Radio-Electronics

SPECIAL ISSUE—HI-FI & STEREO

75¢ ■ OCT. 1975

Radio-Electronics®

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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4-Channel Synthesizer

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How To Buy A System

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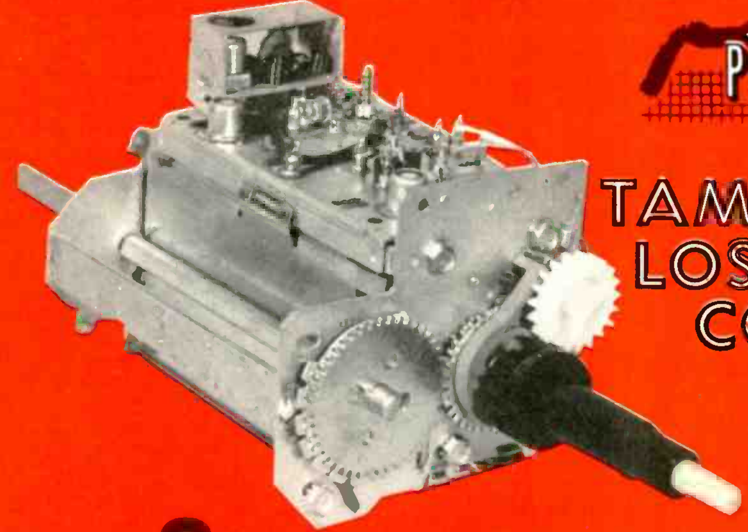

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THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

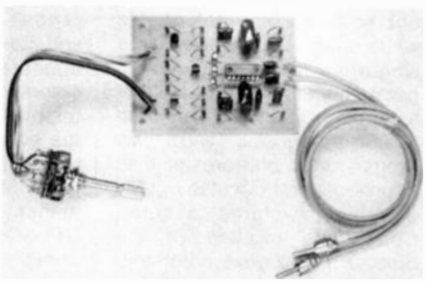
Electronics publishers since 1908

OCTOBER 1975 Vol. 46 No. 10

ON THE COVER

R-E's hi-fi test lab puts some of the latest hi-fi gear through its paces. Here the Pioneer CT-F9191 gets a thorough going over. The complete report starts on page 36.

HI-FI ADD-ON ACCESSORIES can make your system easier to use and more interesting to listen to. See the latest products.
. . . . turn to page 52



4-CHANNEL MATRIX SYNTHESIZER is easy to build. One IC turns 2-channel stereo into 4-channel matrix sound. **. . . see page 33**

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looking ahead

Holographic videodisc

The leading contenders in the home videodisc sweepstakes have been laser-optical systems developed by Philips, MCA and Thomson-CSF; a capacitance system developed by RCA, and the German-British TeD mechanical system. Now along comes Hitachi with the first Japanese-developed system unveiled to date. The Hitachi system, already demonstrated in the lab, uses holography. The disc spins at a lazy 6 rpm, as opposed to 1,800 rpm for the American-standards version of the optical and mechanical systems and 450 rpm for the capacitance system.

The Hitachi system records each frame of the color television picture in the form of a composite hologram about one millimeter in diameter. Actually, three holograms are superimposed—for luminance, chroma and sound—and read out at three different angles while being illuminated by a single laser. In a technical paper on the system, Hitachi scientists said: "More than 2,000 holograms were arranged on a photoresist disc to give several minutes of play of motion pictures in color. Continuous rotation of the disc at 6 rpm gave color motion pictures and sound on a TV monitor."

It's not known whether Hitachi intends to further develop the system, but some industry engineers are encouraged by it. Zenith's Research Vice-President, Robert Adler, said it was an encouraging sign that "there are indeed other alternatives" in approaching the videodisc playing system. If the holographic approach sounds familiar, you may recall RCA's "HoloTape SelectaVision" system, unveiled in 1969 (and since shelved), that used holographic images on Mylar tape. Interestingly, RCA received a British patent in 1969 for a holographic videodisc recording process.

Hitachi's system can accommodate 54,000 frames, or about 30 minutes playing time on a 12-inch record, and records can be reproduced by the standard stamping process.

Unlicensed CB's

The problem of unlicensed Citizens band radio operation was the subject of a recent conference between FCC staff members and two-way radio manufacturers. The FCC is swamped with license applications, with nearly a quarter-million pending, and it's falling farther behind each week as CB sales boom. It currently takes about eight weeks to get a license—which now is done after the equipment is purchased—and this encourages illegal operation. The FCC admits it can't possibly police the band and it has no idea how many illegal operators there are.

The Commission staff proposed a quick-license plan, and most of the manufacturers appeared to agree. This would empower CB dealers to issue temporary licenses at the time the equipment is sold, collect the four-dollar fee and forward the application for a permanent license to the FCC. Using this procedure, a buyer could operate his new CB radio legally as soon as he bought it.

Digital TV tuning

Random-access digital tuning seems to be the wave of the future in color TV. RCA has introduced a new 25-inch color chassis that features a remote hand-held "control center" with a calculator-like keyboard. Selecting a channel ("0" and "7" for Channel 7, or "3" and "5" for Channel 35) turns the set on and tunes it to the proper channel. In the bottom part of the screen, the correct time and channel number appear in white numerals that remain for a few seconds. The silent ultrasonic remote control is also used to adjust color, tint and volume. When color is being adjusted, the time and channel number appear on the screen in red.

The RCA unit is similar in the way it addresses the set to the Magnavox's "STAR" system, which is now in its second year. The new version of STAR is available on some 19- as well as 25-inch sets and has two calculator-like tuning units—one remote and one affixed to the set.

At least five more digital TV-addressing systems are under development by other companies. Recently demonstrated was General Instrument's "Omega" system that uses up to four LSI's and like the RCA device can accommodate up to 100 channels making it suitable for tuning to special CATV as well as broadcast channels. The system employs a non-volatile memory developed by NCR. This memory will store information—fine tuning, last channel viewed, etc.—for more than 10 years, even if the set has been turned completely off or unplugged. Other digital tuning systems are under development by National Semiconductor in cooperation with Plessey as well as Motorola, Texas Instruments and Fairchild.

Filter tube

What is the next step in color pix tubes after negative matrix? It may be the filter tube. RCA is already in production of the "AccuFilter" tube, being used in its newly introduced 19- and 25-inch sets in both slot-mask and conventional phosphor-dot tubes. The AccuFilter tubes optically filter the appropriate red and blue phosphor dots or strips. RCA claims this system provides up to 25% better contrast in bright room light, with a brightness sacrifice of only about 5%. At a recent technical symposium, Zenith engineers described a somewhat similar developmental tube called "Chroma-Filter," that uses red, green and blue filters, and has improved contrast but 30% less brightness than the current negative-matrix Chromacolor. A Zenith spokesman said the company is still working on the filter concept. RCA's new AccuFilter tube has been offered to television manufacturers, but it is a premium-priced tube, so it is expected to show up only in high-end models for some time.

TV, 2000 AD

Zenith's Dr. Adler, addressing engineers in Tokyo, gave some of his thoughts on the "possibilities" of television in the next 25 years. The current trend to simpler controls and automatic operation of receivers will continue to the point where color adjustment will be completely automatic. Elimination of ghosts will be a major challenge. The use of television retrace time, particularly in the vertical interval, suggests many possibilities for supplementary services. One is the transmission of alphanumerical data for onscreen display, as is being tested now in England.

Cable TV may be used to send literally millions of single-frame pictures that could be stored for display at home and in business. For many business uses, higher-resolution television pictures might be necessary. The long-sought flat-panel display will be realized in the laboratory before 1980, Dr. Adler said, with gas-discharge devices and electroluminescence the "leading candidates." With the arrival of such large-screen displays, higher-resolution pictures may be desirable and in city areas they may be transmitted, digitally encoded, either from single high-powered microwave antennas or from many lower-powered antennas.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

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new & timely

Electronic heart mini-checker can be operated by patient

Two new devices—or two variations of one device—weighing only five ounces each, enable a heart patient to check his condition with his doctor immediately over the telephone. (Former devices required that electrodes be applied by a doctor or medical technician, and were often the size of a small typewriter.)

These *CardioBeeper* monitors owe their compactness and light weight to two special integrated circuits designed and developed by ITT Semiconductors, a division of ITT. The complete units are made by Survival Technology, Inc. of Bethesda, MD, and are marketed by Wyeth Laboratories of Philadelphia.

One device is for patients who have a heart condition that requires continued medical follow-up, the other for those who have an implanted heart pacer. Either CardioBeeper can transmit an electrocardiogram to the patient's doctor, or can beep signals direct to the patient's attention.

THE NEW MINIATURE HEART MONITOR is demonstrated by Jes Schlaikjer of ITT. The leads to the plastic armpit sensors are seen entering above the shirt button. The BEEP and ECG (electrocardiogram) contacts are at the bottom of the compact unit, the TEST contact at upper right and the lamps at upper left.

To use, a plastic sensor—attached to the monitor by wires—is placed in each armpit. There are no gels, pastes or straps—the two highly sensitive electrodes are inserted simply by unbuttoning the top two shirt buttons or opening the dress slightly.

To transmit an electrocardiogram, the patient phones his doctor and places the monitor against the telephone mouthpiece. The unit generates a variable tone—frequency-modulated by the heart action—between 1 and 2 kHz that is readily transmitted over any telephone line. From it, the doctor can take an electrocardiogram or pacemaker function on the ECG recorder or scope. Regular checks can be made without the patient's having to visit the doctor's office, or on any occasion the patient may notice a condition that he feels may need attention.

In the other operating mode, an audio beep and one of two flashing lights show the patient his heart or pacemaker rate. One light flashes if the rate is higher than it should be—the other if it is slower. If indications are not normal, the patient follows instructions already supplied by the doctor.

The two modes are selected by touching one of two contacts. The device remains "on" only as long as contact is maintained. Thus the battery, which has a life of 50 hours, cannot be left on and run down. A third contact checks the battery, and is set to drop to zero when there is still 90 minutes of operating power left.

Microprocessors to save 40% of gas used in motor cars?

A tiny electronic device is achieving significant gasoline savings in tests being made by major automobile makers, RCA Chairman Robert Sarnoff told the 29th annual Business Conference of the Indiana University School of Business. Preliminary tests indicate that the device —a microprocessor—will be able to boost mileage up to 40 per cent.

The microprocessor is a miniature computer containing 6,000 transistors and other electronic devices in an area less than a ¼" square. Installed in a car with appropriate link-ups, it can automatically adjust both choke and throttle for maximum starting efficiency, run the motor with the right fuel mixture for highest fuel savings, and shift gears at precisely the right time for optimum fuel efficiency.

Annual savings could amount to 500 million gallons of gasoline—equivalent to 27 million barrels of crude oil. "Working with the automotive industry as we are, the electronics industry should be able to mass-produce microprocessors by the millions at a cost of no more than $100 per unit," Mr. Sarnoff said.

Voice-actuated two-way radios make blind skiing practical

Blind skiers are no novelty in this day when people with disabilities are taking part in almost all kinds of human endeavor. And the use of two-way radio in various types of sports is not new. But Sammy Skobel, blind skier and founder of the American Blind Skiing Foundation, discovered that the standard two-way portable was not entirely suited to blind skiing.

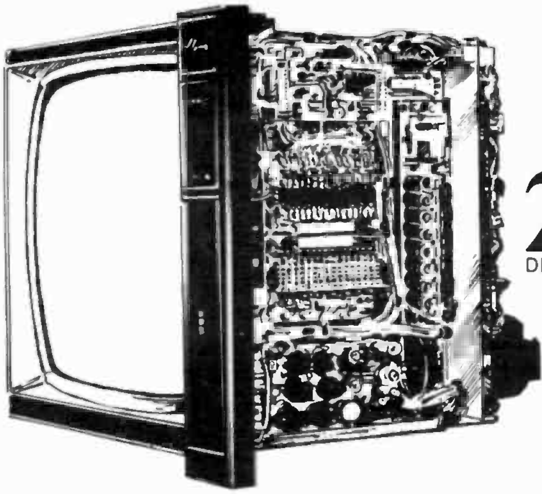
The blind skier needs an assistant when skiing down a hill or when participating in a slalom competition where the skiers must travel a zigzag path around markers strung out in staggered fashion along the course. The guide is often in an unhappy situation, since he must yell at the top of his voice to be heard at all times. After fifteen or twenty minutes his voice starts to weaken, and he must rest for a minute or two.

BLIND SKIER SKOBEL AND GUIDE, with the Motorola voice-actuated two-way radios that will be used between skier and guide in a downhill practice run. With the radios strapped to their waists, the guide will wear a speaker/microphone and Sammy Skobel will wear a speaker on the shoulder of his parka.

Mr. Skobel consulted with Motorola Communications and Electronics for a solution for this sometimes serious problem. The result was a portable two-way radio specially adapted to the needs of the blind skier. The chief difference between it and the regular type is that it is voice-operated. A skier often needs both hands on his poles and cannot push a talk-listen button at will. With the voice-operated setup, all he or his guide have to do is to start talking in a normal voice and the transmitter goes into operation. A speaker worn on the shoulder of the parka near the ear completes the blind skier's radio.

"The radio gives me a feeling of freedom and security," says Skobel. "I can ski almost as if I were alone, but I know that I will be able to hear whatever instructions are necessary and I do not have to worry about becoming separated from my guide."

(continued on page 12)



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That's why we went to the trouble to engineer our own, exclusive solid-state TV. It's the only way a student can (1) get the feel of typical commercial circuitry, (2) learn bench techniques while building a complete set from the "ground" up, (3) perform over 25 "in-set" experiments during construction, and (4) end up with a 25" diagonal solid-state color TV with console cabinet and all the modern features you'll find on sets you'll service. Nobody else can give you this combination of advantages because nobody else invested the time and money to design a set with learning in mind.

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new & timely (continued from page 6)

Old thrown-out radios now sought by collectors

Take another look at that old Atwater Kent radio with dark mottled tubes standing in brass sockets on a flat stained "breadboard", that you never got around to clearing out of the attic. It may now be negotiable at $200 or possibly much more. And if you paid $300 for a Stromberg-Carlson *Treasure Chest* in the 1920's, you may be able to get your money back for it today.

The urge to collect antique radios, long an amateur vocation, has produced collectors who have become dealers, originally to dispose of their duplicates. (Like many other antique dealers, they often refuse to sell the best of their stock, and few models from the 1920's are on sale.)

A recent survey of New York City shows one, Fred Driskill at 2623 Broadway, who has a 1929 Gloritone he is willing to dispose of for $150, as well as a few earlier ones he apparently has no intention of selling, and later jobs all the way down to $50.

Unusual designs are featured by another collector-dealer, Alan Moss of 20 East 17th St., who sees prospective customers by appointment only. His prize piece is a peach-toned Sparton offered at $450, but he has lesser pieces, including a Zenith with a sailboat and sea scene embroidered on the grille cloth for $40.

Richard Utilla exhibits old radios at two shops, 244 East 60th St. and 304 East 62nd St. Some of his more modern selections sell for as little as $28.

Not only do these collectors buy and sell old radios, some of them repair them as well. Fred Driskill specializes in restoring ancient sets, and keeps a large stock of components on hand for that purpose. Mr. Moss has his sets repaired by Daniel Schulman of Rudan TV Service and Parts, 344 Third Avenue. He is an old set designer who was responsible for many of the Emerson models.

The survey, which appeared in the *New York Times,* covered only one city but activity is heavy in many parts of the country, notably the West Coast where not only collectors but amateur museums abound.

1975 marks 15th anniversary of satellite weather prediction

TIROS, a Television InfraRed Observation Satellite, went into orbit April 1, 1960, with the hope that an overview of wide areas of the earth might be helpful in predicting weather conditions. Fifteen years and three generations of satellites later, meteorological procedures are almost entirely based on satellite observations.

Before satellites, a forecaster was unlikely to know the weather conditions in more than 20% of the Earth outside the continental United States. Two-day and three-day or longer forecasts were unknown and impractical, and knowledge of such phenomena as coastal fog, sea ice conditions and snow cover was sketchy at best.

The weather satellites gave scientists that knowledge, enabling them to improve the accuracy as well as the lead-time of their forecasts. They can now even watch the spawning of hurricanes and typhoons at sea often as long as two weeks before they hit land.

Following the success of TIROS I, nine other satellites followed in quick succession, then nine Environmental Survey Satellites (ESSA) and five ITOS (Improved TIROS) observational satellites. Today, the satellite is not only "one of the most successful space programs" to the scientist, but an essential part of the lay television viewer's evening weather broadcast.

New thousand-dollar car radio has everything, plus dictation

A new, totally electronic automobile sound system includes AM radio (four bands) FM (mono and stereo), plays prerecorded stereo or mono cassettes, records stereo from the radio, and receives dictation. It is called by its manufacturer, Blaupunkt Car Division of Robert Bosch Corp., the first fully electronic car radio (there are no mechanical parts).

NEW BLAUPUNKT BERLIN ELECTRONIC's control unit—about as big as a pack of king-size cigarettes—is mounted on a flexible column and may be installed on the steering column or other spot convenient to the driver.

The *Berlin Electronic* will be offered by Blaupunkt as a "limited edition," at an installed price of approximately $1,00C. The installation includes four speakers at selected points in the car. **R-E**

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letters

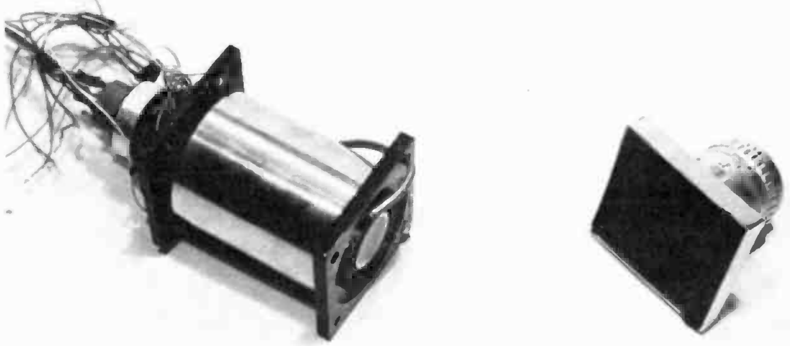
COLOR TV CAMERA

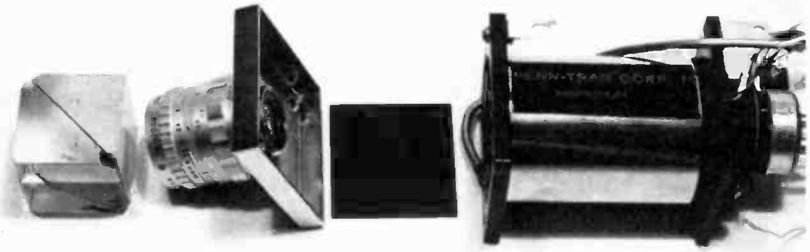
I have finished reading the first two parts of the construction article on building a color TV camera that appeared in the July and August, 1975 issues of **Radio-Electronics.**

I already ordered the parts and am waiting for them to arrive. The assembly looks fairly easy and not to complicated. However, there is one area that is not fully clear. This is the assembly of the vidicon, deflection yoke, lens and filter. The interior photos in the July issue shows the preamp assembly mounted over this assembly. Can you help?

Thanks for another interesting and useful project.

C. A. STROBEL
New York, N. Y.

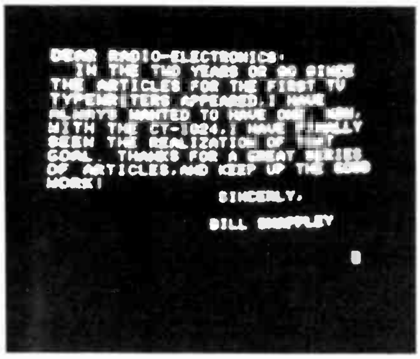




You are absolutely right! The interior photos do not show this assembly and there is nothing in the third and final part of this article that will help clarify this. So, we contacted Gary Davis and he was kind enough to provide some photos. They appear above.

How about the rest of our readers. Drop us a line and let us know how you're making out with this project.—Editor

ANOTHER TV TYPEWRITER


DEAR RADIO-ELECTRONICS:
IN THE TWO YEARS OR SO SINCE THE ARTICLES FOR THE FIRST TV TYPEWRITERS APPEARED, I HAVE ALWAYS WANTED TO HAVE ONE. NOW, WITH THE CT-1024, I HAVE FINALLY SEEN THE REALIZATION OF THAT GOAL. THANKS FOR A GREAT SERIES OF ARTICLES, AND KEEP UP THE GOOD WORK!
SINCERELY,
BILL SHAPPLEY

QS Matrix Simplified

This approach to 4-channel reproduction has gained acceptance in recent years.

by HIDEO KITAHRA*

WHEN WE ARE SEATED IN A CONCERT HALL listening to a musical performance, we are hearing not only the sounds that reach us directly from the stage but also the sounds that are reflected by the walls, ceiling and innumerable other objects inside the hall. These reflected sounds arrive at our ears from many directions and with infinitely different time lags. Actually, our ears usually receive much more reflected sound than direct sounds, and it is these 'indirect' sounds that shape for the most part the peculiar tonal quality of each musical instrument as determined by its dynamic range and other important criteria.

It is generally acknowledged that the conventional monophonic or stereophonic sound reproduction system is not fully able to pick up, store, transmit and reproduce the totality of this important live musical sound field information for subsequent enjoyment at home. Thus the need for a more effective system, possibly using more than two channels of signal transmission, has over the years come to be recognized. The 4-channel or quadriphonic system as we know it today is an answer to this need.

Obviously, whether it uses two or three or four transmission channels, a 4-channel system must resort to using some of the inter-relationships of its transmission channels to contain the infinite number of direct and indirect sounds. And this will be true regardless of the number of transmission channels used, so long as it has a *limited* number of channels.

These inter-relationships among the transmission channels are created by a matrix, and the 4-channel systems available today are characterized by their use of different matrices. And herein lies the cause of the confusion plaguing many people in the audio and musical industries of the world. All too often, the problem of how to secure an appropriate transmission medium—be it a "discrete" 4-channel disc or a matrixed or "discrete" FM 4-channel broadcast—is debated on the same level as the more fundamental issue of how best to distribute the original musical signals to the available number of transmission channels, be it two, three or four.

It is my opinion that, so long as the infinitely complex original sound field information must be conveyed to the listener's home via a limited number of transmission channels, there should be a solution based on a single theory of signal conversion, one that is compatible for the different number of transmission channels. There indeed is such a solution, and it is the purpose of this paper to examine it. I feel that the problem of how to secure the appropriate transmission medium for any given purpose is quite another matter, and should be discussed from a different standpoint. Also, I have been encouraged by the growing recognition of signal conversion theories as a new, separate field of study in the recent several years, both in Japan and abroad.

The QS 4-channel system gives us signal formats that are appropriate for two, three and four transmission channels in trans-

(continued on page 20)

*Staff Engineer
Sansui Electric Co., Ltd., Japan

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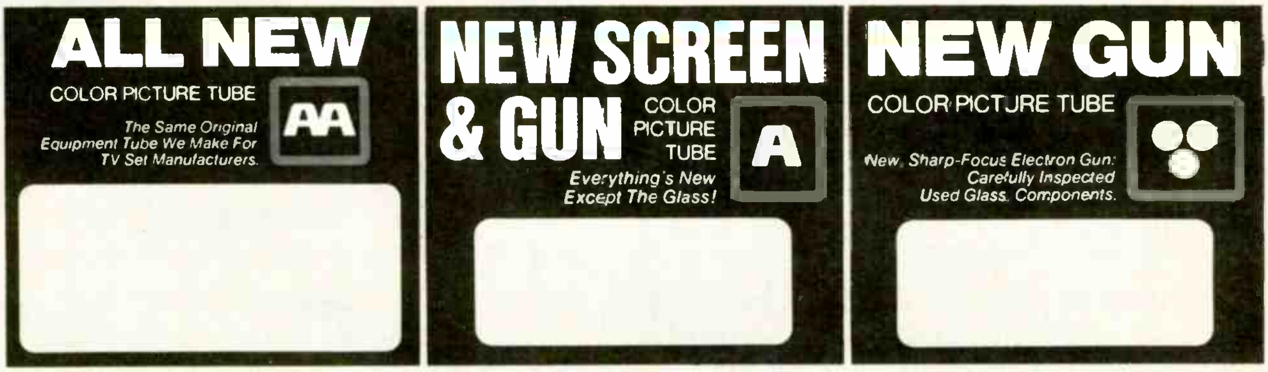

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QS MATRIX

(continued from page 16)

mitting and reproducing the original sound field information. It is based on a single theory of signal conversion, and is compatible for the different number of transmission channels. When used in a 4-2-4 system with two transmission channels, the QS system provides reproduction results that closely simulate the original sound field and that are not inferior in terms of tonal quality, physical characteristics or in any other high fidelity standards. This is largely made possible by the use of a multi-directional encoding technique and a QS variomatrix decoding technique. Let's look at how the QS system encodes 4-channel sound for 2-channel transmission.

The advent of 4-channel sound has brought a number of benefits to the art of reproducing music. Most of them result from the 4-channel systems capability of storing and transmitting a greater amount of sound information than the 2-channel system. This "4-channel information" can be transmitted by either four separate transmission channels through the use of a special high-frequency signal called a carrier, or by transforming the sound information into amplitude and phase relationships and sending these over the two transmission channels currently used. The former method is best exemplified by a so-called carrier ("discrete") disc (CD-4), while the latter is implemented by a so-called matrix system.

