Radio-Electronics

HI-FI – STEREO SPECTACULAR

75¢ ■ MAR. 1976

Radio-Electronics®

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

HI-FI–STEREO
★ Modulus–Heath's Great New Kit
★ What's Happening To 4-Channel
★ How To Buy A Record Changer

BUILD ONE OF THESE
★ ASCII To Bardot Converter
★ Microsecond Fast Fuse
★ More 555 IC Applications

TELEVISION
★ Evaluating Color Circuits
★ Jack Darr's Service Clinic
★ Service Problems & Solutions
★ Equipment Reports

LEARN SOMETHING NEW
★ Komputer Korner
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★ State-Of-Solid State

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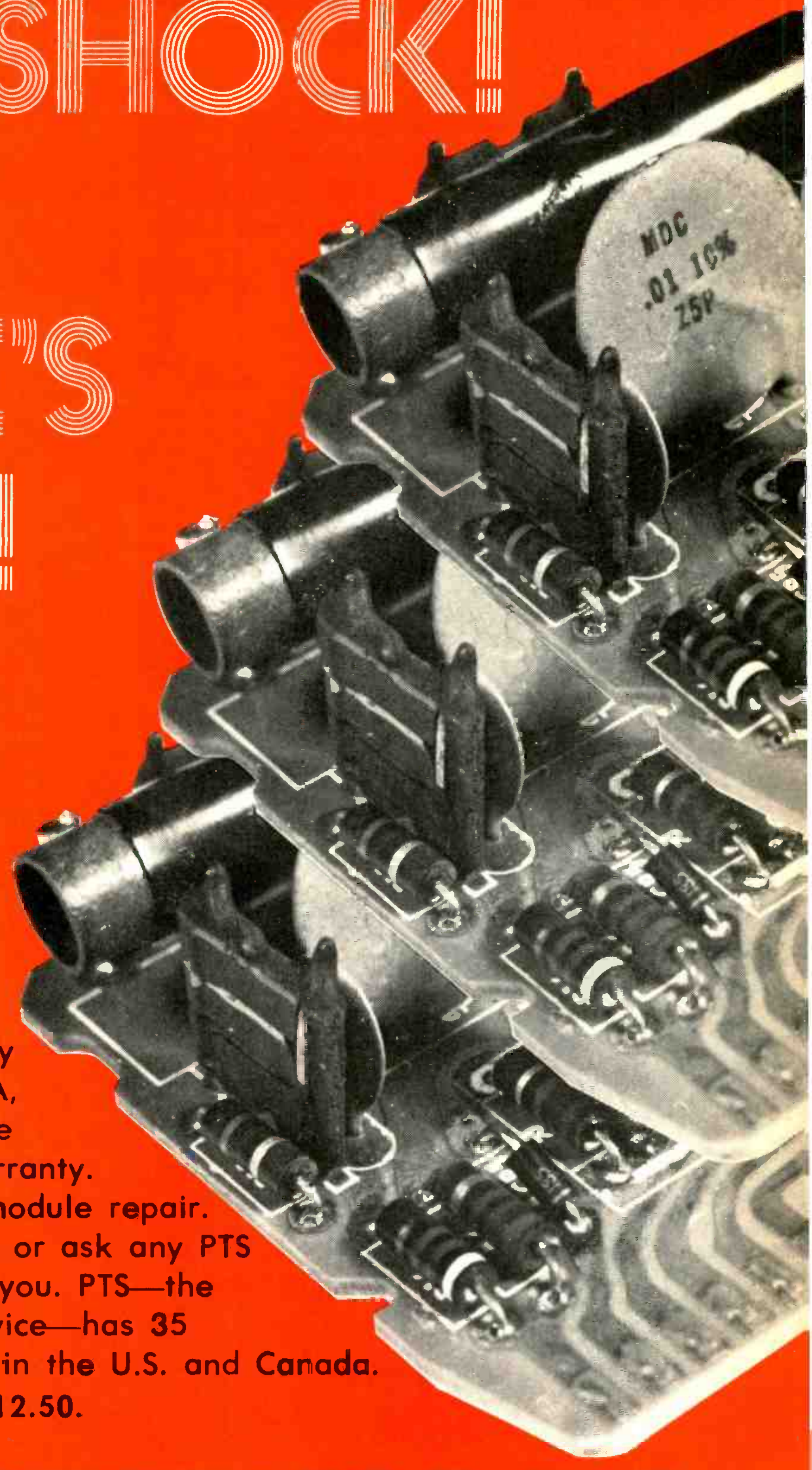
TUNER SHOCK! THE FUTURE'S HERE!



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Circle 1 on reader service card

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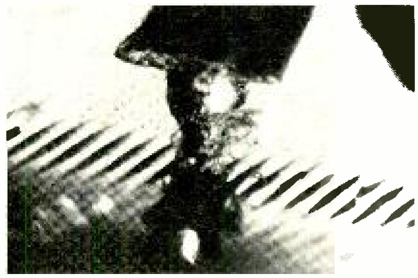
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

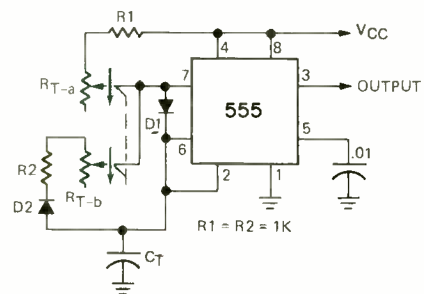
MARCH 1976 Vol. 47 No. 3

ON THE COVER

Fan of circuit boards are the secret element in making the Modulus system so versatile. For a detailed performance report, see story starting on page 33.



RECORD DESTRUCTION occurs each time the stylus traces the grooves of your record. You can prevent this from happening and extend record life and performance.
. . . turn to page 41



TIMER CIRCUITS are easy to design and fun to use when there is a 555 IC around. There's a flock of these circuits in this issue.
. . . turn to page 62

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looking ahead

TV gamesmanship

The TV game attachment promises to be the hottest electronic novelty in 1976. Games, mostly patterned on the table-tennis format, began to proliferate last year and were hot-selling Christmas items. The major games introduced last year were two new versions of Magnavox's Odyssey, Pong by Atari, Video Action by Universal Research, and TV Tennis by Executive Games. Prices range from $65 to about $300.

Toward the end of last year, some of the game manufacturers ran into troubles with the FCC. Any gadget designed to feed RF into the antenna terminals of a TV set is classified by the Commission as a "Class-I television device" and must be type-approved to make certain its radiations fall within specified limits. Two game manufacturers neglected to do this—only because they didn't know it was required—and one was forced to recall and modify games that didn't meet the Commission's specifications. The other manufacturer was alerted just before it started delivery and was able to avoid a recall and possible fine.

Some of the more sophisticated games this year have a "robot" feature, permitting use by one player in a solitaire arrangement. But even more elaborate games are coming, using microprocessors or even connected to time-shared computers, according to advance announcements by their developers. Cromemco of Los Altos, CA, says it will offer a combination game and computer in kit form, providing an almost infinite number of games programmed by the user.

Computer Recreation, a NJ firm, hopes to offer a TV game kit that is connected via phone line to a time-shared computer, letting the user play such games as chess and blackjack as well as complex word and math games. Perhaps a little closer to reality are some non-game "interactive television devices" permitting viewer interface with his TV screen for various programmed education courses.

15% cabled

A total of 10,800,000 U.S. homes, or 15.3% of the total households, now receive their television programs by cable according to a tally in the 1976 *Television Factbook*. This represents an increase of about 1,000,000 homes in the last year. These homes are served by a total of 3,450 cable (CATV) systems, the average system having 3,130 subscribers. Some 53 of the systems have more than 20,000 subscribers each. Just 10 years ago, CATV had only 1,575,000 subscribers.

Quadradio

After more than a year of studies and field tests, the EIA's National Quadriphonic Radio Committee has filed a voluminous report with the FCC, saying that its results "positively demonstrate the compatibility, feasibility and practicality of quadriphonic FM broadcasting" and that "state-of-the-art" equipment is sufficient to perform the quadriphonic service." The NQRC tested five discrete four-channel broadcasting systems developed by Quadracast Systems, RCA, Cooper-UMX, G-E and Zenith. It made no recommendations as to a specific system, but did note that its subjective listener tests "clearly indicate the need for a quadriphonic service." It also commented that station coverage in discrete four-channel will be "comparable or somewhat less than" two-channel stereo.

Proponents of matrix quadriphonic systems, including CBS (SQ) and Sansui (QS), are expected to oppose any attempts to set up standards for discrete four-channel broadcasting, arguing that the material can be (and already is) broadcast over conventional two-channel FM stereo stations without further FCC action. Considering the recently dwindling interest in quadriphonics, the FCC isn't expected to assign a high priority to the four-channel broadcasting proceedings.

Enter the videophile

The original audiophile of the 1930's and 1940's was a hobbyist who wasn't satisfied with sound reproduction of production-line phonographs and radios. He bought top-quality, exotic equipment (sometimes at extremely high prices) for more perfect sound. This pioneer set the pace for the rest of the public and was largely responsible for today's general interest in good audio.

Now there are signs that something similar may be starting in video. Although the average viewer is still satisfied with mediocre picture quality, the television system is capable of far better than that. Cable TV can provide a clear, sharp, ghost-free picture. Pay cable systems supply top movies uninterrupted by commercials. The incentive to reproduce good images in the home is now present. In addition, the availability of videocassette recorders provides another incentive for the video hobbyist. Projection TV sets can bring movie-like realism into the home under optimum conditions.

Although the VTR and the projection set may be considered industrial rather than home-entertainment devices, many audio and television dealers are beginning to handle them and some have been surprised by the demand from perfectionist (and well-heeled) consumers. The number of videocassette recorders and projection TV sets in homes today is probably in the low thousands—but it's a start. Like their parents, the audiophiles, the growing videophiles are expected to spark demand for better quality reproduction. This will eventually raise the consciousness of the general public and trigger new interest in perfect pictures, not just passable ones. It's still a small, low-keyed development, but the growing interest in good pictures by some of America's opinion leaders could be among the most significant events in electronics for the home.

CB license snarl

If you're waiting for a CB license, don't give up. But don't hold your breath either. As of the end of 1975, the FCC was completely swamped with a backlog of 2½ weeks of unopened mail containing approximately 150,000 license applications, 7,000 unanswered letters complaining of licensing delays, an average of 36 inquiries from Congressmen daily asking what happened to constituents' applications, and a jammed-up switchboard often making it impossible to place a call to the Citizen & Amateur Division.

To help relieve this congestion, the Commission hopes to set up a new high-speed license-processing system—but it probably will be late summer or early fall before the equipment can be in operation. Meanwhile, applications are expected to increase from the recent 300,000 level to as many as 1,000,000 a month.

Help may also be on the way on the channel-congestion front. At press time, the Commission was expected to consider increasing the number of channels in the Class-D band from the present 23 to 50. But, once again, action won't be too quick. Expect it by late spring or early summer. And when more channels are added, you can also expect a new flood of applications and a new jam-up.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

new & timely

Sally Knight, John Harris receive Gernsback Scholarship Awards

The winner this month of the Hugo Gernsback Scholarship Award, a $150 grant given annually to an outstanding student in each of eight leading home study electronics schools, is Mrs. Sally E. Knight of Toledo, OH, a student in the Bell & Howell Schools. Mrs. Knight is married and has four children, ranging in age from 21 months to 7 years. She says:

"Since I have been taking the course in Home Entertainment Electronics, I have begun a small business in my home. I take care of the repairs of radios and TV sets in a 16-unit motel, along with repairs in the neighborhood. The course has helped me a great deal, and I am glad to have had the opportunity to enroll in it with the help of the VA.

MRS. SALLY E. KNIGHT

"My husband's money goes to support all of us, and I am using the money I make in my business to purchase some of the needed gear, such as a high-voltage probe, degaussing coil and other small items. A good signal-generator and a good DC-supply are needed in the near future, and probably a good transistor checker.

"My housework has gone undone at times so I could keep up with my lessons, but my family has been very understanding and has stood by me. Maybe some day the business will grow to where it will benefit us all."

Runner-up in the scholarship contest was John K. Harris, of Burlington, NC, who receives a WV-529A special service VOM, donated monthly by RCA to the person who places second in the scholarship contest. Mr. Harris writes:

"I began my study program with the Bell & Howell Schools in June, 1974, and am now over two-thirds of the way towards completing the 173-lesson course. In November, 1974, I injured my back in an accident on the job, but kept on working until February, 1975, when I was advised by my doctor to seek a less strenuous job. I have since been working on the course full time and paying for it out of my savings.

JOHN K. HARRIS

"At the end of 120-lessons my grade average is 97.2. I have thoroughly enjoyed the course so far and find the material presentations and instruction techniques far superior to anything I have previously experienced. In the future, I would like to combine my interest in electronics with that in woodworking, and offer custom-built component systems that would satisfy my customers' individual needs."

Pennsylvania ISCET elect officers

Ronald S. Lettieri, CET (Certified Electronic Technician) of Dunmore, PA, was elected President of the International Society of Certified Electronic Technicians of Pennsylvania for the year 1976.

Other 1976 officers are Lenardo R. Migliaccio, CET, Vice President; Robert E. McHose, CET, Secretary; and James L. Ibaugh, CET, Treasurer.

President Lettieri is an electronics technician at Tobyhanna Army Depot, Tobyhanna, PA. He succeeds Russell Scarpelli, CET, who was the first president of ISCET of Pennsylvania.

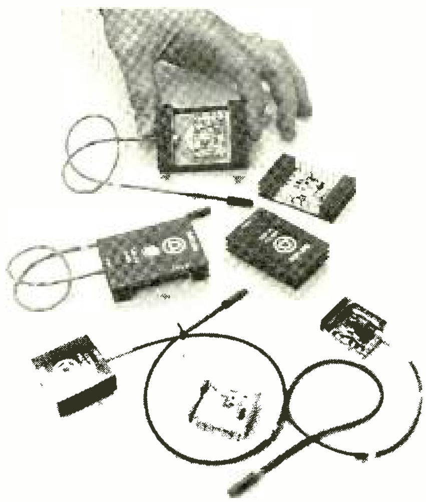
Fiber-optic telephone lines closer to realization

An experimental communications system that uses light guided through thin glass-fibers is slated to start active testing this year. A 2,000-foot cable containing over 100 fibers is being installed in ducts at the Bell Laboratories' Atlanta, GA, facility. Joining individual fibers at the ends of the cables will enable Bell engineers to test transmission lines many miles long.

This—while still a considerable distance from actual use by operating telephone companies—is a significant step forward from a laboratory environment to one approximating actual field conditions.

The experimental communication system is being used in a two-part study at transmission rates of 1.544 million bits a second (Mbs) and 44.7 Mbs. The pulses of light will be created by light-emitting diodes and by miniature lasers modulated by interrupting the electrical current that drives the device.

The devices have been packaged for practical use on circuit boards containing the signal-processing electronics. Individual fiber light-guides are connected to both the transmitter and receiver packages by a plastic-coated section of fiber guide called a "pigtail." Technicians will simply plug the circuit boards containing



PHONE EQUIPMENT OF THE FUTURE: the packages for the Bell Labs fiber-optic communications experiment. At top, two packages that make up the transmitter. The one being held contains the laser. Center—the two packages with their covers. Bottom left—the receiver package with its cover, and at right, the two sections that make up the receiver package.

the transmitter and receiver into specially designed shelves containing special connectors, with no need to work with individual fibers. The packaging has been designed to be compatible with conventional electronics used in central-office equipment.

Microcomputer workshop course supplies take-home microcomputer

The Wintek Corp. of Lafayette, IN, is offering a series of short courses in places as far apart as San Diego, CA, and

(Continued on page 12)

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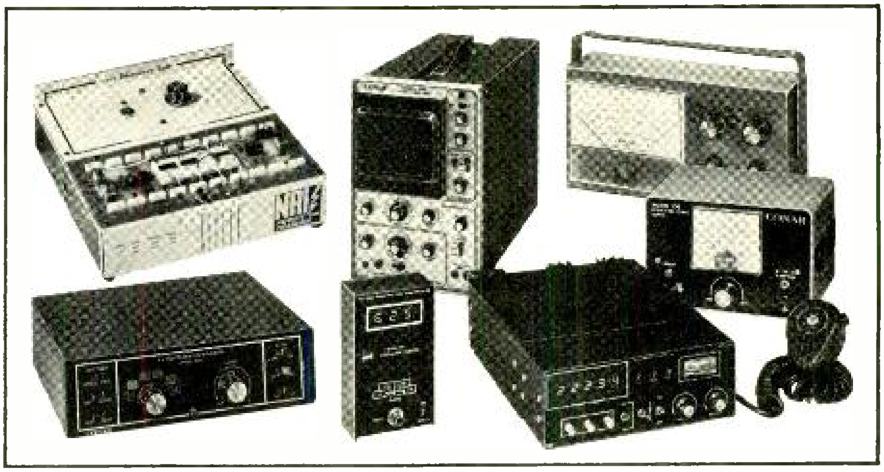

A national survey*, performed by an independent research organization, showed that the pros named NRI most often as a recommended school and as the first choice by far among those who had taken home study courses from any school. Why? Perhaps NRI's 60-year record with over a million students . . . the solid training and value built into every NRI course . . . and the designed-for-learning equipment originated by NRI provide the answer. But send for your free NRI catalog and decide for yourself.

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new & timely

(Continued from page 6)

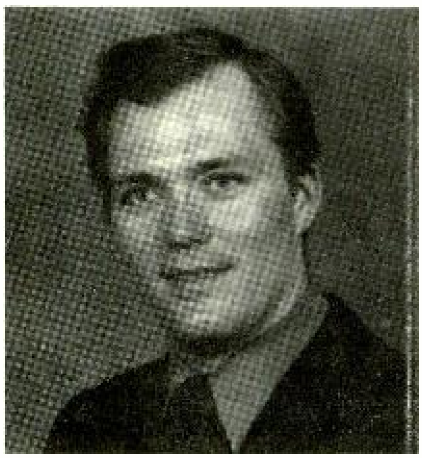
Alpach, Austria. A 3-day "hands-on" microcomputer workshop will be held in San Diego, CA, March 16–18; St. Petersburg, FL, March 31–April 2, and in Alpach, Austria, April 5–7, 1976. Cost of the course, including the take-home computer, is $495.

A 5-day course on digital communications for scientists, engineers and management will be run in San Diego, March 15–19, and in St. Petersburg, March 29–April 2. Tuition is $395. Another 5-day course in image processing will be held in San Diego, March 15–19; St. Petersburg March 29–April 2, and in Alpach, Austria, April 5–9. Tuition is also $395.

The courses are being run by Wintek Corp., 902 N. 9th St., Lafayette, IN 47904.

Midwesterners are winners of Hugo Gernsback scholarships

James H. Byasse, of Marion, IL, is another winner of the Hugo Gernsback Scholarship Award, a grant of $150 given annually to an outstanding student in each of eight leading home-study schools of electronics. The present entries are from the Cleveland Institute of Electronics, Inc. Mr. Byasse is 28 years old, is married and has two daughters. He is a school teacher and works part time repairing electronic musical instruments.



JAMES H. BYASSE

ALBERT TURKOVICH

The second prize winner, Albert A. Turkovich of Eaton Rapids, MI, receives a WV-529A service VOM, donated monthly by RCA to persons placing second in each contest for the scholarships. He is 24 years old, married, and now works as a machinist, with plans to get into electronics in the near future.

FCC improves situation of terminal equipment users

The FCC has moved to permit users of the national telephone network to connect terminal equipment to the network without being compelled to use connecting equipment supplied by the carrier.

The famous Carterphone decision, in 1968, held that a customer of a common carrier could connect his own terminal equipment to the carrier's system, providing that it had no adverse effects. The telephone company immediately insisted that to prevent such adverse effects and to protect other customers and the company's own hardware against damage, all such equipment must be connected through interfacing equipment supplied by the company itself.

The new rule, which will come into effect April 1, 1976, will permit users or designers of terminal equipment to register such equipment with the FCC, and would give them complete freedom to use any equipment approved by the Commission. Two options are proposed: one would be registration of the complete terminal equipment; another, registration of only the protective apparatus (separate, identifiable and discrete electrical circuitry designed to protect the telephone equipment from harm, and registered in accordance with the new rules).

In coming to its decision, the Commission noted that "special" customers, including gas, oil, electric and transportation companies, as well as many of the 1,600 independent telephone companies, the Department of Defense, and NASA, have long been and still are allowed to connect their equipment and facilities to the network by means less restrictive than carrier-supplied connecting arrangements.

The Commission therefore stated that as of April 1, 1976, FCC-registered terminal equipment as well as equipment used in conjunction with FCC-registered protective circuitry may be connected directly with the telephone network in accordance with the new rules and without carrier-supplied connecting arrangements. R-E

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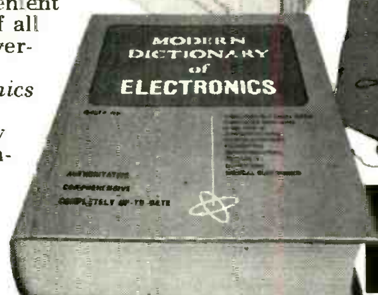

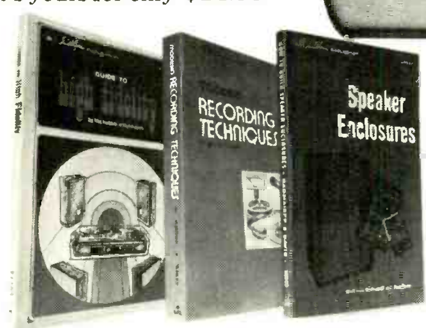

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letters

BURGLAR ALARM UPDATE

After building your burglar alarm system I discovered some improvements that could be made with a minimum of parts.

First, referring to Fig. 7 (May 1975 issue, page 49), gate A should self-latch for only a limited amount of time, otherwise the whole system is disabled (after auto-off) until S7 is reset and switch S1 is turned off and back on again. To do this, an R—C circuit can be installed between pins 3, 5, 6 and ground (see Fig. 1). The R—C network should have a time-constant greater than the R7—C2 network. The effect of this is that S7 can

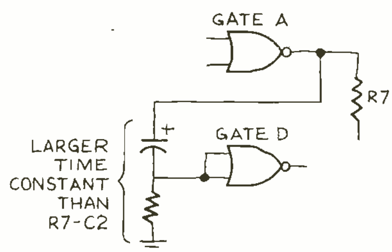


FIG. 1

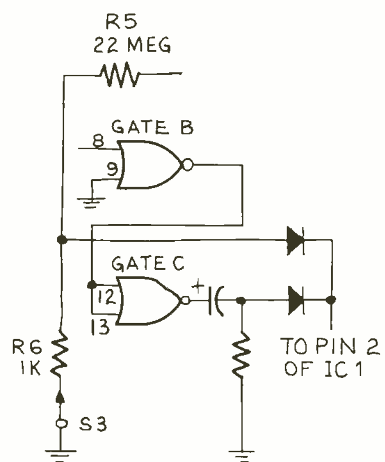


FIG. 2

be reset and the alarm is ready again—no need to hit the key switch.

But what if S7 is opened and not closed again? After auto-off the whole circuit is off again, none of the sensors work. With an R—C circuit and some other changes (see Fig. 2), S7 could be activated and left open and still the alarm would sound when the non-delay sensors were opened. Thus if a burglar opened a delayed switch, left it open and waited for the alarm to turn off, then reentered an inside perimeter; the non-delay switches would get him.

ROBERT JUST
New York, N.Y.

S/N—WHAT DOES IT MEAN?

I enjoyed your article "Signal To Noise—What Does It Mean?" (Sept. 1975 issue) very much. Hopefully, your magazine will continue to promote true high fidelity and encourage consumers to know what they are buying.

However, I must take strong issue with several points in the article.

Mr. Feldman seems to feel that amplifier manufacturers are leading consumers astray by specifying S/N relative to a 10-mV signal rather than to input sensitivity (which is generally lower). If a phono cartridge produced the same output across the audio band, he may be correct. However, the RIAA curve tells us that high frequencies must be attenuated by the preamp in order to get a linear output. For example, at 10 kHz, the cartridge output would be about 14 dB above a 1-kHz signal (for a RIAA equalized disc). This means that if a cartridge has a rated output of 2 millivolts at 1 kHz, the output at 10 kHz would be about 10 millivolts.

Actually, the preamp manufacturer is being realistic by rating his S/N relative to a 10-mV signal. That is why this method is used by most high quality manufacturers (including Audio Research, C/M Laboratories, SAE and ACE Audio, to name but a few). The integrity of these firms will speak for themselves. They do not deceive consumers to make sales as Mr. Feldman implies.

The biggest error in Mr. Feldman's article was the conclusion that S/N specified relative to a 10 mV signal is "meaningless." If Mr. Feldman would prefer his S/N relative to input sensitivity, he can convert it easily using basic high school mathematics. For example, the SAE model Mark XXX has the following specifications:

Noise: Phono—75 db below 10 mV input.

Input Sensitivity: Phono—2 mV.

First find the equivalent input noise voltage:

$$\textbf{S/N} = 75\text{ dB} = 20 \log_{10} \frac{10\text{ mV}}{\text{noise voltage at input}}$$

$$\textbf{Noise Voltage at input} = \frac{10\text{ mV}}{10^{\frac{75}{20}}}$$

$$= 1.78\ \mu\text{V}$$

Now, Mr. Feldman, to calculate for S/N relative to input sensitivity:

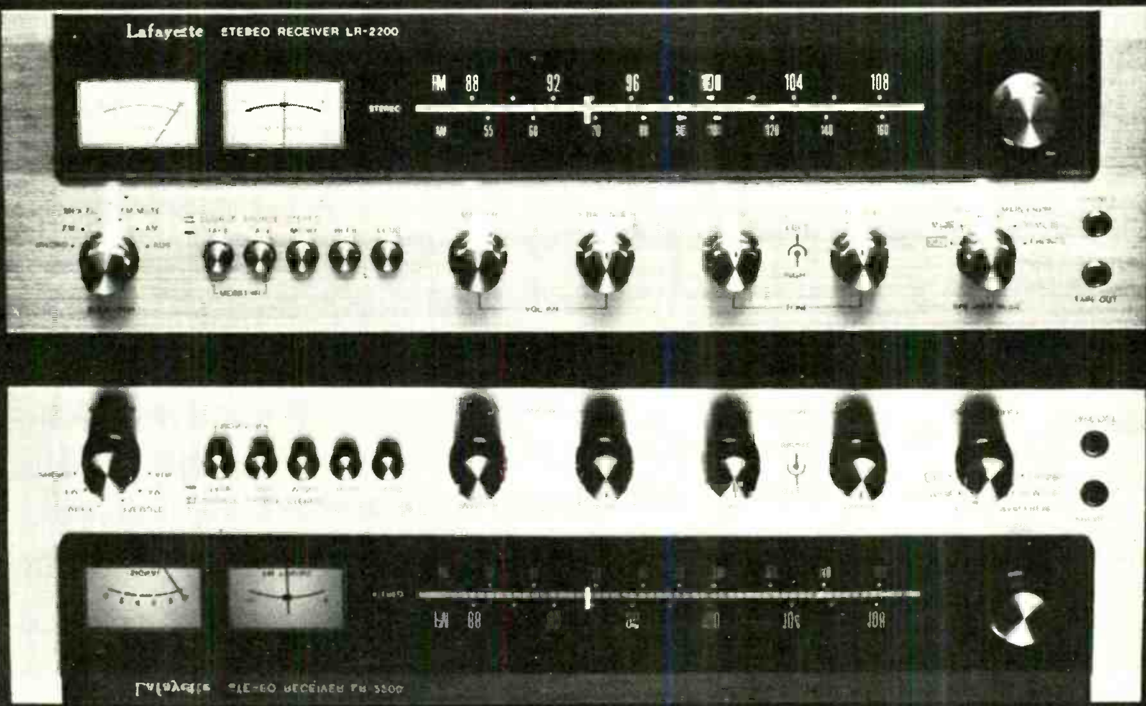
S/N (relative to input sesitivity)

$$= 20 \log \frac{2\text{ mV}}{1.78\ \mu\text{V}}$$

$$= 61.0\text{ dB}$$

This only works if the S/N ratio is unweighted. In fact, this is the reason S/N ratio is specified the way it is: THE S/N CAN BE CALCULATED EASILY FOR ANY

(continued on page 17)



Circle 8 on reader service card

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Circle 9 on reader service card

(continued from page 14)

INPUT VOLTAGE FOR ANY CARTRIDGE SPECIFICATION. As you can see, these specifications are meaningful. I oppose weighted S/N on the grounds that it is a real hassle to determine S/N ratio for your cartridge (unless, of course, it is exactly at the preamplifier input sensitivity).

Personally, I would prefer to see "equivalent noise at input" specifications rather than S/N.

A point that I feel should have been mentioned in the article is that S/N is more correctly specified (S+N)/N. Think about it!

In conclusion, I ask "signal to noise, Mr. Feldman . . . what does it mean?"

CHRIS HORNE
Graduate Engineer
Patton, PA

S/N—REPLY

Your letter addressed to **Radio-Electronics** was forwarded to me for reply. While I cannot disagree with your reasoning, it occurs to me that the same argument applies relative to our statements of S/N as referred to actual input sensitivity. One could just as easily convert the readings to S/N ratios with respect to 10 mV. But why choose 10 mV? Why not 20, or 30 or even 50? Think how good the S/N numbers would look then. Do you know of any magnetic cartridges that put out 10 mV when driven by a velocity of 3.54 centimeters per second (the usual test velocity recorded onto most test records used to measure frequency response and output level)?

The industry is very much divided on this point, and I agree with you that a statement of equivalent noise at the input would be a better form of measurement. However, until most manufacturers begin quoting it, the consumer would be further confused by this additional concept.

Rest assured, Mr. Horne, that I too know how to convert signal-to-noise ratio from one reference point to another as, like you, I too am a "graduate engineer." I also fail to see why the use of weighted figures (we use both weighted and unweighted in our reports) would in any way alter the results if different input levels are used, since the weighting curve is a frequency form of compensation relative to 1000 Hz to compensate for the auditory effect of noise. It will have the same effect on the signal-to-noise ratio (weighted) regardless of the reference level used with it.

You are also technically correct that S/N is more properly called (signal plus noise to noise) but when we are talking about S/N ratios of 60, 65, or 70 dB, we are dealing with rather minute differences. For example, if we read a 1-volt output signal (including noise) and get a S/N ratio of 60 dB, that means the NOISE contribution is .001 volts. Do you really think it worth making a point over the difference between 1.001/.001 and 1.0/.001?

LEN FELDMAN
Contributing Hi-Fi Editor

KOMPUTER KORNER

We are introduced to software—a classification covering appplications and systems programs.

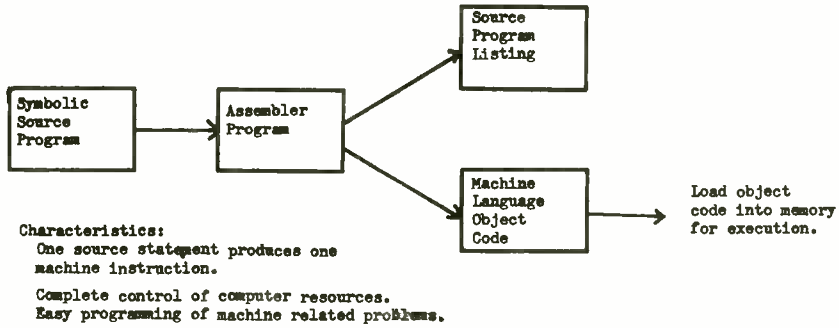
TIM BARRY

SOFTWARE IS A TERM THAT HAS ALMOST AS many definitions as there are programmers. In the broadest sense, software can be considered to be any program written for use with a computer. There are a considerable number of present misconceptions about software, and hopefully these columns will help put them to rest. The feeling that programming is an "art" or in some way mysterious has been around for some time. This is a self-defeating attitude that is probably particularly irritating to hardware designers learning software. While extremely sophisticated or elegant programming can approach an art form, so can hardware design, tennis serving or any other activity when performed by a highly trained person. Most of us will have to be content with getting the job done. This is no problem once you realize that 99% of all programming is a straightforward application of a handful of easily learned concepts and techniques.

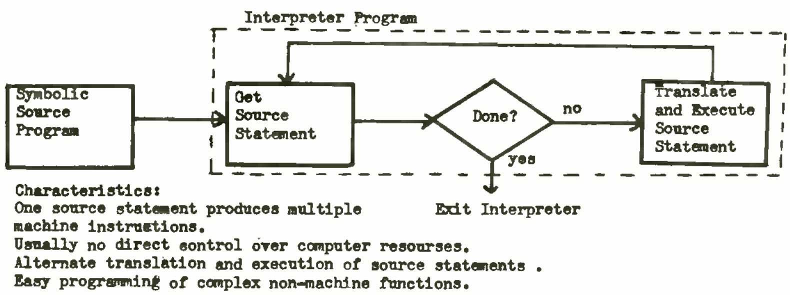
Generally, software is divided into two broad classifications: applications programs and systems programs. An application program is written by a user to solve problems that are not related to the control of the computer system. Systems programs are used to translate and control the execution of applications or systems programs. For example, a home burglar alarm program would be an applications program, while a Basic interpreter would be a systems program. We will be concerned with applications programs in this series (games, home control, hobby use, etc.), but we must discuss briefly a type of systems program known as language translators.

As discussed earlier, for the microcomputer to execute a program, the machine language representation of that program must be present in memory. We then start the processor executing where the program begins and it executes the instructions. Unfortunately, the language that the com-

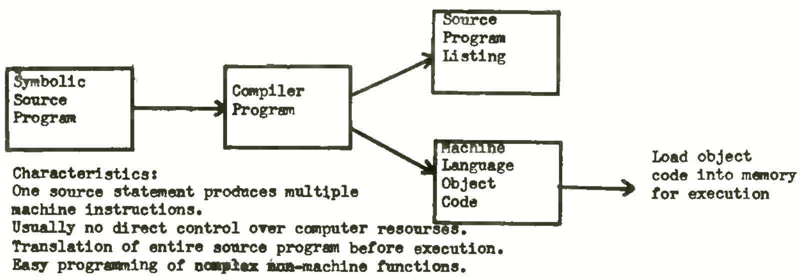
(continued on page 22)



Assembler



Interpreter



Compiler

KOMPUTER KORNER

(continued from page 20)

puter understands (1's and 0's) is not necessarily the most convenient for the human operator to use. A microcomputer or minicomputer will have several hundred machine instructions (the 8080 has 243), and a large computer will have thousands. Each machine instruction is represented by a unique code. The misplacement of a single bit can result in radically different program operations. Even worse, the insertion or deletion of a single instruction may require us to move or change many other instructions. While it is possible to write very simple programs in machine language, as the programs become more complex, the task of making changes and corrections becomes almost impossible.

To improve this situation we use *symbolic languages*. This allows us to use easily remembered symbols to represent machine instructions, addresses, and data constraints. The symbols used to represent the machine instructions are called *mnemonics*. When using a symbolic language, we still have complete control of the machine and it frees us from having to keep track of the large number of machine instruction codes and the value and location of each program element. The translation from this symbolic language (or *source* form) into the actual machine language (or *object* code) it represents is the process called *assembly*. Assembly can be accomplished by hand (we will learn how in the first programming lesson) or by a program called an *assembler*.

Assemblers

The assembler frees us from many of the easily bungled mechanical details of machine language coding and allows us to concentrate on the solution to the problem. For example, the machine code represented by the mnemonic ADD A might be 63. When writing a program it would not be necessary to remember the code, only the mnemonic. During the assembly process, any time the symbol ADD A is encountered, the assembler would automatically substitute the code 63. Similarly, the assembler would translate the entire program, producing one machine code for each mnemonic encountered. Also, the assembler handles all of the assignments of program addresses and symbol values. This makes a tremendous difference when it is time to make corrections to a program by inserting or deleting steps.

The only real disadvantage of assemblers for small systems is that they require a larger memory and more I/O devices than may be available on many hobbyist systems. Normally, a system with at least 4096 bytes of read/write memory, a teletypewriter, and a tape read/write device (paper or magnetic) are required to run an assembler program. However, the simple hand-assembly technique will offer many of the advantages of symbolic languages with no additional hardware. This will probably be the main way that programs will be written for small systems.

The next step up from the assembler in the software hierarchy are the so called "higher level" languages (see diagram). The higher-level languages are structured in a much more English-like fashion. Where assembly languages use mnemonics to represent single machine instructions, higher-level languages use words and operators to specify procedures that represent groups of machine instructions. For example, a program in assembly language to multiply two numbers and print their product on a terminal may take 30 or more instructions. Using a higher level language, the same function can be accomplished in three or four statements.

Another advantage of the higher-level languages is that they make it considerably easier to learn to program. The language processor handles all of the machine details, leaving you free to concentrate on solving the problem. Also, since the language syntax is independent of the machine structure, programs written in a higher-level language can be run on different machines with few modifications. All that is required is that the different computers have the translator for the language used in the program. Ease of programming complex functions combined with shorter program development times and program portability make higher-level languages the usual choice for applications programs on large computer systems.

Higher-level languages are divided into *interpreters* and *compilers*, based on how they produce and execute the final machine-code. An interpreter translates to machine language and executes each source statement each time it is encountered. This means that if a statement is used several times (in a program loop, for example), the statement will be translated every time it is encountered. A compiler, on the other hand, translates the entire program into machine language before it is executed. This means that each source statement is only translated once-per-compilation.

Basic and APL are interpreters while PL/M and FORTRAN are compilers. Compilers are generally more efficient but they are less responsive to frequent program changes. The entire program must be re-compiled if a single source statement is changed. Interpreters translate source statements as they are encountered, making for rapid program changes at the expense of less efficient program execution. Compilers also require more memory and are more complex to implement than interpreters, particularly on small systems. The smaller memory requirements and simpler structure of the interpreter will probably make it the most common type of higher-level language for the hobbyist.

As useful as they are, higher-level languages do have some drawbacks. Since they produce multiple machine instructions for each program instruction, higher-level languages do not always produce the best machine language. A problem solved using a higher-level language is apt to be longer and less efficient than the same task programmed directly in the machine's assembly language. (Efficiency, is of course relative. If it takes you an extra two weeks to make that assembly language program run in an application that is not speed or memory sensitive, it is arguable whether or not the more efficient code is worth the extra time.) Also, by learning a higher-level language, you are insulated from the actual working of the computer. You learn to program a "Basic" computer and not an

(continued on page 108)

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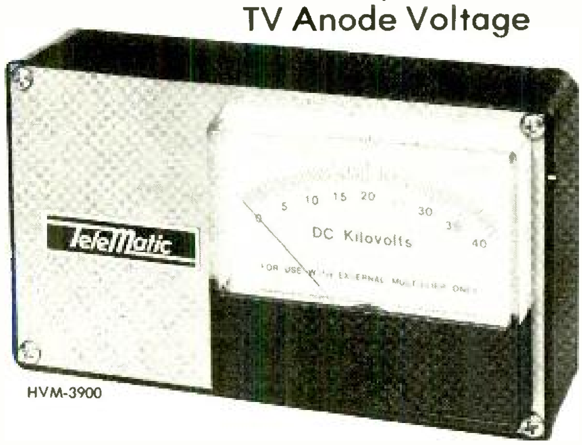

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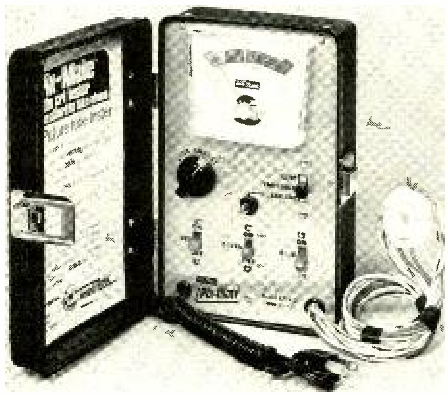
Circle 14 on reader service card

equipment report

Tele-Matic Model KP-710 Color Pix Tube Tester



Circle 31 on reader service card

A COLOR PICTURE TUBE TESTER IS A HANDY thing, especially if you run into some of the "odd-color" problems which could be due to any one of several things. The color picture tube must be either cleared of suspicion or verified as bad, and as soon as possible. If the tester is so compact that it could almost be called pocket-size (large pocket, really) it's handier still. The Tele-Matic model KP-710 Pix-Mate will make all of the necessary tests on any color picture tube, yet it measures only 5 by 8 by 3 inches.

The Pix-Mate will test any 70- or 90-degree color picture tube, for heater-to-cathode shorts, G1 to cathode shorts, as well as reading the emission of each gun for the very useful balancing test, and for output. The socket attached fits the small-base 90-degree tubes. The old 70-degree tubes can be checked with an adapter, the CR90/70.

Operation is fast and simple. There are only four switches, a neon lamp, a LINE ADJUST knob, and the meter on the panel. The Pix-Mate plugs onto the base of the tube, and the LINE ADJUST control set so that the meter reads at the CAL line. The FUNCTION switch is set to LINE position for this test.

Now, moving the FUNCTION switch to LEAKAGE, with the three gun switches (color coded for identification) in the OFF position, the neon lamp will glow if the tube has a heater-cathode short in any gun. Moving the gun switches to ON, one at a time, checks for G1 to cathode shorts in each gun.

For testing emission and matching guns, the FUNCTION switch is set to EMISSION. The three gun switches are set to ON, one at a time. The emission of each gun is read on the meter. This has a GOOD-?-BAD scale, color-coded, and a numerical scale, 0 to 100, for ease of matching guns. Tubes which read well into the middle of the scale are good. For good color-tracking, the three guns should read within 5 to 10 of each other, on the numbered scale. If one gun reads much lower than the others, or much higher, you're going to have problems!

Tubes with low emission, reading down at the 10 to 20 end of the scale, are about gone. A brightener will temporarily bring many of these back to useful life. A chart listing proper brightener to use for each tube is included at the bottom of the instruction sheet in the lid. If tubes have heater-cathode shorts, or G1-cathode shorts, the correct brightener to use for this is also given.

