Electronics World

NOVEMBER, 1971
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TESTING IC's IN TV RECEIVERS

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CIRCLE NO. 130 ON READER SERVICE PAGE

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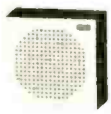

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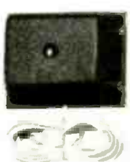

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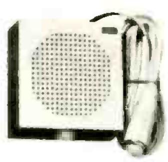

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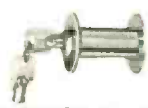

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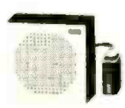

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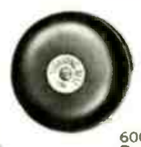

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Write for Bulletin 9-616 describing Mallory Security Systems in detail.

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Electronics World

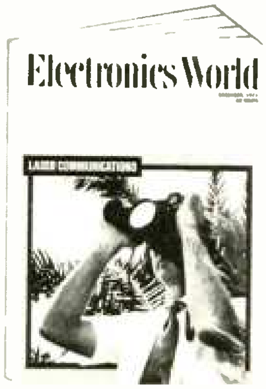
NOVEMBER 1971 VOL. 86, No. 5

Contents

THIS MONTH'S COVER shows five typical scopes designed for applications in servicing and maintenance. Top right Hewlett-Packard's 1707A portable; bottom right Heath's IO-102; top left B&K's 1460 solid-state/triggered sweep model; bottom left, Telequipment D67; while the service technician on call is carrying the Dumont R1053. For specs, see charts on pages 29 & 31 and article on how to select your scope on page 27. Cover photo: Business Techniques, Inc./ Koenig-Elliott Studio.

Coming Next Month

Special Feature Article



OPTICAL COMMUNICATIONS

With the r.f. spectrum so overcrowded, engineers are looking to semiconductor light sources and the high portion of the band to handle short-range optical communications, thus leaving room for other services.

Animal Guidance Systems	Training cats to pilot air-to-air missiles? This is no "sci-fi" dream but is under active investigation as a means of delivering nuclear weapons via a jam-proof system which is almost impossible to detect. L. George Lawrence describes the experiments in progress.
The "Pipe" Speaker System	Designed for use with electronic organs and similar instruments, this system is low in cost, easy to assemble, and resembles the "pipes" of a pipe organ. J. Roy Smith provides step-by-step details on the system design.
Facsimile Via Telephone	The information explosion and the need to transmit graphics as well as text from one place to another has stimulated the development of a number of economical systems that can be linked to conventional phone circuits. David L. Heiserman discusses operating principles and performance.
Conductor Design With Thin-Film Insulated Aluminum	Component costs plus the limited future availability of copper dictates the use of aluminum by the electronics industry. Aluminum makes it possible to fabricate lighter and more compact components. Harry D. Walker, Director of Research, Permaluster, Inc. provides details on the new coated aluminums designed for such applications.

*All these and many more interesting and informative articles will be yours in the **December** issue of ELECTRONICS WORLD . . . . . on sale **November 11th.***

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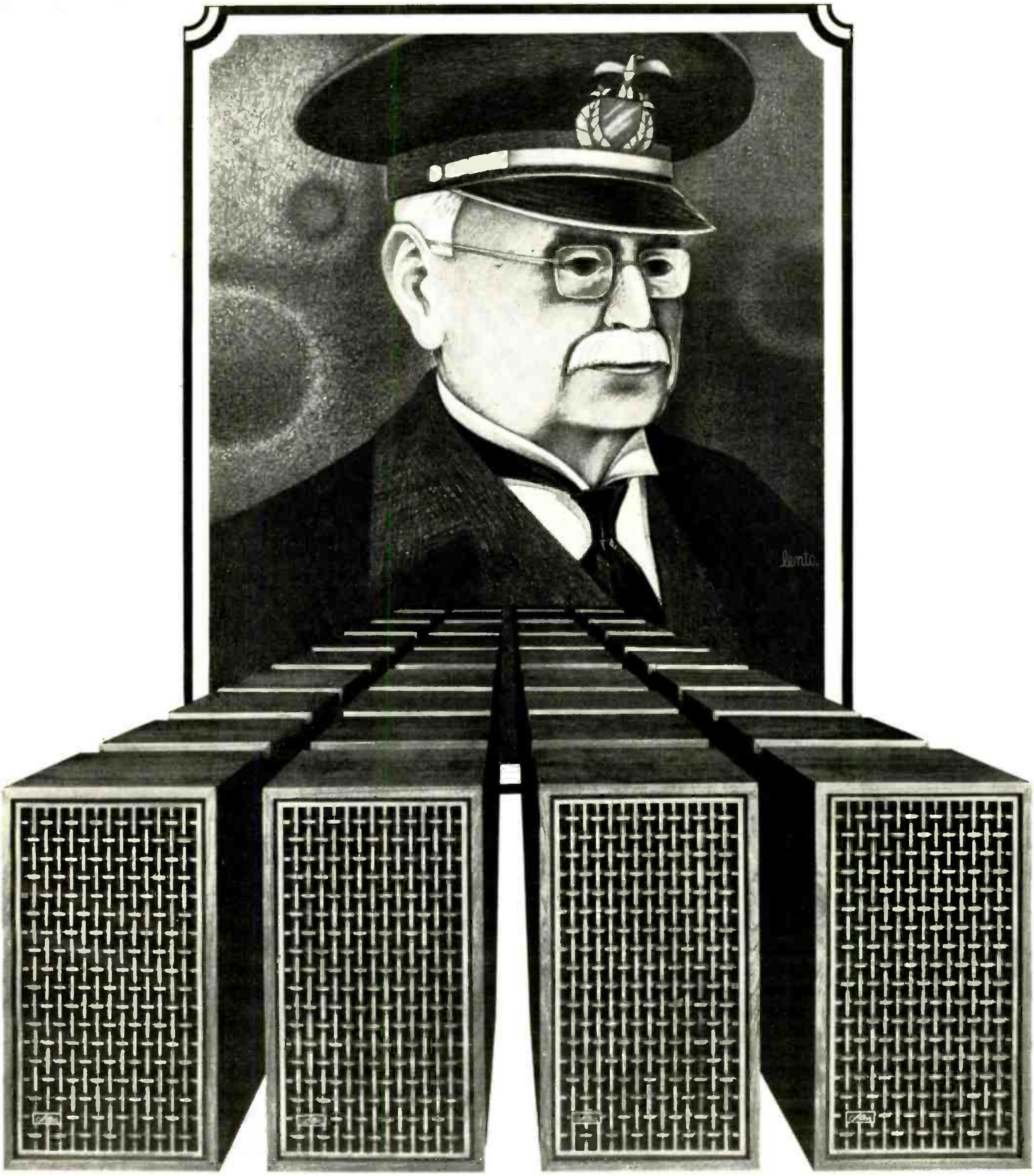
Sousa lives in the new Altec Segovia



If you're going to listen to Sousa, it should sound like Sousa. Oom-pa, oom-pa, oom-pa-pa. It should be so real that you can reach over and nudge the tuba player when he gets out of step.

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CIRCLE NO. 147 ON READER SERVICE PAGE

LETTERS

TRANSISTOR & FET CURVE TRACER

To the Editor:

Regarding the very interesting circuit described in your August, 1971 issue ("Transistor and FET Curve Tracer")—the capability of this circuit could be greatly improved by doubling the step frequency. Thus, each base step input would last from zero to maximum and *vice versa*, alternately, relative to the F.W. rectified collector input. (Of course, synchronization would be necessary.) This would either reduce the flicker or increase the number of traces for the same flicker by a factor of 2. It would also eliminate the "hysteresis" loop (which is quite pronounced with some transistors) since the collector trace would be swept one way only. Further, the base and collector inputs should be permanently synchronized to eliminate the need for a stability control coupled with flicker minimization. By using integrated circuits, I have been able to develop a curve tracer with 8 flickerless lines and a d.c. loadline and "Q" points superimposed.

A. G. BEREZA
Brandon, Man., Canada

To the Editor:

I very much enjoyed reading the article entitled "Transistor and FET Curve Tracer" by Daniel Metzger in the August issue. It is a good-reading, useful article. I have breadboarded the tracer (making a few modifications) and find it to be a most useful piece of test equipment.

Your readers might be interested to know, however, that there are two errors in the schematic diagram of the unit as it is published. First, there must be a connection made from the point marked "scope gnd" and the emitter lead ("emit").

Second, for the device to properly measure *p*-channel FET's, switch S1A must be rewired so that terminal 4 connects to terminal 1 instead of to 3.

Again, my congratulations to Prof. Metzger for an excellent article.

EDWARD B. BEACH
Arlington, Va.

To the Editor:

My thanks to both Readers Bereza and Beach for their comments on my recent article in ELECTRONICS WORLD. *It was indeed gratifying to learn of Mr. Beach's success with the curve tracer circuit. The "scope gnd" terminal should be connected to the circuit ground as he suggests; this was inadvertently omitted from the schematic.*

The wiring of S1A may seem backwards in position 4 but it should be connected as shown to allow viewing MOSFET's in both the enhancement and depletion modes. By clamping the staircase waveform in the negative direction against a variable positive voltage, we can obtain steps which are all positive, all negative, or half of each, simply by adjusting the step position control.

The zero voltage step is identified by opening S5; the step position control is then adjusted to obtain the desired number of trace lines above and below the zero line. R9 will have to be turned almost fully up for p-channel *FET's. If the range is still not sufficient, then R8 can be changed from 1.8k to 1k.*

DANIEL L. METZGER
Toledo, Ohio

* * *

C-D IGNITION SYSTEM

To the Editor:

In regard to your article "Improved Capacitive-Discharge Ignition System" in the February, 1971 issue, there has long been need for a better ignition system and I've wanted to build a transistor circuit for some time; yours seemed to be the answer. I had to do some substituting, though, since I was unable to get all the necessary components. The 1 μF, 600 V electrolytic had to be polarized since that was all I could get. The .002 μF, 1000 V unit had to be .0033 μF, 1600 V—also polarized. For the UJT's I used 2N491's. For the SCR I used a 2N3529. For the TIS-29 I used 2N697; for the TIS-33, 2N697; and for the 400 V diode I used a 1N1406. I removed the car's condenser from the distributor and, by the use of double throw switches, I am still able to use it in the conventional manner, but the +12 V d.c. from the ignition is only +6 V d.c. Is the circuit going to operate at this voltage?

I also have a question concerning the false-trigger preventer. Is the circuit printed wrong? I built two false-trigger-preventer circuits with the same results both times—no voltage to the SCR. The points will not cause the UJT to conduct or to cut off properly.

Incidentally, the circuit draws 1.9 amps, which is a lot more than you specify in the article.

K. F. BOGGUS
Tulorosa, New Mexico

To take your last point first, you are right about the current drain being closer to 2 amps.

In regard to the trigger circuit, there is a problem in the data sheet of UJT's. Their main function is the relaxation oscillation mode. However, they do have a tendency to "latch" just as an SCR does. But the value of the current generally is not specified for UJT's as is the holding current for SCR's. Therefore, I suspect trouble with the trigger portion of this circuit is caused by using a UJT which latches above 1 mA.

This can be eliminated by increasing the value of the two 1-k resistors and correspondingly decreasing the 0.1 µF capacitor connected to the emitter of the TIS-43. If the SCR trigger pulse is too narrow or of too low an amplitude after doing this, then the 100-ohm resistor can be increased to 220 ohms.

RON CARROLL
Plano, Texas

* * *

TELEPHONY CONTROVERSY

To the Editor:

The article "Attachments to Your Telephone" by Walter H. Buchsbaum in your July (1971) issue is very informative so far as educating the general public is concerned. But most of the attachments discussed bypass the telephone company's responsibility and, in some cases, perhaps the regulations of the Federal Communications Commission, as well. Most people think that their monthly service charge pays for the telephone instrument only, since that is all they see. But the author perhaps is not aware of the huge investment behind that instrument in cables and equipment.

Many cases of telephone attachments have been found to be fraudulent, and misuse of telephone attachments may cause malfunction of the phone company's equipment. So, in my opinion, it is a good idea for the customer to stay away from using attachments to his telephone and let the telephone company engineers handle this.

J. L. BANDYOPADHYAY
Equipment Engineer
Central Telephone Company
Hickory, N. C.

We have had numerous requests from readers for elucidation of this subject and as far as we have been able to determine there has not yet been a clear ruling on the matter one way or the other. The phone company, on one hand, insists couplers must be theirs and installed by them (which, of course, involves a monthly service charge). On the other hand, though, we know of many companies introducing telephone couplers apparently without any restriction whatsoever. Walter Buchsbaum's article did indicate specifications that the designs must adhere to and we feel, if his advice is followed, there is no reason attachments couldn't be used.

We wonder if the phone company perhaps does not want to press for a legal determination one way or the other because it might go against them.

If any of our readers have definitive information on the matter of telephone attachments, we would be glad to learn the true legal status of this equipment.—Editor

* * *

DO WE NEED 4-CHANNEL STEREO?

To the Editor:

Mr. Krausser's article, "Do We Need 4-Channel Stereo?" (August, 1971 issue), has caused me to write to clarify a few points which he has raised.

His statement, "Haas concluded from these experiments that the brain integrates certain types of sound in steps of 20 ms," is not quite correct. Mr. E. Roerback Madsen of *Bang & Olufsen* should be credited with this assumption, made by him in his article "Extraction of Ambience Information from Ordinary Recordings" (*Journal of the Audio Engineering Society*, Vol. 18, No. 5, October 1970, page 491). Herr Haas did not make any statements to this effect in his famous paper describing the "Haas Effect" as it has come to be known. Mr. Krausser also draws upon Mr. Madsen's paper for other statements and it seems a pity that proper credit is not given for them. In fact, it seems odd that there are no footnotes at all in such an erudite article. Perhaps this is only "sour grapes" though, since my own paper, "The Effect of Microphone and Loudspeaker Directional Characteristics Upon Recreating Acoustic Fields," has also, it would appear, been the source of much of Mr. Krausser's material. This paper was presented at the 39th Convention of the Audio Engineering Society and is available as AES preprint #763 from AES Room 428, 60 East 42 St., New York, N. Y. 10017 (for $1.00).

EDWARD M. LONG
Manager of Acoustics
Pacific Electronics, Inc.
Emeryville, Cal.

Actually, the author isn't entirely to blame; he did submit a bibliography with his manuscript which we arbitrarily deleted due to editorial space limitations. We are glad to have this opportunity to credit Messrs. Long and Madsen for their fine work on 4-channel sound.—Editor ▲

LOGIC TERMS QUIZ

By WILLIAM R. SHIPPEE

TO test your knowledge of logic circuits and terms, match the descriptions (1 to 10) with the appropriate terms (A to J) given below.

1. Sensitivity of a logic circuit to be triggered by an undesirable signal. ( )

2. With two or more inputs, all must be logic "1" for an output logic of "1." ( )

3. Any one or more logic "1" inputs will produce logic "0" output. ( )

4. Transistor circuit where resistors are used to perform the logic function. ( )

5. Switching circuit that combines binary information to generate the *sum* and *carry* of this information. ( )

6. Transistors, of the multi-emitter configuration, perform this logic function with additional transistor circuitry used as inverting amplifiers. ( )

7. The output is always 180 degrees out-of-phase with the input. ( )

8. Logic is performed with diodes, with transistors serving as inverting amplifiers. ( )

9. A logic circuit whose output is "1" if either of its two inputs is "1" but the output is "0" if both inputs are the same. ( )

10. Logic "1" is represented by a negative voltage and logic "0" by a less negative voltage. ( )

(A) Adder; (B) "and"; (C) DTL; (D) Exclusive "or"; (E) "nor" gate; (F) Not; (G) Negative logic; (H) Noise immunity; (I) RTL; (J) TTL.

(See page 81 for answers)

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50 MHz all-purpose module includes period, time interval. Model 5302A, $250.

500 MHz module with both 50Ω and 1 MΩ inputs. Model 5303A, $750.

100 ns time interval module with: unique "time holdoff" feature, dc coupling, slope and trigger level controls, and period and frequency measurements to 10 MHz. All the functions you'd pay $1200 for in a universal counter. Model 5304A, $300.

Rechargeable battery pack module works with any of the other modules for cord-free operation. Model 5310A, $175.

The 5300 is one system you have to use to appreciate. If you've ever needed to accurately measure frequency or time interval, you owe it to yourself to call your nearby HP field engineer for further information. Or write Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

Counters that promise a lot and deliver it all. 02109

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ELECTRONIC COUNTERS

CIRCLE NO. 135 ON READER SERVICE PAGE

HI-FI PRODUCT REPORT

by Hirsch-Houck Labs

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Sharpe SC-3 Stereo Headphone Adapter

Marantz Model 19 Stereo-FM Receiver

For copy of manufacturer's brochure, circle No. 1 on Reader Service Page.

SELLING for $1000, the *Marantz* Model 19 has the distinction of being the most expensive stereo receiver on the market. Quite naturally, we wondered what could possibly be in a receiver to justify a four-figure price tag. Having tested and lived with a Model 19 for some time, we think we can now answer that question.

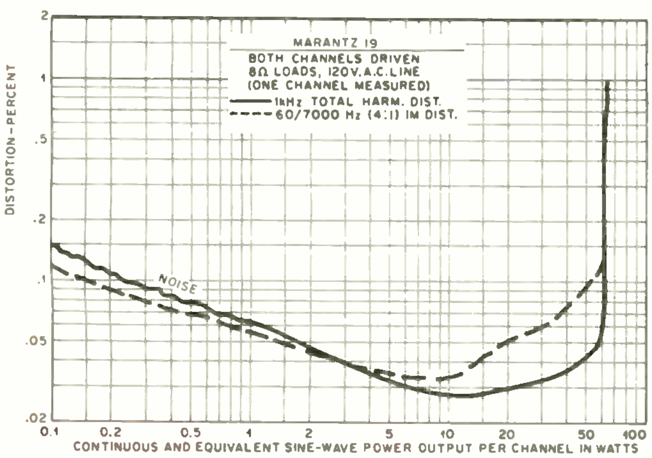
The receiver is imposing with over-all dimensions (less cabinet) of 18¼" wide × 6⅛" high × 16" deep. It weighs about 45 pounds. It is functionally a combination of the company's Model 20 FM tuner, Model 33 preamplifier, and Model 32 power amplifier. These three premium-quality components have a combined price of $1385, plus almost $100 for their cabinets. Viewed in this light, the Model 19 would seem to be something of a bargain especially since it can be housed most attractively in a single $40 cabinet.

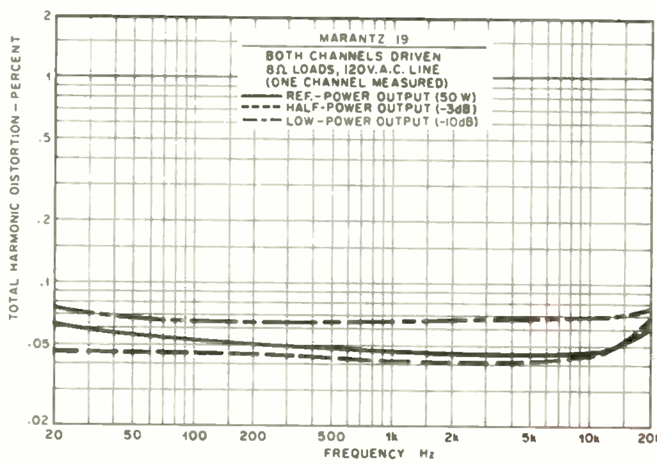
The tuner, which covers only the FM band, has an FET front end, tuned by the horizontal flywheel used in other *Marantz* products instead of a conventional knob. The i.f. amplifier features a modified Butterworth-type *LC* filter with phase-linear response in its 200-kHz passband and sharp cut-off slopes. Muting and automatic stereo/mono selection are performed by light-controlled photoresistors, free from noise bursts or transient thumps.

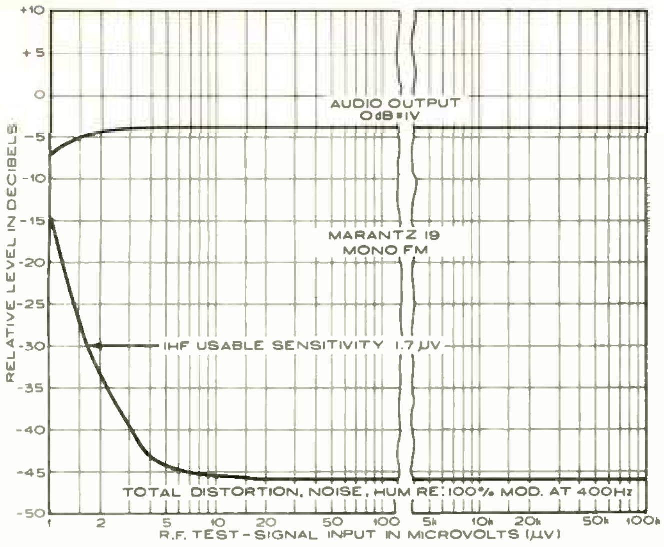
The Baxandall-type tone controls have concentric slip-clutches for individual channel control. There is no automatic loudness compensation, but the bass tone-control characteristic is well suited for this purpose. The high- and low-cut filters have excellent characteristics, with 12-dB/octave slopes at 7 kHz and 70 Hz, respectively.

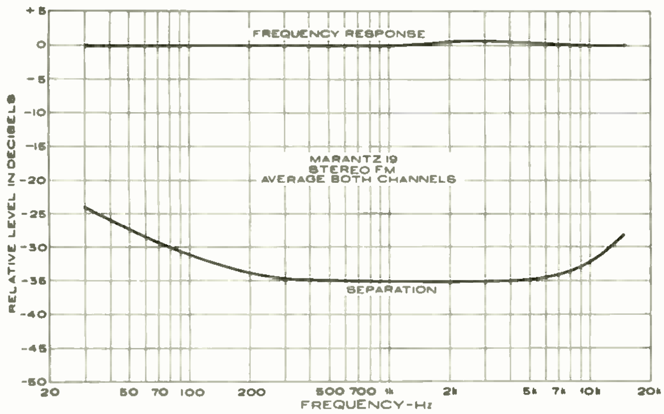
The power amplifiers, conservatively rated at 50 watts per channel into 8 ohms, can be switched to drive either or both of two sets of speakers, which may also be silenced for headphone listening. A protective circuit limits the peak current in the output transistors to a safe value. Since the output stage uses direct-coupled complementary symmetry circuitry, a relay circuit disconnects the speakers if any significant d.c. voltage appears at the output terminals (as might happen in the unlikely event of a catastrophic failure of an output or driver transistor). A time delay of several seconds eliminates any audible noise or thump when the receiver is turned on.

The tuner, like some other *Marantz* components, uses a 1" cathode-ray tube to perform three useful (and unique) functions. As a tuning indicator the spot position shows both the correct tuning point and the relative strength of FM signals. As a multipath distortion indicator the CRT displays instantaneous amplitude variation of the received signal *vs* its frequency deviation. Ideally, this appears as a straight, or slightly curved, horizontal line. Multipath reception, which is a major source of distortion in FM, causes the line to become "wiggly." Orienting the antenna for minimum irregularity of the display assures best reception.









Finally, the CRT can be switched to show the L- and R-channel audio signals. The degree of channel blending, or the presence of out-of-phase signals, can be seen at a glance.

The Model 19 carries an impressive array of controls, including two Aux. and two Phono inputs, separate Tape Monitor and Tape Playback functions, and high-frequency blending for stereo noise reduction. There are two stereo jacks on the front panel, interconnected with the rear tape inputs and outputs so that dubbing can be done from one tape machine to another, or two recorders can be connected simultaneously for recording long programs. There is even a front-panel antenna attenuator switch to prevent overload from strong nearby FM stations, although the tuner is less subject to this sort of interference than most other tuners.

Our laboratory measurements backed up the maker's claims fully and, in addition, gave us a few pleasant surprises. For example, the FM tuner frequency response was as flat as a ruler—within 0.5 dB over-all from 30 Hz to 15 kHz—yet there was no trace of 19-kHz or 38-kHz signals in its outputs. Evidently, *Marantz* has built a low-pass filter of unusual effectiveness into the tuner outputs.

The stereo-FM separation was greater and more uniform over a wider frequency range than we can recall seeing on any receiver, measuring 35 dB over most of the audio-frequency range, 24 dB at 30 Hz, and 27.5 dB at 15 kHz. This was convincing proof of the performance of the phase-linear i.f. filters in the tuner. The IHF usable sensitivity (rated 2 microvolts) measured 1.7 microvolts, with full limiting and minimum distortion occuring at 5 microvolts. The measured distortion was our generator residual of about 0.5%. The signal-to-noise ratio at 1000 microvolts was 75 dB, image rejection was an excellent 85 dB, and AM rejection was 62 dB. The capture ratio of 3.3 dB was the only FM measurement which was not outstanding, although it is an adequate figure.

Virtually all the tone-control action occurred in two-thirds of the available rotation from a center position. The bass controls allowed modest compensation of the low frequencies without affecting response over 150 Hz. The RIAA phono equalization was within +1.5, -0.5 dB from 30 Hz to 15 kHz. The filters had the specified characteristics very well suited to their function.

The power amplifiers were pure *Marantz*, which is to say, very pure indeed. With both channels driven at 1000 Hz into 8 ohms, distortion was under 0.05% up to about 60 watts per channel. IM distortion was similar up to 10 watts, increasing to 0.12% at 60 watts. The receiver is rated at 50 watts; at this power the distortion was about 0.05% over the full 20 Hz to 20 kHz range, and did not change materially at lower power levels. Clipping levels were 58.5 watts into 4 ohms, 63.5 watts into 8 ohms, and 35.5 watts into 16 ohms.

Noise was low, 71 to 73 dB below 10 watts on all inputs. Although only 0.27 microvolt of phono input was required for 10 watts output, it took 65 millivolts to overload the preamplifiers. In other words, the receiver is compatible with just about any phono cartridge whose quality is comparable to its own.

There is much more to the Model 19 than we can discuss in the available space. Suffice it to say that it does most of the things that any receiver (or combination of separate components) can do, plus a few unique to itself. In most of the really important parameters, related to listening quality, the Model 19 is truly a state-of-the-art device. For example, other FM tuners we have seen—even very good ones—simply do not have the uniform channel separation, perfectly flat frequency response, and other characteristics of the Model 19. Its audio performance is equally outstanding; for example, there is no sacrifice of performance at the frequency extremes, a common weakness of receivers.

The CRT display is definitely not a "gimmick." It is expensive and doubtless accounts for a sizable percentage of the receiver's price. However, nothing can match it for accurate tuning, minimizing multipath distortion, or analyzing the nature of program material. Together with the comprehensive instruction manual, the CRT display could even be considered the basis for a home-study course in FM and stereo fundamentals.

Lest we seem uncritically enthusiastic, there were several features of the Model 19 that seemed out of keeping with its price. The tuning mechanism had appreciable free play between the wheel ("knob") and the tuner itself. The CRT made tuning easy, but the wheel could be moved over a noticeable range without having any effect on the tuning. The dial scale is not truly linear, which is perhaps a trifle, but many receivers costing a fraction of the price of this one have accurate, linear dial scales. The speaker connections are screw-type barrier terminals instead of the much more convenient spring-loaded variety. Finally, with all of its input versatility, the Model 19 has only *one* unswitched a.c. convenience outlet. It could use four or five more, and some should be switched.

To answer our initial question, the buyer of a *Marantz* Model 19 gets, for his $1000, a receiver of superior performance in every respect. There are others which can match it in various respects, including some for a fraction of its cost, although none that we have seen is as outstanding in all areas. Also, purely from a listening standpoint, there are other receivers selling for half its price or less whose sound could not, under most conditions, be distinguished from that of the Model 19. As an analogy, most of us would consider a *Cadillac* or a *Continental* a rather good automobile. Nevertheless, there are those who appreciate the "something extra" built into a *Rolls-Royce* or *Mercedes-Benz* 600, and are willing (and able) to pay several times the

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Sharpe SC-3 Stereo Headphone Adapter

For copy of manufacturer's brochure, circle No. 2 on Reader Service Page.

SHARPE has supplemented its line of stereo headphones with "Stereo Control" units. These are remote-control units for connecting headphones to amplifiers lacking headphone jacks and come in three versions with varying degrees of flexibility. The basic Model SC-1 simply provides a headphone jack and individual level controls for each channel. It is connected across the speaker output lines from the amplifier, and while it does offer volume and balance control of headphones, it does not switch off the speakers. The SC-2 goes a step farther and is connected in series with each speaker line. This lets the listener silence the speakers if desired while listening through phones. There are also jacks and controls for two sets of stereo phones.

The SC-3, which we tested for this report, is somewhat more sophisticated. In addition to the features of the SC-2, it has the company's "Stereophase" control which is designed to reduce the unnaturally wide separation which occurs when many stereo programs are played through headphones. While this is startling and impressive at first hearing, it is frequently quite unnatural and has a totally different effect than normal reproduction through speakers.

The Stereophase switch takes a portion of each channel signal, inverts its phase 180 degrees, and mixes it with the other channel. This alters the stereo effect drastically—so much so, in fact, that sometimes one would think he were hearing a mono signal. This is not the case, as can be demonstrated by simply reversing the channels (if the amplifier has this capability). The reversal is heard in the phones, proving the presence of stereo. Instead of the left and right channels seeming to exist as disembodied program sources outside the listener's head, they come together with (to us) a much more pleasing subjective effect. By direct comparison with a pair of speakers, we satisfied ourselves that the Stereophase system does make headphones sound more like loudspeakers insofar as their stereo spread is concerned. Some people may prefer the more extreme type of headphone sound—this is available by simply switching the Stereophase circuit off.

The SC-3 has a $\frac{3}{10}$ ampere fuse in each input line, as well as 100-ohm series resistors to prevent excessive drive from reaching the phones. It can be used with any low-impedance (8 or 16 ohm) phones. The individual level controls are L-pads. When the speakers are silenced, each amplifier output is terminated by a 10-ohm resistor (this is not required by most solid-state amplifiers, but is advisable with a vacuum-tube output stage).

All three Stereo Control units are packaged similarly, in a plastic case with a removable cover providing storage of most makes of headphones when not in use. The cable which connects them to the amplifier is 24 feet.

The installation diagram for each unit is stenciled on its bottom. We found this to be confusing, since a literal interpretation of the drawing would suggest that the phase of one of the speakers should be reversed. This is not the case, since the control leads are really connected in series with the "hot" side of each speaker line, with the fifth wire going to the amplifier ground.

Although most modern amplifiers have headphone outputs, usually with provision for silencing the speakers, few can accommodate more than one pair of phones. This added flexibility, plus the individual level and balance controls for each phone, makes the SC-3 a useful addition to many systems where headphone listening by more than one person is the custom. The major advantage of this unit, however, is the Stereophase system, which might well make headphone listening more acceptable to many people who presently find it too extreme in its stereo effects.

The *Sharpe* SC-3 carries a list price of \$39.95. The other models, the SC-1 and SC-2, are \$19.95 and \$29.95, respectively. ▲

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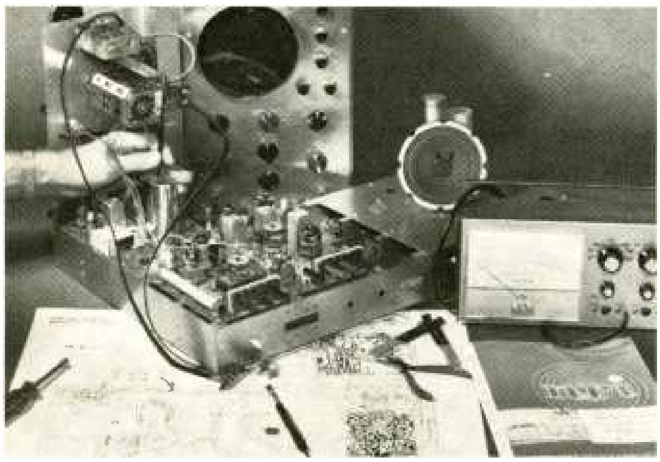

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BOOKS

"BATTERY CHARGERS AND TESTERS" by Charles R. Cantonwine. Published by *Chilton Book Company*, Philadelphia, Pa. 342 pages. Price $9.50.