In stereo sound reproduction, sound images are located in the L (left) and R (right) speakers, and between them. Sound images located between the two speakers are obtained by reproducing a given sound from both speakers at a certain ratio of amplitudes or sound levels. For instance, a signal of L = 1, R = 0.1 will appear as a sound image located slightly inside (to the right of) the L speaker, while a signal of L = 1, R = 1 will appear at the exact center of the distance between the two speakers. However, a signal of L = 1 and R = —0.1 will not seem to fall between the two speakers but will appear to be located slightly outside (to the left) of the L speaker (see Fig. 1). Such a signal is called a reverse-phase signal, and can be easily created on the transmission end. And just as there are infinitely different stereo (in-phase) signals, there can be infinitely different reverse-phase signals, with the two kinds

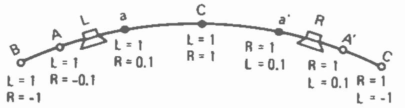

FIG. 1—LOCATION of sound images in stereo reproduction.

each possessing different characteristics.

"Encoding" is when stereo (in-phase) signals and reverse-phase signals are combined into two composite signals (hereafter referred to as an LT signal and an RT signal) in such a manner that they can be later reproduced out of four speakers. "Decoding" means unscrambling the combined signals into four signals on the reproduction end. These processes are described below.

Encoding for 4-channel

Basically, to transmit a sound field via two transmission channels, any matrix system distributes a front signal to LT and RT (Left Total and Right Total) in phase, and a rear signal to LT and RT in reverse-phase. Also, as in stereo recording, if a signal is located more to the left (either front or back), it will be distributed in a greater proportion to LT; if it is located more to the right, it will be distributed in a greater proportion to RT.

One important consideration to remember in encoding sound field information is that no part of it should be cancelled or altered by the encoding process.

To elaborate on this point, let's consider a sound field to be a circle and divide it into four equal parts. We now designate the four points dividing the circle (see Fig. 2) as LF (which can be reproduced by a signal of L = 1, R = 0.414), RF (L = 0.414, R = 1), LB (L = 1, R = —0.414) and RB (L = —0.414, R = 1). This will certainly mean that a front signal is distributed to LT and RT in phase, and that a rear signal is distributed to LT and RT in reverse-phase. However, it also means that if there is a sound source at the rear center (CB), i.e., if signals of identical levels enter LB and RB simultaneously, LT = 1 —0.414 = 0.586 and RT = 1 —0.414 = 0.586, so that the LT and RT signals find themselves in phase, allowing a sound image to be located at the front center (CF) instead of the rear center (CB).

The reason for this is that this technique takes the fact that stereo reproduction uses in-phase signals to create a line of sound images between the L and R speakers, then simply adds reverse-phase signals to stretch that line outside of the two speakers, letting four speakers connected by this stretched line form a circle. The junction points of this line (points B and C in Fig. 2) do not yet meet each other completely, so that the circle is not yet perfect. This is the reason for the undesirable phenomenon described above. In other words, only the information existing over the three-quarters of the circle, excluding the portion between LB and RB, can be transmitted under this condition.

(continued on page 22)

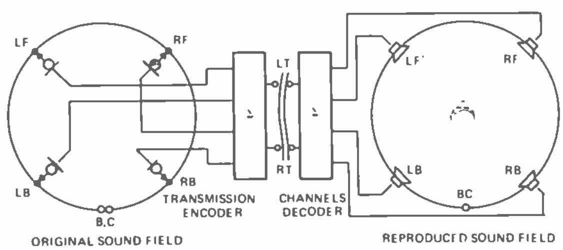

FIG. 2—TRANSMISSION of sound signals by a matrix 4-channel system requires an encoder and decoder.

Circle 12 on reader service card

QS MATRIX
(continued from page 20)

This is the Scheiber system, and it does not completely fulfill the essential objective of the 4-channel sound reproduction system, which is to faithfully reproduce a live sound field.

However, the unconnected points can be eliminated by using a phase shift technique to realize a complete 4-channel encoding system. What this phase shift means is that, as a signal moves away from the front center point (CF) in the original sound field, the phases of the LT and RT signals are simultaneously changed in proportion to the distance the signal has moved from the CF.

In this manner the reverse-phase relationship (a phase difference of 180°) which otherwise occurs at the junction points of the circle (CB) is scattered over the entire circle to create a continuous circle. Since the LT and RT signals are simultaneously phase-shifted, any front signal which is distributed to LT and RT in phase will remain in phase, while any rear signal which is distributed to LT and RT in reverse phase will remain reverse-phased.

The phase shift as described above will allow the points B and C of Fig. 2 to join each other completely, providing a CB signal and creating a continuous circle.

This technique of phase-shifting the LT and RT signals simultaneously in proportion to the level difference between the two composite signals is an essential and important feature of the QS system. Patents have been approved on this feature of QS in several countries around the world. And with this technique, the QS system is able to encode a signal located anywhere on a circle as well as anywhere inside it.

Decoding a matrix signal

On the playback end, the location of a particular signal, along the left-right axis of the original sound field can be determined from the level difference between the LT and RT signals. Similarly, the location of a particular original signal along the front-back axis can be determined from the phase difference between the two composite signals. In other words, the exact location of a signal is reproduced accurately by detecting the level and phase differences of the encoded signals. For instance, a signal encoded as LT = 1, RT = 0.414 will be located in the front half of the sound field because there is a zero phase difference between LT-RT (i.e., they are in phase). Such an encoded signal will be reproduced at a particular point (LF) on the left-hand side quarter arc section of the circle because the LT-RT level difference is LT : RT = 1 : 0.414.

An actual QS decoder reproduces such a signal at its exact location in the original sound field by making calculations that are in precise contrast to those performed by the encoder.

More specifically, assuming a playback set-up (right hand side of Fig. 2) where four speakers are placed to form a square, the QS decoder reproduces the four speaker positions by adding or subtracting

(continued on page 24)

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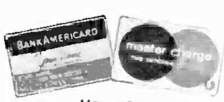

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QS MATRIX
(continued from page 22)

the LT and RT signals and reversing the calculations performed during the encoding process. This will mean that $LF' = LT + 0.414RT$, $LB' = LT - 0.414RT$, $RF' = RT + 0.414LT$, $RB' = RT - 0.414LT$. Once these are fixed, any signal can be reproduced at the position it occupied in the original sound field.

There is still one important deficiency with the reproduced signal, however. While the reproduced signal has the same level, phase and directional characteristics as the original sound signal, its directionality is still not distinct enough because it is obscured by the crosstalk.

The QS decoder handles this problem by performing more advanced QS vario-matrix calculations that take advantage of the level and phase differences between LT-RT to eliminate the crosstalk altogether, locating a signal with the same sharp sense of directionality as it was located in the original sound field.

QS encoding

QS encoding provides for the reproduction of 4-channel signals with excellent channel separation. QS-encoding also creates signals that are compatible for 2-channel and monophonic playback. Furthermore, QS-encoding can be expanded and developed, if necessary, to incorporate three or four transmission channels in a 4-3-4 or 4-4-4 system.

When played in stereo, QS-encoded 4-channel records create a broader sense of perspective than conventional stereo records, and for this reason AudioLab in Japan and several other record manufacturers are using the QS encoder even in the production of their stereo records.

The reason for this expanded stereo perspective is because, as explained earlier, signals generated in the front half of the original sound field are distributed to LT and RT in phase, or in intermediate phase relationships approaching in-phase. This is the same as traditional stereo recording, and such signals are reproduced as sound images between the L and R speakers. At the same time, signals generated in the rear half of the original sound field are distributed to the L and R speakers in reverse phase or in intermediate phase relationships approaching reverse phase, so that they will be reproduced outside of the left and right speakers (i.e., to the left of the left speaker and to the right of the right speaker). The total effect of this is that there is now a broader sense of stereo perspective offering a particularly good balance of distinctively located sound images and ambience (see Fig. 3). Fig. 4 shows a diagram similar to Fig. 3, but for SQ decoding (CBS). Fig. 5 shows decoded CD-4 signal.

A signal that was panned in a clockwise circle from the rear center position in the original sound field will also be panned in stereo playback, starting on the outside (to the left) of the L speaker, passing through the front center and moving on to the outside (to the right) of the R speaker. This demonstrates the fact that a QS-encoded signal accurately corresponds to the

(continued on page 30)

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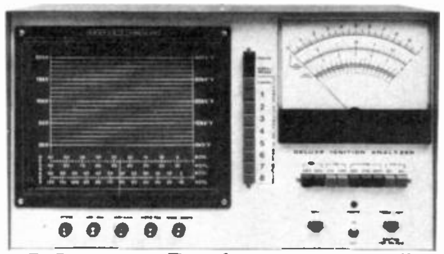

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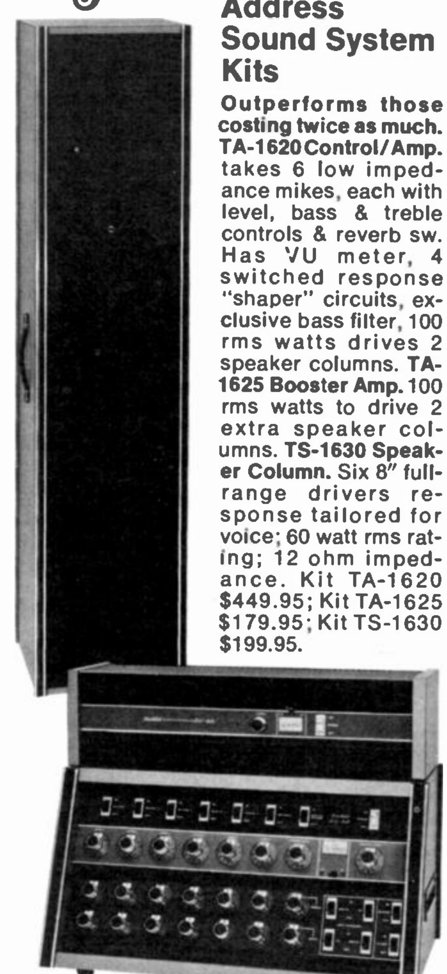

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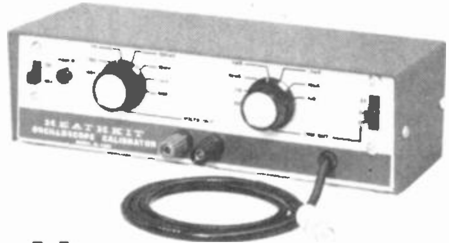

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QS MATRIX

(continued from page 24)

original sound field. A signal generated on the left side of the original sound field will be reproduced on the left side of the reproduced sound field in stereo playback, and vice versa. A signal generated somewhere in the rear and on the left

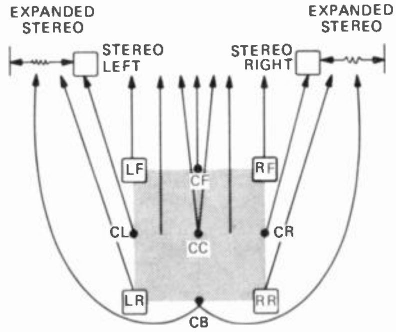

FIG. 3—POSITIONING of sounds when playing a QS record on a stereo system.

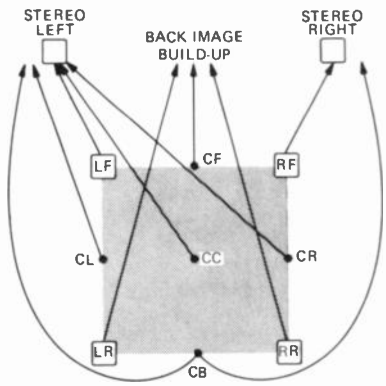

FIG. 4—POSITIONING of sounds when playing a SQ record on a stereo system.

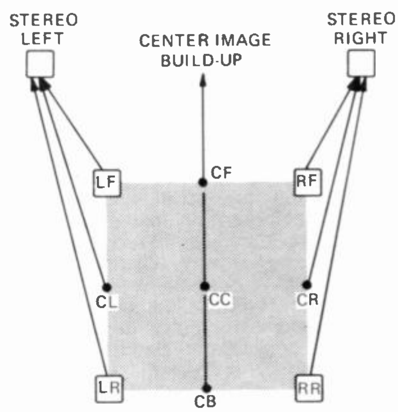

FIG. 5—POSITIONING of sounds when playing a CD-4 record on a stereo system.

will be reproduced farther to the left from the center, and a signal generated somewhere in the rear and on the right will be reproduced farther to the right from the center in stereo playback. Complete left-right symmetry is thus guaranteed.

QS and mono playback

When reproduced monophonically, the present stereo signals give a sound pressure response pattern as shown in Fig. 6, rising in level between the L and R speakers. There are different opinions as to how 4-channel signals should be reproduced in monophonic playback, but the QS-encoded 4-channel signals offer a monophonic sound pressure response pat-

FIG. 6—SOUND PRESSURE RESPONSE for monophonic reproduction of stereo signals.

tern resembling the characteristic of a cardioid microphone. The reproduced level rises as a signal moves closer to the front center position in the original sound field; a signal generated in the rear half of the original sound field is reproduced with a lower level than a front signal, falling in level as it moves closer to the rear center position in the original sound field (see Fig. 7). Consequently, QS-encoded 4-channel records containing on-stage

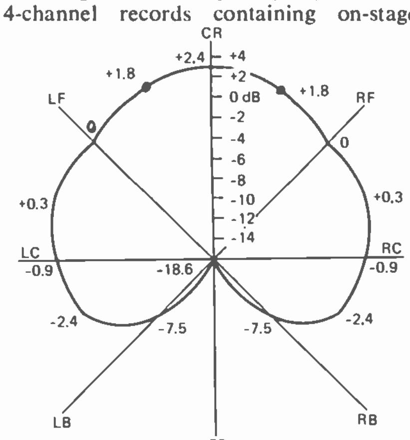

FIG. 7—SOUND PRESSURE RESPONSE of a QS-encoded signal in monophonic reproduction.

music in the front and ambience content in the rear would offer particularly well-balanced monophonic reproduction.

If, for certain applications, it is necessary to emphasize front and rear signals equally in monophonic playback, rear signals may be encoded with a certain amount of phase shift between LT-RT so that the desired monophonic sound pressure response pattern is obtained.

We have demonstrated how the QS system can transmit and reproduce all of the musical information produced in a live sound field via only two signal transmission channels. However, should it happen that more than two channels of signal transmission can be made available without any serious difficulty or inconvenience, the QS encoding theory can be extended as it is, and applied to a number of transmission channels.

For instance, if four transmission channels were available, the original sound field information could be transmitted in QS. Figure 8 presents the sound pressure response pattern of a sound source signal as it is reproduced in 4-channel via only two (LT, RT) transmissions channels, three (LT, RT, t2) transmission channels, and four (LT, RT, t2, t3) transmission channels.

Even if an unlimited number of transmission channels are available, the more

(continued on page 72)

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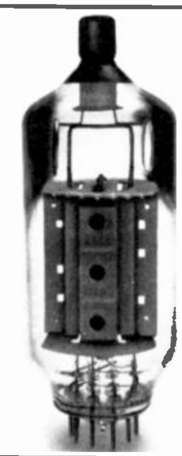

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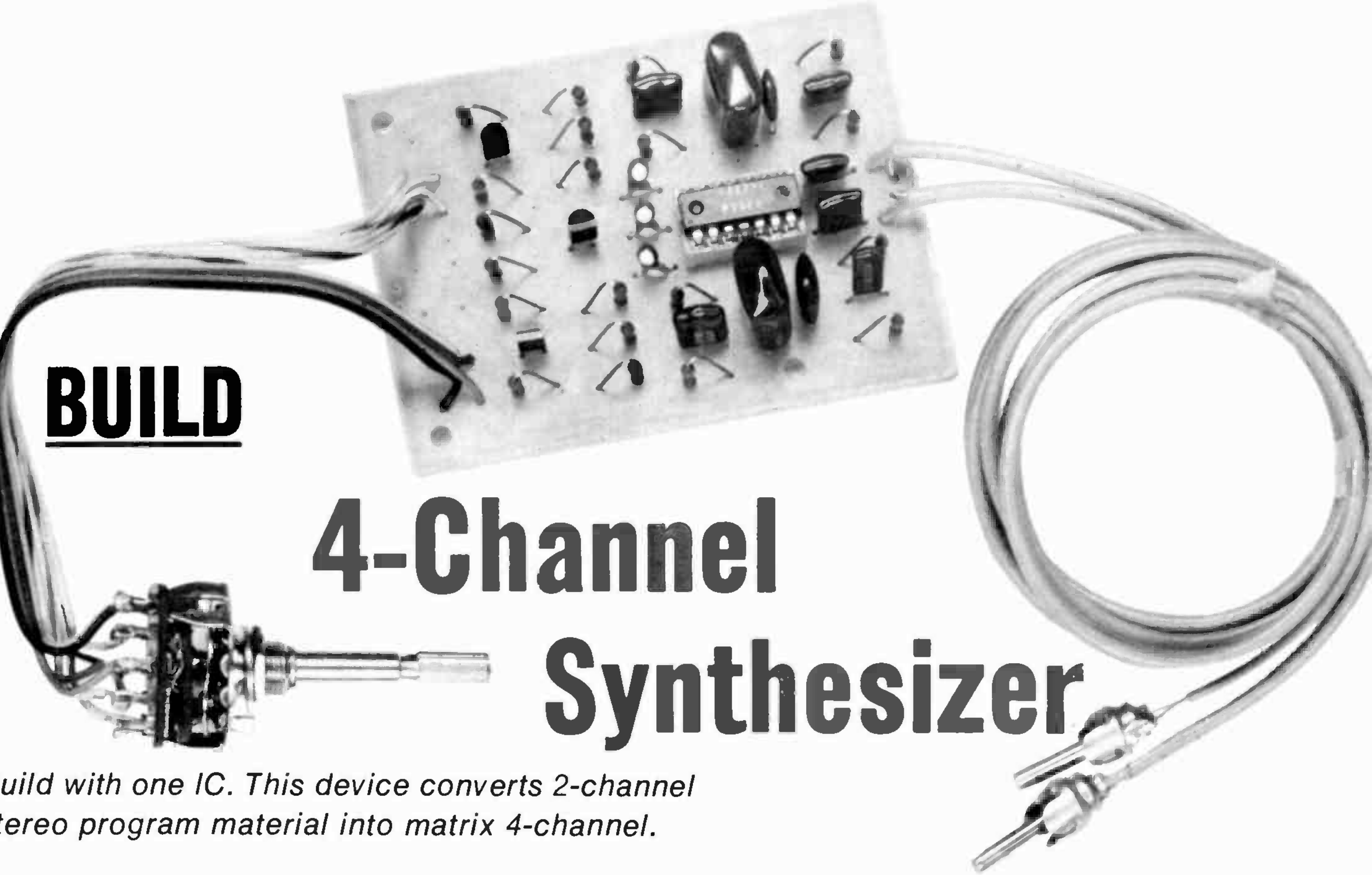
Circle 17 on reader service card

BUILD 4-Channel Synthesizer



Build with one IC. This device converts 2-channel stereo program material into matrix 4-channel.

by ARNOLD NICHOLS

MANY MUSIC LOVERS HAVE EXPANDED their stereo high-fidelity systems to 4-channel sound. But now they find that they are limited to the relatively small number of new 4-channel records and tapes that they have been able to afford to purchase. In addition, they have been unable to adequately use their existing music library.

In this article you'll discover an easy-to-build one-IC matrix synthesizer that performs the magic of converting your existing 2-channel stereo recordings into matrix 4-channel sound.

Faced with a large 2-channel music library, I designed a solution around a CBS Laboratories circuit, that I've designed into a handy little adapter. By using the synthesizer along with any existing 4-channel matrix system you will be able to play any 2-channel material you now own, or any 2-channel stereo FM broadcast through the adapter and on into your system to get a realistic 4-channel effect.

No, it's not magic. The device is based on stereo enhancement and really works. But to give you a better idea of what I am talking about, let's take a brief look at the difference between 4-channel and 2-channel systems.

How it works

Presence, in a live sound situation (when sitting in a concert hall, or attending a live rock group), is created by the effects of having an infinite number of direct and indirect sound waves that combine in such manner as to create a feeling of liveness. The human ear, yours and mine, translates this sound field by sensing the relative time delays of these sound waves as they arrive from a variety of directions.

If we placed a single microphone in the concert hall and made a single-channel recording, we would simply be combining all of the individual sound waves with their various time delays, into one single sum signal. This sum signal, when played back, obviously cannot reproduce the total effect of the original sound field.

Now let's put two microphones into that hypothetical concert hall and see what happens. When we record now, for stereo playback of course, we end up with two sum signals; each one somewhat different from the other. When we play back these two signals through a stereo system (2 channel), these two sum signals (one left and one right), recreate appreciably more information than the monophonic signal we described earlier. While the realism is greatly improved over that of the monophonic system, the stereo playback is still lacking in presence.

To get 4-channel sound from that two-channel recording we must find a way to create the sense of sound source position or sound source location that is so peculiar to 4-channel sound. Fortunately a method for doing this does exist. CBS Laboratories has developed a circuit that solves this problem by analyzing and then synthesizing ordinary 2-channel stereo signals to obtain the separate and indirect sound signals that are characteristic of the output from a 4-channel matrix system.

By using this special decoding system, it is possible to create a 4-channel synthesizer that redistributes the conventional 2-channel stereo signals into a complete sound field made up of four distinct sound sources—front right, front left, rear right, and rear left.

By feeding the output of this simple synthesizer into a matrix decoder (simple, thanks to the use of an integrated circuit) it becomes possible to create the sense of sound position. If you don't use a matrix decoder you'll get 2-channel SQ encoded matrix output.

Any musical instruments or voices that were positioned at the left of the stage when the original 2-channel recording was made, will be heard near the left rear corner. Any sound sources located to right of these will play back in the left front corner. Sound sources originating at the right end play back from the right rear and those a little to the left from the right front.

Fortunately, most 2-channel stereo recordings do contain echo components. And when these sound elements are recovered by the synthesizer the listening area appears to be filled with a natural "live performance" sound.

Using this circuit, built around an MC1312P matrix decoder, successfully creates the impression of sound source positions. However, the total amount of information that is presented to the listener is less than that actually present in a live sound situation.

The indirect sound components separated by the MC1312P are phase-modulated either 180° or 270°. This is done automatically by a 4-pole phase-shift network system developed by CBS Laboratories, before these signals are sent on to the rear channels.

When these phase-shifted signals are combined with the direct sound components that are reproduced by the front channels, a richer, livelier, more realistic sound is produced.

The added phase modulation takes good advantage of a well-known psychoacoustical phenomenon. Two, in phase, speaker systems position the sound at a point midway between them if their sound amplitudes are equal. However, when the same two speaker systems are connected out-of-phase

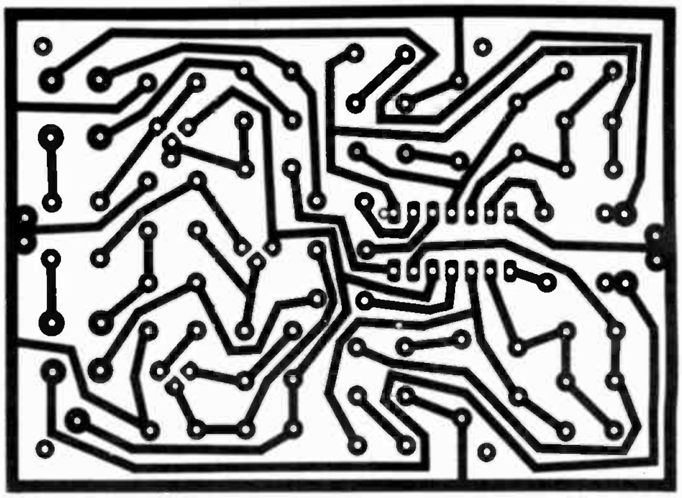


FIG. 2 (right)—FOIL PATTERN of convertor shown full-size.