The Pix-Mate is housed in a stout plastic case, with a handle. Cables and line cord stow inside. This unit is compact enough to be carried in a tube-caddy, and rugged enough to be carried loose in the service truck. It takes quite a bit less time to make these tests than it does to write them out. All of them are simple one-hand "flip" tests, very easy to make.

While running tests on the Pix-Mate, we found one oddity. On the very late model black-surround type picture tubes, you'll see the meter reading go full-scale on all three guns! A few went above this. This seems to be normal; other and more expensive picture tube testers showed the same reaction! Evidently these tubes are made to draw greater beam-current than the older types. **R-E**

"That's it, Alice. Now touch the end of the screwdriver to that exposed wire."

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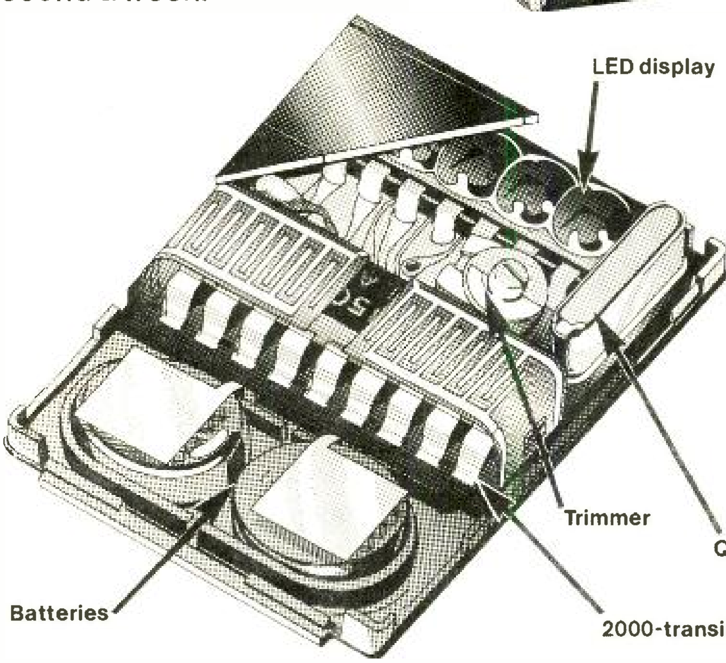

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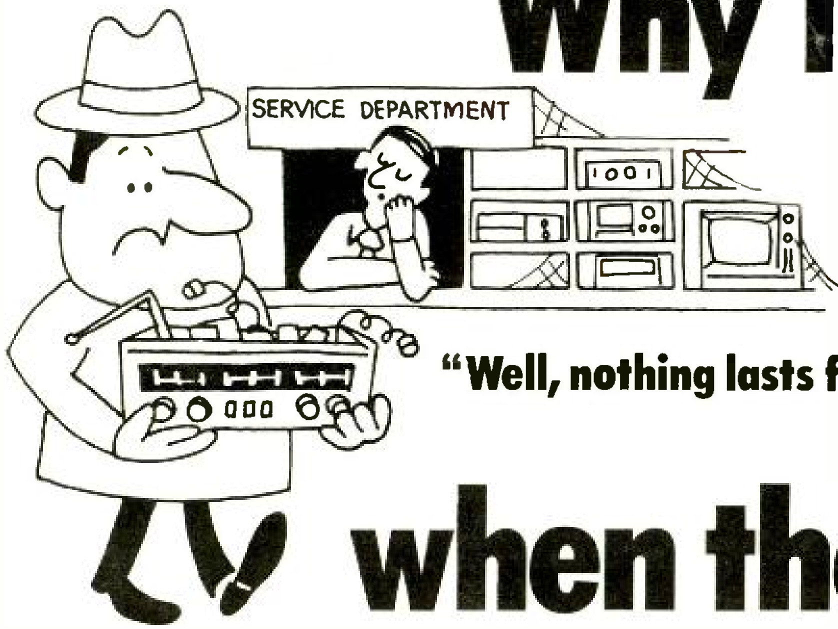

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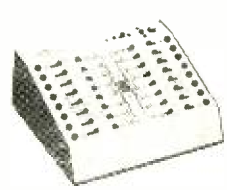
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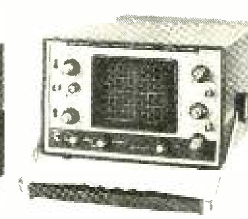
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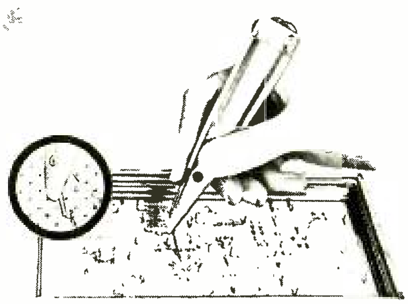
Circle 100 on reader service card

equipment report

Vector P173 Wiring Pencil



Circle 32 on reader service card

THERE IS A NEW TYPE OF WIRE ON THE DIStributor's shelves that has a very unique property. Although it is electrically insulated, it doesn't have to be stripped by cutting, scraping, or with chemicals. Polyurethane or polyurethane-nylon insulation coats the wire. Heat applied with a soldering iron tip melts the insulation away. Wire stripping and soldering take place sequentially during a single soldering iron operation.

Vector Electronics is marketing the *P173* Wiring Pencil they have devised for more convenient use of this heat-strippable wire. The device is a 5½-inch long conically shaped plastic shell. It tapers from its 1-inch diameter top to a point that holds a wire-feed tube extension. Used to precisely guide the wire around the circuit board, the wire dispensing tube is mounted at a 130° angle with the tool axis. Vector claims an approximate 3 times increase in wiring speed when compared to conventional soldering or manual wire-wrap methods.

A wire spool not much larger than a sewing machine bobbin is mounted in the removable top section. The spool holds 250 feet of wire that feeds down the body of the tool and through the metal tip extension. The device is essentially nothing more than a hand held wire spool that is designed to give good control for wiring breadboards and prototype circuit modules. The wiring pencil is a very simple instrument that weighs under an ounce. It is aptly named since circuit connections are "written" by the pencil-like tip.

I tested the P173 by wiring several small breadboards. Wire control was excellent, and the pencil did an effective job. Holes in the plastic shell route the wire external to the body for the lower 1½-inches before entering the dispenser tip. Two holes are provided so that righties and lefties receive rights! Holding the index finger over the exposed section of wire provides drag to maintain tension when wiring. Excessive slack is taken up by simply rewinding the spool. About an eighth of the wire spool is exposed at the top of the tool, and it can be rewound with your finger. As advertised by the manufacturer, the pencil eliminates the conventional measuring and stripping operations. But using the tip as a wire cutter was not entirely satisfactory. The tip begins to slide through the plastic shell when moderate pressure is applied. The wire is only nicked by this procedure and a snap of the wire is needed to complete the severing operation. Diagonal cutters or an Xacto knife might just as well be used at the outset. One or the other has to be used to keep the wire ends neatly trimmed and out of the way.

The wiring pencil is a good complement to Vectorboards and padboards which serve as ideal wiring bases. A line of accessories are available including nylon wire spacers, lead benders, perforated Vectorboards, padboards, terminals, bus strips, and chassis frames.

Components are secured to the boards by manually bending their leads or using the *P133A* staking tool. Quick drying cement or double-sided tape is best for holding down the larger and heavier components. Dual-in-line IC packages are secured by bending the leads 45° outward as they extend through the openings in tenth-tenth Vectorboard. Wrapping the wire three to five times around the component lead anchors the wire. And then according to good soldering practice, both the solder and heat are applied to the joint.

Herein lies the main limitation of this technique. Heat must be applied for a longer than normal interval to make a good connection. I found that brushing off the insulation char and resoldering the connection assured reliable contacts. If you use reasonable heat-sinking practice on temperature sensitive components such as transistors and IC's, there should be no significant problem. But the components are heated longer than with pre-stripped wire and when you deviate from "by the book" methods there is a greater danger of component damage. It is mostly a matter of developing proper technique. Again in keeping with good practice, the iron tip should be clean and tinned and have a small pillow of melted solder on it. Temperatures in the 700 to 750°F range are recommended. Soldering irons rated at 40- to 50-watts will do the trick. Temperature controlled irons are perfect because they maintain a nearly constant temperature. Overheating never occurs.

The wire comes in green, red, blue, and clear in 36 gauge size. Wire cost is $2.50 for three 250 foot spools. For $9.50 you get the *P173* Wiring Pencil, two spools of wire, and a *P176* threader. The threader does not work on the dispenser tip but is used to pass the fine wire from the spool through the barrel openings. Once this is done the wire is easily pushed through the tip. The tool is manufactured by Vector Electronics Co., Inc., 12460 Gladstone Ave., Sylmar, CA 91342. **R-E**

NO HIGH VOLTAGE

This Sears 564.41220001 color TV has sound, but no raster. The control-grid voltage on the horizontal output tube is —43 volts. I have no cathode current at all, and the screen grid resistor keeps burning up! What would you check next?—P.S., Broderick, CA.

I believe I'd check the connections to that cathode current meter! You must be drawing quite a bit of current to burn up the screen grid resistor, and this must flow in the cathode circuit. Look for a possible extra jumper to ground on the cathode pin. This will short-out your meter.

The screen-grid resistor may be overheating because the *plate* connection is *open*. (Check the plate cap contact, flyback winding, etc.) If the plate opens up, all of the current will try to flow to the only other electrode with voltage, and this is the screen grid. (Eyeball this, and the screen grid will probably look like a toaster!)

CORROSION

I couldn't resist writing this. In looking over some old copies of R-E, I found an item about corrosion on PC boards, and you said it was due to salt air in seacoast towns. I've seen the same thing happen in several parts of the country, far from the ocean!—E.B., Woodbury, NJ.

I'll take that. I live quite a way from blue water, and it happens around here. I should have explained that a little more thoroughly. Later checking seems to indicate that the cause is the presence of a fairly high DC voltage on the wire (usually positive) and exposure of the *copper wire* to the air due to a break in the enamel, etc. The green corrosion you see on the end of the wire is some kind of copper oxide caused by a reaction with the oxygen in the air.

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- Monolithic and hybrid Darlingtons
- FET's • SCR's

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MODEL 510 TRANSISTOR TESTER
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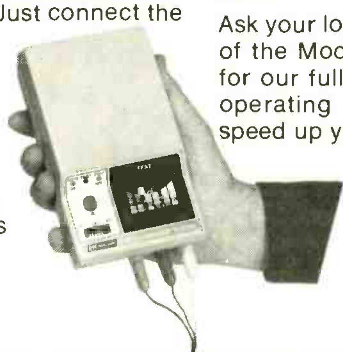
The new Model 510 combines the Dynapeak™ in-circuit semiconductor testing method with the new HI/LO power drive. In LO drive, a "good" power indication also automatically and positively identifies all three transistor leads—base, emitter, and collector. In HI, the Model 510 provides a positive GOOD/BAD indication in circuits with shunt resistance as low as 10 Ω and shunt capacitance up to 25 mfd.

The instrument requires a minimum of control manipulation, so a complete transistor test takes less than ten seconds. Just connect the test clips in any order to the device and turn the tester to LO. Move the six-position test switch until either the NPN-OK or PNP-OK indicator lamp lights. The test switch position identifies the device leads to which each test clip is connected. Out-of-circuit tests are equally fast using the test clips or the convenient plug-in test socket.



The Model 510 measures 6-5/8" x 3-3/4" x 1-3/4" and weighs but a single pound, less batteries. The tester uses four "AA" cells for hundreds of hours of service. A flashing test light reminds you to turn the tester off when not in use. The instrument is supplied complete with three test clips and leather carrying case.

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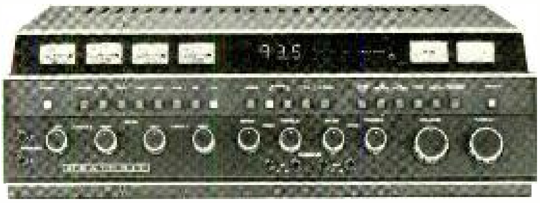

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Radio-Electronics Tests Heath Modulus System

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

MANY HIGH-FIDELITY COMPONENT MANUfacturers have been faced with the problem of what to do about 4-channel equipment. The initial flurry of excitement about quadriphonic sound has died down somewhat in recent months, but there is every indication that "4-channel sound is not dead" and we may well see a resurgence in the months and years ahead. The Heath Company, of Benton Harbor, Michigan, long noted for its innovative do-it-yourself electronic products, believes that it has come up with the answer—and the answer has been named Modulus™. That single word stands for a group of major products and accessories that, taken together, add up to a most complete 4-channel component system. But Heath has been careful to stress the fact that the units adapt themselves most readily to stereo systems, as well.

The key component of the Modulus system is the tuner/control center shown in Fig. 1. Actually, this photo does not do justice to the attractively styled tuner-preamplifier. The elegant black front-panel with sloping lower and upper sections for easy control and readout viewing, is one of the most attractively styled components we have ever seen from Heath and compares favorably with some of the most beautiful (and expensive) designs we have appreciated from other hi-fi makers as well. Not that the AN-2016 is inexpensive. In kit form (the only way in which the unit is offered), the unit sells for $599.95. Purchased at that price, one obtains a complete AM/FM stereo tuner plus 4 channels of preamplification necessary for discrete reproduction of 4-channel program sources such as tapes. The user who is not ready for 4-channel simply purchases one of two available basic power-amplifiers, a pair of speakers and, if desired, a turntable system or a tape deck for a most complete stereo setup.

At any time in the future, a second power amplifier plus a second pair of speakers can be added, at which point 4-channel tape reproduction becomes possible. Then, the user can add a full-logic decoder module for SQ matrix decoding, a CD-4 demodulator module and even an FM Dolby decoder module. All of the modules come in the form of printed-circuit boards that can be neatly slipped into the innards of the AN-2016 main unit. Any or all of these modular additions can be made at any time in the future or you can buy the whole 4-channel system, complete with Dolby FM, for a total cost of $765.80. Assuming you then purchased and built a pair of the AA-1506 power amplifiers to go along with the 4-channel system, you would have spent $1125.70 for all of the electronics of a flexible quadriphonic high-fidelity system. Furthermore, you would have a power output of 60 continuous watts per channel—more than is offered by any currently available all-in-one 4-channel receiver. For "stereo with 4-channel insurance", total cost (again, assuming use of the higher powered separate stereo amplifier) would be $779.90—plus several evenings of assembly work.

As for the features of the AN-2016, most are apparent from looking at the front panel (see Fig. 1). The upper sloped portion of the panel has four output-level meters at the left, each of which responds to the audio signal of one of the four preamp circuits. Each meter is calibrated in dB (from −20 to +10) with 0 dB corresponding to 1.5 volts output. Since each of the available companion amplifiers has an input sensitivity of 1.5 volts, the meters can easily be interpreted in terms of amplifier output as well. The meters have a fast rise-time while the decay is more gradual. These meter ballistics make it possible for the user to judge average power levels but are sufficiently fast acting (in the upward reading direction) to register relatively rapid changes in level.

At the center of the upper section of the front panel are four ½-inch LED numeric displays that displays the tuned-to frequency during both AM and FM reception. The readout simply replaces the conventional dial scale and pointer (it is not associated with a frequency synthesis tuning system such as was employed by Heath

SUMMARY OF MANUFACTURER'S SPECIFICATIONS

FM TUNER SECTION

IHF Sensitivity: 1.7 μV. **50-dB Quieting Sensitivity** (mono): 3.5 μV; (stereo): 35 μV. **Total Harmonic Distortion** (mono): 0.3%; (stereo): 0.35%. **S/N Ratio** (mono): 68 dB; (stereo): 60 dB. **Selectivity:** 100 dB. **Capture Ratio:** 1.3 dB. **AM Suppression:** 68 dB. **Image Rejection:** 90 dB. **IF Rejection:** 100 dB. **Spurious Response Rejection:** 90 dB. **IM Distortion:** 0.1%. **Frequency Response:** 20 Hz to 15 kHz ±1 dB. **Separation:** 35 dB at 100 Hz; 40 dB at 1 kHz; 20 dB at 15 kHz. **SCA Rejection:** 65 dB.

AM TUNER SECTION

Sensitivity: 6 μV for 20 dB S+N/N. **S/N:** 48 dB. **THD:** Less than 1.0% at 30% modulation. **Alternate Channel Selectivity:** 60 dB. **Image Rejection:** 75 dB at 600 kHz. **IF Rejection:** 60 dB at 1400 kHz. **Frequency Response:** 25 Hz to 7 kHz, ±3 dB.

PREAMPLIFIER SECTION

Frequency Response: 10 Hz to 30 kHz, +0, −0.5 dB. **THD:** 0.05% at 20 Hz, 1 kHz and 20 kHz. **IM Distortion:** 0.05%. **Input Sensitivity** (phono low): 6.0 mV; (phono high): 2.0 mV. **Phono Overload** (low): 150 mV; (high): 60 mV. **Phono Frequency Response:** RIAA ±0.5 dB. **Hum and Noise** (phono): 80 dB referred to 10 mV input; (high-level input): 80 dB referred to 0.25 V input. **High Filter:** −3 dB at 7 kHz, 12 dB/octave slope. **Low Filter:** −3 dB at 30 Hz, 12 dB/octave slope.

GENERAL SPECIFICATIONS

Power Requirement: 120/240 VAC, 50/60 Hz. **Dimensions:** 19" wide × 6½" high × 14½" deep. **Net Weight:** 28 lbs. **Power Consumption:** 70 watts.

AM-1503 SQ DECODER MODULE

Frequency Response: 25 Hz to 15,000 Hz, ±1 dB. **THD:** 0.5% or less. **Nominal Separation** (left-front/right-front): 40 dB; (left-rear/right-rear): 12 dB; (front-center/rear-center): 18 dB; (left-front/left-rear and right-front/right-rear): 20 dB; (diagonal): 20 dB; (left-center/right-center): 8 dB.

AD-1507 CD-4 DEMODULATOR MODULE

Frequency Response: 20 Hz to 13 kHz ±3 dB. **THD:** Less than 1.0%. **Front-to-Back Separation:** Greater than 20 dB.

AD-1504 FM DOLBY MODULE

Input/Output Ratio: 1:1. **Nominal Noise Reduction:** −10 dB at 4.0 kHz or above; −9 dB at 2.4 kHz; −6 dB at 1.2 kHz; −3 dB at 600 Hz. **Power Requirements** (from main unit): 15 volts DC, 50 mA.

on their AJ-1510 tuner introduced some years ago) and therefore, both center-tune and signal-strength meters are also included at the upper right of the panel. In the AM mode, only the signal-strength meter remains illuminated and visible. Adjacent to the center-tune meter are a series of illuminated words that indicate stereo FM reception and 4-channel demodulation (if the unit is built with the CD-4 demodulator module added).

The section of the panel below the meters and readout contains no fewer than 22 tiny rectangular pushbuttons, each of which lights up when depressed. The pushbutton at the extreme right applies signals to the output jacks at the rear (it would be deactivated when listening to headphones, since a separate low-powered headphone amplifier is included in this central unit). The rightmost pushbutton turns on power to the entire system. The left cluster of eight pushbuttons select program sources (including CD-4, tape monitoring and dubbing), while the right cluster of six pushbuttons defeat the tone control circuits, introduce high and low filters, loudness, FM Dolby (including automatic switching to the necessary 25 μs deemphasis) and defeat the built in interstation FM muting circuitry.

The five centrally located pushbuttons select mono, 2-channel stereo, stereo to all four speakers, SQ matrix decoding (if the appropriate module has been included) and 4-channel operation.

The bank of ten rotary controls along the lower section of the panel includes separate bass and treble controls for front and back channels and individual level controls for each channel, a master volume control and a tuning knob. Also located on this section of the panel are front and back headphone jacks and dubbing jacks for recording onto (or playing from) a tape deck without having to make rear panel connections. The dubbing jacks are, in effect, a second set of tape monitoring circuits and have full 4-channel capability.

Figure 2 illustrates the great variety of equipment that can be connected to the AN-2016. Not shown is an important accessory included with the unit. It is a loop AM antenna that connects to the appropriate jack on the rear panel. Most FM/AM equipment these days comes with a ferrite-bar AM antenna and, as Heath correctly points out, that sort of AM antenna is much more subject to noise pickup than a properly designed loop. The loop that is constructed by the user acts to shield against noise interference and is a sensitive AM antenna besides.

Major connection points on the rear panel are shown in the closeup photo of Fig. 3. Note that in addition to the usual input and output jacks, there are also a pair of jacks for connection to an oscilliloscope for observation of multipath effects in FM reception. Phono inputs have an associated sensitivity switch to match cartridge levels and a separate pair of phono input jacks are provided for use with the CD-4 optional module, if installed. This has a disadvantage in that if a single turntable system is used, it would have to be switched back and forth between two sets of terminals when listening to CD-4 or stereo/matrix discs. Alternatively, one could leave the turntable connected to the CD-4 inputs (if all the quadriphonic op-

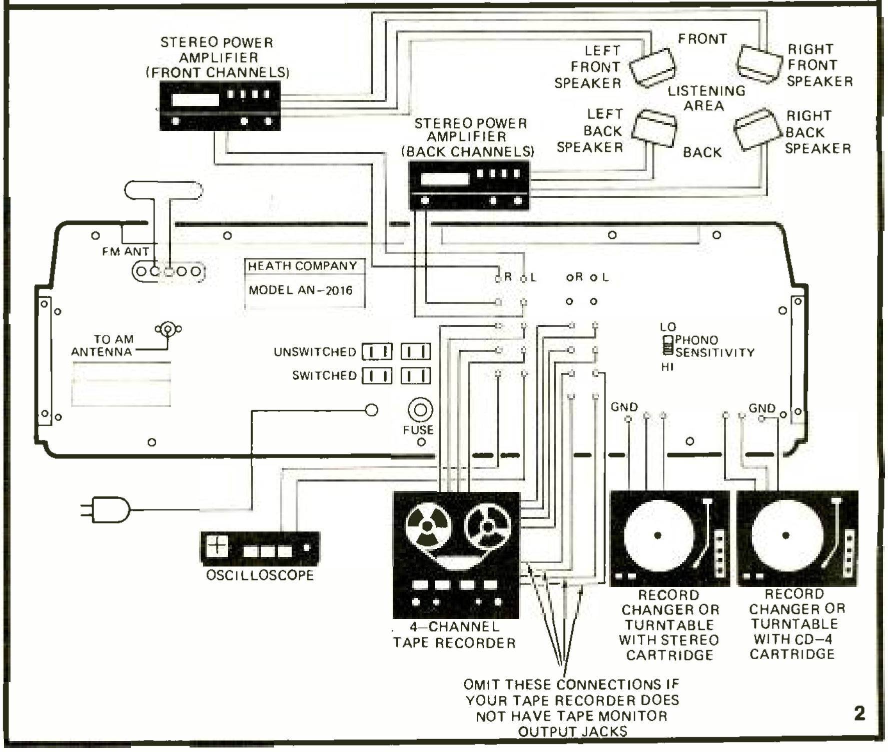
TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer **Heath Company** Model **AN-2016**

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	**R-E Measurement**	**R-E Evaluation**
IHF sensitivity, mono: (μV)	1.8 (10.5 dBf)	**Excellent**
Sensitivity, stereo (μV)	3.4 (16.0 dBf)	**Excellent**
50 dB quieting signal, mono (μV)	2.2 (12.2 dBf)	**Superb**
50 dB quieting signal, stereo (μV)	27.0 (34.0 dBf)	**Very good**
Maximum S/N ratio, mono (dB)	72	**Excellent**
Maximum S/N ratio, stereo (dB)	65	**Excellent**
Capture ratio (dB)	1.2	**Very good**
AM suppression (dB)	68	**Superb**
Image rejection (dB)	94	**Very good**
IF rejection (dB)	100	**Excellent**
Spurious rejection (dB)	92	**Very good**
Alternate channel selectivity (dB)	100+	**Superb**
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz (±dB)	0.2	**Excellent**
Harmonic distortion, 1 kHz, mono (%)	0.28	**Very good**
Harmonic distortion, 1 kHz, stereo (%)	0.20	**Very good**
Harmonic distortion, 100 Hz, mono (%)	0.25	**Very good**
Harmonic distortion, 100 Hz, stereo (%)	0.35	**Good**
Harmonic distortion, 6 kHz, mono (%)	0.13	**Excellent**
Harmonic distortion, 6 kHz, stereo (%)	0.27	**Excellent**
Distortion at 50 dB quieting, mono (%)	1.9	**Fair**
Distortion at 50 dB quieting, stereo (%)	0.4	**Very good**
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV)	2.5	**Excellent**
Separation, 1 kHz (dB)	32.0	**Average**
Separation, 100 Hz (dB)	32.0	**Good**
Separation, 10 kHz (dB)	21.0	**Fair**
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV)	2.5	**Excellent**
Dial calibration accuracy (±kHz @ MHz)	N/A	**(See text)**
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION		
Control layout		**Excellent**
Ease of tuning		**Good**
Accuracy of meters or other tuning aids		**Very good**
Usefulness of other controls		**Very good**
Construction and internal layout		**Excellent**
Ease of servicing		**Superb**
Evaluation of extra features, if any		**Good to Very good**
OVERALL FM PERFORMANCE RATING		**Excellent**



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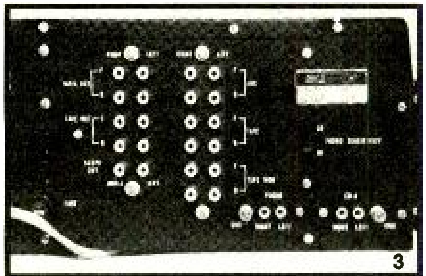
tions has been included) and let the CD-4 module switch electronically from CD-4 to stereo. For SQ matrix listening, it would still be necessary to transfer the audio cables (or use two turntables and cartridges). No provision has been made for any future discrete 4-channel FM broadcasting though anyone who has built the kit would have no trouble finding the composite FM signal output that would have to be connected to an appropriate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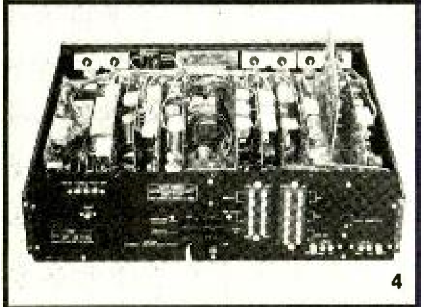
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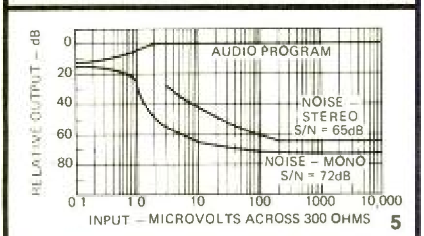

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adaptor if and when such a system of broadcasting is approved in the future.

The view of the inside of the AN-2016 (Fig. 4) chassis shows a series of individual printed-circuit boards, each of which represents a particular major circuit. The three optional modules are shown at the right of Fig. 4. Each module is connected by a multi-pin connector and can be easily pivoted or swung out of the body of the chassis for servicing or testing in-circuit. Not visible in Fig. 4 are a pair of coiled up test leads that are connected to the signal meter (by means of an internal slide switch) which may then be used either as an ohmmeter or as a voltmeter for checking construction and correctness of operating voltages and resistances of the various modules as the kit-building work progresses.

Circuit highlights

A full description of the circuitry of the AN-2016 could fill all the pages of this issue, so we will mention only those circuit highlights that we feel are important to an understanding of this tuner-amplifier. The sealed FM front-end employs two RF stages (FET's) and is tuned by means of a four-gang tuning capacitor. A portion of the oscillator output is coupled to the counter circuit board which subtracts 10.7 MHz from the frequency counted and de-

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer **Heath Company** Model **AN-2016**

PREAMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ± ___dB)	0.5	**Very good**
Maximum input before overload (mV)	60/180	**Good**
Hum/noise referred to full output (dB) (at rated input sensitivity)	76	**Superb**
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ± ___ dB)	10-30, 0.3	**Excellent**
Hum/noise referred to full output (dB)	80	**Very good**
Residual hum/noise (min volume) (dB)	85	**Very good**
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. 6	**Very good**
Action of secondary tone controls	See Fig.	....
Action of low frequency filter(s)	See Fig. 6	**Good**
Action of high frequency filter(s)	See Fig. 6	**Good**
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.0/6.4	
Input sensitivity, auxiliary input(s) (mV)	160	
Input sensitivity, tape input(s) (mV)	160	
Output level, tape output(s) (mV)	160	
Output level, headphone jack(s) (V or mW)	N/A	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		**Very good**
Adequacy of input facilities		**Good**
Arrangement of controls (panel layout)		**Good**
Action of controls and switches		**Excellent**
Design and construction		**Excellent**
Ease of servicing		**Superb**
OVERALL PREAMPLIFIER SECTION PERFORMANCE RATING		**Very good**

TABLE III

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer **Heath Company** Model **AN-2016**

OVERALL PRODUCT ANALYSIS

Retail Price (Kit only)	**$599.95 (FM Dolby: $39.95; SQ Decoder: $49.95; CD-4 Demodulator: $79.95)**
Price Category	**Medium-high**
Price/Performance Ratio	**Good**
Styling and Appearance	**Excellent**
Sound Quality	**Very good**
Mechanical Performance	**Excellent**

Comments: We must admire Heath's unique approach to non-obsolescence in high-fidelity component design. The company refrains from referring to the AN-2016 as a 4-channel tuner/preamp and correctly so, since it can be purchased strictly for stereo use. If that is your purpose in considering this attractively styled, good-performing tuner preamp you will have invested perhaps $60.00 or so for long-term insurance against the day when you may decide to convert to 4-channel. Unlike most quadriphonic conversion attempts, you will not be faced with the prospect of having to add a host of external "black boxes" to update your system, since all three available add-on modules will slip neatly into the main unit, and you can add them one at a time or all at once. By keeping the amplifiers separate, further flexibility is afforded, since you can have all the control features of the AN-2016 (and they are many) with a choice of power outputs for your single stereo power amp (35 or 60 watts per channel) plus a future choice of power output when and if a second stereo power amp is purchased for 4-channel updating. Some cost could have been saved by resorting to a conventional dial scale and moving pointer, but the aesthetic impact of the digital frequency readout cannot be denied, even if it contributes nothing to tuning accuracy. The four output meters, on the other hand, are a most useful addition to the instrument and the ballistics designed into them are ideal for viewing individual channel program levels. Operated with one or two of the available matching power amps (AA-1506, reviewed in this issue, or the lower-powered AA-1505), Heath's Modulus hi-fi system is good to look at, provides excellent sound and exemplifies the kind of thought-out human engineering that we most admire. The complexity of the finished product may frighten prospective kit builders, but if the construction manuals are examined completely before proceeding, one quickly realizes that while the job of assembly is long (Heath estimates it at 40 hours for the main unit), the step-by-step operations are really quite simple and organized for a minimal chance of problems.

codes and drives the LED digital readout display. The display therefore reads the tuned-to frequencies in both AM and FM. Three integrated circuits amplify FM-IF frequencies and are tuned by means of pre-aligned L—C filters.

A digital FM detector circuit is used to demodulate the IF signals and recovered audio is passed on to an IC phase-locked loop multiplex demodulator. Recovered left and right channel audio is filtered to remove unwanted high-frequency carrier products. Squelch control (muting) in FM involves detection of both noise level and deviation from center tuning of desired signals. The phono preamplifier-equalizer circuit consists of a dual, low noise, high-gain differential amplifier in the form of an IC.

Differential amplifiers are used in voltage gain circuits as well as in the tone control circuits for each of the four channels of preamplification. Active filter circuits are formed by a low- and high-frequency filter network and a two resistor complimentary amplifier. The separate headphone amplifier consists of a three-stage amplifier with feedback coupled from output to input stage.

Dual gate FET's are used in the RF and mixer stages of the AM section and a three-section tuning capacitor is used. A separate buffer amplifier follows the oscillator before mixing. Separate IF and RF AGC amplifiers are used in this carefully designed AM section. The performance of the AM section proved to be unusually good in our listening and measurement tests.

No attempt will be made to describe the digital display circuitry, though Heath's typically excellent manual goes into that circuitry in some detail for those who are interested in how FM and AM frequencies can be read directly in LED display numerals.

FM performance measurements

Measurements of FM performance are listed in Table I, along with our individual comments concerning each measured parameter. We were particularly impressed with the steep slope of the quieting curve—one of the most important criteria for good reception under weak signal conditions. That characteristic is plotted in the graph of Fig. 5. Note, that with only 2.2 μV (12.2 dBf) of signal applied, quieting in mono reached a very listenable 50 dB. That's as low as we have ever measured. Distortion in mono and stereo was very good, but not as low as we have seen from other recent designs. At 6 kHz, however, THD in stereo was amazingly low—only 0.27%. At these higher frequencies there is usually a tendency for the single-meter reading of distortion to read higher, influenced by beat frequencies that are not actually harmonic distortion but are nevertheless objectionable. In the case of the Heath AN-2016, such beats were hardly evidenced.

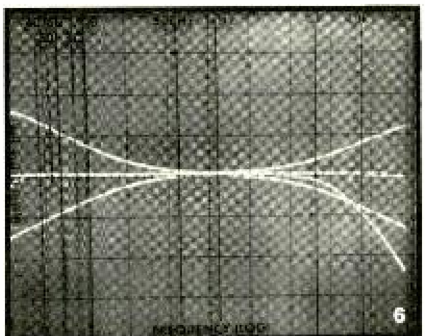
The only specification that fell short of claims was the stereo FM channel separation which measured 32.0 dB at mid-frequencies as opposed to 40 dB claimed.

Preamplifier measurements

Measurements of preamplifier and control section performance are listed in Table II. We felt that the overload level in phono was a bit on the low side in terms of today's dynamically recorded discs, but of course one could easily switch to the low sensitivity phono setting and make up the resulting loss of gain by means of the channel level controls and master volume control. This allows the user to take advantage of the higher (180 mV) overload capability afforded by that setting. Our phono hum-and-noise measurement of 76 dB is referenced to the 2 mV input sensitivity. Translated to the 10 mV reference used by Heath, the S/N ratio would be a whopping 90 dB! Tone control action and low- and high-cut filter action is displayed in our scope photograph (see Fig. 6) using successive 20 Hz and 20 kHz sweeps on our spectrum analyzer. Action of the loudness compensation circuitry at various settings of the master volume control is similarly shown in Fig. 7.

Optional 4-channel modules

Since the SQ and CD-4 modules are available options, and since these circuits do not lend themselves to very much "bench testing", our evaluation of both consisted chiefly of listening tests. The SQ module employs "front-back" plus "variblend" logic. This double-logic system, achieved through the use of three CBS-designed IC chips plus additional components, results in good separation with a minimum of "breathing" or "pumping". The matrix decoder contributes little if any audible distortion to decoded matrix record reproduction.



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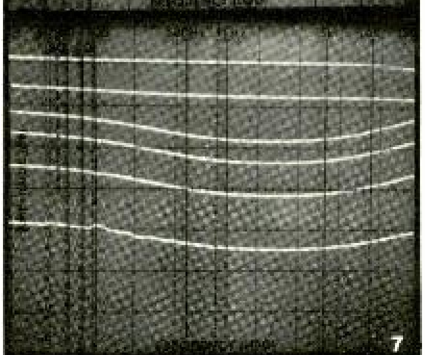

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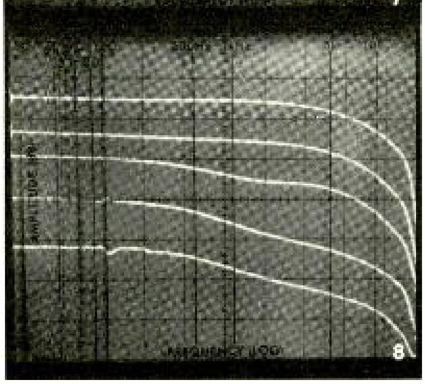

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As for the CD-4 module, it uses a phase-locked-loop FM demodulator scheme that is far superior to the circuitry used in earlier versions of CD-4 demodulators. Some of our earliest CD-4 record samples (that we had regarded as being overly noisy) sound quite good when demodulated by this circuitry—proof that earliest criticism of CD-4 may have been unfairly levied against the discs instead of against the first-generation demodulator circuits.

FM Dolby module

Operation of FM Dolby has been described previously in this publication and elsewhere. A pair of Signetics Dolby chips constitute the heart of this playback Dolby decoder and, in addition to listening to several Dolby broadcasts (three stations in our area use the Dolby noise reduction process in stereo FM broadcasting), we checked the action of the Dolby decoder by sweeping the audio band and using the swept audio to modulate our signal generator. Results, at different modulation levels, are shown in Fig. 8. Note that the top trace (50% modulation, or "0-dB Dolby level" shows flat response and the required 25 μs deemphasis. At lower modulation levels, treble attenuation is introduced in increasing amounts (as levels are lowered) in addition to the fixed 25 μs deemphasis called for in the Dolby FM system. Vertical divisions in each of the scope presentations represents a level change of 10 dB.

Our overall product analysis, together with summary comments, will be found in Table III. Certainly, Heath has come up with a well designed, flexible system of components that perform well and are relatively easy to assemble. If $600.00 seems a bit much to pay for the privilege of spending 40 or more hours with a soldering iron and other assorted hand tools, just imagine how much the assembled version might cost if it were available in that form! **R-E**

POWER AMPLIFIER

1

NORMALLY, WE TRY TO COVER PRODUCTS made by more than one manufacturer in each month's high-fidelity equipment reports. We had to depart from that format this month, simply because the Heath Model AA-1506 stereo power amplifier is such a natural companion component for their new modular AN-2016 tuner/control center that we felt it only fair to evaluate both of these brand new products recently introduced by the Heath Company. We were tempted, in fact, to make it a threesome, for Heath also offers a lower powered stereo amplifier (Model AA-

MANUFACTURER'S PUBLISHED SPECIFICATIONS

Power Output: 60 watts minimum RMS, per channel, into 8-ohm loads, from 20 Hz to 20,000 Hz. **Harmonic Distortion:** Less than 0.1% at any power level from 0.25 watts to 60 watts. **Frequency Response:** 8 Hz to 45 kHz, within 0.5 dB; 5 Hz to 80 kHz, within 1.5 dB. **IM Distortion:** Less than 0.1% at rated power; less than 0.05% at 0.1 watt. **Damping Factor:** Greater than 60. **Hum and Noise:** −95 dB. **Separation:** 60 dB. **Input Sensitivity:** 1.5 V for full output. **Input Impedance:** Greater than 15K ohms. **Power Requirement:** 120/240 VAC, 50/60 Hz (90 watts under no-signal conditions). **Dimensions:** 8" wide by 5⅝" high by 14²¹⁄₃₂" deep. **Net Weight:** 21 lbs. **Price:** $179.95 (available only in kit form).

TABLE I

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer **Heath Company** Model **AA-1506**

AMPLIFIER PERFORMANCE MEASUREMENTS

POWER OUTPUT CAPABILITY	R-E Measurement	R-E Evaluation
RMS power/channel, 8-ohms, 1 kHz (watts)	73.3	**Excellent**
RMS power/channel, 8-ohms, 20 Hz (watts)	66.0	**Good**
RMS power/channel, 8-ohms, 20 kHz (watts)	71.5	**Very good**
RMS power/channel, 4-ohms, 1 kHz (watts)	103.0	**(Not rated)**
RMS power/channel, 4-ohms, 20 Hz (watts)	87.0	**(Not rated)**
RMS power/channel, 4-ohms, 20 kHz (watts	95.0	**(Not rated)**
Frequency limits for rated output (Hz-kHz)	13-32	**Excellent**
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.035	**Superb**
Intermodulation distortion, rated output (%)	0.089	**Very good**
Harmonic distortion at 1-watt output, 1 kHz (%)	0.003	**Excellent**
Intermodulation distortion at 1-watt output (%)	0.010	**Very good**
DAMPING FACTOR, AT 8 OHMS	62	**Excellent**
EASE OF SERVICING		**Excellent**
OVERALL POWER AMPLIFIER PERFORMANCE RATING		**Excellent**

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer **Heath Company** Model **AA-1506**

OVERALL PRODUCT ANALYSIS

Retail Price	**$179.95 ((Kit Only)**
Price Category	**Low**
Price/Performance Ratio	**Excellent**
Styling and Appearance	**Excellent**
Sound Quality	**Excellent**
Mechanical Performance	**N/A**

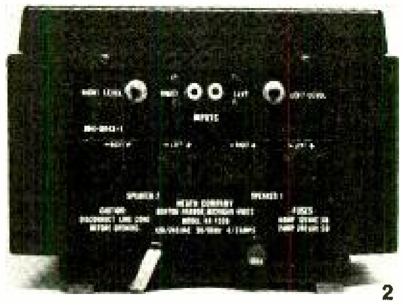
Comments: Given the choice between a 35-watt per channel amplifier at a cost of $159.95 and this 60-watt per channel beauty at $20.00 more, we would choose the higher-powered amplifier tested in this report. This is especially true since, except for power output, other performance specifications are identical. Even the very attractive packaging, designed to fit in neatly with the central tuner/control-center section of Heath's new modular concept, is the same for both power amplifier models. Who, but Heath Company, would ever dream of building in a test meter with which the do-it-yourselfer can test and troubleshoot the product after it has been wired and assembled? If you have been tempted to assemble your own high-fidelity components but have been fearful of possible failure, the AA-1506 (or the lower powered AA-1505) would make an ideal unit with which to begin. Best of all, the Heath AA-1506 sounds as good as it looks and delivers enough power for all but the most demanding listening situations and lowest efficiency speaker systems. Even if you don't follow through with Heath's more complex AN-2016 Tuner/Control Center, or if you already own a separate tuner and a preamplifier control unit, the AA-1506 is a stereo amplifier that should fit in perfectly with your existing components. In our estimation, an amplifier such as this, were it to be purchased fully assembled and wired, could easily cost you around $300.00 or more. Even at that price, it's not likely that you would get better actual specifications or listenability.

1505) that is an identical twin (except for its 35-watt per channel rating) to the AA-1506 amplifier shown in Fig. 1. Both power amplifiers are styled so as to sit comfortably (and aesthetically) alongside the larger control center. And a pair of either amplifier models can neatly flank the tuner-preamp unit if you opt for 4-channel sound now, or in the future.

