. All 64 ASCII or EBDIC codes can be generated. $9.75



I.C. SOCKETS

Mfg. by T.I., Cinch, high quality, most gold plated. Use for SSI, MSI, and LSI chips.

☐ 14 Pin Solder Tail	3 for $1.00
☐ 14 Pin Wire Wrap	2 for $1.00
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☐ 16 Pin Wire Wrap	2 for $1.25
☐ 24 Pin Solder Tail	2 for $1.25
☐ 28 Pin Solder Tail	2 for $1.50
☐ 40 Pin Solder Tail	$1.00 each
☐ 10 Pin Round for to-5 style	3 for $1.00
☐ 3 Pin Transistor Sockets	10 for $1.00

COSMOS & MISC. CHIPS

☐ Harris 256 Bit Programable Read only memory	$2.50
☐ 2501 256 Bit RAM	$2.50
4000AE Dual 3 Input NOR & INV	$ .99
4001AE Quad 2 Input NOR	$ .99
4002AE Dual 4 Input NOR	$ .99
4006AE 18 Stage Shift REG	$4.99
4007AE Dual Comp Pair	$ .99
4009AE Hex Buffer, Inv.	$2.19
4010AE Hex Buffer, NON-Inv.	$2.19
4011AE Quad 2 Input NAND	$ .99

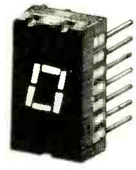
LAST MINUTE SPECIAL! 1/16 inch copper clad board single side-phenolic-brand new individual tissue wrap. 8X10 inches........ 2 for $1.00; 16X20 inches........ $2.00

0.3 HEIGHT L.E.D. NUMERIC DISPLAYS

Always a good seller, we are now offering these displays at the lowest price ever. Use for clocks, counters, and other applications. We have previously sold these for as much as $6.75 per digit.

☐ 0.3 inch height red LED $2.25
6 for $12.00

0.3 HEIGHT GREEN L.E.D. NUMERIC DISPLAY



This is the first time we have had green LED's at an economical price.

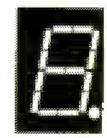
☐ 0.3 inch height green LED $3.95
6 for $21.00

0.3 HEIGHT YELLOW L.E.D. NUMERIC DISPLAY

Vary your display colors for coding or Variety.

☐ 0.3 inch height yellow LED $3.95
6 for $21.00

GIANT 0.750 INCH HEIGHT RED L.E.D. NUMERIC DISPLAY



This is one of the largest LED Displays made. Used in applications where the displays must be read at greater than average distances, or for commercial and advertising purposes.

☐ 0.750 inch LED Numeric Readout $5.75
6 for $30.00

LOWEST PRICE EVER ON DISCRETE L.E.D. LAMPS

These high quality red LED's are useful for Logic and Computor readouts, as Pilot Lights, or at this low price, they can be grouped together to build your own Giant size Alphanumeric Readouts.

☐ Discrete LED's .... 10 pcs. $1.75
100 pcs. $15.00
1000 pcs. $125.00
5000 and up $ .10 each

GREEN L.E.D. LAMPS

☐ Same as above, but Green. .... 3 for $1.00
100 for $30.00 10 for $4.00
1000 for $250.00

YELLOW L.E.D. LAMPS

☐ Same as above, but Yellow .... 2 for $1.25
10 for $5.00

RED WITH BUILT-IN RESISTOR

☐ Same, but no resistor required for 5 Volt operation .... 2 for $1.00
10 for $4.00

CALCULATOR CHIPS

☐ Nortec 4204 – Eight Digit, floating point, constant operation single supply operation, very low power consumption $19.75
($15.00 with purchase of 7400 series LED's.)

☐ 5001 – Twelve Digit, fixed decimal point, no constant, may be used for six digit display $9.75
($7.50 with purchase of 7400 series LED's.)

3½ DIGIT COUNTER CHIP

This chip is useful in building dim's DPM's and small counters, provides multiplexed seven segment output for LED displays, Solitron 4012 or Equivalent $19.00
($15.00 with purchase of 7400 series LED's.)

Send in an order and get on our special customer Mailing List.