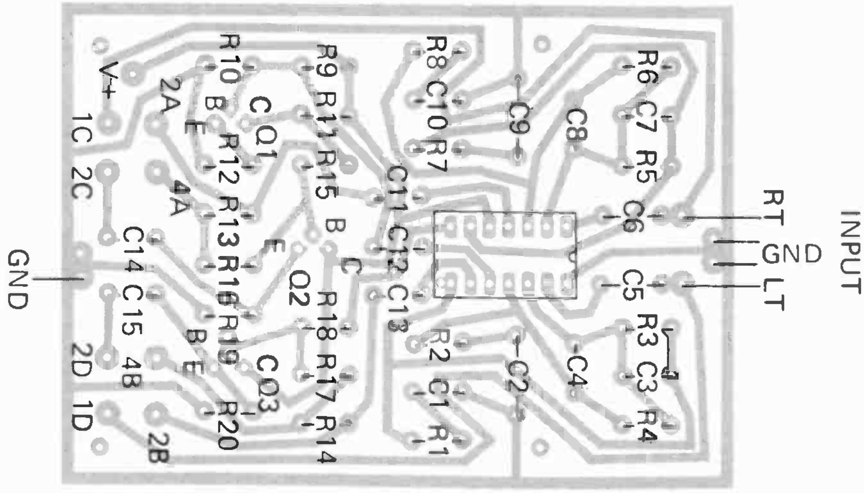
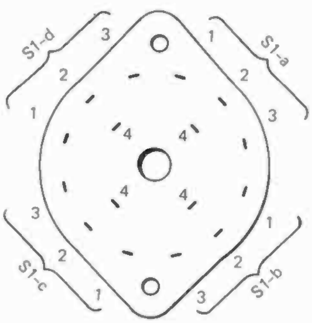
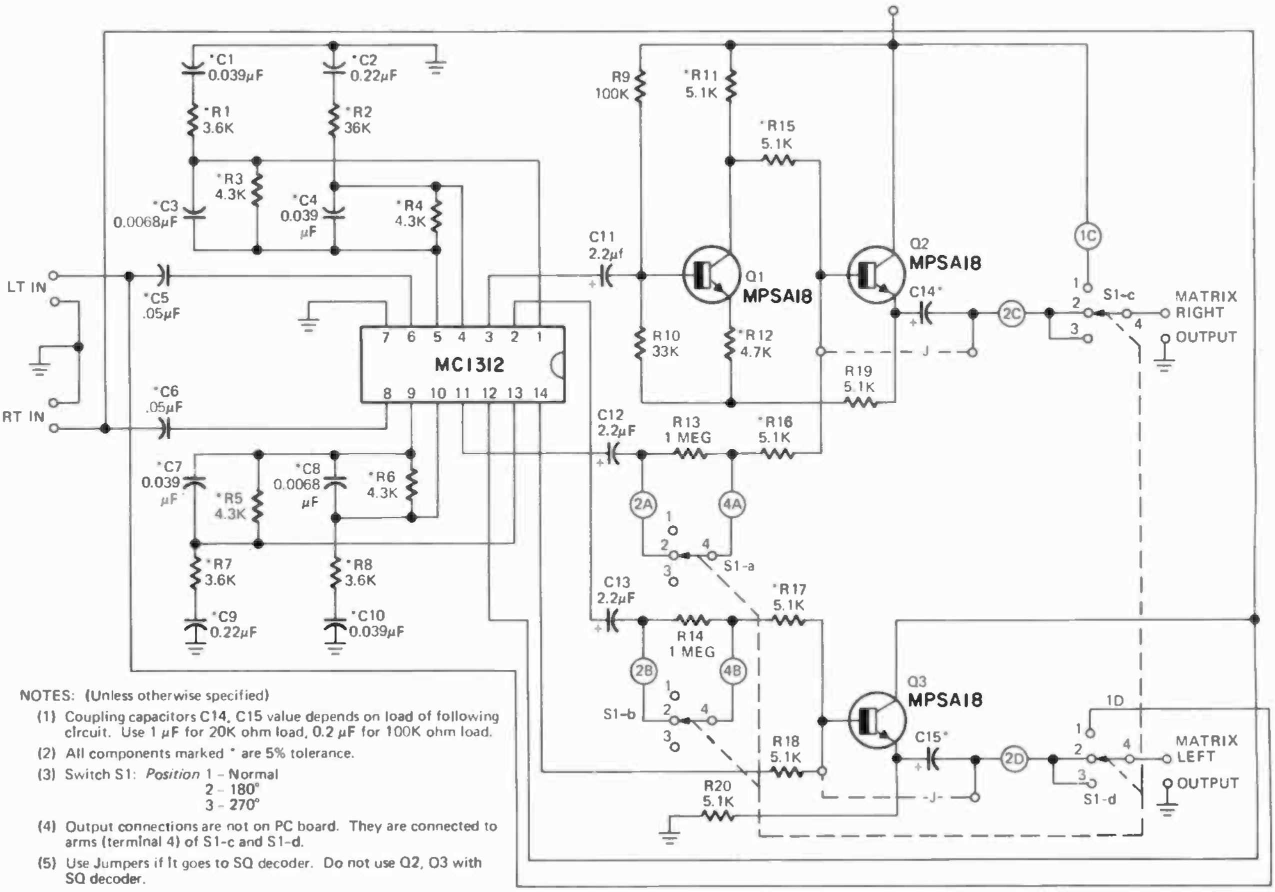


FIG. 3 (below)—COMPONENT PLACEMENT of convertor PC board.





NOTES: (Unless otherwise specified)
(1) Coupling capacitors C14, C15 value depends on load of following circuit. Use 1 μF for 20K ohm load, 0.2 μF for 100K ohm load.
(2) All components marked * are 5% tolerance.
(3) Switch S1: *Position* 1 - Normal
2 - 180°
3 - 270°
(4) Output connections are not on PC board. They are connected to arms (terminal 4) of S1-c and S1-d.
(5) Use Jumpers if it goes to SQ decoder. Do not use Q2, Q3 with SQ decoder.

FIG. 1—SCHEMATIC DIAGRAM of the 2-channel stereo to 4-channel matrix convertor.

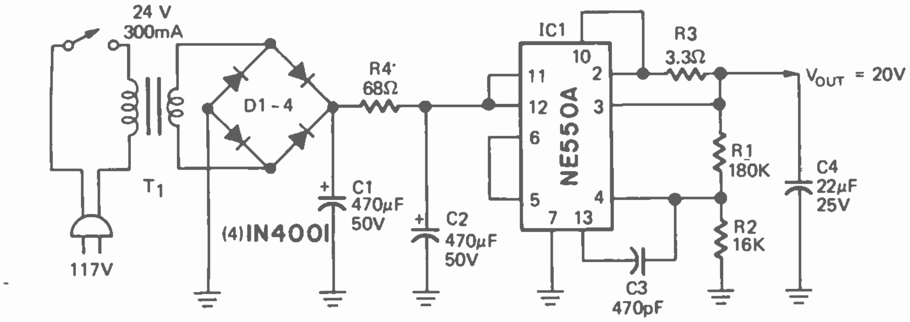


FIG. 4—SCHEMATIC DIAGRAM of power supply.

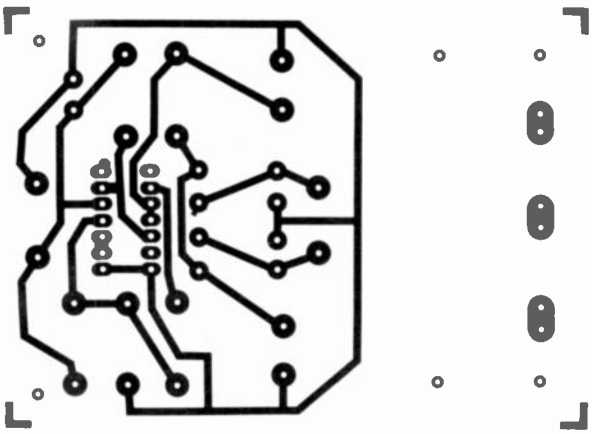


FIG. 5—POWER SUPPLY printed circuit board shown full-size.

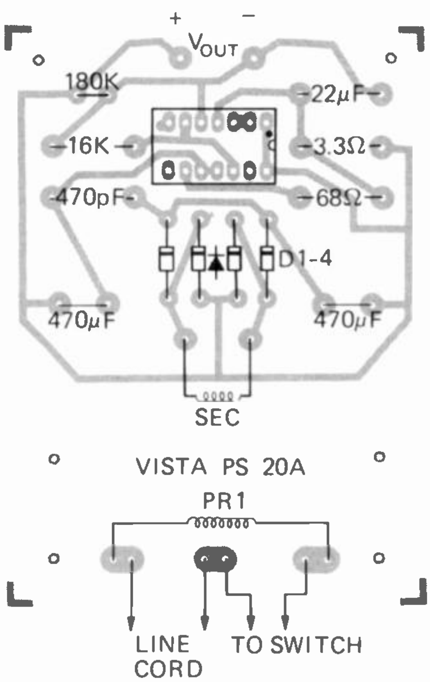


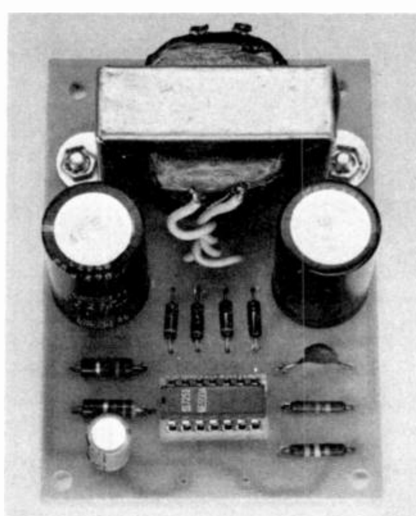
FIG. 6—COMPONENT PLACEMENT of power supply printed circuit board.

with each other, they no longer form a clear sound image. However, the two out-of-phase signals do not totally cancel each other.

When we phase-modulate the signals of either the front or the rear speaker systems under the synthesized 4-channel conditions, what we produce is the same effect we would have gotten if we had placed a number of speaker systems side-by-side around all four walls of the room—a wall of sound with changing characteristics because of the constantly changing phase relationships. Thus by using a 2-channel sound source and the 4-channel matrix synthesizer we create an effect that rivals that of true 4-channel reproduction.

The synthesizer provides three outputs: 1. Standard stereo, 2. 180° matrix, 3. 270° matrix.

If you connect your synthesizer to an SQ decoder or some other matrix decoders you may find that the result is a very strange sounding output. If this occurs, disconnect Q2 and Q3 and add jumpers from the junction of R6 & C14 to S1-b. Add another jumper from the junction of R15 and the base



POWER SUPPLY circuit board shows location of components.

PARTS LIST (SYNTHESIZER)

All resistors ¼-watt, 5%, carbon film (Do not substitute)

R1, R7, R8—3600 ohms
R3, R4, R5, R6—4300 ohms
R9—100,000 ohms
R10—33,000 ohms
R11, R15, R16, R17, R18, R19, R20—5100 ohms
R12—4700 ohms
R13, R14—1 megohm

All capacitors 5% film dielectric, unless noted. (Do not substitute)

C1, C7, C10—.039 µF
C2—0.22 µF
C3, C8—0068 µF
C4—.069 µF
C5, C6—.047 µF, 10%
C9—0.22 µF
C11, C12, C13—2.2 µF, tantalum, ± 20%
C14, C15—Use 1 µF for 20K load, 0.2 µF for 100K load (Not supplied in kit)
IC1—MC1312P
Q1, Q2, Q3—MPS A18 (NPN low-noise device. Do not substitute)
S1—4-pole 3-position rotary. (No knob supplied)
Circuit Board
Molex Connectors for IC1 socket·
Shielded cable for input (Supplied in kit with RCA type plugs.)

PARTS LIST (POWER SUPPLY)

R1—180,000 ohms, ¼ W, 5%
R2—15,000 ohms, ¼ W, 5%
R3—3,300 ohms, ½ W, 10%
R4—100 ohms, ½ W, 10%
C1—500 or 1,000 µF, 25V, electrolytic
C3—470 pF, ceramic
C4—20 µF, 25V, electrolytic
D1, D2, D3, D4—IN4001
IC1—NE550A voltage regulator (Signetics)
Circuit Board
Molex connectors for IC socket
Line cord (Not supplied in Kit)
SPST switch (Not supplied in kit)

Following items are available from Photolume Inc., 128 East 28th Street, New York, N.Y.

Synthesizer and Power Supply Kit No. MAT-5	**$19.95**
Synthesizer Kit No. MAT-4	**$15.95**
Power Supply Kit No. PS-20A	**$ 6.95**
Set of 2 circuit boards for power supply and synthesizer No. MATB	**$ 5.75**

of Q2 to S1-c.

Building your system is easy. The complete schematic is in Fig. 1. A full size circuit board pattern for the unit is shown in Fig. 2 and the parts placement is in Fig. 3. Assembly is fast and straight forward as long as you take reasonable precautions when soldering the IC and low-noise transistors into place A separate power supply is also needed. You may be able to take off the necessary voltage from your existing equipment. You'll need a well filtered and regulated 20 volts at 20 mA.

If this voltage is not available, build the power supply shown in Fig. 4. Its printed circuit board layout is in Fig. 5 and parts placement on this circuit

(continued on page 79)

Radio-Electronics® Tests Pioneer CT-F9191

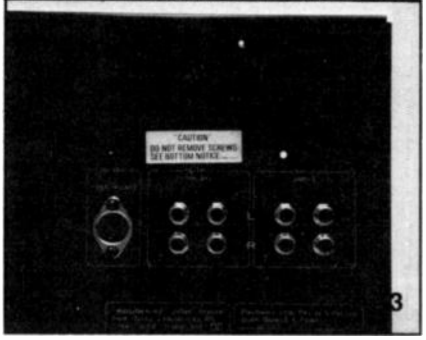
by LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

THE PIONEER CT-F9191 IS THE FOURTH "front-loading" cassette introduced by that company and in terms of features and performance it is the finest of that quartet of products. Just one look at this attractive unit will convince the skeptics that the cassette deck has indeed "come of age" and deserves to join the ranks of other fine component high-fidelity products. Like all of the recently introduced front loaders, access to all controls and to the cassette compartment is gained through the front panel and the unit looks like any other component such as an amplifier or tuner that can be tucked neatly on a shelf or stacked above or below companion components. A full view of the front panel is shown in Fig. 1.

A curved plastic cover swings out of the way at the press of a button, opening the cassette compartment that accepts cassettes in a vertical position. The cassette is inserted in an easy up-and-into-place motion and the cover door flips-down manually. Next to the power ON-OFF toggle switch at the lower left corner are the usual transport controls which are extremely easy to depress (they are of the piano-key type, but more important, they operate electronically, controlling semiconductor logic and solenoid circuits) and any mode can be selected without going through the stop position. The combined use of the separate PAUSE switch and the RECORD and PLAY switch permits the user to set up record levels before tape travel begins. When power is applied, the inside of the casette compartment is illuminated, which makes it easy to see if the tape is travelling.

A close-up view of the major front panel controls is shown in Fig. 2. Dual concentric rotary knobs control the MIC of DIN input record levels, line input record levels and playback output levels. This arrangement permits mixing of microphone and line inputs, or DIN and line inputs in each of the two channels. Above these controls are a three-digit counter with its usual rest button. Zero setting of the counter can be used in conjunction with the memory pushbutton. Like most memory-rewind features found on competitive units, the transport will rewind a given tape to the pre-set point determined by the counter's reach 999. But unlike most, if the PLAY transport button is depressed during the rewind cycle, the tape will reach the predetermined point and begin playing over again, if desired. A light above this button tells the user when the button is depressed.

A record limiter circuit is activated by the next button and is particularly useful when recording from live sources or when unpredictably loud transients are likely to be encountered. Next come the bias and equalization push-button switches with settings for standard (or low noise) and Chrome tapes. This deck is equipped with automatic sensing for the newer Chrome tapes and switching to correct equalization and bias takes place automatically when such tapes are used, completely bypassing the manual bias and EQ buttons. In any case, when Chrome settings are selected, a light above these buttons indicates that fact. Additional push buttons activate an MPX filter circuit and the Dolby noise reduction circuitry. A light above the Dolby button indicates when it is in use. At the extreme right of the panel are a pair of microphone inputs (one for each channel) and the headphone output jack.



Two well illuminated large recording-level and playback-level meters are calibrated all the way from −40 dB to +5 dB, a feature that can only be appreciated fully after you use the deck for serious musical recording work. This wide range calibration permits the recordist to monitor just about the entire dynamic range of anything being recorded. Between the two level meters are a record LED indicator light and a peak-level indicator that flashes whenever instantaneous recording level exceeds +5 dB, preventing over-recording and high distortion levels for signals that are too fast to be registered on the regular VU meters.

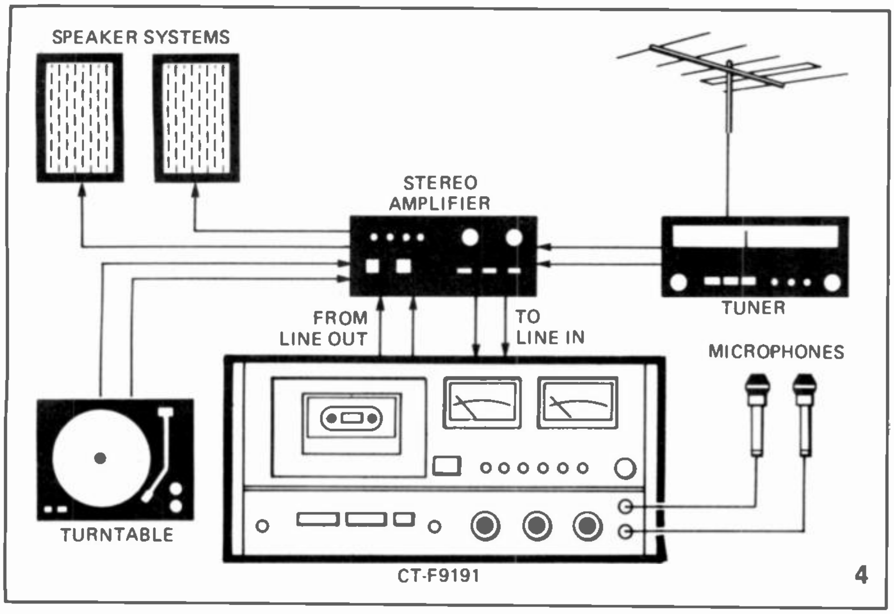
The section of the rear panel shown in Fig. 3 contains the familiar combination DIN record/play multiple connector as well as *dual* pairs of line-input and line-output jacks. This doubling up of input and output pairs (which are simply wired in parallel) is an inexpensive addition, but a mighty handy one if you want to dub to a second deck, or feed two separate playback systems at once. Typical interconnection of the CT-F9191 in a high-fidelity component system is shown in Fig. 4.

Circuit configuration and layout

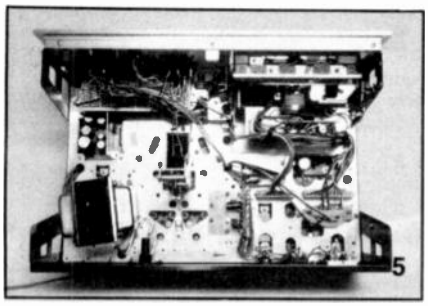
A view of the internal layout of the Pioneer CT-F9191 is shown in Fig. 5. Note that most of the electronic circuitry is below deck, where it is well shielded. Major modules include separate circuit boards for the record/play amplifier, the Dolby noise reduction circuitry, the electronic control circuitry and the switch assembly. Additional separate assemblies include the power supply (which is regulated by means of a transistor-Zener diode

SUMMARY OF MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Frequency Response: (Low-noise, High-output tape) 35 to 13,000 Hz, ±3 dB; (Chromium dioxide tape) 30 to 14,000 Hz ±3 dB. **Wow-and-Flutter:** Less than 0.07% WRMS. **Harmonic Distortion:** Less than 1.7% (at 0 dB). **Signal-to-Noise Ratio:** (Dolby off) 52 dB; (Dolby on) 62 dB (Low-noise tapes). **Input Sensitivity:** (Mic.) 0.22 mV, 30K ohms; (Line) 65 mV or more, 100K ohms; (DIN Rec/PB) **Max Input:** 100 mV; Output same as line. **Output Level** (ref: 0 dB): (Line): 315 mV; (Headphone): 40 mV into 8 ohms. **Power Requirements:** 120 V, 50-60 Hz, 53-watts maximum. **Dimensions:** 17⅞" wide × 7⅞" high × 12⅜" deep, including walnut grained vinyl cabinet. **Weight:** 29 lbs. **Suggested retail price:** $450.00 including cabinet.



arrangement) and a transistor assembly that operates the record solenoid. An electronically controlled DC motor is used to drive the tape capstan, while a separate DC torque motor is used for the fast forward and rewind drives. The record/play head is a solid ferrite type, while the erase head is of ferrite construction. A three-stage direct coupled input amplifier-equalizer is used in each channel. A logarithmic amplifier circuit is used to drive the wide range meters. Total semiconductor complement in the CT-F9191 consists of 71 transistors, 6 FET's (two of which are used in the Dolby circuit), 75 diodes, 5 Zener diodes and 2 LED's. A complete circuit diagram of the unit, including all con-



trol electronics, is supplied as a large separate fold-out sheet with the owner's manual.

Laboratory measurements

Measurements of the performance of any tape deck are inevitably influenced by the brand of tape chosen for use in the tests. In our case, we selected TDK type ED-C-60 High-Output, Low-Noise cassettes for all measurements involving the standard settings of the bias and EQ switches and TDK type KR-C-60 (Chrome) cassettes for measurements involving performance with CrO_2 tape. Both of these tapes are listed in the comprehensive table of recommended tapes and switch settings that is provided in the owner's manual.

Results of our measurements are shown in Table I. Frequency response, using our "standard" tape, is plotted in Fig. 6 on a record/playback basis. While two plots are shown (for 0 dB level and for −20 dB reference recording level), the −20 dB reference curve is the more meaningful one in terms of musical performance. Any properly equalized tape deck (of the cassette variety) will cause saturation of magnetic tape if high frequencies are recorded at 0 VU level—a condition that seldom occurs when recording actual music (and not test tones). We present both curves only because the manner in which the machine causes saturation (and the frequencies at which this roll-off begins) may be of some interest to readers when comparing the performance of this machine with others to be reviewed in the future. In terms of the more conventional −20 dB reference level, the response of the unit extends from 30 Hz to 12,000 Hz, ± 3 dB with this tape sample. While this may not seem overly impressive to hi-fi addicts, we suggest you read our summary comments regarding this point at the conclusion of this repórt, following Table II.

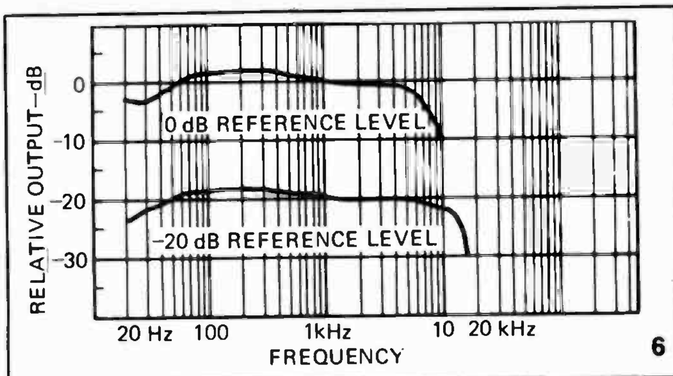
Frequency response was considerably wider using the CrO_2 sample tape, as shown in Fig. 7. In this instance, response was flat from 28 Hz to 15,000 Hz, ± 3 dB—better than claimed by the manufacturer. Remember, some variation in response is to be expected depending upon tape brand and type used, and those seeking that last kHz may want to experiment with some of the other tape brands listed by Pioneer as being suitable.

TABLE I
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer **U.S. Pioneer Electronics** — Model **CT-F9191**

CASSETTE TAPE DECK MEASUREMENTS

FREQUENCY RESPONSE MEASUREMENTS	**R-E Measurements**		**R-E Evaluation**
Frequency response, standard tape (Hz—kHz ±dB)	30—12 ±3		Good
Frequency response, CrO_2 tape (Hz—kHz ±dB)	28—15 ±3		Very good
DISTORTION MEASUREMENTS (RECORD/PLAY)	Low-Noise	CrO_2	
Harmonic distortion @ −10-VU (1 kHz) (%)	1.0	1.0	Excellent
Harmonic distortion @ −3-VU (1 kHz) (%)	1.4	1.2	Very good
Harmonic distortion @ 0-VU (1 kHz) (%)	1.4	1.6	Excellent
Harmonic distortion @ +3-VU (1 kHz) (%)	1.7	2.4	Excellent/Very good
SIGNAL-TO-NOISE RATIO MEASUREMENTS	Weighted	Unweighted	
Standard tape, Dolby off (dB)	56	50	Excellent
Standard tape, Dolby on (dB)	66	57	(See text)
CrO_2 tape, Dolby off (dB)	58	51	Very good
CrO_2 tape, Dolby on (dB)	68	60	(See text)
MECHANICAL PERFORMANCE MEASUREMENTS	WRMS	RMS	
Wow-and-flutter (%, WRMS)	0.05	0.08	Excellent
Fast wind and rewind time, C-60 (seconds)	59		Good
COMPONENT MATCHING CHARACTERISTICS			
Microphone input sensitivity (mV)	0.24		
Line input sensitivity (mV)	60		
Line output level (mV)	300		
Phone output level (mV)	40		
Bias frequency (kHz)	N/A		
TRANSPORT MECHANISM EVALUATION			
Action of transport controls			Excellent
Absence of mechanical noise			Very good
Tape head accessibility			Excellent
Construction and internal layout			Very good
Evaluation of extra features, if any			Excellent
CONTROL EVALUATION			
Level indicator(s)			Superb
Level control action			Very good
Adequacy of controls			Excellent
Evaluation of extra controls			Excellent
OVERALL TAPE DECK PERFORMANCE RATING			Excellent



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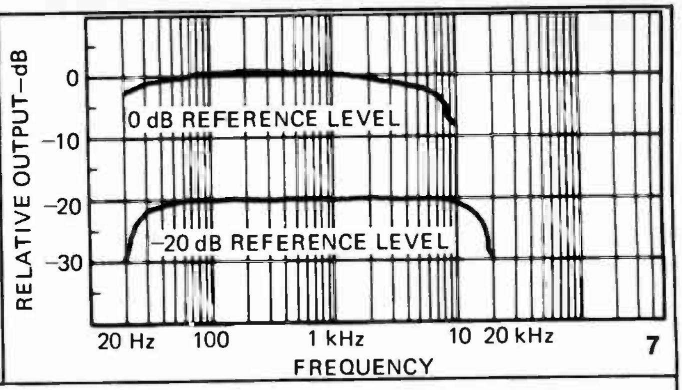

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Distortion was extremely low with both types of tape, and the CT-F9191 is judged by us to have considerable head room—an important quality for serious recordists. It should be noted, too, that the peak indicator LED flashed on for us at +5.5 dB. At this level, using low-noise tape, we were just approaching the 3% THD point considered to be the top end of recorder capability by the professionals. Using the Chrome sample, the 3% distortion point was reached at +4 dB on the VU meters. Chrome tape generally tends to saturate at a bit lower VU meter readings on most recorders, but it should be recalled that the *actual* recording level (because of changes in bias) is really greater than that obtained with standard tapes. This accounts, in part, for the better S/N ratios obtained with CRO_2 tape.

The signal-to-noise ratios tabulated in Table I are in all cases referenced to the 3% distortion point. While it is generally stated that "Dolby adds 10-dB to S/N ratios," you will note that this improvement holds true for our weighted measurements of noise (we use a type-A weighting network), but is not quite true for the unweighted figures. That is because Dolby operates to reduce noise at high frequencies only (hiss). The fact that Dolby improves S/N by some 7 dB even in the unweighted measurement of noise using standard tape suggests that the low-frequency noise content, using the CT-F9191 (hum and other low frequency disturbance) is very low indeed. In fact, all the noise measurements tabulated represent excellent performance by a cassette deck.