As for the front panel of the AA-1506, its vertical portion is equipped with a single POWER on-off switch that illuminates in red when power is applied. Similarly shaped rectangular pushbuttons on the lower, sloped section of the panel select either MAIN or REMOTE pairs of stereo speakers. The only two controls built onto the rear panel (shown in Fig. 2) are the left and right channel input level controls that flank the usual phono-tip input jacks. Speaker connections are made by means of separately supplied polarized plugs, to which speaker leads are permanently attached under the heads of terminal screws. This arrangement has the advantage of permanent correct phasing of speakers even if you have to disconnect the plugs when moving the speakers or the amplifier. A fuseholder completes the rear panel layout. In a typical stereo system hookup, the AA-1506 would interconnect with other components as shown in Fig. 3-a while in quadriphonic systems, two amplifiers might be used as illustrated in Fig. 3-b on page 00.

Construction and circuitry

The amplifier samples tested by us in our laboratory were not actually assembled at the lab, but we did have an opportunity to examine the excellently written 89-page assembly manual supplied



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by Heath to anyone who purchases this amplifier kit. As usual, it is loaded with helpful diagrams, excellent step-by-step instructions, schematic diagram, circuit description and even troubleshooting suggestions in the event that you bungle one or more connections or parts insertions. The amplifier was designed for ease of servicing. With the top cover removed, the component-side of the two identical amplifier circuit boards are completely exposed. (See Fig. 4). Remove just two side screws and both amplifier boards, complete with massive heat sinks, swing completely out of the way exposing the power supply circuitry and—are you ready for this—a tiny built-in meter equipped with a pair of test leads. The meter, which is simply calibrated in numerals from 1 to 5, serves no other function than to assist you in checking out your finished wiring job. By flipping a switch located nearby, the meter can be used either to measure voltages or circuit resistances. A view of the amplifier with upper section swung out of the way to expose the chassis components is shown in Fig. 5.

As for the circuitry itself, it is completely DC coupled, with the exception of a 10-μF input capacitor that feeds the signal to the first pair of transistors. These transistors are arranged to form a differential preamplifier circuit that maintains zero DC volts at the output of the amplifier because of a DC feedback arrangement. The output of the second, voltage-amplifying stage feeds an NPN-PNP pair of driver stages and also develops driver bias via a diode-resistor network. Output

(continued on page 78)

Turntables for Today's HI-FI Systems

Performance and operation varies from model to model. Here's a rundown of the different types that are presently available.

HERB FRIEDMAN

THIS ARTICLE IS SUPPOSED TO DESCRIBE how to select a turntable. Trouble is, you'd be hard pressed to find enough turntables to use up just one paragraph of fifty words, for there are very few turntables and the stores that stock them are few and far between. You see, in their endeavor to prove what isn't so is so, the hi-fi manufacturers have destroyed the true meaning of the word *turntable*. They use the word to imply a high-fidelity quality that might or might not exist in any number or products that aren't really turntables.

Years ago there was such a thing as a turntable; most hi-fi enthusiasts used them. It was a device with a rotating table on which a record was mounted. This turntable device simply provided a rotating support for the record. It had to be mounted in a *base*, and somewhere there had to be a *pickup arm* and *cartridge* that followed the record grooves and converted the groove undulations into an electrical signal. The turntable, base, pickup arm and cartridge combination comprised a *record player*. If the record player had a mechanism that automatically fed more than one record to the turntable and then played the record it was called a *record changer*. In short, the turntable was only a portion of a complete record-playing device.

But the record players and record changers of the early fifties had performance deficiencies that degraded what little fidelity was truly on the record. So the high-fidelity enthusiast assembled his own *record player* by using a turntable of superior performance than usually found on players and changers, a high-performance pickup arm, and a high-performance cartridge. His turntable was just that; a component that simply rotated a record with as little rumble and wow-and-flutter as the state-of-the-art allowed. Soon just the word turntable implied high-fidelity equipment; a sound system could not be high fidelity with a record changer or player; it could only be considered high-fidelity if the record playing equipment was assembled from individual components.

But most audiophiles preferred the convenience of a record changer, or, at the least, a complete record player. Even in the early days of high fidelity, only the serious hobbyist would consider doing the carpentry needed to cut a mounting base for a separate turntable and pickup arm.

GARRARD MODEL Z2000B

But since it was a *turntable* that *implied* high-fidelity, manufacturers simply applied the word to any complete system, be it a record changer or a manual record player. Anything with a pickup arm having automatic start and stop (recycle) operation became an "automatic turntable" while the old manual record player –where the user manually placed the stylus on the record and lifted the pickup arm at the end of play–became a "manual turntable". The terms *record changer* and *player* were used only for general use equipment, such as a $30 child's phonograph or a $75 "stereo".

Today, the magic word turntable is still with us and is still used to imply high-fidelity quality. An automatic turntable can be a record changer (more often termed a multi-record player) or a single-record player with completely automatic pickup arm operation; while a "manual turntable" can be a complete manual record player. And wonder of wonders, a turntable can even mean a device that simply rotates a record, with the user providing a base pickup arm and cartridge.

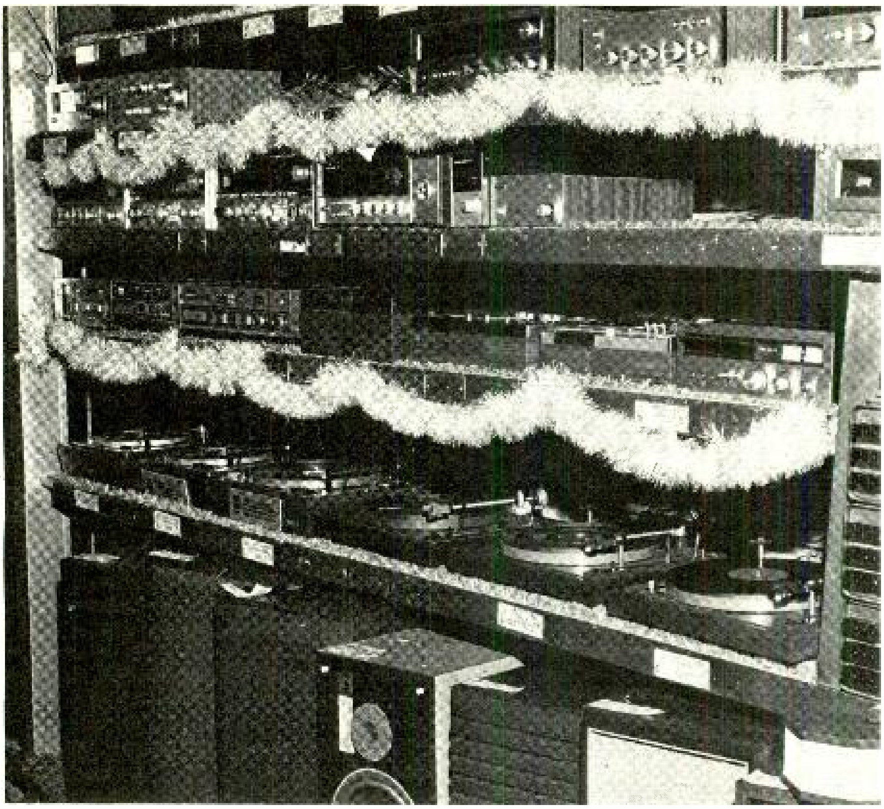
Even if we could straighten out what we mean by turntable, we get a choice of direct drive, electronic regulation, rim drive, belt drive, rim/belt drive, hysteresis drive, induction drive, servo drive, etc., etc., etc. And each manufacturer claims his system is the best; yet in all truth, any system done the right way will work well and give true value for the dollar.

Let us first look at what is meant by "done the right way". From its introduction, the AR manual record-player has had a deserved "quality" reputation, mostly accomplished by delivering a lot of performance at a budget price. Part of the reason the price was kept down was through the use of a lightweight motor; basically a clock motor with not much starting torque but good regulation after the turntable came up to speed (so one waited a few revolutions before lowering the pickup arm). So an imported manual turntable tried to accomplish this same end–quality at low cost through an inexpensive motor. But the manufacturer cut his corners a shade too close and the motor couldn't get the platter started. What do you do when you're all tooled and the platter won't turn? You put a little arm on the start switch that gives the platter a push when the motor is turned on. Cute? Yup! Only how far would you trust the rest of the turntable design

In one instance the use of a lightweight motor was "done well", in the other it was literally a *Rube Goldberg* lash-up.

Most of the turntables, changers and players by well known manufacturers are *done well* in the sense they are compatible with other high-fidelity equipment. As a general rule, you'll find about the same level of performance from model to model in a narrow price range. For example, in the $125 to $150 category, most of the models will have about the same rumble, trackability and wow-and-flutter. The differences will generally be in specific fea-

BIC MODEL 840



tures. Move up to the approximately $200 level and the performance of all high-fidelity changers and players move up a similar notch regardless of manufacturer. Again, differences are generally found in features and convenience of operation.

A motor is a motor

Contrary to popular belief, it does not take a hundred dollars or so of electronic circuitry to maintain a motor precisely on speed over a broad applied-voltage range. It is true that electronically regulated motors such as those used by Kenwood, Pioneer, Technics by Panasonic, Dual and Thorens, to name a handful of many, will maintain precise speed regulation even if the line voltage dances between 90 and 140 volts. You'll be burning out refrigeration motors and poping light bulbs with that range of line voltage variation but the electronically regulated—or *servo*—motors will keep rotating the record with nary a wow or flutter to disturb the most sensitive of ears.

But many, if not all presently used induction (4-pole, 24 pole, hysteresis, etc.) motors will similarly operate rock-steady over a wide voltage range; maybe not 90 to 140 volts, more likely 100 to 130 volts, but 100 to 130 volts is probably the worst possible condition you'd ever run across. The advantage to the DC or servo motor is not speed regulation but *low rumble*. Increase the number of poles in an AC motor and the rumble is reduced. Eliminate all poles through a direct-drive system and rumble is crushed. That's what you pay for and that's what you get with electronic, or DC, or servo type motors. (To keep things simple, we'll refer to all these types as "servo" from here on.)

The servo motor has another great advantage in addition to low rumble, and that is sharply reduced wow-and-flutter through *direct drive*. Servo control allows the motor to rotate at precisely the desired platter speed, thereby eliminating the need for the pulleys, intermediate idler-wheels or belts normally used to reduce the motor speed to platter speed. Since each intermediate drive component is a potential, if not actual, wow-and-flutter producer, the servo drive has an inherently lower susceptability to wow-and-flutter. (But like all things, anything good can be loused up. There are direct-drive systems with greater wow-and-flutter than some modern belt drives.)

Servo control also lends itself quite nicely to precise speed adjustment by the user. A limited range *user-adjusted* speed control is called pitch control. The pitch control is provided for two reasons. First, it allows the user to set the platter speed precisely on 45, or 33 RPM through the use of a strobe pattern somewhere on the platter, and the second is to let the user change the pitch if so desired (some like their music sharp). Though pitch control is also provided on several excellent "standard" AC drive turntables, it is not as precise as the electronic control provided on turntables such as the Kenwood KD-5033, Philips GA-209, Pioneer PL-71, Thorens TD-125 and Yamaha 800.

At the time this article is being prepared, except for the Technics SL-1350 multi-play turntable (record changer), servo motors are used only for single-record players. Some have full manual operation (to provide quality at budget prices) while others have automatic start and pickup arm return and off operation.

For those who do not need nor want the precise speed control and ultra-low rumble of the servo drive motors, there's a host of excellent budget values in single-record players having AC motors, with or without automatic pickup-arm operation. For example, Acoustic Research who reintroduced the "clock motor" drive, is still in there with an updated model XA for under $130. For the real budget minded, there's an all-manual Benjamin 1000 for under $100, while Kenwood, Garrard, Philips, Pioneer, Rotel, Sony and Toshiba all have complete single-record players that hover around $100.

If you're not ready to spend several hundred dollars for servo drive, but want something considerably better than a budget single-record player, the field is wide open with many top values in the $150 to about $200 price range. Just a few of these units that compare quite favorably with some servo models are the Benjamin 600, Dual 501, Hitachi PS-15, Kenwood KD-3033, Rotel RP-1000, Stanton 8004, Micro TM33 and Thorens TD-165C.

Somewhat interesting, you'll find that there are models with AC motors, such as the Empire 598 and Thorens TD-125, that compare favorably in features and performance with servo-type players. Here it is the old story that something need not be "the latest technology" to be good.

Record Changers

While single-play turntables—both manual and automatic—are the glamour queens of high fidelity, the real workhorse is the record changer, and quite often the changer winds up being used primarily as an automatic single-record player.

As a general rule, the term record changer is used for models priced well under $100. These are usually supplied with a ceramic cartridge and intended for "stereo systems"—low cost, low power, medium quality units that are suitable for playrooms, dens and teenagers in general. If the quality is good enough for a true high-fidelity system, the manufacturer will usually use the term "multi-play turntable." This nonsense is semantics of the first order, the same type of thing that causes an elementary school student to ask how a *Hertz* differs from *cycle-per-second*.

A multi-record turntable is a record changer, and the overall quality and performance really has nothing to do with how it's described. Those models specifically suited for a high-fidelity system have several features in common. All have plug-in cartridge heads, shells, or carriers—the same as single-record players. All permit

MARANTZ MODEL 6300

single-record or multi-record operation by changing the spindles. Use a short spindle and it's an automatic single-record player: Use the multi-record spindle and it's an automatic record changer.

There are three common types of record changer mechanisms divided into two groups. Two mechanisms are very similar in that the records are balanced on the spindle. The third mechanism uses a two point suspension with the records stacked on the spindle but resting on a platform adjacent to the platter. Claims are made for each type implying some sort of advantage. As with everything else concerning turntables, if done right it works well. Fact is, you'd be hard pressed to find any record-changer mechanism from a name brand manufacturer that didn't work well. The days of jamming mechanisms is long since past.

The typical record changer uses an idler-drive system whereby a stepped pulley drives an intermediate idler-wheel that in turn drives the platter and changer mechanism. (There have been and will be record changers using separate motors for driving the changer device.) Recently, several record changers have been introduced to the marketplace that use belt drive, or have a direct-drive platter. As a general rule, the rumble and wow-and-flutter characteristics of belt and direct drive are

GARRARD MODEL 125SB

applicable to the record changers as they are for the single-record players. But it is similarly true that belt drive is being used in some rock-bottom priced and rock-bottom performance changers, with the belt drive providing nothing extra in the way of lower rumble and wow-and-flutter.

It is generally accepted that 15° is the optimum stylus tracking angle, though some pickups are now designed for 20° (there's always room for a second opinion). It's obvious that as records are added to the stack already on a platter, the stylus tracking-angle is changed because each new record raises the front of the pickup arm while the rear remains fixed in its pivots. Manufacturers generally set the pickup mounting so the stylus angle is correct for the center of a full stack (most record changers will handle six records). Most of the higher quality record changers, however, have some means whereby the tracking angle can be adjusted for single-record or multi-record operation. Most of the pickup arm tracking-angle adjustments are made at the pickup where a small bar or lever physically tilts the pickup carrier or support. Another method, made popular by Dual, raises and lowers the pickup arm through a preset lever at the pickup arm pivot. Obviously, raising or lowering the back of the pickup arm changes the stylus tracking-angle. Which is best? They both work well. Take your choice.

The latest vogue is multi-record players now coming into popularity on single-record players is the *programmed play*, made popular by the BIC record changers. Basically, it permits the user to dial in as many plays as desired with a final recycle and turn-off after the last record is played. For example, with one record on the platter, or on a changer spindle, and 3-plays programmed, the record will be played three times. If there was three records on a stack and 5-plays was dialed in, the last record would be played three times and then the mechanism would recycle to off. On some models, the replay can be programmed to be continuous until manually stopped.

Straight-line play

It has long been acknowledged that optimum reproduction is attained when the pickup tracks across the record in the exact manner as the grooves were cut—at right angles to the radius. Through many years of experimentation with pickup-arm length and stylus overhang (the distance the stylus extends beyond the center of the platter), the ordinary rear-pivot pickup arm has been made *almost perfect*—tracking-angle errors are very small, and anti-skate correction alleviates the tracking errors caused by the tracing force that pulls the pickup arm towards the center of the record.

There are many high-fidelity enthusiasts, however, who believe optimum sound can only be attained with zero tracking-error and zero skating-force. This can only be had when the stylus tracks exactly as the grooves were cut—by a lath mechanism driving the cutterhead across the platter. For many years the only successful lath-type play mechanism was the Rabco, a single-record mechanism with the pickup driven directly across the record. (Other lath-type mechanisms either ruined the record, or failed to follow warped surfaces). To the still available and updated Rabco lath-type mechanism we can now add the B&O model 4002 that also features a completely automated system (senses record size, record-on-platter, etc.) that accommodates but one cartridge, the B&O model MMC6000.

The only successful *multi-record* zero tracking-error design was the Garrard model Zero 100 that has also been incorporated into the belt-driven model Z2000B. This mechanism uses a rear-pivot pickup arm, but the cartridge head is articulated by a control rod running back to the pivot that keeps the cartridge at right angles to the radius as the arm tracks across the record (much like the articulated windshield wipers on full size-cars). Because the arm is pivoted, an anti-skating force is required to compensate for the pull towards the center. On the Z2000B, the anti-skate is applied by a magnetic arrangement (rather than a spring) originally made successful on the model Zero 100.

Quadriphonic

Though many turntable systems claim 4-channel compatibility, the question must be asked, "Which 4-channel system and how much compatibility?".

Since matrix 4-channel is derived from encoding within a stereo signal, any turntable system equipped with a decent stereo cartridge, standard pickup arm and shielded output-cables is perfectly suitable.

CD-4, however, is a whole new ballgame. Firstly, while it is possible to get acceptable sound quality from CD-4 with a decent cartridge and shielded output-cables, the relatively great high-frequency losses of standard patch-cords generally results in a poorer signal-to-noise ratio, and often, a drifting degree of separation (expands and collapses at random). Also, a better quality turntable system is required for optimum sound as final reproduction is highly dependent on proper tracking; but any good quality equipment (of modern design) will provide the required tracking accuracy. So we are back to the output cables.

For CD-4, the output cables or patch cords should be low-capacitance types. (About 80-100 pF). On certain turntable systems such as the Craig 5102, Garrard 770M and Hitachi PS-15, low-capacitance cables are supplied with the equipment for CD-4 and stereo use. With very few exceptions, most turntables—both single-record and multi-record—have standard phono-jack output connections, and low-capacitance cables (available from local hi-fi accessory dealers) can be substituted if standard patch cords are provided with the equipment. The few players that have the output cables soldered to the output connections are easily converted to low-capacitance output with a few minutes extra work (just cut off the phono plug from one end of a low-capacitance cable).

This leaves the cables inside the pickup arm; an ultra-thin flexible cable that will not produce binding between the tonearm and the pivot. Because the cable itself must of necessity have characteristics determined by resistance to binding, there's not much change that can be done in the way of substantially reducing the inherent capacitance. And as a matter of fact, once the output patch cords have been converted to low-capacitance types, very little improvement in the signal can be heard or measured because of the minor reduction in capacitance possible made by changing the pickup arm wiring.

Summing up

Whether your turntable needs are dictated by price, features, or performance level, you'll find any number of models applicable to your particular requirements. Fact is, there are now so many different models and types of single-record and multi-record player models—well over 120 different models as this article is being prepared—it is almost impossible to see more than a handful at any one hi-fi showroom. Fact is, it might take a visit to three, four, or more showrooms just to see a partial selection of the turntable systems generally available. But keep in mind that somewhere out there is probably some turntable with just about every feature you're looking for. **R-E**

EXCLUSIVE

At last! The long awaited record-care product has arrived. It preserves frequency response while reducing distortion and surface noise.

Record-Care Breakthrough

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

EVERY ONCE IN A WHILE THE CALM routine of my audio lab is interrupted by an unusual test project that adds excitement to the life of an audio engineer and technical writer. Such a project began to take form last summer when I received a strange call from a local ad agency that represented a company called Ball Brothers Research Corp., (P.O. Box 1062, Boulder, Colorado 80302) with manufacturing facilities in Boulder, Colorado; Muncie, Indiana and other locations throughout the country. I had never heard of the company, but was quickly informed that they were engaged in aero-space research and were also the largest producers of Mason jars (used for home canning and preserving).

"So what's that got to do with high fidelity?", I asked, rather impatiently. I was informed that one of the company's divisions had developed a "dry lubricant" that they were convinced would help preserve the life of disc recordings. I listened incredulously as the voice at the other end explained that one simply "sprayed on" this product to the surface of a record, buffed it in with a pad and that the liquid, after quickly evaporating, would deposit a thin coating over all the record grooves very much like the Teflon coating applied to pots and pans.

Any time someone suggests a built-up coating on the surface of a disc I react negatively, since I don't want to see *my* record grooves clogged up with any foreign matter, however much of a lubricant it may be. To me, such coatings have always spelled reduced frequency response retrievable from the disc, since any substance that clogs the minute wiggles in the groove wall *must* inhibit the stylus from properly tracing those fine high-frequency wiggles. The agency people assured me that the coating build-up was self-limiting.

As they explained it, the dry lubricant would bond to the vinyl of the disc but would not build up beyond a thickness of 5 millionths of an inch. Some quick manipulation with my HP-45 calculator confirmed that if this were true, the coating might indeed not adversely affect high-frequency response from a disc and, if all its other attributes were as stated, might be the long-sought-for record preservative that could insure as faithful reproduction from often played discs as that obtained from freshly presed ones. I asked how I could help them. They asked that I examine a report that the company itself had prepared and see if, on the basis of that report, I could verify the findings.

A few days later, the report, prepared by a Mr. Pardee of their technical staff, arrived. Much to my disappointment, the report failed to touch upon the question of frequency response, but dealt instead with total harmonic distortion as a function of repeated playings of similar discs with and without the treatment of the new lubricant. Typical results are shown for the left and right channels of a pair of test records played over 200 times, in Figs. 1-a and 1-b. After examining these diagrams there was no doubt in my mind that the lubricant certainly did reduce record wear, but several other questions were raised.

For one thing, why was the initial distortion so high? Five percent distortion is hardly hi-fi reporduction and I suspected that less than state-of-the-art turntable equipment had been used at higher-than-hi-fi tracking forces. Perhaps the effects were being exaggerated by heavy tracking force and imperfect styli. In addition, the fact that left channel distortion increased more rapidly than right channel distortion for the untreated disc suggested that skating forces were not properly compensated for in the earlier test.

Both of these conclusions proved to be true. Most importantly, no attempt was made to determine whether the application of the lubricant caused any deterioration in frequency response—an important key to the acceptability of the product. I reported my opinions to the people at Ball Corporation and they not only agreed that additional tests were necessary, but commissioned me to perform such tests as I thought might be required.

The next month was spent endlessly playing stereo and CD-4 test records, both treated and untreated, and measuring frequency response "before and after." My test results, coupled with additional microphotography performed by the people at Ball Corporation, were so astounding that I became quite excited about the product, which has since been given the name *Sound Guard,* and is about to be marketed nationally.

Frequency response tests

I decided to use both stereo and quadriphonic (CD-4) test records. If any clogging of minute groove undulations was going to take place as a result of the application of the product, it would certainly be more likely to show up in CD-4 records, where frequencies up to and including 45,000 Hz must be traced by the stylus. A single alternation at that high frequency occupies no more than .0003 linear inches of space along a groove located towards the center of the record.

A reference output level at 40 kHz was measured from a fresh test disc and recorded as 0 dB. This untreated disc was then played 100 times and the measurement was repeated. Level was now down about 6 dB at this high frequency (a result of the wearing away of the high-frequency groove modulation after so many playings). Next, another fresh disc was treated with Sound Guard and played 100 times. The output at 40 kHz was within 1 dB of that observed for the "mint condition" disc! Furthermore, there seemed to be less fluctuation in average output when playing the treated disc—proof, in our view, that more accurate tracing or "hugging" of the groove walls was taking place in the case of the treated record. A plot of output level at 40 kHz for treated and untreated records with repeated playings is shown in Fig. 2 and the results speak for themselves.

Record wear

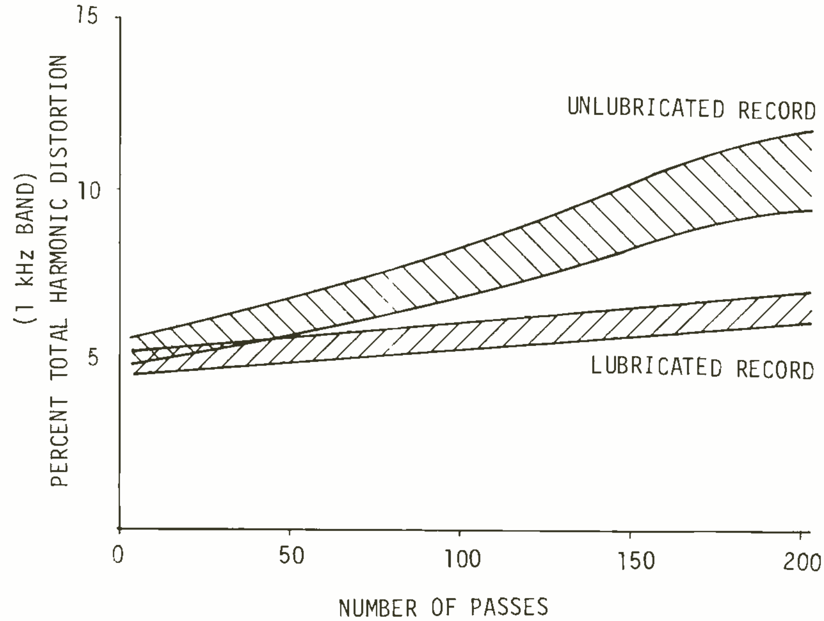
Another attribute of the product became obvious during these extended tests. In the case of the untreated record, we found it necessary to clean the stylus tip after a very few playings. The material which came away from the stylus tip was dark in color—suggesting a wearing away or a gouging out of vinyl material. In the case of the treated record, the entire 100 playings were accomplished without this particle build-up about the stylus tip.

Long after our tests were completed, the people at Ball succeeded in taking some microphotographs of just what a stylus does to a record groove. The photography was done in motion picture format and is even more frightening than the "stills" reproduced in Figs. 3 and 4. Upon first seeing them we were certain that the photos of the stylus tracing an untreated groove had to be defective, but we were assured that the very same stylus was used in both photographic sequences!

Harmonic distortion

Since we were not completely satisfield with the claims made in the Ball Corporation report regarding reduction of distortion with application of the product, we put our spectrum analyzer to work while the tests of the stereo discs were proceeding. First, an unplayed test record containing a 1000-Hz test tone was played and a 20 to 20,000-Hz analysis was made using the spectrum analyzer.

The tallest "spike" in Fig. 5 represents the fundamental tone of 1000 Hz. The next major spike to the right is the



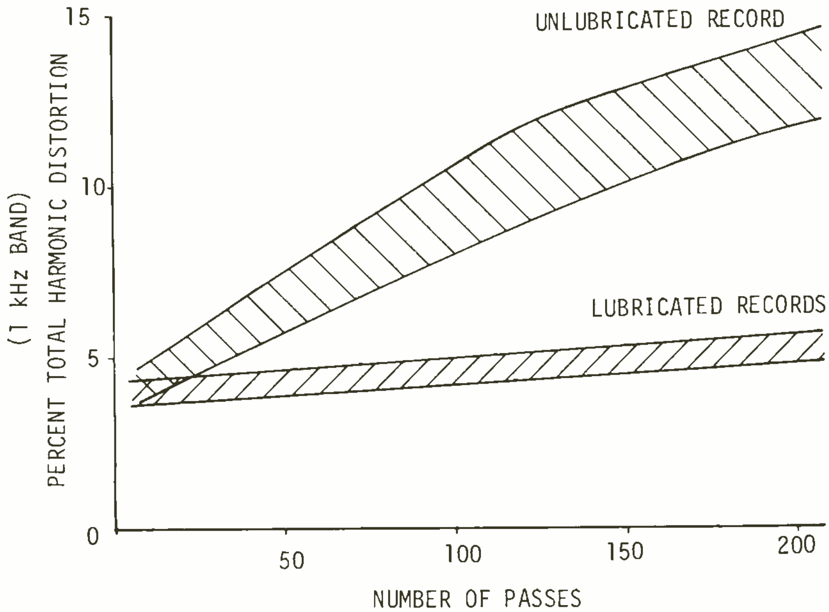


FIG. 1—INCREASE OF TOTAL HARMONIC DISTORTION with repeated playing of untreated test record, compared with record treated with Sound Guard as measured for right channel (a) and left channel (b).

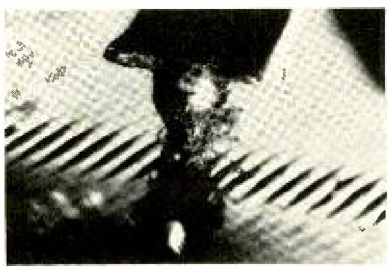


FIG. 3—MICROPHOTOGRAPH OF STYLUS tracing groove of untreated record.

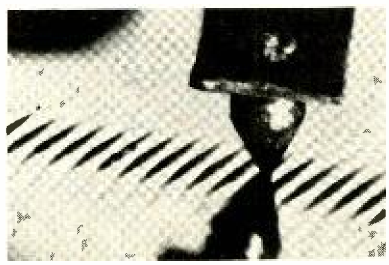


FIG. 4—MICROPHOTOGRAPH OF STYLUS tracing groove of record treated with sound guard.

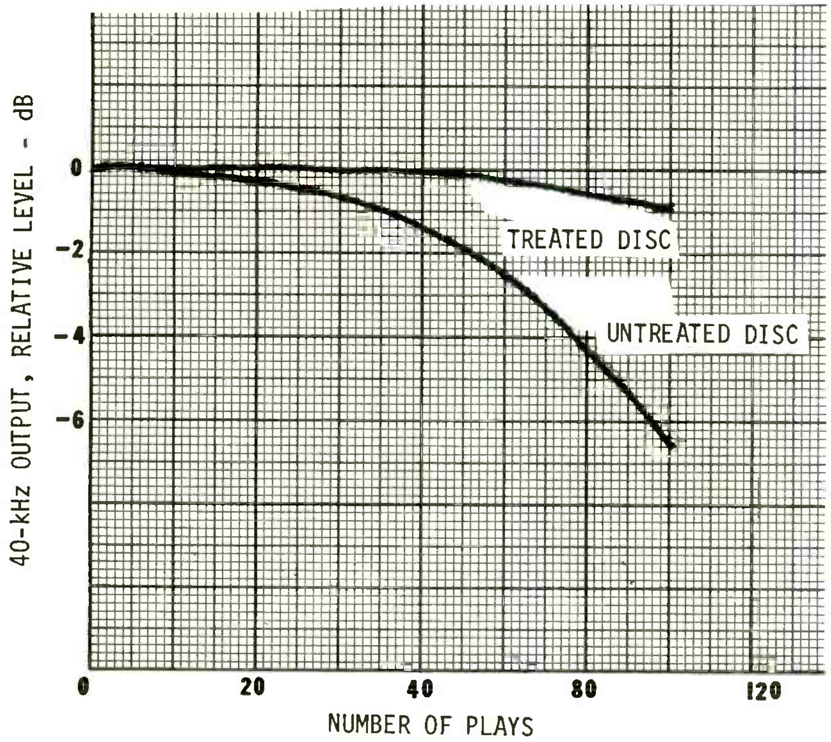


FIG. 2—EFFECT OF REPEATED PLAYINGS on recovered 40-kHz signal from treated and untreated discs.

second harmonic content (2 kHz) and is seen to be about 40 dB below the fundamental, or just under 1.0% (each division on the 'scope face is equal to 10 dB, vertically). The second harmonic distortion content, as we later learned, is a function of pickup arm and stylus mistracking and remained fairly constant during all the tests. The third harmonic distortion content (the next visible vertical "blip" to the right of the 2 kHz indication) is of greater interest in terms of the new product. Note, that for a "mint condition" record it is about 60 dB lower than the fundamental (0.1% distortion).

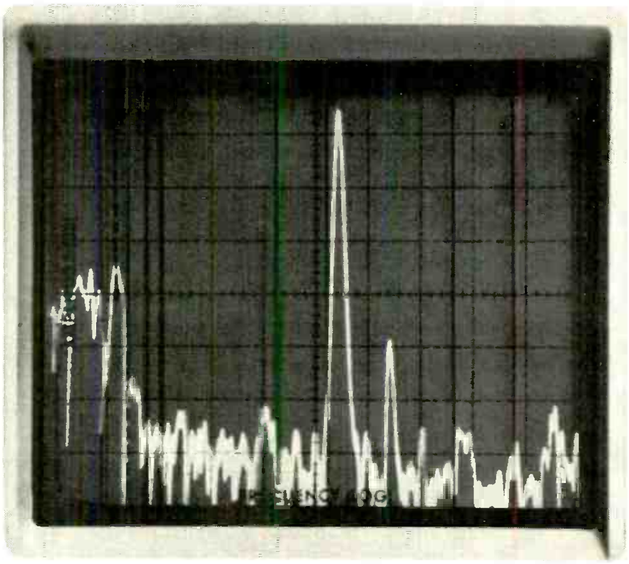
After the record was played 100 times, a new spectral photo was taken (Fig. 6) and this time the third harmonic content had increased to around 0.22%, a significant increase in distortion. Now for the payoff! A second disc was treated with *Sound Guard* and played 100 times. Again, a spectral analysis was made of the distortion content during the 101st playing and results are shown in Fig. 7. Notice that the third harmonic distortion content is exactly the same (some 60 dB below

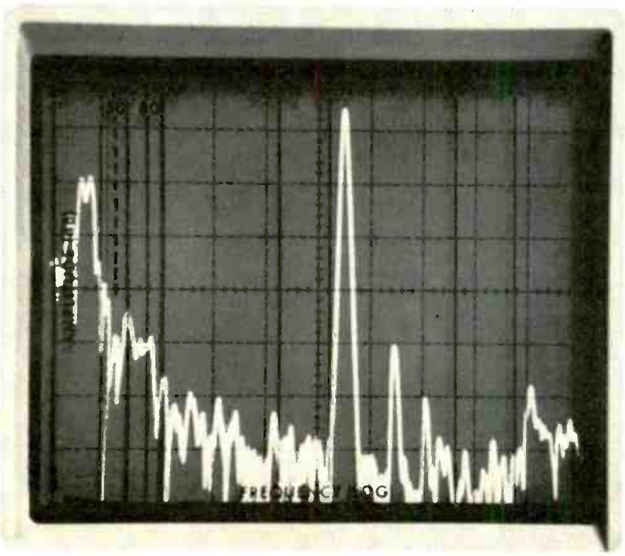
(continued on page 98)

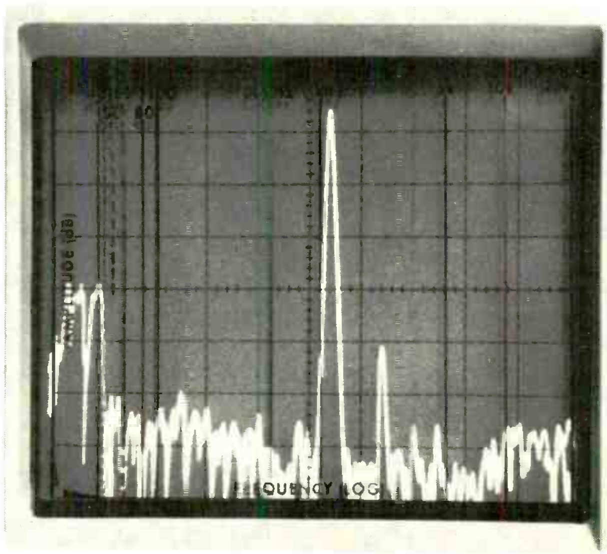
FIG. 5 (right)—SPECTRUM ANALYSIS of THD content produced when playing unit-condition test record.

FIG. 6 (below)—3RD HARMONIC DISTORTION content increases after 100 playings of untreated record.

FIG. 7 (below right)—3RD HARMONIC CONTENT after 100 playings of treated record is no greater than that observed with mint-condition disc. (See Fig. 5).







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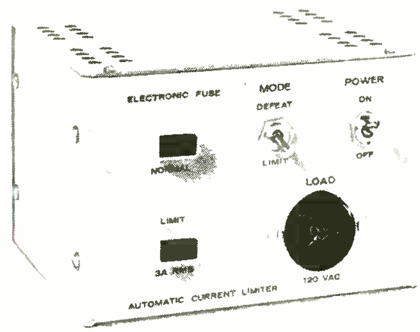


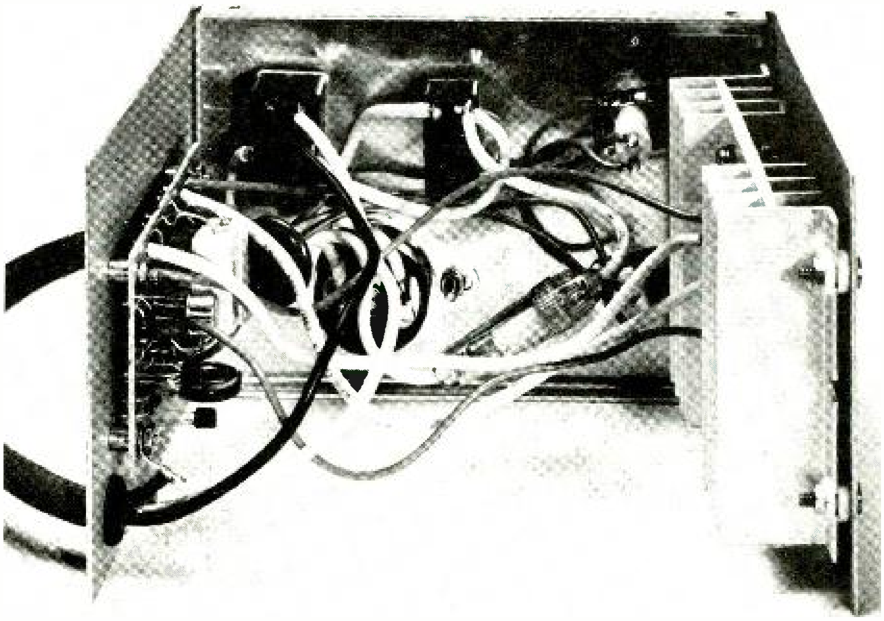
MITCHELL WAITE
and LARRY BROWN

BURNING UP A SET OF POWER TRANSISTORS can be an expensive and time consuming mistake. Such mistakes can easily occur by accidently changing the bias setting on an amplifier, shorting B+ to a transistor base, installing an NPN where a PNP goes, etc. How many times has your voltmeter probe slipped and shorted the B+ line? After you find a new fuse do you have the vague suspicion that the rectifier diodes got awful warm?

But what about that old metal and glass fuse, doesn't it at least provide some protection for the semiconductors? Unfortunately, not always. A 25¢ glass and metal fuse just takes too long to melt and open. By the time it does (5–15 ms), thermal run-away could of easily ran away with $40 worth of your solid-state components.

The obvious solution to these problems is a fast-acting power switch in the AC line that cuts off current if the equipment shorts out. The Electronic Fuse is such a device. It can reduce operating current to zero within *10 microseconds* of being tripped.

The device to be protected, say an audio amplifier, is simply plugged into the 3-wire AC receptacle on the front panel of the Electronic Fuse. If the device isn't shorted, the NORMAL lamp glows indicating current drain is not excessive. If a short occurs, the Electronic Fuse will trip and cut off the AC-line current. When this happens, the LIMIT lamp lights indicating the fuse is in the current limiting mode.



INSIDE VIEW of the Electronic Fuse.

How it works

Referring to the block diagram in Fig. 1, the load (equipment to be protected) is connected in *series* with the AC line and the Electronic Fuse. A full-wave bridge circuit is connected between the AC line and the equipment load, with a current-sensing device and power switch connected across the bridge. The bridge conducts on each half-cycle of the line voltage. This produces a rectified 120-Hz pulsating DC waveform that appears across a current-level sensor circuit and the collectors of a three-stage Darlington transistor power switch. A resistor divider network, in the emitter leg of the Darlington circuit, applies a portion of the 120-Hz waveform to the gate of the SCR. A transistor in the gate circuit of the SCR reduces temperature drift.

As long as the current drawn by the equipment is less than 3 amps RMS, the SCR is off. With the SCR off, the Darlington power switch conducts, effectively shorting out the bridge circuit and allowing full current to flow in the load. With normal operation, there is less then a 5V RMS drop across the fuse. The NORMAL lamp is energized by the voltage across the load socket, while the LIMIT lamp remains extinguished.

When the load draws excessive current, the SCR conducts and the 3-stage Darlington power switch stops conducting. This effectively opens the series connection between the line and the load. When this happens, the voltage across the equipment drops to zero, the NORMAL lamp goes off and the LIMIT lamp lights indicating the fuse is

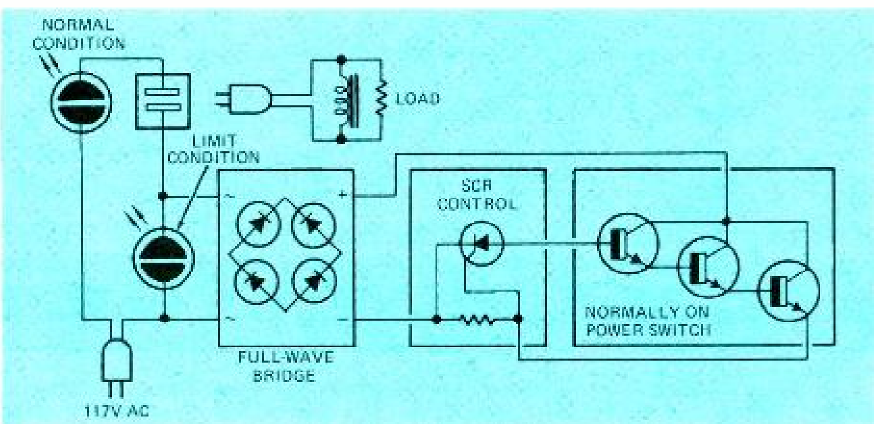


FIG. 1—ELECTRONIC FUSE is connected in series with the load to monitor the load current.