Since battery-operated equipment is everywhere these days, chargers and testers for the batteries are proliferating at an astounding rate. The author feels that there is a real need for a "how-to" book covering the operation, repair, and maintenance of such chargers and testers.

The text is divided into five sections covering battery-charger operation, test equipment, components of battery-charger units, battery-charger testing and repair, and battery-charger modifications. Emphasis is placed on service-bench practicality and illustrative material has been used lavishly to assist the user. Three appendices supply information on battery-charger equipment, brand name/manufacturer listing, and abbreviations and symbols.

* * *

"JAPANESE COLOR TV SERVICE MANUAL NO. 1" by Stan Prentiss. Published by *Tab Books*, Blue Ridge Summit, Pa. 17214. 176 pages plus 36-page foldout section with 12 full-size schematics. Price $7.95, vinyl cover.

This volume covers color sets from *Sony*, *Sharp*, and *Midland*, including chassis in these firms' 1971 lines.

The material is divided into seven sections covering solid-state troubleshooting, *Sony's* four basic chassis, *Sony's* service and setup, *Sony's* alignment techniques, servicing *Midland* receivers, *Sharp's* seven basic chassis, *Sharp's* adjustments and alignment, and chassis layout diagrams. Thankfully, schematics and chassis layouts have been reproduced in sufficient size to permit using this manual on the service bench while actually working on the set.

* * *

"TRANSISTOR TV SERVICING MADE EASY" by Jack Darr. Published by *Howard W. Sams & Co., Inc.*, Indianapolis, Ind. 46268. 155 pages. Price $4.95. Soft cover.

This handy volume covers all aspects of servicing transistorized television receivers—from the types of tools and test equipment that will be required to troubleshooting specific circuits on PC boards.

As is the case with all of this author's books, he is addressing his fellow service technicians and passing along ideas and short-cuts he has ferreted out as a practicing technician himself. In other words, emphasis is entirely on practicality and ways to speed up the service job and make it easier. He even advises his fellow technicians to refuse to service sets on which they are unable to obtain service data since the nature of the construction makes it virtually impossible to trace the trouble in the amount of time the customer is willing to pay for. But he also urges that since transistorized TV is here to stay, the technician had better be willing and able to tackle such sets.

* * *

"TV, RADIO & HI-FI HINTS & KINKS" by John J. Schultz. Published by *Tab Books*, Blue Ridge Summit, Pa. 17214. 251 pages. Price $7.95.

This is a book for the man who enjoys "tinkering" with his own equipment—whether it involves upgrading it, adding an accessory of some kind, or trying to track down some elusive fault in its operation.

Despite the elementary level of the text, some of the ideas will prove helpful to professional technicians as well. The first chapter is devoted to a thorough-going discussion of basic tools and test equipment, reading schematics, parts substitutions, wiring and soldering, breadboarding circuits, and picking the right wire size and insulation.

From then on the author covers remote speakers and headphones, sound-activated light displays, remote controls and timers, microphones, FM and TV antennas, DX AM and short-wave antennas, two-way radio systems, tape recorders and phonographs, hi-fi amplifier accessories, TV and hi-fi equipment care and repair, interference control and suppression, and home video recorders. Because of the lack of technical sophistication on the part of his readers, the author has explained everything in simple terms while the accompanying diagrams are presented clear, unambiguous form. Emphasis in all cases is on the use of standard parts and the author provides information on where such components can be purchased.

This little book should be helpful to the thousands who have an urge to "adapt" their "store bought" equipment to a "custom" design.

* * *

"A DICTIONARY OF ELECTRONICS" by S. Handel. Published by *Penguin Books*. 413 pages. Price $1.95.

This is a new edition of a popular, pocket-sized reference work that first appeared in 1962. Considering the limitations of space, the author has done an amazing job of providing the maximum amount of authentic information. The definitions are terse but accurate and clear and for the non-technical user, any unfamiliar word in the definition is readily tracked down in any standard dictionary.

The material is illustrated where required for clarity sake and definitions are cross-referenced when needed. British and U.S. terminology are included in cases where it is appropriate.

* * *

"UNDERSTANDING OSCILLATORS" by Irving M. Gottlieb. Published by *Howard W. Sams & Co., Inc.*, Indianapolis, Ind. 46268. 155 pages. Price $4.50. Soft cover.

Since oscillator circuits are used in so many electronic devices, it behooves the engineer, technician, ham, or experimenter to be familiar with the various types.

The text is divided into four chapters covering the frequency-determining elements of oscillators, active devices of oscillators, the theory of oscillation, and practical oscillators (including the familiar Hartley, Colpitts, and Pierce and the maybe-not-so-familiar Meissner, Franklin, Butler, and Meacham bridge).

The author's approach is concise and no-nonsense and illustrative material is used lavishly to amplify and clarify the discussion in the text.

* * *

"FIRE & THEFT SECURITY SYSTEMS" by Byron Wels. Published by *Tab Books*, Blue Ridge Summit, Pa. 17214. 174 pages. Price $7.95.

Since "security" seems to be the "in" thing these turbulent days, there has been a rash of books on selecting, installing, and maintaining security systems for the home and office. One can only hope that such books are not being consulted as avidly by would-be burglars as they are by their potential victims.

Written in the author's informal style, there is nevertheless a useful collection of information on the various types of systems available, the companies making such equipment, how to get started in business, how to lay out a protected area, installing the system or systems, and maintenance procedures to be followed. Photographs, line drawings, and charts are used with a lavish hand to show the various types of protection systems available and how they can be used under different conditions to protect a number of diverse premises. ▲

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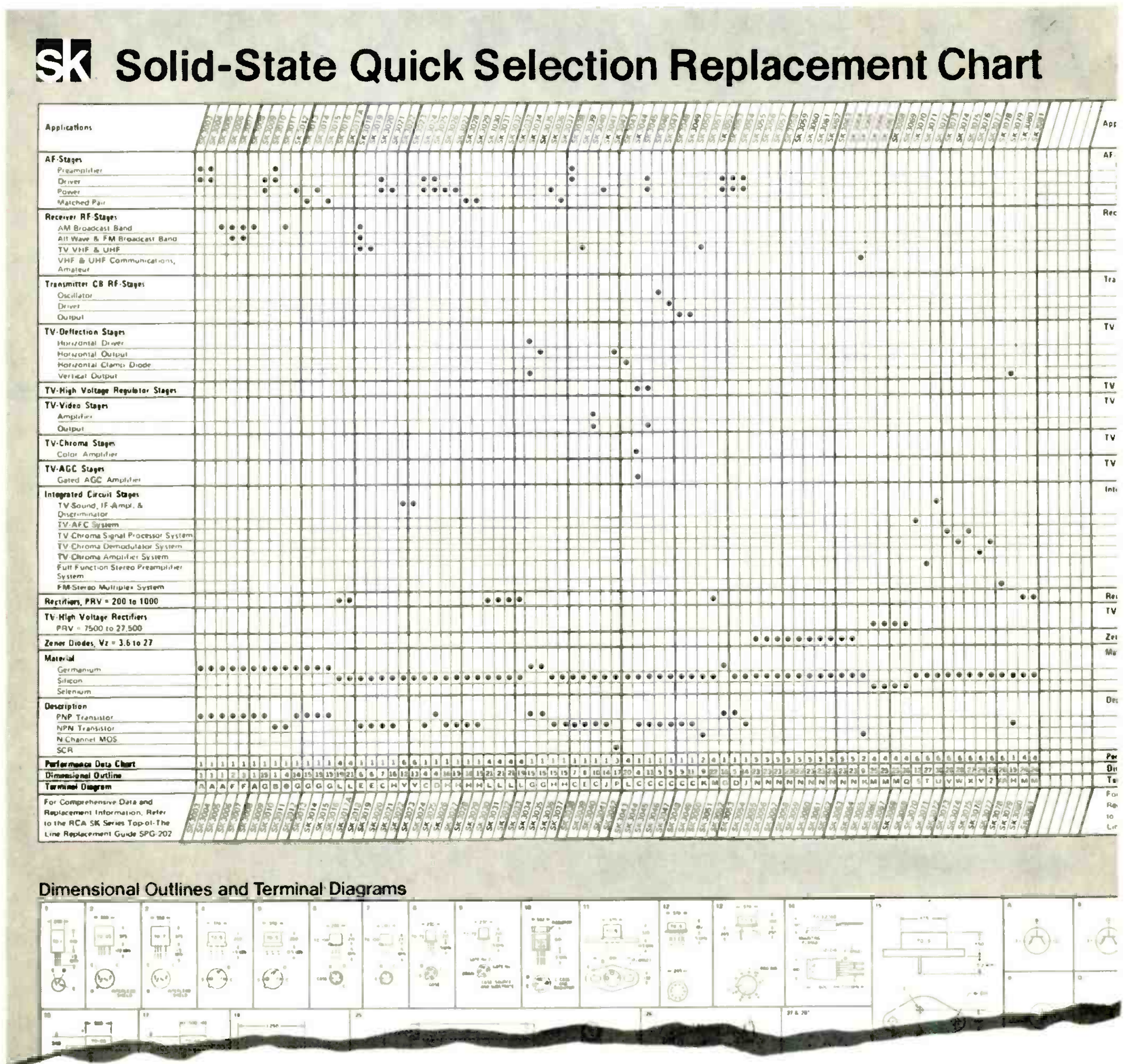

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Also available is the new edition of RCA's SK Series Top-of-the-Line Replacement Guide which shows how only 79 RCA SK devices can replace more that 20,000 OEM solid state devices in radios, TV's, stereos, tape equipment and other home entertainment equipment.

The new Guide also features 17 industrial type SK's that replace devices used in power control and switching circuits and other industrial applications.

All RCA SK types are accurately cross-referenced with industry types in this updated Replacement Guide which you can use to advantage on every service call. See your local RCA distributor for both the SK Quick Selection Wall Chart (1L1367) and the SK Replacement Guide (SPG-202L). They work hand in hand to make your replacement job faster and easier.

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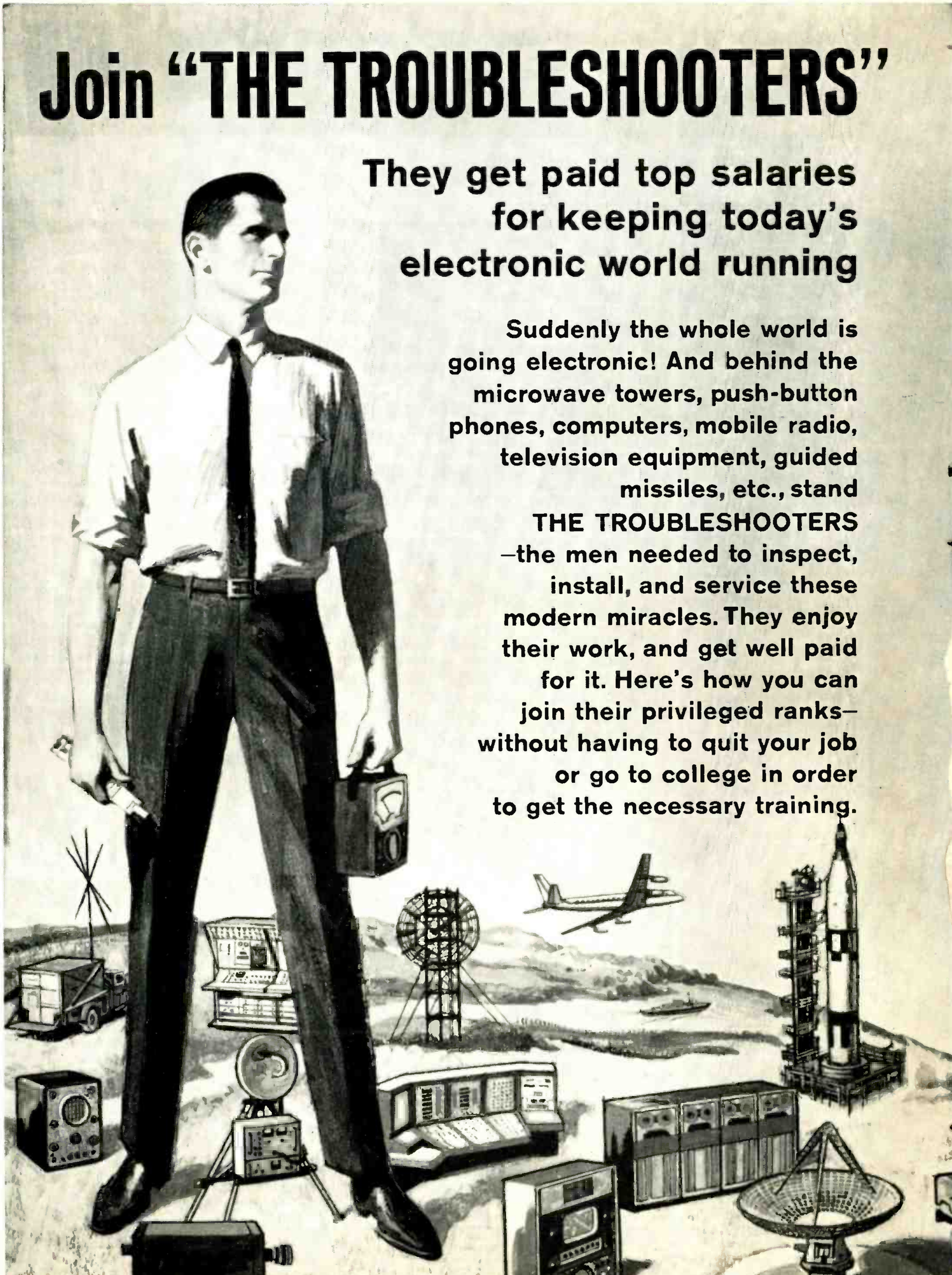
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Suddenly the whole world is going electronic! And behind the microwave towers, push-button phones, computers, mobile radio, television equipment, guided missiles, etc., stand THE TROUBLESHOOTERS —the men needed to inspect, install, and service these modern miracles. They enjoy their work, and get well paid for it. Here's how you can join their privileged ranks—without having to quit your job or go to college in order to get the necessary training.

JUST THINK how much in demand you would be if you could prevent a TV station from going off the air by repairing a transmitter...keep a whole assembly line moving by fixing automated production controls...prevent a bank, an airline, or your government from making serious mistakes by servicing a computer.

Today, whole industries depend on Electronics. When breakdowns or emergencies occur, someone has got to move in, take over, and keep things running. That calls for one of a new breed of technicians—The Troubleshooters.

Because they prevent expensive mistakes or delays, they get top pay—and a title to match. At Xerox and Philco, they're called Technical Representatives. At IBM they're Customer Engineers. In radio or TV, they're the Broadcast Engineers.

What do you need to break into the ranks of The Troubleshooters? You might think you need a college degree, but you don't. What you need is know-how—the kind a good TV service technician has—only lots more.

Think With Your Head, Not Your Hands

As one of The Troubleshooters, you'll have to be ready to tackle a wide variety of electronic problems. You may not be able to dismantle what you're working on—you must be able to take it apart "in your head." You'll have to know enough Electronics to understand the engineering specs, read the wiring diagrams, and calculate how the circuits should test at any given point.

Learning all this can be much simpler than you think. In fact, you can master it without setting foot in a classroom...and without giving up your job!

For over 30 years, the Cleveland Institute of Electronics has specialized in teaching Electronics at home. We've developed special techniques that make learning easy, even if you've had trouble studying before. Our AUTO-PROGRAMMED® lessons build your knowledge as easily and solidly as you'd build a brick wall—one brick at a time. And our instruction is personal. Your teacher not only grades your work, he analyzes it to make sure you are thinking correctly. And he returns it the same day received, while everything is fresh in your mind.

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To keep up with the latest developments, our courses are constantly being revised. This year CIE students are getting new lessons in Laser Theory and Application, Microminiaturization, Single Sideband Techniques, Pulse Theory and Application, and Boolean Algebra.

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And no wonder. The licensing exam is so tough that two out of three non-CIE men who take it fail. But our training is so effective that 9 out of 10 CIE graduates pass. That's why we can offer this famous warranty with confidence: If you complete a license preparation course, you get your FCC License—or your money back.

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Name ____________________ (PLEASE PRINT)

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☐ Check here for G. I. Bill information. EW-95

We compared our new $550 preamp to a 10¢ piece of wire.

First we ran a signal through a 10¢ length of shielded cable. What came out the other end was, of course, audibly identical to what went in. Then we ran the same signal through our new TA-2000F preamplifier, and ran an A-B comparison between its output and the wire's. Both were audibly identical. As we'd expected.

This is not to say that sufficiently precise instruments could not detect inaudible differences between our preamp's signal transmission and a wire's. Whereas a straight wire has no distortion whatsoever, we must admit to having some—three hundreths of one per cent harmonic, and five hundreths of one per cent intermodulation, maximum, at rated output. And whereas a wire theoretically does generate some noise, its signal-to-noise ratio is still somewhat better than the 73dB obtained through the TA-2000F's phono inputs, or even the 90dB obtained through our Aux, Tape and Tuner inputs.

But as you'd expect, the $549.40 difference between our preamp($549.50)* and two feet of cable, buys you a great deal more than just a pure, clean signal. As our preamp's 58 levers, switches, meters knobs and jacks would indicate.

NEARLY 2,000 RESPONSE SETTINGS

Six of those controls are devoted to precise adjustment of frequency response. The calibrated, 2dB-per-step, bass and treble controls have switches that adjust their turnover frequencies, so you can choose how deeply the tone controls will affect —or not affect the midrange. Still another switch cuts the tone controls out of the circuit altogether. And a single knob controls the sharply-cutting, 12dB-per-octave, 50Hz and 9kHz filters. Together, these six controls give you a choice of 1,935 *precisely repeatable* response settings including flat (10Hz-100kHz, +0, −2dB) response.

The facilities for tape recording are exceptional and unique; you can record on two tape decks at once, monitoring either (or your program source) at the flick of a switch. You can dub from one machine directly to the other, without external patching or connections. For straight microphone recordings, there's a mic input position on the function selector knob; for voice-over-music, there's a separate mic level control that diminishes all other input signals as it increases the microphone level.

And, of course, the two, front-panel VU meters, are as useful for testing as they are for monitoring record levels.

TOTAL INPUT AND OUTPUT FLEXIBILITY

The TA-2000F can feed two stereo amplifiers (and an additional monophonic or center-channel amp) at one time, at either a 1 volt or 300mV level. The second amplifier output could also be used for still another tape recorder, should you wish to use the ultra-versatile tone controls and filters in recording. The front-panel output jack feeds both high- and low-impedance headphones, or can be used as a tape output, by suitable adjustment of its independent level control; the same knob also controls the center-channel output.

Five of the 8 rear-panel stereo inputs have rear-panel level adjustments. A sixth—the Phono 1 input — has a switch that selects three separate input impedances at the normal 1.2mV sensitivity setting, and two more impedances at the 0.06mV setting that lets you use even the lowest-output cartridges.

96 TRANSISTORS VERSUS A SINGLE WIRE

But all these features merely make our TA-2000F more versatile than any wire. They don't explain how we can come so close to the wire's pure, unadulterated performance. That explanation will rest with our circuit designers, and with the 96 *high voltage*, and Field Effect transistors they used.

THE TA-3200F: AN AMPLIFIER TO TRULY COMPLEMENT OUR PREAMP

A preamplifier like the TA-2000F deserves, of course, its complement in a power amplifier. Not too surprisingly, we make one: the TA-3200F ($349.50) * Its fully direct-coupled circuitry produces 200 watts continous (RMS) at 8 ohms, with power bandwidth from 5 to 35,000Hz. IHF Dynamic Power is rated at 320 watts into 8 ohms (and fully 500 watts into a 4 ohm load). Its distortion, at a listening level of one half watt, matches the preamplifier's at 0.03%; at full rated output, it is still a mere 0.1%. And the signal-to-noise ratio is 110dB.

Our amplifier's facilities nearly match our preamp's. The 3200F has controls you've rarely, if ever, seen on power amps before: switch-selected stereo input pairs; a speaker selector switch; a power limiter (which holds output down to 25 or 50 watts, should you so desire), and a rear-panel switch that lets you limit bass response below 30Hz., instead of letting it extend to 10Hz.

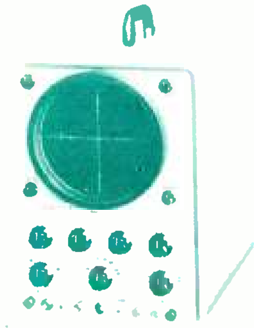
For further information, see your Sony dealer, or write us. Or wire. Sony Corporation of America, 47-47 Van Dam Street, Long Island City, N.Y. 11101.

*Suggested retail price subject to Fair Trade where applicable.

SONY®

CIRCLE NO. 119 ON READER SERVICE PAGE



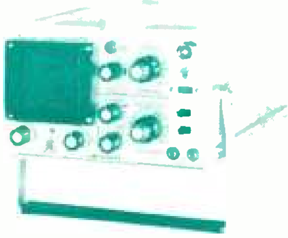
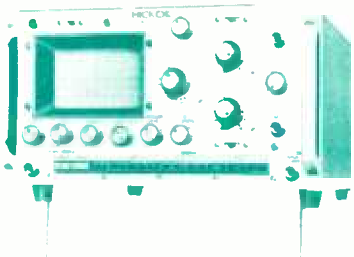
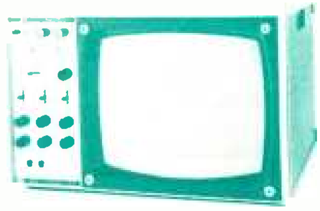



Some of the newer bench-type scopes: Above (from left to right): Heathkit IO-101 vectorscope; Sencore PS163; Lectrotech TO-50; Simpson 458. Below Eico 465. Bottom (from left to right): Leader LBO-301; Hickok 5002; Kikusui 5122; RCA WO-33A.

OSCILLOSCOPES for SERVICING

By STANTON R. PRENTISS
Author, "How to Use Vectorscopes, Oscilloscopes & Sweep-Signal Generators"

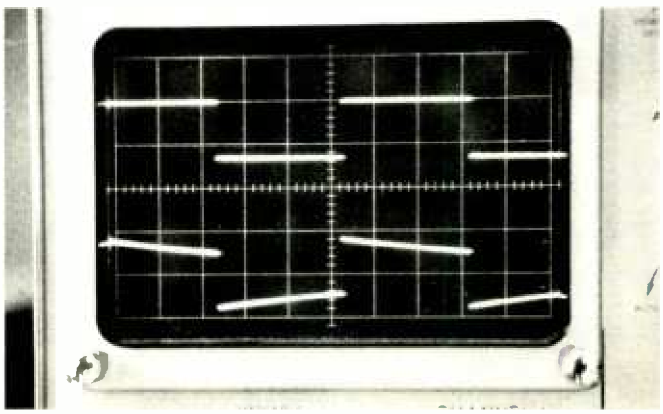
New and more sophisticated circuits call for equally sophisticated test equipment. Here's the rundown on portable and bench models.


THE days of relay switching and slow, current-consuming vacuum tubes have yielded to the transistor; computer; nanosecond logic; high-gain, high-slew-rate operational amplifier; light-emitting diode; ion implant; molecular electronics; and more. Today, emphasis is on gain and speed. Not long ago a bandwidth of 15 MHz was considered exceptional; now 500 MHz to a GHz is a reality. As one active element reaches a certain complexity and speed, another device is developed that surpasses it. There is a price to pay, however. The equipment required to test and analyze these fast, high-gain circuits must be equally sophisticated. One of the more versatile test instruments—the oscilloscope—is available over a wide price range and an equally wide range of sophistication. When purchasing a scope it is logical to select a unit that is adequate for the task at hand, but it is wasteful to choose one that is unnecessarily complex and costly.

All better standard oscilloscopes are judged by the capabilities of both the vertical and horizontal amplifiers, sweep speeds, and dual- or single-time base. Obviously, the less expensive scopes have fewer features. For instance, if the scope you are contemplating has a delay line for X-axis trigger-signal coincidence, a vertical amplifier with a bandwidth of 50 or more MHz, and a dual time base from about two seconds to 100 nanoseconds, then it is going to fall into the $1700-$2500 bracket. On the other hand, a scope with an a.c.-only vertical amplifier, recurrent sweep (no calibrated time base, only gross frequencies), vacuum tubes, and a five-inch CRT, in kit form or built, can cost from $180 up. In between is the scope with a 10 or 15 MHz a.c.-d.c. verti-

Fig. 1. The 6 × 10 graticule of a modern scope. Upper waveform is perfect square-wave; lower shows tilt due to l.f. phase shift.



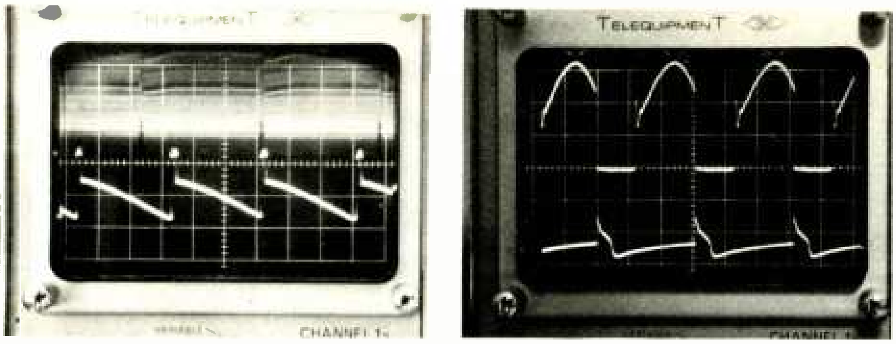


Fig. 2. (Left) Upper waveform is sync output of a TV receiver; lower trace shows the vertical driver output. (Right) Upper trace shows SCR conduction in horizontal output circuit of RCA CTC 46; lower, differentiated output of horizontal blocking osc.

Table 1. Scope features required for various types of service work and their price range.

APPLICATION	VERT. SENS. (mV_{p-p}/cm)	BANDPASS (MHz)	SINGLE/DUAL TRACE	TIME BASE	SWEEP RATES (approx.)	POWER SUPPLY	APPROX. PRICE ($)
Computers[1]	5	50-150	Dual	T with D	1s-50/100ns	a.c.	2000-3000
Aircraft	5	15-35	Dual	T with D	1s 100ns	a.c./batt	2000
TV Broadcast[2]	10	35	Dual	T with D	5s-1μs	a.c.	1500-2000
2-Way Radio	5	15	Single/Dual	T	5s 5μs	a.c./batt.	700 2000
General Lab	10	50	Dual	T with D	1s-100ns	a.c.	2000
Marine	10	15	Single/Dual	T	5s 5μs	a.c./batt	700-2000
Microwave[3]	5	50	Single/Dual	T	1s-100ns	a.c.	2000
Audio	10	1–2	Dual	T	2s-1μs	a.c.	200 1000
Automotive	Usually engine analyzers only						500-1000
Medical	01	1–2	Dual/4-trace Dual Beam	T with D	5s 1μs	a.c.	800 3500
Radar	5	50-500	Dual	T with D	1s-100ns	a.c.	2500-5000
AM-FM Broadcast	10	1–2	Dual	T	2s 1μs	a.c.	200 1000
Digital Logic	10	50-500	Dual	T with D	1s-100ns	a.c.	2500-5000
Nuclear Electronics	100	Up to 1GHz	Single	T	1s 5ns	a.c.	5000
Satellites[1,3]	5	50-100	Dual	T with D	1s-100ns/1s-200ns	a.c.	2500-3500
Oceanography	5	50	Dual	T with D	1s 100ns	a.c./batt	2500 3500
CCTV	10	20-40	Dual	T with/without D	1s-200ns	a.c.	1000-2000
Telephone	10	15 50	Dual	T with D	1s 100ns	a.c./batt	1500 2500
Cable TV[3]	10	10-35	Dual	T with/without D	1s-200ns	a.c./batt	600-1800
TV Service	10-20	5 10	Single/Dual	T (pref.)	5s-200/500ns	a.c.	350-600

NOTES: T=triggered; D=delay; [1] storage oscilloscopes; [2] waveform monitors; [3] spectrum analyzers

cal amplifier with no delay line but with triggered sweep from about 0.5 second to 500 nanoseconds, that can retail from $340 to $450 and have its calibrated accuracy well within 5%.

What over-all accuracy do you really need? A new oscilloscope, with acceptable tolerance and guaranteed for a vertical-horizontal calibration of 3% is probably good over most of its ranges for 2%, at least for the first year. Thereafter, with aging components and a few *beta* changes among the various transistors, the accuracy (without calibration) will probably stretch to between 4% and 5%. It would not be difficult, however, to recalibrate to within at least 3%. On the other hand, an inexpensive scope with initial tolerances of 10% can drift considerably between relatively frequent calibrations. In short, the better scope always has greater accuracy, less drift, and usually much longer periods of service between breakdowns.

Bandwidth/Sweep-Amplifier Relationships

There are certain relationships (and tradeoffs) between the various scope characteristics. For instance, a scope containing amplifiers with wide bandwidths will insure both a better rise time and usually greater sweep ranges, particularly at high frequencies.

The rise time of an amplifier is related to the bandwidth by $t_r = K/BW$, where the factor K is generally 0.35. Therefore, for a bandwidth of 15 MHz, the rise time will be $t_r = 0.35/15 \times 10^6 = 23.3 \times 10^{-9}$ or 23.3 nanoseconds. Such oscilloscopes have sweep speeds from 200 to 500 nanoseconds with 5X magnifiers that permit them to show expanded rise and fall times as low as 40 nanoseconds provided, of course, that the cathode-ray tube has sufficient accelerating voltage to make the trace visible.

Along with wider bandwidth and faster horizontal sweep comes an improved vertical deflection factor. This is sometimes expressed in terms of deflection sensitivity (the inverse of the deflection factor) but such a description normally applies to the scope's CRT. Today's scope manufacturers use the deflection factor to express amplifier sensitivity, where vertical amplifiers are calibrated in volts per division (V/div) whether they are measured in whole or fractional centimeters or in the antiquated unit of V/inch. The use of voltage divider and low-capacitance probes has expanded the voltage range of scopes from microvolts/per division to as high as 500 V/division.

The better oscilloscopes use a graticule with a 6 × 10 or 8 × 10 division. The 6×10 graticule is shown in Fig. 1. Also shown in Fig. 1 is the effect of not using a low-capacitance probe (lower trace) for low frequencies with an a.c. amplifier. The phase shift of the low-frequency components causes the waveform to tilt. The d.c. amplifiers, of course, show no tilt if they are properly compensated.

A 10:1 low-capacitance probe also adds 9 megohms to the normal 1-megohm input impedance of the oscilloscope while, at the same time, lowering the effective input capacity of the instrument.

For some types of measurements and observations in radio-frequency and intermediate-frequency circuits, diode demodulator probes are required.

D.C. Vertical Amplifiers

The d.c. vertical amplifier has no coupling capacitors and any d.c. input to the scope will be shown by a shift of the trace. A direct-coupled amplifier is more complex and costly and the prospective purchaser should question its importance to him. This is especially true of the experimenter. For example, in vacuum-tube circuits using the normal "B" supply voltage of 250 volts, the actual d.c. plate voltage is usually so high that using the d.c. amplifiers of the scope will flip the trace off the screen unless the vertical amplifier sensitivity is reduced. With reduced sensitivity, the a.c. portion of the signal would be difficult, if not impossible, to read. For example, a 20-V p-p waveform swinging on a 400-V d.c. level would occupy only 1/20th of the display and would be completely lost. On the other hand, a 15-V p-p signal riding on 30-V d.c. level would represent a 2:1 ratio and would be easily visible. This would indicate that scopes with d.c. amplifiers would have greater application in low-d.c. voltage circuits—those using semiconductors—where a.c. and d.c. measurements could be made simultaneously and use of a meter avoided.