Wow-and-flutter measured a constant 0.05% WRMS, considerably better than the .07% claimed by the manufacturer, and again, one of the lowest figures we have read for any cassette deck. Other subjective evaluations of machine performance and features will be found in Table I.

TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer **U.S. Pioneer Electronics** Model **CT-F9191**

OVERALL PRODUCT ANALYSIS

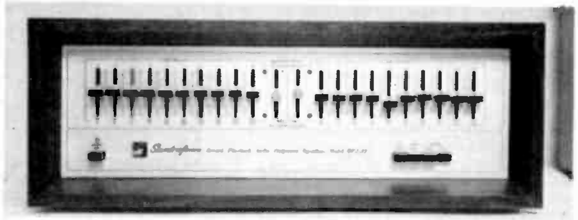
Retail price (suggested)	**$450.00**
Price category	**Medium-high**
Price/performance ratio	**Excellent**
Styling and appearance	**Excellent**
Sound quality	**Very good**
Mechanical performance	**Excellent**
Comments:	Pioneer has been stressing the fact that well-designed cassette decks can do just about everything that more expensive open-reel machines can do—and can do it more conveniently at that. With the exception of the lack of tape monitoring facilities (which requires a three-head machine), the CT-F9191 comes as close to fulfilling that claim as any machine in its price category. Certainly, the "non-professional" recordist may question its somewhat limited frequency response, having been conditioned to believe that any component that does not have a ruler-flat response from 20 Hz to 20 kHz is deficient. Ask any professional recordist about this, and he will tell you that he'd rather have excellent S/N and low distortion than super-high frequency response. Those qualities are supplied in abundance in the Pioneer CT-F9191. Add to that its extra features such as the peak limiter, the wide range VU meters (the only other machine we know of that can register a range of 45-dB costs $1200.00 or more), its front-load configuration and its many automatic features and the unit will be very hard to beat.

Utilization and listening tests

We tried a variety of input signal sources with the CT-F9191 and even did a bit of microphone and line mixing in the course of our lab testing. (We find it handy to "announce" frequencies when recording our tests for frequency response measurements, since on playback we don't have to remember precisely what test frequencies we used.) A simple little feature we neglected to mention earlier is the addition of a plastic reference-ring at the rear of each set of level-control knobs. These rings act as markers after you have established a preferred level for a particular microphone or line input source. An inexpensive but useful addition that is typical of this fine cassette deck. Nothing has been overlooked, and no unneeded frills have been added.

Our use tests included the recording of music from disc as well as from FM. While there is no published indication of bias frequency, it is evidently high enough so that we did not find it necessary to employ the MPX-filter when recording stereo FM programs. This, of course, may not be so when using poorer quality tuners which have fair amounts of sub-carrier output products.

Our capsule summary, along with overall comments regarding performance of the CT-F9191 will be found in Table II. Several of the performance measurements were repeated after using the machine for a couple of days, and results remained the same, indicating a high degree of mechanical and electrical stability for this new entry from Pioneer. **R-E**



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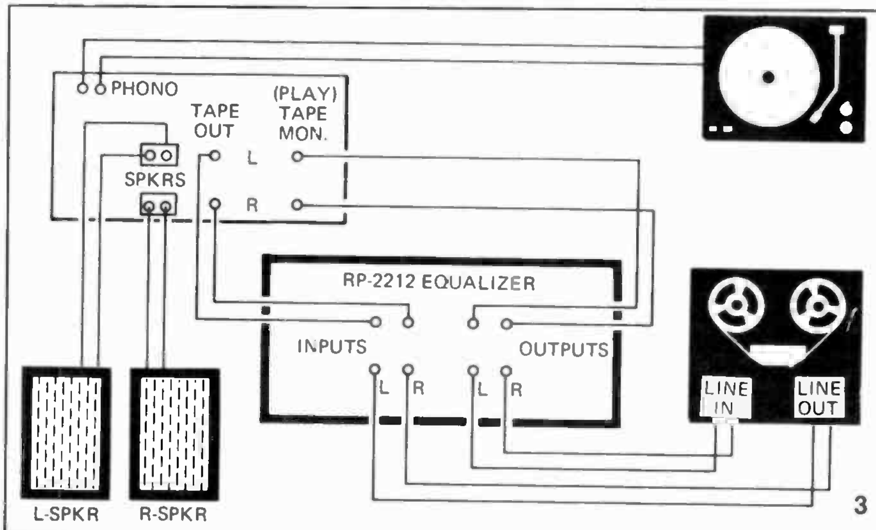
Radio-Electronics® Tests Soundcraftsmen RP2212

by LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

AUDIO PERFECTIONISTS HAVE LONG RECOGnized the limitations of the typical bass and treble controls found on preamplifiers, amplifiers and integrated receivers. These controls alter the tonal response of nearly half of the entire audio spectrum with one turn of a knob. More often than not, what is needed in a system is a specific "boost" or "cut" for a narrow range of frequencies to compensate for speaker system deficiencies, room acoustic problems or frequency response limitations in other associated components or even the program source itself. Thus, a new category of components is becoming increasingly popular with demanding audiophiles. The octave-by-octave equalizers (and even some third-octave-by-third-octave equalizers) have been in use for some time in the sound reinforcement segment of the audio industry and are used to "equalize" large halls and auditoriums with respect to the public address systems installed in them.

Taking an approach similar to that used in much more expensive and complex professional equalizers, Soundcraftsmen offers a pair of equalizers for home music systems. The more expensive of these, the RP-2212, is shown in Fig. 1. The upper portion of the front panel is divided into two equal and symmetrical sections, each containing ten separate lever controls for a single channel of a stereo system. Since each control affects approximately a one octave frequency-band, the controls are given octave designations, as follows: 20/40, 40/80, 80/160, 160/320, 320/640, 640/1280, 1280/2560, 2560/5120, 5120/10240, 10240/20480. With all the levers set to the center positions (controls are calibrated in 1 dB increments from −12 to +12), each range of frequencies named is neither boosted nor attenuated. By moving a lever up or down, the octave of frequencies affected by that control can be boosted or attenuated by a maximum of 12 dB.



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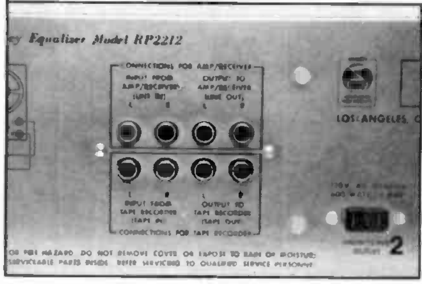

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At the center of the panel are a pair of master gain controls that adjust overall gain of the system so that after final equalized settings are established, the music will sound as loud as in its unequalized form. A pair of LED lights associated with each master gain control helps establish this equal loudness setting by blinking equally when the master control is properly set. The less costly model RP20-12 lacks these LED's plus one other feature that we'll discuss in a moment.

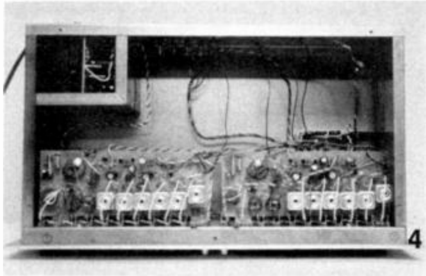
Along the bottom of the front panel are a power on/off pushbutton and four more pushbuttons at the lower right. One of these simply tests the LED lights. The second button activates the tape monitor circuitry (since the equalizer must be connected to the tape-out/tape in jacks of your present amplifier or receiver, thereby using up your original tape monitoring circuit). The final pair of buttons determine whether the equalized response should be applied to the tape output jacks, or to the line output jacks. By pressing the EQUALIZE TAPE button of this pair, it is possible to pre-equalize programs being fed to your recorder, a feature not possible with regular tape monitoring circuits that are always positioned *ahead* of any tone control circuits in amplifiers or receivers. This equalize-tape feature is also omitted in the lower cost model RP20-12.

Figure 2 shows a closeup of the connecting jacks on the rear panel of the RP2212, while Fig. 3 illustrates how the unit would be incorporated in a complete stereo high-fidelity component system.

The circuitry of the RP2212 is contained on two glass-epoxy circuit boards (one per stereo channel) and L-C filter circuits are used for each octave. Toroidal inductors are used for the lower three octaves of each channel, while ferrite-core inductors are used for the remaining seven octaves. Internal layout of the RP2212 is shown in Fig. 4. Note the fully shielded and enclosed power supply area at the rear left of Fig. 4. A metal top cover was removed for this photograph and when it is in place, the entire circuitry of the RP2212 is fully sealed within its overall metal housing before it is inserted in the decorative walnut grain

SUMMARY OF MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Frequency Response: 20-Hz to 20,000-Hz ±0.5-dB. **Harmonic Distortion:** Less than 0.1% at 2 volts (typically 0.05% at 1 volt in and out). **IM Distortion:** Less than 0.1% at 2 volts (typically 0.05% at 1 volt). **Signal-to-Noise Ratio:** Better than 90-dB referred to 2-volt input. **Input Impedance:** Operates from any signal source 100K ohms or less. **Output Impedance:** Operable into 3K ohms or greater. **Control range:** ±12 dB, each octave. **Dimensions:** 20" wide × 7¼" high × 11¾" deep (including supplied walnut-grained cabinet). **Suggested retail price:** $349.50.



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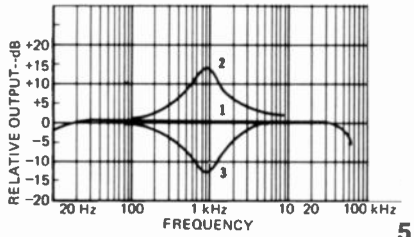
cabinet seen in Fig. 1. It should also be noted, that all resistors used in the octave filters are specially selected, low-noise carbon film types.

Laboratory measurements

Nominal input and output of the RP2212 is 1 volt with all the controls set for a flat response and we measured frequency response from input to output under these conditions. The results are plotted in Fig. 5 (curve 1). Response is flat within 1 dB from 15 Hz to 30 kHz,



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with the —3dB roll-off point at 40 kHz. Next, we plotted response of the system with just a single lever adjusted to maximum boost. We chose the 640/1280 octave for this curve, and, as can be seen from curve-2 of Fig. 5, response peaked at almost precisely 960 Hz, the mid-point of that particular octave. Maximum boost at that frequency was 13.5 dB. Next, we adjusted the same lever for maximum attenuation and obtained curve-3 of Fig. 5. Other levers responded singly in just about the same fashion and we observed a high degree of precision in terms of frequency accuracy of the designated octaves.

Before attempting to equalize our system for a flat acoustic response, we set the levers for an arbitrary curve. Setting the system to any desired curve is greatly facilitated by a series of paper charts that Soundcraftsmen calls Computone charts. When a group of desired settings of controls is determined (and settings may vary depending upon program sources, listening position and other factors), the user simply marks the control settings on the

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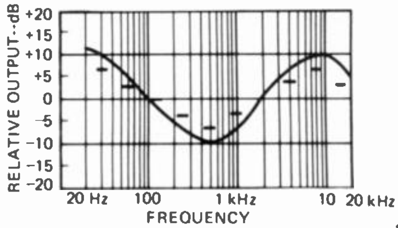
chart. The chart can then be cut out to the noted settings and placed on the surface of the front panel. Levers are quickly slid up to meet the remaining cardboard template and the desired response curve is quickly reestablished. The technique is illustrated in Fig. 6 which shows the settings we used in this first arbitrary response curve.

Figure 7 shows the individual lever settings we used in this experiment (dash marks), and the resultant response curve (continous plot) obtained with these settings. As you would expect there is a



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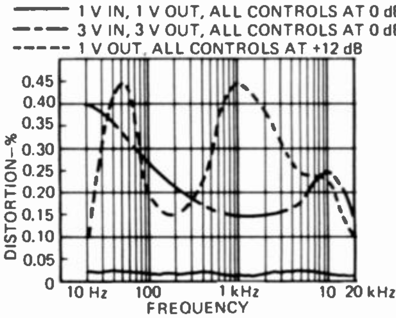
certain amount of interaction between adjacent lever controls, but the response curve corresponds quite well in overall shape with the octave-by-octave settings on the front panel.

We measured the total harmonic distortion for a variety of input levels and control settings. Results are shown in Fig. 8. With all the control levers at their center position, and an input and output voltage adjusted to 1 volt, THD varied



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from 0.01% to 0.02%, well below the 0.1% claimed. Increasing the input level to 3 volts (far more than is likely to be available from any program source connected from the tape out jacks of an amplifier or receiver), THD was still quite low, ranging from a high of 0.4% (at 20 Hz) to a low of 0.15% (at mid frequencies). Finally, we boosted all controls to their maximum (+12 dB) positions and adjusted the output for 1 volt. Even under these extreme conditions. THD never exceeded 0.5% at any frequency measured.

Equalizing a system

Trying to equalize a hi-fi system in a given listening environment would be almost impossible without very elaborate test equipment were it not for a very

cleverly conceived test record that Soundcraftsmen supplies with each RP2212 (See Fig. 9). The recording contains third-octave bands of pink noise on the left channel and a reference tone on the

(continued on page 90)

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Soundcraftsmen** Model: **#RP-2212**

OVERALL PRODUCT ANALYSIS

Retail Price	**$349.95**
Price Category	**Medium-high**
Price/Performance Ratio	**Very good**
Styling and Appearance	**Good**
Sound Quality	**Excellent**
Mechanical Performance	**Excellent**

Comments: The Soundcraftsmen RP2212 equalizer can hardly be classified as an accessory, since it costs as much as some complete receivers and amplifiers. Nor is it an item that every audio enthusiast will consider a necessity in his or her hi-fi system. For those who seek the ultimate in tonal compensation, the unit is highly recommended. We consider its ten-octave control (octave-by-octave) to be the *least* required to accomplish true acoustic equalization. There are five-control units on the market which do not have the degree of tonal segmentation required for this type of adjustment, and there are also units (at much higher cost) which break down the audio spectrum into thirds of an octave.

An important word of caution! Inordinate amounts of bass boost using any tone control system may result in flat response for your system, but unless your amplifier has enough reserve power output capability, such high levels of boost may well send the amp into overload clipping at frequencies that are accentuated to that degree. Remember, 10 dB of boost means *ten times the power output* that must be delivered by your amplifier at the boosted frequencies. One of the most useful applications of this equalizer is the pre-equalization of tape recordings, when trying to dub from old discs (or even tapes which had tonal deficiencies) to tape. If you are a serious recordist, don't settle for the lower cost RP20-12, which does as good a job of equalizing for home listening but lacks this important extra feature.

Even if you think your entire system (and room) provides perfectly flat response, you'll find the RP-2212 useful with many program sources, including FM and records which were "pressed" at anything but flat response.

BOOKSHELF SPEAKERS

How To Buy

Understanding the specifications is the first step. But there's more. Knowing how to conduct listening tests, speaker placement and room acoustics are just as important.

by ARTHUR KLEIMAN
ASSOCIATE EDITOR

SELECTING A SPEAKER SYSTEM IS FAR FROM an easy task. The vast number of speaker systems currently available can present the potential purchaser with so many choices that he will reach a point of complete indecision. Let's face it, just about everybody and their relatives are manufacturing speaker systems, and a day hardly goes by that a new model or a major breakthrough isn't announced. This coupled with a lack of an industry-wide standard for specifying speaker characteristics creates a nightmarish situation, but not a hopeless one. Armed with the weapon of meaningful specifications and the knowledge of the important considerations simplifies the task.

The speaker system is probably the weakest link in the high-fidelity chain. The purpose of a hi-fi system is to *accurately* reproduce original sounds. The ideal system should not alter the original sound in any way. The response of the total hi-fi system is made up of the response of each individual component. Each component alters the sound in its own way. Each adds its own "color". Of all the components in the system, the speaker system is the worst offender. It alters the sound the most. Therefore, selecting a speaker system is a crucial choice. The idea is to choose the best speaker system for a given amount of money. Best meaning the most accurate. It also means you must consider factors such as size and amplifier-speaker matching parameters.

The first two parts of this article will investigate important speaker specifications and describe how to use them when selecting a speaker system. These specifications include frequency response, dispersion, linearity, efficiency, power handling capacity, maximum sound output and impedance. Manufacturers' specifications for a number of speaker systems are provided. The third and last part of the article covers listening tests, room acoustics, speaker placement and speaker set-up.

Manufacturer's specifications

In this article, specifications for a number of speaker systems are presented. These specifications are manufacturers' specifications and not those measured by **Radio-Electronics** hi-fi lab. **Radio-Electronics** queried 93 manufacturers (see Table I) covering 232 different speaker systems. Not every manufacturer responded. Of those that did, some gave only a partial reply. Others bent over backwards to provide all of the requested information and more.

Specifications have little or no meaning if the conditions that they are measured under are not known. For example, let's say, I connect a voltmeter with a high input impedance across two terminals in a circuit and measure 100 volts. Now someone comes along with a low-impedance voltmeter and measures 75 volts. If he concludes that the circuit is erratic, he is wrong. The fault is in the testing procedure. This is why "How You Measure" is just as important as what you measure. Also, if the circuit was used in a frequency-dependent application where voltage is irrelevant, the voltage measurement would be meaningless. But a frequency measurement would tell us something meaningful about the performance of the circuit. Therefore, measurement conditions must be specified.

Radio-Electronics mailed a detailed questionnaire to each manufacturer. It specified the conditions that each speaker characteristic was to be measured under. Some readers will question, as some manufacturers have, the validity of the conditions. But for a comparative-only analysis, the conditions outlined are valid. For that matter, almost any set of conditions would be valid *for comparative purposes*, so long as all the speaker systems are measured under that same set of conditions. These conditions only affect the meaning of the specifications.

Physical size

The small speaker system is very popular today. It is used in the vast majority of hi-fi systems. For this reason, this article is limited to those speakers falling into the "bookshelf" category. However, a much more precise definition of a bookshelf system is necessary.

We decided to call any speaker system measuring 25 × 15 × 14 in. or smaller a bookshelf speaker system, with a few exceptions. These are the direct-reflecting speaker systems that must be placed at least 12 inches away from the wall. Such systems are usually placed on a pedestal and cannot be considered a bookshelf speaker system.

Size is important when selecting a speaker system. Don't try to stuff a large system into a room that won't accommodate it comfortably. The largest size that the room will accommodate should be determined first. Whether you plan on a 2-channel or 4-channel hi-fi system can also influence this decision. Don't be misled. There is no direct relationship between the size of a speaker system and the quality of sound it produces.

Types of enclosures

The operating principle of the speaker enclosure is unimportant to the ear of the user. What you are looking for is a system that reproduces sound well, and not what kind of system is in the box. However, there are practical considerations. If your hi-fi system uses a low-power amplifier you cannot drive an inefficient acoustic-coupled speaker system. So while you should select a speaker system for its reproduction qualities, don't lose sight of the practical problems. The operating principle is important to the design engineer but it should not influence your final selection. This decision should be based on the quality of sound the speaker produces.

All the bookshelf speaker systems we examined fall into two basic catagories—acoustic suspension or bass reflex. The bass reflex enclosure is a high-efficiency system with a bass response that tends to be peaky. This type of response produces what is often referred to as "boom". There are people that prefer a speaker system with a bass that booms, but it detracts from the reproduction accuracy. Not all bass-reflex systems have a boomy bass, but they are more prone to producing it. On the more positive side, the medium-efficiency of these systems suits low-power amplifiers rather well.

The acoustic-suspension speaker system is a low-efficiency system that has a smooth bass response. A smooth bass response produces a natural sounding bass, but the low efficiency requires driving this system with a medium- or high-power amplifier.

The basic design of the acoustic suspension enclosure is fixed. As a result, the majority of manufacturers of these systems refer to them as just that—acoustic suspension. The bass-reflex enclosure is different. The original patent for the bass-reflex enclosure covered many different variations, and manufacturers still introduce new ones periodically. The manufacturers of these systems have come up with many names for the bass-reflex enclosure. These include Center Excited Pipe, Tube Vented Reflex and Resistive Tunnel, to name just a few. Don't get confused. The basic characteristics of the bass-reflex system still apply.

Frequency response

The frequency response (sound output level vs. frequency with a constant-level drive signal) of a speaker system is important for determining the overall sound quality and the accuracy of reproduction. However, with the advent of graphic equalizers that alter the frequency response to the user's taste, it is possible to compensate, to a degree, for poor response. But this is like using Dolby to reduce tape noise. It works, but a faster tape speed is better.

When a speaker is placed in a listening room, the frequency response is no longer solely dependent upon the speaker system itself, but rather a combination of the frequency response of the speaker system *and* the room acoustics. The sound energy radiated from a speaker system is reflected off the various surfaces (walls, ceiling, floor, furniture, etc.) in the listening room. The intensity of these reflections vary with frequency and the type of reflective surfaces. The resulting reverberant field will reinforce the sound level at various frequencies. Figure 1 shows the reverberant room and anechoic chamber response of a typical speaker system.

To get a meaningful frequency-response measurement, we must isolate the speaker system from the effects of the listening room. A special chamber called an anechoic chamber, is used for this purpose. This chamber has no reverberations. A frequency-response measurement made in this chamber represents the response of the speaker system alone. This response can not be obtained in a normal listening room environment (See Fig. 1). The anechoic chamber eliminates the need to define a

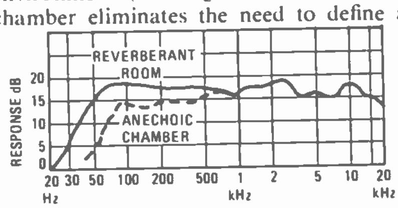


FIG. 1—ACOUSTICAL ENVIRONMENT changes frequency response measurement.

"typical listening room" and provides a common basis for making a comparative judgement.

(When we originally started working on this article we intended to present frequency response charts of every speaker system covered. Unfortunately, we were not able to make these measurements ourselves. Instead we asked the various speaker manufacturers to make them for us according to our specifications. We received this data for many of the speakers, but have decided not to publish it. As we ourselves did not make these measurements we have no way of determining which ones are faithful accurate measurements and which ones have been smoothed out a bit to improve their appearance. As a result we felt the information we have might be misleading and have decided to omit from this article—Editor)

The second condition outlined in our questionnaire specified that a system called ⅓-octave averaging be used. Consider the frequency graphs shown in Figs. 2 and 3. The response in Fig. 3 appears to be vastly superior to that shown in Fig. 2. Yet both responses were taken from the same speaker system. The graph in Fig. 2 is a point-to-point plot that shows every glitch

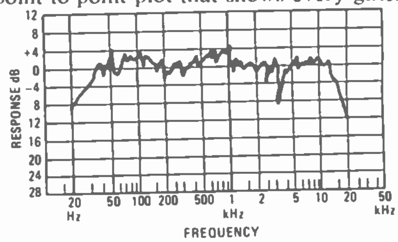
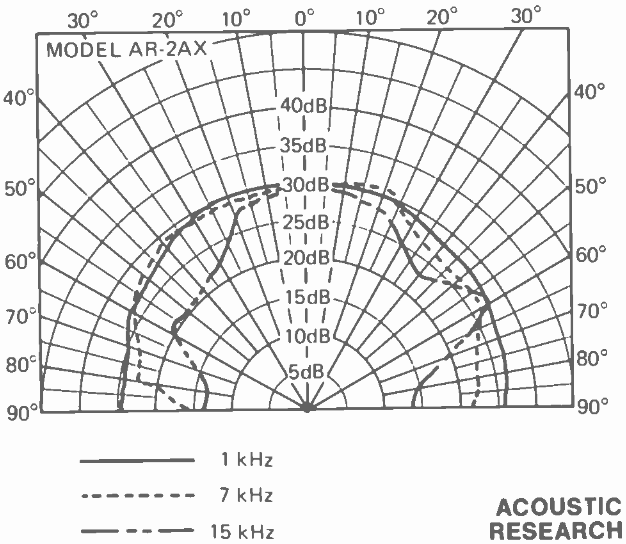
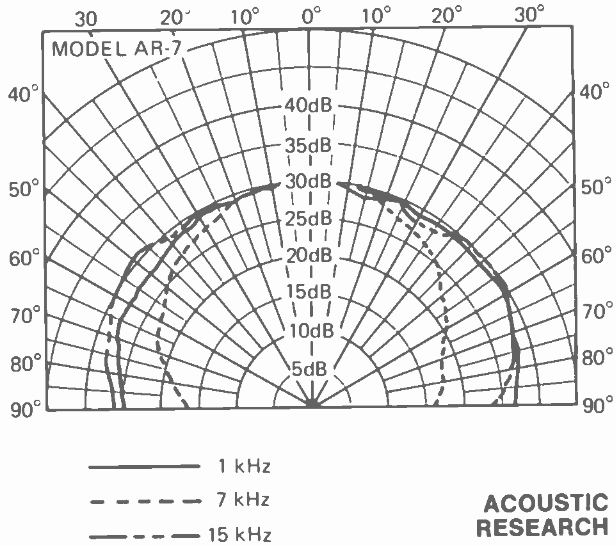
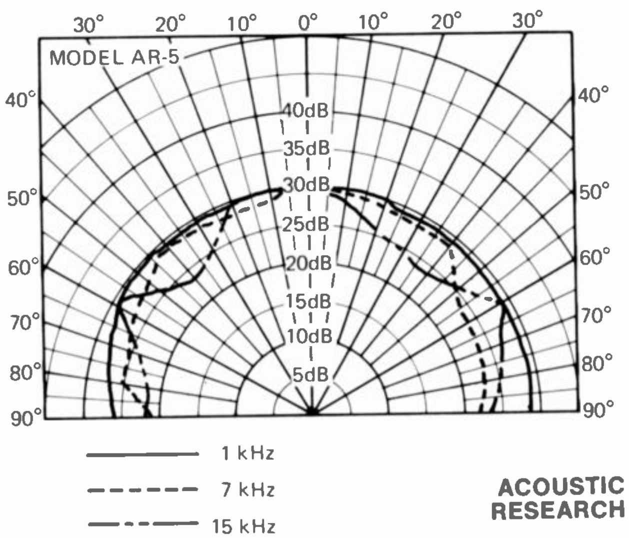


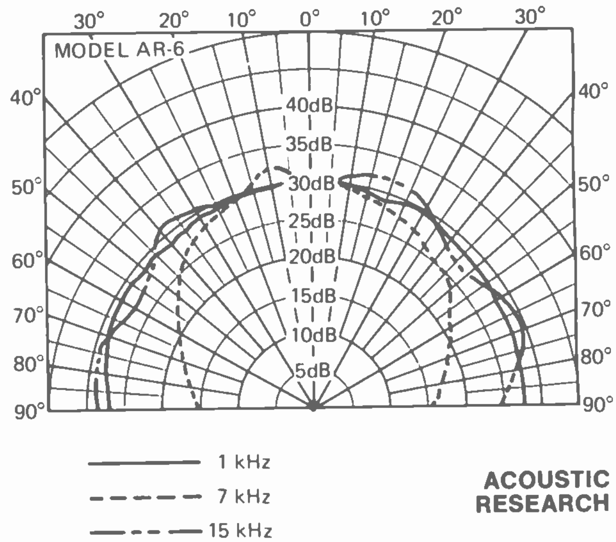
FIG. 2—POINT-TO-POINT response of typical speaker shows every glitch.

in the response. However, it has been suggested that the human ear cannot distinguish between amplitude variations that are less than ⅓-octave wide. Figure 3 is the smoothed version of Fig. 2 where the output over each third of an octave has been averaged. This graph is thought to correspond more nearly to the actual sound that is heard. In any case, for our









purposes, the graph in Fig. 3 is definitely easier to interpret. The other conditions

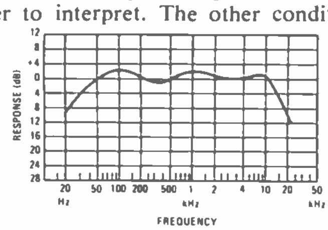


FIG. 3—SMOOTHED response of same speaker shown in Fig. 2 using ⅓-octave averaging.

outlined in the questionnaire specified that the frequency response measurement be made at a distance of 1 meter on-axis.