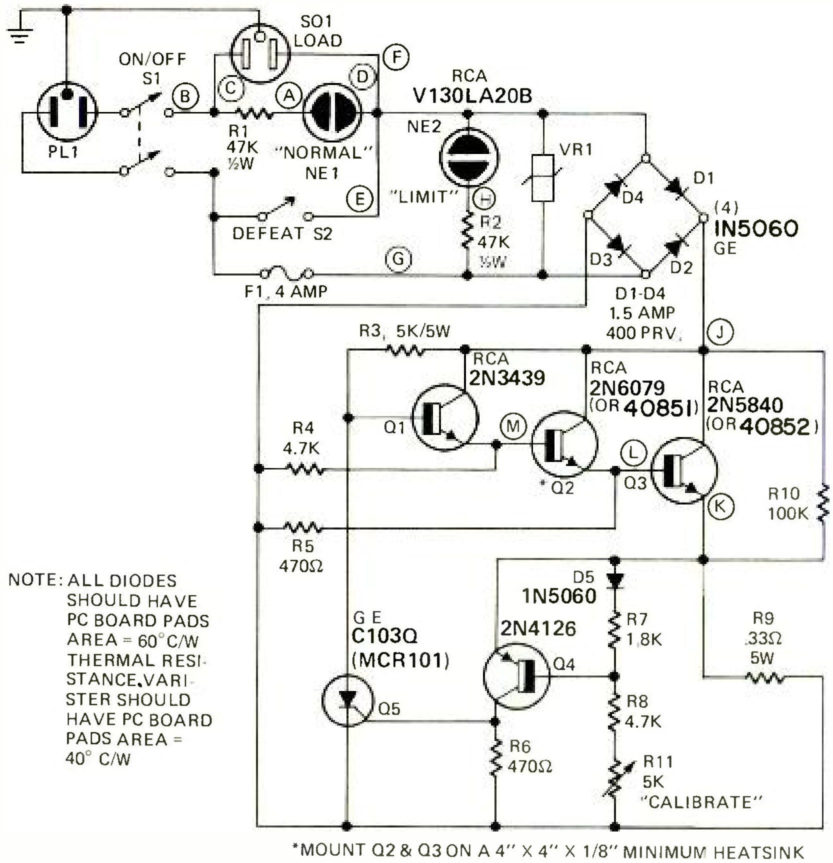


FIG. 2—ELECTRONIC FUSE trips when load draws more than 3-amps. The fuse can be adjusted to trip at lower values of load current by selecting different values of resistor R9.

PARTS LIST

R1, R2—47,000 ohm, ½-watt, 10%
R3—5000 ohm, 5-watt, 10%
R4, R8—4700 ohm, ¼-watt, 5%
R5, R6—470 ohms, ¼-watt, 5%
R7—1800 ohms, ¼-watt, 5%
R9—0.33 ohms, 5-watt, 10%
R10—100,000 ohm, ¼-watt, 5%
R11—5000 ohm trimmer
Q1—2N3439 transistor
Q2—2N6079 transistor
Q3—2N5840 transistor
Q4—2N4126 transistor
Q5—SCR (G-E C103Q or equal)
D1-D5—1N5060 diode
VR1—Varistor (G-E V130LA20B or equal)
S1—DPDT toggle switch, 3 amp
S2—SPST toggle switch, 3 amp
NE1, NE2—neon pilot lamps, panel mount
F1—4 amp in-line fuse
SO1—3-wire AC socket
PL1—3-wire AC plug and cord
Misc. PC board, heatsink for Q2 and Q3 (Thermalloy 6500B-6 or equal), Teflon spacers, mica insulators for transistors, hardware, etc.

Note: A complete kit of all parts including drilled and screened enclosure, drilled and solder-plated PC board, and all components is available from Cal Kit, P.O. Box 38, San Rafael, CA 94901. Order #EF-2, $63.95. Board only, order #EF-1, $4.95. All prices postpaid and insured. California residents add 6% sales tax.

in the current-limit mode. Note that the fuse monitors the current during each ½ cycle of the line current and proceeds to shut down on each ½ cycle as long as the over-current condition persists. In order to use the fuse with highly inductive equipment (such as tape recorders and phonographs), a varistor is inserted across the bridge. Its purpose is to damp out the large-amplitude voltage spike these loads can cause.

The Electronic Fuse triggers at 3 amps RMS or 4.25 amps peak when used with a resistive load. Most audio amplifiers with transformer/diode power supplies draw less than this amount and will not falsely trigger the fuse. Small black-and-white televisions as well as most test equipment will operate properly when connected to the fuse. However, large color TV's often will not work. This is because the power supply draws a large current pulse on each cycle that is greater than 4.25 amps peak. In general, wattage ratings are rather poor indicators of whether the fuse will trip falsely. This is due to the fact that wattage ratings are calculated on an RMS basis while the power supplies draw current in pulses. The acid test is to plug the unknown load in and see if it causes the fuse to trip. If it does, its too big.

A more subtle limitation of the Electronic Fuse is the possibility that a hefty charged filter capacitor in the

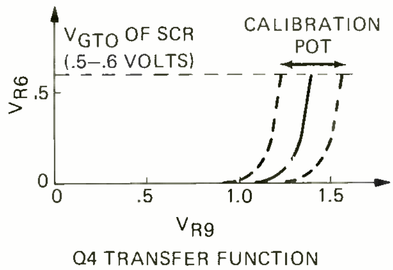


FIG. 3—TRANSFER CHARACTERISTIC of the temperature compensated inverter amplifier.

power supply of the equipment connected to the fuse can store enough energy to damage the transistors in spite of the fact that the fuse is limiting. The danger here will depend on the size of the charge on the filter capacitor, the type of transistor, the degree of heat-sinking, and the type of power-supply. Normally, filter capacitors are expensive components and a consumer product will generally use the smallest possible value consistent with good fil-

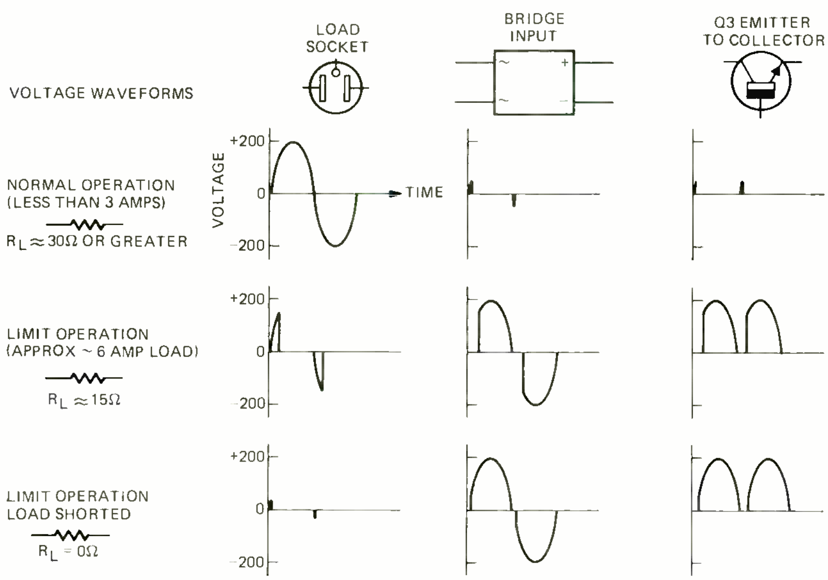


FIG. 4—VOLTAGE WAVEFORMS of the Electronic Fuse during normal operation, current-limit operation and when the load is shorted.

tering. But this isn't really such a big worry, because when a set of new transistors are installed, the amplifier is off and the filter capacitor is not charged. If a short exists, then as the equipment is turned on the fuse will trip long before the filter capacitor has time to charge. (The typical technician gets around this problem by using a Variac and an ammeter in series with the equipment load. The line voltage is increased and the ammeter is carefully monitored. A sudden rise in the current as the voltage is increased indicates a short. As quick as possible the technician switches the Variac off, but often he is too late and the damage is permanent.) In over 1½ years of service, the fuse has "saved" many replacement transistors from biting the dust. In most cases, devices that are normally on and develop shorts will be protected from damage.

The electronic fuse is not only restricted to high current (3 amp RMS) operation, it also may be used to protect low-current devices such as portable phonographs and low-power (5-15 watt) audio amplifiers. For example, to protect the components of a 120-volt, 12-watt amplifier, first calculate the current level that will trip the fuse. This is found from the equation:

$$I_{RMS} = P_{max}/120 \text{ volts}$$

For the example cited above; $I_{RMS} = 12/120 = 100$ mA. Now adjust the fuse to limit at this current by calculating the proper resistance of R9 (see Fig. 2):

$$R9 = 1/I_{RMS} \ (R9 \leqq 10 \text{ ohms})$$

For our example, $R9 = 1/.1 = 10$ ohms. To check the power rating for R9, use the formula:

$$P = 1.96/R9$$

The power consumption of R9 is: $P = 1.96/10 = .196$ watts. Thus R9 should be a ¼ watt resistor.

A DEFEAT switch on the front panel of the Electronic Fuse is used to override normal operation and apply line current directly to the equipment. This is useful when you are making a test and can't tolerate the 5-volt drop across the fuse or when you expect large current surges and don't want the fuse to limit.

Circuit description

When the Electronic Fuse isn't in the current-limit mode, current flows from the AC line, through the equipment load, the full-wave bridge rectifier, 3 stage Darlington and back to the AC line (see Fig. 2). Diodes D1 through D4 make up the bridge rectifier and conduct on alternate cycles of the 60-Hz line voltage. This produces a 120-Hz pulsating DC voltage that is applied across the collector and emitter of the Darlington circuit. Resistor R9, in the emitter leg of the final stage of the Darlington (Q3) develops a voltage waveform that follows the instantaneous load current.

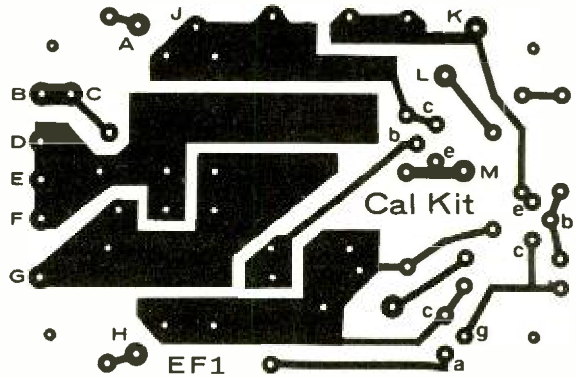


FIG. 5—FOIL PATTERN of printed circuit board.

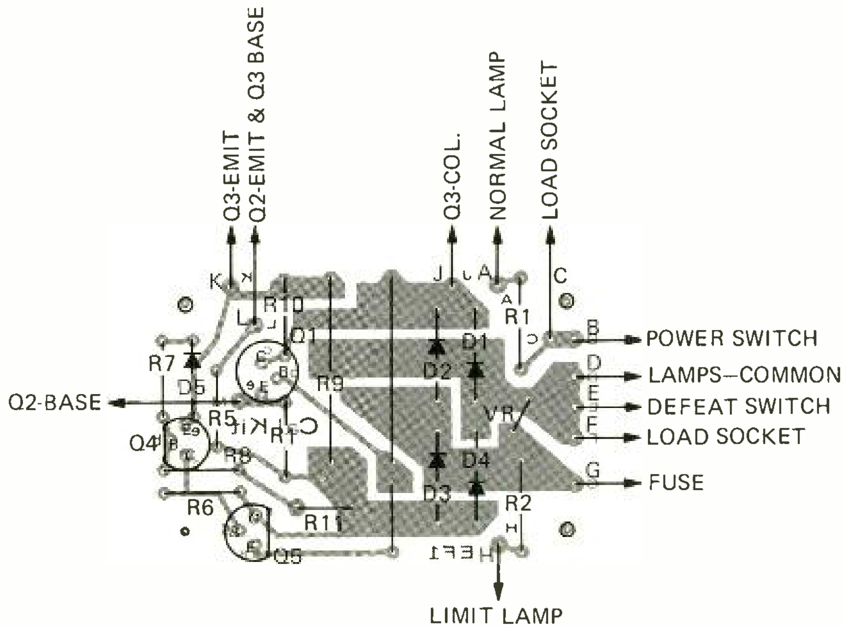


FIG. 6—COMPONENT PLACEMENT diagram for the Electronic fuse.

Transistor Q4 and its associated components make up a temperature-compensated inverter amplifier that senses when the voltage across R9 reaches the trip-point of the fuse and triggers SCR Q5. When the SCR conducts, the base voltage of Q1 is lowered, thus turning it off. This in turn shuts off Q2 and Q3. The voltage across R10 produces positive feedback that turns Q1, Q2, and Q3 off in under 10 microseconds.

Any inductive spike or transient due to the fast switching speeds is absorbed by varistor VR1. A varistor is similar in operation to two back-to-back Zener power diodes and produces excellent low-cost protection for the switching transistors. Trimmer R11 is used to adjust the trip point of the fuse by adjusting the threshold voltage of the temperature-compensated inverter amplifier. This stage may appear rather strange at first. What is odd is that V_{cc} for Q4 is developed from the same signal used to trigger Q4. The overall operation of Q4 is such that it functions like a diode with an adjustable offset. The transfer function of Q4 shows this more clearly (see Fig. 3).

The voltage waveforms of the Electronic Fuse shows what happens as the fuse goes from normal operation to the current-limiting condition. The voltage waveforms are shown in Fig. 4.

Construction

There are a number of ways to construct the circuit—Vector board, point-to-point wiring, etc. However, a printed circuit board (see Fig. 5) will allow the varistor and diodes to be heat-sinked by the copper foil. A finished board is available from the supplier shown in the parts list. The component placement for the printed-circuit board is shown in Fig. 6.

The diodes should be heat-sinked at 60° centigrade per watt and the varistor at 40° centigrade per watt. Mount the 5-watt resistors, R9 and R3, as far from transistors Q4 and Q5 as possible. Power transistors Q2 and Q3 are mounted on a sheet of 4 × 4 × ⅛"

(continued on page 91)

ASCII to BAUDOT

Build this converter to connect your TV Typewriter or Mark-8 Minicomputer to a teletypewriter for a hard-copy print-out

ROGER L. SMITH

MANY HAM RADIO OPERATORS HAVE PUT THE older model Teletype[R] and Kleinschmidt page printers to work for print-out (they call it RTTY). With the present increase of digital equipment in the homes of other electronic enthusiasts, the use of these older machines for "hard-copy" print-out has spread. The Kleinschmidt models TT100 and TT117 and Teletype models 32, 28, 26, 19, 15, etc., are presently available at prices from $20 up which puts them within reach of anyone.

Hobbyists have built micro-computers and TV Typewriters for their home use and many now want a printer of some type. Many Ham radio operators already own an older Teletype and have now added a TV Typewriter. However, they are faced with one big problem—the older printers operate from the 5-level BAUDOT code while newer equipment uses the ASCII code! So how can you hook an ASCII coded device to a BAUDOT machine? Microcomputer owners can write a program to handle the problem in software, but the conversion is not so simple for those without a computer. In addition, even the computer owners would like a conversion device to save them programming routines. For this reason, the circuit described here was made compatible with the Mark-8 Minicomputer (**Radio-Electronics**, July 1974) as well as both TV Typewriters (**Radio-Electronics**, Sept. 1973 and Feb. 1975), and most Ham gear.

Some of the ROM (*R*ead-*O*nly *M*emory) manufacturers explain how to convert from BAUDOT to ASCII by using a ROM and several NAND gates. Converting from ASCII to BAUDOT however, is much more complicated. The complication arises because the BAUDOT machines have two special function keys not required on ASCII equipment. These are the FIGURES key that shifts the mechanism to the upper case characters, and the LETTERS key that shifts the machine back to the lower case. Without these keys, the 5-bit code would be capable of handling only 32 characters and functions. Perhaps now you can see what would happen if ASCII encoded characters were fed to a BAUDOT machine. Your print-out would have to be all letters or all figures and punctuation since there would be no way to shift the machine.

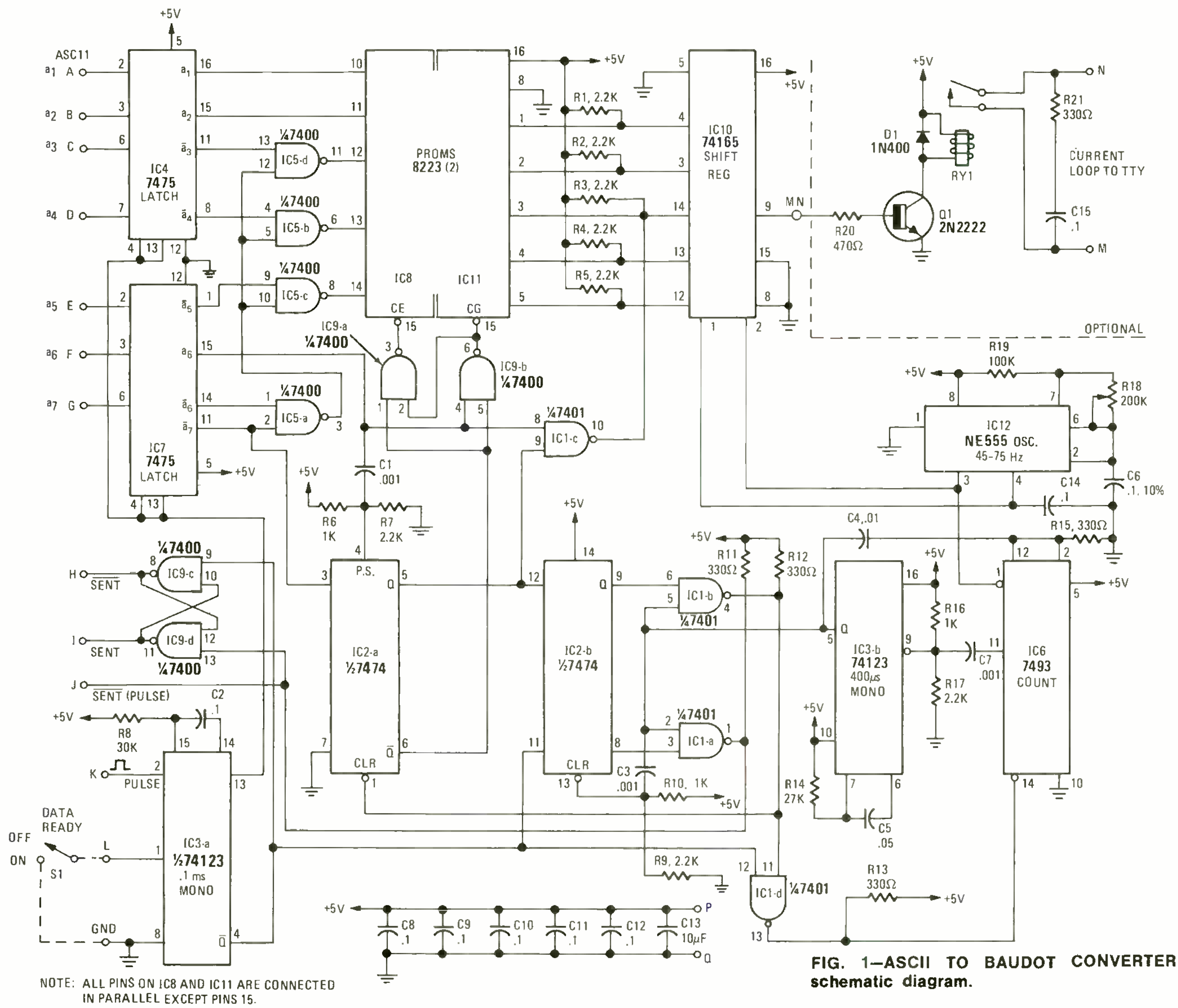


FIG. 1—ASCII TO BAUDOT CONVERTER schematic diagram.

One solution to the problem would be to look at each incoming ASCII character, determine whether it is upper or lower case, generate the correct shift character (FIGURES or LETTERS), and then generate the correct BAUDOT encoded character. As you can see, if you typed a whole page of letters, it would take twice as long as normal for the machine to type this page because each character would be preceded by a shift character.

A better solution is to detect when there is a *change* in the incoming ASCII characters (from one level to the other) and generate the proper shift character *only* when there is a change. The first circuit described here does just that and, of course it converts the ASCII character to Baudot thru the use of a special PROM (actually 2 PROM's for reasons of economy). You will have to program your own PROM's because ASCII to BAUDOT ROM's are not available.

ASCII to BAUDOT converter

Nearly all BAUDOT-encoded machines will operate at speeds from 60 to 100 words-per-minute (a word is 6.1 characters). This represents a transmission time of 163 to 100 milliseconds per character. This means our output oscillator which determines the transmission speed (IC12 in Fig. 1) must be tuned to match the machine speed to some frequency between 45 Hz. and 75 Hz. (more on this adjustment later). We can't set the ASCII input rate at 60 or 100 words-per-minute because occasionally one of the BAUDOT output characters will be one of the shifts not present in the ASCII input code. The solution is to use a "handshake" arrangement where the BAUDOT machine tells the ASCII device when it is ready to accept another character. This assumes the BAUDOT machine is the slower of the two.

The schematic diagram of the ASCII to BAUDOT converter is shown in Fig. 1. Monostable multivibrator IC3-a is enabled when switch S1 is placed in the ON position. Next, the input ASCII data is received along with a "data ready" pulse. The "data ready" pulse generates a 1-ms pulse from IC3-a pin 4 that stores the

PARTS LIST
ASCII TO BAUDOT CONVERTER

R1–R5, R7, R17—2200 ohms, ¼ watt
R6, R10, R16—1000 ohms, ¼ watt
R8—30,000 ohms, ¼ watt
R11, R12, R13, R14—330 ohms, ¼ watt
R14—27,000 ohms, ¼ watt
R18—200,000 ohms, trimmer
R19—100,000 ohms, ¼ watt
*R20—470 ohms, ½ watt
*R21—330 ohms, ½ watt
C1, C3, C7—.001 µF, disc
C2, C8-C12, C14—.1 µF, disc
C4—.01 µF, disc
C5—.05 µF, disc
C6—.1 µF, 10%, ceramic
C13—10 µF, 25 volt, electrolytic
*C15—.1 µF, disc
*D1—1N4001 diode
*Q1—2N2222 transistor
IC1—7401
IC2—7474
IC3—74123
IC4, IC7—7475
IC5, IC9—7400
IC6—7493
IC8, IC11—8223 32 × 8 PROM
IC10—74165
IC12—555 timer
*RY1—1A5AH relay (Electronic Applications, 2213 Edwards Ave., South El Monte, CA 91733)
S1—SPST switch
*Optional parts
See Connection Details for listing of additional parts

The following items are available from Southwest Technical Products Co., 219 W. Rhapsody, San Antonio, TX 78216:

A kit of all basic parts (order additional and optional parts separately) for the ASCII to BAUDOT Converter for $24.50 postpaid.

Etched and drilled printed circuit board for the ASCII To BAUDOT Converter for $4.35.

TABLE I
TRUTH TABLE FOR 8223 PROM—TO BE USED AS IC8
Check that the symbols given here agree with your machine

WORD	INPUTS						OUTPUTS								SYMBOL
	A_4	A_3	A_2	A_1	A_0	ENABLE	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0	
0	0	0	0	0	0	0									Null
1	0	0	0	0	1	0							1	1	A
2	0	0	0	1	0	0				1	1			1	B
3	0	0	0	1	1	0					1	1	1		C
4	0	0	1	0	0	0					1			1	D
5	0	0	1	0	1	0								1	E
6	0	0	1	1	0	0					1	1		1	F
7	0	0	1	1	1	0				1	1		1		G
8	0	1	0	0	0	0				1		1			H
9	0	1	0	0	1	0						1	1		I
10	0	1	0	1	0	0					1		1	1	J
11	0	1	0	1	1	0					1	1	1	1	K
12	0	1	1	0	0	0				1			1		L
13	0	1	1	0	1	0				1	1	1			M
14	0	1	1	1	0	0					1	1			N
15	0	1	1	1	1	0				1	1				O
16	1	0	0	0	0	0				1		1	1		P
17	1	0	0	0	1	0				1		1	1	1	Q
18	1	0	0	1	0	0					1		1		R
19	1	0	0	1	1	0						1		1	S
20	1	0	1	0	0	0				1					T
21	1	0	1	0	1	0						1	1	1	U
22	1	0	1	1	0	0				1	1	1	1		V
23	1	0	1	1	1	0				1			1	1	W
24	1	1	0	0	0	0				1	1	1		1	X
25	1	1	0	0	1	0				1		1		1	Y
26	1	1	0	1	0	0				1				1	Z
27	1	1	0	1	1	0									Null
28	1	1	1	0	0	0									Null
29	1	1	1	0	1	0					1				CR
30	1	1	1	1	0	0							1		LF
31	1	1	1	1	1	0						1		1	Bell
ALL	x	x	x	x	x	1	1	1	1	1	1	1	1	1	

ASCII character in IC4 and IC7.

If bit-6 or bit-7 of the ASCII character are different than these bits of the previous character, then flip-flop IC2-a is set. This disables the outputs of the PROM's (IC8 and IC11) causing them to go high (BAUDOT 11111). If input ASCII bit-6 was a "0" (indicating a LETTER character), then gate IC1-c is disabled and all BAUDOT output bits are "1". If input ASCII bit-6 was a "1" (indicating a FIGURE), then IC1-c is enabled and BAUDOT bit-3 becomes a "0". Therefore, we have generated either the BAUDOT LETTER shift-character (11111) or the FIGURE shift-character (11011).

After the BAUDOT shift character has been generated, the output of IC3-a will return to a logic "1", storing the contents of flip-flop IC2-a into IC2-b and setting a single flip-flop in IC6 (pin 12 goes high). Counter IC6 contains three additional flip-flops connected to count from 0 thru 7, which is used to count the BAUDOT output shift-register clock pulses and stop oscillator IC12 after 7½ bits have been shifted out. When IC6 pin-12 goes high, shift-register IC10 changes from the "load" to the "shift" mode and oscillator IC12 clocks IC10 and IC6.

After the BAUDOT shift-character has been clocked out, single-shot IC3-b is triggered by counter IC6. Single-shot IC3-b clears IC6 to "0", stopping oscillator IC12 and returning shift-register IC10 to the "load" mode. Flip-flop IC2-a is cleared by single-shot IC3-b via gate IC1-b which enables PROM's IC8 or IC11. At the end of the 400-μs pulse from IC3-b, gates IC1-b and IC1-d set the single flip-flop in IC6 and the BAUDOT character from IC8 or IC11 is clocked out of the shift register IC10. At the end of the character output, IC3-b generates another 400-μs pulse that passes thru gate IC1-a generating the "sent" signal for the next character. Note that three different "sent" signals are available. If the input device is a computer, this "sent" signal could serve as the "interrupt" signal.

If the next character received at the input is also a LETTER (or FIGURE as the case might be), then flip-flop IC2-a will not be set and the only character sent to the output shift register IC10 will be the BAUDOT-coded character generated by the PROM's. The only time two BAUDOT characters (a shift and a print character) are transmitted for one ASCII input character is when the input changes from a LETTER to a FIGURE or vice versa. Therefore, if you printed nothing but LETTERS, the BAUDOT and ASCII devices would operate at the same number of characters-per-second.

Now that we have the circuit operating properly, all that remains is to determine the truth tables for the PROM's. If we did not require use of control functions (carriage return, line feed, bell), we could get by with a 6-bit ASCII input which would match the 6 input PROM's (refer to Tables 1 and 2). However, we need the controls and therefore, the 7th bit. The easiest way (fewest IC's) to handle the problem is to add NAND gate $\overline{IC5}$-a to detect when both bits $\overline{a6}$ and $\overline{a7}$ are "1" (a control function) and then change the PROM address to an unused location to read out the stored BAUDOT codes for CR, LF and BELL. NAND gates IC5-b, IC5-c and IC5-d change the address as desired to words 29, 30 and 31 of PROM IC8. Note that these words are normally ASCII characters not found on BAUDOT machines. Hopefully, they will not be in the received message. Two 8223 PROM's were chosen not only for their combined 64 word capacity and *low price*, but also because they can field-programmed.

Now let's look at the output section. The output of shift register IC10 (pin 9) is normally high, so transistor Q1 is normally conducting and the relay contacts are closed. This means the magnet coil in the Teletype is energized, provided it has some source of power for the 20 to 60 mA normally used with these machines. Thus the circuit is in the normal "mark" mode and there is no output from the Teletype.

Adjustments

Assuming you have your BAUDOT-coded machine operating properly, here is how to adjust the ASCII to BAUDOT converter board. First, be sure your machine is set for 60, 66, 75 or 100 words-per-minute. Remove PROM's IC8 and IC11 from the board and ground pin 5 (bit 5) on the IC8 socket. Connect the "sent" (pin [illegible]) and "data ready" (pin K) lines together. Place switch S1 to the ON position. The output should consist of a start bit ("0"), four mark bits ("1"), and a space ("0") bit. This is the BAUDOT

TABLE II

TRUTH TABLE FOR 8223 PROM—TO BE USED AS IC11

Check that the symbols given here agree with your machine

WORD	INPUTS						OUTPUTS								SYMBOL
	A_4	A_3	A_2	A_1	A_0	ENABLE	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0	
0	0	0	0	0	0	0						1			Space
1	0	0	0	0	1	0					1	1		1	!
2	0	0	0	1	0	0				1				1	"
3	0	0	0	1	1	0				1		1			#
4	0	0	1	0	0	0					1			1	$
5	0	0	1	0	1	0									Null
6	0	0	1	1	0	0				1	1		1		&
7	0	0	1	1	1	0					1		1	1	'
8	0	1	0	0	0	0					1	1	1	1	(
9	0	1	0	0	1	0				1			1		)
10	0	1	0	1	0	0									Null
11	0	1	0	1	1	0									Null
12	0	1	1	0	0	0					1	1			,
13	0	1	1	0	1	0							1	1	-
14	0	1	1	1	0	0				1	1	1			.
15	0	1	1	1	1	0				1	1	1		1	/
16	1	0	0	0	0	0				1		1	1		0
17	1	0	0	0	1	0				1		1	1	1	1
18	1	0	0	1	0	0				1			1	1	2
19	1	0	0	1	1	0								1	3
20	1	0	1	0	0	0					1		1		4
21	1	0	1	0	1	0				1					5
22	1	0	1	1	0	0				1		1		1	6
23	1	0	1	1	1	0						1	1	1	7
24	1	1	0	0	0	0						1	1		8
25	1	1	0	0	1	0				1	1				9
26	1	1	0	1	0	0					1	[illegible]	[illegible]		[illegible]
27	[illegible]	[illegible]	0	1	[illegible]	0				[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
28	[illegible]	[illegible]	1	0	0	0									Null
29	1	[illegible]	[illegible]	0	[illegible]	0									Null
30	1	[illegible]	1	[illegible]	0	0									Null
31	1	[illegible]	1	1	[illegible]	0				[illegible]	[illegible]			[illegible]	?
ALL	X	X	X	X	X	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

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letter "K" or "(" depending on the shift position. The 200K trimmer (R18) between pins 6 & 7 of IC12 should be set to within 20 K ohms of its minimum position and then slowly increased in value (slows down oscillator) until the machine prints out a "K" or "(". Keep on turning until you get a "Q" or a "1", then back off to a point midway between the misprints.

Of course, if you have a calibrated scope or frequency counter, you can use that to adjust the oscillator. The frequencies are 45.5, 50, 57 or 74 Hz (60, 66, 75 or 100 words-per-minute, respectively). Once you get the oscillator tuned properly, remove the grounds from IC8, replace the PROMS, hook up the ASCII device and you're in business. Refer Fig. 3 on page 00 for hookup of your particular device along with PC board patterns for this unit.

It is a good idea any time you begin to use your conversion board and machine for print-out to start the transmission with a "space" (treated as a FIGURE on this board) followed by a letter. This puts the machine in the proper mode. Also, with the TV Typewriter, it will put the memory in the "protect" mode. Note that since you are now storing the control characters (CR, LF and BELL), that these will appear on the TV screen as letters. Control character CR will be a "M", LF will be a "J" and BELL will be a "G". *If your machine can be set up for automatic CR and LF, you may be able to avoid storing them.*

Coming: In a future issue of **Radio-Electronics** we will present construction plans for a BAUDOT to ASCII converter circuit. This converter will enable you to use your BAUDOT Teletype (or Kleinschmidt, or Creed) machine as an input device. If you are a Ham operator, you can connect your receiver to your TV Typewriter. This will enable you to receive and display BAUDOT RTTY transmissions on your TV Typewriter. **R-E**

CONNECTION OF ASCII TO BAUDOT CONVERTER

TV Typewriter I

*Add a new 2524 IC to the Memory board. Piggyback the new 2524 on top of IC4 by first bending pins 2 and 6 straight out from the new IC. Pinch the remaining pins together slightly (1 toward 8, 4 toward 5 etc.), so the IC will make physical contact with IC4's pins and only pins 4 & 8 will need soldering (just a very light touch). Tack on a 2.2K resistor from pin 6 to common of R1 through R5 (+5V) and a 6.8K from pin 2 to bus on pin 4 (−5V). Add jumper wires from pin 6 of IC to pin 2 on PC board and from pin 2 of IC to pin 46 of board.

*Also on the memory board, cut the foil to pin 52 of the board and add a SPST switch (see Fig. 3-a).

On the Timing board, cut the foil connection to pin 23. The REPEAT switch now becomes the TRANSMIT-NORMAL switch.

Add Molex pins to required pins on edge of board and add jumpers as shown in Fig. 3-a.

Add a 74123 dual monostable, resistors and capacitors (see Fig. 3-a) at the spare IC location at the top of the board. Connect the output from pin 5 to pin K on the board.

Put TV Typewriter I in "Memory Protect" mode when transmitting out.

TV Typewriter II (CT-1024)

You must use the Screen Read (CT-E) and Cursor boards.

*Add a 2102 IC to the memory board. Piggyback the IC to one of the other 2102's connecting all but pins 11 & 12 in parallel. Connect pin 11 of 2102 IC to P7-10 and pin 12 of 2102 IC to P8-14. On Main board, add a pin to J8-14 and cut a break in foil between J8-14 and IC36-5. Also, add a wire from J7-10 to J4-4.

*Cut a break in foil coming from IC36 pin 3 (between IC36 and IC37 on top of board). Connect a SPST switch to each end of cut foil. This will be the STORE switch.

Add a Molex connector (09-52-3151) to board (see Fig. 3-b) and pins to J2. Add jumpers and capacitor and resistor as shown in Fig. 3-b.

When operating, close switch S1 (connected to L), put SCREEN READ switch to ON and pulse pin J9-9.

Mark 8 Minicomputer

Connect output port bits 0 through 6 to pins A through G.

Connect output latch (or bit-8 or a "flag" bit) to pin K.

Connect pin I to Interrupt input, or use "timed" software.

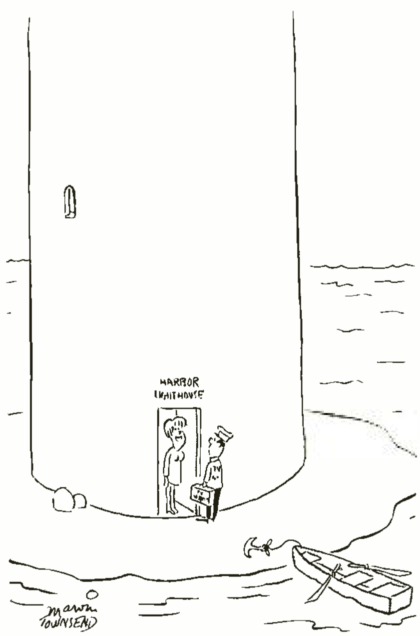
Ham radio connections

Connections will vary, but check to see that power is properly connected (+5V) to pin P, GND. to pin Q.

*Do not incorporate this step if you can set the margin on your teletype for 32 spaces and have automatic CR and LF.

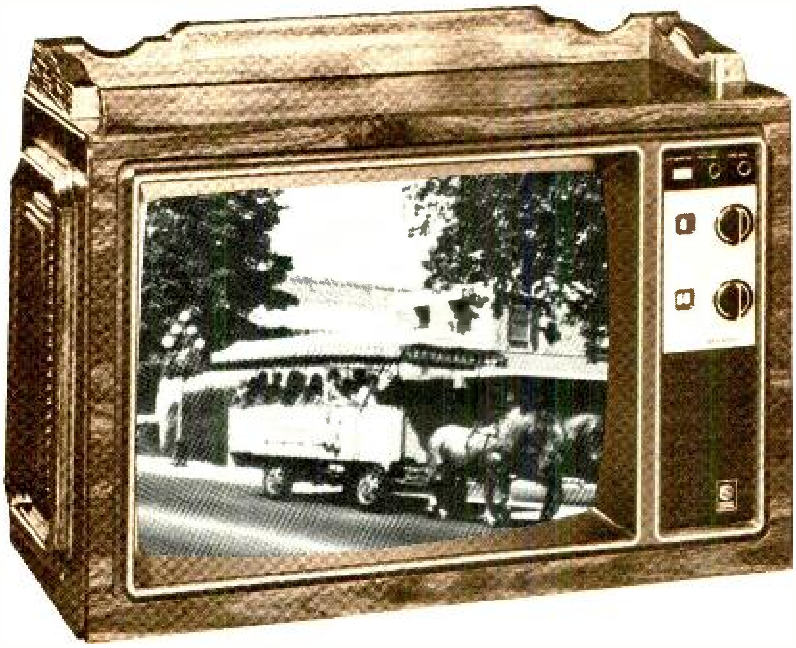
TABLE III

SYMBOL	ASCII bits 7 6 5 4 3 2 1	BAUDOT 5 4 3 2 1	SYMBOL	ASCII bits 7 6 5 4 3 2 1	BAUDOT 5 4 3 2 1
@	1 0 0 0 0 0 0		Space	0 1 0 0 0 0 0	0 0 1 0 0
A	1 0 0 0 0 0 1	0 0 0 1 1	!	0 1 0 0 0 0 1	0 1 1 0 1
B	1 0 0 0 0 1 0	1 1 0 0 1	"	0 1 0 0 0 1 0	1 0 0 0 1
C	1 0 0 0 0 1 1	0 1 1 1 0	#	0 1 0 0 0 1 1	1 0 1 0 0
D	1 0 0 0 1 0 0	0 1 0 0 1	$	0 1 0 0 1 0 0	0 1 0 0 1
E	1 0 0 0 1 0 1	0 0 0 0 1	%	0 1 0 0 1 0 1	
F	1 0 0 0 1 1 0	0 1 1 0 1	&	0 1 0 0 1 1 0	1 1 0 1 0
G	1 0 0 0 1 1 1	1 1 0 1 0	'	0 1 0 0 1 1 1	0 1 0 1 1
H	1 0 0 1 0 0 0	1 0 1 0 0	(	0 1 0 1 0 0 0	0 1 1 1 1
I	1 0 0 1 0 0 1	0 0 1 1 0	)	0 1 0 1 0 0 1	1 0 0 1 0
J	1 0 0 1 0 1 0	0 1 0 1 1	*	0 1 0 1 0 1 0	
K	1 0 0 1 0 1 1	0 1 1 1 1	+	0 1 0 1 0 1 1	
L	1 0 0 1 1 0 0	1 0 0 1 0	,	0 1 0 1 1 0 0	0 1 1 0 0
M	1 0 0 1 1 0 1	1 1 1 0 0	-	0 1 0 1 1 0 1	0 0 0 1 1
N	1 0 0 1 1 1 0	0 1 1 0 0	.	0 1 0 1 1 1 0	1 1 1 0 0
O	1 0 0 1 1 1 1	1 1 0 0 0	/	0 1 0 1 1 1 1	1 1 1 0 1
P	1 0 1 0 0 0 0	1 0 1 1 0	0	0 1 1 0 0 0 0	1 0 1 1 0
Q	1 0 1 0 0 0 1	1 0 1 1 1	1	0 1 1 0 0 0 1	1 0 1 1 1
R	1 0 1 0 0 1 0	0 1 0 1 0	2	0 1 1 0 0 1 0	1 0 0 1 1
S	1 0 1 0 0 1 1	0 0 1 0 1	3	0 1 1 0 0 1 1	0 0 0 0 1
T	1 0 1 0 1 0 0	1 0 0 0 0	4	0 1 1 0 1 0 0	0 1 0 1 0
U	1 0 1 0 1 0 1	0 0 1 1 1	5	0 1 1 0 1 0 1	1 0 0 0 0
V	1 0 1 0 1 1 0	1 1 1 1 0	6	0 1 1 0 1 1 0	1 0 1 0 1
W	1 0 1 0 1 1 1	1 0 0 1 1	7	0 1 1 0 1 1 1	0 0 1 1 1
X	1 0 1 1 0 0 0	1 1 1 0 1	8	0 1 1 1 0 0 0	0 0 1 1 0
Y	1 0 1 1 0 0 1	1 0 1 0 1	9	0 1 1 1 0 0 1	1 1 0 0 0
Z	1 0 1 1 0 1 0	1 0 0 0 1	:	0 1 1 1 0 1 0	0 1 1 1 0
[	1 0 1 1 0 1 1		;	0 1 1 1 0 1 1	1 1 1 1 0
\	1 0 1 1 1 0 0		<	0 1 1 1 1 0 0	
]	1 0 1 1 1 0 1		=	0 1 1 1 1 0 1	
^	1 0 1 1 1 1 0		>	0 1 1 1 1 1 0	
_	1 0 1 1 1 1 1		?	0 1 1 1 1 1 1	1 1 0 0 1
CR	0 0 0 1 1 0 1	0 1 0 0-0	Letter		1 1 1 1 1
LF	0 0 0 1 0 1 0	0 0 0 1 0	Figure		1 1 0 1 1
Bell	0 0 0 0 1 1 1	0 0 1 0 1			



"The jokes on me! I forgot to plug it back in after I cleaned behind it."