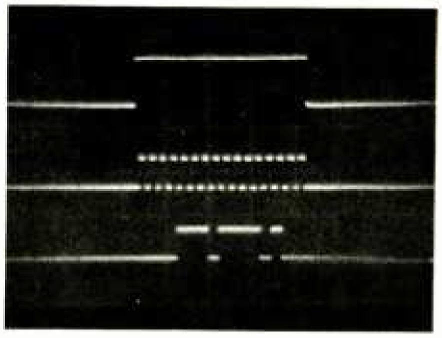
A d.c. voltage can be measured on the scope simply by observing the number of divisions it causes the trace to shift and then multiplying this figure by the vertical amplifier setting, taking into account the effects of any probe being used.

If you are an experimenter and your projects are con-

General-Purpose Oscilloscopes for Servicing

MFR. & MODEL	D=DUAL TRACE T=TRIGGERED SWEEP DS=DELAYED SWEEP CRT OR DISPLAY SIZE		VERTICAL CHANNEL Freq. Response Hz	Sensitivity $mV_{p\text{-}p}$/cm	Direct Input Z MΩ – pF	HORIZONTAL CHANNEL Freq. Response Hz	Sensitivity $mV_{p\text{-}p}$/cm	Direct Input Z MΩ – pF	SWEEP RANGE[1]	PRICE S (K=Kit)	REMARKS
B&K											
1440*	–	5"	d.c.-10M	16.6	1 – 35	d.c.-800k	400	.1 – 50	5-500kHz	279.95	TV sync capability; "Cali-Brain"[2]
1460*	T	5"	d.c.-10M	10	1 – 35	d.c.-800k	300	.1 – 40	.5μs-5s/cm	389.95	TV H&V sweeps plus 19 calibrated ranges
1465*	T	5"	d.c.-10M	16.6	1 – 35	d.c.-800k	300	.1 – 40	1μs-20ms/cm	349.95	TV H&V sweeps; Cali-Brain"[3]; Has 5X magnification
1470*	T-D	5"	d.c.-10M	10	1 – 35	d.c.-800k	300	.1 – 40	.5μs-.5s/cm	499.95	TV H&V sweeps; Has 5X magnification
Eico											
427	–	5"	d.c.-500k	10	1 – 30	2-450k	510	10 – 40	10-100kHz	149.95 109.95(K)	TV H&V sweeps; Has automatic sync
435	–	3"	d.c.-4.5M	51	1 – 35	1-500k	1975	4 – 40	10-100kHz	179.95 129.95(K)	TV H&V sweeps; Flat-face CRT; Automatic sync
460	–	5"	d.c.-4.5M	28.2	3 – 35	1-400k	677	5 – 35	10-100kHz	159.95 109.95(K)	TV H&V sweeps; Has automatic sync
465	–	5"	d.c.-8M	34	1 – 35	d.c.-1M	48	1 – 35	10-100kHz	249.95 179.95(K)	TV H&V sweeps; Flat-face CRT; Can be used as Vectorscope
Heath[5]											
IO-17	–	3"	5-5M	33.8	1 – 25	2-300k	337	10 – 15	20-200kHz	79.95(K)	
IO-101*	–	3"	–	–	–	–	–	–	–	124.95(K)	Vectorscope only
IO-102*	–	6x10cm	d.c.-5M	30	1 – 35	d.c.-1M	100	1 – 50	10-500kHz	179.95 119.95(K)	
IO-105*	T-D	8x10cm	d.c.-15M	50	1 – 35	d.c.-100k	750	.1 – 30	.2μs-.1s/cm	399.95(K)	5X magnification
Hickok											
5000A*	T	6x10cm	d.c.-25M	10^3	1 – 30	d.c.-5M	200	1 – 30	.05μs-2s/cm	595.00	TV sync capability; 24 calibrated ranges
5002*	T-D	6x10cm	d.c.-25M	10^3	1 – 30	d.c.-5M	200	1 – 30	.05μs-2s/cm	845.00	TV sync capability; 24 calibrated ranges
Kikusui											
536A*	–	3"	d.c.-1.5M	20	1 – 22	2-500k	300	.2 – 20	10-100kHz	183.00	
539*	–	3"	5-700k	150	1 – 30	2-400k	1500	2.2 – 75	10-100kHz	130.00	
553*	T-D	5"	d.c.-10M	10	1 – 38	2-200k	1000	1 – 40	1μs-1s/cm	538.00	Has 5X magnification
553P*	T-D	5"	d.c.-10M	10	1 – 38	2-200k	1000	1 – 40	1μs-1s/cm	583.00	Same as 553 except has 3kV acceleration
555*	T	5"	d.c.-10M	20	1 – 33	2-200k	1000	1 – 40	1μs-1s/cm	346.00	Has 5X magnification
555G*	T	5"	d.c.-10M	20	1 – 33	2-200k	1000	1 – 40	1μs-1s/cm	349.00	TV H&V sweeps
556A*	–	5"	d.c.-1.5M	20	1 – 35	2-40k	300	.22 – 35	10-100kHz	239.00	TV H sweep
557A*	–	5"	d.c.-5M	20	1 – 30	2-500k	300	.22 – 35	10-100kHz	249.00	TV H sweep
572*	–	7"	2-600k	20	1 – 30	2-600k	20	1 – 30	1-100kHz	589.00	TV H sweep; X-Y scope
573*	–	7"	2-200k	1	1 – 50	d.c.-200k	1000	.22 – 60	1-400kHz	410.00	TV H sweep; X-Y scope
5121*	–	12"	d.c.-10k	5	.2 – 30	d.c.-1k	100	.5 – 30	d.c.-1kHz	580.00	X-Y scope; Has line sweep
5122*	D	12"	d.c.-10k	2	.2 – 30	d.c.-1k	100	.5 – 30	d.c.-1kHz	798.00	X-Y scope; Has line sweep
5502*	T	5"	d.c.-3M	10	1 – 38	2-200k	500	.22 – 40	1μs-1s/cm	273.00	Push-button operation
5510*	T	5"	d.c.-10M	10	1 – 38	d.c.-200k	1500	.22 – 50	1μs-.5s/cm	383.00	TV H&V sweeps; Has 5X magnification
Leader											
LBO-31M	–	3"	3-1M	80	1 – 33	3-400k	2.5	1 – 50	10-100kHz	139.50	
LBO-32B	–	3"	d.c.-7M	10	1 – 35	d.c.-400k	300	1 – 50	1-200kHz	189.50	TV H sweep
LBO-53B†	–	5"	d.c.-10M	10	1 – 35	d.c.-500k	300	1 – 50	1-200kHz	229.00	TV H sweep; Automatic sync
LBO-54B†	–	5"	d.c.-10M	10	1 – 33	d.c.-500k	300	1 – 40	1-200kHz	249.50	TV H sweep; Calibrated vert. input
LBO-301	T	3"	d.c.-7M	10	1 – 33	2-200k	200	1 – 40	1.25μs-62ms/cm	334.50	TV H&V sweeps
LBO-501†	T	5"	d.c.-10M	20	1 – 33	2-200k	200	1 – 40	1μs-.2s/cm	339.50	TV H&V sweeps
Lectrotech											
TO-50†	T	5"	d.c.-10M	20	1 – 30	d.c.-500k	500	.1 – 30	1μs-.02s/cm	339.50	Vectorscope[4]; TV H&V sweeps; 5X mag.
Panasonic											
VP-517A	T	8 x 10cm	d.c.-5M	20	1 – 35	d.c.-300k	100	–	1μs-.1s/cm	325.00	TV H & V sweep ranges
RCA											
WO-33A	–	3"	5-5M	3.33	1 – 50	3.5-350k	1000	10 – ?	15-75kHz	180.00	Wide or narrow bandwidth; Low or high gain
WO-505A*	–	5"	d.c.-5M	5.92	1 – 25	3.5-2M	157	1 – 20	10-1MHz	299.00	TV H&V sweeps
Sencore											
PS-148A	–	5"	10-5M	18	2.7 – 20	5-400k	666	3.2 – 18	5-500kHz	269.50	Vectorscope[4]
PS-163*	T-D	5"	d.c.-8M	5	1 – 35	d.c.-7M	50	1 – 40	.1μs-.1s/cm	495.00	Can be used as free-running scope; X-Y scope
Simpson											
458	–	7"	10-5M	16.6	3.3 – 20	10-300k	128	?	14-250kHz	420.00	Wide or narrow bandwidth; Low or high gain
446	–	5"	15-100k	33.2	.1 – 40	15-100k	777	.25 – 40	15-80kHz	190.00	
Telequipment (Tektronix)											
51 Series	T	8x10cm	d.c.-3M	100	1 – 47	d.c.-500k	100	1 – 100	1μs-.1s/cm	245.00	TV H&V sweeps; 2X magnification; Dual-beam model $375.00
54 Series*	T	6x10cm	d.c.-10M	10	1 – 47	d.c.-1M	600	1 – 30	.2μs-2s/cm	450.00	TV H&V sweeps; Battery powered $715.00; Dual trace $595.00
D67*	T-D-DS	8x10cm	d.c.-25M	10	1 – 47	d.c.-1M	600	1 – 30	.2μs-2s/cm	975.00	TV H&V sweeps; Has 5X magnification

NOTES: *=solid-state; †=hybrid (semiconductors plus tubes); 1. On triggered sweep models, figures are without sweep magnification; 2. "Cali-Brain" is a B&K registered trademark covering instant direct-reading p-p voltage capability; 3. 1mV$_{p\text{-}p}$/cm optional for $75.00 additional; 4. Can also be used as conventional scope; 5. All Heath prices are for mail order. Prices slightly higher through retail outlets.



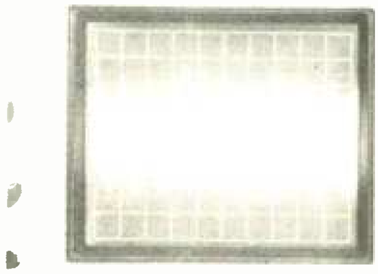


Fig. 3. (Above) Pulse train from computer shown on storage oscilloscope; (Above right) Output waveshape of marine depth finder; (Bottom right) Modulation envelope of a marine transmitter modulated by a 2-kHz audio-frequency tone.

fined to vacuum-tube circuits, consisting of low-frequency oscillators, amplifiers, or stereo units, a relatively inexpensive scope will serve your purposes. It must, of course, be linear, have a bandwidth of from 1.5 to 3 MHz, a sensitivity of at least 50 mV/cm, and a normal input impedance of 1 megohm. The scope will have to be supplemented by a meter for the measurement of d.c. voltages and no accurate frequency measurements can be made with this type of unit. If you wish to compare stereo output channels, the scope will have to have matched vertical and horizontal amplifiers to prevent phase shift. If this is not available, the scope may provide direct access to the deflection plates. With this arrangement, non-amplified Lissajous patterns can be used to determine phase and frequency relationships.

Should you be more ambitious and want to measure time or frequencies to within fairly close tolerances, then you must give up recurrent sweep with its gross calibration and purchase a time-base scope accurate enough for your purposes. Failing this, you can purchase an electronic counter to make your time and frequency measurements. While an improved scope will double your expenditure (still cheaper than the counter), it will also include d.c. amplifiers, an improved deflection factor, greater bandpass, and relegate your d.c. meter to measuring resistance or dB.

The TV Service Technician

What used to be an area of point-to-point wiring, sizzling tubes, and 380-V low-voltage power supplies—the TV set—has now changed drastically. Modular plug-in boards, IC's, transistors, 35- to 150-volt power supplies, and high-voltage triplers and quadruplers are here now—not in the future. The inexpensive non-linear a.c. scope kit of the past, which was dusted off only on special occasions, is not too useful today. To troubleshoot the new solid-state TV receivers, with or without plug-in boards, a completely new approach is needed.

There are many more 5% tolerance resistors, closer tolerance capacitors, and transistors whose *beta* ratings must remain high to drive their dependent circuits. There are also direct-coupled amplifiers, digital gates, silicon controlled rectifiers, unijunction transistors, metal-oxide semiconductors, and just plain silicon transistors. These esoteric circuits and devices just don't respond too well to servicing with a 20k ohm/V multimeter. Measuring static power-supply voltage was satisfactory for vacuum-tube circuits, but is not for semiconductor troubleshooting.

The TV technician must attack his problems with a good oscilloscope in order to locate the offending part more easily. What component will it be? Usually a semiconductor as long as the biasing resistors are mostly ½ watters and the big capacitors haven't yet aged. Occasionally there will be an open coil or transformer, but most of the problems will be caused by marginal rather than completely defective transistors.

How can this type of problem be handled? Probably in no other way than with a scope containing triggered sweep and d.c. amplifiers. Initially, you'll require d.c. accuracy to at least 5% in order to eliminate the need for separate d.c. measurements with a meter. You can simply measure the a.c. and d.c. voltages simultaneously. An accurate time base is also necessary so that you can measure the frequencies in the horizontal and vertical circuits. The scope can also be used to test for horizontal signal components in the vertical circuit and *vice versa*, poor oscillator output, and other vague types of difficulties that cannot be located or identified without a good scope.

As an example, consider the dual-trace display of Fig. 2 (left); the top waveform is the 16.67-ms (60-Hz) sync output waveform while the lower trace is that of the vertical driver. Observe anything unusual? The sweep is set for 5 ms/cm. Since $f = 1/T$, the lower trace is $f = 1/(2.8 \times 5 \times 10^{-3})$ = 73 Hz. Since the vertical frequency of a color transmission is 59.94 Hz, you know immediately that the lower trace is much faster than the sync trace and the receiver is well on its way to doubling its vertical frequency.

The frequency of the upper trace works out to $f = 1/(3.8 \times 5 \times 10^{-3}) = 53$ Hz. Since the transmitted sync signals are actually 59.94 Hz, you might assume this scope to be slightly off calibration and you'd be correct.

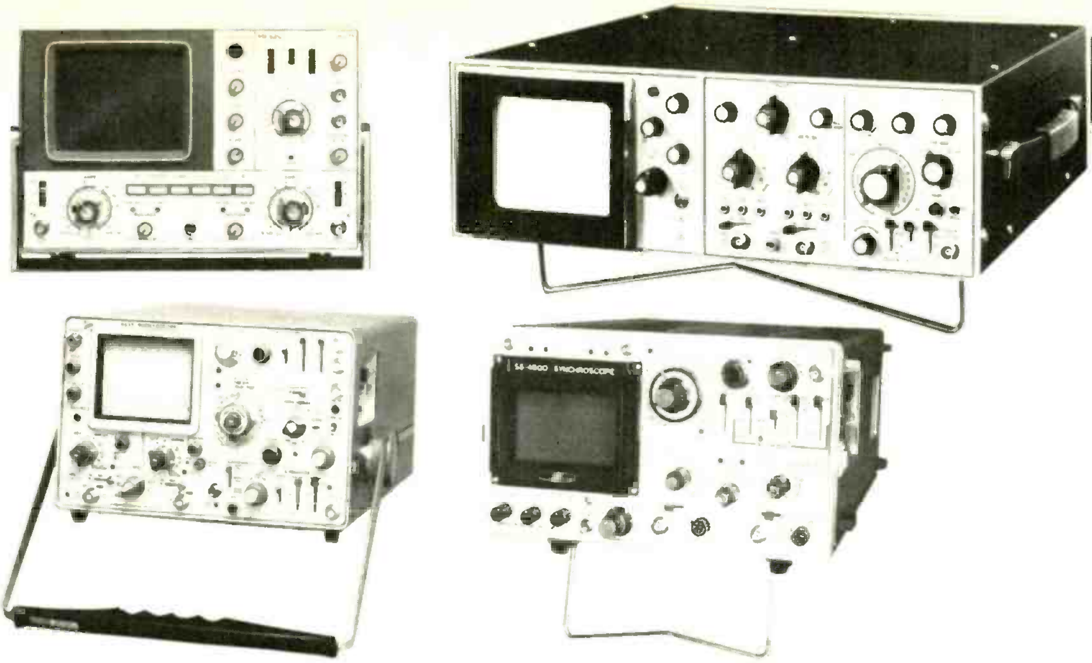
It might be well at this point to note that there is a difference between a dual-trace and dual-beam scope. The dual-trace scope permits two presentations by switching the beam back and forth rapidly, while a dual-beam scope actually has two electron guns in the CRT which generate two independent beams.

Another application of the time-base scope is shown in Fig. 2 (right). The bottom trace is that of a differentiated output of the horizontal blocking oscillator of an *RCA* CTC 46. The top trace is the 330-V p-p output of the horizontal SCR. Ground is the center line and cut off the top line of the graticule. With the time base set at 20 μs, the horizontal frequency can be calculated from $f = 1/T = 1/(20 \times 10^{-6} \times 3.7 \text{ div}) = 15.8$ kHz; a figure very close to the 15,734.264-Hz color scanning rate. As you might also suspect, this is a convenient way to check or calibrate your scope. Done very carefully you can achieve 2% to 3% accuracy. With horizontal and vertical frequencies translated into time-base information, you can check sync circuits, identify hum, transients, and other peculiar manifestations.

One further point deserves mention here. Obviously, a dual-trace scope has been used. Does TV work require two traces? If you are willing to spend between $500 and $1500 for a scope to service semiconductor equipment and want to work quickly, accurately, and dependably, get dual trace. While you're about it, invest in a pair of suitable low-capacitance probes.

A good test for a scope to determine its suitability for TV

(Continued on page 70)

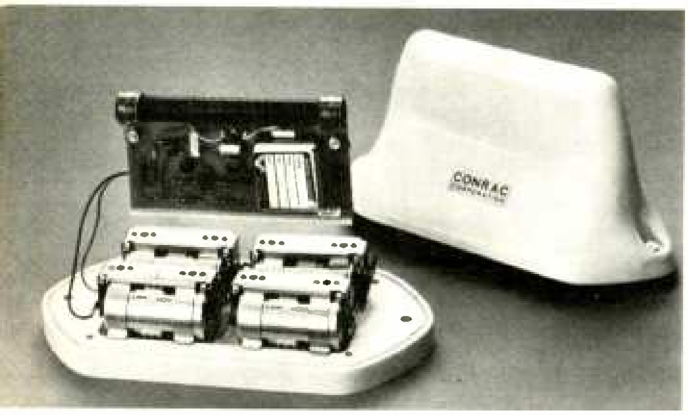


Some portable oscilloscopes currently available include: (top left) Philips PM-3210; (top right) Dumont R1053; (bottom left) Tektronix 453A; and (bottom right) the Iwatsu SS-4500.

Portable Oscilloscopes for Servicing

MFR. & MODEL	D=DUAL TRACE T=TRIGGERED SWEEP DS=DELAYED SWEEP B=BATTERY POWERED	CRT OR DISPLAY SIZE	VERTICAL CHANNEL Freq. Response Hz	VERTICAL CHANNEL Sensitivity mV_{p-p}/cm	VERTICAL CHANNEL Direct Input Z MΩ – pF	HORIZONTAL CHANNEL Freq. Response Hz	HORIZONTAL CHANNEL Sensitivity mV_{p-p}/cm	HORIZONTAL CHANNEL Direct Input Z MΩ – pF	SWEEP RANGE[1]	PRICE $	REMARKS
Dumont											
R1053 Series*	D-T	8 x 10cm	d.c.-50M	10	1 – 24	d.c.-4M	120	1 – 24	.1µs-1s/cm	1845.00	10X magnification; With 60MHz & 5mVp-p sensitivity $2045; With delayed sweep $2045; With 1.0 mVp-p/cm at 25MHz ea. channel $1995; With 1.0 mVp-p/cm at 25MHz & delayed sweep $2195
Hewlett-Packard											
1200*	T	8 x 10cm	d.c.-500k	5	1 – 45	d.c.-300k	100	1 – 20	1µs-5s/cm	715.00	With dual trace $875; With 100µVp-p/cm $790; With dual trace & 100µVp-p/cm $990; With d.c.-7 MHz vert. bandwidth– $950 single channel, $1175 dual
1700*	D-T-B	6 x 10cm	d.c.-35M	10	1 – 27	d.c.-35M	50	1 – 27	.1µs-.2s/cm	1680.00	With delayed sweep $1800; Battery powered add $200; With delayed sweep & d.c.-75MHz vert. bandwidth $1925
Iwatsu											
SS4200M*	D-T	6.4 x 8cm	d.c.-15M	6.25	1 – 25	d.c.-15M	6.25	1 – 25	25ns-13s/cm	1360.00	10X, 20X, 50X magnification; 12ns signal delay
SS4500A*	D-T-DS	4.8 x 8cm	d.c.-50M	6.25	1 – 18	d.c.-50M	6.25	1 – 18	.125µs-6.25s/cm	1950.00	10X magnification; 150ns signal delay
SS5020*	T	8 x 10cm	d.c.-2M	20	1 – 40	d.c.-300k	500	1 – 50	.2µs-1.25s/cm	250.00	5X magnification X-Y phase shift 3° 10kHz
SS5050*	D-T	8 x 10cm	d.c.-5M	10	1 – 40	d.c.-200k	200	1 – 30	.3µs-1.25s/cm	550.00	5X magnification; X-Y phase shift 3° 10kHz
Panasonic											
VP-561A†		6 x 7.5cm	d.c.-15M	66.6	1 – 35	d.c.-1.5M	66.6		.67µs-.67s/cm	1100.00	10X mag.; X-Y scope, 3° phase shift at 50MHz
Philips											
PM3200†	T-B	6 x 7.5cm	d.c.-10M	2.7	1 – 30	10-.1M	400	.1 – 25	.33µs-.67s/cm	395.00	With battery pack $590
PM3210*	D-T	8 x 10cm	d.c.-25M	1.0	1 – 15	d.c.-25M	1.0	1 – 15	.1µs-.5s/cm	1350.00	5X magnification; X-Y scope
Raytheon											
CDU110*	D-T-DS	6 x 10cm	d.c.-20M	5	1 – 35	d.c.-3M	1500	1 – 35	.2µs-.5s/cm	1200.00	5X magnification; Available with differential plug-in; Flat-face CRT
CDU150*	D-T-DS	8 x 10cm	d.c.-35M	5	1 – 25	d.c.-3M	100	1 – 25	.1µs-1s/cm	1495.00	5X magnification; Flat-face CRT
CDU130*	T-B	4.8 x 8cm	d.c.-15M	5	1 – 39	d.c.-1M	1560	1 – 39	.625µs-.25s/cm	925.00	5X magnification; Battery pack $70 extra
Tektronix											
321A*	T-B	3.8 x 6.35cm	d.c.-6M	15.7	1 – 47	d.c.-1M	1575	.1 – 25	.79µs-.79s/cm	1250.00	Battery powered add $77
323*	T-B	3.8 x 6.35cm	d.c.-4M	15.7	1 – 47	d.c.-10k	315	–	7.9µs-1.57s/cm	1050.00	
344*	T-B	3.8 x 6.35cm	d.c.-10M	15.7	1 – 47	d.c.-200k	110	–	1.57µs-.315s/cm	1225.00	
422*	D-T-B	6.4 x 8cm	d.c.-15M	12.5	1 – 33	d.c.-500k	1250	.3 – 35	.52µs-.63s/cm	1600.00	Battery powered add $390
453A*	D-T-DS	6.4 x 8cm	d.c.-60M	25	1 – 20	d.c.-5M	6.25	–	.13µs-6.3s/cm	2050.00	
454A*	D-T-DS	6.4 x 8cm	d.c.-150M	12.5	1 – 15	d.c.-2M	2.5	–	.625µs-6.3s/cm	3200.00	
7403N*	D-T-DS	9.76 x 12.2cm	d.c.-50M	4.1	1 – 5.8	d.c.-2M	82	–	.041µs-4.1s/cm	2200.00	24 different plug-in versions available
Waterman											
OCA-11A	T	4.43 x 6cm	d.c.-200M	19.7	1 – 30	d.c.-200M	19.7	1 – 30	3-30kHz	350.00	
OCA-11B	T	4.43 x 6cm	d.c.-200M	19.7	1 – 60	d.c.-200M	19.7	1 – 60	1ms-10s/cm	405.00	
OCA-12A	D-T	4.43 x 6cm	d.c.-200M	39.4	1 – 60	d.c.-200M	39.4	1 – 60	3-30kHz	405.00	

Notes: *=solid-state; †=hybrid; [1] On triggered-sweep models, figures are without magnification



Computerized Scoring

The robot timer—solid-state car transmitter which is part of Conrac Corp.'s timing and scoring system installed at the Ontario Motor Speedway in California. It instantly identifies a car as it crosses antenna arrays buried beneath the track's surface. System will time fields of up to 60 race cars. Each of the 60 transmitters operates 24 hours on four "D"-type alkaline batteries and radiates a crystal-controlled r.f. signal. Circuit board is encapsulated in the cover to protect against shock and vibration and insure circuit's reliability.

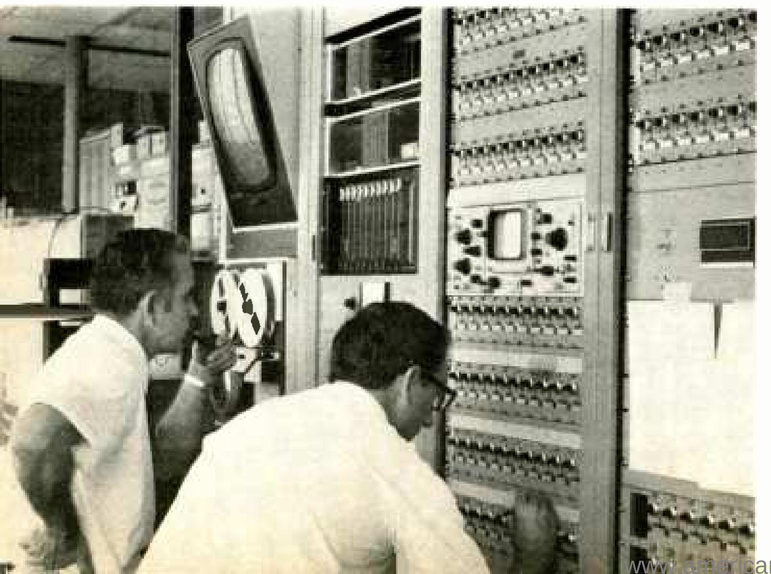
ELECTRONICS and the digital computer are making steady inroads into new areas, one of which is the timing and scoring of automobile racing. The need for automatic data acquisition and processing is great since the sport is enjoying an unprecedented boom.

Since the early days of auto racing, scoring and timing chores have been handled by electromechanical instruments. Even today the Indianapolis 500, the premier racing event, is timed with equipment developed in the 1920's and manually scored by a highly trained staff. With prize money increasing at a rapid rate (the 1970 Indianapolis winner collected over $270,000), more is riding on each race and a scoring error cannot be tolerated. In the past, results were not known for hours or days and sometimes standings were changed after a scoring recheck. With increased television coverage, real-time standings and final results must be announced promptly.

Any automated timing and scoring system must include, as inputs, a time reference mark and a code which uniquely identifies the car. The first presents no problem and can be implemented with basic digital circuitry. The second requirement, however, has stumped timing and scoring system designers for some time. Various schemes, such as optical decoders and pulse-modulated r.f. transmitters, have been developed but with limited success.

A system must store the input data and from it develop lap standings of all participants, compute speeds in miles per hour, and determine time interval between cars. The system must, as well, correlate the data in a format which can be presented manually or automatically to officials and spectators on a real-time basis. The computer programs must include checks and balances to validate the stored data, which is retained for later playback in case of any challenges.

Crystal-controlled receivers which are part of timing/scoring system.



When construction was begun on the $25-million Ontario Motor Speedway in Southern California, it was realized that a complex timing and scoring system had to be included in the plans. The *Conrac Corporation*, which had experience with large-scale electronic display systems, was chosen to develop a complete system for the Ontario track. Its systems approach to a technical problem resulted in a fully integrated, computer-controlled timing and scoring system unique in auto racing. The Ontario system is divided into two parts: Phase I is presently installed and operating while Phase II will get underway in the near future.

The key to the Ontario system is a small, solid-state transmitter mounted on each race car. The extreme environment of shock, vibration, and temperature associated with a high-speed race car is counteracted by installing the transmitter in an aerodynamic fin and encapsulating it with polyurethane foam. *Conrac* has not disclosed the operating frequencies of the transmitters, stating only that they are below the broadcast band.

Each car is equipped with a unique-frequency, crystal-controlled transmitter rated at approximately 100 milliwatts and powered by four "D" cells. Loop antennas are buried under the track and sense the radiated signal as the car crosses the antenna. The buried antennas, located at the start-finish line, pit entrance, and pit exit, are terminated by a line and summing amplifier. This amplifier is connected by coaxial cable to the control booth and to parallel matched crystal-controlled receivers. Each individual car crossing is identified by a pulse output from the applicable receiver for the particular antenna.

The master race-time clock is started when the first car crosses the line at the beginning of a race and continuously generates running time to an accuracy of 1 millisecond throughout the event. Each time a car crosses an antenna, the master race clock is strobed and the time entered into a buffer computer, along with the antenna location and transmitter identification code.

Two Teletype machines are used to print out the raw data developed by the buffer computer. This real-time is used primarily for checking and validating later computer-compiled data listings.

Automatic operation with the transmitter-receiver link is paralleled by a manual backup system which comes into play should either a transmitter or receiver fail. Small manual consoles are provided, one for each car in the race. When a car crosses an antenna, the master clock is manually strobed by an operator. If, within 10 seconds, the receiver senses a transmitted strobe, the manually entered time is

and Timing System for Auto Racing

by PHILIP HARMS/Willard Laboratories, Inc.

With auto racing enjoying an unprecedented boom and purses getting larger and larger, timing is playing an increasingly important role at speedways throughout the country—from Indianapolis to Ontario.

canceled. If an automatic strobe signal is not received within the 10-second window, the system uses the manually entered time and returns a signal to the operator, indicating that the automatic channel is inoperative and he must continue to enter data manually.

The heart of the data-acquisition operation is an *IBM* 1130 computer, operating with a 16-bit word length, a 16K core memory, and a 512K auxiliary disc file memory. The 1130 continuously interrogates the raw-data computer for unprocessed data, retrieving updated times and storing pertinent data for later processing. The computer operator can instruct the 1130 at any time to prepare a hard-copy print-out of the lap order of the field for the benefit of the press and for official use.

The *Conrac* system provides not only data computation but pylon display of the standings for spectators. Three pylons, each 55 feet high, are located at strategic spots within the track infield. These pylons provide real-time lap positions of the nine top positions as well as the lap number of the leader. Serial data is transmitted to the pylons by means of 12-gauge twisted pairs. Readout is by incandescent lamp arrays for each character, with triac control. Power consumption for each pylon is 65 kilowatts. The pylons can display computer-developed standings or read out manually entered numbers.

Phase II

The Phase I system has been operating without problems at Ontario Motor Speedway for three major racing events. Soon to be undertaken will be the expanded Phase II system, which includes a main display board 47 feet high by 246 feet wide, a second *IBM* 1130 computer, and additional peripheral equipment.

The main display board, consisting of 16,000 lamps, is controlled by the second computer and can read out five lines of 40 characters each with a character height of 63 inches. The computer will also be able to generate characters 15 feet and 37½ feet high. The basic transmission rate provides changes in board information at a 15 frames-per-second rate.

Control of the main display board will be through two CRT keyboard terminals. Here operators can insert statistics into standard pre-formatted presentations, preview prepared messages stored in disc memory, edit messages for display, and generate new messages on a real-time basis. Upon command, the CRT-displayed message can be transferred to the display board or to a 300-line-per-minute console printer.

With the display rate of 15 frames per second, the main board will be able to show animated "cartoon" pictures. This will be accomplished by the animation unit, which accepts high-contrast films and converts them to display data.