Analyzing a frequency response graph is not a difficult task provided you know what to look for and the graph is accurate to start with. Ideally, the graph should be ruler flat, extending from an infinitesimal fraction of a hertz above DC all the way out to infinity. Unfortunately, speaker systems aren't capable of producing this kind of response and we must accept what is available. Don't expect the response of a speaker system to even approach the response of a typical amplifier.

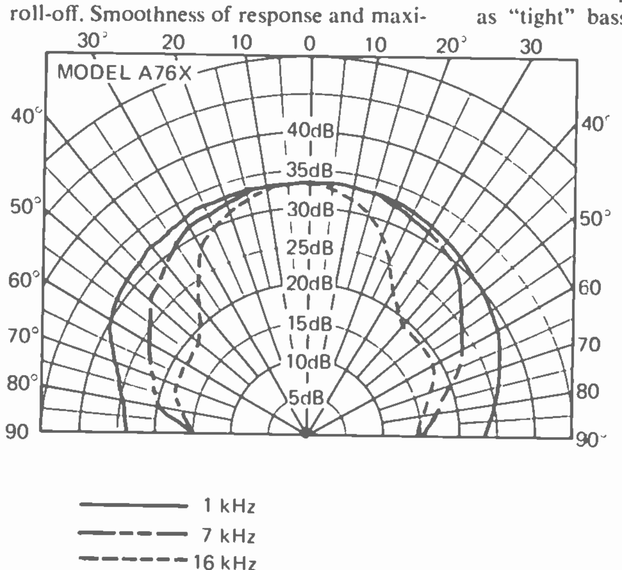
There are several points to look for in a frequency response graph. They are overall balance, smoothness of response, maximum bandwidth and minimum rates of roll-off. Smoothness of response and maximum bandwidth are self explanatory. Overall balance refers to the amplitude balance between the bass, mid-range and treble portions of the audio spectrum. In the common three-driver system, the woofer handles the frequencies below 600 Hz, the tweeter handles the frequencies above 5000 Hz and the mid-range driver handles the frequencies in the middle. The "crossover" frequencies vary from speaker system to speaker system and are approximate.

If the overall output of any one of the drivers is relatively lower than the output of the other drivers, problems will arise. For example, suppose the overall bass response of a speaker system is lower than the mid-range and treble response. A speaker system with this deficiency will reproduce bass notes, but not in the proper balance. As a result, the reproduced music will lack the natural "warmth" that the original music had.

A speaker system with this deficiency will also have a poor transient response in the decay (dying away) portion of a bass note. The attack portion of a bass note, which is composed of mid-range frequency components, will be good. The attack is emphasized by the poor transient response in the decay portion. As a result, the attack will be unnaturally "crisp". This unnatural crispness is sometimes praised as "tight" bass. Tight bass can be quite impressive if you are not aware of the actual sound of the original bass note. It should be avoided however, as it detracts from the reproduction accuracy.

Fast rates of roll-off at the extreme ends of the frequency response graph can produce unnatural sound characteristics. It is not unknown for speaker systems to have a roll-off in the low-frequency end of the spectrum that starts very rapidly and approaches an 18-dB/octave rate. This produces a "heavy" bass effect that some people prefer. However, it again detracts from the reproduction accuracy and should be avoided. Fast rates of roll-off in the high-frequency end of the spectrum produce similar results.

Speaker systems are a compromise of all the above factors and more. Not one factor, however, is more important than any of the other factors. They all affect the reproduction accuracy and should be carefully considered. Don't choose a speaker system with a frequency response that is vastly superior in one or two areas and deficient in the remaining areas. It is better to choose a speaker system that is average in all the areas. This not only applies to frequency response but to the sum total of all the speaker specifications. (Unfortunately, not all manufacturer provide comparable measurements, so you must listen to a speaker system to find out how it sounds. *Editor*) (*turn to p. 48*)



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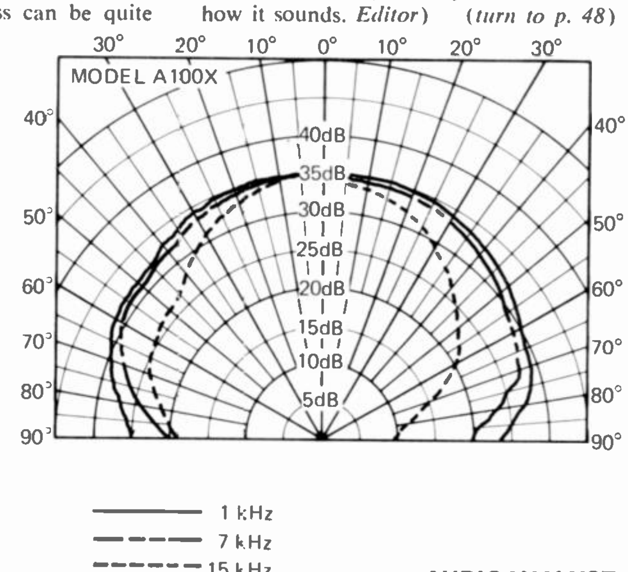

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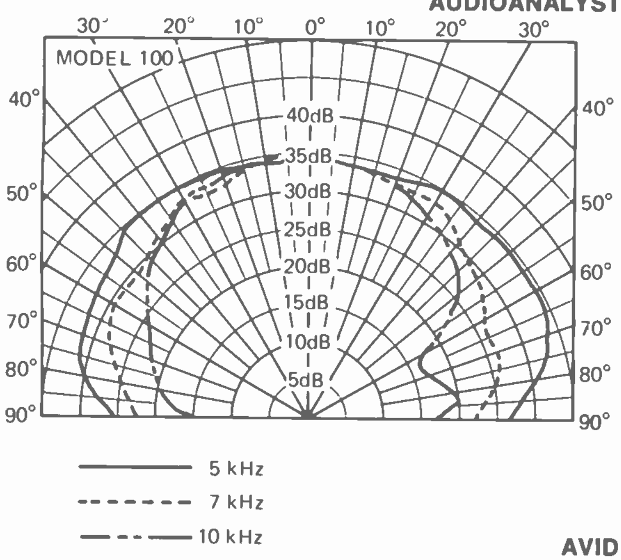
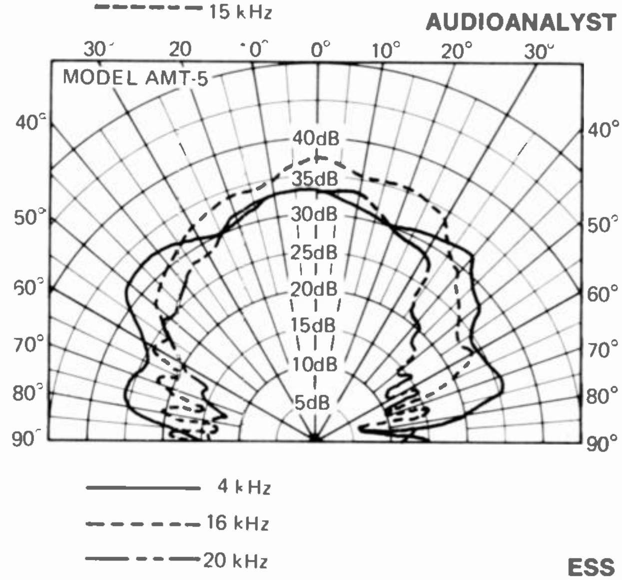


AVID



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Dispersion

This is one of the most important and misunderstood of all the specifications. It refers to the ability of a speaker system to radiate sound energy in different directions. Many mid- and high-frequency drivers have a tendency to beam the sound energy. This effect increases as the frequency increases. The dispersion graph illustrates this effect.

The dispersion graphs presented in this article are polar co-ordinate graphs. These graphs illustrate the dispersion pattern of the speaker system. The rays (See Fig. 4.) emanating from the center point—this point represents the speaker system—are marked off in angular degrees with 0° representing on-axis. Circles or semi-circles represent the various relative amplitude levels.

To obtain a dispersion graph, a microphone is placed in front (on-axis) of the speaker system. The speaker system is driven with a constant-level constant-frequency signal. The microphone is rotated around the speaker system (keeping the microphone-speaker distance constant) and

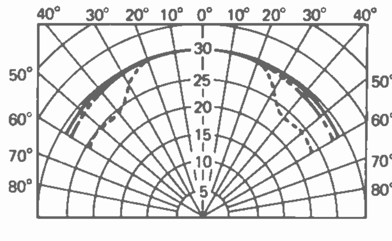
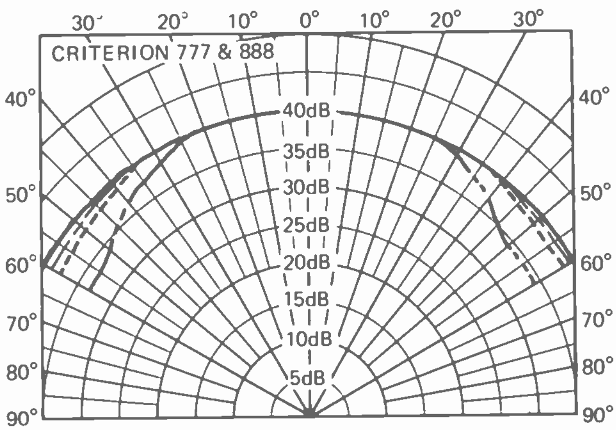


FIG. 4—DISPERSION GRAPH of a typical speaker system.



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10 kHz
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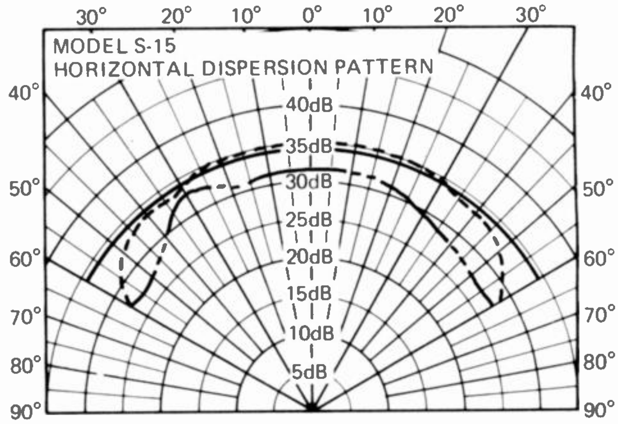
LAFAYETTE



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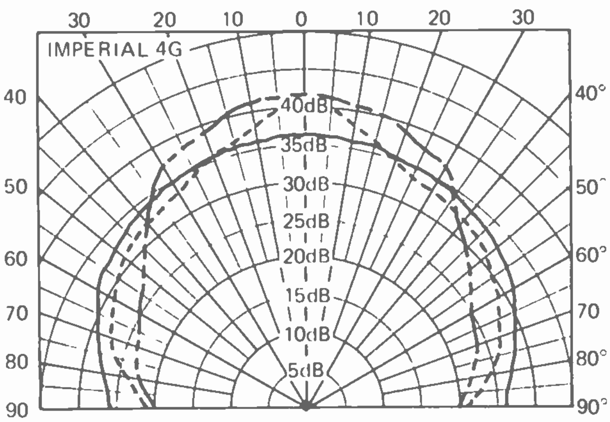
H. H. SCOTT



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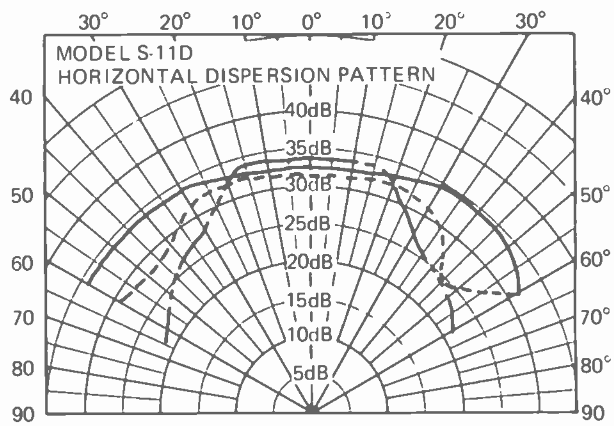
MARANTZ



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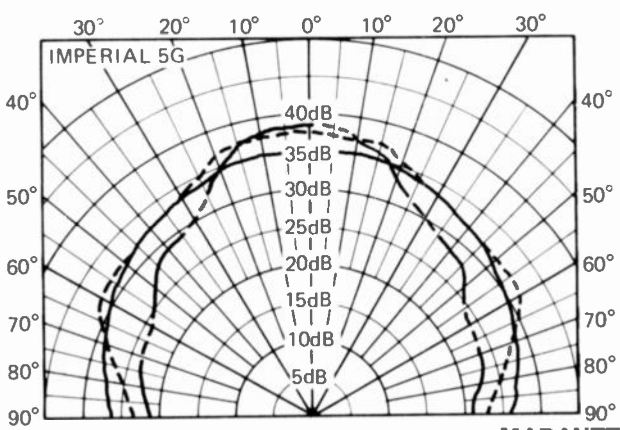
H. H. SCOTT



MARANTZ

1 kHz
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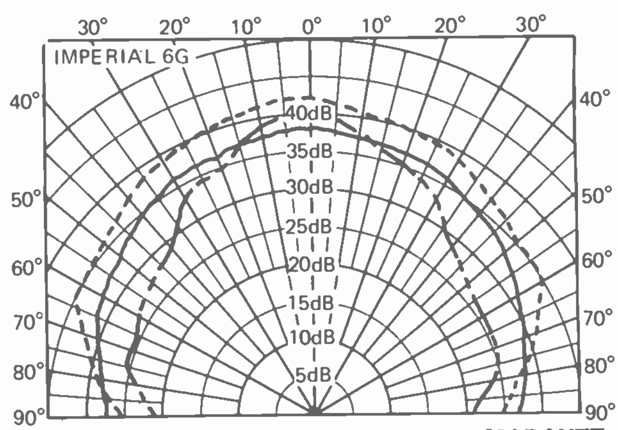

MARANTZ

1 kHz
5 kHz
12 kHz

the output is plotted at different angles. At this point the microphone is returned to the front of the speaker and the frequency of the drive signal is changed. In most cases, the amplitude of the drive signal is held constant (usually 1 watt is the standard.) The procedure is then repeated. Of course, you will probably never have to make this measurement, but the explanation will help you understand the graph. The questionnaire specified that a minimum of three different frequencies be plotted.

As stated previously, dispersion is one of the most important and misunderstood of all the speaker specifications. The off-axis high-frequency sounds of a speaker system with good dispersion will closely approximate the on-axis high-frequency sounds, but this is not the main advantage of good dispersion. When a speaker system is placed in a listening room, the sound reflections create a reverberant field. The *majority* of what is heard is *reflected* sound, not direct sound. As a result, we *primarily* hear the reflected off-axis sound that is radiated by the speaker system even if we are positioned directly on-axis. Therefore, the sound quality is strongly influenced by the sound energy radiated in the other directions.

The dispersion graph goes hand-in-hand with the frequency response graph. A speaker system with a perfect on-axis frequency response but poor dispersion will sound dull and lacking in high-frequency sound. Concert halls have a sense of spaciousness, a sense of openness, created by the many sound reflections reaching the ear from different directions. Speakers with poor dispersion have a hard confined

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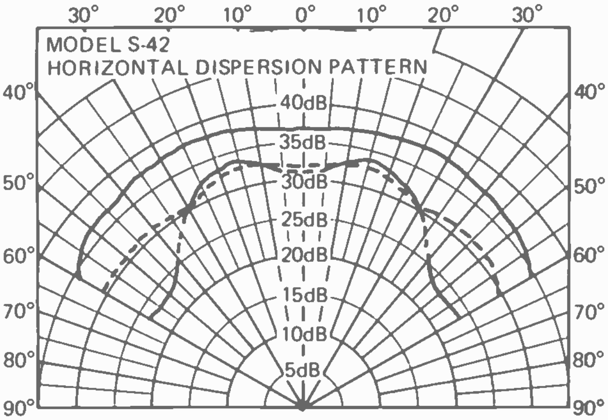

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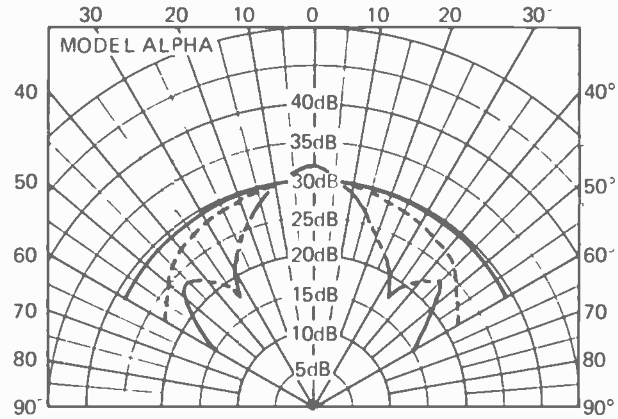

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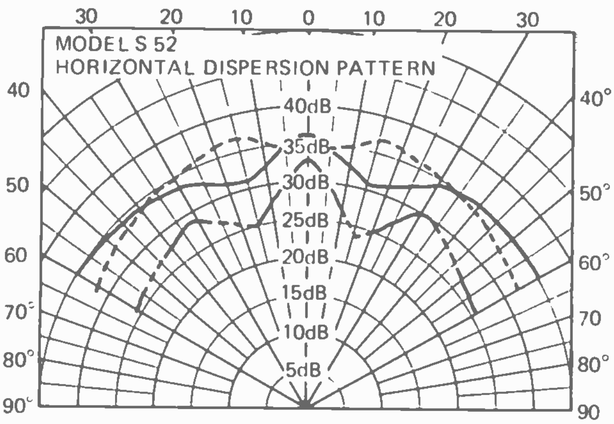

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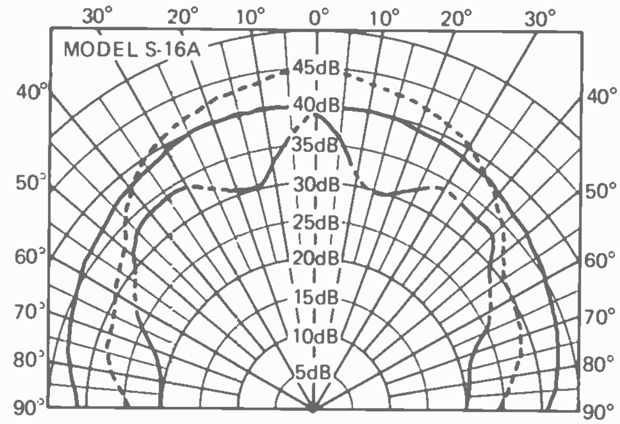

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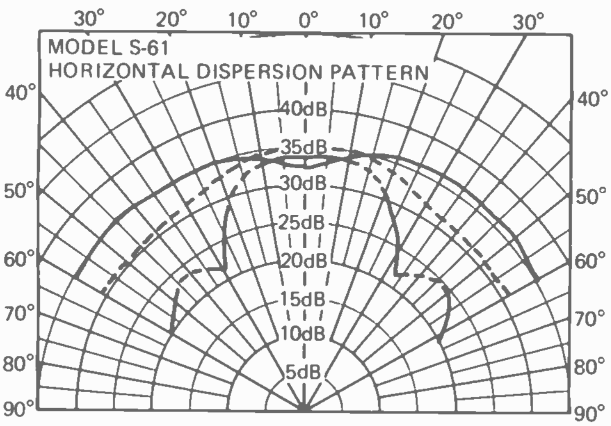
SUPERSCOPE



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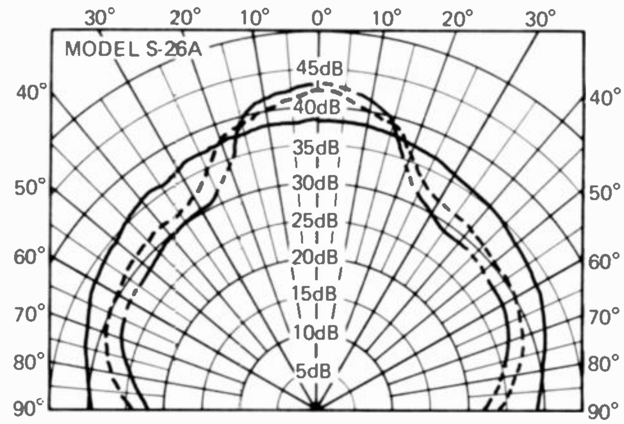
H. H. SCOTT



1 kHz
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SUPERSCOPE

Super-Fi Testing ...the only way to go!

by LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

State-of-art audio equipment has progressed from high-fidelity to super-fidelity. Testing this modern equipment requires modern test gear. Here's the inside story on a new distortion analyzer.

STATE-OF-THE-ART AUDIO MOVES QUICKLY. The amplifiers of just a few years ago, boasting harmonic distortions of perhaps 1.0% or better would be regarded as low-fi gear by today's audiophile. Just a short while ago, an FM tuner that could deliver demodulated signals containing distortion no greater than 1.0 or even 2.0% were regarded as true hi-fi equipment. Today we see tuners with distortion specifications, even when operating in the stereo mode (where distortion tends to be a bit higher), that are 0.1% or even lower.

While progress in consumer audio equipment continues at this fast pace, few users concern themselves with the progress of the test equipment needed to measure and confirm these superb performance specifications. Yet, every manufacturer of hi-fi equipment, not to mention service shops, testing laboratories and quality control departments, faces the problem of how best to measure the new super-fi equipment.

The matter of performance confirmation has become increasingly important since the Federal Trade Commission promulgated its recent Ruling on amplifier power disclosure. To truly measure an amplifier's power and distortion parameters, you must be able to measure power output accurately, at all levels from 0.25 watts output-per-channel up to rated output. Further, such measurements must be made with signal inputs ranging in frequency over the power-band that the manufacturer claims for the product. The newly defined power-band is that range of frequencies over which the amplifier can deliver its rated power. Therefore, to truly verify performance of an amplifier, it is necessary to check distortion at a variety of power levels and at a sufficient number of audio frequencies to make certain that the total harmonic-distortion is always less than (or equal to) the rated figure. Such tests can easily involve dozens if not hundreds of individual distortion readings.

Distortion analyzers found in most audio service shops fall into two categories. There are the simpler units that use a tuned notch-filter that can be adjusted to null out the fundamental frequency in the range from under 20 Hz to 20 kHz or higher. These require a separate audio oscillator or may have a built-in audio oscillator that covers the same frequency range and can be used as the signal source for direct application to the amplifier being tested. The process of manual nulling usually involves careful tuning of the null control until the fundamental frequency is attenuated maximally, followed by an adjustment of the phase relationship between input and output signals to further refine the nulling process. An inexperienced operator may take as long as from thirty seconds to one minute to effectively read a single distortion figure in this manner.

More sophisticated audio distortion meters (such as the Hewlett-Packard 333A or 334A) provide automatic nulling that speeds up the measurement process. That is, once the output signal of the amplifier has been adjusted to read 100% on the distortion meter (for reference), switching to the distortion reading mode causes the instrument to self-tune for best null and permits a more rapid readout of the THD products. For the automatic nulling feature to work in a reasonable amount of time, the instrument must be tuned visually to approximately the frequency of the signal being measured. This type of instrument can reduce effective THD measurement time to between 15 seconds and 30 seconds, but as signal levels are changed (corresponding to different levels of power output), the operator must re-set the 100% reference point for each new measurement, at each new frequency—still a time consuming process.