Evaluating Color TV Receivers



Here are a few tips on evaluating a color television receiver's overall performance and localizing the possible trouble-causing circuits

STAN PRENTISS

WHEN WE CAN SAY NICE THINGS ABOUT a color television receiver manufacturer and also offer some good tips on color TV evaluation with this manufacturer's newest TV receiver, then it's double pleasure indeed. The set we'll use is a brand new 1976 19YC series having G-E's special Quadline™ (in-line) black matrix color picture tube, 4 dynamic and 4 static convergence controls, 7 simple pullout modules, and 5 standardized integrated circuits.

EIA's resolution pattern

For studio use, closed circuit applications, and general "eye-ball" evaluations, the EIA (RETMA) Resolution Chart (Fig. 1) is excellent—as far as it goes. For instance, you can readily look at all 10 shades of gray (gray scale) and determine the horizontal and vertical resolution on either 400-line or 800-line scales. There are also outer circles for determining corner resolution. With these you can count up to 600 lines and evaluate such critical factors as streaking, ringing, interlace, shading, scan linearity and aspect ratio. The only problem with this pattern is that it is set up for black and white and the monochrome portion of color projections, but has nothing to do with color. In addition, unless you have some means of getting it to your television receiver, it's useless.

True, if you believe you have a receiver that's flat to 4 MHz, then the number of distinct lines divided by the horizontal resolution factor will tell you the frequency: F = 200 lines/80 = 2.5 MHz—with 80 being the horizontal resolution factor. Very good, but with no transmitter or broadcaster handy, how can you see the pattern? Obviously, you can't, and here is where a somewhat different but readily available method will help anyone evaluate the luminance and chroma sections of any color set in literally minutes. And all the equipment you'll need is a good triggered sweep oscilloscope and a clean color bar generator.

The VITS signal

VITS stands for *V*ertical *I*nterval *T*est *S*ignal (Fig. 2) and is used by broadcasters as a gain check at certain frequencies, amplitude vs. frequency response, black or white compression and differential phase/gain (staircase). It is also used to check the frequency response below 3 MHz and group envelope delay (2T sine^2 pulse), amplitude-frequency response errors above 3 MHz (12T sine^2 pulse), white level, sync compression or expansion, and a check on ringing (window signal). The multiburst portion of the VITS signal is transmitted on line 17, field 1 of the vertical signal (262.5 lines). Color bars can be shown on line 17, field 2 while a composite VITS may be transmitted in field 1, line 18. All three patterns are shown in Fig. 2.

NTSC color bar signal

An aid in evaluating television receivers is the NTSC color pattern that's visible in the early morning before programming begins. This is a locally generated station signal, that amounts to six color-bars (Fig. 3). The pattern begins with yellow and progresses through cyan, green, magenta, red and blue with −I and +Q following burst and cyan. This signal is displayed on your oscilloscope at whatever level the receiver's video detector demodulates the composite video waveform. Individual details of the waveform are shown in Fig. 3 with the relative amplitude levels. The oscilloscope display (Fig. 4) shows superimposed fields for color bars and I and Q signals between horizontal blanking and burst. The signal is used at the studio transmitter for equipment adjustments such as cameras, color monitors, etc., and a good indication of white reference and color information amplitudes.

Vector pattern

The vector pattern shown in Fig. 5-a is produced by a gated rainbow generator. Most generators drop a horizontal line even before the oscillator frequency is established and develop a sinusoidal signal of 3.563812 MHz, just 15,734 Hz below the transmitted subcarrier signal. This sinusoidal signal is chopped by a separate 189 kHz oscillator to produce 12 gatings during each 63.5 μs line. When processed through a television receiver, however, there are but 11 color bars visible after the video detector and first chroma bandpass amplifier. One bar becomes color sync, then only 10 are seen after horizontal blanking, which usually takes place in the second bandpass amplifier. Ten color bars, then, actually appear at the inputs to the receiver's picture tube.

Note we specified *picture tube*, and not the output of the demodulators. Signals prior to the pix tube are often inadequately filtered and considerable hash is present. An oscilloscope connected to such test points would produce an unusable, smeary pattern—just the same as a badly gating color bar generator. A drawing of a color bar pattern showing the usual R − Y and B − Y reference patterns from which it is derived is shown in Fig. 5-b.

Naturally, such a pattern can be used for more than simple receiver evaluation. You can do excellent chroma alignments and troubleshoot color sections just by the shape and amplitude of the pattern—a subject you may want discussed in a future article. In the meantime, let's begin putting the VITS and color bars in perspective so the overall checkout can take shape.

Receiver evaluation

Fields 1 and 2 of the color bars are superimposed in Fig. 4 to offer an idea of their appearance as a composite signal. Note that the yellow and cyan bars are at nearly *equal amplitude* levels as it should, and that the green bar is at the relative amplitude level it should be. Also, the red and blue bars are just above the burst level where it should be. You will note few transients and clean color bar reproduction throughout. The waveform shows very clean −I and +Q signals that are compressed to 0.5 MHz by the TV receiver, phase shifted about 33 degrees, and demodulated on the R − Y and B − Y

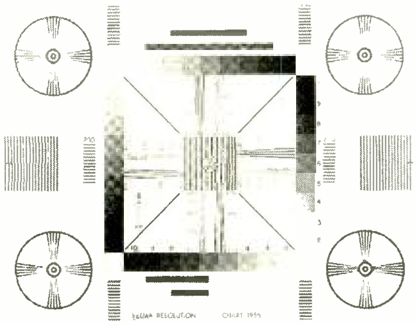


FIG. 1—EIA (RETMA) TEST PATTERN used basically for studio camera adjustments.

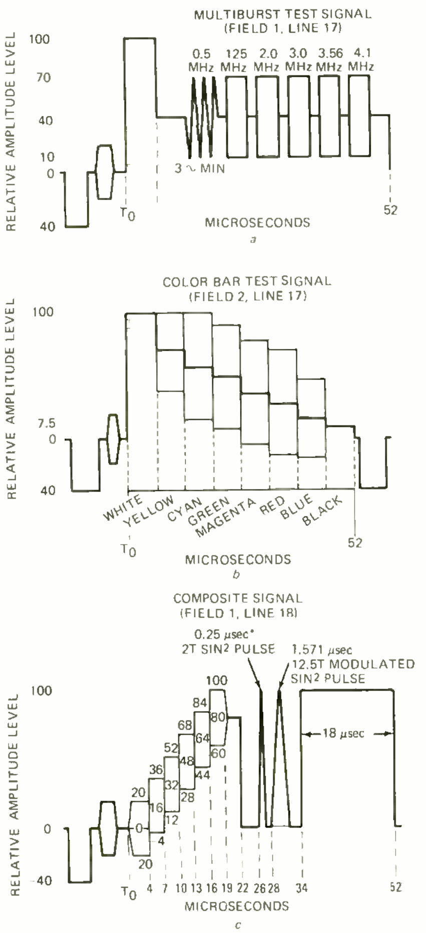


FIG. 2—VITS TEST PATTERNS are transmitted on lines 17 and 18. Multiburst is shown in a, color-bar test signal in shown in b, and the composite signal is shown in c.

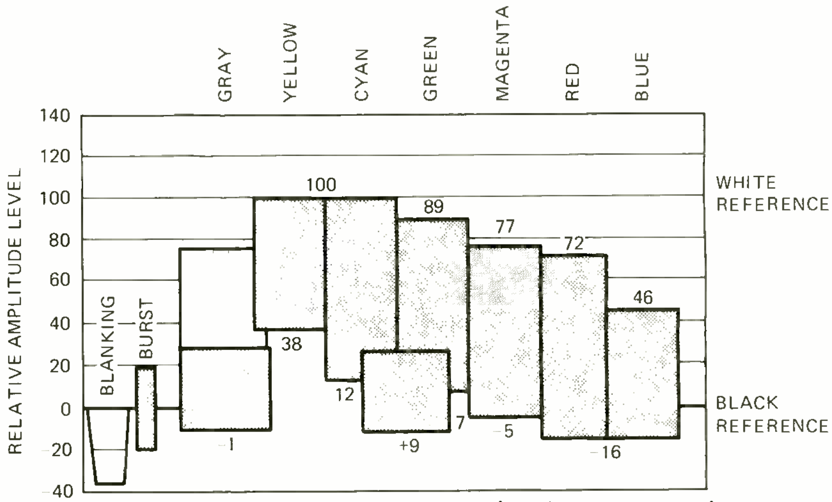


FIG. 3—NTSC COLOR-BAR PATTERN is usually transmitted in the early morning hours.

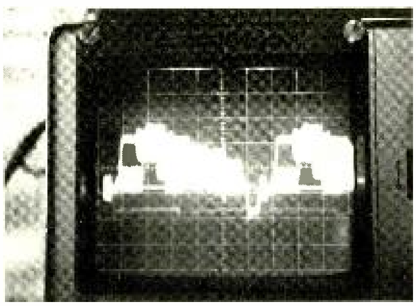
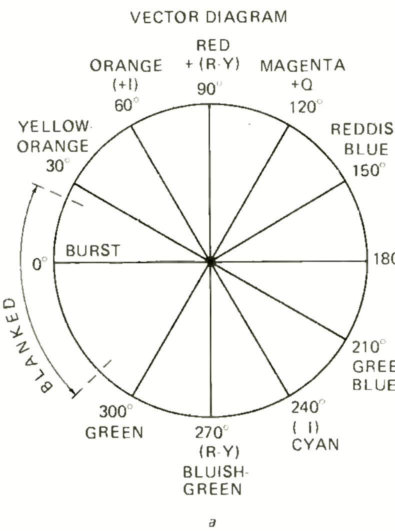


FIG. 4—NTSC COLOR-BAR SIGNAL.



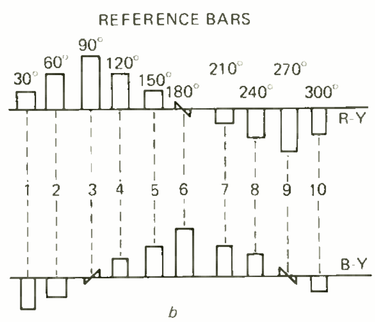


FIG. 5—VECTOR DIAGRAM is shown in a, and accompanying reference bars are shown in b.

axis. Burst amplitude and placement is excellent since it must occur immediately following the 5-μs horizontal sync-pulse interval. The pattern, of course, may be broadcast differently by other transmitters, but here at least is one good version and a worthwhile working example.

The VITS signals are our most important evaluation means, however, you can't always be sure of seeing two separate fields even on very expensive oscilloscopes. So when we show both multiburst and staircase as part of a single signal (see Fig. 6, upper trace),

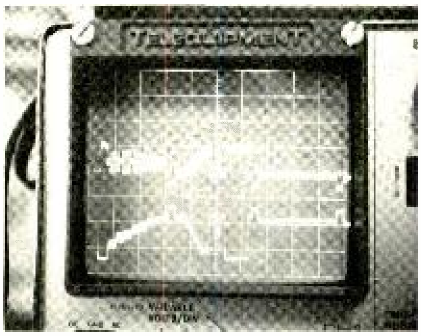


FIG. 6—MULTIBURST AND STAIRCASE waveform shown in upper trace appears at the output of the video detector. Lower trace was obtained from a point following luminance delay line and shows signal deterioration.

don't misinterpret this as a product of a single horizontal scan line—it isn't. Our oscilloscope—and probably yours, too—can't often selectively trigger on individual lines at these frequencies and combine two fields as a single frame. The time base we're working with amounts to 20 μs-per-division, so the scope is actually looking at at least three fields. The second trace (Fig. 6, lower trace) was taken at a point following the luminance delay line with all the subsequent signal deterioration, and can't make up its mind whether to show line 18, 19, or whatever. Therefore, we'll work with the top trace in Fig. 6 exclusively since its reference is an emitter follower transistor connected directly to the receiver's diode envelope detector.

In using the VITS pattern, beware of your receiver's fine tuning. All VITS may not be transmitted exactly by the book and your antenna could also have possible problems. General signal evaluation with a look at other channels, however, will usually confirm or reject either of these possibilities. What this particular multiburst-composite signal (Fig. 6, upper trace) shows is:

- Slight intial gain toward higher frequencies.
- Gradual roundoff of higher frequencies after 1.25 MHz.
- Excellent IF bandpass to 3.6 MHz and slightly beyond.
- Properly modulated 12T sine^2 pulse.
- Linear modulated staircase without differential phase errors.
- No ringing, but possibly a little noise.
- Adequate burst amplitude and blanking.

Next is the gated rainbow pattern shown in Fig. 7 that is produced by a color-bar generator. This signal is connected to the receiver's antenna terminals. Oscilloscope connections are made to the picture tube red and blue

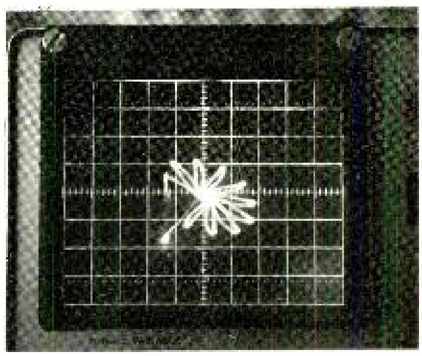


FIG. 7—VECTOR PATTERN obtained from a gated color-bar generator.

grids or cathodes. The oscilloscope is set for between 20 and 50 volts-per-division depending on whether the receiver is solid-state, tube or hybrid.

The waveform shown in Fig. 7 is symmetrical, oval, and consists of 10 color bars with all the luminance information removed from the signal. The symmetry of the pattern, lack of crossovers among the various "petals," fast rise and fall times of the 3rd R—Y petal, and no loss of amplitude in the R—Y (top) and B—Y (right), will tell you much about the color design and operation of the receiver. There is a little phase twisting of the pattern toward the right, part of the 1st bar is missing—just a little blue overblanking that doesn't show in the picture, there are no crossovers and the angle of demodulation between R—Y and B—Y amounts to 105° to capture better fleshtones.

Overall, the pattern is good. There are no damaging distortions, greens and reds (10th and 3rd petals) are relatively proportional, with just a bit of emphasis on blues (6th through 8th bars). The oscilloscope is set to 20 volts-per-division, so the pattern amplitude is normal. Therefore, the bandpass amplifiers, color sync and final RGB amplifiers are good, and there is no pattern smear.

Obviously, such conditions can vary from receiver to receiver, model to model and manufacturer to manufacturer. But for a quick and accurate examination of how one particular set is operating, this transmitted VITS signal and the simple color-bar check will reveal a great deal.

If you wish, go through the evaluation procedure first before taking a look at the picture. You'll pretty well know what to expect before you turn the receiver around to take a look. Poor receivers tell their troubles in a hurry; but the good ones always stand up to be counted! **R-E**

NO BOOSTED BOOST

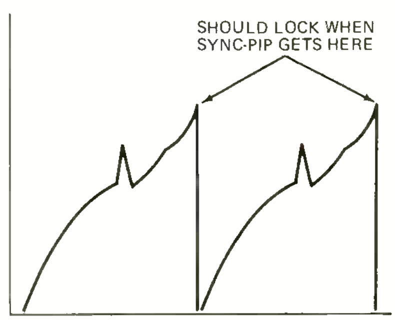
After replacing a shorted flyback in this Zenith 19DC20, I can get the high voltage and focus voltage. My problem is in the boosted boost. I get only about +400 volts on the picture tube screen controls instead of the normal +1170 volts. I changed the boost rectifier, no luck. Any assistance will be welcome.—C.M., Madison Heights, MI.

Well, most of your outputs from the flyback stage are normal. So, this shows us that the driving pulses that develop these outputs are also normal. They have to be. Our problem is in only one small circuit! One of three things could cause it; the 120K resistor, the boost rectifier (replaced) and that little RF choke between the rectifier anode and terminal 14 on the flyback (see diagram). Something is opening the circuit between the flyback, where the pulses *are* present, and the rectifier anode. Probably that little RF choke.

NO VERTICAL SYNC

The picture in this Motorola TS-912 has a slow vertical roll. You can stop it with the hold control, or make it go both ways, but it won't lock. Scoping the grid waveform of the oscillator shows a very small sync pulse; is this a valid test?—J.O., Carson, CA.

Yes it is! You should see a very good sync pip on this waveform, as shown in the diagram. When the pip reaches the top of the curve, the picture should snap in and stop momentarily. You can see this reaction by rolling the blanking bar slowly down; when it reaches a point about 2-3 inches from the bottom of the screen, you should see it "snap"



and hold. No snap, no sync.

From the reaction, you have practically no vertical sync at all in this one. A possible cause would be an open vertical integrator. Check the total resistance end-to-end. Should be about 150K. Kill the vertical output stage by grounding the grid, and you can check for sync alone.

555 IC TIMER CIRCUITS

PART II *The 555 IC timer has a wide variety of applications. This month we will discuss various multivibrator circuits—how they work and how to control their output frequency.*

by ROBERT F. SCOTT
TECHNICAL EDITOR

LAST MONTH WE COVERED THE OPERATION of the 555 timer as a time-delay or pulse generator operating in a monostable mode. We noted that the time delay is controlled by one external resistor R_T and one external capacitor C_T and that the timed interval or delay (in seconds) is $1.1\ (R_T \times C_T)$, where R_T is in *ohms* and C_T is in *farads* or where R_T is in *megohms* and C_T is in *microfarads.*

How long, how short?

The minimum length of the output pulse (time delay) is a function of the IC itself. First, the trigger pulse must be applied to the trigger terminal for at least 50–100 nanoseconds (see Fig. 7, last month). The second, and major, factor contributing to the minimum delay is the time it takes the threshold comparator to react when the timing capacitor charge reaches $2/3\ V_{cc}$. Because of the variations in the internal construction of the IC and on temperature and other external influences, do not try for time delays or pulses shorter than about 5 µs.

The longer the timed period, the larger the values of C_T and R_T. The maximum practical value for R_T is 20 megohms. The maximum practical value of C_T is determined by the availability of low-leakage electrolytic capacitors. I have constructed an experimental 10-minute timer that operated quite reliably with a 3.9-megohm resistor and a 150-µF tantalum capacitor.

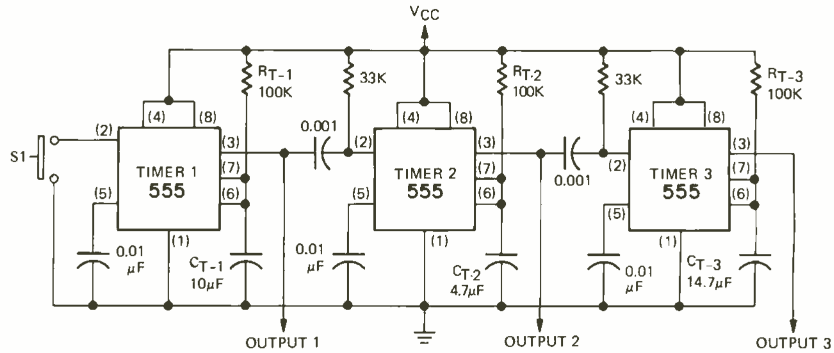
If you require a timer with exceptionally long intervals, resulting in unreasonable values for C_T and R_T, there are several methods that you can use. Perhaps the simplest is to use two or more timers in cascade—the output of the first triggers the second and so on. The resulting time delay is the sum of the multiple delays.

Figure 10 shows a sequential timer consisting of three 555's. It was designed for initiating three operations in sequence. For example, it can be used to apply power to cooling fans, then turn on the filaments in mercury-vapor rectifiers and then apply plate voltage to the rectifier plates. The output waveforms are shown in Fig. 11. In this case, the delays are in the order of seconds. For longer delays, of say 20 minutes, timers 1 and 2 could each be set for 10 minutes. Timer 3 could be adjusted to provide the required pulse width.

For even longer timed intervals— for example, in time-lapse photography we might want to operate a movie camera for 10 seconds every 8 hours—the 555 can be connected as a free-running oscillator feeding into a chain of counters that expand the time delay by the number of divide-by-2 stages. In the case of the 8-hour photography timer, we can connect the 555 as a 7.5-minute recycling timer (multivibrator) and feed its output into a six-stage divide-by-2 to multiply the delay by 64. The counter chain feeds a second 555 to expand the output pulse to the desired 10 seconds.

Free-running oscillator

When the 555 is used in the astable or self-triggering mode to form an oscillator (Fig. 12), the timing resistance R_T is divided into sections R_{T-a} and R_{T-b} with the discharge terminal (pin 7) connected to the junction of the two resistors. The trigger (pin 2) is connected to the threshold terminal (pin 6) to insure oscillation.



S_1 CLOSES MOMENTARILY AT t = 0.

FIG. 10—SEQUENTIAL TIMER consisting of three 555's.

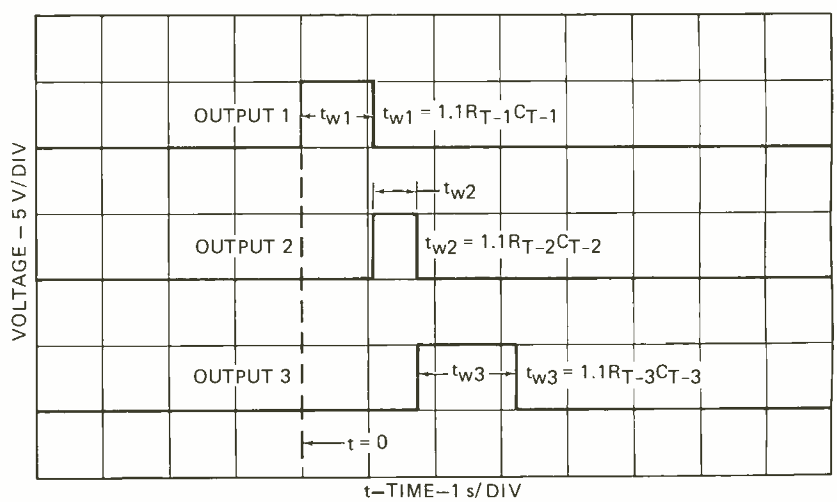


FIG. 11—OUTPUT WAVEFORMS of the sequential timer shown in Fig. 10.

When V_{cc} is first applied to the circuit (time = 0), capacitor C_T (Fig. 13) charges to ⅔ V_{cc} through $R_{T\text{-}a}$ and $R_{T\text{-}b}$ during time t1 and then discharge to ⅓ V_{cc} through $R_{T\text{-}b}$ during time t2. The delay cycle can be controlled by selecting values for $R_{T\text{-}a}$ and $R_{T\text{-}b}$ as the voltage on C_T swings between ⅔ V_{cc} and ⅓ V_{cc} as in Fig. 13.

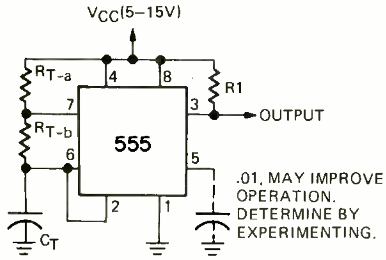


FIG. 12—ASTABLE MULTIVIBRATOR using a 555.

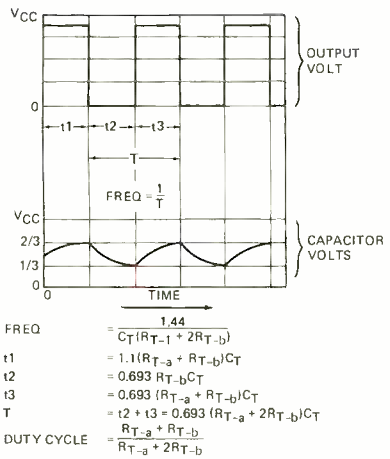


FIG. 13—OUTPUT WAVEFORM and capacitor voltage of the astable multivibrator.

As capacitor C_T starts charging toward ⅔ V_{cc}, the output goes high and remains so for period t1—in seconds equal to 0.693 ($R_{T\text{-}a}$ + $R_{T\text{-}b}$) C_T. The discharge period—the time that the output is low—is 0.693 ($R_{T\text{-}b}$) C_T. Frequency is the reciprocal of the total time period (T) or 1.44/($R_{T\text{-}a}$ + 2$R_{T\text{-}b}$) C_T. The free-running frequency of the multivibrator can be determined from Fig. 14 which relates frequency in *hertz* to C_T, $R_{T\text{-}a}$ and $R_{T\text{-}b}$. Note that if $R_{T\text{-}b}$ is greater than ½$R_{T\text{-}a}$, the circuit cannot oscillate because the voltage at pin 2 cannot drop to ⅓ V_{cc} so that the circuit can retrigger.

Duty cycle

The duty cycle depends on the values of $R_{T\text{-}a}$ and $R_{T\text{-}b}$ and is equal to ($R_{T\text{-}a}$ + $R_{T\text{-}b}$)/($R_{T\text{-}a}$ + 2$R_{T\text{-}b}$). It can be set from slightly above 50% to nearly 100%. The maximum duty cycle—the on-time divided by the total time is approximately 100%—is developed when $R_{T\text{-}a}$ is as small as possible while still sufficiently large to limit the current through the discharge transistor (Q1 in Fig. 3) to a level that does not exceed the value specified for the specific device.

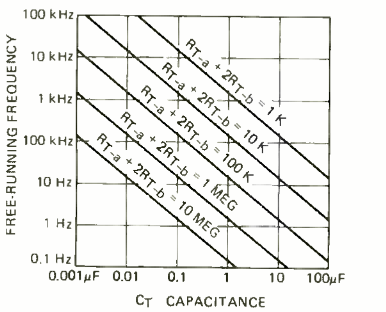


FIG. 14—FREQUENCY of the astable multivibrator can be determined from the graph.

For duty cycles less than 50%, a diode (D1 in Fig. 15) is connected between the

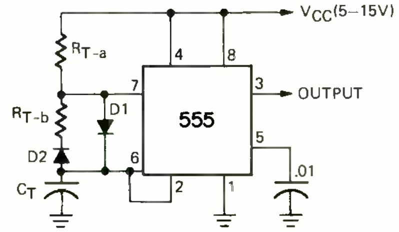


FIG. 15—DUTY CYCLES of less than 50% is achieved by this circuit.

discharge and threshold terminals. Capacitor C_T now charges only through $R_{T\text{-}a}$ ($R_{T\text{-}b}$ is shorted by diode conduction during the charge cycle) discharges through $R_{T\text{-}b}$ so the duty cycle is now $R_{T\text{-}a}$/($R_{T\text{-}a}$ + $R_{T\text{-}b}$) and can be varied from almost 0 to nearly 100%. Fig. 16 shows the wave-

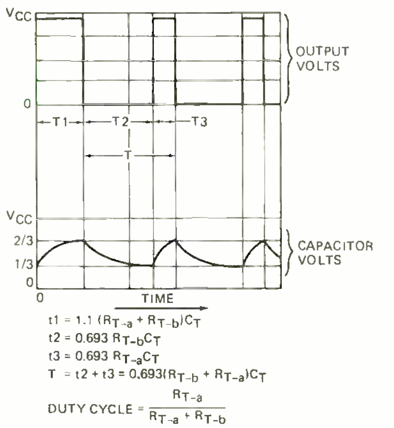


FIG. 16—OUTPUT WAVEFORM and capacitor voltage of astable when duty cycle is less than 50%.

forms as the duty cycle is decreased below 50%.

The voltage drop across D1 will prevent the timing cycle from being *completely* independent of $R_{T\text{-}b}$. This can be prevented by installing D2 in series with $R_{T\text{-}b}$ as shown.

In some applications, we may need to vary the duty cycle of a multivibrator from about 0 to 100% while holding the frequency constant. In this case, replace $R_{T\text{-}a}$ and $R_{T\text{-}b}$ with a single linear-pot as in Fig. 17. Resistors R1 and R2—approximately 1,000 ohms each—are connected in series with the pot. R1 limits the maximum current through the discharge transistor. Resistor R2 establishes a minimum value for $R_{T\text{-}b}$ and to compensate for the addition of R1 to the network.

Variable-frequency square-wave generator

If $R_{T\text{-}a}$ and $R_{T\text{-}b}$ are varied simultaneously by equal amounts, we can then develop a variable-frequency square-wave generator as in Fig. 18. Resistors $R_{T\text{-}a}$ and $R_{T\text{-}b}$ should be kept at equal values so as to develop a good square wave with a duty cycle of approximately 50%. If $R_{T\text{-}a}$ and $R_{T\text{-}b}$ are both 500K and C_T is .036 μF, the frequency range of the oscillator will be

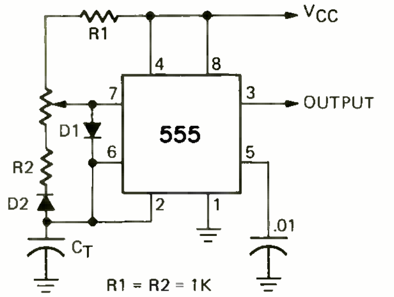


FIG. 17—ASTABLE MUTIVIBRATOR with duty cycle variable from 0 to 100% and frequency constant.

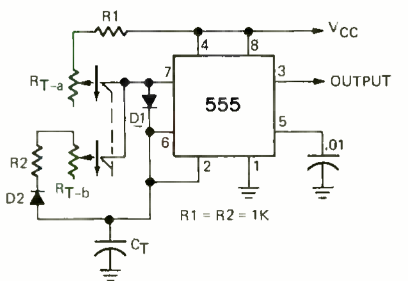


FIG. 18—SQUARE-WAVE GENERATOR with variable frequency and constant duty-cycle.

from about 40 Hz to about 20 kHz. Use linear pots for the most constant duty-cycle throughout the tuning range.

Selectable monostable/astable operation

You may want to use the 555 both as an astable oscillator and as a pulse generator operated by a signal applied to the trigger terminal. However, with the same values for $R_{T\text{-}a}$, $R_{T\text{-}b}$ and C_T, the time periods will be quite different for the two modes of operation.

In the monostable mode, the duration of the pulse is 1.1RC because C charges from 0 volts to ⅔ V_{cc}; while as an oscillator, the time period is 0.693RC because the charge on C varies between ⅓ V_{cc} and ⅔ V_{cc}. Figure 19 is a circuit (from *Radio*

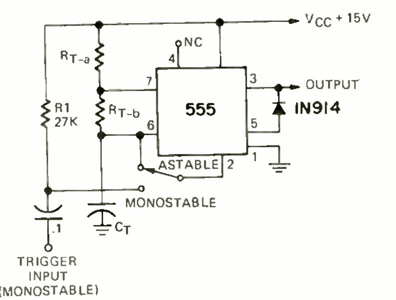


FIG. 19—ASTABLE OR MONOSTABLE operation can be selected by a switch.

Electronica, Netherlands) showing how the 555 can be operated in both modes at the throw of a switch. A diode is connected between the output and control-

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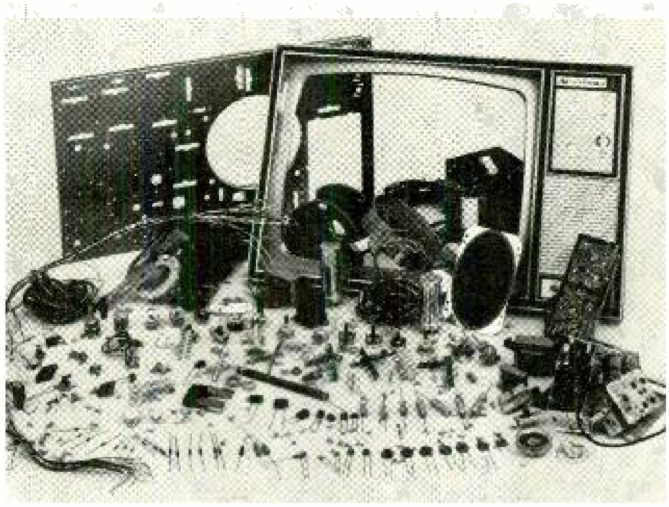

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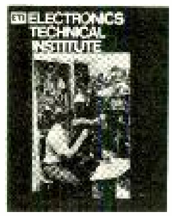

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volt voltage terminals, pins 3 and 5, respectively. With the diode in place, the reference voltage to comparator 1 (pin 5) is pulled down to approximately 0.9 volt when the output goes low. The fixed voltage on comparator 2 is now 0.45 volt so the timing capacitor must discharge almost to ground—to about 0.45 volt—before the circuit is retriggered by the voltage on trigger terminal pin 2. The periods of the monostable and astable modes are now equal to within about 5%.

The 555 family

In the months to come, we will give you lots of applications for your car, photo lab, home, as test instruments and many others. The 555-type of timer IC is available as a dual and as a quad device. You may want to adopt the device in some of the circuits that will follow or use in circuits that you develop as you become more familiar with the device. Before we get too far along, let me warn you of some pitfalls to watch out for.

The 556 is defined as a dual timing circuit containing two independent 555-type timers on a single monolithic chip. The pin configuration for the basic Signetics NE/SE556 dual timer is shown in Fig. 20-a. This same configuration is used in the XR-556 and many others. But, if you use the XR-2556 or the D555 by Teledyne, watch out: The pin connections are different as you'll see in Fig. 20-b.

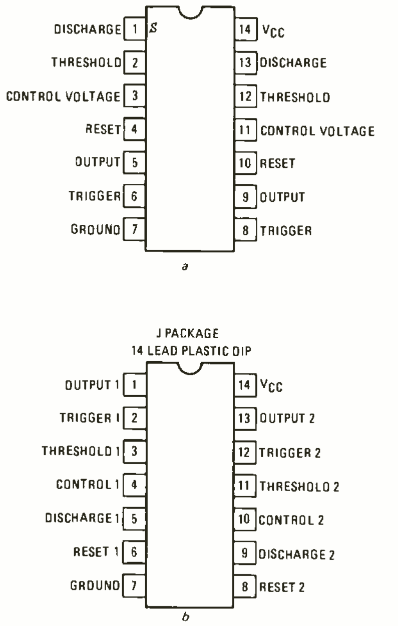


FIG. 20—PIN CONFIGURATION for Signetic's NE/SE556 and many others is shown in a. Exar's XR-2556 and Teledyne's D555 is shown in b.

Another thing to be careful of is the *output load.* The 555 can either sink or source up to 200 mA. Some duals—the Raytheon 556, XR-2556 and Teledyne D555, for example—can source or sink 200 mA while the Signetics 556 and XR-556 have a maximum current drive capability of only 150 mA per output. The 553's output *sinks* (consumes) 150 mA while the 554's output *sources* (supplies) 150 mA.

Quad timers such as the 553 have their threshold and discharge functions connected for use only in the monostable mode. If you want to use a quad timer as a free-running oscillator, the best bet is to use *two* sections with their output and trigger terminals cross-connected. A load can be connected in series with each trigger/output pair and V_{cc}. The time constants in the threshold circuit of each timer can be adjusted for frequency and duty cycle.

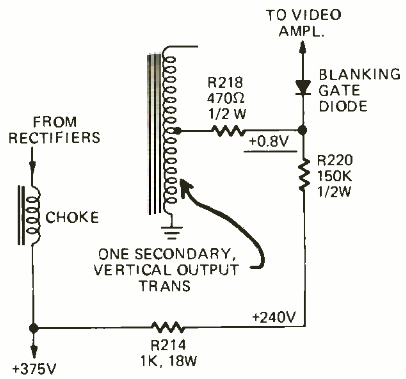
That's it for now. Next month, we'll give some really practical circuits that you will enjoy putting to work.

(To be continued)

BIG RESISTOR BLOWS

I replaced the horizontal output tube in this Zenith 20X1C38, and it promptly got red hot. Checking, I found the horizontal oscillator wasn't working, and that R214, 1000-ohms 18-watts, had blown out. Later, I discovered that R218 (470 ohms) and R220 (150K) were burnt up. These are in the blanking circuit. Replacing all of these and turning the set on (cautiously!), it worked. Question: why did that big resistor blow out?—W.B., Marietta, GA.

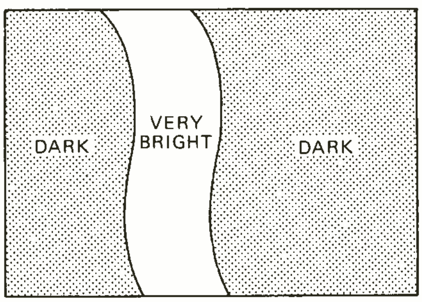
Honest answer; I don't know! However, I have replaced quite a few of these resistors in this chassis! If you use a 20–25 watt Brown Devil or similar type, it holds. There is no apparent reason, since in addition to the size, it is also mounted in a heat-sink clip on the chassis.



For a crystal-ball guess on the failure of the other two, I'd say that the 150K had arced internally and gone away down in value. The 470-ohm returns to ground through the heavy secondary winding of the vertical output transformer. So, it promptly overheated and went out too. Of course, in normal operation, the high resistance of R220, 150K, is enough to hold the current in this circuit to a very low value. "After the fact", there's no way of telling which one went out first.

WEIRD RASTER

I never saw anything like this before! All I can get on this G-E DC chassis portable is a weaving bright line about three inches wide (see diagram). If I turn the brightness full on, I can see a dim raster, but the vertical bar is much brighter. There's a hum in the sound, too. I've checked the horizontal output transformer, tubes, and so on, and the horizontal AFC. No luck. Give me a good place to start!—C.H., Allentown, PA.



I can give you a very *good* place to start. Check the filter capacitors! The best way to do this is with a scope. Look for *any kind* of *signal* on their terminals. Since this is a tube-type chassis, you can bridge them with good ones without trouble.

Whenever you see any kind of screwball symptom that you can find no logical explanation for, go to the filter capacitors and see if one of them is *open.* If so, this sets up a feedback loop through the DC power supply.

WHISTLE, CAR RADIO

This Bendix auto-radio, whistles! Sometimes it can be reduced by careful tuning, but it's usually audible. Shows up on all stations, even strong ones. Sounds lik a regenerative set!—W.F.

It is! This sounds very much like regeneration due to a feedback loop somewhere in the set, probably in the IF. Even though this is a battery powered set, it needs filter capacitors. Without these, your DC supply lines will allow a feedback loop to form. This causes the oscillation and whistling.

Check the chassis carefully for a ‥ɔd big electrolytic capacitor. This will probably be found open. If the DC supply capacitor is OK, check for a similar unit on the AVC line.

GREEN FLASH AT TURN-ON

When I turn this RCA CTC-24 on, I get a light, medium-green raster for about 8-12 minutes. Then a normal picture, purity and all, and it stays on until I turn it off and let it cool for a good while. Any ideas?—E.G.

Could be a heater-cathode short in the green gun, but this would also wipe out the video. I believe that it is a bad solder joint somewhere around the plate circuit of the G-Y diff-amp tube, or perhaps a dirty plate contact on that tube's socket. Look for the little pale blue 3-watt plate load resistors behind the color difference amplifier tubes and check the solder joints on the PC board. **R-E**

Understanding Tape Specs

Good tape deck performance is only half, good performance from the tape itself is the other half

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

IN THE MAY, 1975 ISSUE OF **R-E**, I discussed tape bias and equalization in general terms and attempted to show how bias and equalization affect overall performance of a tape recorder, regardless of the type of tape you use. If you own a tape deck (cassette or even open reel), you have probably noticed that in recent years more and more tape formulations have been offered to the tape enthusiast, each claiming "superior fidelity". Very little is said in these claims regarding how the tape performance itself is measured and, clearly, the inter-relationship between a particular tape and the machine upon which it is tested has much to do with the results obtained. How, then, does a legitimate tape manufacturer go about providing data that is meaningful. In an attempt to get at the heart of the matter, we recently visited the laboratories of 3M, in Minneapolis, where, along with a dozen or so other technical editors and writers, we were treated to an all-day seminar designed to clear up some of the mysteries of tape formulation and specifications. 3M, of course, manufactures the famous "Scotch" brands of recording tape for both professional and consumer use and offers a variety of formulations for all three tape formats—8-track, cassette and open-reel.

Tape performance with respect to what?

The first thing we learned is that in order to specify tapes in a meaningful fashion, a reference tape must be agreed upon. To say that a tape is "more sensitive" without qualifying that it is more sensitive than some reference tape tested under similar conditions is meaningless. In the case of cassettes, 3M uses a special reference tape known as the DIN Bezugsband 4.75/3.81 Reference Tape. (DIN stands for Deutsche Industrie Normen—a group of standards developed in West Germany, and widely used throughout the world). To properly specify a given tape with regard to its electromagnetic properties, at least six characteristics must be listed. These are (in the case of cassettes): sensitivity at 333 Hz, sensitivity at 12.5 kHz, maximum modulation level, distortion level, biased tape noise, and saturation at high frequencies (12.5 kHz for cassette tests).

Before any of the tests can begin, two additional references must be established. These are the "reference recording level" and "reference bias." Since output level varies with bias, a plot is first made of bias level versus output level, using a frequency of 6.3 kHz at a reference recording level of 25 millimaxwells-per-millimeter, using the reference tape. The reference bias level is that bias level at which amplitude falls off by 2.5 dB after having reached a peak, as shown in Fig. 1. This

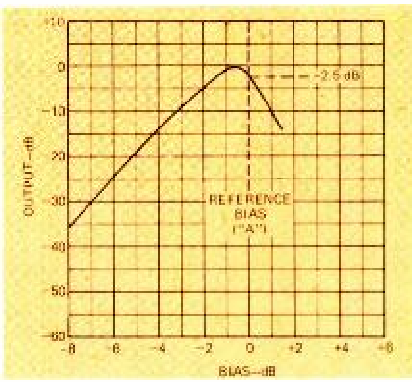


FIG. 1—REFERENCE BIAS LEVEL is established at a recording frequency of 6.3 kHz.

value of bias is assigned a "0 dB" designation and the test is repeated using the "unknown" tape, at the same reference recording level, until output also decreases by the same 2.5 dB, as shown in Fig. 2.

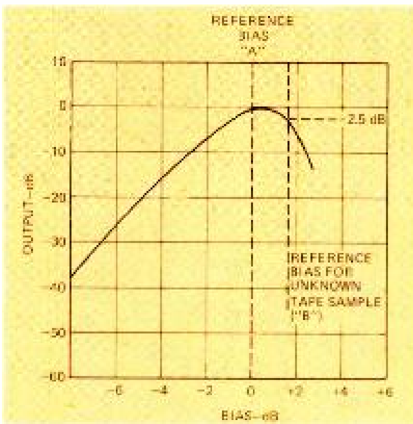


FIG. 2—REFERENCE BIAS LEVEL for test-tape is higher than reference tape.