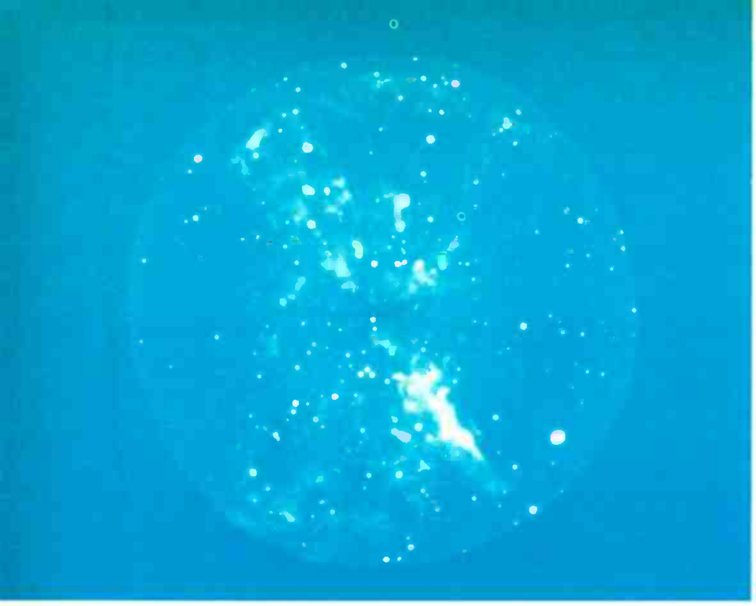
Permanent race records will be stored on magnetic tape for later usage and playback. In case of a power failure, an auxiliary battery power supply will switch in automatically to maintain race sequence. Once power is restored, the race sequence can be rerun at a fast rate within the computer in order to re-synchronize all timing and scoring operations. The magnetic tape can be rerun at a later date, in order to arbitrate protests and for system checkout and simulation.

The Future

While the electronic timing and scoring system at Ontario Motor Speedway is only the beginning, computer-controlled systems will be providing the necessary timing and scoring functions for auto racing in the future. While the cost of the Ontario equipment may preclude wide acceptance (the price tag for Phase I is in the $1.2-million bracket), other plans under evaluation may permit widespread adoption of automatically controlled systems.

The most practical approach may be a self-contained system installed in a van or trailer, which can be moved from one location to another. The speedway owner need only provide permanently installed antennas in the track and foundations for portable pylons. A standard mounting plate could be installed on all cars and the transmitters mounted in minutes. Line summing amplifiers, computer, storage elements, and printers would be carried in the van. Such a semi-mobile system may bring automatic timing and scoring costs of auto racing within the range of the many racing organizations throughout the country. ▲

Transmitter is installed on a car, inside an aerodynamic fin.



Electronic

By DAVID L. HEISERMAN

Image-tube photo of the Dumbell Nebula made by R.E. Williams at University of Arizona's Steward Observatory.

ONE of the main goals of modern technology is to develop instruments that extend the range of normal human senses. The human eye, for example, doesn't function very well in a darkened environment. Technology has answered this particular challenge with several kinds of see-in-the-dark devices, including ***electronic images tubes***.

Commercial electronic image tubes—or image-intensifier tubes to be more precise—accept light from a dimly lit scene, amplify it electronically, and produce a brightened version of the original scene on a phosphor viewing screen. Unlike ordinary TV camera tubes, image tubes produce their output images simply and directly without resorting to electronic scanning.

Astronomers have always been interested in getting brighter views of the objects they study through their telescopes, so it was inevitable that image tubes would find their way into observatories. It was an astronomer, in fact, who built the first workable electronic image-intensifier just prior to World War II. The device, called a Lallemand tube or camera, produces its output images on a piece of film rather than on a directly viewable phosphor screen. As far as astronomers are concerned, film is still the best image-tube output medium. When industry and the military took up image-tube development during World War II, however, the film was eliminated and phosphor screens took over.

Most people who buy image tubes today are interested in one thing—seeing in the dark. Whether or not the contrast is perfect is of no real concern as long as they can see what they want to be able to see. Astronomers, on the other hand, must be able to make reliable measurements of the relative light intensities and perform other kinds of photometric studies that demand faithful reproductions of the original contrast information.

Commercial image tubes have directly viewable phosphor screen outputs and, in order to make photographs of the images, astronomers have to use a light-sensitive film. However, films that have sensitivities and spectral responses matching light from phosphor screens do not reproduce contrast information linearly. Light-sensitive emulsions have intensity response curves that level off at some saturation point. The more exposed a portion of the film becomes, the smaller the effect each photon has upon it.

Astronomers use an electron-sensitive film, called a nuclear emulsion. By discarding the phosphor screen and replacing it with a nuclear emulsion, every electron from the photocathode contributes exactly the same amount of exposure, no matter how much activity has gone on before. Astronomers, in other words, want a linear contrast response that a phosphor-film interface on an image tube cannot provide.

In spite of astronomers' needs, the development of commercial phosphor-screen image tubes proceeded quite rapidly. Among the more popular image-tube devices are the infrared "snooperscopes" of WW II and the starlight scope now used in Vietnam. The military market for image tubes has grown to the point where it is possible to buy new tubes for less than $1000 and surplus tubes for less than $300. Compared to these commercial and military devices, the image tubes astronomers have to beg, borrow, or build seem primitive. Some astronomers can buy new astronomical image tubes that are custom products from major image-tube manufacturers, but the small demand keeps the price in excess of $25,000 per unit!

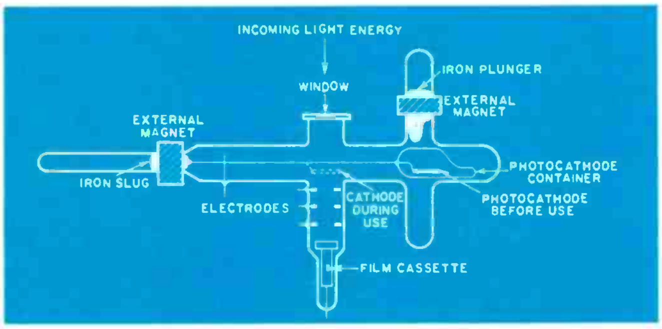
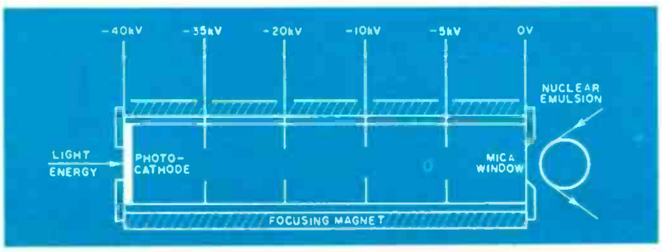


Fig. 1. Although Lallemand tubes, properly called "electronic cameras," are extremely awkward to set up and use, astronomers have applied them quite successfully since the 1930's.

Fig. 2. Because they are so easy to set up and operate, Spectracon tubes are most promising astronomical image devices.



Lallemand Tubes

Although Lallemand tubes are simple in principle, they are extremely awkward devices to prepare and use. A specialist has to begin preparations at least a day in advance and, even then, he has to prepare several tubes at a time in case something goes wrong with one or two of them. The most delicate part is the photocathode. These elements arrive at the observatory sealed in evacuated glass vials. The vials protect the cathodes from both physical damage and contamination by moisture and chemicals in the air.

When preparing a Lallemand tube, the user has to load

Image Tubes in Astronomy

Various types of electronic image-intensifier tubes are used in astronomy for light-intensity measurements and other photometric studies. Here are descriptions of several kinds and how they operate.

the film cassette and photocathode—still in its glass container—into the tube through a small window opening (Fig. 1). The entire photocathode assembly remains in a position well away from the film until the moment the tube is ready for use. After loading the tube and sealing the glass window into place, the user must evacuate the tube and bake it out as much as possible without damaging the emulsion.

When the tube is in place on the telescope and the astronomer is ready to expose the film, he has to break the glass container around the photocathode by hammering it with a magnetically operated iron plunger. He then uses another magnet to pull the bare cathode into place over the film cassette. If all goes well to this point, the only remaining step is to slide the cover off the film cassette with another external magnet. The cassette has several plates in it that the user can change, also by means of an external magnet.

When he uses up all the plates in the film cassette, the astronomer has to break the vacuum on the tube and remove the exposed plates through the opened window. Breaking the vacuum exposes the photocathode to contamination, however, so the tube must be completely disassembled and prepared for use again.

Kron Tubes

C.E. Kron, an astronomer at Lick Observatory (California), decided that contamination of the photocathode created most of the headaches associated with Lallemand tubes. He built a modified Lallemand tube that has a vacuum seal between the cathode and film cassette. Once the cathode is in place, it can be sealed off from the rest of the tube whenever the user wants to change film cassettes. After changing the film, the user reseals the opened half of the tube, evacuates it, and opens the vacuum seal.

The photocathode in a Kron tube, unfortunately, doesn't last indefinitely, either. Electrons striking the nuclear emulsion send off energetic bits of matter and ions that contaminate the photocathode material. This contamination eventually builds up to a point where the user has to replace the cathode.

The Kron tube is now a popular device among image-tube astronomers. Although it reduces the preparation time considerably, a Kron tube still requires a skilled operator to manipulate the magnetic cassette mechanism, operate the vacuum system, and occasionally change the photocathode.

Spectracon Tubes

The most promising astronomical image tube in use and still under further development is one designed by J.D. McGee at the Imperial College in London. Contrary to popular consensus, McGee decided to bypass all the problems with the Lallemand and Kron tubes by placing the nuclear emulsion outside the tube.

McGee's astronomical image tube, called a Spectracon, contains the photocathode and accelerating electrodes in a permanently sealed glass envelope (Fig. 2). A small mica window, only about 4 microns thick, transmits energetic electrons out of the tube to the nuclear emulsion. This technique reduces the quantum efficiency of the tube by about one-third, but it eliminates all forms of cathode contamination, and does away with all the tricky magnet manipulations and vacuum processes.

The Spectracon doesn't require a highly skilled operator and it can be set up and in full operation within minutes. Astronomers are now beginning to believe these two advantages alone compensate for the loss of quantum efficiency.

The current activity in Spectracon development concerns finding materials that make it possible to build tubes with larger output windows. Since the windows have to withstand full atmospheric pressure, the largest Spectracon windows measure only 4.5 by 33 mm. This long and narrow configuration makes it almost impossible to take electrographic pictures of large stellar objects. For this reason, astronomers generally use Spectracons only for analyzing the spectral content of steller light.

Merle F. Walker, one of America's leading image-tube astronomers, recently stated that "The one-million-dollar cost of developing the 4-inch diameter (image) tube is less than that of a single new telescope 100 inches or more in aperture, but the results for photometry would be to transform every existing 60-inch instrument (telescope) into a 200-inch!" ▲

Image-tube photo of Smoke-Ring Nebula from Steward Observatory.

15 Years

◀The "Emmy" awarded to Ampex in 1957 is shown with the original VR-1000 video tape recorder for which it was given.

VIDEO-tape recording, which is attracting growing interest in fields ranging from home entertainment to information storage and retrieval, was born just 15 years ago. It was conceived to solve a vexing problem of the then-youthful television broadcasting industry.

It not only solved the problem of time delay in network broadcasts, but it also dramatically improved television viewing with techniques such as "instant replay," it has spawned \$730,000,000 worth of business in the last 15 years, and it created three entirely new markets: (1) institutional closed-circuit television; (2) home recording and playback; and (3) automated information processing.

According to *Ampex*, which invented video-tape recording and has collected well over half the \$730,000,000, this figure will be equaled again in less than five years. In fact, \$730,000,000 is projected as a likely *annual sales figure* for video-recording equipment by 1976!

In 1971, the broadcast industry continues to be the largest user of video recording, constituting about half the market, while institutional closed-circuit television users (in education, industry, government, and medicine) are expected to account for 43%; home recording and playback, virtually nothing; and automated information processing, 7%.

In five years the picture will change drastically. Broadcasting and CATV are expected to represent about 10 to 15 percent, with closed-circuit television, home use, and information systems each taking 25 to 30 percent of the total.

The Ampex Instavideo recorder can record color or black-and-white TV programs off-the-air or play back previously recorded programs on home receivers. It is the smallest cartridge-loading video playback device on market to date.

Broadcasting and CATV

In the early days of television, networks and stations had no practical way of recording programs and commercials for quality re-broadcast within a few hours. News programs originating in New York City at 6 p.m. Eastern time, appeared simultaneously throughout the country, before most residents of the Midwest and Western states were home from work. Moreover, because it was impossible to edit live broadcasts, viewers from coast-to-coast witnessed those many embarrassing moments, such as when an announcer coughed his way through a cigarette commercial.

The *Ampex* VR-1000 video-tape recorder, introduced at the National Association of Broadcasters convention in 1956, provided the solution to these problems. It successfully converted images to electronic impulses and recorded them on tape for immediate or delayed transmission.

Before the end of that year, people in California could watch "Douglas Edwards and the News" at 6 p.m. Pacific time, since *CBS* recorded the live program and replayed it each hour to a different section of the country.

If production errors were made while putting a show or commercial on tape, the recorder was stopped, the tape erased and rewound, and the scene re-done.

The video-tape recorder was rapidly adopted throughout the broadcast television industry in the United States and abroad, but remained an exclusive tool of the broadcast industry for nearly 10 years.

Before the end of the 1950's, the National Academy of Television Arts and Sciences recognized the importance of the video-tape recorder and awarded *Ampex* an "Emmy" for its development. The firm began manufacturing a line of color recorders and another manufacturer, *RCA*, entered the growing broadcast field with its video-tape recorder.

Quadraplex recording on two-inch-wide tape rapidly became the broadcast-industry standard and the capability whetted broadcasters' appetites for more sophisticated technologies. Their new requirements brought about the development of significant advances; among the most important of which were electronic editing, high-band recording, and the "instant-replay" system.

In 1962, electronic editing became feasible so the video-tape recorder could be used as a production/editing tool, as well as a delayed-broadcast system. Until then, if a tape editor wanted to change the sequence in which segments occurred in a tape, or add or delete material in a program, he had to physically cut the tape and splice together the desired finished production.

Electronic editing, widely used today, places an electronic signal on the tape at the touch of a button. This signal tells the recorder to erase a scene, to transfer a segment of action to another recorder, or to cue in a new input from a TV camera, film chain, or another video-tape recorder.

# of Video Recording

By WILLIAM SLATKIN/ Product News Manager, Ampex Corporation

One of the great developments of our times—but will it really spawn a home recording/playback market as large as many anticipate?

At the moment the insertion or deletion takes place, the electronic editor automatically synchronizes the change so the editing point will not be visible during playback. The viewer sees a change in scenes without the slightest jitter.

Because of further refinements in this capability, electronic editing can be accomplished from a single console which controls a variety of production systems. Modern consoles employ a computer memory to store cues and editing instructions.

High-band recording, developed in 1964, significantly advanced video-tape recording technology by substantial improvement in the signal-handling characteristics of the record/reproduce electronics.

The advancements in later designs (VR-2000) were significant enough to produce a noticeable improvement in the quality of color recordings. "Second-generation" equipment also made possible, for the first time, the production of several successive duplicates of a taped program through many generations without degradation of picture quality.

Another significant development in video recording for the broadcast industry was the video disc recorder—the "instant-replay" device so familiar to armchair sports enthusiasts. The HS-100, introduced by *Ampex* in 1967, was first used in televising the 1967 U.S. Ski Championships from Vail, Colorado. Disc recording was developed because video-tape recorders, like audio recorders, do not provide a practical and totally accurate means of finding and replaying specific segments of recorded pictures and sound, and because slow-motion and stop-action effects are nearly impossible to obtain on a video-tape recorder.

The video disc technique uses a magnetically plated disc as the recording medium with the video record/playback heads placed in a movable carriage. During the recording operation, the head moves across the rotating disc, electronically placing video information in magnetic tracks on the disc, much as the rotating heads in a video-tape recorders place images on the tape.

When a particular segment of action is to be played back, the operator presses a button to command the head to return to a particular video frame and begin a replay.

By altering the speed at which the head moves across the disc either in record, playback, or both, speed of the segment being played is correspondingly altered. If the head is "frozen" over a single track, the HS-100 replays a single frame and the monitor exhibits a stop-action picture.

Scores of these machines are used throughout the world for "instant-replay" coverage of sporting events while a modified version, introduced in 1968, uses the disc technology along with a computer memory for the production of television programs and commercials. When used with electronic editing, it produces the fast, slow, and stop-action effects seen on many of the most popular comedy/variety shows.

Although sales of video equipment to commercial and educational television broadcasters and CATV operators will soon be surpassed by the three newer markets, broadcasting will remain the major source of technological innovations in the video-recording field. New developments, such as high-speed video-tape duplication, which will eventually serve all industries concerned with video-tape recording, are emerging first in the broadcast market.

Institutional Closed-Circuit TV

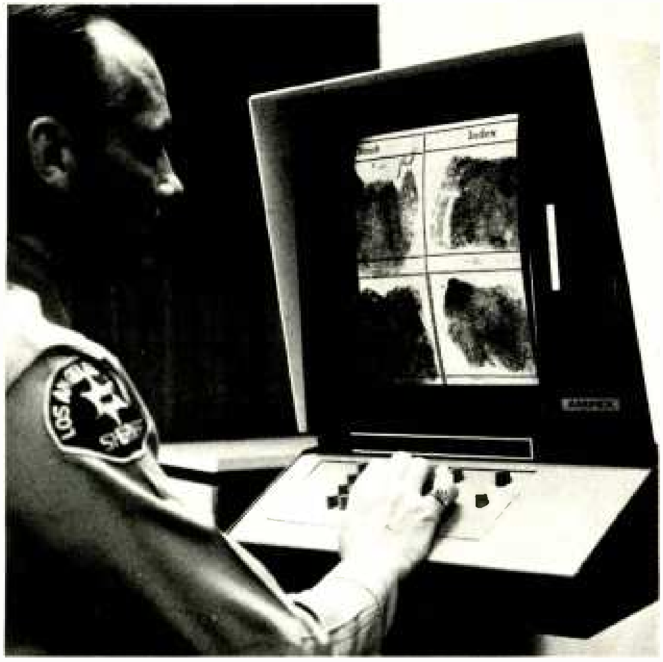
The largest of the three new markets for video-recording technology is currently closed-circuit television (CCTV) used in education, industry, government, and medicine for various training and communications applications. Various closed-circuit video-tape recording systems, offered by *Ampex*, *Sony*, and several other manufacturers, first appeared on the market in 1962.

While broadcast video-tape recorders weighed about 1200 pounds, were priced at approximately $60,000 and up, and used only two-inch-wide tape, the first closed-circuit video-tape recorders weighed between 50 and 100 pounds and were priced from about $10,000. Some used inch-wide tape.

A major technical difference between broadcast and CCTV recorders is the recording technique. Broadcast systems use four record/playback heads mounted on a drum which is rotated rapidly across the tape at virtually a 90-degree angle to the path of the tape. In this manner, the relative tape-to-head speed reaches approximately 1500 inches per second. At this speed, frequencies of more than 5 MHz may be obtained. This frequency is required to produce TV pictures with the quality necessary for commercial broadcasting.

Closed-circuit recorders use the helical recording format. The tape is wrapped diagonally around the drum, which contains one or two record/playback heads. The rotating drum records across the moving tape in a diagonal curve. In this manner, relative tape-to-head speeds of from 650 to 1000 inches per second are produced, creating frequencies up to 3.2 MHz. Although this bandwidth is ordinarily un-

The central file facility of a $1.8 million Videofile information system accepted by American National Insurance Co. The system will store documents as television recordings on video tape and make them available for viewing as TV pictures or printed copies. It will reduce file space to one-fourth that presently required for paper records containing the same data.



The Los Angeles County Sheriff's Department will retrieve, compare, and identify fingerprint records in minutes using a Videofile system as the key element in a county-wide television records system. Installation will begin this summer.

suitable for broadcast television, it produces pictures of high enough quality for the demanding requirements of the institutional market.

Within eight years after their introduction, at least 75,000 closed-circuit recording systems were being used throughout the world in a variety of applications.

Since the introduction of closed-circuit video-tape recording equipment, the prices of cameras and video-tape recorders have generally declined and new generations of systems have become available, offering sophisticated production-editing capabilities. Complementing the one-inch systems, a standard for half-inch video-tape recorders (the Type 1 standard) has emerged, to permit broad interchange of recorded programming. This half-inch standard plus the imminent availability of cartridge-loading recorders and players will greatly expand the closed-circuit market for video-recording equipment.

Home Recording and Playback

No aspect of video recording has attracted such wide interest as the anticipated home market. Many forecasts of future sales in the hundreds of millions of dollars have been made, although no true home recording or playback system is presently available.

Unlike the institutional CCTV market, which has grown steadily over the last seven years, this is a brand-new field in which there are many questions yet to be answered. Among the current problems is a lack of system compatibility. No unit will accept and play a cartridge from any other manufacturer's unit.

In addition, there are many unanswered questions related to the programming, or "software." Among the most perplexing are: What kind of programming will the consumer buy or rent? Can programming be produced and distributed economically enough to attract wide consumer support? Who will produce and distribute programs for this market?

Although interest in home systems arose because of the potential seen in closed-circuit video-tape recorders for this market, several new technologies have emerged to vie for a share of the video cartridge business.

The EVR system, developed by *CBS*, is the only cartridge playback unit currently available on the market, with the present model designed for institutional use and the home version planned for the future. It uses ordinary although small, fine-grain photographic film. When plugged into the antenna terminals of a television set, EVR converts the optic information off the film to impulses that can be interpreted and re-created by a TV picture tube.

The *RCA* SelectaVision system, demonstrated in experimental models, effects an optic-to-electronic conversion, in this case from images imprinted by a laser on holographic tape.

Unique among the emerging technologies is the Teldec television disc to be produced jointly by *Decca* and *Telefunken*. Instead of a cartridge, the Teldec System plays a plastic foil platter, about the size of a long-playing record. Although limited to about 10-15 minutes of playback time, prerecorded programs on disc will be available for a fraction of a dollar, considerably cheaper than program cartridges ($10-$20 and up for 30 minutes playing time).

In addition to these systems, a number of manufacturers are working on home video-cassette units using helical video-tape recording techniques, but a variety of cassette and cartridge configurations.

Video-tape units will have the important advantage of providing the record capability, while owners of EVR, SelectaVision, Teldec, and other non-tape systems will not be able to use their equipment to record off-the-air or from camera.

While a number of industry spokesmen are heralding the imminence of the cartridge video market, there are enough unanswered questions—not the least of which concerns the availability of consumer-priced hardware—to suggest it may need a few more years of experimentation.

Even so, *Ampex* estimates sales of equipment for home use could reach $200 to $300 million by 1976, with most of the growth coming in the fourth and fifth years. For the longer term, it remains a market of great potential.

Automated Information Storage

From its inception, video recording's ability to store visual data faithfully and compactly and reproduce it immediately and electronically suggested its application in storing documents.

Ampex undertook development of a system (Videofile) for this purpose in the mid-1960's. Prerequisites were the development of precise single-frame electronic editing capability, computer control equipment, and TV cameras and monitors with unprecedented reliability and picture resolution. The concept was announced in 1964 and the first commercial system was delivered in 1968. Following this long gestation period, the Videofile system has become a significant factor in the video-recording industry.

Videofile systems are not small. They are sophisticated, large-scale systems for automating large, active files. The first system, priced at $750,000, was installed at *Southern Pacific Company* in San Francisco in 1968 to automate the processing of hundreds of thousands of freight waybills each day. The system uses video tape to store images of documents, and computer address and search techniques to enable clerks to file and retrieve the documents in seconds. It operates virtually around the clock.

Video discs, like those used on "instant-replay" recorders are also part of the system. Document images called from the tape files are duplicated on disc recorders so office personnel are presented each required document for study in much the same way that single images are provided during stop-action "instant replays."

The discs also provide access to the images for several people at the same time without disturbing the original recording. As long as there are enough disc systems to go around, each person may view his own "copy" of a document, and no entry is ever "out of file."

(Continued on page 81)

Sound-Operated Light Controllers

By JAMES F. KENNEDY

Simple SCR circuits to turn on and vary brightness of lamp loads with incoming sound or audio from speaker.

TRIACS and SCR's, both members of the thyristor family, have found many applications as power-control devices. Among the most popular of these uses are light controllers. The SCR is a 4-layer device, triggered on by a momentary gate input and remaining on (assuming a minimum holding current of 10-40 mA) until the current through it is interrupted. The triac is like two SCR's connected so that current will flow either way when it is gated on. In addition, the triac may be turned on by either a positive or negative gate voltage, while the SCR requires a voltage that makes the gate positive with respect to the cathode.

Some measurements and calculations were made with SCR's and triacs and a couple of circuits emerged that have proven quite satisfactory in prolonged use. First, the input resistance of an SCR was measured. This setup is shown in Fig. 1A. The input acts as a diode and the input resistance measured between 200 and 400 ohms, depending on gate current. The device measured was the HEP 302 because of its wide availability. A suitable transformer to match the input is the *Lafayette* 99-6127, a small voice-coil-to-500-ohm transformer.

The light-control circuit shown in Fig. 1B was then built into a small plastic box. The voice-coil winding of the transformer clips onto the voice-coil leads of a speaker. Only about 0.15 volt r.m.s. at the speaker is sufficient to trigger the SCR. This corresponds to a rather low volume of sound from the speaker.

This particular SCR is rated at 5 amperes. The heat sink is 1/16 inch aluminum about 2 inches by 1 1/2 inches. With music input and a load of several hundred watts of lamps, no appreciable rise in temperature was noticed. The SCR is not insulated from its heat sink and one end of the heat sink is screwed to the a.c. outlet to simplify wiring. In addition,

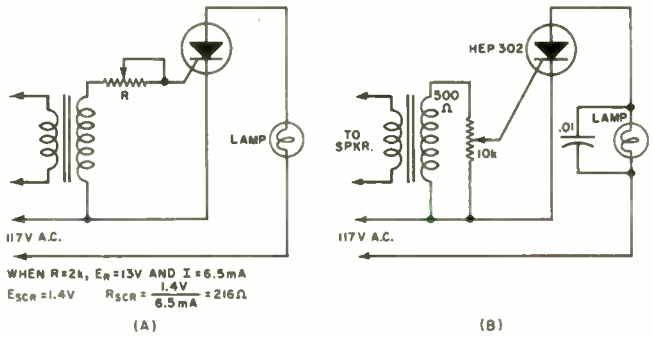


Fig. 1. (A) Circuit used to determine input resistance of SCR. (B) Basic audio-operated lamp controller. Note the unit is not isolated from the a.c. line; refer to text for precautions.

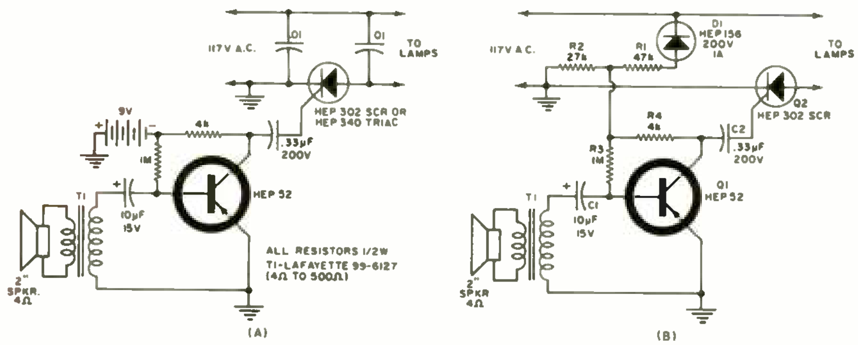
the heat sink is epoxied to the bottom of the box. (*Since there is no a.c. line isolation, be careful to use an insulated box which completely encloses all the components. Note also that the sensitivity control shaft may be "hot" with a.c.—Editor*)

There might be situations in which it would be impossible to connect directly to the speaker in a sound system so some work was done on a control device that would operate from the sound from a speaker without any direct connection. A transistor amplifier was indicated, and a small speaker seemed most practical as the transducer.

The same transformer was used as in the previous circuit. Output variations are transferred to the SCR gate through a coupling capacitor. This circuit is shown in Fig. 2A.

This circuit operated well, but the next step was to eliminate the battery. A half-wave rectifier was used and its output does not even require filtering. A voltage divider is used to obtain the low voltage. The basic circuit is shown in Fig. 2B.

Fig. 2. (A) SCR can be triggered by using separate speaker and single-transistor amplifier. (B) This version eliminates need for battery. Note unit is not isolated from a.c. line; observe previous precautions and do not use external ground. With SCR's shown here and in (A) lamp load of several hundred watts can be handled.

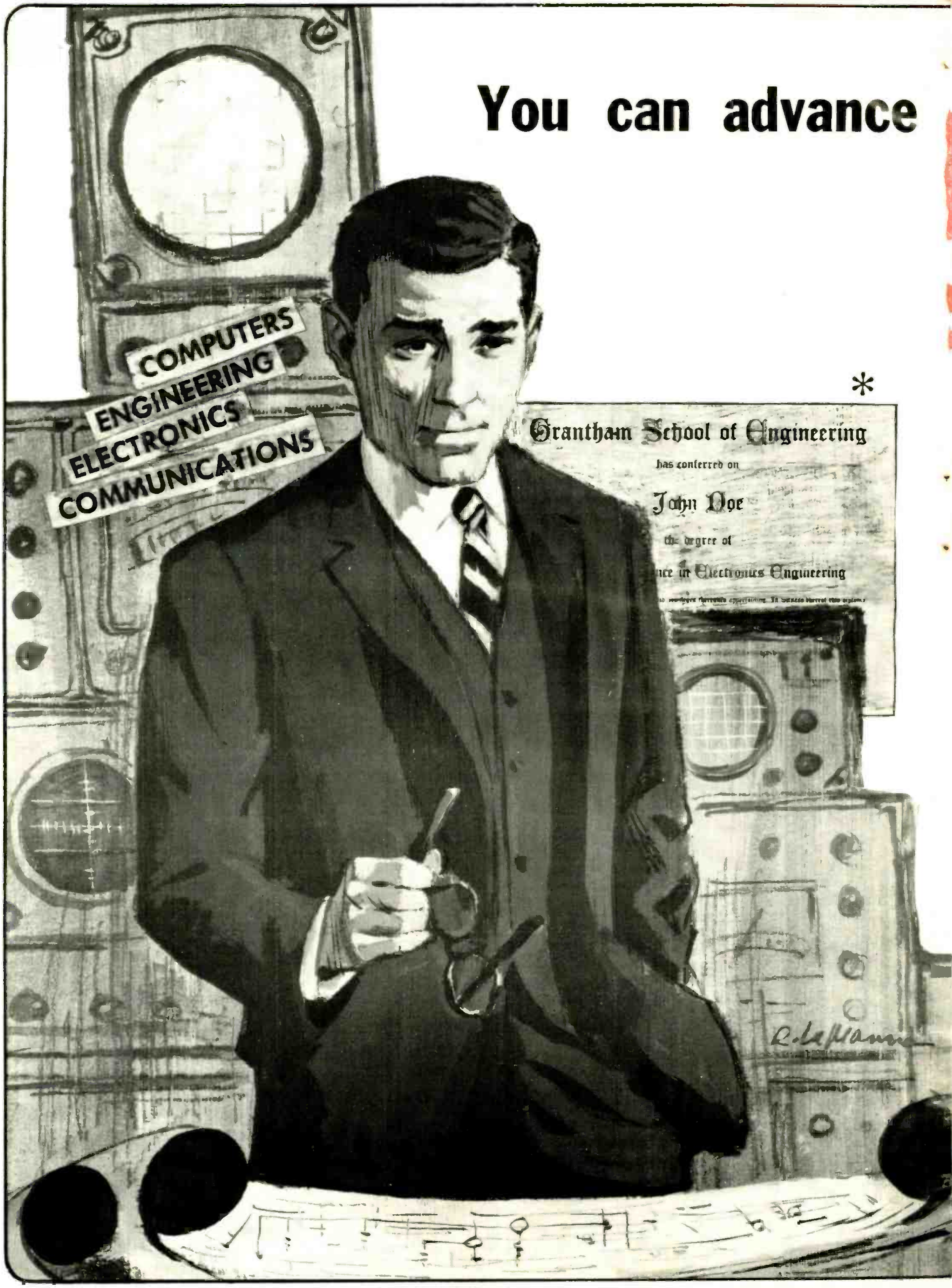


With no input, the collector of Q1 measures about 5 volts and with audio input the voltage at the collector varies from 1 volt up to 9 volts. These changes, coupled through C2, turn on the SCR. Sensitivity is good, depending on the transistor. Some of these units will control lights halfway across the room from the sound source. Others will respond a foot away from the source. Sensitivity is adjusted by placement of the unit with respect to the sound source.