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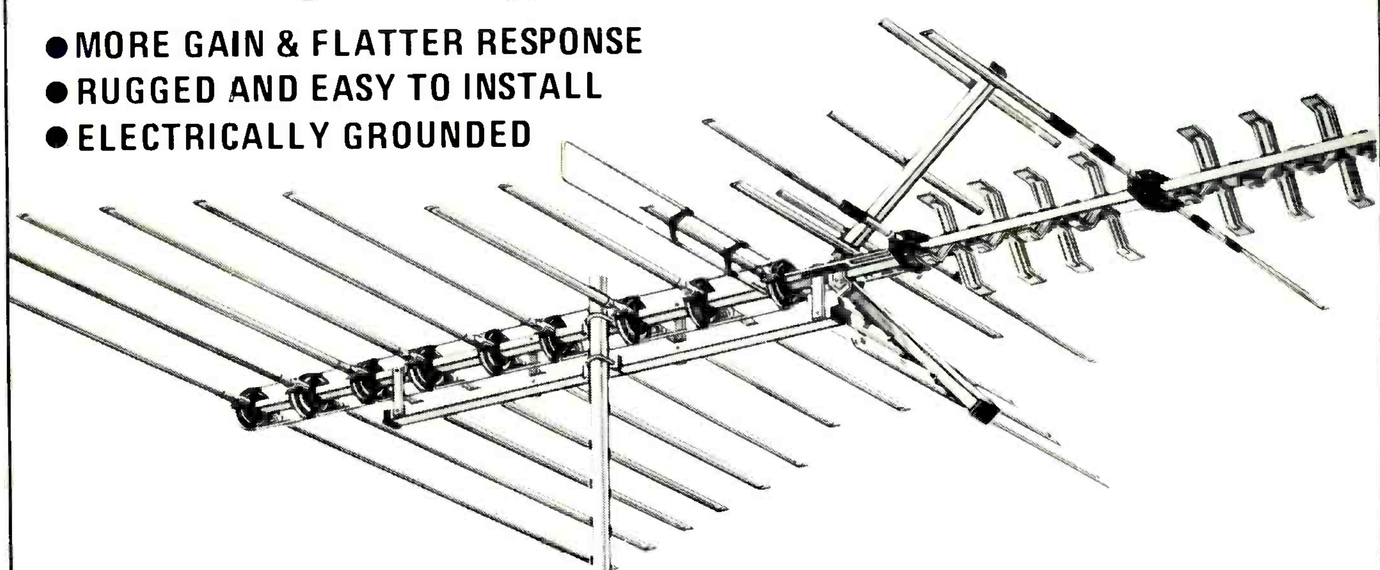
- ELECTRICALLY GROUNDED



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Last year we offered NFL Coffee Mugs for trying Jerrold antennas. This year it's Tool Pouches. Why do we make these offers? Because we know that once you stack Jerrold antennas up against the antennas you are using now, you'll switch to Jerrold. Hundreds of dealers switched last year.

If you're a professional antenna installer, you owe it to yourself to make this evaluation.

FOR EVALUATING ANY SUPER VU-FINDER OR PARALOG 300 PLUS.

JERROLD ELECTRONICS CORPORATION
P. O. Box 350, Dept. DSD, 200 Witmer Road, Horsham, Pa. 19044

RE

Please send me a free Tool Pouch. Enclosed is an instruction sheet from the following Super VU-Finder antenna.

(model) ____________________

1 Before trying the Super VU-Finder, I was using the following antenna: (make) __________ (model) __________

2 In my opinion the Super VU-Finder is: ☐ BETTER ☐ WORSE
because: ____________________

3 Comments: ____________________

NAME ____________________
COMPANY NAME ____________________
ADDRESS ____________________
CITY __________ STATE ______ ZIP ______
COUPON MUST BE POSTMARKED BEFORE FEB. 28, 1974.

Circle 78 on reader service card

The Timesaver!

Latest, all solid state version of the sensational signal circuit analyzing timesaver originated by Castle.

Invaluable for locating the break in the tuner and i.f. signal chain or analyzing agc system defects in tube TV receivers . . . essential for speedy location of signal circuit defects in modular IC, solid state and hybrid TV receivers.

A NEW APPROACH to agc system analyzing!

Permits signal injection after the agc controlled stages to simplify testing for agc defects.

- Works with any 40MHz receiver . . . color or black and white . . . solid state, tube or hybrid.
- High level, low impedance output furnishes signal usable at input of final i.f. stage.
- Special output circuit works equally well into first i.f. input of late model, link coupled systems and older, low "C" bandpass coupled systems.
- Antenna input and i.f. output electrically isolated; no "hot" chassis hazards.
- No need to disconnect supply leads from suspected tuner being tested. Substitutes the VHF tuner and tests the UHF tuner.
- Tunes all 12 VHF channels, has preset (memory) fine tuning on all channels.
- Higher overall gain than previous models with wide range gain reduction control of 60db.
- Completely self contained and battery operated, uses popular batteries available everywhere. Simple battery replacement; battery compartment in rear of custom molded case.
- Reduced current consumption extends battery life to as much as double that of previous models. Bright LED indicator warns when unit is ON.
- Use on the bench or in the home . . . anywhere.
- Comes complete with extension cables, batteries and instructions.

Specifications

Inputs:	300 ohms balanced VHF antenna terminals, electrically isolated. 75 ohms 40 MHz amplifier (Ch. #1) RCA phono jack.
Sensitivity:	30 microvolts. Input signal handling capability: over 100,000 microvolts.
Output:	40 MHz TV i.f.: bandwidth 6 MHz. "Mastermatchcoupler" output circuit with matched cable to furnish usable signal for all input circuits. Termination is RCA phono jack, electrically isolated.
Tuning Range:	All 12 VHF TV channels, plus Ch. #1 40 MHz amplifier position for testing UHF tuners. High stability of 40 MHz amplifier permits two Mk. IV Subbers to be cascaded for high level 40 MHz output signal from any VHF channel.
Tuning:	Preset (memory) fine tuning.
Gain Control:	Gain reduction 60 dB.
Power supply:	18 volts. Uses two 9v transistor batteries.
Size & Weight:	6.5"x 6.5"x 3.25" exclusive of control knobs and handle. 1.5 lbs complete with batteries.
Accessories:	"Mastermatchcoupler" output cable with RCA phono jack termination. "Mastermatchcoupler" output cable with alligator clip terminations. UHF tuner test cable.

TV TUNER SUBBER™ Mark IV net $45.95

Contact your distributor

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