Comparing the results of Figs. 1 and 2 we see that the "unknown" tape requires higher biasing (by about 1.5 dB) than the reference tape. Subsequent specifications are then measured both at the reference bias level and at the bias level established for the unknown tape and are referred to as bias "A" and bias "B," respectively.

Sensitivity

Sensitivity of a given tape with respect to the reference tape is quoted at two frequencies: 333 Hz and 12.5 kHz in the case of cassettes (15 kHz and 10 kHz are used as the high-frequency specifying points for open-reel and 8-track tapes, both at a speed of 3¾ ips). Tests for sensitivity are made at a —20 dB level and reported as the difference between playback output observed for the reference tape and the newly tested tape. In the example shown in Fig. 3, both outputs turn out to be

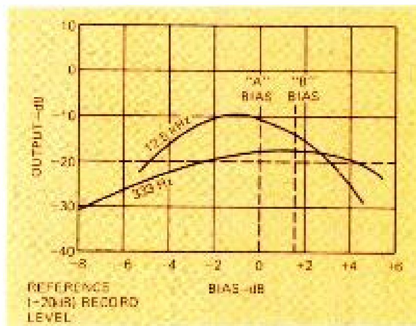


FIG. 3—SENSITIVITY TEST compares output for both reference bias levels with that obtained from standard reference tape.

higher for both the "A" and "B" bias conditions compared to the reference level, particularly at the high test frequency, so the tape in question would certainly qualify as a "high energy" or "high output" tape in the vernacular of tape advertising.

Maximum modulation level

Maximum undistorted modulation level is generally considered to be that recording level which results in 3% total third-order harmonic distortion. If this recording level is determined as a function of bias, the resulting plot would appear somewhat as shown in Fig. 4. Note that at the two reference bias points, this distortion occurs at a recording level of +2.0 dB and +3.5 dB with respect to the reference recording level.

Interestingly, the tests are made only with regard to third-order distortion. If second-order distortion appears, it can be safely assumed that it is caused by deck problems such as improper bias waveform, since the tape magnetization process will result only in third-order (and possibly higher order) harmonic distortion products. This test is conducted at a test frequency of 333 Hz. For high frequencies, such a test would be impractical since, if the high frequency reference signal of 12.5 kHz were used, its third harmonic would be well beyond the range of audibility and of no significance. Instead, tests of saturation level are made at the 12.5 kHz frequency, plotting peak recording level (beyond which no further increase in output occurs with increased input) versus bias level, as shown in Fig. 5. In the test tape illustrated, saturation level occurs at —4.0 dB and —6.0 dB for the two reference bias points.

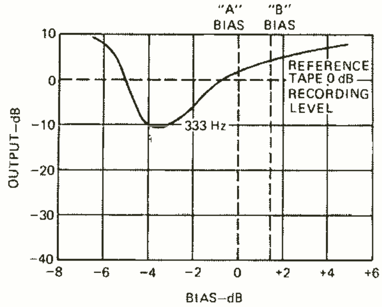


FIG. 4—MAXIMUM MODULATION LEVEL is the maximum recording level that results in 3% total third-order harmonic distortion. Graph shows output vs. bias for constant 3% distortion.

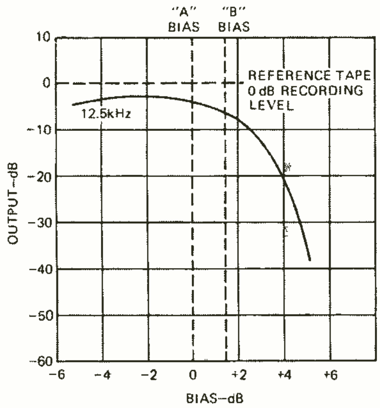


FIG. 5—SATURATION of test-tape occurs at —4.0 dB and —6.0 dB for bias levels "A" and "B", respectively, at a recording frequency of 12.5 kHz.

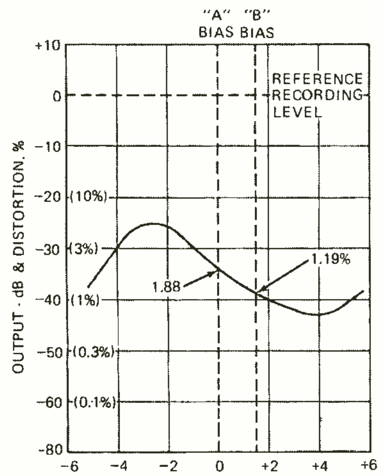


FIG. 6—DISTORTION LEVEL vs. bias level when the reference recording level is applied to the tape.

Distortion level

Another useful specification is the distortion level that is recorded onto the tape (using a 333-Hz signal) when the reference recording level is applied. This characteristic, too, can be plotted as a function of bias, as shown in Fig. 6 and can be specified either in percent or dB below reference recording level for the two bias points of interest. In the case of our test sample, results turn out to be —34.5 dB and —38.5 dB or 1.88% and 1.19% respectively. Clearly, such a plot would help the serious recordist to bias his machine for lowest distortion, if that was the objective.

Tape noise

The final electromagnetic property that 3M feels should be specified for any tape is biased tape noise. This is defined as the level of tape noise when it has been recorded with only the bias signal and when that signal has been weighted or modified (during playback) by means of a standard NAB weighting network that takes into account the low-level hearing characteristics of the average human ear. The level of noise measured in this manner is referred to the reference level and quoted as so many dB below that reference level.

A single graphic presentation

All of the parameters we have discussed thus far can be presented in a single graph, as shown in Fig. 7. The particular graph shown is that applicable for 3M's "Classic" brand of Scotch cassette tape, a formulation that consists of a layer of gamma ferric oxide coating on polyester base plus a top layer of chrome oxide. The advantage of presenting data in this form is fairly obvious. For one thing, the machine or deck used in making the tests, while it should be of the highest quality, is less of an influence in the final results since the reference tape will have been measured and tested using the same machine.

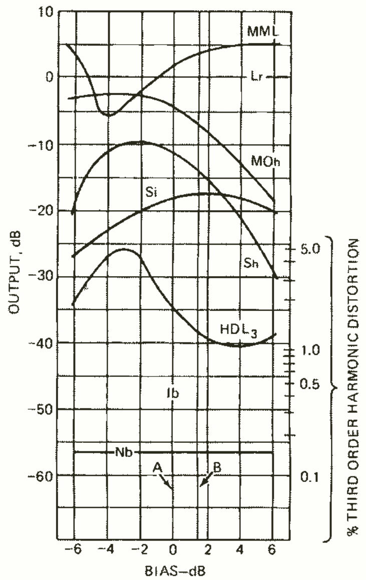
Admittedly, most home recordists, especially if they are using cassette decks, are not apt to change the bias settings of their machines in order to achieve one or more optimum characteristics of a given tape. Manufacturers of tape decks, however, given access to this kind of data from tape manufacturers, can easily adjust their products to take best advantage of given types of tape and, when such machines are provided with multiple bias switch positions, those settings can each be adjusted to yield best (or nearly best) performance from a variety of tapes.

Serious tape deck manufacturers should therefore specify the actual tape brands and types for which their machines have been adjusted, even if this means offending makers of other brands of tape that might not work as well on their decks. The end user, after all, would still have freedom of choice of tapes if he or she wishes to economize, but would at least be armed with enough data to choose the right tape if they so desired.

Magnetic and physical properties

In addition to the electromagnetic properties of a given variety of tape, there are certain intrinsic magnetic properties that should be specified by a manufacturer in describing a product. These include coercivity (measured in oersteds), retentivity (measured in gauss), remanence (stated in lines-per-quarter-inch) and erasing field required (again, stated in oersteds). Coercivity is the demagnetizing force or field intensity required to reduce the magnetic induction of a piece of tape from saturation level to zero. Remanence is a measure of the lines of flux per unit width of tape that remain when the magnetizing force is reduced to zero from a level producing saturation. It might be considered as a figure of merit for magnetic tape since it is indicative of relative output, distortion and response at low frequencies.

Retentivity is equivalent to remanence, except that it is expressed in terms of flux



MML Maximum Modulation Level: plotted against bias at a constant 3% third-order harmonic distortion.
Lr Level of Reference: a level of fluxivity (flux density per unit track width) of 25 millimaxwells per mm (mM/mm) at 333 Hz.
Si Sensitivity at 333 Hz; plotted against bias.
Sh Sensitivity at 12.5 kHz; plotted against bias.
HDL3 Third Order Harmonic Distortion level; the level of distortion present at the level of Lr.
MOh Maximum Output of 12.5 kHz signal at standard tape speed of 1-7/8 ips (4.75 cm/s), with level increased to point of peak output.
Ib Bias Current level in dB/ with 0.0 dB equal to bias referenced in DIN, Section 455/13, Sheet 6 for standard tape (Bezugsband 4.75/3.81).
Nb Noise level of Biased Tape; level is referenced at a tape speed of 1-7/8 ips (4.75 cm/s), with bias operating. Plotted output is shown measured through the NAB Standard (April 1965) weighting network.

FIG. 7—SINGLE GRAPH shows seven important tape parameters as a function of bias level.

density or flux per unit cross-sectional area. It is therefore something of a figure of merit for coating dispersion in the tape surface, independent of coating thickness and therefore useful for estimating the oxide coating sensitivity at short wavelengths (high frequencies).

The erasing field required by a tape is defined as the peak value of a 60 Hz alternating field applied to a tape along its longitudinal direction which causes at least a 60 dB reduction is the level of a

(continued on page 100)

R-E's Service Clinic

Bang bang servicing

Fast is dollars

by JACK DARR
SERVICE EDITOR

THE SPEED WITH WHICH WE DIAGNOSE troubles in electronic equipment is in direct proportion to our income! We need test equipment and methods that give us a handle on the problem in the least possible time. So, let us look at a test instrument and a method of using it, that will do exactly that! This method is used by all good technicians, whether they know it or not. I didn't invent the name but it's apt.

Colloquially, we call it "Bang Bang." If you don't know about it, you should. (This brings up another of those ancient jokes of mine. The Traditional Englishman, complete with bowler and umbrella, fell down an open manhole, landing on a pair of astonished navvys. He looked up and said "Oh, I say! I didn't know there was a manhole there!" One of the navvys looked at him in disgust and said "Well, mate, it's time you *learned*!") Same here. If you don't use this method, "it's time you learned."

In plain language, this method consists of selecting key test points in any circuit, then taking readings on each one in rapid succession. Hence, bang-bang. The only instrument that will do this is the scope! What you do is find the key test points, then touch the scope probe to each one in turn. You can go either way; input to output or vice versa. The only other thing you need is a source of known test signals; you can work with off-the-air signals if you want to.

All you need to know is "Is there a signal here or isn't there?" When you find the point where there is no signal, you've found the location of the trouble. A few DC voltage and resistance checks and you should be able to pin down the faulty part.

Take an easy practical example, a four-stage audio amplifier with no output. Feed in a test signal, and check it right on the input. The actual level isn't critical; anywhere in the ballpark. About 100 millivolts is a good average for this type. Now, go bang-bang from input to output of each active device. Grid-plate-grid-plate or base-collector-base-collector, etc. Somewhere along the line you'll find a place where the signal stops.

Follow the *signal path*, which is always a simple series circuit. In tube sets, you'll always see a signal voltage gain between input and output. In solid-state sets, especially direct-coupled types, you may not see a voltage gain but you will see that the signal is getting through. The only thing you may have to do is reduce the scope's vertical gain when the signals go off the screen. Absolute gain is not important *now*. All you need to know is whether the signal is getting through a given stage.

Take a very similar stage in a color TV set; the bandpass amplifiers. Here, feed in a color-bar signal from a bar-dot generator, and you have an unmistakable test signal. Start at the color

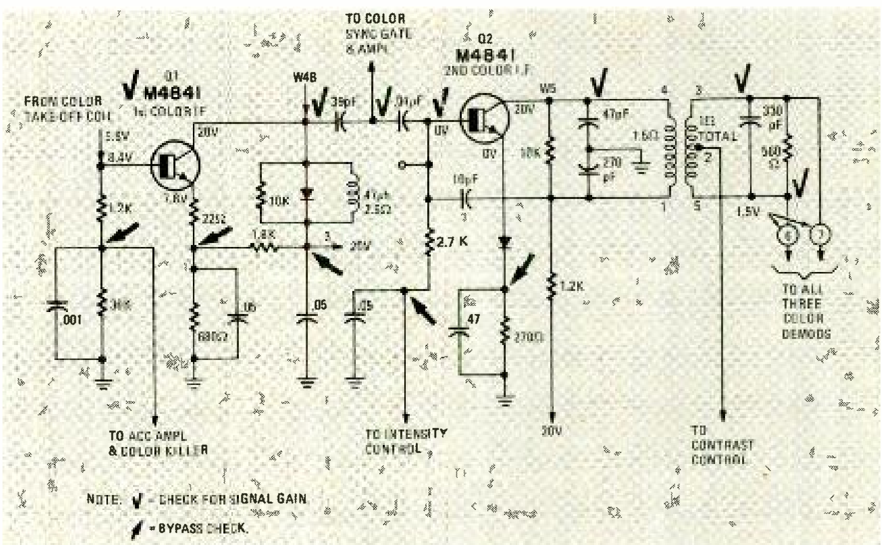


FIG. 1

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

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

takeoff coil, and bang-bang through all stages, winding up at the input of the demodulators. Tube sets will have one or two stages; transistor sets may have up to three. In IC sets, all you'll have to do is bang (input) bang (output). If you have a normal input signal and no output, there's only one thing between these two points; the IC. Be sure to check for normal DC voltage supply before you replace it. This is a very valuable test for anything using IC's.

Figure 1 shows a typical stage. The bang-bang test points are marked. Go from input to output, and there you are. With a no-color symptom, this will either verify the idea that the trouble is in the bandpass stages, or prove conclusively that they are OK. This is valuable data; you've eliminated one possible cause of the trouble. Go and bang bang the 3.58-MHz oscillator stages, from the control, up to the demodulator inputs.

Other uses

In the most common use of bang-bang, you're looking for signals at places where they should be. There is another one; invaluable for catching those sets with multiple weird symptoms (and, in general, no significant DC voltage variations!) You look for signals, again, but this time you look at the places where they should NOT be. This includes all the DC voltage supply lines, and any point that is *bypassed*. This is very important.

When we have a circuit-point that must be a perfect "signal ground", such as the bottom of the primary or secondary of a tuned transformer, we can make this point "ground" by hooking a bypass capacitor from it to chassis ground. The capacitor must be big enough so that its impedance is practically zero for the signals in this stage. (In stages handling very high frequencies, the bypasses can be small; in audio stages they must be much larger). So, the unwanted signals will flow harmlessly through the capacitor to ground and disappear. But if there is anything wrong, such as an open bypass or one that's too small, or a bad ground connection, the impedance will go up to the point where there is a *signal voltage drop* across the bypass.

What harm can this do? Plenty. Any signal appearing on points like this will be fed back into other stages. This causes very strange problems. One of the most common is oscillation, developing beat frequencies. The real zingers are the ones where the feedback signal shows up in another stage with just the right polarity and phase to cancel out the normal signals, sync, color, and so on! Some smart cookie said a long time ago that this causes "a combination of frequencies, amplitudes and phases utterly impossible to predict!"

However, this is very easy to test. All you do is bang-bang with the scope probe, on *every* bypassed point in the circuit or stage under suspicion (and in all nearby ones, if these don't show up anything.) Set the scope gain **high** so that you can see the smallest signals; it doesn't take much. If you see signal on any point with a bypass capacitor, that bypass isn't doing the job. Watch out for this: in some cases, you will see signals on the scope as the probe comes near the test point. This is stray pickup, and is perfectly normal. When the probe tip touches the bypassed point, it should *disappear*!

Don't overlook the DC supply lines, either. Electrolytic capacitors can develop problems such as high power factor, or drying up, and not do their job. Needless to say, any stray feedback signals on the DC voltage supply lines can get into any stage in the set, since these are common to every one of them.

There's a very common cause of trouble in audio circuits that is easy to bang-bang; especially in solid state. If you have low volume with quite a bit of distortion, check on the base and emitter of all stages having an emitter bypass capacitor. If you see practically the same amount of signal on both points, the emitter bypass is open. This

(continued on page 74)

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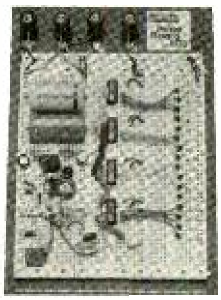

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Circle 20 on reader service card

SERVICE CLINIC

(continued from page 72)

causes a terrific degeneration, which cuts down the gain and causes distortion.

There you are. Simple, isn't it? In fact, you don't even have to set the scope's horizontal sweep to show a few cycles of the test signal if you don't want to. You can go by the amplitude of the scope pattern, even if it's just a blurry bar across the screen. All you need to know for the initial bang-banging is the answer to the very simple question, "Is there signal here or isn't there?" **R-E**

reader questions

HASH, NO SIGNAL

All I get through the vertical amplifier of my RCA WO-91A scope is hash. All tubes in the vertical amplifier checked; 6BQ7 replaced. It was shorted. This tube runs hot for some reason. When you put a fingertip near it, you see sinewaves on the scope screen. Something's odd in this circuit.—L.C., Ink, AR.

This is a "rare but possible" fault. Check that litle 220-ohm resistor in the grid circuit (pin 7) of the cathode-follower (6BQ7).

The 6BQ7 tube has a habit of developing "catastrophic" shorts; everything shorts to everything else. This blows the small resistor and opens the circuit.

SUBSTITUTE TRANSISTORS

Two transistors in the transmitter of my CB set have gone out. Can you tell me what will replace them? Numbers are 2SC481 and 2SC482. I can't locate them.—J.D., Howard Beach, NY.

The 2SC481 is a NPN silicon transistor in a TO-5 case. Substitute an RCA SK-3047 for it.

The 2SC482 is a NPN silicon RF transistor rated at 300 MHz. You can substitute an RCA SK-3046 transistor for it.

A CRY FOR HELP!

We have a classroom display oscilloscope; this was made by Electromec Inc., 3200 N. San Fernando Blvd., Burbank CA. It has a 21-inch tube. The firm seems to be out of business. We need the instruction manual so that we can calibrate it. If anyone has this manual, please send it to:

Rev Laurence C. Langgruth, S.J.,
Physics Department,
Bishop Connolly High School,
373 Elstree St.,
Fall River, MA 02720.

Thank you.

LOSS OF HEIGHT

I can't get enough height on this Wards Airline color receiver. I've checked everything in the vertical circuit and it just won't work? I'm lost; where do I go from here?—B.H., Humboldt, IA.

You listed all of the parts in that circuit except one! This is the little (physically) 50-μF electrolytic capacitor (C807) in the cathode circuit of the vertical output stage. This fools a lot of us, self included. The capacitor is mounted on the *convergence* board, not on the chassis! Check this; you'll probably find that it is open.

(He did! Incidentally, this applies to quite a few makes of color TV sets. If you can't find that little electrolytic, look on the convergence board.)

REPLACEMENT 189-kHz CRYSTAL

I have a Mercury color-bar-dot generator with a bad 189-kHz crystal. Can't get in touch with the company. Where could I get one like this?—F.F., Kenosha, WI.

Try International Crystal Co., 18 North Lee, Oklahoma City, OK 73102. They have all kinds of crystals. Since this is a fairly common frequency in such instruments, they should have one.

(continued on page 97)

What's Wrong With 4-Channel

Quadriphonic reproduction—the rage of a year ago—is seeing very little action today. This explains what happened and tells what we can expect in a revival

HERB FRIEDMAN

JUST ABOUT A YEAR AGO IT WAS ALMOST impossible to find a technical, hobbyist or music magazine without an article touting 4-channel sound. Even some of the classier *girlie* magazines managed to work 4-channel into their stereo picture stories. As for the trade magazines, they were all wrapped up in how to sell 4-channel and what percentage of sales to expect: On one side of the page would be dealer comments how 4-channel was only 10% of the gross sales; while the other side of the page showed how proper sound room facilities could bring 4-channel up to be 30% or even 50%.

Today, 4-channel is vitrually dead. To be honest, if it disappeared from the scene few dealers would ever know the difference. The very same manufacturers who exhibited a 1975 line, well represented by 4-channel equipment, have reverted to an almost complete stereo line for '76. For the stereo 4-channel enthusiast, or audiophile, the range of available equipment gets narrower and narrower, while paradoxically, the range of software has greatly increased. (What's in the pipeline is often difficult to cut back.)

The problem with 4-channel is really two-fold: A) A good idea handled very poorly by most of the industry; and B) *hard times:* It is difficult to get a luxury idea off the ground when a substantial number of your potential customers are unemployed, while many of those employed are being beat to the ground by inflation.

But other exciting, though no-essential, products have done well in hard times, and 4-channel sound is exciting. Since the economic condition of the U.S. is beyond the scope of this article, let's look instead at why the *average stereophile* was not turned on to 4-channel. After all it is the average stereophile rather than the hi-fi purist that represents the needed mass market.

Surround sound

Modern *surround-sound*, which is what 4-channel is supposed to provide, really got started with the so-called "Dyna" speaker connection. Basically, the Dyna speaker connection simply extracted "ambient" sounds of the recording location concealed within ordinary stereo programs or recordings. By connecting one or two speakers across the "hot" stereo amplifier outputs, the common frequencies to both channels were cancelled (a differential connection to be later done electronically in "4-channel synthesizers"). What came out of the "Dyna speaker" was any signal that did not appear in both channels: some were direct program signals; others were sounds reflected by the walls, floor, ceiling and furnishings of the recording location—the "ambient sounds."

If the Dyna-connected speaker(s) were placed behind or to the side of the listener he experienced an "enhanced stereo" effect, which we later termed "surround-sound." And this is the very first place 4-channel went wrong.

Instead of simply stating we had "enhanced stereo," the industry, and in particular the music magazines, took the "recreate the concert hall" route. According to many writers "You could recreate the concert hall in your living room." Hogwash! There was no way to create anything resembling a concert hall in anyone's living room because the reverb time of the living room is much too short. You cannot take a large hall's reverb and recreate it in a smaller room. Neither can anyone synthesize *ambient sounds* from a mix-down recording, and except for on-location stereo recordings, stereo recordings are mixed-down from several tracks (like 8, 16, 24 or 32 individual tracks). Because there is no ambient sound from mix-down, the differential-decoder—which is what the Dyna speaker connection really is—became known as a *synthesizer*; meaning a rear speaker output was synthesized with no particular foundation in the actual structure of the program.

The first successful Dyna-type decoder came from Lafayette Radio;

priced at under $30 it featured null, balance and volume optimization and really provided the first "spectacular" introduction to surround-sound. Within a year or so the Lafayette "decoder" was selling for less than $15, and stripped down imitations combined to create a substantial interest in low cost surround-sound.

Trouble is, except for the extra rear speakers the Dyna decorders did not represent really substantial sales gain, for some decorders were selling for as little as $10. While they didn't have the flexibility of the Lafayette model, they did nevertheless provide enhanced stereo at rock-bottom cost.

Had there been enough time—like several years—for the Dyna decoder to establish substantial interest and demand in either enhanced stereo or surround-sound (same thing, different name), perhaps a 4-channel market of considerable dimension would have been a logical outgrowth.

Three competing systems

Instead, the public was to be socked over the head by three new competing 4-channel systems, each claiming superiority over the others, and none really developed at its introduction for mass-market appeal. In actual fact, there were some five or six 4-channel systems proposed by engineers: only three, QS, SQ and CD-4 had the backing of "industrial giants" and the financial resources that went with the likes of Sansui, Panasonic-JVC and CBS-Sony.

Matrix 4-channel

Both SQ and QS 4-channel both suffered the same problem, that of early introduction. Both use phase encoding of the rear channels into a compatible stereo program. A decoder unscrambles the signal into front and rear components. (This is not the place to get involved with specifics such as which provides the better reproduction, or phantom mono for AM broadcasting.) Both systems initially depended very heavily on psycho-acoustic effects to create a surround-sound: the speakers had to be in precise relationship to the listener, and the listener lost perspective if he moved from a centralized listening location. The home, unfortunately, rarely provides for optimized speaker placement or listening location (would *you* necessarily sit on a chair in the middle of your living room when there's a comfortable chair only a few feet away?).

After the first rush of enthusiasm by audiophiles in the *avant garde*, who are the first to try anything new, 4-channel remained little more than a curiosity. There was little software (records) specially made for 4-channel, and few

(continued on page 102)

R-E TESTS HEATH MODULUS

(continued from page 37)

stages operate in Class AB, and signals from them are direct coupled to the speaker switches.

A power dissipation limiting circuit consisting of two transistors (one for each half-cycle of output conduction) and associated components protects the amplifier circuitry. Under normal operation, each of these transistors is turned off. If the amplifier's output should become shorted, the emitter of the protection trannsistor is grounded while its base is driven positive. Once the transistor starts to conduct, the audio signal fro·ı the second amplifying stage is coupled to ground and the output power from the amplifier is limited to a safe value.

The power transformer of the AA-1506, in conjunction with a full-wave bridge rectifier and a pair of 6000-μF capacitors, supplies ± 46 volts DC to the output stage pairs. This voltage is further filtered by appropriate R–C networks to supply voltages to other low-level signal stages. Another secondary winding on the power transformer supplies 11 volts AC for the pilot lamp and the built-in test meter circuit.

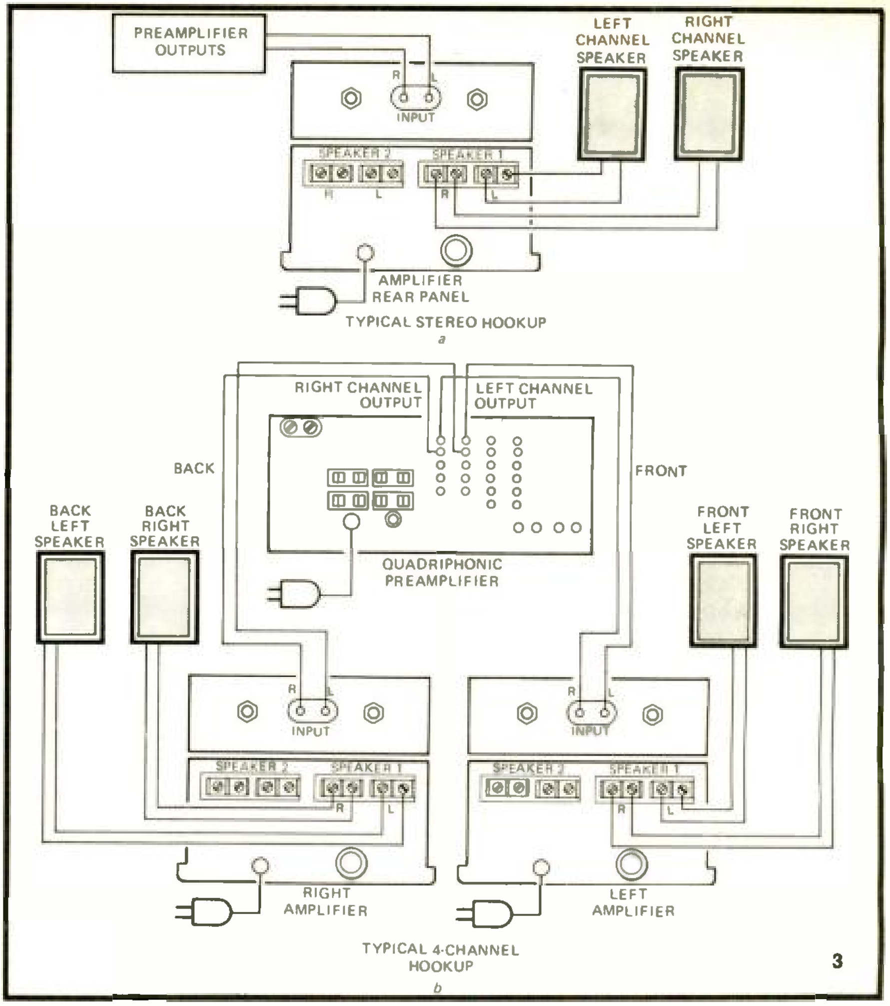
Amplifier performance measurements

The lab measurements of the AA-1506 is listed in Table I. It is obvious that Heath has applied very conservative ratings to this amplifier since, at mid-band frequencies, the unit delivered over 73 watts per channel as opposed to 60 watts claimed. All measurements were made *after* preconditioning the amplifier by driving it to one-third of its rated output (20 watts per channel for one hour). Even at the audio frequency extremes, power output exceeded published ratings. Backing off the rated output, total harmonic distortion at 1 kHz measured only 0.035% while IM at 60 watts per channel output (both channels driven) was a low 0.089%. (Harmonic distortion content at 0.1% THD is shown in Fig. 6.)

Although Heath Company provides no published ratings for 4-ohm operation of the amplifier, we decided to measure power output capability (for rated THD of 0.1%) using 4-ohm loads. As was to be expected, power output was considerably higher, though we did note that sustained steady-state operation under these test conditions (a situation that would never be encountered under actual musical listening conditions) caused a gradual increase in total harmonic distortion readings after a few minutes.

Additional measurements, not shown in our summary, included input sensitivity, which was 1.3 volts (as opposed to 1.5 volts claimed) for full-rated output and a hum-and-noise level of 98-dB referenced to 60-watts output.

An overall product analysis is listed in Table II, along with our summary comments concerning this well designed amplifier. Like its matching tuner/control-center module, the AA-1506 is not available in wired form (some Heath prod-



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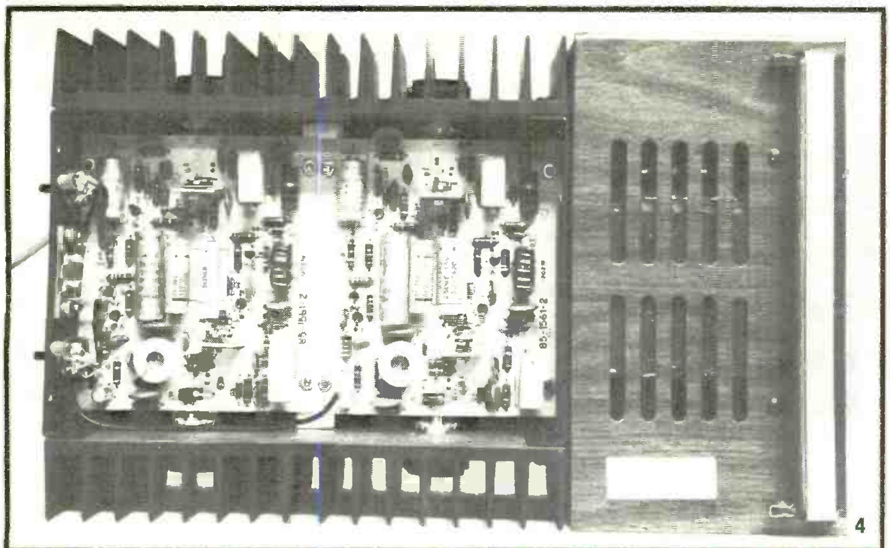

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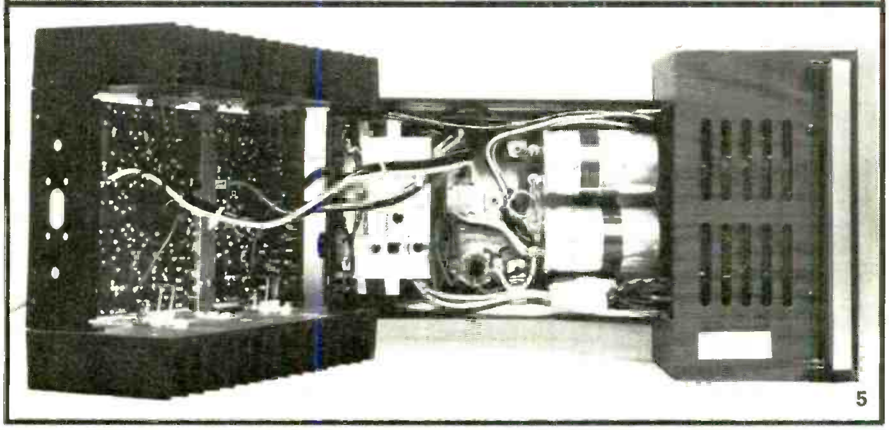

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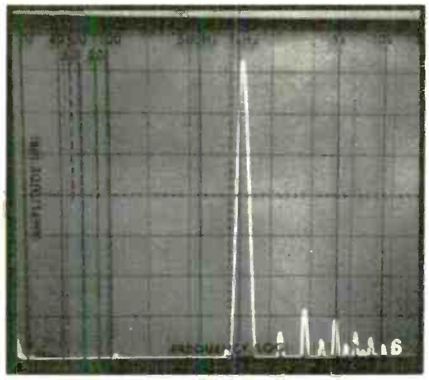

6

ucts are). When we asked the people at Heath why this was so (not everyone is brave enough to build an amplifier from a kit, though certainly more people could complete the job successfully than you might think), they had some very valid reasons. Chief among these is the fact that the AA-1506 and other products in the new "Modulus" line was designed with the do-it-yourself builder in mind. It is one thing to assemble a single kit in a few evenings time, and quite another to run an assembly line to mass produce a product. Each requires a different design approach for best efficiency and ease of assembly and wiring.

Clearly, the AA-1506 was "meant to be a kit"—and a very good one at that. **R-E**

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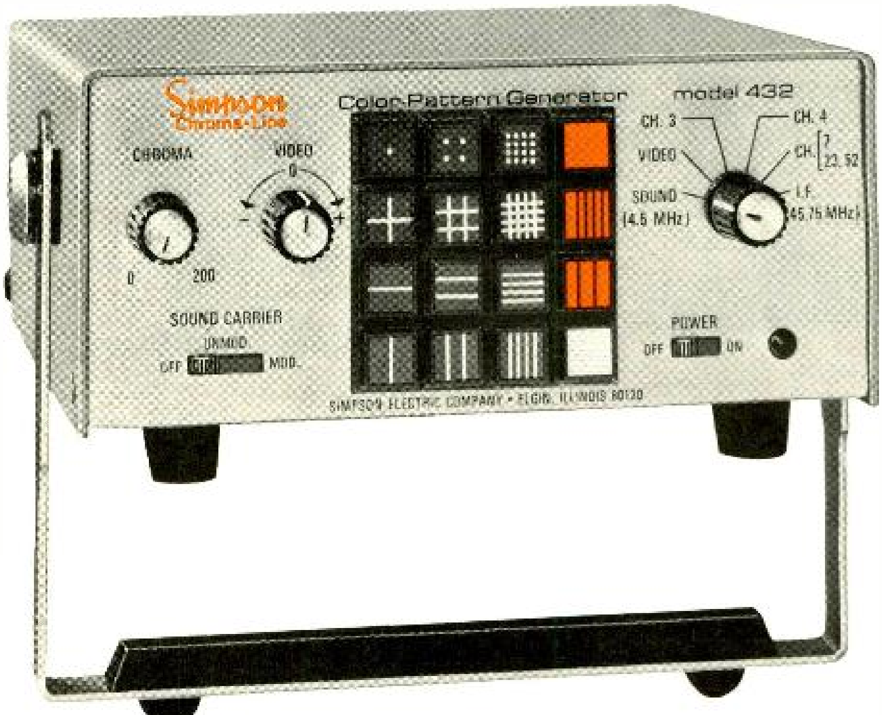

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Circle 86 on reader service card

ALL ABOUT PROBES

Part III

Test leads, transmission lines, connectors and probes are as much a part of a measurement system as the test equipment itself. This month we will discuss passive probes and accessories.

CHARLES GILMORE*

LAST MONTH, WE DISCUSSED THE DIFFERent types of connectors and coaxial cables used in measurement systems.

This third and concluding part of this article discusses passive probes, adaptors and accessories.

Passive probes

The low-capacitance or passive probe first gained its popularity with the oscilloscope. Its popularity in the low-cost area of instrumentation has only been recent, as the cost of this probe for what it could offer was rather high. With the price of this handy accessory substantially reduced and the sophistication of the measurements being made on the home experimenter's bench and service bench increasing every day, the need for the passive probe has grown. It was recently noticed that the passive probe is a great adjunct to the digital frequency counter, as well as the oscilloscope. Both of these instruments have input impedance of 1 megohm resistances paralleled by 20 to 40 pF. Both instruments usually have BNC connectors on their inputs. Both are often involved in in-circuit high-frequency measurements that will not tolerate the high capacitive loading of the simple shielded cable which has been used in the past.

Specifications for the ×10 (or other multiple) passive probes include the multiplication factor; the circuit load capacitance and resistance the probe will show when working into an instrument with a specified input resistance and capacitance; and the range of input capacitance the instrument may have and still achieve compensation. The range of acceptable instrument input capacitance will usuallly lie between 20 and 40 pF. Other specifications include the maximum working voltage (peak AC plus DC), the cable length (probe input capacitance will vary with cable length), and the probe rise time.

Accessories available for this type of probe are important, as they add considerably to the ease of connection to the circuit under test. Probes having spring loaded tips for grabbing circuit components should also have a replaceable tip, as these parts are often worn by use or damaged by contact with a hot soldering iron.

The passive probe is one of the few probes that has operating adjustments. As was noted in the theoretical discussion, a variable capacitor is usually provided so the probe may be adjusted (compensated) to make the capacitive ratio exactly equal to the resistive ratio. As the input capacitance of various instruments varies from one instrument to another (even between units of the same model), compensation must be made every time the probe is moved from one instrument to another, and often when the probe is moved from one input to another on the same instrument. Compensation of the probe is only important when the user desires to use the probe in an application where amplitude measurements are being made.

To compensate the probe, it must be connected to a square-wave source. A satisfactory source has a frequency about 1 kHz and risetimes of a few microseconds or better. The variable capacitor is adjusted until a square wave with good sharp edges is obtained without overshoot (see Fig. 13).

The ×1 oscilloscope probe is used in measurement situations where input resistance and capacitance are not serious problems and where the full sensitivity of an instrument as well as the convenience of the probe mechanics are important. Usually the ×1 probe is designed so the load capacitance it presents to the circuit under test is less than that presented by a simple shielded cable made with coaxial cable. Specifications for this probe will give the maximum operation voltage for the probe and the capacitance this probe will contribute to the circuit. The voltage rating of the probe will be given as a DC plus peak AC. On the better units, the risetime of the probe will be specified with the probe connected to an oscilloscope of given input resistance and shunt capacitance. The series resistance of the probe center conductor may also be given.

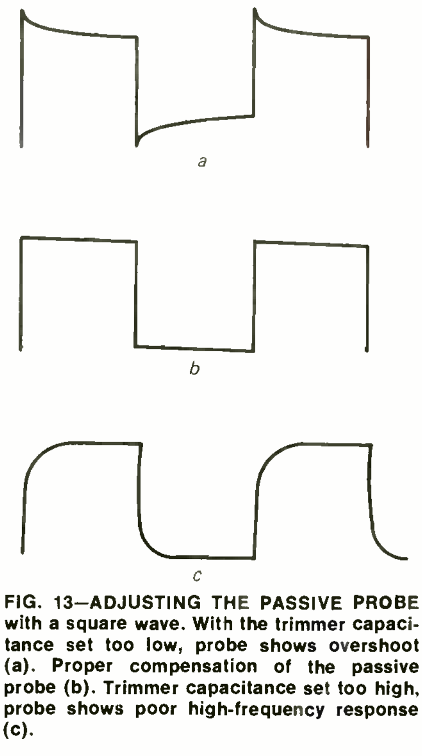

FIG. 13—ADJUSTING THE PASSIVE PROBE with a square wave. With the trimmer capacitance set too low, probe shows overshoot (a). Proper compensation of the passive probe (b). Trimmer capacitance set too high, probe shows poor high-frequency response (c).

Low-cost versions of these probes have been available for a number of years. Most of these probes offer minimal compensation, limited accuracy of attenuation, and most important, they generally do not offer any mechanical sophistication in making the connections to the circuit. It is this mechanical sophistication that is of value to the user. With today's circuits employing many integrated circuit packages, tight foils, custom modules, and transistors in very small packages mounted close to the circuit board, any assistance in making mechanical connections to pins and foil is of great value.

There are some probes that offer the ×1 and ×10 feature in one unit. A switch selects between the two modes of operation. Generally speaking, these probes also fall in the classification of the low-cost probes. Considering the investment in the oscilloscope or the frequency counter, there is little justification in saving a few dollars on the probe. The frustration avoided by spending this twenty dollars or so is well worth the money.

RF probes usually have a specification indicating the frequency response or accuracy vs. frequency. Accuracies are usually specified in dB. Most probes have an upper limit from 100 to 300 MHz. The minimum input voltage level required to cause linear diode conduction is usually specified, starting near 0.2 to 0.3 volts for the germanium or Shottky diode. Most diodes used in this service have a reverse breakdown voltage around 30 volts. If greater potentials are to be measured, a number of diodes must be placed in series. A series of diodes cause the minimum voltage specification to increase by 0.3 volt or more per diode.

Demodulator probes fall into two cate-

(continued on page 96)

*Design Engineer Heath Company, Benton Harbor, Mich.

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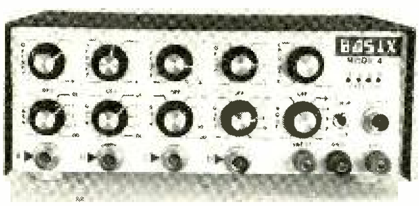
The *PB-6* lets the user test and build circuits without soldering or patch cords; all interconnections between components are made with common No. 22 AWG hook-up wire. The kit includes 630 component tie points.

It measures 6 in. long by 4 in. wide. $15.95 —**Continental Specialties Corp.,** 44 Kendall Street, New Haven, CT. 06509 or 351 California St., San Francisco, CA 94104.