A triac will also operate in this circuit without circuit changes. Lights will be brighter because the triac conducts on both halves of the 60 Hz. ▲

You can advance

*



Nomogram for Power

By using a straightedge and some simple calculations, the power dissipated during switching interval can be readily determined.

TRANSISTORS are quite often used in a *saturated* configuration as switches, because a saturated transistor operated under similar circumstances will dissipate much less power than one operating in the linear or active configuration. This can be illustrated by the simple circuit shown in Fig. 1A.

For a device conducting a continuous current I_C, the power dissipated by the device itself is simply the collector-emitter voltage V_{CE} (in this case V_{SAT}, or saturation voltage) multiplied by the collector current I_C. Since V_{SAT} is usually quite small (several hundred millivolts), rather large amounts of current can be drawn without exceeding the power-dissipation ratings for the transistor itself. If the transistor is not saturated, the collector-emitter voltage will be larger, and less current can be conducted in a device of a given power rating.

If the transistor is not conducting continuously but is switching on and off, the problem of power dissipation is modified somewhat. Fig. 1B shows a transistor conducting current for the time *T1* and not conducting for time *T2*. Power is absorbed by the device only during the times (*T1*) when current is flowing. The *average* power for a complete cycle can be defined as being the maximum power multiplied by the fraction of the total time that power is actually being used.

$$P_{AVG} = (I_C \times V_{SAT} \times T1) / (T1 + T2)$$

The quantity $T1/(T1 + T2)$ is the fraction of a complete cycle of the waveform that current is being conducted. It is also called the "duty cycle" of the waveform.

The equation for average power can be applied to Fig. 1A by setting *T2* equal to zero (duty cycle equal to unity).

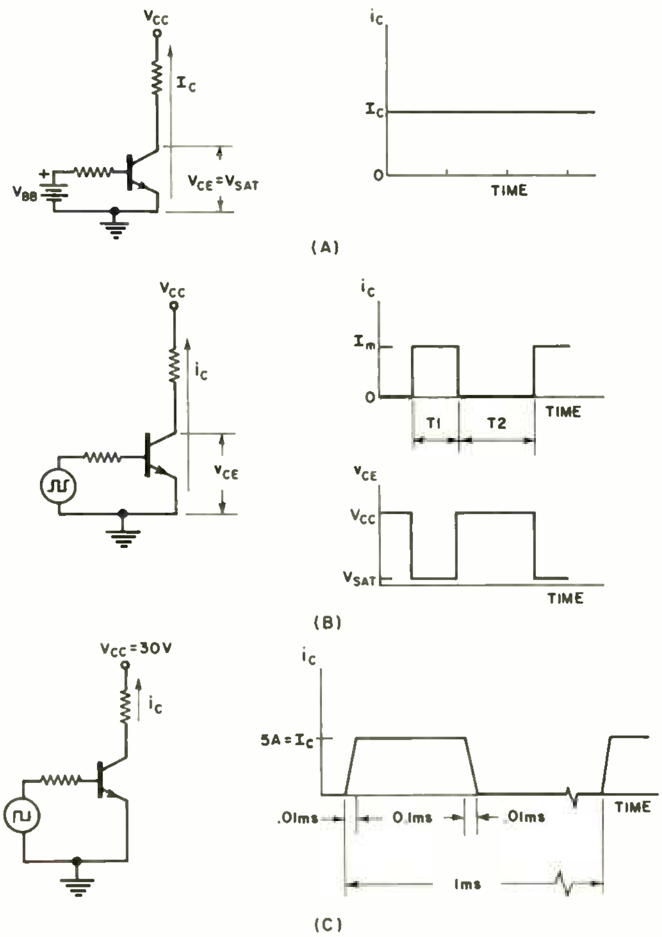
An interesting and quite useful side effect of having a small duty cycle is that large currents can be conducted for short periods of time and still have the average power dissipation remain low. For example, a device carrying 1 ampere continuously absorbs the same average power as one conducting 4 amps ¼ of the time (duty cycle of 0.25).

The current waveform shown in Fig. 1B is somewhat idealized, for it indicates that our transistor is either conducting maximum current or no current at all. In reality, the current through the device will build up from zero at a nearly constant rate. In changing from the "off" state to the "on" state or saturated condition, the transistor must pass through a period of "active" operation.

In this active region, large values of both collector current and collector-emitter voltage (and therefore large values of instantaneous power) may exist simultaneously. The power dissipated during this transition period can be minimized by performing the transition as quickly as possible. For this reason, power lost during the switching interval of high-speed switches can often be neglected. In slow-speed circuits, however, the power lost during the switching time can contribute substantially to the total device dissipation and should be considered.

A nomogram (Fig. 2) is included to aid in estimating power during the switching interval. In order to use the nomogram, the saturation voltage for the device being considered must be known. It can be obtained from the transistor's data sheet, or can be measured as shown in Fig. 1A.

Fig. 1. Switching-transistor circuit and operating parameters.



Example of Use

Problem: Estimate the transistor power dissipation in the circuit of Fig. 1C. Assume that V_{SAT} is 1 volt.

1. First estimate the power dissipated when the transistor is fully conducting (I_C = 5 A). In this case, our duty cycle, λ, will be the time of complete conduction divided by the period of the waveform.

$$P_{AVG} = I_C \times V_{SAT} \times \lambda$$
$$= 5A \times 1V \times 0.1\ ms/1\ ms = 0.5\ watt.$$

in Switching Transistors

By JAMES E. McALISTER

2. Now estimate the power dissipated during one of the switching intervals. The nomogram should be used for this calculation.

A line is first drawn connecting V_{SAT} (1 volt) and V_{CC} (30 volts) and extended to intersect the horizontal graph axis (A). From A a line is drawn vertically to intersect the graph itself (B), and then horizontally to cross the other graph axis (C). From C, a line is projected through the value of I_C that will be used (in this case 5 amps) until the Q scale is crossed (D). A value for λ is determined, and a line drawn from D through λ to cross the average power axis P_{AVG} at E. The value of this power is the average power dissipated by the transistor during the switching control.

For this problem, λ is 0.01 ms (the switching time) divided by 1 ms (period of the waveform), which gives a value of 0.01 P_{AVG} is approximately 270 milliwatts.

3. Next, the power dissipation during the other switching interval should be estimated. In this example, this power will also be 270 milliwatts.

4. The total average power dissipation is the sum of the individual average power dissipations.

$$P_{AVG} = 0.5 + 0.27 + 0.27 = 1.04 \text{ watts}$$

In this example, average power dissipated during the switching interval (0.54 watt) was more than the power used (0.5 watt) during maximum current conduction. This emphasizes the need for accurate estimation of total device power dissipation before circuit construction. ▲

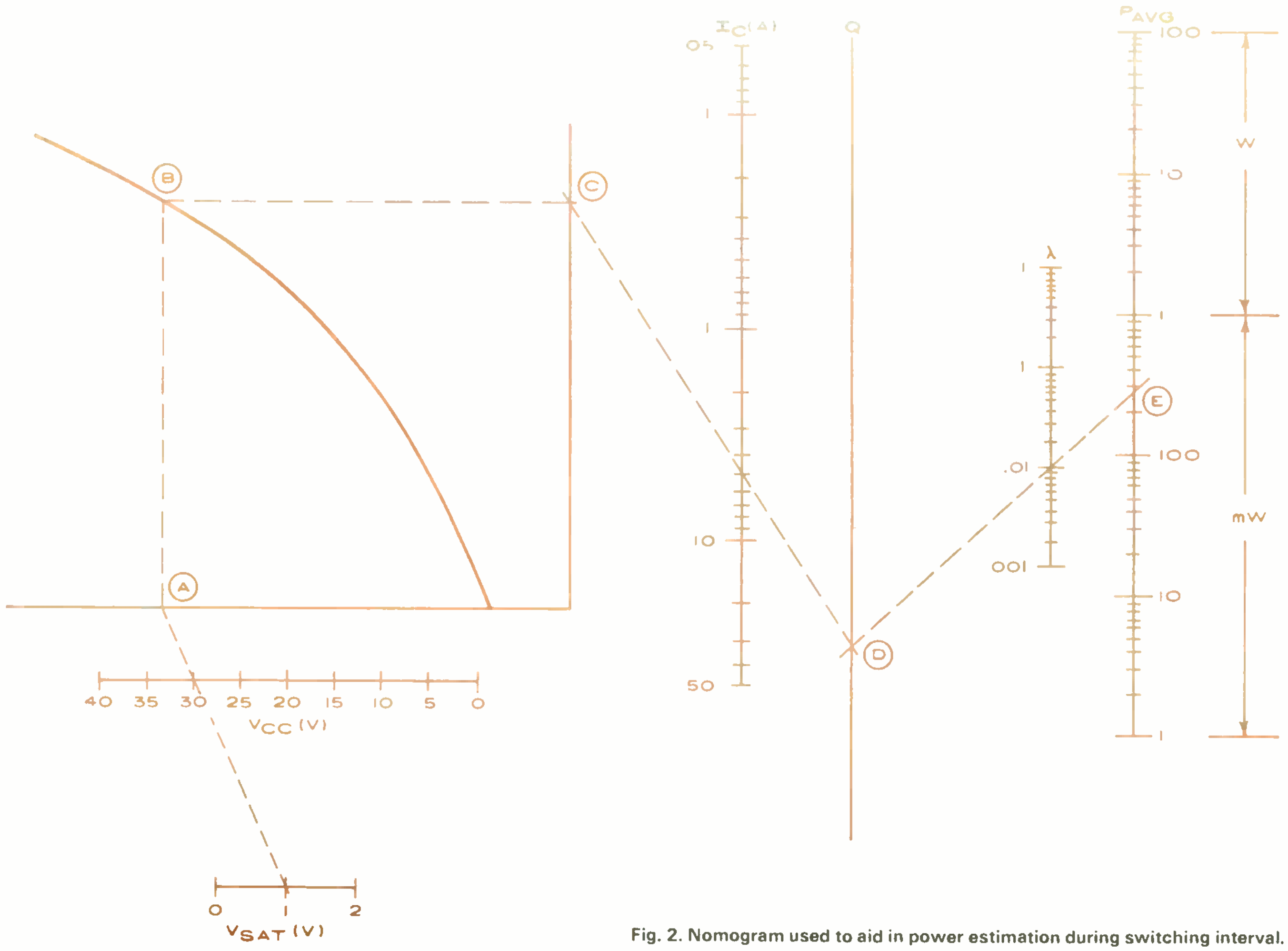


Fig. 2. Nomogram used to aid in power estimation during switching interval.

WHICH COMPUTER—

Time-Sharing

By N. LEE BEYER/Applications Specialist
Information Services Marketing Dept., General Electric Co.

A time-sharing terminal puts "creativity" back into engineering by eliminating time-consuming, repetitive and complex calculations and permitting the simulation of complete designs.

HOW many times have you had a good design idea only to have it get bogged down in the myriad problems which crop up in attempting to bring it to fruition? Problems like:

- Simple calculations which must be repeated over and over
- Computations which are too complex for your slide-rule, pencil, or patience
- Breadboarding and testing, which cuts into your parts inventory (what inventory?) and requires the use of test equipment (someone dropped it?)

Despite these obstacles, suppose your idea begins to see daylight. Now you must consider design optimization. How sensitive is voltage to component variation? What should the tolerances be? What alternatives should be considered? Can the deadline be met?

Successfully overcoming these problems, which are encountered almost every day in design work, is critical to "creative" engineering. But too often the desire for creativity gives way to expediency or even abandonment of the idea. This is where computer time-sharing comes in. It can give you the time to be creative by quickly performing those repetitive and often complex calculations. Or you can have it simulate complete designs and perform "knob twisting" and analysis of alternatives. Time-sharing is the easy-to-use tool which will allow you to do all these things and many more.

Time-Sharing is Personal Computing

To many people, the thought of using a computer is actually frightening. Many regard it as a super-genius that is the ultimate in automation and does away with the need for a human brain, hands, ingenuity, and the privilege of making a decision.

Time-sharing, often referred to as "personal" computing, is quite different. And, unlike having a computer, you don't need to be a large company or operation to afford time-sharing. In fact, many one-man consulting and design firms have the service in their offices or homes.

Time-sharing service enables you to use a multi-million-dollar computer system for your own calculations and analysis on much the same basis as you use the telephone. You get all the benefits of the remote system and related equipment, but pay only for the time you're "talking" to the computer over regular telephone lines from a typewriter-like terminal by your desk.

The distant computer system is usually accessible by dialing a local telephone number from the terminal. Once connected with the computer, it is nearly as easy as a typewriter or telephone to use.

While you are working with the computer, so are dozens of other people. Of course, you have to talk in a language which both you and the computer understand. So, "conversational" languages have been developed using ordinary English words and phrases. The whole thing seems pretty ordinary, until you have the experience of using it.

Time-sharing makes the computer a personal tool that is available and responsive when you want it. For design engineers and technicians, time-sharing service becomes an inexpensive and extremely efficient laboratory in which to experiment with ideas. For example, "what if" questions can be answered quickly and then different approaches investigated while the previous steps are still fresh in your mind.

Time-sharing, then, is a new capability that makes it possible for engineers, technicians, scientists, businessmen, students, and even housewives, to obtain the benefits of modern computer systems. Charges are based on the actual time used. It is easy to learn and use, thanks to the simplified languages. It is extremely resourceful. And with a little experience, most users can develop their own applications programs while also having full access to the extensive program libraries available from most commercial time-sharing service firms.

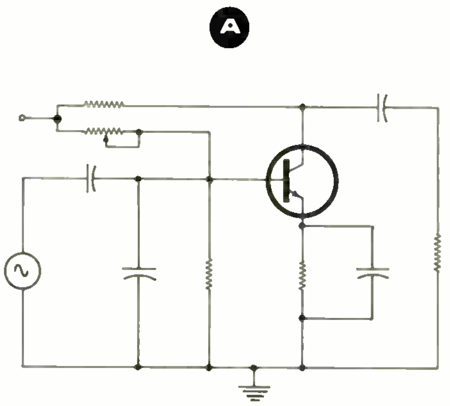
Time-Sharing in Engineering

Engineers were pioneers in the use of time-sharing, which was first offered on a commercial basis in 1965 by *General Electric Company*. Time-sharing is now applied in all fields of engineering and has become an indispensable tool in many design projects.

Structural engineers in electric utilities use time-sharing to help design and analyze transmission towers. Design alternatives and customized structures can be evaluated in a fraction of the time previously required using other means. Mechanical engineers use time-sharing to study the performance of vehicle suspension systems.

Power-systems engineers use time-sharing to determine the effect of three-phase and line-to-ground faults at various points within an electrical distribution system. The economic evaluation of all alternatives enables them to place the necessary equipment in the best location so as to minimize the effects of these faults should they occur.

In the field of electronics, time-sharing has played a significant role for many years. It has been used to analyze very simple circuits; to design filters and transformers; to simulate the performance of entire networks; and to optimize component layout and generate necessary artwork.