A new laboratory distortion analyzer

More than two years ago, we were introduced to a new distortion analyzer, built by Sound Technology (10601 S. Saratoga-Sunnyvale Road, Cupertino, CA 08882). These are the same people who designed and sell the famous FM generator (model 1000A) that has become the standard instrument for measuring FM performance of tuners and receivers (we use this in our R-E Equipment Reports). When we first saw the new model 1700A Distortion Measurement System, we were impressed by the fact that it contained a built-in low-distortion audio oscillator that would enable users to measure THD to around 0.002%. Our best audio oscillator at the time guaranteed a residual THD of 0.02%—or a whole order-of-magnitude worse. We were also impressed with the automatic nulling feature that reduced the nulling time to approximately five seconds per reading. But, we held off spending the approximately $1500.00 that the instrument cost since we felt that our THD reading capability at the time was adequate and that the savings in time would not pay for the new investment for quite a while. More recently, we learned of a new option that could be purchased when buying with 1700A that changed our thinking completely. With option 003 (as the company calls it), not only does the

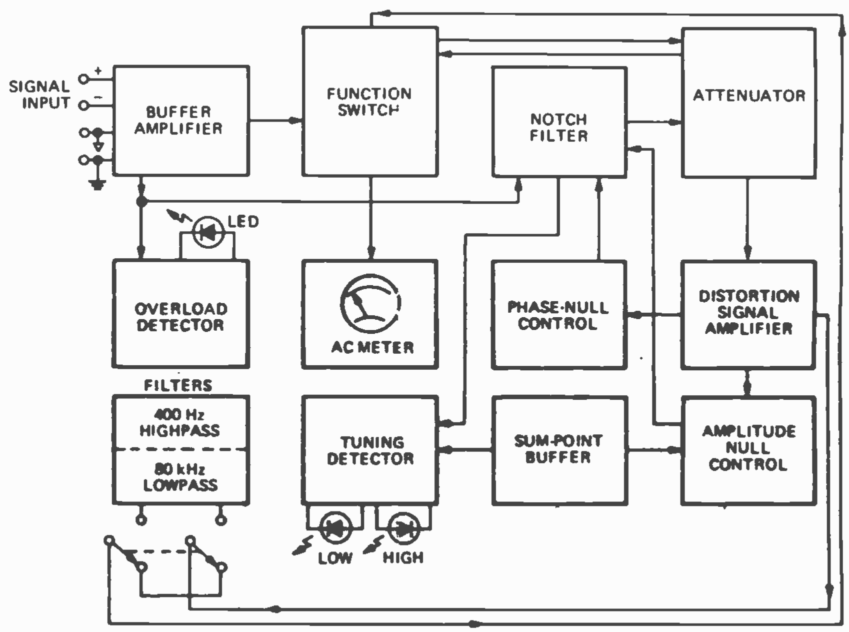

FIG. 2—DISTORTION ANALYZER section of Sound Technology model 1700A Distortion Measurement System.

FIG. 1—SOUND TECHNOLOGY MODEL 1700A distortion measurement system.

machine measure distortion at any power level and at any frequency from 10 Hz to 110 kHz, but in addition to the automatic nulling feature, there is now an automatic 100% reference level adjust—which means no more fussing with a knob every time you change the output level. You can make successive readings of distortion just about every five seconds, directly in % THD. We figured that this would enable us to measure about 500 readings per hour (allowing time for breath-catching) and that was enough to convince us to buy the unit.

A close-up view of the front panel of the 1700A is shown in Fig. 1. Here are some of the things you can do with it:

1. Use the .001% distortion audio oscillator for testing any audio equipment at frequencies from 10 Hz to 110 kHz.
2. Measure total harmonic-distortion down to 0.002% in 5 seconds.
3. Measure AC voltages from 30 microvolts to 300 volts with 2% accuracy at full scale.
4. Measure voltage or signal-to-noise ratios with 100-dB dynamic range.
5. Measure power levels across an external 8-ohm load (the taut-band meter is calibrated in watts, as well as dB's, % and volts).
6. Apply 400 Hz and/or 80 kHz high and low-pass filters to eliminate hum and high-frequency noise components from all measurements.

The 1700A features a differential input, which means that signals can be applied from floating or balanced output sources. This is particularly useful when you are trying to measure noise or THD that is "down in the mud" and might otherwise be influenced by ground loops. It is also essential when trying to measure the output from strapped amplifiers (such as the new 4-channel units which, when strapped for 2-channel operation do not permit connection of a common ground between channels).

How it works

A block diagram of the 1700A Distortion Analyzer section is shown in Fig. 2. The signal to be measured is connected to the input of a buffer amplifier. This circuit has two outputs; a fixed output that may be connected to the AC voltmeter, and a variable ouput (controlled by the ADJUST control on the front panel) that is connected to the notch filter. The voltmeter is an average reading type that measures the signal level selected by the appropriate function switch.

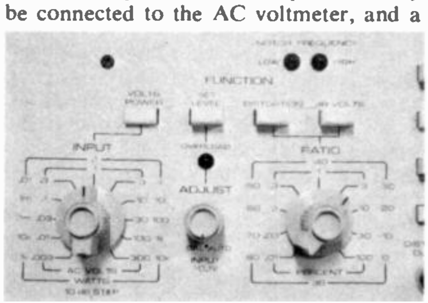

FIG. 3—AUTOMATIC LEVEL SET is accomplished by rotating the ADJUST knob to the AUTO position when making distortion measurements.

The overload detector monitors the variable output of the buffer amplifier. If an excessively high voltage is applied, the detector turns on the front panel overload indicator that remains illuminated until the user moves to an appropriately higher scale on the front panel input or RATIO selector switches.

The notch filter is mechanically coupled to the audio oscillator FREQUENCY selector switches. It suppresses the fundamental frequency from the output of the buffer amplifier. The ouput of the notch filter is connected to the input of the distortion amplifier through a step attenuator controlled by the front panel RATIO switch. This attenuator adjusts signal level for the distortion amplifier for the various percentages of distortion or voltage ratio readings.

The amplitude null control and phase null control circuits supply the notch filter with its automatic nulling feature. Both circuits monitor the output of the distortion amplifier and feed control signals back to the notch filter. The sum-point buffer supplies reference signals to the tuning indicator and to the amplitude null control circuit.

The tuning indicator circuit, using frequency information from the notch filter, provides the user with a visual indication of the frequency being analyzed versus the input frequency. This circuit operates two lights on the front panel labelled HIGH and LOW. Normally, they will not become illuminated so long as the built-in audio oscillator is used with the analyzer, since the pre-set frequency of this oscillator is close enough in frequency to the tuned settings of the notch filter for the automatic nulling to work quickly and effectively. However, since it is possible to measure the distortion of equipment using other signal sources (such as a separate audio oscillator), the indicators help the operator to select the correct frequency selector buttons on the 1700A for quick and accurate automatic nulling under these conditions.

The switchable low-frequency and high-frequency filters (with cut-off frequencies of 400 Hz and 80 kHz respectively, and 18 dB-per-octave slopes) are connected to the output of the distortion amplifier. Thus, they may be selected only for distortion and dB or voltage ratio measurements.

The function switches select the circuit to be measured by the AC voltmeter. When the VOLTS/POWER switch is depressed, the meter monitors the output via a stepped attenuator from the buffer amplifier. When the SET-LEVEL switch is depressed, the meter monitors the variable output from the buffer amplifier. Depressing the DISTORTION switch connects the signal from the distortion amplifier via the low- and high-frequency filters (if they

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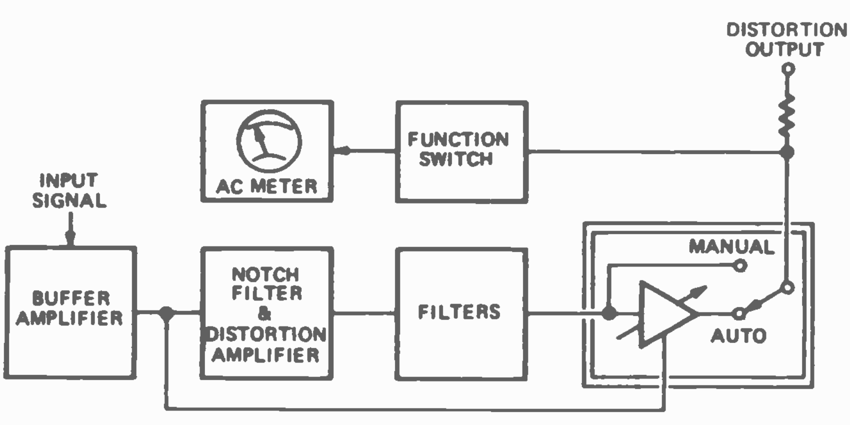


FIG. 4—AUTOMATIC LEVEL ADJUST feature on the model 1700A.

add-ons improve your Hi-Fi rig

Greater operational flexibility and improved performance are gained when these add-ons are incorporated into your component hi-fi rig.

by FRED PETRAS

NOT LONG AGO A "COMPLETE" AUDIO SYSTEM usually consisted of a tuner, a control amp, record player, one to three tape units and speakers. Such a system provided a fair measure of operational flexibility and control of a signal from electrical impulse to reproduced sound.

But audio technology kept improving, and the audiophile abreast of the advances found himself questing even greater flexibility from his rig, and greater capability to accommodate needs generated by the advancing technology.

Today's HI-FI rig not only includes the system mentioned above, but may easily contain as many—or more—*additional* units as in the basic system. Today's audio buff has far more flexibility of operation, far broader capability, and substantially more control of the signal from impulse to sound waves. In effect, many of today's HI-FI systems are mini "sound studios," a result of add-ons widely available to audio buffs, and not necessarily expensive.

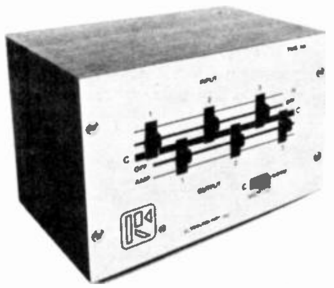
The add-ons are in effect, comparable to accessories available to car buffs, but far more functional. They can be regarded as "creative" additions to a HI-FI rig, that make it possible for the enthusiast to be more deeply involved with his equipment and to tailor the sound to his desires . . . with considerable ease and convenience. They can also improve the function and quality of the system. Essentially, the accessories we'll discuss can be regarded as practical, professional devices that enhance the pleasure potential of your HI-FI outfit. Why not add some to yours?

Equalizers

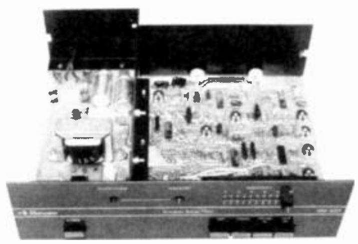
One of the most versatile add-ons is the equalizer. It is a multi-function device that helps "tune" the listening room for optimum sound/acoustic qualities; helps change the characteristics of a record by enhancing the music in favor of a vocalist —or vice-versa, change voice characteristics and change musical sounds in other ways; adjusts reproduction of 78 rpm shellac records so they sound as they were meant to; cuts back low frequency response to eliminate hum; helps balance the response of some cartridge recordings so they sound better in the home and does the same for other tape recordings whose response is non-linear; improves broadcasts from radio stations that effect rolloffs at both ends of the sound spectrum; compensates for the boosted highs of Dolbyized tapes; enables the user to sometimes improve the response characteristics of phono cartridges and microphones; and adjusts the response characteristics of speaker systems to "color" their sound, or to eliminate "coloration."

The practical applications mentioned are obvious; an equalizer enables the buff to create personalized sound reproduction, to satisfy individual preference or specific aural needs and/or sophistication. But there's more . . . an equalizer can be a "fun" device, permitting you to alter sounds to a point of non-recognition, to do zany things to sound just for laughs.

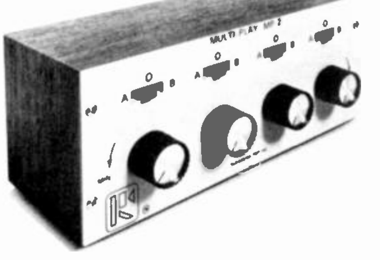
There are equalizers in at least eleven nationally-distributed brands: Altec, BSR, Burwen, Custom Designs, JVC, McIntosh, Quintessense, Realistic, SAE, Soundcraftsmen, and Southwest Technical. They fit slim as well as fat budgets, namely $69.50 (Realistic) to $1095 (Burwen). They permit sound alteration in at least four bands, and as many as 24, in a range of plus/minus 12 to 16 dB, and in one case plus 24, minus 12 dB. Their total harmonic distortion is minimal—from 0.001 to 0.5 per cent, and signal/noise ratio maximal—65 to 100 dB. Their size and shape are typical of most audio components, and they can



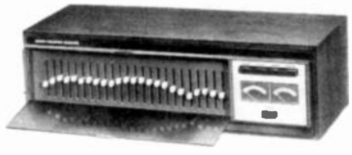
RUSSOUND MODEL TMS-1W tape recorder selector switch.



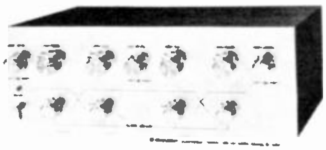
BURWEN MODEL DNF 1201 dynamic noise filter.



RUSSOUND MODEL MP-2 speaker and amplifier switch control.



BSR MODEL FEW-3 frequency equalizer.



PIONEER MODEL SF-850 electronic crossover network.

SCOTT INSTRUMENTS MODEL 451C sound level meter.

be plugged into most any HI-FI rig just like any other component.

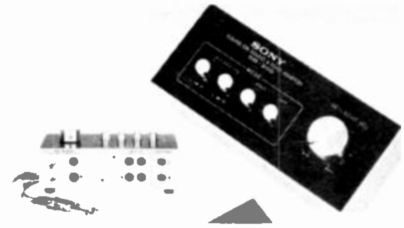
Noise reduction systems

Today's audio buff is no longer at the mercy of noise. He can reduce or switch out the annoying hiss and other noises associated with recorded tapes and phono records as well as radio broadcasts—with virtually no effect on the music being reproduced. He can do this through at least five different approaches.

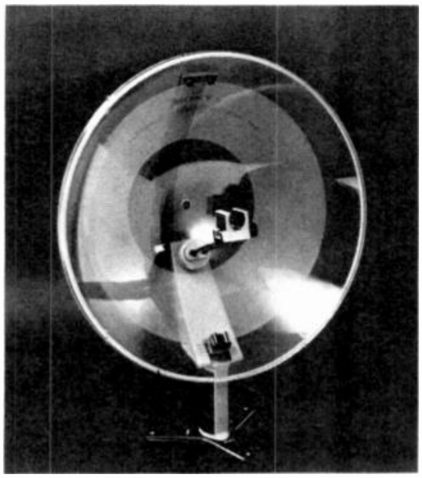
The five approaches break down into two basic types—closed-end and open-end. Within the closed-end group—covering equipment from Dolby and Dolby licensees, JVC, and some from dbx—*professional* noise-reduction units are used in program production at recording studios (and in some cases, radio stations) to code the program material. At the other end, the home *consumer type* noise-reduction units are used to decode the program material for playback. Included in the consumer types are models that permit the home tape recordist to perform both the coding and decoding. Overall recordings (and broadcasts) processed through Dolby equipment benefit by up to 10 dB less noise; under the JVC ANRS approach there is a 5 to 10 dB improvement; and using certain dbx brand equipment, the improvement is as high as a claimed 30 dB. Prices for home type Dolby noise-reduction equipment start at $89.95 and range to $400 for a quad model. The JVC unit is $150. The dbx models sell for $259 to $379, the latter a combination two-channel/four-channel instrument.

NOTE: The three record/playback noise reduction systems are incompatible; recordings made under each approach must be played back within that approach for optimum results.

The open-end group covers units from Burwen, Phase Linear and some from dbx. These are playback-only models and are used to reduce noise in *existing* program materials such as records, tapes and radio broadcasts, in a range of 6 to 20 dB. The model from Burwen is priced at $299. The Phase Linear unit, a preamp containing a noise reduction circuit called an "Auto-



SONY MODEL SB-200 sound-on-sound and echo adaptor and SB-300 tape recorder selector.



SONY MODEL PBR-400 parabolic reflector.

Correlator" is $599. One dbx unit, Model 117, is $159, the other, Model 119, is $189. On the way is a separate "Auto-Correlator" to be priced around $300.

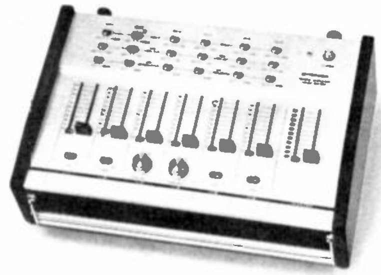
Each system—closed- and open-ended—uses a proprietary means to achieve noise reduction; it is beyond the scope of this article to delineate the differences. If you decide to buy such equipment, be sure to determine the differences, to most effectively fill your listening needs.

Other add-ons

In record/tape production and in radio broadcasting, it is necessary to compress the dynamic range (ratio between soft and loud passages) of the program material in order not to overload the equipment. Consequently you do not hear the program material in its optimum form, even though it may be quite satisfying to most listeners. For the audio buff seeking the last nuance of reproduction, add-ons are the answer. One such unit is the Robins "Stereo Dynamic Sound Enhancer," priced at $30. It "expands" the compressed dynamic range of recordings and broadcasts up to 8 dB, to come that much closer to the original sound. Expansion of up to 20 dB is claimed for the dbx Model 117, a noise reduction unit (mentioned earlier) which incorporates compression/expansion in its particular approach to reducing noise.

Radio stations have found that by Dolby processing their FM broadcasts they can triple their effective broadcast range. Hence, many stations have adopted this procedure and more are doing so. And, of course, astute equipment manufacturers have been sizing up the situation and have been getting into the act with tuners and receivers containing Dolby circuitry.

Since Dolby broadcasting began back in 1971, there has been a change in the pre-emphasis requirement, from 75 micro-



PIONEER MODEL MA-62 6-channel mixing amplifier.

SONY MODEL MX-8 passive 6-channel mic/line mixer.

seconds to 25 microseconds. But leave it to smart equipment manufacturers to see a problem, then attempt to solve it. Now available to owners of early Dolbyized tuners and receivers are add-ons that permit dual operation; they convert a 75 microsecond unit to 25 microsecond operation, at a mere $12.95 investment in a device from Switchcraft. The widget also converts separate Dolby units for optimum results in listening to or taping FM broadcasts.

The AM section of tuners and receivers has been the subject of many blasts at the industry for not improving AM broadcasting and/or reception. The industry has bypassed the complaints, or promised constructive action in the future, a future which has already encompassed many years. But one company has come to the rescue. It is Dymek, with its Model DA3 shielded ferrite antenna system which greatly increases the sensitivity of a receiver's AM section, AM tuner, or AM section of an AM/FM tuner. It also reduces electrical interference and nulls out interfering signals through tilting and tuning. The indoor device comes in a space-age configuration that causes people to ask "What IS it?" The price, $155.00.

Some audio buffs like to experiment to obtain "super" sound. In addition to using an equalizer, one way is through checking/comparing phono cartridges. The most effective way is on an A/B basis—side by side comparisons. This is difficult unless you have two turntables. But owning two turntables is not always the answer; your preamp, amplifier or receiver is most likely geared to accommodate one turntable with a magnetic cartridge and one with a ceramic cartridge—permitting comparisons of "apples with oranges," but no "apples with apples," so to speak. If you're into cartridge checkouts, it's most likely at the level of magnetic models. To the rescue comes All-Test Devices Corp. with its

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There are no classes to attend. No dry lectures to sit through. Everything comes to you in the mail. Lesson by lesson. Exciting package after package. And you work at a flexible pace in the relaxed atmosphere of your workshop—or wherever your favorite spot may be.

Sure, books are important. But they're only the beginning.

With this fascinating learn-at-home program, you do a lot more than just read about electronics. You'll conduct dozens of experiments . . . build your own laboratory equipment for testing out electronics principles . . . and also as part of this program you put together a 4-channel amplifier and FM/FM stereo tuner as you delve into advanced audio technology.

We try to make learning so interesting you look forward to receiving each new lesson. And enthusiastically dive into each new project we send you.

We'll start you off on the right foot.

You may be thinking, "I don't have any training in electronics . . . I might be getting in over my head."

Well, you can stop worrying about that. You don't need previous experience. You'll begin with the basics and acquire a thorough understanding of the fundamentals before moving on.

And remember, it's not just reading. With your very first lesson you get our LAB STARTER KIT, consisting of a simple voltmeter and electronics "breadboard" you can experiment with right away.

Of course, if you're already into electronics, you might be thinking, "I already know the basics . . . I want to get into the advanced stuff right away!"

For you there's an advanced standing program that lets you skip the beginning lessons.

Next you build the exclusive Electro-Lab® electronics training system.

Once you've mastered the basics, we'll send you everything you need to put together these three important testing instruments:

The design console. You use it to set up and examine various kinds of circuits. It's completely modular . . . no soldering!

The digital multimeter. Use it to measure voltage, current and resistance. Displays data accurately in big, clear numbers—just like on a digital clock.

The solid-state "triggered-sweep" oscilloscope. Use it to analyze modern,

HANNEL AUDIO!

state-of-the-art integrated circuits. Triggered-sweep feature locks in signals for easier observation.

These three superb testing instruments are the basis of your own home electronics laboratory. You'll use them throughout the program as you move into more advanced electronics principles and work into audio technology.

Bell & Howell's high performance 4-channel audio center you actually build and experiment with yourself!

You need practical experience with high caliber equipment to develop professional skills and understand the ins and outs of today's audio technology.

So we came up with a system that Bell & Howell is proud to have its name on:

First, there's the sophisticated outstanding 4-channel amplifier with SQ full-logic decoding and front to back separation.

35 watts per channel—Min. RMS into 8 ohms at less than 0.25% total harmonic distortion from 20-20,000 Hz, all channels fully driven.

As you build and experiment with this remarkable piece of equipment, you'll learn about matrix 4-channel and discrete—including CD-4 when processed through an external demodulator.

And with it you'll have the advanced circuitry you need to get into signal tracing low level circuits . . . trouble-shooting high power amplifier stages . . . and checking the operation of tone control circuits.

Next, the advanced FM-FM stereo tuner. As you build this superb stereo tuner, you'll come to fully understand how the advanced, "state-of-the-art" features lead to such high performance. You'll learn about all solid-state construction, FET front end for superior sensitivity, crystal IF filters for wide bandwidth and the superior multiplex circuit that produces such excellent stereo separation.

A wealth of knowledge in digestible chunks.

O.K.! So now you might be thinking, "It sounds really interesting . . . but kind of complicated." And you're right. But that is why we use the "hands on" teaching approach.

We've taken all the material and broken it down into short, simple-to-grasp lessons, so you can master one thing at a time before moving on. And we take you through it step by step. From the basics to advanced theory to applied audio technology. So you actually have an easier time with it.

Special learning opportunities give you extra help and attention.

In case you do run into a problem or two, we're ready to give you more help and personal attention than you'd expect from most learn-at-home programs.

For example, many home study schools ask you to mail in your questions. Bell & Howell Schools gives you a toll-free number to call for answers you need right away.

Few home study schools offer personal contact with instructors. Bell & Howell Schools organizes "help sessions" in 50 major cities at various times during the year—where you can discuss problems with fellow students and instructors in person.

And when you're done, you'll know a lot more than just 4-channel sound!

You'll have covered the complete spectrum of electronics principles, leading to a full understanding of audio technology.

And while no school can promise you a job or income opportunity, you will have occupational skills necessary to become a full-service technician. With the ability to work on the entire range of audio equipment. Such as tape recorders, cassette players, FM antennas and commercial sound systems. You'll know audio technology from the inside out. And you'll be proud of it.

Plus you will have the basic skills that apply to the entire electronics field, including television technology and repair.

For more details, mail card today!

Here's your chance to break out of the mold. And break into 4-channel audio with Bell & Howell Schools. Why not look into it today. Mail the attached postage-paid card now.

Taken for vocational purposes, this program is approved by the state approval agency for Veterans' Benefits.

Wood cabinets available at extra cost.

"Electro-Lab®" is a registered trademark of the Bell & Howell Company

If card has been removed, write:

An Electronics Home Study School
DEVRY INSTITUTE OF TECHNOLOGY 766 R2
ONE OF THE
BELL & HOWELL SCHOOLS
4141 Belmont, Chicago, Illinois 60641

Model ATD-25 "Laboratory Reference Phono-Preamplifier" priced at $150. The add-on was designed to amplify magnetic phono cartridge signals to a level that will drive the high level inputs of any stereo preamplifier, integrated amplifier or receiver. The unit has less than 0.01 per cent IM distortion, thus giving you two similar sources for comparing magnetic cartridges. (NOTE: There is a caveat in this; All-Test claims that the input involving the ATD-25 will actually be superior to the existing magnetic input. The degree to which it will be superior will relate to the basic quality/price of the equipment; there will be more of a difference if the existing equipment is low priced.)

If cartridge checkouts are not your bag, the ATD-25 will stand on its own original *raison d'etre*—as a second, high quality magnetic phono facility that may be superior to an existing one.

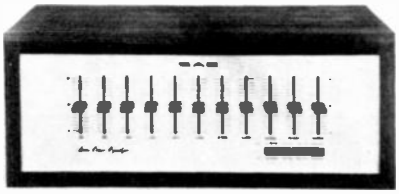
Many stereo buffs are not convinced that four-channel sound is a viable entity yet. They are curious however, but not curious enough to make a grand investment in the growing medium. They have an "out" in the form of add-ons that will give them a taste of quadriphonics that may be sufficient to convince them they can live without quad sound, or to convince them they can't, and that they *should* make the grand investment. The add-ons are best described as "quad adaptors." They are low-priced passive devices that create a four-channel *effect* from stereo records, tapes or broadcasts in conjunction with a second pair of speaker systems. The instruments are priced as little as $6.95 (Robins) and range up to $40 in the Utah line. BSR markets a "package" of a quad adaptor and a pair of speaker systems for $60.