Circle 34 on reader service card

QUAD MULTIPLEXER, *MODE 4,* is a compact accessory instrument that permits display of up to four simultaneous analog and/or digital signals on *any* signal- or dual-channel oscilloscope. Modification of the scope is not required. The instrument was developed and marketed so that four-channel scope capability will cost less than the single-channel scope still found on so many benches despite the frustrating handicap that one- or two-



channels impose upon the users.

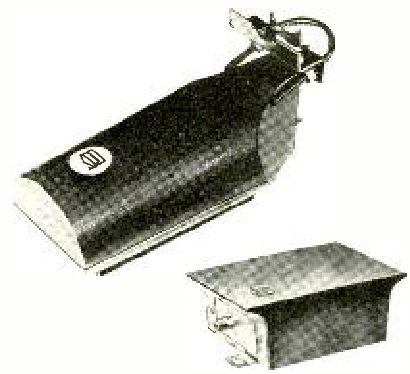
Incorporating the latest in linear and digital IC's, *MODE 4* employs user-selected parallel or serial multiplex modes to produce optimum display continuity, clarity, stability, and retention of realtime relationships between displayed channels. The four inputs may have widely differing amplitudes as a result of individual channel gains of × .01 to × 100 in decade steps.

Digital signals are processed as analog waveforms. Precise waveform reproduction permits identification and correction of such circuit malfunctions as marginal rise and falltimes, switching "bounce", ringing, false triggering, and excessive noise. When used for displaying digital signals, *MODE 4* is compatible with all modern logic families, including TTL and CMOS. Dimensions; 3" H × 8" W × 5" D. Price; $189.00.—**Basix,** 1067 Seneca Street, Bethlehem, PA 18015.

Circle 35 on reader service card

ANTENNA PREAMP/AMPLIFIER, a new combination UHF/VHF preamplifier and amplifier, the *Powercaster model 4287-PC,* combines a Jerrold mast-mounted *Powermate* preamplifier with a *Colorcaster* indoor amplifier. The result is exceptionally high gain and high output capability.

The *Powercaster* is expected to be especially popular in fringe areas, for use with multiple-set installations in homes, apartment houses, hotels and motels. VHF gain is 30 dB,



UHF gain is 25 dB and FM gain is 18 dB. Output capability is +40 dBmV for each of four VHF channels and 37.5 dBMV for each of three UHF channels.

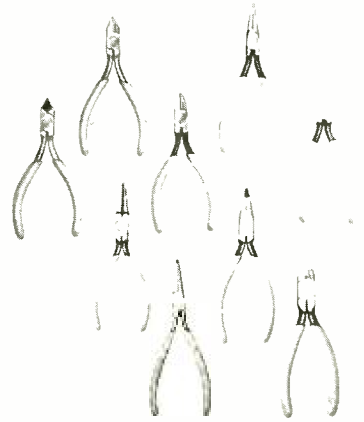
Input of the mast or boom-mounted preamp is matched to 300-ohm antennas. Downlead and output impedance are 75 ohms. A built-in 12-dB FM tunable trap can be used to eliminate interference from a local FM station.

For reception in deep fringe areas, noise figure of the *4287-PC* is very low, 6 dB at VHF and 8 dB at UHF. $97.50.—**Jerrold Electronics,** 200 Witmer Rd., Horsham, PA 19044.

Circle 36 on reader service card

PRECISION ELECTRONIC PLIERS. The nine new models are designed and engineered for electronic assembly and servicing. They are forged and machined from top-grade tool steel. Cutting edges are induction hardened and hand-honed for maximum accuracy and reliability. Pliers for pulling and twisting applications feature two-way, cross-checked serrated jaws. Comfortable turquoise plastic insulating grips and handle opening coil springs assure quicker less fatiguing operation.

The electronic pliers provide all of the basic requirements needed for close precision work. The nine models include diagonal and long-reach cutting pliers plus bent-nose, chain-nose, round-nose and flat-nose

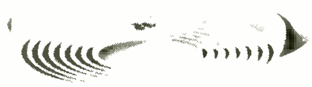


pliers for pulling, twisting, looping, etc. Diagonal cutting pliers are available in 4- and 5-in. sizes with choice of flush or hairline cutting edges and pointed or rounded nose. The 5-in. long-reach plier features a serrated tip ahead of the cutting edge. Chain-nose and round nose pliers, both 4-in. length, are ideal for looping, twisting and forming wire as is the 5-in. bent nose model. The 5-in. flat-nose plier, with serrated tip, is the ideal choice for pulling, holding and clamping requirements.—**Vaco Products,** 510 N. Dearborn St., Chicago, IL 60610.

Circle 37 on reader service card

EARLY WARNING SMOKE DETECTOR, The *B6* solid-state ionization smoke detector should be of special interest to apartment managers, homeowners, warehouse owners and office tenants.

A single unit can protect your entire house (a minimum of 900 sq. ft.). It has a solid-state lamp to indicate proper operation. The *B6* detects the earliest fire indications long before visible smoke, flames and elevated tem-



peratures can be detected by other devices. The attention-getting alarm (110 decibels) is enough to waken heavy sleepers through closed bedroom doors.

Approved by FHA, UBC, BOCA, and ICBO, this unit meets NFPA standards and is also listed by Underwriters Laboratories. Weighing 13 oz., being only 7 in. in diameter and using 120 VAC house current permits quick installation in hallways, living rooms or in furnace rooms where smoke from fires is likely to collect. $69.50—**Mountain West Alarm Supply Co.,** 4215 North 16th St., Phoenix, AZ 85016.

Circle 38 on reader service card

Circle 27 on reader service card

Circle 29 on reader service card

DUAL TRACE 10-MHz TRIGGERED SCOPE, *model 1471*, has 18 calibrated sweep ranges from 1 μs cm to 0.5 sec/cm, and sweeps to 200 ns/cm. The scope will display characters directly from TTL drives, and is suitable for logic and digital design; and for troubleshooting phase-lock loops, DMM's, synthesizers, counters, and calculators.

Vertical sensitivity is 0.01 V/cm to 20 V/cm ±5% in eleven ranges. Calibration accuracy is maintained over line variations from 105 VAC to 130 VAC. Risetime is rated at 35 ns.

Automatic triggering is obtained on waveforms with as little as 1-cm deflection at 10 MHz. Dual-trace mode shifts automatically between CHOP and ALTERNATE as sweeptime is changed.

TTL-compatible intensity modulation Z-axis input enables the *model 1471* to be used in character display systems, and for time and frequency markers. The input is 5 VP-P nominal. Other features include a built-in calibration voltage, line-frequency 1 VP-P squarewave and a 470,000 ohm nominal input impedance.

The scope weighs 19.6 lbs and measures 9⅞ W × 16⅛ D × 7⅞ H. Two PR-20B probes (not supplied) are required. Power consumption is 20 watts. Suggested retail price is $495.—**B & K-Precision Div. of Dynascan Corp.** 1801 W. Belle Plaine Ave., Chicago, IL 60613.

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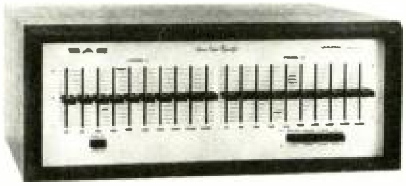
DUAL-CHANNEL EQUALIZER. The *model 17* stereo equalizer features full octave equalization control of ten frequencies (per channel).

The *model 17* corrects poor room acoustics, compensates for improper speaker placement and improves sound quality in old or bad recordings. Reproduced sound can be enhanced by adjustment of the various frequency controls, giving the listener exactly the type and timbre of sound desired. This unit features long-throw, oil-damped, linear slide potentiometers for greater accuracy. Equalization bands can be adjusted over a ±8 dB or ±16-dB range for even greater flexibility. Less than 0.3% total harmonic and intermodulation distortion levels, a greater than −90dB noise level and sufficient signal to feed any amplifier system. Price; $300.—**SAE, Scientific Audio Electronics,** 701 E. Macy St., Los Angeles, CA 90014. **R-E**



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new lit

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WHEEL & BELT FINDER, *No. SBW-1,* is a new measuring device that accurately determines the size of phonograph and tape wheels and belts. It provides the complete capability to measure all dimensions necessary to identify any wheel or belt, such as inside and outside circumferences, widths, thicknesses, diameters and cut lengths.

It is a plastic coated slide-rule caliper-type device, which enables the user to quickly and accurately determine any dimension of the wheel or belt, using either the decimal or metric system. A clear vinyl protective dust cover is included.—**EV-Game Inc.,** 186 Buffalo Avenue, Freeport, NY 11520.

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Also included are ten new modules that were designed to be used as audio console building blocks. These modules can be used singly or as part of a large audio system. They include high- and low-impedance microphone preamplifiers, an active equalizer module, high-gain line amplifier, and a power amplifier.—**Sescom, Inc.,** P. O. Box 590, Gardena, CA 90247.

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TEST INSTRUMENTS CATALOG, *75CBA,* describes the full line of Hickok portable and bench test instruments for service, industry and education. Products covered include single- and dual-trace oscilloscopes, a digital multimeter, function generator, curve tracer, tube testers, a CRT tester/rejuvenator and a sweep/marker alignment generator. Features, operating data and complete specifications are given for each unit.—**Tom Hayden, Instrumentation & Controls Div., Hickok Electrical Instrument Co.,** 10514 Dupont Ave., Cleveland, OH 44108.

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COMPUTER NEWSLETTER, *Computer Notes,* published monthly, presents the latest information by users of the Altair Computer Systems. Tabloid newspaper sized publication runs as many as 24 pages and should be must reading to anyone interested in getting into microprocessors. For information on how you can get your own copies, write to—**MITS Inc.,** 6328 Linn, N.E. Albuquerque, NM 87108.

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ELECTRONIC INSTRUMENT CATALOG lists RCA's line of electronic instruments for use in electronic servicing, industrial maintenance, laboratories, schools and safety tests. It provides highlights on the features of 58 instruments, detailed specifications, photos and applications information for each. Also included is an array of 89 accessory items (probes, cables, carrying cases, etc.) that can be used with these RCA instruments and similar instruments of other makes and models.—**RCA Distributor and Special Products Div.,** Cherry Hill Office, Camden, NJ 08101.

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LOUDSPEAKER CATALOG *'76* shows a variety of speakers in many different types including coaxial, air suspension, public address, intercom miniatures, radio-TV replacements and universal replacement speakers. This 12-page catalogue is likely to contain a speaker for everyone of your speaker replacement requirements.—**Quam-Nichols Co.,** Marquette Rd. & Prairie Ave., Chicago, IL 60637.

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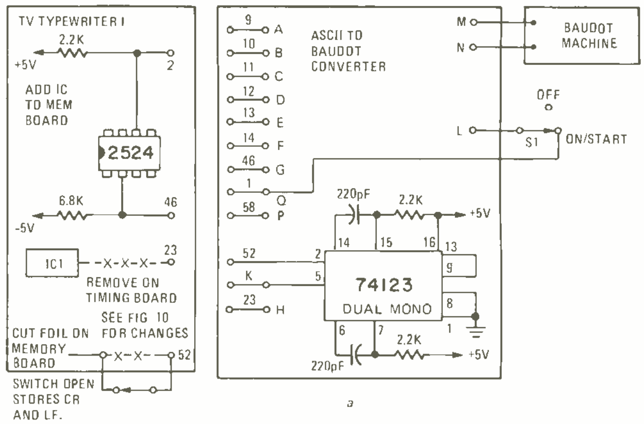
DYMEK NEWS, a four page newsletter that talks about the latest McKay products and developments. A great way to keep up on what's happening in radio equipment.—**McKay Dymek,** 675 North Park Avenue, Pomona, CA 91766. **R-E**

Circle 48 on reader service card

Circle 61 on reader service card

ASCII TO BAUDOT

(continued from page 58)



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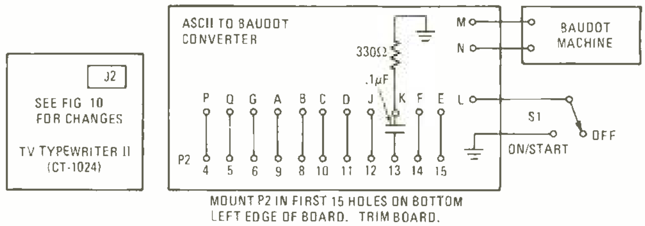

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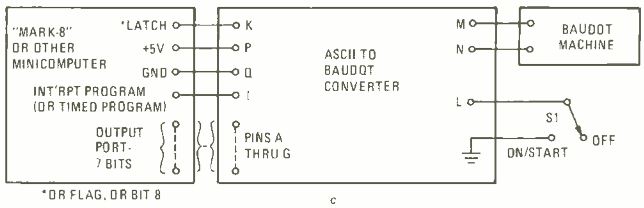

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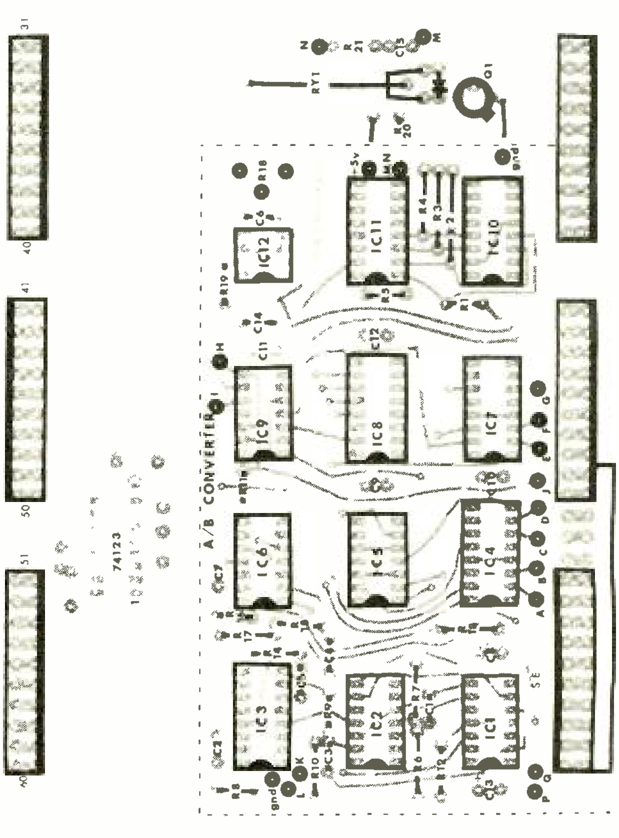
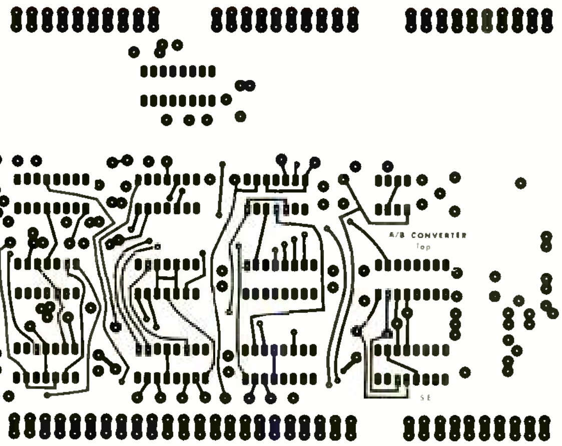
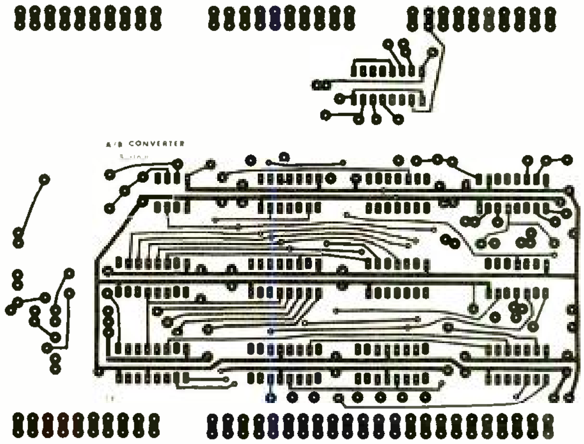


COMPONENT LAYOUT of ASCII to BAUDOT converter board.

FIG. 3—(left) ASCII TO BAUDOT CONVERTER connections to TV Typewriter I are shown in a, TV Typewriter II are shown in b, and mini-computer are shown in c.



ASCII TO BAUDOT CONVERTER printed circuit board foil pattern. Component side of double-sided board is shown ½-size.



ASCII TO BAUDOT CONVERTER printed circuit board foil pattern. Bottom-side of double-sided board is shown ½-size.

ELECTRONIC FUSE

(continued from page 50)

aluminum. Even better is a commercial heat sink like the one described in the parts list. Use number 16 gauge wire with 300 volt insulation for connecting between the board and the controls and transistors. For safety use a 3-wire type AC receptacle and plug. Use a well ventilated enclosure to keep the internal temperature below 75° centigrade.

Calibration

A convenient calibration procedure is to plug incandescent lamps totaling 350 watts into the fuse with the fuse switched OFF. Adjust trimmer R11 to its approximate mid-point position. Turn the fuse ON. After about 2 to 5 seconds, the lamps should come on (the delay is due to the thermal lag in the filaments). Adjust the trimmer until the lamps just turn off. What you have done is adjusted the fuse to "trip" at a 350-watt 3-amp RMS load. The final test is to remove about 50 watts of lamps and see if the remaining lamps turn on without causing the fuse to trip. R-E

ALL ABOUT PROBES

(continued from page 81)

gories: those designed for general purpose applications and generally tailored for use with an oscilloscope; and those designed for use with some specific purpose instrument. The general-purpose type is designed to operate into the 1-megohm input impedance of an oscilloscope and provide demodulated bandwidths between 100 kHz and 1 MHz. Most of the basic specifications of the demodulator probe are similar to those of the RF probe. Demodulator probes are usually of the single diode type.

Specific-purpose demodulator probes may either be part of an instrument or they may be supplied as independent packages. The specifications applied to such demodulators will be determined by the intended application. Generally these will not suffice for universal service oriented demodulator probes.

High-voltage meter probes specify the multiplication factor, input impedance, accuracy of the multiplication, meter impedance which they are designed to operate with, and the maximum voltage the probe may be used to measure. The accuracy of these probes degrades with humidity and temperature and with lack of cleanliness of the probe or multiplier resistor. The resistor must never be handled as this creates a leakage path and lowers the accuracy of the voltage division. The high-voltage probe must always be disconnected from the voltage source first. Disconnecting the probe from the meter first may damage the meter and the operator.

Frequently, a high-voltage probe will have apparent capability to work at higher than rated potentials. For example, a ×100 probe designed for use with a VTVM is rated at 30 kV but 100 times the maximum range on the VTVM is 150 kV. Do not attempt to use high voltage probes beyond the indicated ratings as both the insulator and the multiplying resistor may well breakdown.

Accessories

There are many adaptors and other accessories that are useful. One of the most important is the 50-ohm feed-through terminator. This handy little device consists of a BNC male to BNC female connector assembly shunted internally with a 50 ohm nonreactive resistance. The terminator allows the user to properly terminate a 50 ohm line at the one megohm input to an oscilloscope, for example, when a non-terminated line would cause severe reflections and distort the measurement. Such terminators are invaluable for use on any pulse or RF systems. Terminators usually come in 1- or 2-watt models. The voltage standing-wave ratio (VSWR) is usually specified for these units; however, the importance of the VSWR specification is somewhat dubious as the majority of the reflections that do occur are caused not by the terminator, but by the capacitance of the device to which it is connected. Power levels of one or two watts will generally take care of most instrumentation uses. Remember these are not kilowatt dummy loads for transmitters!

A 75-ohm version of the inline terminator is available for video or TV RF work, and a 93-ohm terminator is also available.

Simple low-power attenuators are also available in similar packages as the inline terminator. These attenuators are available with a number of different attenuation levels, and are capable of handling power in the one to two watt area. These attenuators come in both 50- and 75-ohm models.

Another useful series of accessories is the coaxial adapters. A number of these devices are shown in Fig. 14. The need

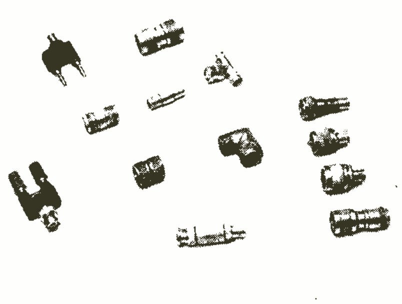


FIG. 14—COMMON AND HANDY coaxial adaptors and accessories.

for these devices will vary with the type of work being done: however, the knowledge that these devices do exist and their source can be quite valuable. The various connections that can be made are self-explanatory. It should be noted that these devices will have some reflections and the total number of devices used should be held to a minimum wherever possible.

Shop necessities

The investment in accessories, cables and probes, can be sizable. On the other hand, the time lost trying to make do when one simple device is not available can easily pay for the device. Of course the selection of accessories depends on the type of work being done. A number of cables will work as adapters. Such cables are often cheaper than purchasing the adapters and can be made up as they are needed. One note of caution—home-made adapters usually cost more than they save, as they seldom are successful. The BNC female to UHF male, and the phono jack to UHF male are moderately successful home-brewed, but such items as a BNC female to N male, a UHF female to N male and a phono socket to BNC male have caused a great deal of trouble, and have taken time to troubleshoot out of a system.

Probes, cables, and accessories can be the items that make an instrument what you thought it should be. A good selection of these items is well worth the comparatively small cost they represent. They are good items to have in mind when bargain hunting. A good collection of these devices can be quickly assembled and a dot of enamel paint or the like enables quick identification of personal property should these devices become pooled with someone else's. **R-E**

(continued from page 74)

LOW-VOLTAGE BREAKER ON 120-VOLT AC?

I had a circuit-breaker problem in an old Packard-Bell. It would trip after a few minutes. Tried another one with the same results. Apparently no other problems. So, I put in an 8-A breaker of the type used in automobile accessories, and it holds very nicely! Set still plays perfectly, but I wonder about the low-voltage breaker on 120-volt AC. What do you think?—A.B., Rochester, NY.

It sounds as if is all right. Actually a circuit breaker works on the *current* flow through it. As long as it doesn't arc over, it should be all right. Your original breakers may have been in a location on the chassis where the temperature was too high! I've run into this in quite a few sets. The high ambient temperature made the breakers trip even though the current was not too high. Try moving the breaker to a cooler spot.

STRANGE VERTICAL PROBLEM AND BAD FOLDOVER

I've found the strange vertical problem on a Hitachi CT-901 chassis to be due to a 14-volt 1-watt Zener diode. This diode is located in a plastic sleeve soldered to the back of the circuit board near the vertical oscillator transistor. The fun part is that this isn't on all the schematics!

On a Philco 15J27 chassis, the bad foldover problem is usually due to a shorted .0082-μF capacitor connected between the two 820K resistors in the vertical output grid-bias circuit. When this goes, it shorts out the negative bias from the VDR in the plate circuit.

(These were two Questions printed in the November, 1975 issue of **R-E.** Thanks to Ken Krueger, GET, Active TV, Milwaukee WN for two different answers! Keep them cards and letters comin' folks).

BRIGHT HORIZONTAL LINES

There are three or four bright white horizontal lines, broken up, near the top of the screen in this Zenith 13A16. They're not retrace lines; they're perfectly horizontal. No slant. Do you have anything on this in your files?—D.W., Arroyo Hondo, NM.

Yes. In several cases, these have turned out to be due to a vertical integrator that is either open or greatly increased in resistance. Lift one side and check the resistance from end to end. This seems to cause a very sharp foldover at the top, and you're actually seeing the VITS signals (*V*ertical *I*nterval *T*est *S*ignals) in the raster.

NO SOUND, NO PIX

I've got voltage problems, also no sound or picture on a Panasonic TR-449B. I can't get anything like the normal DC voltages anywhere! What's going on?—J.L., Millburn, NJ.

In this chassis, the most likely thing to cause such a symptom would be a bad IC voltage regulator in the DC power supply circuits. This is a Panasonic TVC MK3800. Don't seem to find a substitute listed for it.

(Feedback; that was it!)

POWER TRANSFORMER

I asked you to help find a suitable power transformer replacement for my Hickok model 209 VTVM. You suggested a Thordarson 24R101. This works fine! Thanks a lot. Incidentally, if you run into trouble with your model 209 and the meter needle slams back and forth, check to see if the 6SN7 tube doesn't have a slight *leakage*. That's what caused this trouble in mine.

(Thanks to Frank Kramer, S. Euclid, OH.) **R-E**

RECORD-CARE BREAKTHROUGH

(continued from page 43)

the fundamental, or 0.1%) as it was for the mint condition disc.

When you consider that we were using a top grade turntable, pickup arm and cartridge tracking at 1.5 grams, this is quite significant and serves as more reliable confirmation of the results obtained by Ball Corporation with their more crude playback setup. It proves, too, that even at such light tracking forces as we used there is an increase in total harmonic distortion after 100 playings of ordinary vinyl discs.

Surface noise

Everyone knows that with repeated playings of a disc, surface noise increases. Ball Corporation had told me that, in their experience with the new lubricant, they had found that it tended to "smooth over" some of the ticks and pops that already existed in some of the recordings they had treated. While they did not plan to emphasize this fact in their promotion of the product, I decided to investigate the effect of the product on surface noise generally.

Again, two test records were used, one treated with *Sound Guard* lubricant, the other untreated, and each was played 100 times. This time the spectrum analyzer was swept over its full frequency range, from 0 to 100 kHz in a linear rather than a logarithmic fashion and the sweep was slowed down sufficiently to integrate the spectral noise patterns on the scope face. The noise distribution for the untreated record is shown in the scope photo of Fig. 8.

Using the same amplitude settings for the display, the sweep was repeated, this time playing the grooves of the treated record. In addition to the significantly lower noise level distributed over this wide frequency spectrum, notice that in Fig. 9 there are far fewer sharp "spikes" in the audible region at the leftmost portion of the sweep. We could only conclude that not only does *Sound Guard* lubricant inhibit the gradual increase of surface noise that occurs with repeated playings but it actually decreases the severity of those annoying "pops" and "clicks" which are so familiar to record fans.

We further confirmed this effect by applying the *Sound Guard* lubricant to several of our favorite (and therefore often-played) discs. Sure enough, while the surface noise was still there, it was noticeably less obtrusive—"softer" would be the best term we could find to describe the change. It would seem that a coating of .000005" is not enough to mess up high-frequency response but *is* enough to smooth over some of the "rough edges" in the grooves that cause "surface noise."

Additional side benefits

The results we obtained from these experiments suggested to us that friction between the stylus and the record groove must be significantly reduced when the product is applied to a disc. This may have a beneficial effect for users in terms of anti-skating adjustment. Skating force is a function of the geometry of the pickup arm, the shape of the stylus tip and the coefficient of friction between the stylus tip and the vinyl surface.

If applying *Sound Guard* lubricant reduces friction, than required anti-skating force is also reduced. Since many record players are not equipped with anti-skating adjustments, the application of this preservative lubricant may well promise reduced left-groove record wear in addition to the overall reduction in record wear.

The reduced friction between the stylus and groove might be thought to present a problem in the case of a very light-tracking cartridges (designed to track at 1 gram or less). Would the stylus have a tendency to "slide right out of the groove"? Actually the reverse is true. Because of the greatly reduced friction, the stylus rides more smoothly in the groove and such irregularities in the groove as nicks, scratches or even record warpage have less of a tendency to throw the stylus out of the groove than would be the case with an untreated disc.

An even more significant record preservation effect will take place in cases where heavy tracking force is used between stylus and record surface. Many less expensive record changers to require cartridge tracking forces of 3 or more grams and users of such equipment stand a greater danger of early record wear than do those who use more expensive record playing equipment. As confirmed in Ball's own earlier distortion measurements (where higher than average tracking forces were used), the rate of distortion increase—and the amount of increase in harmonic distortion with relatively few playings of the untreated disc—suggests that the extension of the life of a record will be proportionately greater with heavier tracking forces.

The new product would therefore seem to have as much application in systems owned by critical audiophiles as it does for the least expensive type of "portable" stereo record player.

Since users of any record care product are probably not too keen on having to use more than one preparation, the makers of *Sound Guard* have also included an anti-static compound in the total formula which reduces static

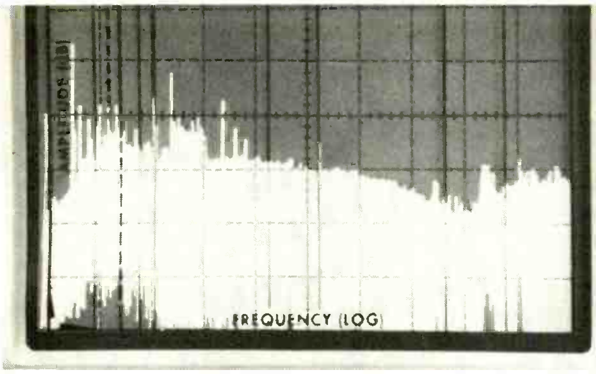


FIG. 8—SPECTRAL DISTRIBUTION of random noise after 100 playings of untreated record.

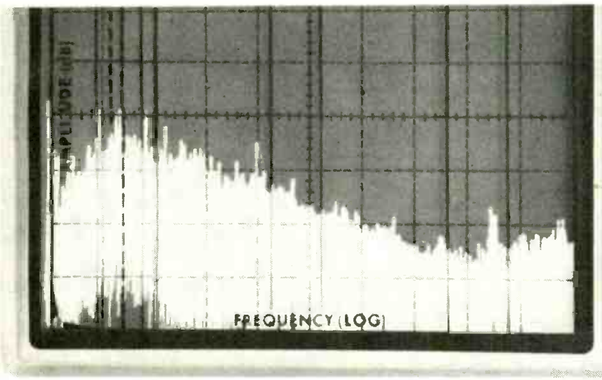


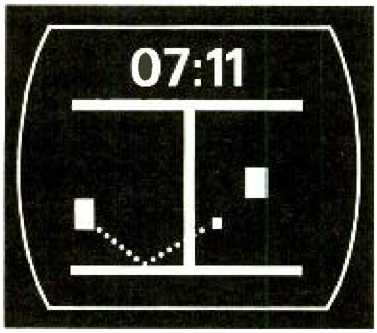
FIG. 9—SPECTRAL DISTRIBUTION of random noise after 100 playings of treated record.

charges on record discs and thereby prevents dust from being attracted to the surface while the record is being played. While casual users may well think of the new product as "another record cleaner" (and indeed, it does serve that function), it's important to note that the product should be applied to perfectly clean record surfaces in the first place. If there are minute particles of debris in the record groove when the product is applied, the coating may well trap such particles permanently bonding them to the surface of the record.

How to use it

As packaged, *Sound Guard* comes in a small glass bottle. A separate hand spray cap is screwed onto the bottle when records are to be treated and about 15 to 20 sprays are applied to the disc, held vertically, while it is rotated by hand so that the entire surface is covered. Then the buffing pad is used in a circular motion around the surface of the record to buff in the material and remove any excess. After a few seconds, the liquid disappears and all that is left is the thin bonded coating, which becomes invisible after a playing or two. There is enough in the bottle to treat from 20 to 25 twelve-inch discs. Re-treatment is recommended after from 25 to 50 playings. The photo in Fig. 9 shows the contents and packaging of the product, and the kit will sell for around $5.00.

There are many people who decry our much debated space program. Arguments defending the program have pointed out the many derivative products and techniques that are a direct result of our investment in space technology. Benefits have ranged from the medical field to improvements in communication and have been far reaching indeed. I would never have guessed, though, that space research would lead to a product that preserves the fidelity of records—but that seems to be exactly what has happened in the case of Ball Corporation's *Sound Guard*. Well, that's the story of a couple of months of work in my lab, and now you'll have to excuse me. I still have about 300 more records that need to be "sprayed." . . . R-E



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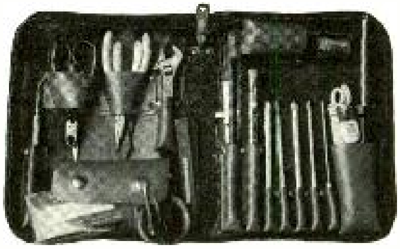

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UNDERSTANDING TAPE SPECS

(continued from page 70)

333 Hz signal recorded at 3% third order distortion level using the reference DIN bias.

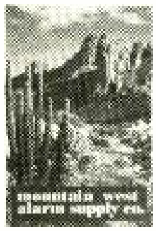
In addition to the electromagnetic and intrinsic magnetic properties of tape, such physical properties as width and width tolerance, thickness (of the backing itself, of the oxide and total), yield strength, and ultimate breaking strength are often specified in describing a tape. At 3M, yield strength is defined as the force that produces a 5% elongation of a sample of tape under test.

Tapes and tape decks

As you can see, fully specifying the performance and physical qualities of any tape involves more than the kinds of superlative statements we find in most tape advertising. Even if all of the parameters discussed thus far are clearly spelled out, the interdependence of the tape machine and the tape itself cannot be overly emphasized. In comparing two tapes on two different machines, it is not uncommon to find that the differences between the two tapes under test may vary from machine to machine. We have not, for example, considered differences in record and playback equalization built into different machines. Such differences may have a significant effect on the overall *system* performance and especially on such performance criteria as wow-and-flutter which, in the case of cassettes, are a function of both the dimensional tolerances of the cassette itself and of the transport mechanism of the machine upon which it is being tested or used.

All of this suggests, once more, that manufacturers of tape decks owe the consumer a bit more definitive information when specifying the best tapes for use with their machines. By the same token, it might not be a bad idea if manufacturers of tapes came right out and listed specific bias and equalization settings for a variety of machines that would deliver best results when used with their tape products.

Many years ago, records were made using a variety of equalization techniques and playback equipment (amplifiers, preamplifiers, receivers) of better quality was fitted with various switch positions. Each switch position corresponded to a particular playback equalization. Record companies specified the equalization they used, and listeners adjusted their equipment accordingly. Today, RIAA equalization is standard for all discs, so the switch positions are no longer needed. The number of variables involved in tape recording and playback are far greater than the simple equalization differences we used to have in records, so the more information supplied by both tape manufacturer and tape deck manufacturer, the better able we will be to use our tape decks more effectively. A cooperative effort by the major tape and tape recorder manufacturers could lead to the development of equipment designed to get the best results from any tape, regardless of type. **R-E**



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4-CHANNEL, WHAT'S WRONG
(continued from page 77)

knew whether a contemplated purchase was SQ or QS encoded. (Even many record salesmen couldn't unscramble some record identification codes.) And waiting in the background there was CD-4 which was always ready for introduction to the marketplace just as soon as a few bugs were eliminated. Trouble was, it took too long to get rid of the bugs.

CD-4 De-bugged

Unlike matrix surround-sound that depended initially on pscho-acoustic effects that proved inadequate in the typical home environment, at its introduction CD-4 did in fact produce four discrete sound directions if the demodulator was properly adjusted and the software was adequate. Software, as it turned out, was to be CD-4's main problem; there were few CD-4 records available for an otherwise viable system, and few record shops stocked them.

By the time a sufficient CD-4 library was available QS and SQ matrix systems has been "logic'd," and there was a considerable matrix library available. Note that I say "matrix library" and not SQ or QS library. To all but the serious stereo enthusiast there wasn't much distinction between the systems because many magazines articles stressed that good results could be had with an intermix, i.e.: QS records with an SQ decoder and vice versa. This of course was nonsense; what was being sold was "some sort of a surround-sound effect," not real 4-channel. You could not hear what the arranger put on the record if the systems were intermixed.

The buyer, therefore, was faced with a choice of three 4-channel systems: two matrix and CD-4. This eventually narrowed to a choice of two systems (by a smart salesman): matrix and CD-4. Either took one hell of a good demonstration to justify the extra equipment expense represented by two speakers, two amplifiers (even if built into the same cabinet as the front or stereo amplifiers), the decoder (whose cost was now formidable since logic was added), and a CD-4 demodulator and pickup (another formidable cost). In short, the user would pay almost double that for a stereo system of equal sound quality.

The falling out

Many of the top names in high fidelity were introducing expanded 1975 4-channel lines just as our inflation-depression deepened. Unemployment was rising in late '74, inflation was cutting into disposable income and high fidelity equipment costs were soaring. Almost overnight, the money that could buy superb stereo or excellent 4-channel systems could now purchase only an excellent stereo system or a minimal 4-channel system. The typical consumer opted for the better stereo.

Between the average consumer's confusion over 4-channel, his decision to go stereo, and the general depression in hi-fi equipment sales, many manufacturers cut back sharply on their '76 and '77 4-channel lines, while many audio showrooms similarly cut back on their 4-channel demonstration facilities. It was almost as if the industry was saying "Though we show 4-channel we suggest you buy stereo." Even the leaders, who pushed 4-channel from its very inception, expanded their stereo lines at the expense of 4-channel.

From the beginning

Four-channel must now build from the beginning again if it is to get a solid foundation in the high-fidelity market. Only this time it must avoid psychoacoustic rationalizations, and substantial quantities of software must be available in all record stores. Most important, 4-channel must be sold as a complete system encompassing matrix, CD-4 and enhanced stereo. The user must get it all in a single equipment. He must not be forced to make the choice as to which is best.

But until times get better and the consumer has an extra dollar or so, mass-market surround-sound will be represented primarily by stereo receivers (and amplifiers) with a second speaker system(s) output doubling as a Dyna connection for enhanced stereo. Many of the latest receivers provide this simple form of surround-sound through a rear apron switch that costs pennies.

As long as this Dyna connection is promoted as enhanced stereo all will be fine for it will still be stereo for stereo enthusiasts, serving as an introduction to surround-sound. But if enhanced stereo is once more promoted as matrix-compatible it will simply return confusion to the marketplace and insure more years of reduced interest in 4-channel.

Four-channel originally went wrong trying to establish under-developed systems as viable hi-fi mediums. As proven, it just doesn't work when the dollar is tight. 4-channel can only build the market it deserves by building up from the most advanced matrix logic and PLL CD-4 circuits presently available; not as a lesser-quality compromise to stereo. 4-channel should represent a trade up, or upgrading, rather than a quality *trade off*. Unfortunately, the way things are being handled by many manufacturers and dealers, 4-channel is still treated as a *trade off*. R-E

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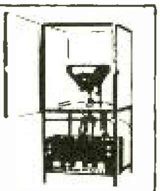

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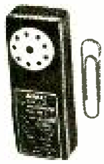

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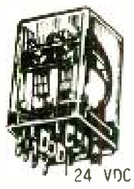

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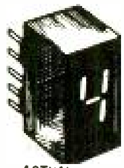

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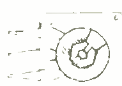

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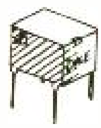

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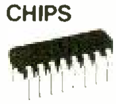

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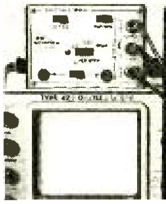

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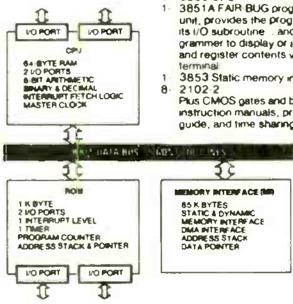

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(continued from page 22)

actual machine. Your programs will be largely independent, but you will not develop the understanding of computer operation and machine architecture that you will gain from programming in a machine's assembly or machine language.

Another factor to consider is size and availability. Higher-level language processors are at least as large as assemblers and require the same I/O devices. They are also considerably harder to develop.

All examples for this column will be presented in the assembly language of the 8080 microprocessor. This will give us maximum coverage of both hardware and software interaction while providing a good medium for programming.

Microcomputer evolution

The microprocessor has received a lot of press as being a revolutionary device that sprang fully formed from the logic designer's forehead. In actuality, the microprocessor is a logical evolution of increasingly sophisticated integrated circuit technology combined with program-controlled logic.

Early SSI (*S*mall *S*cale *I*ntegration) integrated circuits were simple gate functions. Logic designers combined these together to form more complex functions and systems. As the technology improved, it became possible to provide more complex functions as building blocks for logic design. At this point the integrated circuit designers were faced with the problem of what basic functions to build. Since there were many more devices on the chip than there were pins available for I/0, some decisions had to be made as to which inputs, outputs, and functions should be provided to make generally useful devices.

The families of MSI registers, counters, adders, memories, and so on are the partitioned logic devices that resulted. As the trend to more complex devices continued, the question of what types of general devices to build became a crucial factor. Eventually the decision came down to hardwired functions which would be built for large volume special applications (clock chips, calculator chips, custom controllers, memories, etc.) and general purpose devices whose function could be altered by means of programming (microprocessors). Actually, the calculator chips are really special purpose microprocessors, combining memory, control, ALU, and some I/O all on a single chip. While very cost effective for their specific functions, the calculator chip's architecture was compromised to the point of making it difficult to use for anything else. The more general purpose microprocessors, on the other hand, did not have their main memory on the same chip as the ALU and control. This extra room allowed the designers to implement more versatile architectures for use in general applications.

The first generation of microprocessors to be introduced were 4-bit machines bearing a strong resemblance to their dedicated calculator relatives. They were designed for use in arithmetic applications such as advanced calculators, process controllers and computer peripherals, and as a result their architectures were optimized for arithmetic operations on 4-bit BCD numbers. These were followed by the first generation of 8-bit machines. These were intended for use in more sophisticated control and data processing systems, eight-bits conveniently storing one ASCII character. The early four- and eight-bit machines all suffered from extreme compromises forced by the process and packaging technology. Heavily multiplexed data paths, limited instruction sets, and complex interface and timing requirements made these devices difficult to use.

The introduction of the 8080 marked the beginning of the second generation of microprocessors. Featuring a sound general purpose architecture with a broad instruction set, unmultiplexed data paths, and TTL-compatible N-channel technology, this device offered major increases in both speed and useful computing power. It is this microprocessor and the others of its generation that have brought us to the day of a computer in every home.

Whats next? To try and predict the trends in the microprocessor evolution at this point is apt to be futile, since the field changes at a bewildering pace. What we will try to do is establish some sound programming and analysis procedures that will allow us to keep up on the technology as it evolves. To give a basis for future comparisons we will use these principles on a real processor. In this manner we will develop skills that will be real and readily transferred to any other devices as the technology advances. **R-E**

Circle 92 on reader service card

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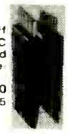
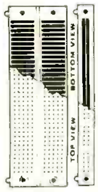


SOCKETS & BUS STRIPS



Plug-in, wire, test, modify or expand without patch cords or solder. Snap together to form breadboard needed.