B

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1000 C  SINGLE STAGE AMPLIFIER
1010 C  FREQUENCY SWEEP
1020 C  OUTPUT PLOTTED FROM AN ANSCII FILE
1030 C
1040 AC ANALYSIS
1050 *OUTPUT
1060 B1 N(0,1),R=115E3
1070 B2 N(1,0),R=22E3
1080 B3 N(1,2),R=1800
1090 B4 N(2,0),R=1E3
1100 B5 N(3,2),G=100E-6
1110 B6 N(0,3),R=5.6E3
1120 B7 N(0,4),R=100,E=5E-3
1130 B8 N(4,1),C=10E-6
1140 B9 N(1,0),C=1E-8
1150 B10 N(2,0),C=100E-6
1160 B11 N(3,5),C=10E-6
1170 B12 N(5,0),R=100E3
1180 T1 B(3,5),BETA=100
1190 T2 B(5,3),BETA=-1.11E-3
1200 FREQUENCY=10
1210 TAB,NV(3,5),PNV(3,5),CA(12)
1220 PRINT,NV(1,2,5),CA(10-12)
1230 PLOT,(SCALED),NV(5),PNV(5)
1240 MODIFY
1250 FREQUENCY=15.848932(1.5848932)1E5
1260 EXECUTE
```

C

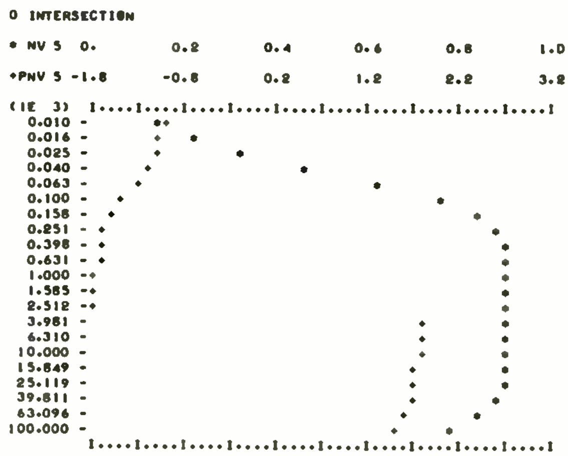


Fig.1 (A) Single-stage amplifier to be analyzed for frequency response. (B) Complete listing of information describing circuit. (C) Resulting analysis produced by ECAP.

Typical Electronics Applications

The classic example of time-sharing use in electronics is circuit analysis. Programs such as ECAP (Electronic Circuit Analysis Program) have received much attention and have been used by circuit designers for many years.

This particular program allows you to breadboard your circuit on the computer by describing circuit topology and component values in simple, easy-to-understand terms. ECAP will then perform the desired analyses of the circuit.

For example, suppose you want to determine the frequency response of the single-stage amplifier shown in Fig. 1A using time-sharing and the ECAP program.

First you would dial the computer over regular telephone lines from your office typewriter-like terminal. You would then describe to the computer your circuit topology, component values, and the analyses you want to perform. This procedure would take a few minutes. Fig.1B shows a listing of the information that describes this single-stage amplifier.

In line 1040 of the description you have requested an a.c. analysis. In line 1170, the load resistor is shown to have a value of 100k and is in branch 12 (B12) which lies between nodes 5 and ground [N (5, 0)]. In line 1230 a scaled plot of the voltage and phase at node 5 is requested.

Fig. 1C shows the resulting analysis produced by the ECAP program. From these results, you could easily make circuit modifications and rerun the analyses in a matter of minutes. In this way, you can evaluate alternatives and optimize your design, without the necessity of finding parts, checking out equipment, or waiting days or weeks for results.

Fig. 2. Result produced by circuit-analysis program indicating how sensitive a node voltage is to 1% component value change.

COMMAND? 3

TOLERANCE ANALYSIS AT 10000.00 HERTZ

GAIN = 37.9680
PHASE = -155.981 DEGREES

PART NUMBER	CODE	PARTIALS GAIN-PCT	PHASE-PCT
1	CAP	.12	-.98
2	RES	.03	-.22
3	RES	103.52	-.01
4	RES	-99.85	-.78
5	RES	-.00	.00
6	CAP	.00	-.02
7	DEP	102.57	-.01
8	RES	4.21	-.08
9	DEP	2.53	-.03
10	RES	84.93	-1.56
11	CAP	13.80	-9.66
12	RES	28.12	-8.16

TYPE	MINIMUM	NOMINAL	MAXIMUM
UNIFORM DIST	24.9	38.0	51.0
WORST CASE	24.1	38.0	58.1

One distinct advantage of using computer time-sharing programs for circuit design and analysis is the statistical information which these programs can provide about your circuit's behavior. Such data would be too time-consuming and laborious to obtain manually.

Fig. 2 is the result produced by a circuit-analysis program indicating how sensitive a node voltage is to a one-percent change in the value of various components. Often referred to as a sensitivity analysis, it shows which components have the most effect on circuit performance and thus you can, for example, adjust the tolerances accordingly.

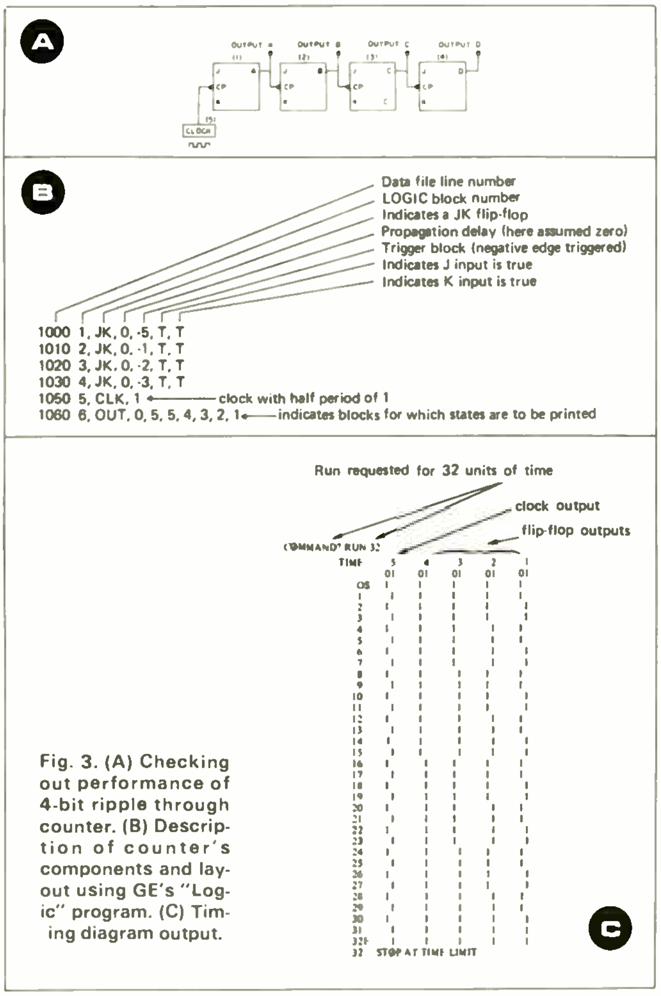
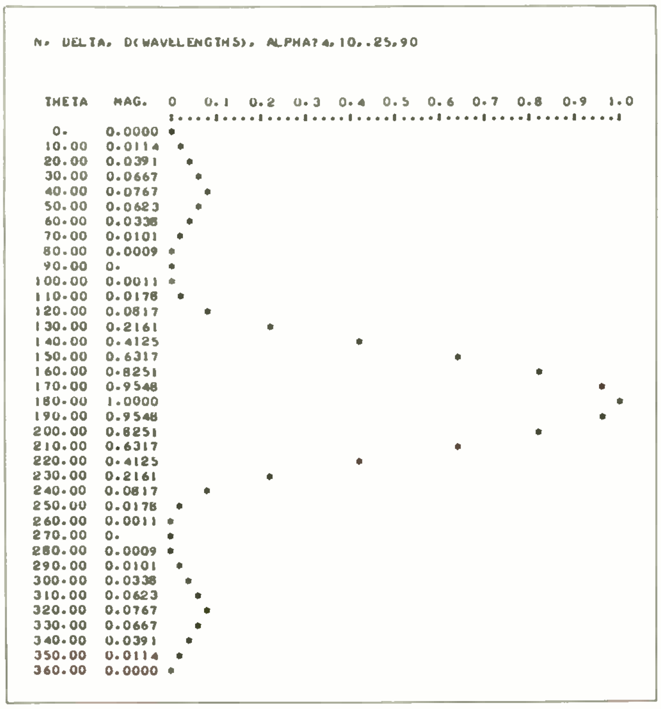


Fig. 3. (A) Checking out performance of 4-bit ripple through counter. (B) Description of counter's components and layout using GE's "Logic" program. (C) Timing diagram output.

Fig. 4. Part of the results of "conversing" with "Array" terminal.



Digital Systems

Another major use of time-sharing in electronics is in the design of digital systems. As a simple example, suppose you need to check out the performance of the 4-bit ripple through the counter shown in Fig. 3A. One of the many time-sharing programs available for simulating digital systems could be used.

Using *GE's* "Logic" program, you would first describe the counter's components and layout. Fig. 3B shows the information contained in such a description. Fig. 3C is the timing diagram that would be produced at your office terminal. Should such results not be satisfactory, you can quickly make modifications and produce additional results in minutes. Although only a few modules were used in this example, the program can handle a network containing up to 500 modules consisting of logic gates, flip-flops, counters, registers, etc.

Antenna Design

Characteristic of time-sharing service is the "conversational" manner in which it operates. This means that both you and the computer "talk" to solve your problem.

For example, suppose that you are designing a special linear antenna array and you want to plot the antenna pattern. Fig. 4 shows part of the results of conversing with a program called "Array" from your terminal. The program requested the number of elements in the array (*N*), the polar angle increment for the plot (*delta*), the number of wave-lengths separating each element in the array (*D*), and the progressive phase shift between elements in the array (*alpha*). You would supply the answers as italicized to obtain the resulting plot.

The two-way English language conversation carried on between you and the computer makes time-sharing extremely easy to learn and use. And, if you make mistakes, the computer will usually notify you immediately so that you can take the appropriate corrective action.

System Dynamics

Most design projects at some point involve a study and analysis of the design's dynamic behavior. A common solution to the problem has been the use of analog computers, which allows you to model and analyze the system dynamics. However, there are many time-sharing programs which simulate the operation of analog computers and enable you to study dynamic performance.

For example, suppose you wanted to determine the controlled response of the feedback system in Fig. 5A. Fig. 5B shows a typical analog block diagram describing this particular system. If an analog computer were used to provide a solution, you would have to wire up a patchboard describing this block diagram. Using the time-sharing program "Dysim," you would merely describe the block diagram to the computer.

Fig. 5C is a plot of the controlled response produced at the terminal in response to the command "Plot 3." The entire process took a few minutes and you could easily perform on-line modifications to your block diagram if the response were not satisfactory.

These examples can only begin to demonstrate the versatility of time-sharing and its significance in the field of engineering. But they illustrate why many engineers, designers, and technicians have found time-sharing an indispensable tool in obtaining creative solutions to both the simple and complex problems which they face. Even companies with extensive in-house data-processing systems subscribe to time-sharing because it is accessible to the man with the problem when he needs a solution. And most users gain considerable value from on-line libraries of application programs, such as those described here, which help them ob-

(Continued on page 64)

Testing IC's in TV Receivers

By FOREST H. BELT

Linear IC's are popular in color sets this year. Here's how to check them for proper operation.

Fig. 1. A large number of integrated circuits are now showing up in consumer products. Besides TO-type shown here, flat-pack IC's are used with their connections in-line along sides.

ABOUT five years have passed since the first linear integrated circuit was used in a television receiver. In all that time not much has been published to help technicians service them. The established procedure has been: If you suspect one, try a replacement.

But that's haphazard. And, besides, it costs money. Who wants to carry an inventory of IC's just for making substitutions? It is far better to know how to test them.

If you've kept up with what's in 1971-model color receivers, you know how popular IC's are. (*Editor's Note: See the January, February, and March 1971 issues of* ELECTRONICS WORLD.) Sixteen different brands have integrated circuits in them, from *Admiral* to *Zenith*. Quite a few black-and-white sets use them, too (Fig. 1).

IC's are used several ways. By far the most popular is an integrated-circuit sound section. In fact, that was the first use ever made of an IC in television. *RCA* put the first home-electronics IC into the sound section of one color chassis in June, 1966. Throughout the next three years, that was the only purpose for which any company used IC's.

Second most popular now is the integrated-circuit chroma demodulator. *Zenith* kicked off this application only a couple of years ago. Since then other set makers have followed suit. And more brands will have IC demodulators next season.

About the biggest IC news in 1971 models was that made by *Zenith*. Two basic *Zenith* color chassis—one all-transistor and the other a mostly transistor hybrid—have an all-IC chroma section. Actually, the only other active components in the whole color section are three transistors that amplify color-video outputs.

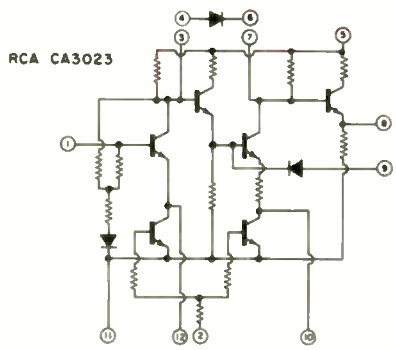
With so many integrated circuits popping up, it must be obvious that the TV technician has to learn to service them efficiently. Don't fret. They're not as impossible to test as their small size and complex inner-workings might lead you to believe.

Active Tests for IC's

There are three practical ways to check any IC.

1. You can check its d.c. operation. At least one supply voltage is fed in. Usually, a regulator section inside the IC cuts the input voltage to whatever level is needed by the transistor amplifiers on the IC chip. Voltages are dropped across transistors and resistors in the IC. The result is reduced voltage at some terminals. If those voltages are wrong when measured, it indicates trouble inside the IC.

Also, there's usually a series resistor between the d.c. supply voltage and the d.c. input terminal of the IC. If the voltage drop across that resistor is too high, the IC may be



RED →, BLACK ↓

BLACK \ RED	1	2	3	4	5	6	7	8	9	10	11	12
1	X	20k	7.5k	INF	9k	INF	12k	12k	35k	20k	9k	INF
2	INF	X	INF	INF	INF	INF	INF	INF	INF	INF	INF	INF
3	6k	10k	X	INF	2k	INF	5k	8k	30k	10k	5k	INF
4	35k	50k	30k	X	30k	INF	32k	9k	30k	500k	6k	INF
5	6k	7k	2k	INF	X	INF	3k	6.5k	25k	8k	4k	INF
6	INF	INF	INF	7.5k	INF	X	1M	40k	1M	INF	30k	INF
7	10k	12k	5k	INF	3k	INF	X	8k	30k	12k	5k	INF
8	14k	21k	10k	INF	7k	INF	7.5k	X	12k	40k	2k	INF
9	35k	50k	30k	INF	28k	INF	31k	9k	X	500k	6k	INF
10	35k	21k	30k	INF	28k	INF	31k	9k	30k	X	5k	INF
11	12k	20k	9k	INF	8k	INF	10k	2k	9k	35k	X	INF
12	7.5k	20k	8k	INF	11k	INF	8k	8k	30k	40k	5k	X

INTERTERMINAL RESISTANCES (1kΩ RANGE OF B&K MODEL 176)

Fig. 2. Sample chart of internal resistances, measured from terminal to terminal. Resistances depend on which lead is connected to each terminal, but this chart takes that into account.

drawing too much current. If the drop is too low, the IC may not be drawing enough.

2. You can check signals fed into the IC and those coming out. Because of necessary external components, signals may go in and go out several times, in various forms. What you do is supply the normal signal to the first input and then test outputs at succeeding points. If an output is incorrect or missing, that section of the integrated circuit is likely to be at fault.

3. You can check tuning of associated resonant circuits. When you're troubleshooting any section of a TV receiver, tunable coils can offer a valuable clue to operation. They can also tell you whether a fault is in the active elements of the section (the IC, in this case) or in passive components. A quick run-through of any adjustments—coil or potentiometer—in an IC section is another way to verify IC operation.

There's a fourth way, too. It's called passive testing. For technicians, it's not very practical. It requires a detailed knowledge of what is inside each IC. What you do is measure between terminals with an ohmmeter. If you know what value of resistance should appear between each of them, or between certain key terminals, you can evaluate whether a section of the IC is defective or not.

There are no lists of values for various IC's, not even in manuals some manufacturers publish. But you can compile your own list for an IC type you work with very often. Just take one you know is okay, get it out of the circuit, and measure resistance between various leads. Check them with your ohmmeter leads in both polarities and chart what you find. First chance you get, repeat it with a couple more good ones of the same type. Then you'll recognize any normal variations.

The sample chart in Fig. 2 is for one IC. Actual values depend on what model ohmmeter you use, polarity of its internal battery, and which range you use.

You may also find substrate leakage that confuses certain readings. An example is terminal 4 in Fig. 2. There is some leakage to terminal 11—about 6k ohms—when the *black* lead is on 4. Resistance from 4 to 9 is also low, but that's because of a low-value resistor (about 3k ohms) between terminals 8 and 11 inside the IC. Terminal 4 is supposed to be isolated, according to the internal diagram of the IC. That this leakage is in the substrate is verified by the diode nature of the leakage; when the *red* test lead is on terminal 4, it reads infinite as it should to all but terminal 6.

Because of complications like these, active testing is quicker, handier, and more dependable. Leakage such as described above may not hinder performance. Also, unsoldering some IC types is a real chore and presents the possibility of damage from heat. Easiest testing is with the IC right in its circuit and operating.

Integrated Sound Sections

There are strong similarities among brands that use IC's in the sound section. These include *Admiral, Andrea, Heath, MCA, Midland, Motorola, Packard Bell, Panasonic, RCA, Sony, Sylvania,* and *Zenith.* The integrated circuit usually includes sound-i.f. (4.5 MHz) amplifier, diode sound detector (usually ratio type), and audio preamp.

Internal connections vary widely, even among IC's in different models of the same brand. But operation is so alike, once you understand how to evaluate one, you can test your way through any of them.

The IC sound section in Fig. 3 is typical. The integrated circuit has three major sections. Compare the terminal connections of the external components in Fig. 3 with the internal diagram of the IC in Fig. 4. You'll find the circuit connections to the IC chip are similar for any IC sound section; only the terminal numbers are different.

The secondary of *T301* applies 4.5-MHz sound i.f. signal between pins 1 and 2 of this IC. Pin 2 is held at r.f. ground by a capacitor. *Q1* inside the IC (Fig. 4) gets the sound i.f. signal. The base of *Q5* is the other side of a differential amplifier, held at ground by resistor *R11* and the external 0.01-μF capacitor.

Differential amp *Q1* through *Q5* amplifies the 4.5-MHz signal. It then goes to differential amp *Q6* through *Q9*, is further amplified, and fed to terminals 11 and 12. They are the output terminals of the first IC section.

The sound i.f. signal goes to the primary of discriminator transformer *T302*. The secondary of *T302* applies the signal to terminals 9 and 10 of the IC. Inside the IC, those terminals connect to a diode-bridge ratio detector. That demodulates the FM sound from the sound i.f. Audio is taken from terminal 13.

Volume and tone networks feed the audio to terminal 7. That's the input

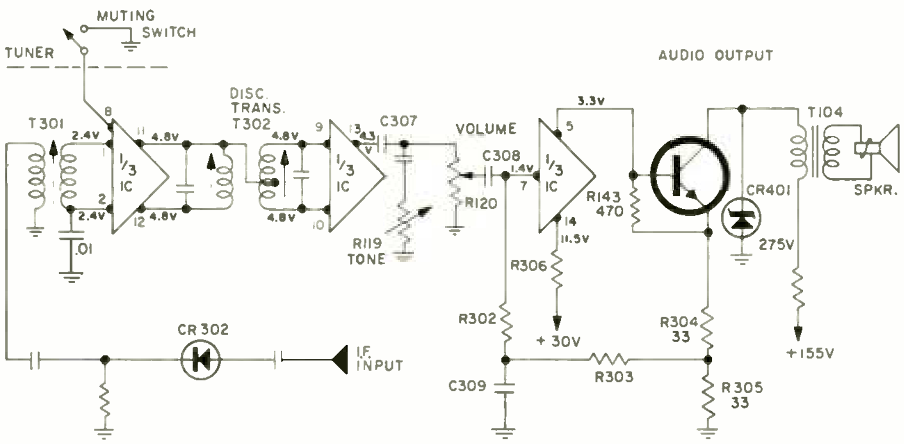
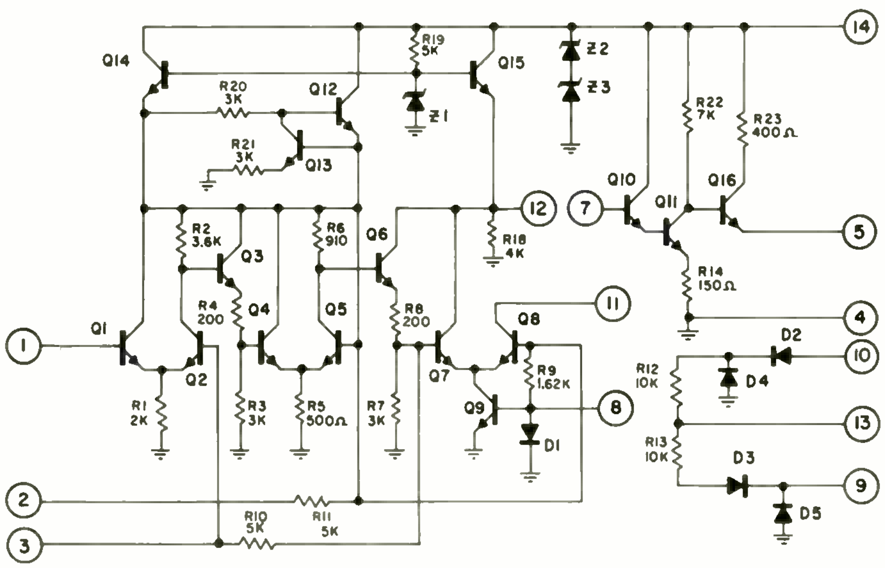


Fig. 3. External components for sound-section integrated circuits are similar in most brands. That makes stage-to-stage signal tracing probably the most dependable testing procedure.

Fig. 4. Internal diagram of IC used for sound section in Fig. 3.



terminal for the final section of this IC. On the chip, a Darlington amp ($Q10$, $Q11$) and emitter-follower ($Q16$) amplify the audio. Audio-output terminal 5 feeds the signal to the output transistor in the receiver.

Terminal 14 of the IC is the power-supply input terminal. An external resistor drops the d.c. supply voltage to whatever level is set by Z2, Z3. Transistors $Q12$ through $Q15$ and zener diode Z1 regulate d.c. power for the various stages of amplification.

Terminal 8 goes to the second differential amp in the i.f. section of the IC. It permits grounding the base of $Q9$, thus disabling the i.f. amp and blocking the sound i.f. signal. That's so sound can be muted while the tuner rotates in remote-controlled operation.

The methods of servicing this IC must be fairly obvious. If you're using the signal method, you can do it by tracing or by injection.

For tracing, use a 4.5-MHz signal modulated with an audio note; inject it across the detector diode (*CR*302 in Fig. 3) load resistor. If *T*301 is okay, the tracer's demodulator probe should detect the audio signal at terminal 1 of the IC. The same signal should appear, much amplified, at terminal 11. It should also be present at terminal 12, since the end of the discriminator transformer is not grounded. If *T*302 is okay, the amplified signal should be found at terminals 9 and 10, too.

You don't need the demodulator probe for the tracer at terminal 13. Audio there won't be particularly strong (unless you are using a signal generator with FM tone instead of the usual AM). Touch the tracer to terminal 7; that lets you check the action of the volume and tone controls. You should find a considerably amplified audio note at terminal 5 of the integrated circuit.

If you choose the tuning method of checking the IC, use a 4.5-MHz signal, frequency modulated, or station sound. Or, if you're familiar with sweep alignment, a response curve can tell you plenty about operation and tuning. Make the three adjustments—peaking *T*301 and the primary of *T*302, then tuning the secondary of *T*302, for clearest station sound. If *T*301 doesn't respond to adjustment, it or the first differential amp in the IC is likely bad. If *T*302 primary doesn't respond, suspect the coil or the second differential amp. If the secondary of *T*302 doesn't respond, suspect the coil or the bridge diodes.

The d.c. testing method is dependable, too. The voltage at terminal 14 lets you know that Z2, Z3 (both in the IC), and series resistor *R*306 are okay. If the voltages at terminals 2 and 12 are okay, the rest of the regulator inside the IC is all right. Wrong voltage at terminal 2 could mean trouble in the first differential amp. Incorrect voltage at terminal 7 or 5 means trouble in the audio preamp. Terminal 13 could have a wrong voltage if there's trouble in the detector circuit.

Voltages at certain terminals are brought there mainly by external components. For example, the 4.8 volts at terminal 11 is carried there by the winding of *T*302; likewise the voltages at terminals 9 and 11. The d.c. voltage at terminal 1 comes from terminal 2 through the winding of *T*301. Facts like these are important to notice in case a coil opens.

The All-IC Chroma System

The first IC for chroma use was the color demodulator *Zenith* introduced in 1969. It is a plug-in IC that eliminates the aggravation of so many soldered leads. It is round and has 9 pins that plug into a socket.

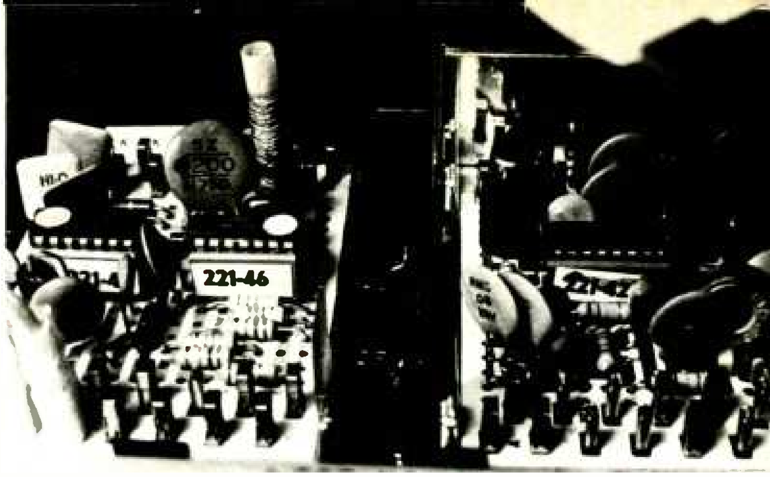


Fig. 5. Three flat-pack in-line IC's contain all the active elements of Zenith chroma section. For terminal numbers, look at the IC from the top with the large dot or notched end down. Count up right side of IC and down left side in counterclockwise direction. From bottom of the IC, pins are numbered in a clockwise direction starting at notched or dot end.

But the big advance in chroma circuitry took place just recently. *Zenith's* 4B25C19 hybrid and 40BC50 all-transistor chassis have an all-IC chroma section. It comprises three integrated circuits, pictured on their Dura-Modules in Fig. 5. The IC's are the in-line flat-pack type and fit into sockets on the printed boards.

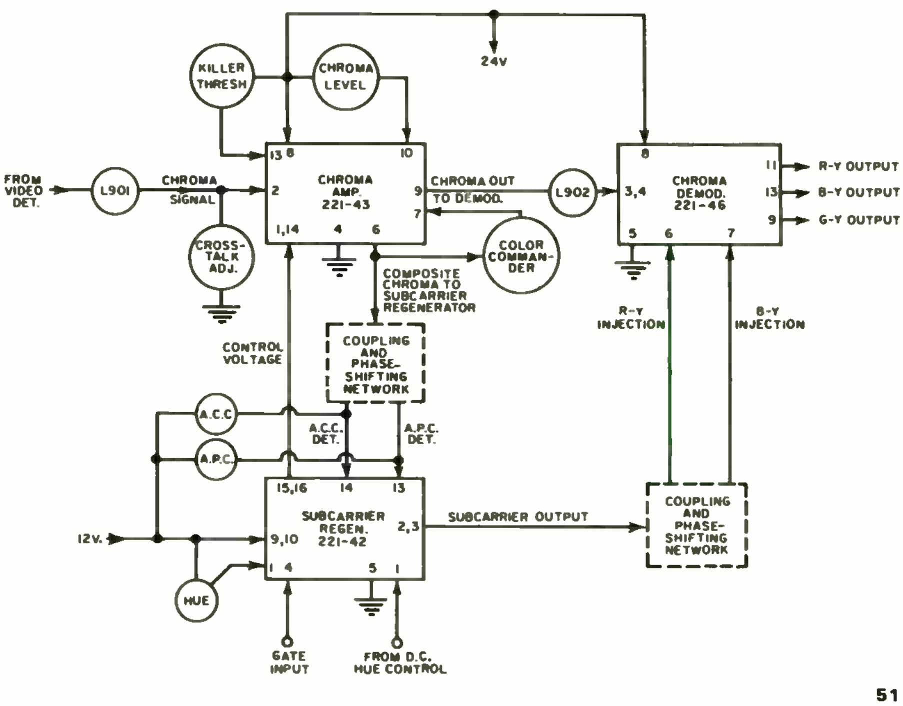
Testing this trio of IC's might appear complicated. Yet it is less trouble than you'd think. The principles of testing already described suit these IC's as well as any others. A combined signal-tracing-and-adjustment method is a good way to start and you can follow up with d.c. voltage testing if you think it's necessary.

You can get an idea of the system from the block diagram of Fig. 6. It contains about what you've learned to expect in any chroma section.

The detailed diagram of associated components in Fig. 7 is a more specific help in knowing where to make connections for testing. The IC terminals are accessible along the edge of each IC. In one chassis, we had to take the convergence panel out of the way so we could reach the IC terminals with a test probe.

To get at the subcarrier IC, you remove one screw and

Fig. 6. Block diagram of IC chroma section shows how similar it is to the chroma sections that employ discrete components.



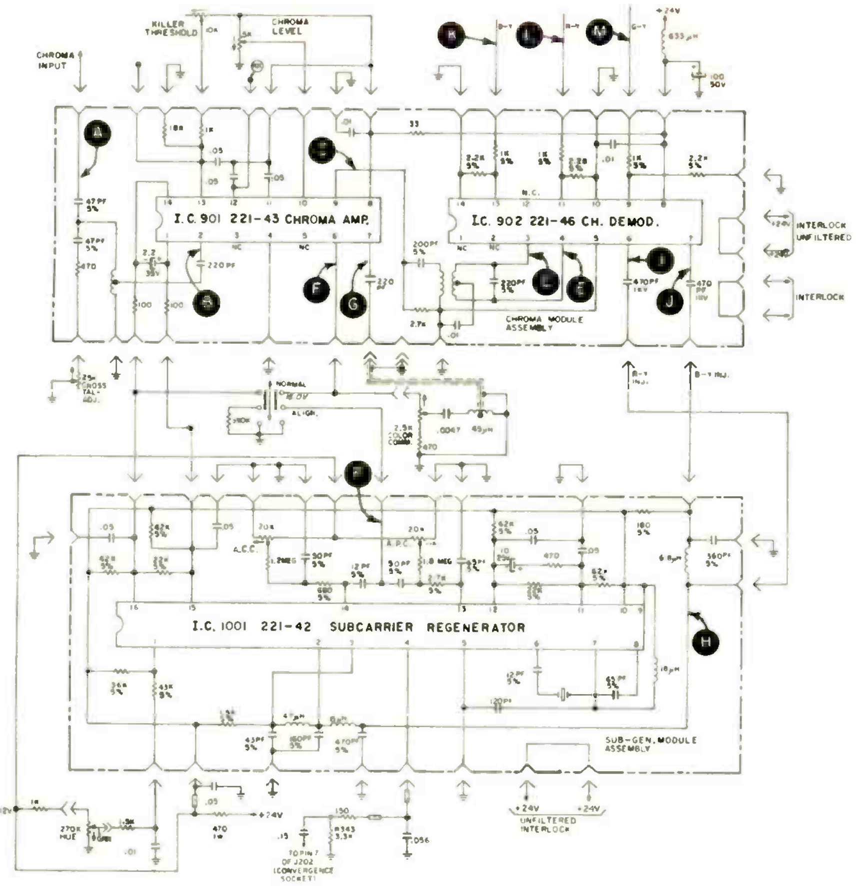
lift a shield out of the way. Even then, you may have difficulty reaching terminals 1 through 8 of this IC, as they're along the back of the IC, and the picture tube and yoke get in the way. A bent piece of wire clipped in the voltmeter probe tip makes it possible to reach them. Use care to avoid shorting two terminals together.

For testing, the receiver should have a keyed rainbow signal fed to the antenna terminals. Signal tracing is done with your scope, using a direct probe.

Start at test-point A, with the scope set at a submultiple of the horizontal line rate (about 5 kHz shows three lines). You should see a keyed-rainbow video waveform (as in Fig. 8). Normal amplitude is 2 or 3 volts p-p. A similar but lower-amplitude waveform occurs at test-point B.

The waveforms at C, D, E, and F have the sync pulse obliterated. They are in fact difficult to lock on an ordinary scope. Switch the scope to External Sync and drape a sync lead near

(Continued on page 65)



◀ Fig. 7. External parts that work with IC's to complete Zenith chroma section. Significance of the test points is covered in the text, while the waveforms for each are shown in Fig. 8 below.

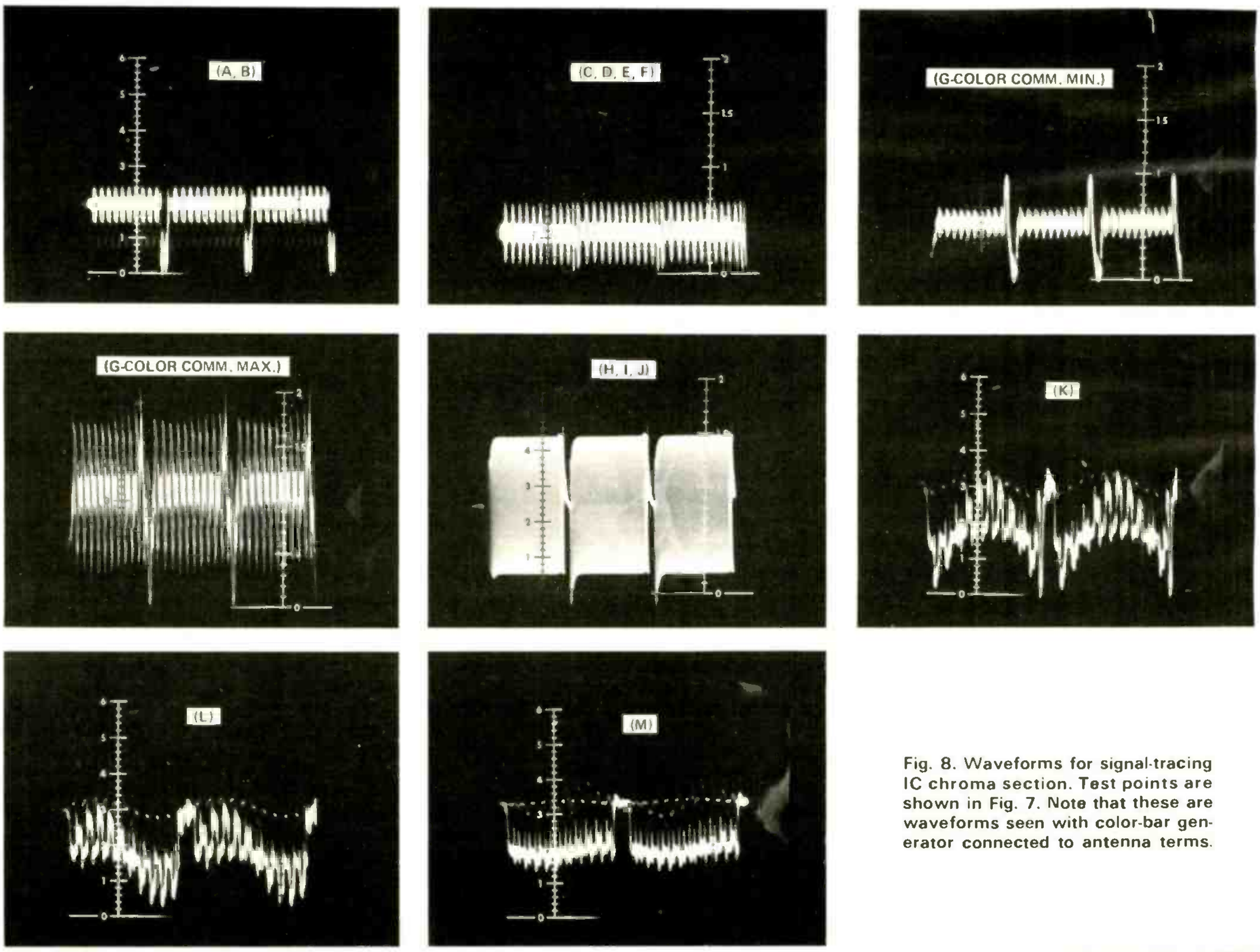
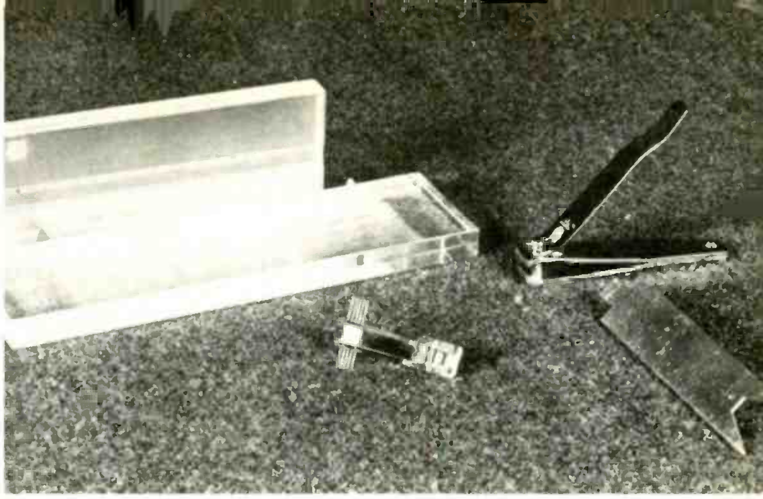


Fig. 8. Waveforms for signal-tracing IC chroma section. Test points are shown in Fig. 7. Note that these are waveforms seen with color-bar generator connected to antenna terms.

Author points out one of the encapsulated microcircuits which require precision soldering. NASA has established new high-reliability standards and Lowry AFB has developed tools.



Some of the improvised soldering tools used at Lowry. Plastic blocks bend wire leads, hair clip serves as heatsink, nail clipper is used to cut wires, and the flat tool shapes the circuits.

Microelectronic Soldering

By T/Sgt. EDWARD H. BRESLIN/Lowry Air Force Base, Colo.

Advent of IC's, modular designs, and miniaturized parts has made new soldering techniques and tools a virtual necessity.

IT all began during early space flights when bits of floating soldering debris plagued the astronauts. NASA researchers solved the problem and then imposed rigid new soldering standards on the aerospace industry. As a vitally concerned party, the U.S. Air Force—through its Air Training Command—immediately dispatched experts to learn the new high-reliability soldering and microelectronic procedures, and today teaches them in continuing courses at three of its large technical training centers.

Have you ever worked on an IC chip $\frac{1}{8}'' \times \frac{1}{8}'' \times \frac{1}{64}''$? This miniaturization poses undreamed-of precision soldering problems. Since multi-lead, multi-circuit epoxy capsules allow minimal tolerance, former standard soldering procedures became unacceptable.

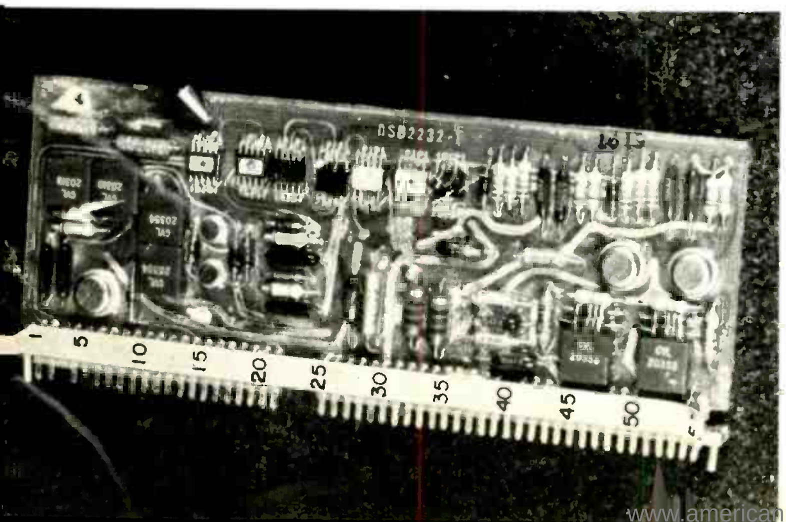
A new family of solders had to be developed. Miniscule circuits, extremely sensitive to heat, need solder which melts at low temperatures and quickly passes through the plastic state. Circuits which can tolerate rapid temperature changes, but not prolonged heat, require an eutectic solder which instantaneously changes from solid to liquid.

The new technology also called for an impractically large number of new irons and "mini-tips." Based on the rules for choosing the right iron for the right job—terminal thermal point, dissipation, and recovery rates—several irons were developed in which heat at the work surface (the single most important factor in any soldering operation), could be controlled by a variable transformer. With this, a 120-V, 25-W power source could be reduced to the point where the job could be done with the lowest possible heat.

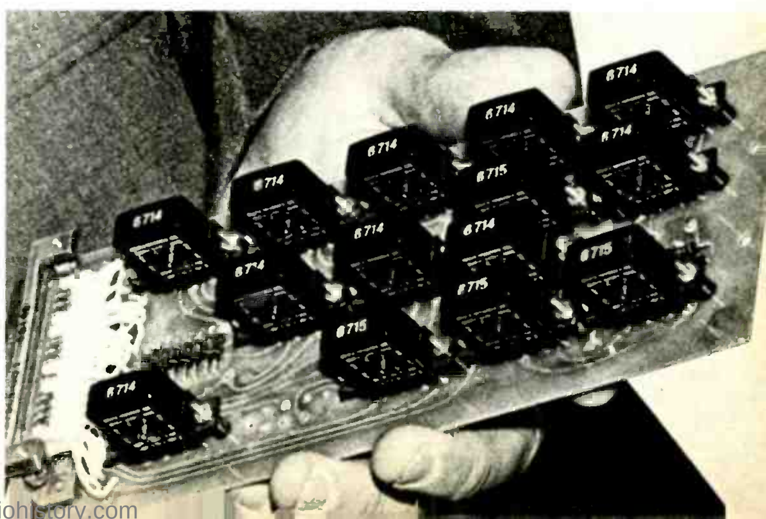
Proper fluxes, cleaning solvents, and conformal coatings are equally important to the efficiency of the finished job. (The latter are plastic sprays which waterproof, bind, and assure even distribution of heat to the part.)

The fantastic growth of miniaturized electronic technology far outstripped the manufacture of tools for servicing them, so some makeshifts were developed in the field. For instance, at Lowry AFB, technicians discovered that dental probes perform well in delicate areas and that a metal hair clamp with flat arms holds the chip perfectly without interfering with the soldering process. It also aids in distributing the heat evenly. Such ingenuity hints at the dawn of a new era for the micro-miniaturization soldering expert. ▲

Pen points to one of the micro-mini circuits on component board used for student practice in hi-reliability soldering.



This relay matrix circuit board is an example of components serviced by students in Lowry AFB soldering course.



Solid-State — the newest development

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The Swan Song of Mechanical Weighing?

Sophisticated electronic weighing equipment is rapidly replacing mechanical scales in industry.

By **John Frye**

WINTER'S first snowflakes were lazily drifting down as Mac entered his service shop. "I surely hate to think about having to wear that overcoat for the next several months," he said to Barney, already at work at the service bench as he hung up the garment. "It seems to weigh a little more every winter."

"Ha! You said the magic word!" Barney exclaimed, laying down his solder gun.

"What magic word?"

"'Weigh.' Last evening an uncle, who is a sales-engineer for electronic-weighing equipment, was at our house for supper. I don't know how good an engineer he is, but he certainly comes on strong as a salesman. He bent my ear for three solid hours about how electronic-weighing equipment works, how good it is, and what it can do for industry. But you know something? I enjoyed it. Ordinarily, I'm bored stiff when a layman tries to talk electronics to me. You know how that goes. He has so many wrong and half-baked ideas it's hopeless to try and straighten him out. But this uncle of mine really spoke our language, and he knew what he was talking about."

"Okay, you may as well regurgitate what you learned. You are not going to put out any work until you do. How big is this new market? Who manufactures the electronic equipment? What are the advantages over mechanical weighing? How does it work? How—"

"Hold it!" Barney interrupted. "let's take things one at a time. For several years the mechanical industrial-weighing market has coasted along on annual sales of about $160 million. Even as late as ten years ago, the electronic portion of this market was insignificant. But this year electronic-weighing equipment grossed at least $80 million. One manufacturer estimates the electronics side of the scale market at only 35%, but it is rapidly overtaking the mechanical side. Weighing manufacturers are buying more and more semiconductors and other electronic components. And you must remember that electronic weighing can do many things, which I'll discuss later, that are impossible with mechanical weighing. The potential of this market is tremendous.

"Right now there are three major producers of the new equipment: *Fairbanks Morse Weighing Systems Division* of *Colt Industries*, St. Johnsbury, Vermont; the *Howe Richardson Scale Company*, Clifton, N.J.; and *Toledo Scale and Systems Company*, Toledo, Ohio. Two or three other companies I'll mention later are getting into the act. But for right now, I want to talk a little about the development of electronic weighing and how it works.

"Electronic-weighing equipment really shines in automatic weighing and proportioning. Back in the thirties the *Richardson Scale Company* (now *Howe Richardson*) supplied automatic proportioning systems for mass-production process companies such as distilleries or those making glass, prepared mixes, tires, and abrasives. In these systems, each ingredient in the formula was weighed out by its own individual scale, usually to a collector conveyor, and the loading and discharge of each scale was controlled through relays and timers. Changing formulas called for time-consuming readjustment of each scale. While this worked quite well in high-volume operations where formulas were changed infrequently, what was needed was a system that could handle frequent formula changing quickly and use one scale for several ingredients.

"The development of the servomechanism during World War II, for radar, made such a system possible. It provided a basic electronic positioning device that could be adapted to remote weight setting in formulation, and *Richardson* electronic engineers realized these possibilities and came out with their first system about 1951.

"This system used a control panel with weight-selector dials (one for each ingredient in the formula) having the same graduations as the scale dial at the weighing site. A potentiometer was mounted on the spindle of each weight-selector dial, and a similar potentiometer was mounted on the spindle of the dial-scale pointer. Each control potentiometer was switched into a bridge circuit with the scale potentiometer for weighing a particular ingredient. The wiper contacts were wired into an electronic circuit which amplified any voltage differential between them. This output operated a small relay which caused the ingredient feeder to start or stop. A null position occurred when the weight of material in the hopper equaled the preset weight on the selector dial. Later, a plug-in formula capsule was substituted for the adjustable selector dial panel, and still later a punched card contained the formula information.