(If you should succumb to the benefits of quad sound, you would be put in the position of evaluating your present equipment *vis-a-vis* the true-quad add-on equipment route, or starting off with a new quad receiver, amplifier or tape deck as your prime sound source. In either case, the subject is too involved to spell out within the scope of this article.)

The Hi-Fi buffs using tape decks in their rigs have an excellent potential for expressing their creativity and expanding the capability of their equipment through add-on mixers. With such equipment they can produce special effects using multiple microphone and other sound sources, to mix and blend the sounds in a variety of ways to suit their fancy. The consumer type mixers generally have six channels of input and two channels of output for the mixed signal to be fed into the stereo tape recorder. However, if you have four-channel equipment, TEAC has a model with six chanels in, four out, or if you wish, one, two or three out. Available from Sony, Pioneer and TEAC, the mixers range from $59.95 for a passive model, up to $250 for an amplified type. Two models are twin-powered, operating off house current and/or batteries.

Related to the mixers is a sound-on-sound and echo adaptor from Sony, Model SB-200. It is an inexpensive ($39.95) way to add studio-type special effects in home recordings. Echo can be created, and its intensity regulated, on any three-head tape recorder. The sound-on-sound capability allows multiple source recordings to be built up with perfect synchronization on any two or three-head tape deck with the ability to record each channel independently.

ALL-TEST DEVICES **laboratory reference phono preamplifier.**



SAE stereo octave equalizer.

JVC MODEL NR-1020 noise reduction unit.

BSR METROTEC sound level meter.

Another aid to tape recordists is a parabolic reflector from Sony, Model PBR-400, priced at $79.95. The attachment was designed to pick up high quality sound from a distance. Depending on climatic conditions and surroundings, it has an effective recording range of several hundred yards. It can be used in a variety of ways, including field research recording such as capturing the sounds of birds, recording live concerts, speeches, sporting events, etc. The PBR-400 will improve the sound sensitivity of most omni-directional microphones by 10 to 20 dB over rated sensitivity, the company claims. The reflector is hand operable or can be mounted on a tripod.

A final aid to tape recordists—those into tape in a big way—are multi-tape recorder switches. These enable the user to interconnect up to three different tape decks so that all or any can record or play at the same time in any combination, operating through a single preamp, amplifier, receiver or mixer. They are ideal for dubbing from one format to one or two others, or recording in all three basic formats simultaneously—as well as for other uses. Typical are models from Russound, the TMS-1W at $22.95 and $32.95, depending on finish, and Sony, Model SB-300 at $44.95.

Audiophiles wanting to expand the playing capability of their rigs beyond just the listening room can do so with add-ons. While many amplifiers and receivers permit connection of an additional pair of speaker systems, you may want to operate speakers in three or four different locations. At your aid is Russound, with its MP-2 speaker amplifier control switch priced at $69.95. The control does the following: Selects either of two amplifier sources and directs the output of either to any or all speakers. It distributes sound to any one, two, three or four pairs of stereo speakers from a central location. Changes the volume of one or turns on or off completely without affecting the sound level of the others. Connects any combination of high and low efficiency speakers with any mix of impedances. Maintains proper loading of your amplifier regardless of the number of speakers in use or their volume control settings. Other, less elaborate speaker or speaker/amplifier switching devices are also obtainable from Switchcraft, Audiotex, and Lafayette Radio, as well as Russound. They are priced from $11 to $82.50. Russound also has a "super-deluxe" switching center at $250.00.

The speaker switching boxes also permit the HI-FI "nut" or sound perfectionist to play different kinds of music with different types of speakers—all at the touch of a switch.

Audio buffs experimenting or "playing around" with speaker systems have a handy widget in the form of sound level meters, available from BSR at $60 and from Scott Instruments at $98. The meters, with a range of 60 to 116 dB and 45 to 130 dB, respectively, permit checks of speaker systems to help balance their outputs, or, in conjunction with an equalizer, enable the user to obtain precise flat reproduction and accurately tune the speakers to a room setting. They also permit measurements of ambient and background noise, as well as other signals of interest. The BSR model also acts as a quality microphone.

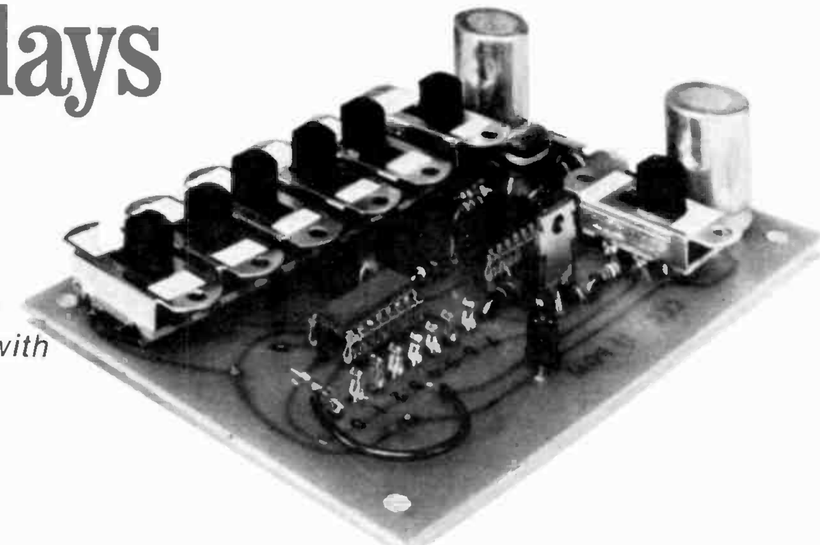
A final add-on that can assure optimum performance of a HI-FI system is the "Turntable Foundation" by Discwasher. The foundation is just that—a solid base on which to place a turntable. Made of thick marble and mounted on eight damping feet, the device filters out vibrations and rumble that can affect the performance of the turntable. If your player is sensitive to feedback generated by subtle or overt vibrations in the listening room, the Discwasher foundation may be just what the doctor ordered. Price, $40.

Maintenance and prevention

Radio-Electronics readers are familiar

(continued on page 78)

IC Doorbell Plays Your Song



You can program your own tune into this device and connect it to your doorbell. It features a PROM with a 32-note capacity.

by RALPH E. COUSINO

PART 1 OF THIS ARTICLE CONTAINED THE circuit description and construction details for this unusual doorbell.

This month, part 2 concludes this article with the circuit and programming details for the PROM.

Programming your melody

The electronic music box covers two octaves which provides the musical range to program most melodies. These two octaves begin at F below middle C or F3, when the master oscillator is set for 21560 HZ. Table I illustrates programming for the melody "Home Sweet Home." The notes of the melody are shown in the sequence in which they are played, beginning with program step one. The corresponding beats per note is also shown and designates the time the note will be held. The program word consists of eight bits B7 through B0. Refer to Tables II and III for the proper encoding of each note and beat. Since the melody requires only 28 steps, the remaining four steps are muted by making B3, B2, B1 and B0 all high. Where it is required to hold a note longer than four beats, step to the next word. Repeat the note and hold for the required additional beats. This is illustrated by steps #13 and #14, plus #27 and #28 where six beats are required.

The PROM can now be set up with your completed program. The address for each word should be noted as in Table I. Addressing all words of the PROM, blow the fuse to program each bit as shown for your melody. The program may be checked before programming the PROM. With the PROM IC6 and IC1 removed from their sockets, connect the poles of six SPDT switches to pins 1, 2, 3, 4, 5 and 6 of IC6. This corresponds to bit positions B0, B1, B2, B3, B4 and B5, respectively. One side of the switches should be tied to 5 volts —the other to ground. In the 5 volt position, a "1" is programmed. In the ground position, a "0" is programmed. Set the switches for the note required which plays continuously. Using a tape recorder with pause control, record each note in the sequence it will be played for a period equal to the number of beats it is to be held. Playing back the tape you will hear the melody.

TABLE I

PROGRAMMING FOR THE MELODY "HOME SWEET HOME"

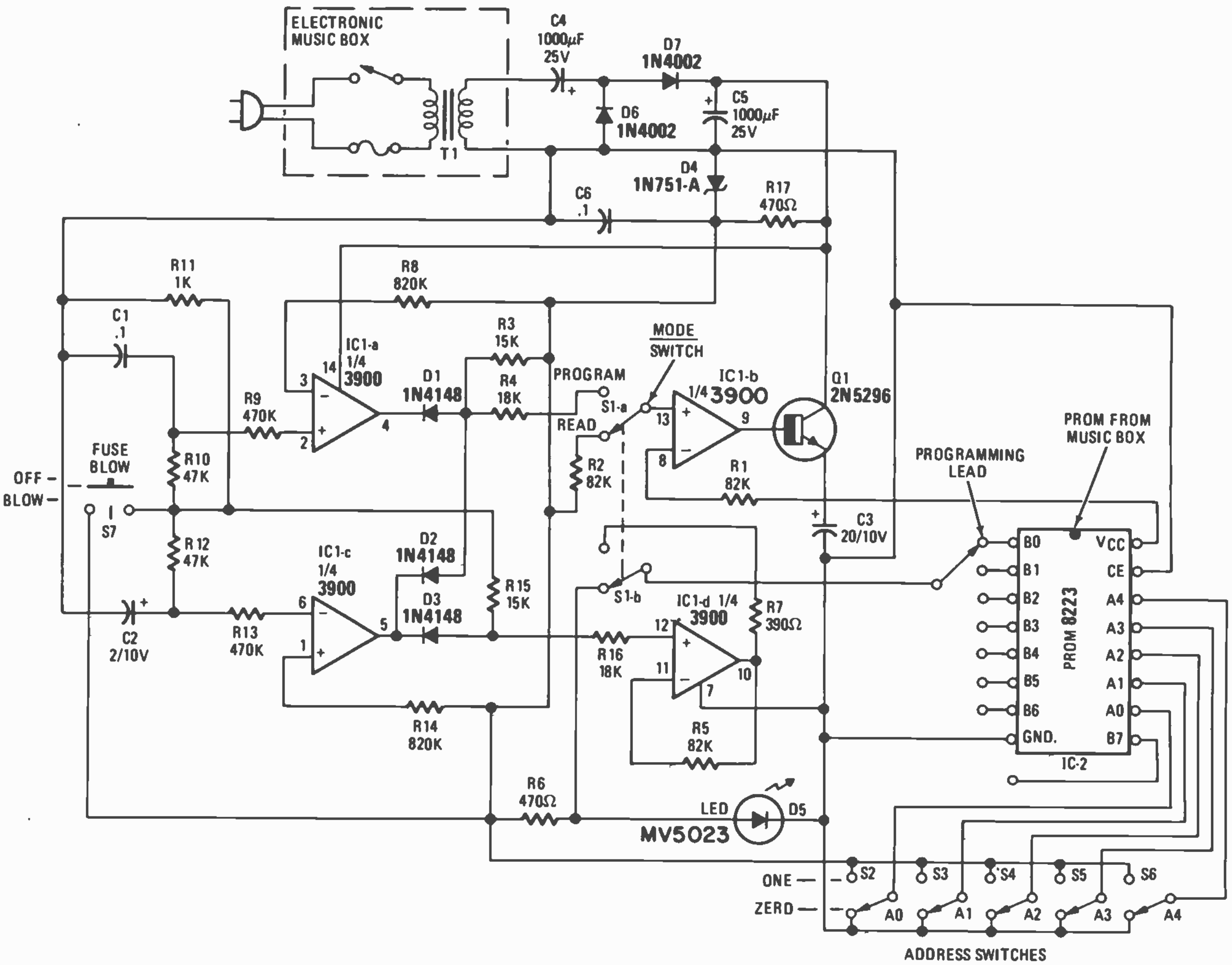
Program Step	Program Steps Binary Address					Notes of Melody	Beats per Note	Binary Program for Note and Beat							
	14†	13†	12†	11†	10†			9†	7†	6†	5†	4†	3†	2†	1†
	A4	A3	A2	A1	A0			B7	B6	B5	B4	B3	B2	B1	B0
1	0	0	0	0	0	F4	1	0	0	0	1	1	1	1	0
2	0	0	0	0	1	G4	1	0	0	0	1	0	1	1	1
3	0	0	0	1	0	A4	4	1	1	0	1	0	0	0	1
4	0	0	0	1	1	B4♩	2	0	1	0	0	1	1	1	0
5	0	0	1	0	0	D5	2	0	1	0	0	0	1	0	1
6	0	0	1	0	1	C5	4	1	1	0	0	1	0	0	1
7	0	0	1	1	0	A4	2	0	1	0	1	0	0	0	1
8	0	0	1	1	1	C5	2	0	1	0	0	1	0	0	1
9	0	1	0	0	0	B4♩	3	1	0	0	0	1	1	1	0
10	0	1	0	0	1	A4	1	0	0	0	1	0	0	0	1
11	0	1	0	1	0	B4♩	3	1	0	0	0	1	1	1	0
12	0	1	0	1	1	G4	1	0	0	0	1	0	1	1	1
13	0	1	1	0	0	A4	4	1	1	0	1	0	0	0	1
14	0	1	1	0	1	A4	2	0	1	0	1	0	0	0	1
15	0	1	1	1	0	F4	1	0	0	0	1	1	1	1	0
16	0	1	1	1	1	G4	1	0	0	0	1	0	1	1	1
17	1	0	0	0	0	A4	4	1	1	0	1	0	0	0	1
18	1	0	0	0	1	B4♩	2	0	1	0	0	1	1	1	0
19	1	0	0	1	0	D5	2	0	1	0	0	0	1	0	1
20	1	0	0	1	1	C5	4	1	1	0	0	1	0	0	1
21	1	0	1	0	0	A4	2	0	1	0	1	0	0	0	1
22	1	0	1	0	1	C5	2	0	1	0	0	1	0	0	1
23	1	0	1	1	0	B4♩	3	1	0	0	0	1	1	1	0
24	1	0	1	1	1	A4	1	0	0	0	1	0	0	0	1
25	1	1	0	0	0	B4♩	2	0	1	0	0	1	1	1	0
26	1	1	0	0	1	G4	2	0	1	0	1	0	1	1	1
27	1	1	0	1	0	F4	4	1	1	0	1	1	1	1	0
28	1	1	0	1	1	F4	2	0	1	0	1	1	1	1	0
29	1	1	1	0	0	mute	1	0	0	0	0	1	1	1	1
30	1	1	1	0	1	mute	1	0	0	0	0	1	1	1	1
31	1	1	1	1	0	mute	1	0	0	0	0	1	1	1	1
32	1	1	1	1	1	mute	1	0	0	0	0	1	1	1	1

†Number designates pin connection on IC-6.

Programming the PROM

The PROM 8223 is a read-only memory that is programmed by means of built-in fuses. For each bit position, a "1" is programmed when the fuse is blown and "0" when not blown. The 8223 is supplied with all bit positions low or zero. The programming is accomplished by addressing each word of eight bits and blowing those bit fuses that are required to be "1".

The circuit used for programming is shown in Fig. 4. The circuit operation consists of addressing each word by



PROM PROGRAMMER PARTS LIST

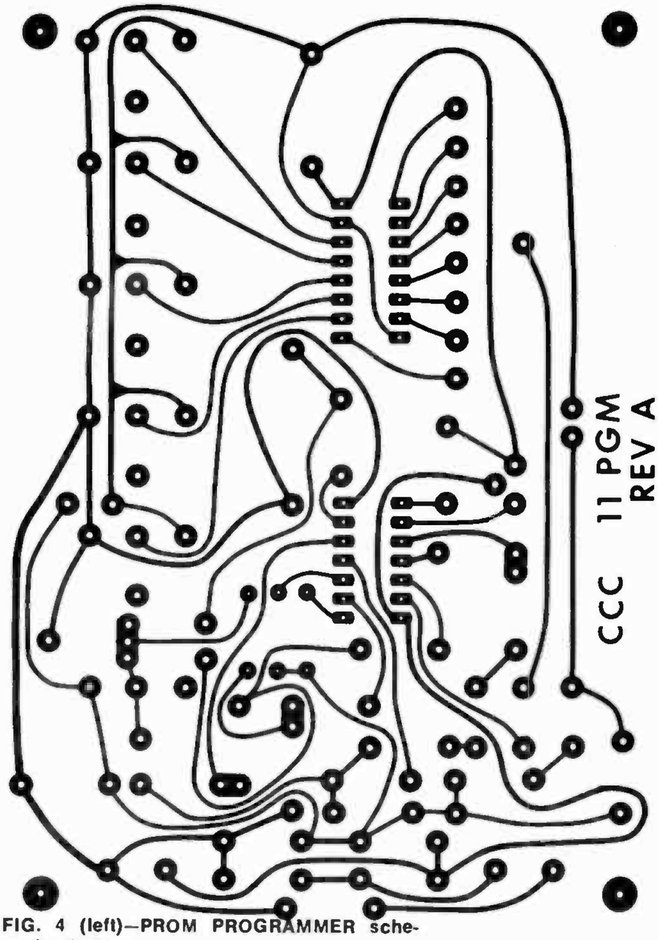
All resistors are ¼-watt, 10%, unless noted
R1, R2, R5—82,000 ohms, 5%
R3, R15—15,000 ohms, 5%
R4, R16—18,000 ohms, 5%
R6, R17—470 ohms
R7—390 ohms
R8, R14—820,000 ohms
R9, R13—470,000 ohms
R10, R12—47,000 ohms
R11—1,000 ohms
C1, C6—.1 μF polyester film
C2—2 μF, 10 volt electrolytic
C3—20 μF, 10 volt electrolytic
C4, C5—1,000 μF, 25 volt electrolytic
IC1—3900 linear quad amplifier
Q1—2N5296
D1, D2, D3—1N4148
D4—1N751A
D5—MV5023 LED
D6, D7—1N4002
S1—DPDT slide switch, PC board mount
S2, S3, S4, S5, S6—SPDT slide switch, PC board mount
S7—SPST normally open spring return slide switch, PC board mount
T1—117 volt primary, 6.3 volt @ 0.6A secondary
Misc.—Molex IC connectors, wire, solder, hardware.

The following parts may be ordered from Cousino Circuit Company, 3313 Brace Street, Burbank, CA 91504
#K11-EMB—Kit of all items in Electronic Music Box parts list, except miscellaneous items, fuse and transformer. Includes PC board and un-programmed PROM. $36.95 postpaid within USA.
#KHS11-EMB—Same as #K11-EMB except PROM is pre-programmed with "Home Sweet Home" melody. $39.95 postpaid within USA.
#11-EMB—Drilled glass epoxy printed circuit board for Electronic Music Box. $6.95 postpaid within USA.
#K11-PGM—Kit of all parts in parts list for PROM Programmer except miscellaneous items. Includes printed circuit board and programming data for several melodies. $21.95 postpaid within USA.
#11-PGM—Drilled glass epoxy printed circuit board for PROM Programmer. $5.95 postpaid within USA.
California residents add sales tax.

setting switches S2, S3, S4, S5 and S6 to the binary address being programmed. This address is designated as A0, A1, A2, A3, A4 in the programming Table 1. The bit positions for each word B0, B1, B2, B3, B4, B5, B6 and B7 are programmed "1" as designated in Table 1 by connecting the programming lead to each bit position being programmed. The mode switch S1 placed in the READ position shows the bit status. The LED is on when a "1" is programmed. With the LED off, a "0" is programmed which should be the case of an unprogrammed bit. Changing the mode switch S1 to the PROGRAM position prepares the circuit for blowing the bit fuse.

Depressing pushbutton switch S7 for one second or more blows the bit fuse, thereby programming a "1". When S7 is depressed, 5 volts is applied to the two R-C networks and voltage regulater IC1-d. The R10-C1 network switches comparator IC1-a after a brief delay. This unclamps voltage regulator IC1-b applying 12.5 volts to V_{cc} of the PROM. At the same time, 12.5 volts is applied immediately by voltage regulator IC1-d to the bit position being programmed. After an elapsed time determined by R12-C2, comparator IC1-c clamps both voltage regulators to ground reducing both 12.5 volt outputs to 1.5 volts or less. At this time, the bit fuse should be blown. It is confirmed by switching the mode switch to the READ position. The LED should light, confirming a "1".

The programming circuit can be constructed on a PC board, with the circuit layout shown in Fig. 5 and component location detailed in Fig. 6. All components should be soldered in place using care to observe polarities



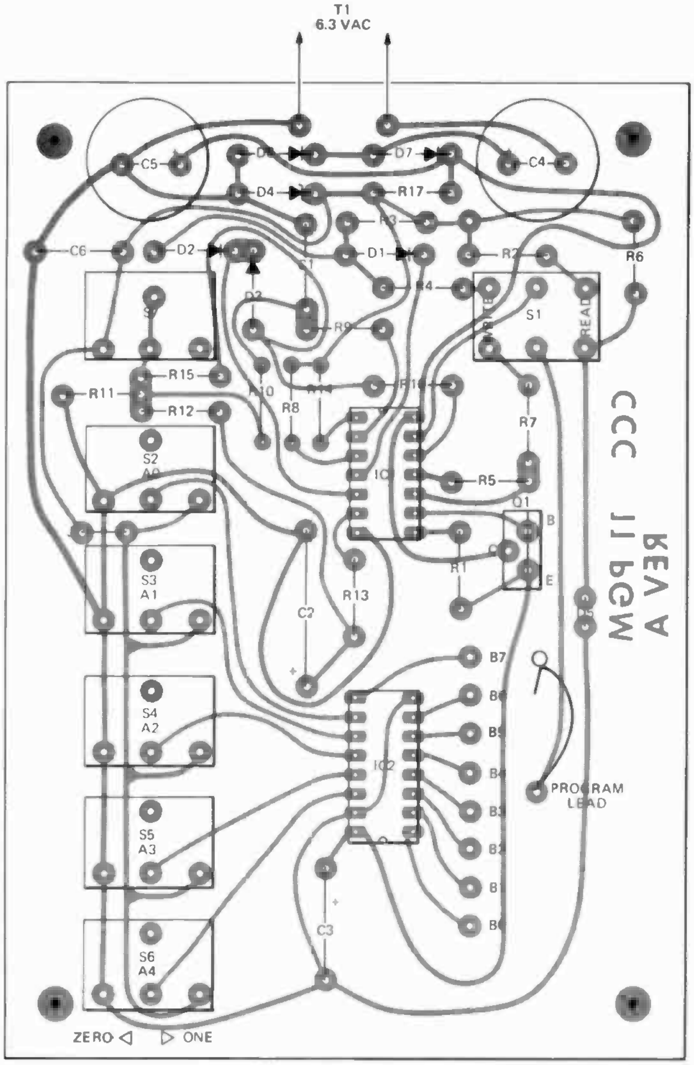


FIG. 4 (left)—PROM PROGRAMMER schematic diagram.

FIG. 5 (above)—FOIL PATTERN of printed circuit board for PROM Programmer.

FIG. 6 (right)—COMPONENT LAYOUT for the PROM programmer.

TABLE II

BINARY CODING FOR MUSICAL SCALE COVERING TWO OCTAVES

Musical Note	Binary word for each note					
	6*	5*	4*	3*	2*	1*
	B5	B4	B3	B2	B1	B0
E5	0	0	0	0	0	1
E5♭	0	0	0	0	1	1
D5	0	0	0	1	0	1
C5♯	0	0	0	1	1	1
C5	0	0	1	0	0	1
B4	0	0	1	1	0	0
B4♭	0	0	1	1	1	0
A4	0	1	0	0	0	1
G4♯	0	1	0	1	0	0
G4	0	1	0	1	1	1
F4♯	0	1	1	0	1	1
F4	0	1	1	1	1	0
E4	1	0	0	0	0	1
E4♭	1	0	0	0	1	1
D4	1	0	0	1	0	1
C4♯	1	0	0	1	1	1
C4	1	0	1	0	0	1
B3	1	0	1	1	0	0
B3♭	1	0	1	1	1	0
A3	1	1	0	0	0	1
G3♯	1	1	0	1	0	0
G3	1	1	0	1	1	1
F3♯	1	1	1	0	1	1
F3	1	1	1	1	1	0
mute	0	0	1	1	1	1

of capacitors and diodes. The Molex IC terminals provide a socket for the integrated circuit and a connector for plugging in the programming lead to select the bit position. For simplicity, the slide switches and push button are soldered directly to the circuit board.

Before plugging in the PROM for programming, the circuit should be checked as follows. Confirm that the power supply voltage is 17-19 volts measured across C5. With the mode switch in the READ position, measure the voltage on the emitter of Q1 which should be 4.75 to 5.25 volts. Place the mode switch in the PROGRAM position, and connect a temporary short across C2. Pressing the pushbutton switch S7, measure the voltage at emitter Q1 and the programming lead. Both should measure between 12 and 13 volts which then drops to 1.5 volts or less when the short is removed from C2.

To illustrate a typical programming procedure, refer to the Table I. Start at program step #1. Set address switches A0, A1, A2, A3 and A4 all to "0" (ground). Place mode switch on READ. Connect the programming lead to B0 (IC pin 1). The LED should be off confirming that the B0 fuse has not been blown. Throw mode switch to PROGRAM. Note the LED will always light when the mode switch is in PROGRAM position. Since Table I shows B0 as a "1", the fuse for this bit position should be blown. Pressing the pushbutton switch S7 blows the fuse programming a "1". Verify the "1" by switching to the READ mode. It may be necessary to repeat the procedure if the fuse does not blow the first time. It is also advisable to check the "0" bit positions to confirm that the fuse has not been blown. Use great care in programming since it is not possible to change a "1" to "0". **R-E**

TABLE III

PROGRAMMING THE BEATS PER NOTE

Beats Per Note	Bit Position	
	B7	B6
	9*	7*
1	0	0
2	0	1
3	1	0
4	1	1

*Number designates pin connection on IC6.