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7400N	$.12	7442N	.58	7497N	5.00	74164N	1.10
7401N	.15	7443N	.77	74100N	1.00	74165N	1.10
7402N	.14	7444N	.77	74104N	1.20	74166N	1.28
7403N	.15	7445N	.77	74105N	.50	74170N	2.05
7404N	.16	7446N	.83	74107N	.33	74173N	1.34
7405N	.19	7447N	.72	74109N	.74	74174N	1.25
7406N	.29	7448N	.80	74110N	.72	74175N	.94
7407N	.29	7450N	.14	74111N	1.20	74176N	.90
7408N	.18	7451N	.14	74116N	2.00	74177N	.90
7409N	.20	7453N	.14	74121N	.36	74178N	.90
7410N	.16	7454N	.14	74122N	.38	74179N	2.50
7411N	.24	7459N	.20	74123N	.70	74180N	.80
7412N	.33	7460N	.14	74125N	.47	74181N	2.39
7413N	.44	7470N	.26	74126N	.53	74182N	.70
7414N	.95	7472N	.26	74128N	.84	74184N	1.84
7416N	.30	7473N	.37	74132N	1.10	74185N	2.20
7417N	.33	7474N	.32	74136N	.95	74188N	4.75
7418N	.25	7475N	.50	74141N	1.20	74190N	1.20
7420N	.13	7476N	.32	74145N	.91	74191N	1.20
7421N	.33	7480N	.48	74147N	2.40	74192N	.96
7422N	.50	7481N	1.30	74148N	2.00	74193N	.95
7423N	.37	7482N	.98	74150N	1.00	74194N	1.10
7425N	.23	7483N	.70	74151N	.80	74195N	.74
7426N	.23	7484N	3.00	74152N	1.40	74196N	.99
7427N	.25	7485N	.90	74153N	.79	74197N	.78
7428N	.33	7486N	.34	74154N	1.40	74198N	1.60
7430N	.20	7489N	2.20	74155N	.97	74199N	1.60
7432N	.24	7490N	.48	74156N	.95	74200N	5.60
7433N	.36	7491N	.78	74157N	.74	74221N	1.50
7437N	.29	7492N	.49	74158N	1.60	74251N	1.75
7438N	.29	7493N	.49	74160N	1.24	74278N	2.45
7439N	.38	7494N	.72	74161N	.99	74279N	.94
7440N	.16	7495N	.80	74162N	1.25	74293N	1.00
7441N	.87	7496N	.70	74163N	.99	74298N	1.98

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

LOW POWER TTL

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

74LS

74LS00	.39	74LS27	.45	74LS109	.92	74LS163	2.25
74LS01	.56	74LS30	.39	74LS112	.65	74LS170	5.80
74LS02	.39	74LS32	.45	74LS113	.92	74LS174	2.20
74LS03	.39	74LS38	.53	74LS114	.92	74LS175	2.40
74LS04	.45	74LS51	.39	74LS138	1.89	74LS181	6.00
74LS08	.39	74LS54	.55	74LS139	2.00	74LS194	2.25
74LS09	.57	74LS55	.39	74LS151	1.55	74LS195A	2.25
74LS10	.39	74LS73	.65	74LS153	1.89	74LS196	2.76
74LS11	.42	74LS74	.65	74LS157	1.55	74LS251	2.06
74LS15	.57	74LS76	.65	74LS158	1.68	74LS253	2.42
74LS20	.39	74LS78	.92	74LS160	3.06	74LS257	1.89
74LS21	.56	74LS95	2.30	74LS161	3.06	74LS258	2.06
74LS22	.60	74LS107	.65	74LS162	2.25	74LS260	.55

SCHOTTKY TTL

74S00	.44	74S32	.80	74S113	1.50	74S174	3.30
74S01	.76	74S40	.65	74S114	1.20	74S175	2.90
74S02	.60	74S50	.76	74S133	.80	74S181	6.00
74S03	.75	74S51	.80	74S138	2.20	74S189	4.40
74S04	.55	74S60	.80	74S139	2.20	74S194	3.30
74S05	.76	74S64	.80	74S140	.80	74S195	3.30
74S08	.80	74S65	.80	74S151	2.20	74S251	2.20
74S09	.76	74S74	.90	74S153	3.40	74S253	2.40
74S10	.55	74S76	1.15	74S157	2.40	74S257	2.40
74S11	.65	74S78	1.16	74S158	2.00	74S258	2.40
74S15	.76	74S85	6.10	74S160	3.90	74S260	1.20
74S20	.65	74S86	2.50	74S161	4.70	74S280	5.70
74S21	.76	74S112	1.00	74S172	6.00	74S289	4.00
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9309PC	1.60	9334PC	2.95	93L10	2.80	93L34	4.00
9310PC	1.50	9338PC	3.30	93L11	4.20	93L38	4.20
9311PC	2.30	9340PC	5.00	93L12	1.80	93L40	6.50
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9314PC	1.30	9342PC	1.15	93L16	3.20	93L60	3.00
9316PC	1.50	9360PC	1.75	93L18	3.50	93L66	2.70

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LM300H	1.20	LM312N	1.75	LM711CN	.90
LM300N	1.20	LM318H	1.50	LM715CH	3.50
LM301AH	.50	LM318M	2.40	LM715CD	4.60
LM301AM	.80	LM324N	1.90	LM723CH	.60
LM301AN	1.10	LM331N	1.25	LM723CN	.65
LM301M	.95	LM336K	2.40	LM725CH	1.50
LM302N	1.30	LM339N	2.20	LM725CD	5.00
LM302H	1.40	LM320-5K	2.90	LM733CH	1.40
LM304H	1.20	LM320-5T	2.50	LM733CD	3.50
LM305H	.85	LM320-12K	2.90	LM733CN	1.30
LM305AH	1.05	LM320-12T	2.50	LM741CH	.40
LM305N	1.00	LM340-5K	2.60	LM741CD	1.25
LM306N	.95	LM340-6K	2.60	LM741CM	.39
LM307H	.60	LM340-8K	2.60	LM747CH	.75
LM307M	1.50	LM340-12K	2.60	LM747CN	.90
LM308H	.85	LM340-15K	2.60	LM748CM	.55
LM308AH	5.00	LM340-18K	2.60	LM777CH	2.15
LM308D	2.25	LM340-24K	2.60	LM777CM	2.10
LM308M	1.00	LM555CM	.70	LM3046CN	.95
LM309H	1.75	LM556CM	1.30	LM3054CN	1.50
LM309K	1.50	LM567CM	1.70	SG4501T	2.40
LM310H	1.50	LM709CH	.75	SG4501N	2.40
LM310M	1.80	LM709CN	.75	LM5000K	7.50

C-MOS

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

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APS15-6	15	6		
APS24-5	24	5		
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MM507H	3.20
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MM555H	5.60

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1403AH	4.00
1403AN	3.80
1404AH	4.50
1404AN	2.90
1405A	4.00
1406	8.40
1407	8.40
1506	3.00
1507	3.00
1602	33.00
P2101	5.00
P2101-1	5.50
P2101-2	4.90
P2111	5.80
P2111-1	6.00
P2111-2	5.90
P2112	5.00
P2112-2	5.90
P2401	9.90
P2405	9.70
2505K	3.30
2512K	4.00
2521V	2.50
2525V	3.50
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PIN	1-24	25	100
8	.21	.19	.17
14	.25	.22	.20
16	.28	.25	.23
24	.67	.61	.55
28	.88	.80	.72
36	1.09	.98	.89
40	1.24	1.12	.92

WIRE-WRAP GOLD

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

SOLDER - GOLD

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

TEFLON TO-5

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

LEDs

.125" dia.

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

.160" dia.

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

.200" dia.

220 RED $.25
220 YELLOW .30
220 GREEN .30

LOW PROFILE

.200" dia.

226 RED $.25
226 YELLOW .30
226 GREEN .30
226 ORANGE .30

.200" dia.

5053 RED $.35
5053 YELLOW .40
5053 GREEN .40
5053 ORANGE .40

MV50 RED $.30

216 = MV5024
5053 = MV5053

DISPLAYS

OPCOA			XCITON		
SLA1	RED	2.25	XAN72	RED	2.00
SLA11	GREEN	3.50	XAN52	GREEN	2.00

LITRONIX

DL80	RED	6.00	DL44	RED	6.00
DL81	RED	6.00	DL402	RED	4.00
DL10	RED	6.00	DL701	RED	3.40
DL10A	RED	4.00	DL704	RED	2.25
DL101	RED	4.90	DL707	RED	2.35
DL57	RED	9.90	DL747	RED	2.50
DL61	RED	12.00		1-9	10 up
DL33	RED	4.00	DL747	RED 2.50	2.40

CARBON FILM RESISTORS

¼ WATT 5%

150 STANDARD VALUES . . . . $1.69 per 100
10 ohm to 10 megohms . . . . Only in multiples of 100 per value

EP 9125 9-DIGIT DISPLAY
$7.90
1/8" Character Ht. Compact, Thin PC Pkg., Wide Viewing Angle

ELECTRONIC ARRAYS

EA1500AJ
1-24 $21.00
25 16.80
100 14.00

EA 1500ASJ
1-24 $16.00
25 14.40
100 12.00

OPTOISOLATORS

MONSANTO		LITRONIX			
MCT2	1.35	IL1	1.30	IL74	1.35
		IL12	1.40	ILD74	1.75
		IL16	1.80	ILQ74	3.40

AUDIO AMPS

TYPE	V	W	Ω	PRICE
LM352	6-15	1.15	8	1.60
TAA611B12	6-15	1.15	8	1.60
TAA621A12	6-27	1.40	8	2.00
TAA641811	6-18	2.20	4	3.00
TBA800	5-30	4.70	8	2.20
TBA810AS	4-20	2.50	4	3.00
TBA820	3-16	0.75	4	1.70
TCA830	5-20	2.00	4	2.20
TCA940	6-24	6.50	8	4.40

Prices effective through March 31, 1976.
Minimum order: $10.00. Add $1.00 to cover postage and handling. California residents add 6% sales tax.

SEND CHECK OR MONEY ORDER TO:

ANCRONA CORP.

Mail order: P.O. Box 2208R, Culver City, CA 90230. Phone order: (213) 641-4064
Visit our Electronic Shop: 11080 Jefferson Blvd., Culver City, CA
(Studio Village Shopping Center)
Prices may vary at over-the-counter locations.

STANDARD MICROSYSTEMS

	1-9	10 up
COM2502	$13.20	$10.60
COM2502P	8.00	6.85
COM2017	13.20	10.60
COM2017P	8.00	6.85
COM2502H	25.00	20.00
COM2017H	25.00	20.00
COM2601	30.00	24.00
COM5016	12.00	9.60
KR2376-ST	20.00	17.50
KR3600-ST	20.00	17.50
NMX5010	12.00	9.60
CAL1022	60.00	52.00

Circle 93 on reader service card

Circle 94 on reader service card

CRYSTALS

Part #	Frequency	Case Style	Price
CY1A	1.000 MHz	HC33/U	$4.95
CY2A	2.000 MHz	HC33/U	$4.95
CY3A	4.000 MHz	HC18/U	$4.95
CY7A	5.000 MHz	HC18/U	$4.95
CY12A	10.000 MHz	HC18/U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

— AVAILABLE IN THESE FREQUENCIES ONLY —

CLOCK CASES

Nicely styled cases complete with red bezel for use in such applications as desk clocks, car clocks, alarm clocks, instrument cases. DIMENSIONS: W-4", L-4½", H-2" **$5.95**

SEMICONDUCTOR SUPER SPECIALS

2N2222	Low Power 2N2222A	7/$1.00
MJ3055	Same as T03 2N3055 but with solder lugs on leads	.59
1N4308	Fast 1N4148 Si Switch	20/$1.00
MCT2E	Si NPN Photo Trans./Opto Isolator	2.95
MV5025	.4 MCD, 20 mA LED with Mounting	.79
MV5377	Low Profile Yellow LED	3/$1.00
XC526R	RED .185" dia. LED	7/$1.00

DL728

The DL728 is a dual 0.5" common cathode red display. It is ideal for use with clock chips, as segments are already multiplexed. **$2.95**

CALCULATOR CHIPS AND DRIVERS

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

CLOCK CHIPS

MM5311	6 DIGIT W/BCD	$4.95
MM5312	4 DIGIT W/BCD	4.95
MM5313	6 DIGIT W/BCD	4.95
MM5314	6 DIGIT CLOCK	3 95
MM5316	ALARM CLOCK	4 95
CT7001	CAL/CLOCK CHIP	5.95

DIGITAL WATCH READOUT

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

HP-5082-7300

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

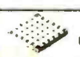
HP 5082 7304
+1 version of 7300 **4.95**

1¼" x 1½" XFMERS — P.C. Mount

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

SPECIAL $.79

1/16 VECTOR BOARD



0.1" Hole Spacing P-Pattern

	Part No	Length	Width	Price 1-19	Price 20-49
PHENOLIC	64P44 062XXXP	4 50	6.50	1 72	1.54
	169P44 02XXXP	4 50	17 00	3.69	3.32
EPOXY GLASS	64P44 062	4.50	6 50	2.07	1 86
	84P44 062	4.50	8 50	2 56	2 31
	169P44 062	4 50	17 00	5 04	4 53
	169P84 062	8 50	17 00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062C1	4.50	17 00	6.80	6 12

VECTOR WIRING PENCIL

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

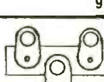
REPLACEMENT WIRE — BOBBINS FOR WIRING PENCIL

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

9V BATTERY CLIP

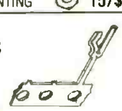
STANDARD CLIP FOR USE WITH 9V TRANSISTOR BATTERIES WITH 4" LEADS **9/.99**

TERMINAL STRIPS



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

AMP TERMINAL PINS



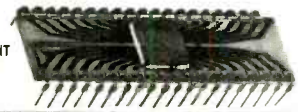
TERMINAL PINS FOR MOUNTING COMPONENTS ALSO PERFECT FOR USE WITH BOARD CONNECTORS AND SUBASSEMBLIES **$1.00/100 PCS.**

MICROPROCESSOR COMPONENTS

CENTRAL PROCESSOR UNITS

Each processor feature 2µs instruction cycles, and are brand new from the manufacturer. The TMS8080 is and 2nd generation processor; and the AMD9080A/8080A is a 2½ generation processor.

T.I 8080 $29.95 DIRECT REPLACEMENT FOR INTEL C8080

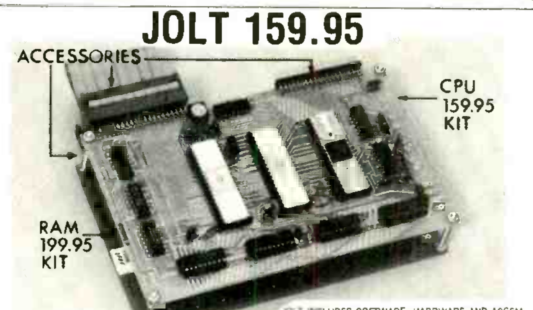


AMD 8080A $39.95 DIRECT REPLACEMENT FOR INTEL C8080A

CPU'S		
8008	8 Bit CPU	$19.95
8080	Super 8008	$29.95
8080A	Super 8008A	$39.95
SR'S		
2504	1024 DYNAMIC	$9.00
2518	HEX 32 BIT	7.00
2519	HEX 40 BIT	4.00
2524	512 DYNAMIC	2.95
2525	1024 DYNAMIC	5.00
2527	DUAL 256 BIT	3.95
2529	DUAL 512 BIT	4.00
2532	QUAD 80 BIT	3.95
2533	1024 STATIC	7.95
3341	FIFO	6.95
74LS670	16X4 REG	3.95
UART'S		
AY-5-1013	20K BAUD	$6.95
ROM'S		
2513	CHAR GEN	11 00
7488	RANDOM BITS	3 50

RAM'S			
1101	256X1	STATIC	$2.25
1103	1024X1	DYNAMIC	2.95
2101	256X1	STATIC	6.95
2102	1024X1	STATIC	2.49
2107	4096X1	DYNAMIC	19.95
2111	256X4	STATIC	7.95
7010	1024X1	MNOS	29.95
7489	16X4	STATIC	2.49
8101	256X4	STATIC	7.95
8111	256X4	STATIC	7.95
8599	16X4	STATIC	3.49
91L02	1024X1	STATIC	2.75
74200	256X1	STATIC	6.95
93410	256X1	STATIC	1.75
5262	2048X1	DYNAMIC	2.95
PROMS			
1702A	2048	FAMOS	15.95
5203	2048	FAMOS	14.95
8223	32X8	BIPOLAR	3.00
74S287	1024	STATIC	7.95

JOLT 159.95



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

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

JOLT SYSTEM DESCRIPTION

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

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

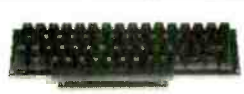
JOLT Accessory Bag — Contains enough hardware to connect one JOLT card to another. Such necessary items as flat cable, connectors, cord spaces, hardware, etc. AVAILABLE FOR IMMEDIATE SHIPMENT. $39.95.

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

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

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

64 KEY BOARD



There high quality keyboards, which were originally made by a large computer manufacturer. Each keyboard has 64 keys, which are brought out on unencoded pins. They utilize magnetic reed type switches, and are new in appearance **$29.95**

H00165 Keyboard Encoder ROM **$7.95**

WIRE WRAP WIRE

AWG	COLOR	25 FT. MIN.	50 FT.	100 FT.	1000 FT.
30 AWG	WHITE	$2.10	$2.75	$3.50	$24.00
30 AWG	YELLOW	2 10	2.75	3.50	24 00
30 AWG	RED	2.10	2.75	3 50	24 00
30 AWG	GREEN	2.10	2.75	3.50	24.00
30 AWG	BLUE	2 10	2.75	3.50	24 00
30 AWG	BLACK	2.10	2.75	3.50	24.00

RIBBON CABLE

Conductors	1-9ft/ft	10-24ft/ft	25-99ft/ft	100ft
10	39	29	25	23
20	59	49	45	43
30	79	69	65	62
40	99	89	85	80
50	1.19	1 09	1.05	1.00

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

THREE CONDUCTOR POWER SUPPLY CORDS

NUMBER	LENGTH	AWG	O.D.	RATING	COLOR	PRICE
17236	6	18(41X34)	.265	1250W 10A-125V	BLACK Special	79 ea.
17237	6	18(41X35)	.253	1250W 10A-125V	GREY	[illegible]
17238	8	18(41X34)	.265	1250W 10A-125V	BLACK Special	.99 ea
17239	8	18(41X34)	.253	1250W 10A-125V	GREY	[illegible]
17000	4'	18(41X34)	.253	1250W 10A-125V	BLACK	[illegible]

Satisfaction Guaranteed. $5.00 Min. Order. U.S. Funds.
California Residents — Add 6% Sales Tax
Write for FREE 1976 Catalog — Data Sheets .25¢ each

JAMES

P.O. BOX 822, BELMONT, CA. 94002
PHONE ORDERS — (415) 592-8097

JE SERIES KITS

JE801 DVM

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

$39.95 Per Kit printed circuit board

JE803 PROBE

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

$9.95 Per Kit printed circuit board

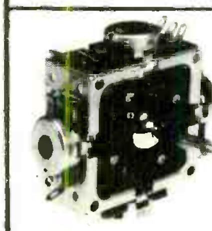
JE700 CLOCK

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

12 or 24 Hour

115 VAC—
$19.95 per kit
$29.95 assembled

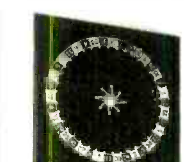
JOYSTICK



These joysticks feature four 100K potentiometers, that vary resistance proportional to the angle of the stick. Sturdy metal construction with plastics components only at the movable joint. Perfect for electronic games and instrumentation.

$9.95 ea

ELECTRONIC ROULETTE



Complete kit with all components case and transformer

$29.95 Per Kit

115 VAC

Dimensions: 6½" x 6½" x 1½"

ELECTRONIC CRAPS

6½" x 3½" x 1"

Complete kit with all components case and transformer.

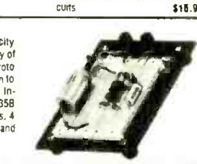
$19.95 Per Kit

Dimensions: 6½" x 3¼" x 1½"

CONTINENTAL SPECIALTIES $15.95

PROTO BOARD 6
The PB-6 lets the user test and build circuits without soldering or patch cords: all interconnections between components are made with common #22 AWG hook-up wire. This quality breadboarding kit inludes 630 component tie points at less than 2.5c each. It measures 6" long by 4" wide. Designed specially to Breadboard Microprocessor Circuits **$15.95**

PROTO BOARD 100
A low cost, big 10 IC capacity breadboard kit with all the quality of QT sockets and the best of the Proto Board series . . . complete down to the last nut, bolt and screw. Includes 2 QT-35S Sockets, 1 QT-35B Bus Strip; 2 5-way binding posts, 4 rubber feet; screws, nuts, bolts; and easy assembly instructions.
$19.95



Bring IC leads from pc board for fast signal tracing and troubleshooting. Inject signals. Wire unused circuits into boards. Scope probes and test leads lock onto Dynagrip Insert (see circle) for hands-off testing. Plastic construction eliminates springs, & pivots. Non-corrosive nickel/silver contacts for simultaneous low resistance connections.
PC-14, 14-pin Proto Clip **$4.50 ea.**
PC-16, 16-pin Proto Clip, **$4.75 ea.**
PC-24, 24-pin Proto Clips **$8.50 ea.**

Circle 96 on reader service card

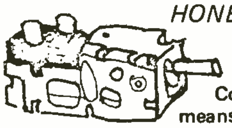
For faster service USE ZIP CODE on all mail

Circle 97 on reader service card

Circle 98 on reader service card

Circle 99 on reader service card

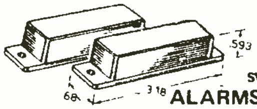
HONEYWELL HUMIDITY CONTROLLER



Made by **HONEYWELL** for automatic control of humidifiers or de-humidifiers. Control range 10% RH to 60% RH, sensing by means of a nylon ribbon. Snap action switch with 240v AC contacts. Ideal for home lab, or greenhouse. 3½ x 2¼ x 1¼.

STOCK NO. R6263 1 lb. $4.95 each, 3/14.00

PROXIMITY REED SWITCHES



These small magnetic proximity reed switches are ideal for all types of **BURGLAR ALARMS.** One case contains an Alnico magnet, which actuates a Normally Open reed switch in the other case within a distance of 1". Mount on windows & doors, on the back of valuable equipment, etc. Protect your home, car, and shop.

STOCK NO. R5351 $1.75/set, 4 sets/6.00, 10 sets/12.50

13.5 KV HIGH VOLTAGE POWER SUPPLY

This high voltage power supply is rated at 13.5 KV DC, @ 0.31 ma. Completely sealed. Ideal for CRT's, high voltage experiments, bug zappers, etc. Shipping weight 6 lbs.

STOCK NO. R5356 $13.95 each, 2/26.00

650 WATT POWER TRANSFORMER

This versatile transformer has dual primaries, for 115v or 230v operation, or for isolation use. Each is also tapped for low or high line. Secondaries are 24v center tapped at 8 amps, 24v at 10 amps, and 24v at 10 amps! Possible combinations include 24v at 20 A and 48v center tapped at 10 amps. Shipping weight 13 lbs.

STOCK NO. R9898 $14.95 each, 2/28.00

MINIMUM ORDER $5.00. Include sufficient postage, excess refunded. Send for new 88 page Catalog 15, bigger than ever.

BANKAMERICARD and MASTERCHARGE now accepted; minimum charge $15.00. Please include all numbers. Phone orders accepted.

DELTA ELECTRONICS CO.

BOX 1, LYNN, MASSACHUSETTS 01903
Phone (617) 388-4705

Circle 101 on reader service card

INTRODUCING VDM-1

Video Display Module

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

The VDM-1 configuration allows you to build a power terminal, with a standard video output into your Altair Processor. **Price: $160.00**

SPECIAL FREE OFFER!

Scientific Notation Software Package with Formatted Output

With the purchase of (1) VDM-1 and (1) 4KRA Memory:

Just $299.00

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

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

Processor Technology
2465 Fourth Street
Berkeley, Ca. 94710

SPECIAL

4 DIGIT ALARM CLOCK KIT

$15.95 (with PC Board)

Features the only LED direct drive clock chip on the market. Kit includes all parts (except Xfmr) for a 4 Digit alarm clock kit. Uses .25 inch LED readouts.

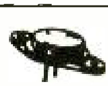
CLOCK KIT TRANSFORMER $2.00

GUARANTEE: ALTAJ Will ship your order within 48 hours of receiving it, or send you a FREE LED ASSORTMENT (2.00 Value).

NEW PRODUCTS

METRIC MASTER: Adds, subtracts, multiplies, divides, takes percent. Addressable memory and recall, constant and chain calculation on all five functions. Plus metric conversion: pounds to kilograms, gallons or quarts to liters, miles to kilometers, yards or feet to meters, inches to centimeters, ounces to grams or cubic centimeters, Fahrenheit to Centigrade, cubic and square as well as powers, reciprocals, fractions and complex quotients. AC and rechargeable nicad batteries. UL approved charger. Molded protective cover.

Metric Master THIS IS NOT A KIT! 49.95



LM309K
TO-3 Case, 1 AMP 5 VDC Voltage Regulator. Brand New by National $1.19

PRICES SLASHED! WE WANT YOUR BUSINESS. Satisfaction Guaranteed on Every Item.

TRANSFORMER SPECIAL #1
Miniature size. Primary 115 VAC Secondary 11 VAC NO LOAD. 8 VAC with 400 MA Load. Perfect for clocks or calculators or small power supply.
99c each or 6 for $5

AUDIO AMP ASSEMBLY
From Audio Eqmt. Mfg. PC Board with 2 watt LC Amp plus other components.
SPECIAL — 99c Very Limited Qty.

FORD SOLID STATE MODULES
Mfg. by Centralab for Ford car radios. Each module contains 2 transistors plus other components. These modules were used as audio preamps. We include specs. — 4 for $1

COMPUTER BOARD BONANZA
We bought over 4 tons of assorted boards. Contains TTL, diodes, transistors, etc. 5 board assmt. with 150 to 250 IC's — **$3.95.**

RCA CA3043 — FM IC
Used in FM stereos. Contains IF Amp, Limiter, FM Detector, and an Audio Preamp and Driver all in one 12 lead TO-5 package. With Spec Sheets.
A $3.00 Value — 99c

FM TRANSFORMERS
We bought a load of coils and transformers that were used in Ford AM-FM car radios. Includes 19KHz, 38KHz, OSC. Coils, etc. All New. Perfect for experimenters or repairmen. 10 PC Asst. — 99c

COLOR ORGAN CONTROL MODULE
Completely self-contained. Has SCR circuitry, AC line cord, etc. From a close out by a mfg. of color organs. New, unused.
$1.49

MOTOROLA SCR
2N4443 8 Amp 400PN, Plastic Power Case. 69c

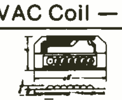
P & B RELAYS
4 P.D.T. Miniature Size
24VDC Coil — .99
115VAC Coil — 1.19

PRIME TTL DIP IC's

7400-16c	7448-89c	74151-75c
7402-16c	7453-16c	74153-89c
7404-16c	7473-37c	74154-95c
7406-24c	7474-37c	74157-99c
7408-16c	7476-39c	74163-1.19
7413-49c	7483-85c	74164- .89
7420-16c	7490-69c	74165-1.49
7427-24c	7492-75c	74174-1.29
7430-16c	7493-75c	74175-1.39
7437-39c	7495-75c	74181-2.75
7438-35c	7496-75c	74192-1.25
7440-16c	74121-38c	74193-1.25
7442-69c	74123-75c	74195-79c
7447-89c	74150-70c	74197-79c

GE POWER DARLINGTON
NPN, Plastic Power Tab Case. VCEO-30 HFE-30,000 TYP. Brand new units, but leads are slightly trimmed for P.C.B.
#D40C1 — SPECIAL 4 For $1

TANTALUM CAPS
By Sprague. 4.7 MFD 10 VDC. Axial Leads. Perfect for timers.
10 for $1



6 DIGIT LED READOUTS
Brand new arrays by T.I. Common cathode, properly multiplexed. Six digits plus a negative sign. Perfect for calculators, mini-clocks, stop watches, etc. **SUPER SPECIAL $1.29 ea 3 for $3**

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TTL

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

LOW POWER TTL

74L00	$ .25	74L51	$ .29	75L90	$1.49
74L02	.25	74L55	.33	74L91	1.45
74L03	.25	74L71	.25	74L93	1.69
74L04	.25	74L72	.39	74L95	1.69
74L06	.25	74L73	.49	74L98	2.79
74L10	.25	74L74	.49	74L164	2.79
74L20	.33	74L78	.79	74L165	2.79
74L30	.33	74L85	1.25		
74L42	1.49	74L86	.69		

HIGH SPEED TTL

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

8000 SERIES

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

9000 SERIES

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

CMOS

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

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

MARCH SPECIALS

½ PRICE SALE

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7425	$.13	7473	$.17	74121	$.21
7430	.10	7475	.28	74123	.42
7441	.49	7483	.39	74151	.39
7442	.38	7490	.29	74153	.49
7446	.46	7495	.39	74180	.45
7447	.44	7496	.39	74193	.60
7448	.52	74107	.20		

MARKED — NO FACTORY LOGO GUARANTEED FUNCTIONAL

7400	$.07	7420	.08	7460	.08
7402	.07	7437	.17	7474	.17
7403	.08	7440	.08	7493	.30
7404	.09	7445	.44	7496	.39
7406	.17	7450	.08	74195	.44
7408	.09	7453	.08		
7410	.08	7454	.08		

ALARM CLOCK CHIP
MM5375AA 4-6 digit, 12 hour, 60Hz snooze alarm, brightness control capability, alarm tone output 24 pin DIP
$4.95

8038 FUNCTION GENERATOR
Voltage controlled oscillator — sine, square, triangular output. 16 pin DIP with data $3.95

7001 CLOCK CHIP
4-6 digit, 12-24 hr. alarm, timer and date circuits — with data $6.95

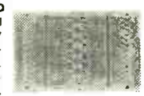
DVM CHIP 4½ DIGIT
MM5330 — P channel device provides all logic for 4½ digit volt meter. 16 pin DIP with data $14.95

UV ERASABLE PROM
1702A — 2048 bit static PROM 256x8 elect programmable & erasable TTL/DTL comp. $14.95

POCKET CALCULATOR

5 function plus constant — addressable memory with individual recall — 8 digit display plus overflow — battery saver — uses standard or rechargeable batteries — all necessary parts in ready to assemble form — instructions included.
Kit with AC adaptor included $14.95
Set of Alkaline batteries (disposable) $ 2.50

UNIVERSAL BREADBOARD



Silver plated copper circuit board 3-3/16" x 5-1/16", 2 rows of 27 holes for DIP IC's - space for transistors, resistors & capacitors. Versatile and simple for breadboarding IC circuitry $1.50 ea.
50 pcs. 1.00 ea.

ALARM CLOCK KIT

4 Large Digits - AM-PM. Complete kit includes TMS 3834 chip — green flourescent panel with .5" digits — PC board — alarm speaker — all necessary components — case — schematic and instructions.
Shipped UPS or Parcel Post. $31.95

NEW ITEMS

TTL

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

SCHOTTKY

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

LOW POWER SCHOTTKY

74LS00	$ .36
74LS02	.36
74LS04	.36
74LS08	.38
74LS10	.36
74LS20	.36
74LS32	.38
74LS40	.45
74LS42	1.40
74LS74	.59
74LS90	1.30
74LS93	1.30
74LS95	2.09
74LS107	.59
74LS164	2.20
74LS193	2.50
74LS197	2.20

LINEARS

546	AM radio receiver subst. DIP	$ .75
733	Diff. video AMPL TO-5	.89
5556/ MC1456	Int. compensated Op Amp mDIP	1.59
7525	Dual core mem. sense AMPL DIP	.98
MC1310	FM stereo demodulator DIP	1.95
CA3046	Transistor array 14 pin DIP	.89

6 DIGIT LED CLOCK KIT
INCLUDES:
MM314 clock circuit
6 FND70 LED displays (.250" red 7 segment)
All necessary transistors, resistors & capacitors
1 double sided PC board accommodates LED's & clock circuitry
Schematic & instructions
Does not include 12V-300 ma transformer, switches & case $12.95

TANATLUM CAPACITORS SOLID-DIPPED +20%

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

MISC. DEVICES

2513	64 x 8 x 5 character generator	$11.00
2602	1024-bit static RAM, N-channel DTL/TTL compatible	3.95
F93410	256 bit RAM	2.19
MV5020	Jumbo green	.22
XC209-R	.125" red LED	.15
L100	Red LED	.15
L101	Red LED	.15

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

LINEAR CIRCUITS

300	Pos V Reg (super 723) TO-5	$ .71
301	Hi Perf Op Amp mDIP TO-5	.29
302	Volt follower TO-5	.53
304	Neg V Reg TO-5	.80
305	Pos V Reg TO-5	.71
307	Op AMP (super 741) mDIP TO-5	.26
308	Mciro Pwr Op Amp mDIP TO-5	.89
309K	5V 1A regulator TO-3	1.35
310	V Follower Op Amp mDIP	1.07
311	Hi perf V Comp mDIP TO-5	.95
319	Hi Speed Dual Comp DIP	1.13
320T	Neg Reg 5, 12, 15, TO-3	$1.39
320K	Nep Reg 5.2, 12 TO-3	1.39
322	Precision Timer DIP	1.70
324	Quad Op Amp DIP	1.52
339	Quad Comparator DIP	1.58
340K	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-3	1.69
340T	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-220	1.49
372	AF-IF Strip detector DIP	2.93
373	AM/FM/SSB Strip DIP	.53
376	Pos V Reg mDIP	2.42
377	2w Stereo amp DIP	1.16
380	2w Audio Amp DIP	1.13
380-8	.6w Audio Amp mDIP	1.52
381	Lo Noise Dual preamp DIP	1.52
382	Lo Noise Dual preamp DIP	.71
550	Prec V Reg DIP	.89
555	Timer mDIP	.89
556A	Dual 555 Timer DIP	1.49
560	Phase Locked Loop DIP	2.48
562	Phase Locked Loop DIP	2.48
565	Phase Locked Loop DIP TO-5	2.38
566	Function Gen mDIP TO-5	2.25
567	Tone Decoder mDIP	2.66
709	Operational AMP TO-5 or DIP	.26
710	Hi Speed Volt Comp DIP	.35
711	Dual Difference Compar DIP	.26
723	V Reg DIP	.62
739	Dual Hi Perf Op Amp DIP	1.07
741	Comp Op Amp mDIP TO-5	.32
747	741 Dual Op Amp DIP or TO-5	.71
748	Freq Adj 741 mDIP	.35
1304	FM Mulpx Stereo Demod DIP	1.07
1307	FM Mulpx Stereo Demod DIP	.74
1458	Dual Comp Op Amp mDIP	.62
1800	Stereo multiplexer DIP	2.48
LH2111	Dual LM 211 V Comp DIP	1.70
3900	Quad Amplifier DIP	.35
7524	Core Mem Sense AMPL DIP	.71
8038	Voltage contr. osc. DIP	4.25
8864	9 DIG Led Cath Drvr DIP	2.25
75150	Dual Line Driver DIP	1.75
75451	Dual Perepheral Driver mDIP	.35
75452	Dual Peripheral Driver mDIP	.35
75453	(351) Dual Periph Driver mDIP	.35
75491	Quad Seq Driver for LED DIP	.71
75492	Hex Digit driver DIP	.80

LED's

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

MEMORIES

1101	256 bit RAM MOS	$ 1.50
1103	1024 bit RAM MOS	3.95
1702A	2048 bit static PROM UV eras.	17.95
2102-2	1024 bit static RAM	4.25
5203	2048 bit UV eras PROM	17.95
5260	1024 bit RAM	2.49
5261	1024 bit RAM	2.69
5262	2048 bit RAM	5.95
7489	64 bit ROM TTL	2.48
8223	Programmable ROM	3.69
74200	256 bit RAM tri-state	5.90

MULTIPLE DISPLAYS

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

CALCULATOR & CLOCK CHIPS

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

SHIFT REGISTERS

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

DTL

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

Satisfaction guaranteed. Shipment will be made via first class mail in U.S., Canada and Mexico within 5 days from receipt of order. Add $.50 to cover shipping and handling for orders under $25.00. Minimum order $5.00. California residents add sales tax.

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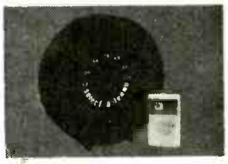
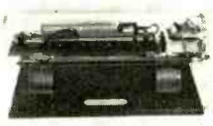
Does Everything Big Ones Do Small but mighty! 8-digit, 4-function electronic calculator does everything big ones do—even has automatic % key . . . **for only $19.95.** Take it anywhere. Fits in your pocket—2/3 size of cigarette pack 3½ oz. dynamo features floating decimal, constant key, lead zero depression, more! Includes plug-in rechargeable Ni-Cad battery pack. 2x3½x9/16" with plenty of room for most fingers. Another Edmund first with advanced technology.
Stock No. 1945EH .... $19.95 Ppd.

SUPER POWER FOR ANY AM RADIO



New antenna assist turns a tiny transistor into a tiger, has pulled in stations 1000* miles away! Just set beside radio (no wires, clips, grounding) and fine-tune Select-A-Tenna's dial to same frequency—"gangbusters"! Great for clearing weak signals in radio depressed areas, off-coast islands, crowded frequency stations. Solid state—uses no electricity, batts., tubes.
Stock No. 72,095 EH .... $15.95 Ppd.
Ultra Select-A-Tenna No. 72,147 EH
(*Over 1000 Mi.) .... $22.95 Ppd.

ACTUAL WORKING SEE-THRU LASER!



See the full lasing process *work*, why this technological breakthrough revolutionized optical field! Beautiful 0.5mW TEMoo HE-NE 6328A laser enclosed in completely safe clear acrylic housing. *Shows everything*—power supply to actual lasing action within plasma! Diffraction grating attchmt's. for multiple beam display. Converts to hologram viewing system (3 holograms included). Polished walnut base. Fantastic demonstrator/display. 2 year tube guar.
No. 79,089 EH (15½x6½x7½") .... $350.00 Ppd.

SOLAR POWERED WATCH: $199.95

Fantastic new digital watch powered by the sun with quartz accuracy—for less than $200! Bright LED display for 3-sec. reading of hr., mins., secs. at press of button; press again for self-correcting (till leap yr.) calendar to flash mo., date. 9 silicon solar cells charge 2 sub-mini batteries (guaranteed for minimum 3-yr. life) to power quartz control oscillator. Accuracy to within *1 min. a yr.*—no moving parts in mechanism. Gold-plated case & band.
Stock No. 1675EH .... $199.95 Ppd.

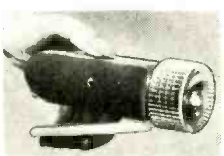
AN ALPHA MONITOR FOR $34.95?

Yes, because **you** built it! Use your ability to tune in your brainwaves, an aid to relaxation, concentration. Kit incls. everything you need (except 9v trans. batt.) to own a portable self-cont. BIOFEEDBACK unit for a pittance: steth. earphones, electrode headband, solid-state circuitry; 5 microvolt sensitivity, more! Compl. assembly instructions & op. manual. With basic electronics knowledge, you can do it!
No. 61,069 EH (KIT) .... $34.95 Ppd.
No. 71,809 EH (FULLY ASSEMBLED) .... $55.00 Ppd.

PLUG IN 200,000 CANDLEPOWER!

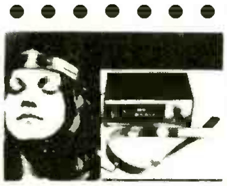
Powerful 12v emergency light projects big straight beam **visible for 2 miles.** Plugs into car's cigarette lighter; only 3½ lbs. Great for motorists, outdoorsmen, emergency crews, security men, campers. Super bright 200,000 candlepower G.E. aircraft landing light in a rugged weatherproof steel housing with baked enamel finish, steel lens grate, polished chrome-plated reflector, on/off switch. 15 ft. extension cord; 6¼ dia. x 11⅛". Keep it handy!
Stock No. 72,093 EH .... $22.95 Ppd.

FLYWHEEL GENERATED FLASHLIGHT



Never needs batteries! Lights the way free by using flywheel energy. Each time you squeeze handle the alternator generator spins, flywheel disengages from the clutch, and your flashlight lights for about 2 seconds. By continuous squeezing (generating a soft hum), the light stays bright. Energy-saving 6-oz. flashlight pays for itself many times over. And demonstrates flywheel generator principle. Never buy flashlight batteries again!
No. 61,086 EH .... (2x5½") .... $14.95 Ppd.

KNOW YOUR ALPHA FROM THETA!



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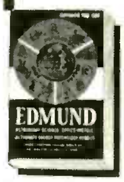

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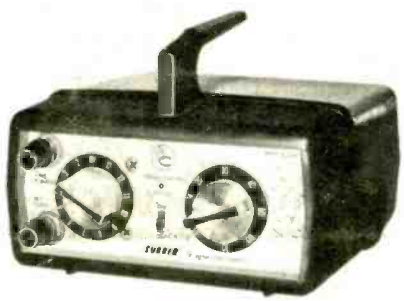

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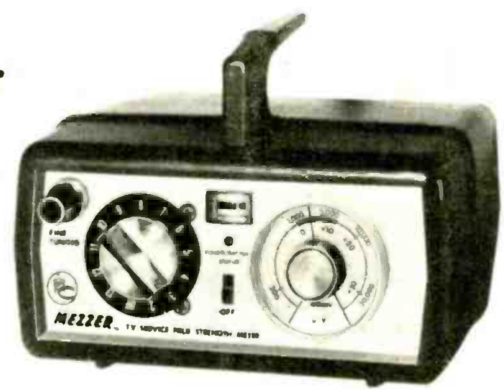

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