"Along with greater sophistication in formula input devices came greater variety in formula readout devices: remote indicators and recorders, counters and totalizers, digital printers and calculators, typewriter readout, and others. Automatic proportioning systems are now used in most plants proportioning ingredients for rubber tires, plastics, animal feeds, baked goods, coffee, ice cream, glass manufacturing, ceramic ware, alcoholic beverages, and cement and asphalt highway paving.

"Space-age developments applied to electronic weighing added new dimensions in reliability, standardization, faster delivery, lower cost, and quicker service. In a process built around an automatic weighing system, downtime is dangerously costly. Mechanical-weighing systems required talented service personnel. Modern electronic systems require only the plugging in of a new module to correct a difficulty, and users are encouraged to keep such modules on hand."

"I see what you mean by saying electronic weighing can perform many operations impossible with mechanical systems."

"That's right. *Fairbanks Morse* considers the application of electronics to weighing as falling into two categories: Category One covers the use of electronics instruments and techniques with existing scale designs that previously used a mechanical-type of indicator (pendulum, spring, beam, etc.). Category Two includes completely new products designed to take full advantage of electronic techniques.

"In the first category, *FM* markets both analog and digital instruments for use with every type of platform scale, motor truck, and railroad scales for static weighing purposes. Ancillary devices such as printers, remote displays, tare entry facilities, etc. are available with these. Their 'Digitruck-Levetronic' weighing system is a good example of a digital readout system for use with new scales or with existing weighbeam or dial-scale systems.

"The second category employs small load cells or transducer strain gages in place of weighbeams, springs, etc. The weight on the platform causes an electrical change in the load cell that can be processed to produce an analog or digital readout. *FM's* 'Slim Jim' low-profile floor scale is an example. The platform stands only 1¾" above the floor and is simply free-standing on a suitably solid floor. It was originally developed for the U.S. Post Office and comes in two models with maximum limits of 7000 and 14,000 pounds, respectively. The digital indicator can be up to 200 feet from the platform. If the platform must be flush with the floor, a pit only 2½" deep is required. A printer is available if desired.

"In-motion weighing requires speed that is duck-soup for electronics. Here we need to weigh discrete objects—anything from a whole train, a tank car, or a package—while in motion. An example is the weighing of meat carcasses transported on hooks suspended from a monorail through a processing plant. Lessons learned from in-motion weighing techniques (how to overcome vibration, for example) led to the *FM* 'Livestock Weighing Scale' in which a number of live cattle are weighed on a large platform scale, as at a public auction, and the average weight per beast is calculated and indicated.

"A still tougher problem overcome by electronics is continuous weighing of ore, coal, quarried materials, etc., being transmitted in bulk on a conveyor belt. In one system, load cells under idler rollers are fed pulsed signals from a tachometer driven by the belt. The output of the load cells thus consists of pulses whose height is a function of the belt speed. The signals are fed to a weight/speed integrator and totalizer that keeps a continuous accumulating record of the weight of the material passing along the conveyor."

"Are electronic weighing devices only useful in large-scale industry? Aren't small electronic scales practical?"

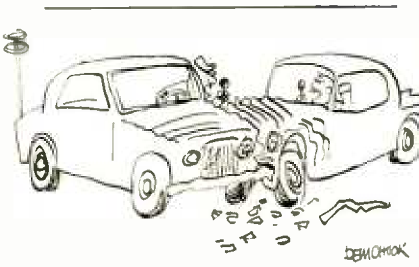
"*Toledo Scale* is checking that out. They have been field-testing a retail point-of-sale digital computing scale in food chains. Separate digital displays face the clerk and the customer, each of which indicates unit price, weight, and total price. *Toledo*, which got into electronics about ten years ago, uses a strain-gage type load cell as the weight sensor; and two years ago they changed their readout system from a servo-type analog system to a digital-IC system and their control system from photoelectric to a remote-control straight digital-IC system. As a result, they claim their scale is accurate to better than 0.1%. A *Toledo* spokesman says there are definitely fewer service problems with electronic equipment than with mechanical equipment and that he thinks eventually electronic equipment will be less expensive than mechanical equipment.

"A couple of smaller companies edging into the market are *Data Controls Systems, Inc.*, Danbury, Connecticut and *Metrodyne Corp.*, Riverside, Connecticut. *DCS* is specializing in batching by weight—that is mixing up to 16 feeds per formula for corporate farmers—but they are interested in tailoring equipment to customer needs instead of pushing standard products.

"*Metrodyne* manufactures 'Dyne-A-Mat,' a portable electronic weighing system light enough to be hand-carried and with a capacity of 10,000 pounds. It consists of a ⅜-inch thick elastomeric mat which can be spread on the floor anywhere and attached to the digital readout and print-out equipment. The mat is actually a capacitor with black layers of conductive neoprene alternating with non-conductive layers that act as a dielectric. Applied weight compresses the dielectric allowing the conductive layers to come closer together. The resulting change in capacitance is proportional to the deforming weight and can be used to produce a signal actuating the readout equipment.

"Finally, a barely tapped market lies in 'on the fly' weighing of tractor-trailer trucks approaching toll stations at up to 20 miles per hour. Experiments have been carried on in Pennsylvania with transducerized load cells in an attempt to weigh trucks traveling 4 to 6 miles per hour, but truck oscillations—especially in partially loaded tank trucks—and driver braking create recalibration and maintenance problems. The Japanese are quite interested in truck weighing in connection with a series of new asphalt roads they are building, and they have been looking into the 'Dyne-A-Mat' system."

"Well," Mac said, as he switched on his bench light, "all this is a switch, anyway. Physicists used to be quite interested in weighing the electron, and now the electron is doing the weighing." ▲



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Time-Sharing Computer

(Continued from page 48)

tain immediate and effective use of time-sharing without having to become a computer programmer.

The exciting thing about this "personal computer" service is that its use and potential is limited only by the person using it. But to fully evaluate how time-sharing can help put more creativity into your engineering activities, arrange for a personal visit by one or more of the 100 or so firms now marketing commercial service throughout the country. In your initial meeting, be prepared to review your engineering tasks and problem-solving requirements.

From this first meeting, the time-sharing representative can put together a special proposal of services, capabilities, and programs tailored to your needs. To be presented at a second meeting, this proposal should cover:

1. A description of specific services and programs available.
2. What initial and follow-up training does vendor provide and at what cost?
3. What personnel support does the supplier provide to assure your effective use of the service?
4. A clear definition of monthly charged.
5. Examples of documentation describing the various services and programs.
6. Types of contractual agreements, if any, that you must sign.
7. A full demonstration of appropriate programs and capabilities.

After reviewing the various proposals, it should be clear which supplier can best provide the service you require.

Before you know it, you'll be on your way to creative problem-solving with your own personal time-sharing computer. Within a short time, you'll be writing your own special application programs. ▲

A time-sharing terminal is a compact, desk-top unit which lets engineer "tap" the memory of a full-size computer.

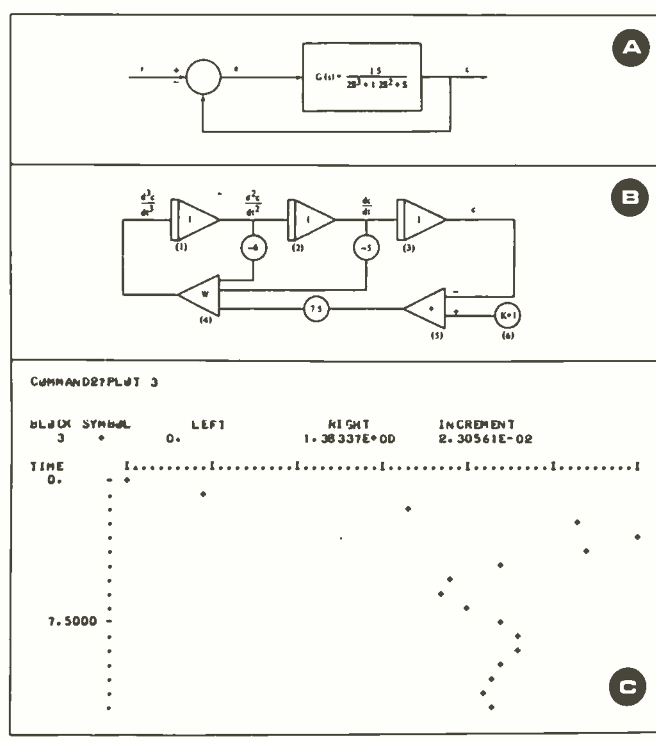

Fig. 5. (A) Feedback system on which controlled response is to be determined. (B) Typical analog block diagram describing the system. (C) Plot or response produced by "Dysim."

Testing IC's in TV Receivers

(Continued from page 52)

the horizontal sweep section of the receiver. You should see the waveform shown with amplitude about 0.7 volt p-p.

The shape of the waveform at G depends on the setting of the Color Commander control. With the control at minimum, the waveform is about 0.1 volt in amplitude. Turning the control fully clockwise increases amplitude above 0.2 volt p-p as shown.

The waveform at point H is the 3.58-MHz subcarrier. It is solid r.f., but is blanked off during each horizontal sync pulse, so you don't have to change scope settings. The waveform as pictured is normally about 1.5 volts p-p.

The R-Y and B-Y injection waveforms at I and J look the same. Amplitude is about the same, too. The phase difference is not noticeable on an ordinary scope.

The color waveforms at points K, L, and M seem similar in appearance. However, their phase is not the same. (Only two lines are displayed, for easier study.) The B-Y output at point K has an amplitude of about 4 volts p-p and the sixth bar is the highest positive one.

The R-Y output at L has slightly less amplitude. The third bar goes farthest positive.

The G-Y output at point M has low video amplitude. Even the blanking pulse, the highest part of all, is only about 2 volts p-p. The ninth bar—the last visible one—goes the farthest positive, as you can see from Fig. 8.

Signal-tracing the IC color section is very similar to doing it in a tube or transistor model. You look for the same kind of signals and the amplitudes are not very much different.

One major difference is the d.c. nature of the controls. Hue, Chroma Level, A.P.C., A.C.C., and Killer Threshold, all affect the IC by applying a variable voltage to it. To test them, just clip a d.c. voltmeter on the slider portion of each control and see if the voltage goes up and down as it should. If it does, then it should have the desired effect on IC operation.

Only the Color Commander and Cross Talk Adjust (CTA) controls operate directly on signal. (The CTA is set with color bars in place; leave it in a position that makes the fewest "worms" and sharpest edges on the color bars seen on the picture tube.)

For other d.c. tests, use the charts below. They list normal voltages at the terminals of all three IC's. All the voltages are taken on an FET v.o.m., with a keyed rainbow signal fed into the receiver. Variable voltages depend on control settings. ▲

IC 901 (Chroma Amp):

(1) 7.5 V	(7) 1.3 V	(11) 14 V
(2) 1.7 V	(8) 22 V (supply)	(12) 14 V
(3) NC		(13) 13-16 V (15 V normal)
(4) Gnd	(9) 18 V	(14) 7.5 V
(5) NC	(10) 0-22 V (5 V normal)	
(6) 20 V		

IC 902 (Demodulator):

(1) NC	(6) 6 V	(10) Gnd
(2) NC	(7) 6 V	(11) 14 V
(3) 3.5 V	(8) 23 V (supply)	(12) NC
(4) 3.5 V		(13) 14 V
(5) Gnd	(9) 14 V	(14) Gnd

IC 1001 (Subcarrier Regenerator)

(1) 7-7.5 V (7.3 normal)	(6) 2.6 V	(11) 8 V
	(7) 11.5 V	(12) 8 V
(2) 11 V	(8) 11 V	(13) 6.5 V (A.P.C. Control)
(3) 11 V	(9) 12 V	(14) 6.5 V (A.C.C. Control)
(4) -1.5 V	(10) 12 V (supply)	(15) 7.5 V
(5) Gnd		(16) 7.5 V

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Oscilloscopes

(*Continued from page* 30)

work is to see if the trace is steady with internal sync at 60 Hz or below; if a 3,579.545-MHz chroma oscillator sine wave is resolved cleanly and broadly; if the trace is still sharp, bright, and noise-free with maximum vertical amplifier gain; whether the scope will sync on a signal that is a portion of a division/cm; and if there is abnormal d.c. amplifier drift after warm-up.

Industrial/Laboratory Scopes

Now let's consider professional scopes that require the best accuracy, fast writing rates, a variety of vertical amplifier types, and a time base whose speed must range from fast to spectacular. These oscilloscopes are expensive, ranging from \$1500 to \$5000. They must operate over long periods of time, sometimes at above-normal temperatures, and with little or no maintenance.

The standard scope in this price class (and we're not speaking of spectrum analyzers, sampling, or storage oscilloscopes) must have high sensitivities (as low as 10 mV/cm or less), rise times in the low nanoseconds, bandwidths wider than 20 MHz, special time-base triggers for low-level and very rapid signals, and usually two time bases (A delayed by B) so that small portions of a waveform can be observed in detail.

While the above requirements almost dictate the need for plug-in amplifiers, smaller, lighter scopes are rapidly appearing on the market without plug-in capabilities but with characteristics broad enough so that they will do for many applications. If this is not the case then there are the larger scopes which accept plug-in amplifiers that offer vertical differentiated amplifiers with 10-μV sensitivity, operational amplifiers, transducers, strain gages, current amplifiers, 4-trace amplifiers, and even multimeters and counters (*Tektronix* 7400 Series). Very important, too, is the 4 to 12 kilovolts, or more, supplied to the CRT accelerating anode which permits trace resolution at extremely fast repetition rates.

These professional-type scopes also contain regulated power supplies in order to maintain steady-state characteristics over a prolonged period of time after calibration. The less expensive scopes must depend upon the regulation of the a.c. power line and this can cause inaccuracies even over short periods of operation.

Battery-Operated Scopes

Battery-operated scopes have become popular with the advent of low-voltage and low-current transistors and special cathode-ray tubes. Both *Hew-*

lett-Packard and Tektronix have quality scopes in portable form which can be operated from batteries or a.c. power. Practical continuous operating time varies from 3 to 8 hours depending of course on the particular design, with all vital characteristics maintained over this period. In all probability the only real limiting factor is the current drawn by the CRT filament.

The portable scope finds its application on such jobs as aircraft maintenance, telephone long-lines, balloon electronics, shipboard communications, mobile rigs, and just about any application where no power lines are available. As far as price is concerned, the portable scope is bound to run higher.

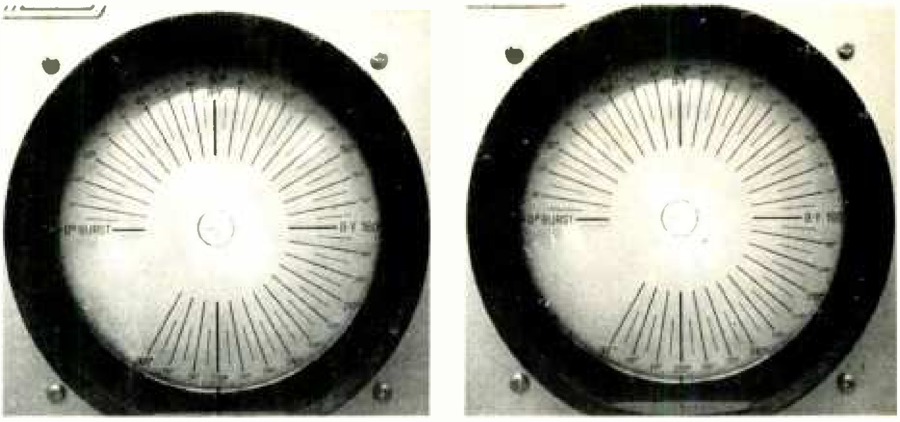

Fig. 4. (Left) A vectorscope pattern with luminance information; (Right) The correct vectorscope pattern with luminance removed.

Professional Scope Specs/Uses

Since scope characteristics are pretty well covered, we can now set up a table of typical specifications needed for the various areas of the industry and the NASA-Military. Jim Walcutt of *Tektronix* helped with this chart and it includes information on sensitivity, bandpass, single- or dual-trace, time base (delayed or not), sweep rates, a.c. or battery-operated, and round-figure prices. Along with the table and discussion, we will show some typical waveforms from some of the gear described.

Computers: These can be analog or digital, but digital are faster, so we will take a look at one of this type. Ken Wallgren of Goddard Space Flight Center had us take a look at the pulse train in a 750-nanosecond *Systems Engineering Laboratories'* 810B computer which will fetch and store usually in two cycles of the sub-microsecond rate. The display (Fig. 3) was made from a storage oscilloscope, accounting for the murky background.

Marine Depth Sounder: The trace shown from this unit (Fig. 3), appears as an amplitude-modulation envelope but really is the r.f. output of the sounder taken at 100 V/div and 100 μs/div on the X-axis. Slower sweep speeds simply show large pulses of voltage at regular intervals emanating from the depth sounder.

Konel Marine Transmitter: The output of the transmitter display at 2 V/div and 0.5 ms/div (Fig. 3) shows the effects of a 2-kHz whistle. The rig (and whistle) was supplied by Alfred Fry III of *Fry Electronics*, Annapolis, Maryland.

Service Vectorscopes

The "garden variety" of vectorscope is a most useful instrument for making all Lissajous phase and frequency comparisons. It is ideal for color-TV troubleshooting as it can check chroma bandpass, burst transformer, 3.48-MHz subcarrier output transformer alignment, and peaking. For stereo work it can be used to check the 19-kHz-38-kHz pilot to regenerated subcarrier precision alignment by a 2:1 discrimination.

Any oscilloscope can be a vectorscope since it has a set of both vertical and horizontal deflection plates. You can feed the plates through the X and Y amplifiers provided they are linear and matched for equal deflection and impedances. Because of the voltages involved, capacitive coupling should be used from the signal source to the amplifier inputs or to the deflection plate connections at the rear of the scope. When feeding the deflection plates for vectorscope operation, one plate of the V and H must be grounded for a.c. (no push-pull operation). Further, both V and H plates must be reversible for color-grid drive or cathode drive which, of course, are 180° out-of-phase.

In addition to feeding through coupling capacitors you'll need an *RC* compensation network for the red amplifier to match the blue in order to produce a rounded pattern. Some scopes designed for color work have this built in. Others require an outboard network that would consist of approximately 180 pF in parallel with 390k ohms in series with the TV red signal.

Another concern is whether the vectorscope loads the signal source being observed. If the scope has a low input impedance, the loading will cause phase changes (Hue shifts) and the colors will shift positions.

Vectorscope Signal Generator

Since you are going to view patterns that are 90° out-of-phase, a very clean signal source is necessary for the amplifiers under test. Sine-wave inputs must have little or no harmonic content and other signal generators, particularly gated-rainbow color-bar generators, must be free from fundamental gating "spray" (usually 189-kHz oscillations) to produce a clean, distortion-free pattern in the receiver's R-Y (red luminance) and B-Y (blue luminance) outputs. G-Y is not used since it is more than 180° from the reference 0-360° burst and more than 90° from R-Y. Any color pattern that has patches of bar internal interference or runs rapidly up and down probably has such gating problems. On the vector pattern, this will show as a smear among the bars. Other generators will not show blanking between 300° and 360° and will cause one or more bars in the vector output to distort, usually the first or tenth.

As examples of vector patterns we chose to use *RCA's* modular plug-in, solid-state 1972 color receiver. Fig. 4 (left) is an example of a vectorscope display with the luminance information still left in the pattern. The signal is fairly readable but somewhat distorted. Fig. 4 (right) shows the correct vectorscope pattern with the luminance removed and all petals of the vector pattern in their correct (approximately) position. The sharp rise and fall times of the third R-Y bar verifies the fact that the bandpass transformers are tuned correctly.

X-Y Scopes

A type of instrument that is increasing in popularity is defined as the X-Y scope. This scope is different in that it has matched vertical and horizontal amplifiers. They are matched in input impedance, input capacitance, gain, frequency response, and—most important of all—phase shift. Some models list a phase difference of only a degree. The advantage is that the scope can be used to determine the phase difference between two signals (without actually adding an error due to its own phase shift), using Lissajous patterns.

For this reason, the X-Y scope can readily serve as a vectorscope for color-TV work provided it has an adequate bandwidth. Unfortunately, many vectorscopes cannot double as X-Y scopes since they have insufficient gain. ▲

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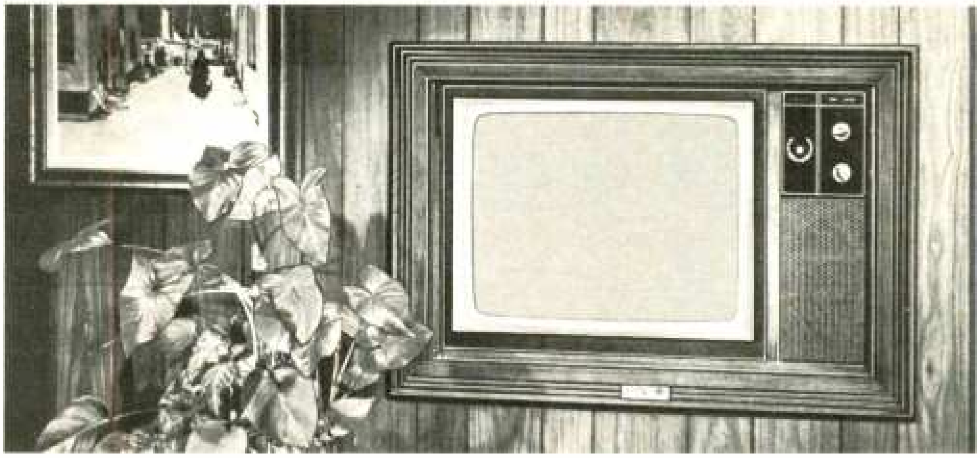
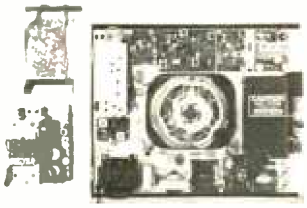


Heath's finest color TV, now available in optional new hide-away wall mount



Here's the inside story:...the Heathkit 25" solid-state color TV with exclusive MTX-5 ultra-rectangular tube to bring you the largest color picture in the industry! The etched, bonded tube face cuts glare, increases contrast for sharper picture, purer colors, more natural flesh tones. But the true story of color TV reliability starts in the solid-state modular circuitry ... 45 transistors, 55 diodes, 2 silicon-controlled rectifiers, 4 ICs containing another 46 transistors, 21 diodes, and just two tubes (picture and high-voltage rectifier). Major circuit functions are contained on individual plug-in glass epoxy boards (see chassis inset above) to simplify assembly, service and adjustment. And, of course, only Heathkit color TV offers you the money-saving advantages of home-serviceability...with the built-in dot generator and tilt-out convergence panel to let you perform the periodic adjustments required of all color receivers.

Other advanced design features incluue solid-state VHF tuner with MOSFET for greater sensitivity, lower noise and cross modulation; solid-state UHF tuner with hot-carrier diode design for greater sensitivity; 3-stage solid-state IF for higher gain and superior picture quality; Automatic Chroma Control for constant color quality under different signal conditions; adjustable video peaking; adjustable noise limiting and gated AGC; "Instant-On"; VHF power tuning on 13 channels plus one preselected UHF channel; Automatic Fine Tuning; Tone-Control; and an output to your stereo/hi-fi system for the ultimate in sound reproduction.

And to wrap it all up...custom install your Heathkit GR-371MX in the exciting new Heathkit TV Wall Mount. Push the button on the picture frame — or on your optional GRA-70-6 Wireless Remote Control — and the carefully crafted tambour doors silently glide open to reveal your color TV with turned-on picture and sound. Another touch of the button and the doors slide closed, turning off the set. The Custom Wall Enclosure is available in either walnut or unfinished versions. Kit includes trim frame, sliding tambour doors, electric motor assembly — forms completely self-contained enclosure with tilt-out speaker baffle and convergence panel mount, slides easily into prepared opening. Also can be used to conceal wall safe, built-in bar, etc. Cabinet measures $23\frac{5}{16}$" H x $38\frac{11}{16}$" W x $22\frac{3}{8}$" D. Frame measures $26\frac{1}{8}$" H x $39\frac{9}{16}$" W x $1\frac{5}{16}$" D.

Kit GR-371MX, TV only, 125 lbs. **579.95***
Kit GRA-402-25, TV Custom Mount (finished), 50 lbs. . . **114.95***
Kit GRA-407-25, TV Custom Mount (unfinished), 50 lbs. **109.95***

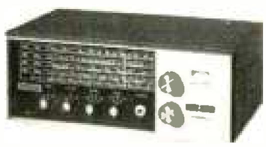
New Heathkit Solid-State Wireless Intercom

29.95*

Plug two of them into standard 105-130 VAC outlets for 2-way communications. Three channels let you carry on 3 conversations in a 6-unit system, call one unit without disturbing the others in a 3-unit network. Intercoms have channel selectors, spring loaded "talk" button, slide-action volume control, and "dictate" for extended one-way communication.

Kit GD-113, 5 lbs. ...... **each 29.95***

New Heathkit Solid-State Shortwave Receiver



59.95*

Four over-lapping bands provide continuous coverage from 550 kHz to 30 MHz, giving you local AM plus international, amateur, marine & weather and citizens band broadcasts. Features band-spread tuning for close station separation; BFO control for receiving code; signal meter; front-panel headphone jack; noise limiter; built-in AM antenna.

Kit SW-717, 10 lbs. **59.95***

New Heathkit Automatic Battery Charger...

Charges 12-volt batteries automatically. 10 amp max. charge rate. Impossible to hook up wrong. No charge setting to make ... can be left hooked up indefinitely. Meter monitor charge. **Kit GP-21,** 13 lbs. **29.95***

New Heathkit Automotive Timing Light...

Completely self-contained. Bright flash lets you work in sunshine. Adapter for connecting to distributor. Hi-impact plastic case.

Kit CI-1020, 3 lbs. **19.95***

there's a Heathkit present

229.95*

New Heathkit Solid-State Digital Multimeter...

Here's a breakthrough in instrumentation. The new Heathkit IM-102 gives you a true digital multimeter for about half what you'd pay for comparable wired DMM's! And with an accuracy that's better than many wired digital units on the market... decidedly superior to most analog type instruments. This great new meter measures AC and DC voltages and currents, and resistance with no need to change probes or switch for changes in DC polarity. Automatically displays a positive or negative DC voltage and current, indicating the correct amplitude and polarity. Five overlapping ranges measure voltage from 100 uV to 1000 V on DC (either polarity); five ranges cover 100 uV to 500 V on AC; 10 ranges measure 100 nanoamperes to 2 amperes on AC or DC, and six ranges show resistance from .1 ohm to 20 megohms. Input impedance is exceptionally high — approximately 1000 megohms on 2V range (10 megohm on higher ranges), with overload protection built-in on all ranges. Decimal point is automatically placed with range selection and overrange is indicated by a front panel light.

Ends parallax and interpolation errors! There's no mistaking a digital display — everyone reads it the same way. High quality precision components, 3½ digits and ease of calibration contribute to the IM-102's lab-grade accuracy. Analog to digital conversion is accomplished by a patented, dependable Dual Slope Integrator that does not depend on a stable clock frequency for accuracy. A Heath-designed and assembled precision DC calibrator is furnished with each IM-102. An internal circuit and transfer method provides accurate AC voltage calibration. The all solid-state design incorporates cold cathode readout tubes and a "memory" circuit to assure stable, non-blinking operation. Features include detachable 3-wire line cord (no batteries needed), dual primary power transformer, isolated floating ground and completely enclosed, light-weight aluminum cabinet with die-cast zinc front panel and tinted viewing window. Kit includes standard banana jack connectors complete with test leads. Assembles in approximately 10 hours. The new Heathkit IM-102 Digital Multimeter will be the pride of your bench!

Kit IM-102, 9 lbs., mailable **229.95***

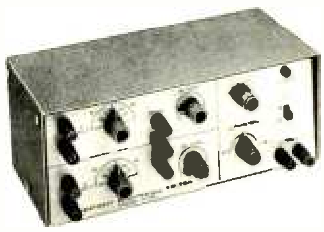
New Heathkit Vector Monitor...

49.95*

Designed for use with the Heathkit IG-28 Pattern Generator or similar units which display either "rainbow" (offset carrier) or NTSC patterns, the IO-1128 vector display helps you perform fine tuning, static and dynamic convergence, purity, 3.58 oscillator, reactance coil, phase detector transformer, demodulator angle check, and chroma bandpass adjustments. Represents exactly the color signals fed to CRT guns.

Kit IO-1128, 10 lbs. **49.95***

New Heathkit Electronic Switch... 39.95*

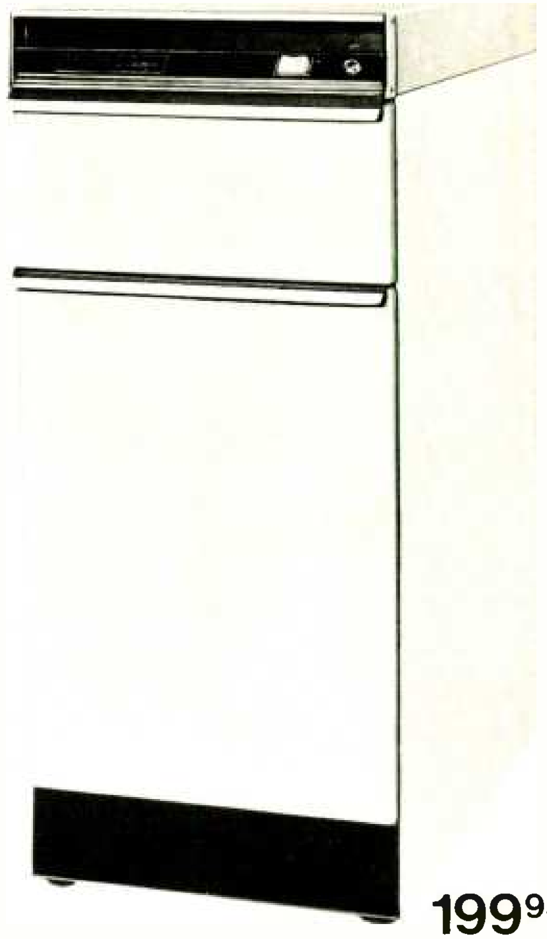


Provides simultaneous visual display of 2 input signals on a single trace oscilloscope. Has DC coupling and DC-5 MHz ±3 dB frequency response. Conventional binding posts permit fast hook-up. Can be left connected to scope. Ideally suited for digital circuit work; amplifier input and output for gain and distribution checks; simultaneous monitoring of 2 stereo channels.

Kit ID-101, 6 lbs. **39.95***

for every age, every hobby!

New Heathkit "Minimizer" kitchen waste compactor...



Today's most modern refuse handling method in easy-to assemble kit form! Now you can own the most exciting kitchen appliance on the market for less than you'd pay for any other comparable compactor. The Heathkit Minimizer lets Mom throw out the unsightly waste baskets and garbage cans for the latest in clean, convenient, odor-free disposal. The Minimizer handles all normal household trash — food wastes, glass and plastic containers, tin cans, wrappings, boxes, floor sweepings, light bulbs, etc. The packing ram descends with 2,000-lb. force to reduce refuse to almost ¼ of its original size, packaging the material in a strong disposable bag — one bag holds an entire week's trash for a family of four! When the bag's full, Mom simply folds over the top and removes a neat, dry package for normal rubbish pickup. And the Minimizer deodorizes the contents each time the drawer is opened and closed. The sanitation man will love Minimizer, too!

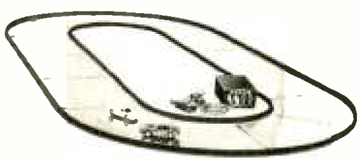
Simple, safe operation! To use, Mom merely inserts a Minimizer plastic-lined bag in the drawer and starts the compacting cycle. In less than a minute the ram forces down the trash, returns to its normal position, and the Minimizer shuts itself off. For maximum safety, the Minimizer uses a key lock switch and an interlock which automatically turns unit off if drawer is not fully closed or is accidentally opened during cycling. Your Heathkit Minimizer can be built-in under the kitchen counter or left freestanding. Its bright white enamel finish with marble-tone vinyl-clad top complements any decor. And you can build it yourself in 6 to 10 hours. Has long-life ⅓ hp motor, plugs into 110-120 VAC conventional household outlet. Kit includes 5 plastic-lined bags, one 9 oz. aerosol can of deodorant. Minimizer measures 34⅜" H x 15" W x 25½" D.

Kit GU-1800, 203 lbs. **199.95***
GUA-1800-1, 15 plastic-lined bags, 5 lbs. **4.99***

199.95*

New Heathkit Slotless 1/32-Scale Raceway

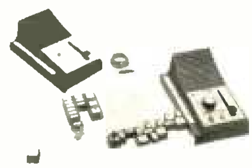
129.95*



You race up to 4 GT cars — each with independent acceleration, deceleration and steering! Make all the maneuvers of real high-speed drivers. You can even turn around completely and backtrack. Kit includes track sections for 8'x4' oval, power transformer, 2 cars and controllers.

Kit GD-79, 13 lbs., mailable **129.95***
Kit GDA-79-1, extra car and controller, 3 lbs., mailable . . **21.95***

New Heathkit Electronic Workshops



Completely self-contained electronics labs teach youngsters the basics of electronics. Each contains basic electronic components in easy-to-work-with module form. Kids simply follow the instructions, arrange the blocks on the board to form actual working circuits for code flashers, timers, alarms, etc.

Kit JK-1033, 36 experiments, 11 lbs. **29.95***
Kit JK-1022, 25 experiments, 8 lbs. **24.95***
Kit JK-1011, 12 experiments, 6 lbs. **19.95***

SEE THESE KITS AT YOUR LOCAL HEATHKIT ELECTRONIC CENTER... or send for FREE catalog!

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Retail Heathkit Electronic Center prices slightly higher to cover shipping, local stock, consultation and demonstration facilities. Local service also available whether you purchase locally or by factory mail order.

HEATHKIT
Schlumberger

HEATH COMPANY, Dept. 15-11
Benton Harbor, Michigan 49022

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☐ Please send FREE Heathkit Catalog.
Name__________
Address__________
City__________ State__________ Zip__________

*Mail order prices; FOB factory.
Prices & specifications subject to change without notice. CL-421

NEW PRODUCTS & LITERATURE

For additional information on items identified by a code number, simply fill in coupon on Reader Service Page. In those cases where code numbers are not given, may we suggest you write direct to the manufacturer on business letterhead.

COMPONENTS ▪ TOOLS ▪ TEST EQUIPMENT ▪ HI-FI ▪ AUDIO ▪ CB ▪ COMMUNICATIONS

CASSETTE DECK RECORDER

A stereo cassette deck recorder which combines the Dolby noise-suppression system with the Wollensak-patented heavy-duty, constant-speed drive system has been introduced as the Model 4760.

The deck incorporates a switch to adjust the

record bias for standard and special high-biased tapes; an end-of-tape "guardian" which lifts the pressure roller to prevent damage to the tape or recorder when the end of tape is reached or jam occurs; easy-to-read dual calibrated illuminated vu meters; separate input level controls with master gain; and a mono/stereo record/play selector switch.

Frequency response is 35-15,000 Hz ± 2 dB, wow and flutter is less than 0.15%, and the signal-to-noise ratio is better than 54 dB with Scotch high-energy or chromium-dioxide tapes. 3M

Circle No. 3 on Reader Service Page

PLASTICS REPAIR KIT

A plastic repair kit for all soluble plastics which can be used either as a cement or plastic putty is now being marketed as "Plas-T-Pair." It is well suited for repairing radio and TV knobs, cracked or broken plastic cabinets, screws mounts, and carrying handles on portable sets.

It is a two-part compound consisting of a powder and liquid solvent. The products are mixed and then poured or brushed onto a repair as a liquid plastic cement or it can be mixed and allowed to set for a few minutes to be molded onto the repair area as a plastic putty.

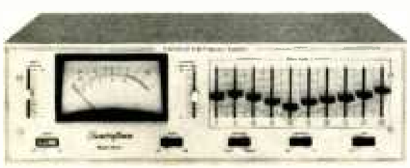
According to the company, the cement is strong, fast-setting, and waterproof. No clamps or pressure is required. When used as a putty, it can be molded and formed into any shape. After it dries it can be sanded and varnished to blend in with the original surface. Chemtronics

Circle No. 4 on Reader Service Page

A.F. EQUALIZER

A single-channel audio-frequency equalizer has recently been introduced as the Model 10-12.

The new instrument permits the precise monitoring of input and output levels to assure undistorted, clean response, using an accurate dB meter. A calibration control as well as full-frequency and individual octave-frequency controls are coodinated with metering bypass, selection, tape bypass, and equalizer bypass switches.



Equalization during recording or playback can be accomplished with this unit, with a 12-dB boost or cut of each octave, plus an additional 12 dB cut or 6 dB gain of the full-frequency spectrum. Thus peaks up to 24 dB and valleys down to 18 dB can be compensated under extreme conditions.

The unit is supplied with a special instructional test record which provides alternate pink noise tones, alternating each frequency band with a 1000-Hz reference tone, for rapid equalization of room conditions. Step-by-step instructions are also included on the record.

The instrument is housed in a walnut-grained case with brushed gold and black accents. Soundcraftsmen

Circle No. 5 on Reader Service Page

FM-MULTIPLEX GENERATOR

An FM-multiplex generator which provides r.f. and i.f. markers and multiplex signal output has just been introduced as the Model LSG-230.

This new service and testing instrument has a 3-V output voltage at approximately 19 kHz

with a continuously adjustable frequency range of 75 to 110 MHz. Separation is over 30 dB from 50 to 15,000 Hz.

The new unit not only checks separation and balance in FM receivers and tuners but can also be used as a sweep/marker for 10.7-MHz FM and i.f. alignment.

It features a 117/230 V, 50/60 Hz dual power supply, measures 10½" high × 7" wide × 11" deep and weighs 13½ pounds. Accessories include 300-ohm and 75-ohm cables. Leader

Circle No. 6 on Reader Service Page

STEREO MUSIC CENTER

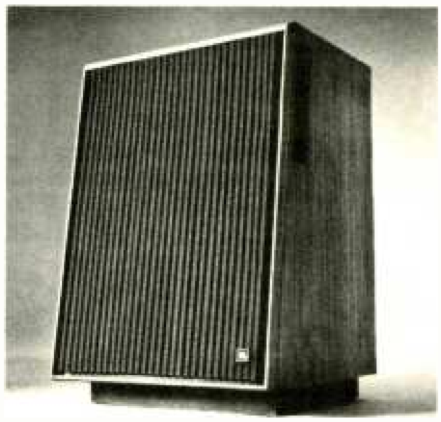
The SC-8700 is a stereo music center featuring a four-channel receiver plus a four-speed Garrard automatic turntable and two speakers. The amplifier can function with an 8-track, 4-channel cartridge; four-channel open reel tape; or any new four-channel source to produce quadrasonic sound.

The unit's unique amplification system can also be used to provide multi-amplification. Panasonic

Circle No. 7 on Reader Service Page

NEW SPEAKER SYSTEM

The new L200, Studio 2 is a consumer version of the company's professional Studio Monitor and features a 15-inch low-frequency transducer, a horn-loaded high-frequency driver with an



acoustic lens, and a matched frequency-dividing network.

This floor-standing model has a deep fluted vertical grille pattern of Crenelex—a material described as being acoustically more transparent than cloth. The cabinet is finished in oiled walnut and the face of the cabinet has a sloping front, aiding sound dispersion and creating an unusual geometric design. JBL

Circle No. 8 on Reader Service Page

PORTABLE P.A. SYSTEM

A compact, solid-state portable sound system is now being offered as the PA-500. The entire system is packed as a suitcase measuring 10" × 26" × 22" and weighing 60 pounds.

The full-range amplifier has 100 watts r.m.s. power. There are four channels each with two input jacks for high-impedance microphones, volume, treble, bass, and reverb control. The power section includes a master volume control, low-frequency cut switch, an anti-feedback control, an output jack for tape recording, monitor jack for headphones, volume control for headphone listening, and a rocker-type power switch with line-reversing features. There are two speaker outputs on the rear panel (2 to 8 ohms) and an auxiliary 120-volt, 60-Hz power outlet. Two speaker columns are supplied with the system, each containing three heavy-duty 8" specially designed speakers. Input jacks on the front of the columns permit the use of multiple columns for patching a series of speakers.

A data sheet supplying complete details on the PA-500 is available on request. Jordan Electronics

Circle No. 9 on Reader Service Page

FOUR-CHANNEL ADAPTER

The "Dual Triphonic" (QX-1A) adapter is designed to permit the conversion of matrix stereo into "concert-hall" sound, according to the company. With this unit and appropriate additional speakers, any present stereo system can be used to reproduce 4-channel stereo.

According to the company, when the speakers are arranged in a diamond pattern, rather than a four-corner system, the psychoacoustic distribution of the four channels matches the way people actually hear. The direct source of the sound is spread out in front of the listener and the bulk of the reflected sound radiates from the listener's left and right sides. Part of the total sound that would reflect forward again from the rear wall is channeled through the last speaker in the diamond, behind the listener.

The adapter contains a power amplifier, switched speaker connections, and volume control. It is compatible with all stereo receivers. Denon

Circle No. 10 on Reader Service Page

FREQUENCY METER/ SIGNAL GENERATOR

The Type 107A digital frequency meter/synthesizer/signal generator is designed especially for those in the mobile-radio maintenance field but has other applications in the educational, aerospace and industrial lab fields as well as in manufacturing, research, and production operations; in AM, FM, and TV broadcast engineering and receiver servicing; and in commercial frequency-measurement services.

The instrument is completely solid-state and operates from either 12 volts d.c. or 115 volts a.c. It weighs 22 pounds.

As a heterodyne frequency meter, it will measure carrier frequencies of nearby transmitters or signals picked up on a receiver. Coverage on FCC-assigned frequencies is continuous from 10 kHz to above 500 MHz. Guaranteed accuracy in the field, independent of WWV, is considerably better than 0.0001%. Readout is better than 0.00002%.

As a synthesizer, any frequency from below 1000 Hz to 999.9 kHz can be generated, in steps of 100 Hz, phase-locked to the internal crystal standard. Voltage output level is 1.0 volt r.m.s. down to 0.0005 volt, continuous and calibrated into 50-ohm load or greater.

Complete technical specifications on the Type 107A will be forwarded on request. Lampkin Labs

Circle No. 11 on Reader Service Page

SOLID-STATE COLOR-TV KIT

The Model GR-269 is a solid-state color receiver in kit form which uses modular plug-in circuit boards for ease of assembly and servicing.

Standard features include automatic fine tuning, instant-on, switch-controlled manual degaussing, readily accessible secondary controls, and 180 square inches of viewing area.

The fine-tuning control, three-stage i.f., v.h.f. and u.h.f. tuners, and high-voltage assembly are supplied factory assembled to speed construction. Heath

Circle No. 12 on Reader Service Page

DIGITAL READOUT CLOCK

Two new digital readout clock movements which are designed to be installed in any equipment, product, rack, console, cabinet, or panel have been introduced as the #140-12H (12-hour readout) and #141-24H (24-hour readout).

Both feature large, easy-to-read digits (5/8" high on the 12-hour model and 5/16" high on the 24-hour version); front-panel reset facility; individually resettable digits; front-panel mount; and completely enclosed anodized metal dust-proof case. Each movement weighs 3 1/2 pounds and measures 3 1/2" high × 5 1/2" wide × 3 1/4" deep. Standard models are 110-120 volt, 60-Hz powered but the movements can be supplied in 120-V, 50 or 60 Hz; 220-240 volt, 50 or 60 Hz; or 115-volt, 400 Hz versions on special order. Pennwood Numechron

Circle No. 13 on Reader Service Page

REPLACEMENT COLOR CRT's

Three new "Hi-Lite" color picture tubes can now replace 185 different types of color tubes used throughout the TV set industry.

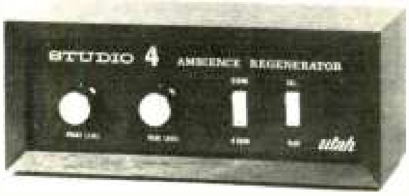
These new "V" type picture tubes: the H-18VAHP22, H-19VABP22, and the H-23VALP22, contain the latest x-ray attenuating glass and replace key industry types. The first replaces 92 types, the second replaces 22 types, while the third can be used in place of 71 types. This latter tube has matrix screen construction which allows the service technician to upgrade the brightness performance of the customer's TV set.

Additional technical information on these tube types or copies of the complete interchangeability guide is available on request. RCA Distributor Products

Circle No. 14 on Reader Service Page

4-CHANNEL ADAPTER

The new "Studio-4" ambience regenerator, when combined with two speaker systems, converts any stereo installation into 4-channel, according to the company. The third and fourth channels are derived from phase- and amplitude-information which already exists on stereo



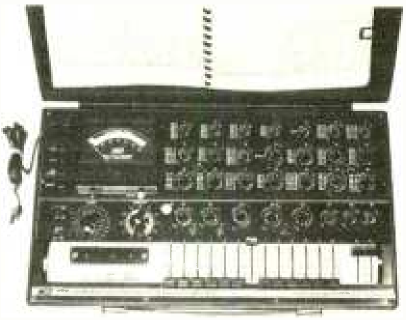
tapes or discs. L-pads individually control each rear speaker. One rocker switch permits rapid changeover from 2- to 4-channel operation while another places all speakers in the difference mode for balancing of the amplifier or receiver.

Installation is quick and easy. No additional channels of amplification are required. The adapter is housed in a cabinet measuring 3 7/8" high × 9 7/8" wide × 4 5/8" deep. Utah

Circle No. 15 on Reader Service Page

MUTUAL-CONDUCTANCE TESTER

The Model 747 "Dyna-Jet" mutual-conductance tube tester will, according to the manufacturer, test more vacuum tubes in general use in radio and TV receivers and in audio equipment



than any other tube checker. It is said to be obsolescent-proof because future tube types can also be checked on the 747 with supplementary tube chart information.

To speed tube checking, a special section has 21 pre-wired sockets to test the most popular tubes currently in use, with only two settings—heater and sensitivity. There is also a programmed section with nine sockets for testing all other tubes. The controls for each pin are fast lever-type switches. To clear the programmed section for additional tests, a single lever is provided which resets all programming switches simultaneously. B & K

Circle No. 16 on Reader Service Page

MANUFACTURERS' LITERATURE

ELECTRONIC PRODUCTS

A 740-page, 50th Anniversary Year electronic product catalogue has just been issued as No. 101.

Included is an IC and semiconductor directory, listings of IC's, semiconductors, tubes, resistors, pots, capacitors, switches, relays, fuses and circuit breakers, connectors and sockets, wire

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and cable, transformers, lamps and lights, racks and cabinets, tools and power supplies, batteries, hardware, chemicals, instruments, audio and recording equipment, among others. A comprehensive index makes it easy to locate the product desired. Newark Electronics

Circle No. 17 on Reader Service Page

HI-FI EQUIPMENT DATA

Three folders describing high-fidelity components, tape decks, and stereo music centers are now ready for distribution.

The component folder describes the company's line of stereo receivers, stereo-FM tuners, pre-main amplifiers, turntables, and air-suspension speaker systems. The tape-deck folder covers open-reel, stereo cassette, and 8-track tape cartridge players, while the music-center folder features a complete line of systems which include speakers and a variety of sound sources. Panasonic

Circle No. 18 on Reader Service Page

TEST-EQUIPMENT CATALOGUE

A 24-page, two-color catalogue picturing and describing 21 B&K test instruments for servicing, school, laboratory, and industrial applications is available.

The equipment listed ranges from a new 100% mutual-conductance tube tester to a new d.c.-to-10 MHz triggered sweep scope. Numerous accessories, such as probes and adapters, are also featured. Dynascan

Circle No. 19 on Reader Service Page

STANDARD-DESIGN FILTERS

Standard-design filters that meet most circuit-design needs are covered in a new 12-page catalogue.

The publication outlines the immediate and long-term benefits to filter users with standard filters, shows how to order filters under the standard-design concept, and how to cut spec-writing time.

The brochure covers high-pass and low-pass filters with impedances between 50 and 5000 ohms and frequencies from 1 kHz to 10 MHz. Also covered are bandpass filters in the range 50 to 10,000 ohms and 3 kHz to 5 MHz. Data includes case sizes, attenuation ranges, and characteristics for the 18 basic filter types available in standard designs. Nytronics

Circle No. 20 Reader Service Page

PRODUCT-SELECTION GUIDE

A new short-form catalogue covering digital multimeters, oscilloscopes, digital measuring systems, tube and transistor testers, data-collection terminals, and card and industrial readers has been issued.

The catalogue contains photographs of the various instruments, short descriptions, abbreviated specifications, and complete prices. Hickok

Circle No. 21 on Reader Service Page

ELECTRONIC TEST EQUIPMENT

A 48-page catalogue describing an extensive inventory of scopes, pulse generators, voltmeters, etc. has been issued by the distributor. Listed are specifications and prices for signal generators, Q meters, frequency converters, power supplies, counter-timers, microwave components, and other electronic test equipment, production tools, and electrical components.

According to the company, before shipment, performance is verified to original manufacturer specifications in its own NBS-traceable standards lab. Baynton Electronics

Circle No. 22 on Reader Service Page

SOLDERING IRONS & AIDS

A new, expanded 28-page, two-color soldering-iron-tip and soldering-aids catalogue has been issued as No. 0471.

Featuring plug, sleeve, and threaded shank soldering-iron tips to fit all leading brands and models of soldering irons, desoldering tips, tip wipers iron holders, and desoldering wick, the new file-folder-type catalogue has been designed to facilitate accurate selection of tips and aids. Plato Products

Circle No. 23 on Reader Service Page

V.O.M. BROCHURE

A four-page, two-color brochure that describes three unique hand-size v.o.m.'s for electronic and electrical testing, plus accessories such as a complete maintenance kit with clamp-on a.c. ammeter is available.

The brochure, three-hole punched for catalogue use, provides complete specs on the Models 310, 310-C, and 310-FET volt-ohm-milliammeters. Triplett

Circle No. 24 on Reader Service Page

INDUSTRIAL SECURITY SYSTEMS

A 12-page booklet, entitled "What You Can Do About Industrial Pilferage," has been published to help companies reduce dollar losses from theft in plants, warehouses, and similar industrial facilities.

The brochure describes and diagrams several video systems for "patrolling" capital property and provides a simple five-step calculation for management's evaluation of potential savings through the use of video equipment. Apeco

Circle No. 25 on Reader Service Page

SILICON BRIDGE RECTIFIERS

A handy pocket-size guide to silicon bridge rectifiers is available for the asking. It provides complete cross-reference to silicon bridge rectifiers rated up to 25 amperes.

The material is presented in handy tabular form and details on case sizes are also provided. General Instrument

Circle No. 26 on Reader Service Page

SOLDERING/DESOLDERING

Catalogue #511 is a 12-page compilation of material on all of the soldering and desoldering equipment made by the company.

Each unit in the Standard, Imperial, and Princess lines is pictured and described along with action shots of appropriate applications. A handy heating-element selection chart makes it easy to pick the right equipment for the job at hand. Ungar

Circle No. 27 Reader Service Page

THICK-FILM MATERIALS

Transene Company, Inc., Route One, Rowley, Mass. 01969 has issued a 22-page collection of technical data on materials for thick-film hybrid microcircuits.

Included are conductor cermet pastes, temperature metallizing, low-temperature bonding, dielectric pastes, protective coatings, and resistor cermet. Also included is a selector guide on the proper choice and application of the various conductor pastes.

A letterhead request direct to the company will bring your copy.

H.V. TEST EQUIPMENT

A new 24-page catalogue (#671) which illustrates a revised and expanded line of high-voltage test equipment is now available from Peschel Instruments, Inc.

The publication contains complete specifications, photos, prices, and delivery information. Included are 1 to 300 kV a.c. and d.c. power packs, power supplies, plus test sets for dielectric strength, breakdown, leakage, corona, and continuity checking.

For a copy, write the company at 1412 Viscaya Parkway, Cape Coral, Florida 33904.

DRY-REED SWITCHES

Form A and Form C "drireed" switches, from microminiature to standard sizes, are presented in a new 16-page catalogue from Hathaway Instruments, Inc., 5250 East Evans Avenue, Denver, Colorado 80222.

Included are specifications, application information, and dimensions of the various switches. Copies of the catalogue are free upon letterhead request.

Answers to Logic Terms Quiz

appearing on page 8.

1. H	6. J
2. B	7. F
3. E	8. C
4. I	9. D
5. A	10. G

RADIO AND TV COILS

A new 92-page radio and TV replacement coil cross-reference guide (No. 172) has just been issued and is available for distribution.

The guide covers replacement coils for all known domestic and foreign color and black-and-white TV sets, as well as home and car radios. Over 22,000 replacement coils for 327 manufacturers' products are listed. J. W. Miller

Circle No. 28 on Reader Service Page

MATV CATALOGUE

Detailed architectural engineering specifications for Finco's completely new line of MATV systems products are presented in a specially designed hard-cover, three-ring binder catalogue by The Finney Company, Bedford, Ohio 44146.

The new "Greenline" equipment is presented in detailed specification sheets which picture each product and provides engineering and electrical specifications. In addition to the individual product detail sheets, supplemental materials, such as an architectural engineering specifications outline, are included.

Since the catalogue is being issued on a registered basis with periodic updating of the material, only letterhead requests will be honored.

GAS SAFETY CHART

Scientific Gas Products Inc., 513 Raritan Center, Edison, N.J. 08817 is now offering copies of its free Gas Safety Data Chart to the scientific community.

This quick and easy reference chart lists 72 gases with indicated hazards to humans as well as the proper materials of construction. The chart is designed for either wall-mounting or for insertion in a notebook.

RESISTOR HANOBOOK

A new and expanded version of the "Precision and Power Wire-Wound Resistor Engineering Handbook" has just been published.

Included is a special section giving complete specifications on dual-function fuse resistors (with characteristics of 28 different types), cross-reference charts for applicable MIL-Specs, millimeter conversions on all dimensions, engineering curves, resistance/temperature characteristics, plus data on 18 different temperature coefficients for use in compensating circuits.

Nineteen separate resistor series are included, as well as information on new DIP networks and ladder and summing networks.

For a copy, write RCL Electronics, Inc., 700 South 21st Street, Irvington, N.J. 07111 on your business letterhead.

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Video Tape Recording

(Continued from page 38)

In addition to *Southern Pacific*, insurance companies and several government agencies have also become Videofile users in the past few years. The largest application of Videofile may be in the law-enforcement field. The Los Angeles County Sheriff's Dept. and Royal Canadian Mounted Police have ordered Videofile systems for automating law-enforcement records.

Thus far, no other system—including computers and microfilm devices—is capable of handling large stores of visual records with the degree of efficiency afforded by Videofile and it has the advantage of having been the first product in an entirely new market.

Computer Memory

The latest outgrowth of video-recording technology is its adaptation to digital recording for storing unprecedented volumes of data for on-line computer use. Such a system, called the terabit memory (TBM), stores from 90 billion to three trillion data bits on-line, *i.e.*, electronically available to the computer. Unlike standard computer tape memories, TBM offers random access to any record on the tape.

Conventional digital recording uses a row of magnetic heads which lay down parallel tracks (usually seven or nine) of digital bits along the length of the tape. Packing density is limited to about 20,000-bits-per-square inch, even under laboratory conditions. TBM uses standard rotating video heads which record and reproduce by contacting the tape in transverse patterns across its surface. The effect is to allow the bits to be smaller and closer together on the tape than they are in conventional digital recording.

Unlike conventional systems, TBM records every data bit twice on the tape (redundant recording), allowing data reliability better than present industry standards for magnetic devices. The TBM stores up to 45 billion bits on a single 10 1/2-inch reel of standard video-tape—enough data to fill up to 500 reels of conventional computer tape.

Although it is too soon to predict the dollar value of TBM's importance to the computer industry in the future, it is expected to gain wide acceptance as an on-line system in large data-processing operations. The first TBM system will be delivered to the government this year.

New capabilities and uses for video recording are emerging at an increasing rate. There is every indication that the potential for this technology is so vast that the surface has merely been scratched during its first 15 years. ▲

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GENERAL INFORMATION: First word in all ads set in bold caps at no extra charge. All copy subject to publisher's approval. All advertisers using Post Office Boxes in their addresses MUST supply publisher with permanent address and telephone number before ad can be run. Closing Date: 1st of the 2nd month preceding cover date (for example, March issue closes January 1st). Send order and remittance to: Hal Cymes, ELECTRONICS WORLD, One Park Avenue, New York, New York 10016.

FOR SALE

GOVERNMENT Surplus Receivers, Transmitters, Snooperscopes, Radios, Parts, Picture Catalog 25¢. Meshna, Nahant, Mass. 01908.

CONVERT any television to sensitive big-screen oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans, $2.00. Relco-A22, Box 10563, Houston, Texas 77018.

INVESTIGATORS, Latest Electronic Aids. Free Literature. Clifton, 11500-J NW 7th Ave., Miami, Florida 33168.

SENCORE, B & K Test Equipment Unbelievable Prices. Free Catalog and Price Sheet. Fordham Radio, 265 East 149th Street, Bronx, N.Y. 10451.

ELECTRONIC PARTS, semiconductors, kits. Free Flyer. Large catalog, $1.00 deposit. Bigelow Electronics, Bluffton, Ohio 45817.

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CIRCLE NO. 125 ON READER SERVICE PAGE

ELECTRONIC COMPONENTS—Distributor prices. Free catalogue. Box 2581, El Cajon, California 92021.

ELECTRONIC Ignition. Various types. Information 10¢. Anderson Engineering, Epsom, N.H. 03239.

CONSTRUCTION PLANS: Laser . . . $2.00. Investigation aids—2-FM microphone transmitters . . . $1.00. FM telephone transmitter . . . $2.00. Sound telescope . . . $2.00. Space monitor-missile tracker . . . $2.00. Free equipment and kit catalog. Howard, 20174 Ward, Detroit, Michigan 48235.

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BURGLAR ALARM SYSTEMS. We manufacture intruder-fire detection systems, radar and perimeter types. Accessories available. Free Literature. Inquiries for dealership and wholesale prices must be on letterhead. U.S. and Canada only. Microtech Associates, Inc., Box 10147, St. Petersburg, Florida 33733.

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HOW to break into Radio, Television Broadcasting Book, $2.69. I.Q. Engineering, Box 374, Canoga Park, Calif. 91305.

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RECONDITIONED Test Equipment. Reasonably priced, list available. Walter, 2697 Nickel, San Pablo, CA 94806.

INTEGRATED circuits, brand new at surplus prices. No minimum. Marco Enterprises, POB 216, Dayton, Ohio 45401.

CAPACITIVE Discharge Ignition Systems; Citizen Band Equipment. Low prices. Southland Communications, Box 3591, Baytown, Texas 77520.

O.E.M. POWER SUPPLIES. Transformer isolated, regulated. 115VAC ±10V 60Hz. Dual output ±8.Vdc at 8ma, <.3% ripple. Solid potting, P.C. Board mounting. 1.25"X1.02H. $12.50 plus .50 handling. MANCHESTER ELECTRONICS, 20 Meadow St., Manchester, N.H. 03103.

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BARGAIN MUSIC, Tape, Equipment Catalog 25¢. Saxitone, 1776 Columbia Road, Washington, D.C. 20009.

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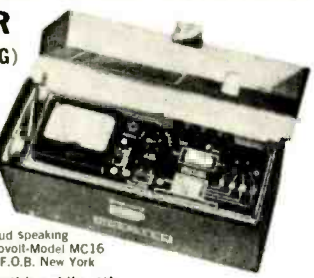

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ELECTRONICS WORLD

November 1971

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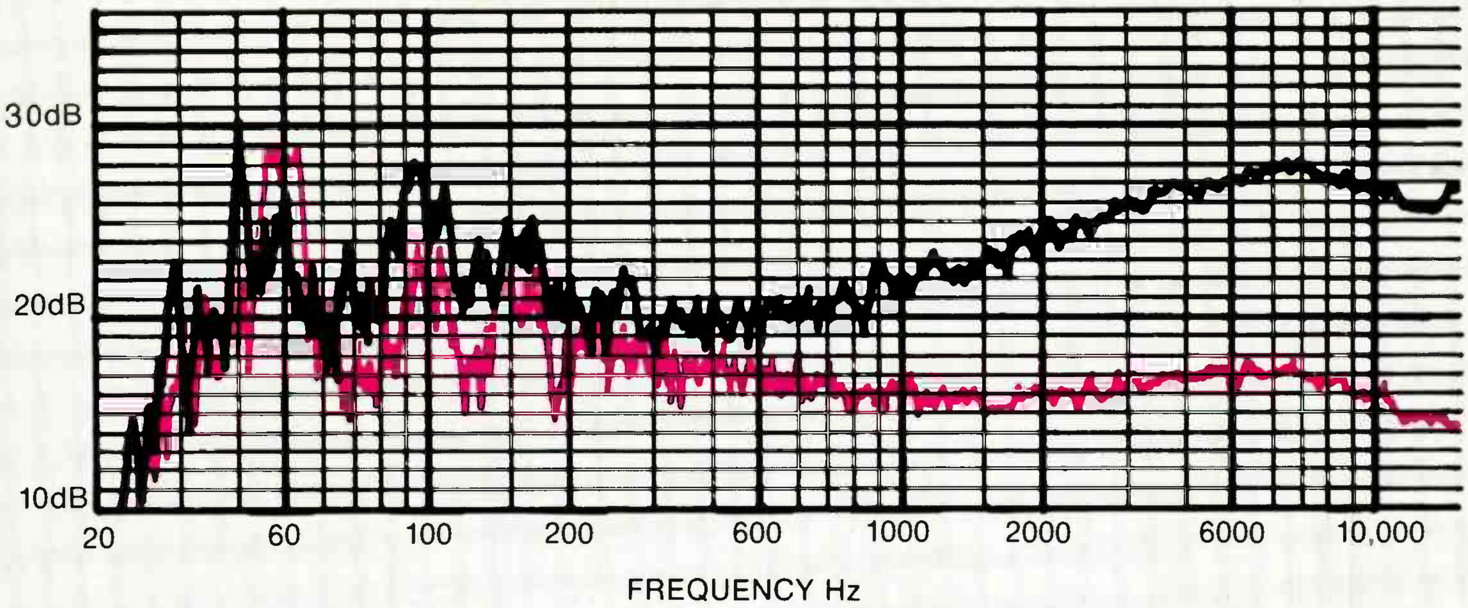
CIRCLE NO. 131 ON READER SERVICE PAGE →



The A-24's excellent signal-to-noise ratio (upper curve) is further enhanced by the TEAC AN-50 (lower curve) for an overall S/N improvement of 6 db of better.

TEAC's new low-noise cassette duo: the A-24 stereo deck and our new AN-50 Dolby* unit

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Take our A-24 stereo cassette deck, for example. It does credit to any top-quality component system. Mechanically matchless. Electronically excellent. Operationally simple. And ruggedly handsome, too.

Behind those good looks are the precision-crafted parts that guarantee performance and dependability. The low-noise electronics and narrow gap heads for wide, natural-sounding 40-12,000 Hz frequency response @ 1⅞ ips. The hysteresis-synchronous outer-rotor drive motor for low 0.2% wow and flutter.

And where's the Dolby? Right alongside, thanks to TEAC's new AN-50 plug-in noise reduction unit.

So if you're looking for a stereo cassette with the quality of TEAC and the convenience of Dolby-type noise reduction, choose TEAC's A-24 cassette deck and the TEAC AN-50. They're sensibly priced at $229.00 for the duo. Separately the A-24 retails for only $179.50 and the AN-50 for only $49.50. And of course, if you already own a TEAC cassette model, the AN-50 was designed for you. It's perfectly matched to the TEAC A-23 stereo cassette deck.

TEAC®

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Condenser microphones have long been known for their sound ... and their cost, and their complexity. Now Electro-Voice introduces a series of genuine condenser microphones that provide sound embarrassingly close to the most expensive studio models, without the high cost and complexity.

A big problem with conventional condenser microphones has been the need for a high voltage power supply to polarize the diaphragm. E-V has eliminated it completely with its new *electret* condensers. We've found a way to permanently trap this voltage right on the surface of the diaphragm, thus doing away with the need for bulky, expensive power supplies.

How do the new Electro-Voice electrets sound? Response is clean, flat, and transparent, with very high output for full recording volume. It's just what you would expect from condenser microphones costing much more, and by far the best sound-per-dollar you've ever heard.

A simple FET circuit inside each E-V electret microphone matches both professional and home tape recorder inputs with equal quality. This low-noise, high-output circuit operates from a single "AA" penlite battery for as long as 1200 hours of use.

Choose either omnidirectional or Single-D cardioid types. The chart shows the prices, and some of the reasons for the difference in cost. Whichever model you choose will give you excellent transient response, high sensitivity, and uniform polar response. Our "second-generation" electret design offers vastly improved protection against extremes of humidity and temperature. And the ruggedness of E-V electret condensers is rivalled only by E-V dynamic models. All-in-all, new E-V condensers are a significant improvement over less sophisticated condenser microphones (electret or otherwise).

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Single-D Cardioid
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Balanced 150 ohm output
Professional cable connector
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$75.00

*Output level ref. to 1 mw/10 dynes/cm². The smaller the number the better. Prices shown are suggested retail.

Electro-Voice®
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