Step-by-step TV Troubleshooters Guide

A good color picture depends upon a good video signal. Check the video stages if the color isn't quite right.

by JACK DARR
SERVICE EDITOR

AFTER THE TV SIGNAL COMES OUT OF THE video detector in a color TV, it is divided into two parts. One is the color signal, and the other is the black and white. The black and white signal is called luminance, "Y," and so on, but I think most of us say "video," so that'll be it from now on. This signal is very important in making a good *color* picture. Since all colors are actually the color signal minus the video (That's why you see terms like "R-Y," etc.), if the video signal isn't right, your color picture is going to look very odd indeed.

How It Works

The signal from the video detector output is fed through a straight cascade amplifier. This amplifier may have two or three stages, but the signal comes out the same. We must have a signal voltage at the output of at least 100 volts p-p to drive the picture tube cathodes, with the sync positive-going. Normal output voltage of the video detector will be about 2 volts. So, our video stages must have an overall voltage gain of at least 50.

The signal polarity will be the same in either of the two basic circuits found in color TV sets; the old original circuit, where colors are fed to the grids and video to the cathodes, and the later "RGB" circuits. In the RGB circuits, the video is a part of the composite signal which is fed to the cathodes. Grids are tied together. So, we still need signals with positive-going sync.

Why? Very simple reason. All TV sets start out with a *white* raster. The signal must blackout the raster at certain places to make the picture. So, we must have a signal with enough *amplitude* to drive the picture tube to full cutoff, and it must have the right *polarity*. If the signal is fed to the grids, it would have to be negative-going. (All vacuum tubes can be cut off by enough negative voltage on the grid.) Since we are feeding the cathodes, we need the opposite polarity, or positive going sync. If we place a high enough positive voltage on the cathode, this is the same as making the grid negative, and we get cutoff.

In the typical B/W pix tube, this will be about 50 volts; in color picture tubes, about 100 volts. We do not want the sync signal in the picture. So, the sync actually starts at what is called the "black level" in the picture and goes on into the "blacker-than-black" part. See Fig. 1. The sync pulses actually help to blank out retrace for both sweeps.

If the video amplifier loses *gain*, we'll have a washed-out picture without enough contrast. Blacks will be gray and colors will be pale and weak. This happens because the signal voltage is not high enough to drive the picture tube into full cutoff. Some beam current still flows.

Peaking

Video amplifiers are simple cascaded stages. However, we must "peak" them for a very good high-frequency response; ideally up to 5.0 MHz. In practical circuits its not that wide, but it is wide enough to get all of the fine detail into the picture. This high-frequency peaking is done by adding small RF chokes in the input and output circuits of each amplifier stage. This increases the load *impedance* at higher frequencies. In the color video signal, there are a few things that we'd rather not have in the picture, the 4.5-MHz sound i.f. and the 3.58-MHz color subcarrier for example. So, these are reduced in amplitude by adding sharply tuned trap circuits. This will not greatly affect the overall frequency response of the circuit.

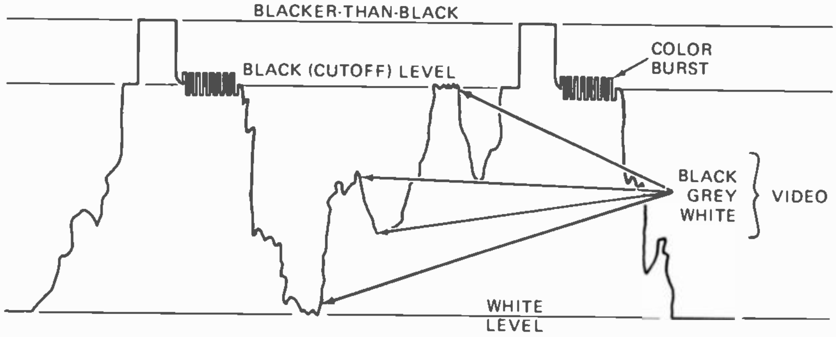


FIG. 1—STANDARD VIDEO signal shows the blacker-than-black level of the sync and the black, grey and white video signals.

The delay line

The final unusual thing found in color-TV video stages is the delay line. Video signals go straight through; the color signals must go through several more stages. Therefore, the video must be delayed very slightly (about 1.0 microsecond) so that both video and color signals will arrive at the picture tube at precisely the same time. You'll usually find this unit in either the input or output circuit of the final video amplifier, although it can turn up anywhere. The delay-line unit is simply a single-layer coil with foil wrapped around it.

Blanking

Blanking of the raster is needed during retrace time for both sweeps. This is often added to the video signal in the form of a pulse. The blanking pulse must be of the right polarity to cause cutoff when it gets to the picture tube. You'll find it added to the signal in some of the early video stages in many sets.

Brightness control

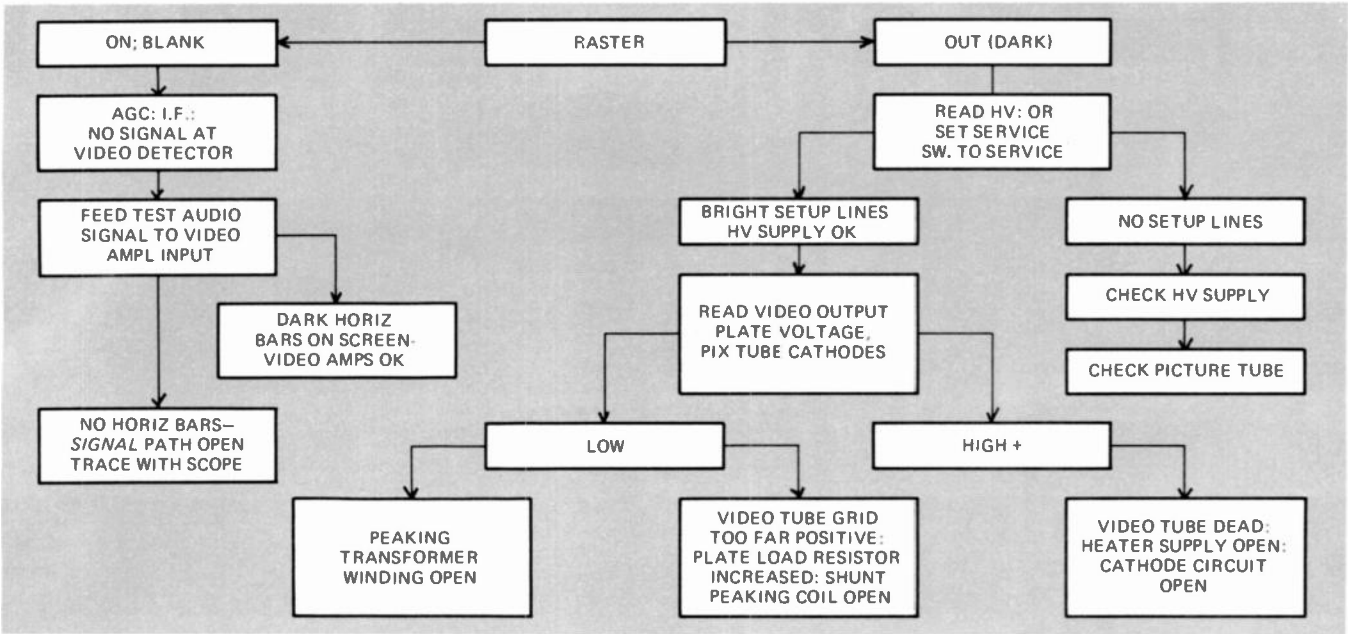
In the vast majority of color TV sets, the whole video circuit will be directly coupled all the way from the video detector to the picture tube. So, a small change in DC level at the input can cause a large change at the output. We control brightness by varying the DC voltages on the picture tube cathodes. Grid voltages can also be varied for this effect and you'll find it in a few sets.

You may find the BRIGHTNESS control at any point in the video amplifier! It will be hooked up so that it varies the DC level in the video signal-path. Possibly the most common location would be in the input circuit of the last video amplifier. It will be connected across a source of negative voltage at one end, and positive at the other. Here, it controls the grid bias on the video output amplifier.

Color drive controls

In many color sets, you will find variable resistors in the green and blue cathode circuits. The red cathode is usually fed straight through. These are called drive controls although you'll find them labelled BLUE GAIN, etc., in some sets. They are used for better black-and-white tracking of the picture at varying brightness levels, usually near the brightest point. They're adjusted to make the whites white.

TROUBLESHOOTING CHART (video amplifiers)



For instance, if whites are slightly bluish, the blue drive control is turned down a little.

The contrast control

The standard CONTRAST control used in this circuit is a simple cathode-degeneration control, from the video output cathode to ground. This will be a small variable resistor, around 100 ohms. This control does NOT vary the cathode resistance; this would change the DC level and affect the brightness. Instead, its slider is connected to a big electrolytic capacitor, 50-100 μF or more. This can be moved from ground (maximum degeneration, lowest contrast) to the cathode (minimum degeneration, maximum contrast) without changing the DC bias. It affects only the *signal*. (Theoretically; actually, there will be a slight shift and an apparent increase in brightness in most cases.)

The BRIGHTNESS and CONTRAST controls in the typical set will show some interaction. You'll usually have to adjust both controls to get the picture you want. Excessive contrast can actually cause blooming of some colors and even a false misconvergence. In many of the older sets, the best setting for the CONTRAST control is practically at minimum.

Signal polarity

In the common-cathode tube amplifier, there is a polarity inversion between input and output. The same polarity inversion exists in common-emitter transistor amplifiers. So, the designer must start at the

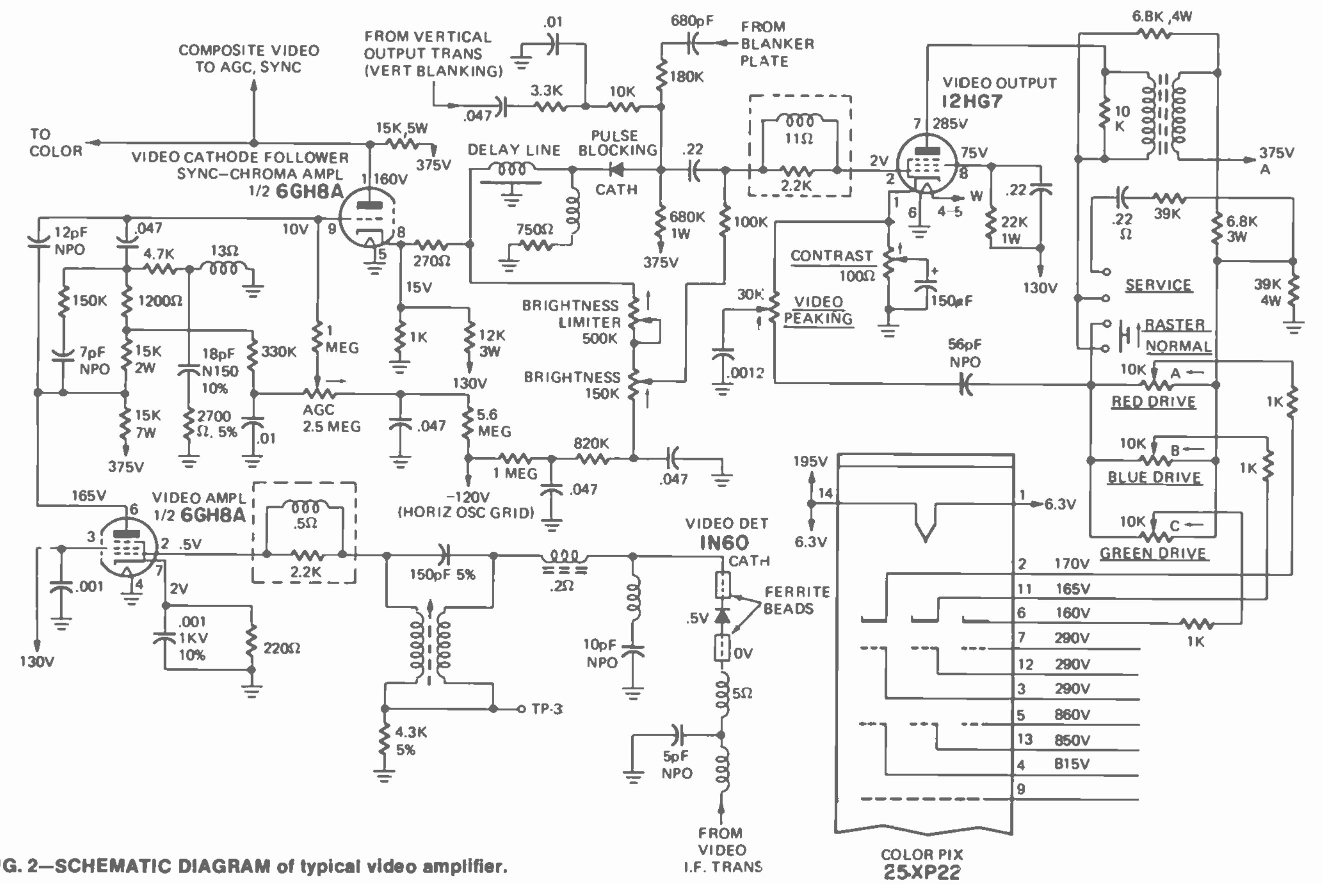


FIG. 2—SCHEMATIC DIAGRAM of typical video amplifier.

AMERICA NEEDS ONE MILLION

picture tube cathodes, where the signal must be positive-going sync, and count the number of stages. (If need be, he can reverse the polarity of the video detector diode!)

In certain sets you'll see what looks like an odd number of stages for the correct polarity. Look closely, one of these may be a cathode-follower. In tube or transistor circuits, this does not invert the signal. In the complete circuit seen in Fig. 2, note that the "2d video" stage is a cathode follower for the *video* alone. Color signals are taken off at its plate; this is a combination stage! An emitter-follower transistor stage does the same thing.

In some sets, you'll find a transistor video amplifier. These can cause some unusual problems if a transistor base-collector short develops. The signal will still pass through the stage, but it will lose the voltage gain of this stage. It will also lose one polarity inversion! So, you'll come out with a negative picture, but in the black-and-white signal *only*. This results in a very weird-looking color picture! To make sure, simply turn the color completely off. The black-and-white picture will then be quite obviously negative. This can also happen if someone pulls out plug-in transistor video amplifier and replaces it backward!

General rules

The first thing you must do when checking for video problems is get the *raster* on the pix tube. Check DC voltages on cathodes, grids, screens and the high voltage. DC voltage problems caused by the video stages, can upset the bias on the picture tube. This can cause two different problems; excessive negative bias can cut the raster off, or excessive positive bias can cause the picture tube to draw a very heavy beam current, overloading the high-voltage supply and once again the raster goes out. Quick-check: disconnect the high-voltage lead. If the high-voltage comes back, you have a bias problem in the video stages.

Clear this up first. Then if you still have a blank raster, look for signal problems with a test signal and the scope. Quick-check: a blank raster could be video troubles or a loss of signal from the IF's etc. To find out, feed an *audio* signal (any frequency) directly into the input of the video stages. Set this at the normal input level of about 2 volts P-P. If the video stages are OK, you'll see dark horizontal bars on the screen. If the video amps have normal gain, the dark parts of the bars will be black.

A square wave is a good test signal, or you can use the video signal output provided on many color-bar generators. The color-bar pattern is fine. You can also use the vertical-line or crosshatch patterns. This will test not only the gain but the horizontal resolution of the video amps (high-frequency bandpass).

If you see a good signal here, the trouble must be ahead of the video detector; check IF's, AGC, etc.

Troubles

Video troubles can be divided into two classes; those that affect the DC voltages and so the raster, and those which affect only the video signal. We must check out the no-raster problems first, of course. The troubleshooting chart shows the steps, in order. If we can't see the raster, we can't tell much about picture quality!

There is a good deal of overlap. Problems which affect the DC voltages inevitably upset the picture quality, and vice versa. The picture-only problems will be things like smear, which also have multiple causes—often not in the video stages. Let's take them up one at a time.

No-raster problems

One of the most common problems is "black screen; sound OK, tubes lit, no sign of overheating, etc." There are many things that can cause this. The first thing which must be checked is the high-voltage. This will instantly tell us *where* to start—in the HV supply or in the video-picture-tube circuits. Quick-check: flip the SERVICE switch to SERVICE. If we can get three bright lines by turning up the screen controls, the high-voltage supply is OK (also, the picture tube is good! Two for the price of one). No service switch? Turn the set off, disconnect ultor lead, turn set on and measure the high-voltage. If it comes back to normal or above, you have a bias problem.

Cutoff problems

Picture tube cathode voltages too far positive will cut off the beam current. This could happen if the video output tube was dead or had an open circuit in its heater supply. The contrast control could be open, this would break the plate-cathode circuit. In all of these cases, the video output tube can not draw plate current. With no load, its plate voltage rises to the supply voltage, usually about +400 volts, enough to cut off the picture tube.

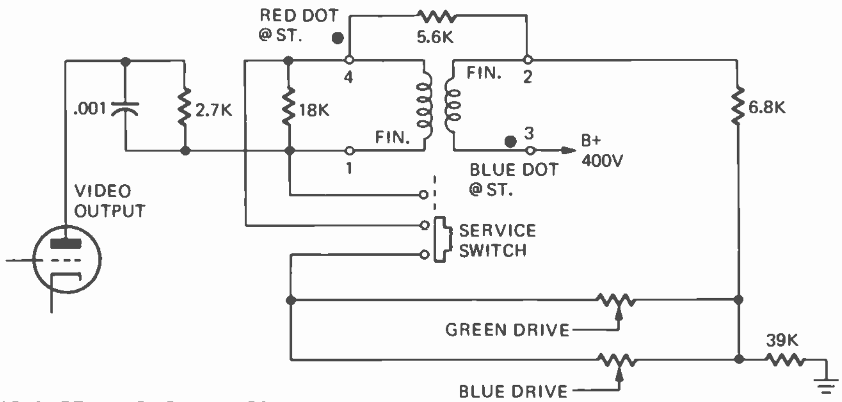


FIG. 3—PEAKING TRANSFORMER as used in RCA and other TV sets.

This is the same effect as making the grids too far negative. This can happen if there is a DC voltage *supply* problem in the color-difference amplifiers. Since there are three of these, one for each grid of the picture tube, the cause has to be something *common* to all. An open circuit or bad joint at the point where the three plate-load resistors connect to the supply is a common cause. Anything which *reduces* the diff-amp plate voltages simultaneously will do it.

In the later RGB circuits and especially in solid-state sets with individual modules feeding combined video and color to the picture tube cathodes, this would almost have to be a problem in the common voltage-supply. (Notice that I said "almost"?)

The key clue to a cutoff condition in the pix tube will be the fact that the high-voltage, still hooked up to the picture tube, will be up to its normal value. It may be slightly high because there's no beam current and therefore no load on the supply.

No or very low high-voltage

Here again we have no raster. However, now we have no high-voltage or perhaps very low high-voltage while the lead is connected to the picture tube. Using the service-switch test or disconnecting the high-voltage lead and finding full high-voltage, shows that the high-voltage supply is being badly overloaded. (You will find cases where the high-voltage will be pulled down to zero.)

Here, we have the opposite condition. The picture tube is being biased on, drawing excessive beam current. The video amplifier plate may be low or less positive. A bad video amplifier tube or a bias problem on its grid will cause it to draw excessive plate current and therefore, will pull its plate voltage down. In many circuits, there is a parallel-feed to the video amplifier plate and picture tube cathodes. A higher DC voltage is fed to the cathodes through a peaking transformer (see Fig. 3). RCA and many others use this. If one of its windings open, it will break the path to the +400-volt supply and the cathode voltage of the picture tube will drop to about 150-200 volts.

The grid voltages can go more positive, too. This can happen if something breaks their common plate-cathode circuit. They generally have a common cathode resistor, a bad solder joint or open resistor will do it. Also, in some sets, their heater circuit can be open due to a bad solder joint on the PC board. If this occurs, both tubes (two twin triodes) will not draw plate current. As a result, their plates will jump to the supply value and so will the picture tube grids. Several sets use a triple triode (6MD8, etc.); if this tube goes dead, same reaction.

Either of these problem can also be due to trouble in the brightness control circuit. This usually has a high negative voltage to one end of the pot and a positive voltage to the other. If either of these should be lost, the BRIGHTNESS control will not function properly. Many late-model sets include a brightness-limiter circuit. This, of course, is subject to troubles, so check it too.

The key clue to this one is the high-

(continued on page 91)

R-E's Service Clinic

DC volume controls

Old idea, new technique.

by JACK DARR
SERVICE EDITOR

THE TERM "DC VOLUME CONTROL" sounds strange. Actually, this isn't new. Back in 1928, a variable DC voltage was used to control the volume. Specifically, the filament voltages of the 01A tubes was varied! (This was "filament" then, not "heater".) A similar approach could be used with modern tubes, but it isn't for several reasons. You get into problems.

The standard volume control circuit for many years has been a simple signal-voltage divider (see Fig. 1). To get the signal from the sound-detector output to the front-panel control, then back to the audio output grid, you had to run two well-shielded cables. This was necessary to get the audio signal to the control and back through all of the assorted interference floating around inside a TV set. Using a DC control voltage can be done much more easily. Single wires can be used for this purpose, filtered if necessary.

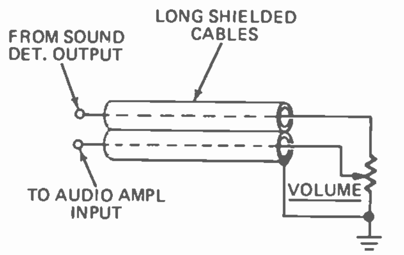


FIG. 1—OLD VOLUME CONTROL circuit with long signal-carrying cables. Cables must be shielded.

This technique is especially simple in receivers using IC's. IC terminals are provided that can be used to control the gain of an amplifier stage, by varying a little DC voltage. The signal literally "never leaves the premises" of the IC. (One of my pet terms in IC terminology refers to anything outside the IC as being in the "outside world"!) Anyhow, all you need is a couple of extra transistors, and this is very simple. A couple of dabs of silicon and there you are.

Figure 2 shows a typical circuit in a sound-detector output-IC. Only the control circuitry is shown. Transistors Q1 and Q2 are the actual volume control stage. The dual pair (Q3 through Q6) are a "current-mirror" stage. Current-mirror stages are common in most op-amps and similar IC applications. The output of the dual current-mirror stage feeds the volume-control stage. The DC voltage on the VOLUME control adjusts the bias on the volume-control stage (Q1 and Q6).

The setting of the VOLUME-control adjusts the base voltage of one side of the current-mirror pair (Q6) that in turn controls the signal fed to the common base of transistors Q1 and Q2. This is called a double-differential amplifier system. The output of transistor Q2 is directly coupled to the audio amplifier, which is more or less a stock op-amp type of circuit. If all of this looks very complicated; it is, but this is all inside the IC. If a circuit such as this doesn't work, and the DC supply and signal input voltages are normal, just replace the IC!

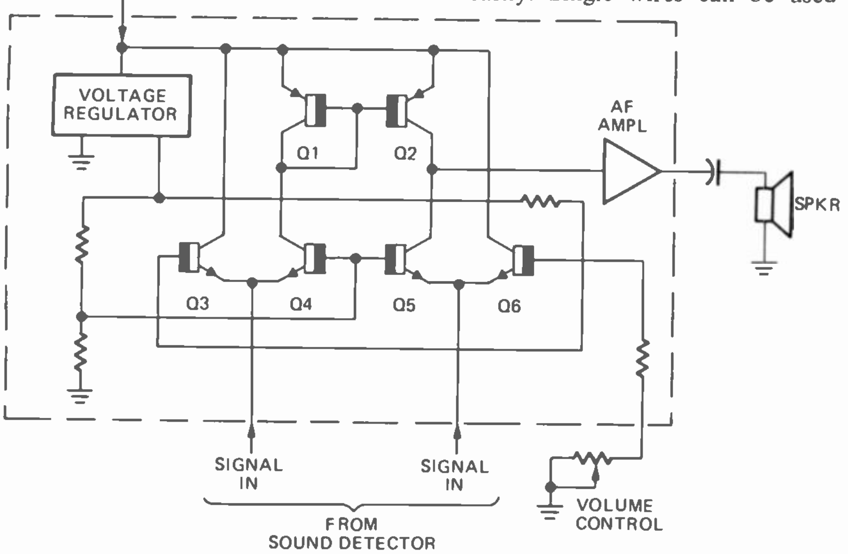


FIG. 2—DC-CONTROLLED VOLUME circuit. All components except volume control are inside the IC.

DC voltages can be used to control a great many things. For an already-familiar example, the frequency of a TV tuner can be controlled by applying a carefully-regulated DC voltage to a varactor diode. Quite a few set-makers are already using tuners which contain nothing but a row of varactor diodes. A set of preset pots are adjusted to apply the DC voltage to the tuning diodes, and that's all there is to it. Actually, this is pretty complex, but the operation is simple!

In the same tuners, you'll find another form of DC control. Switching-diodes are used for changing between low- and high-VHF channels, UHF, etc. Reverse-biased, the diodes are open switches; forward-biased they become a closed switch. Carefully regulated DC supplies are used.

You'll find DC control techniques used in many other circuits. For a practical example, in the RCA CTC-49 chassis, the sound volume is DC controlled by a circuit very much like the one discussed before. This comes from the PM-200 module, and consists of a 3K resistor, a 40K control, bypassed by a .047-μF capacitor.

The color is controlled by another DC control circuit. This circuit regulates the gain of the second bandpass stage, in the IC on Module MAC. The tint is also controlled in this way, in the MAE module. In the MAL module, the brightness is adjusted by the same type of circuitry. Even the horizontal hold control, instead of the familiar coil or variable resistor, is a DC-control type.

These are the manual adjustments. Practically all of the automatic control circuits use the same principle. AFPC, ACC, color killer, brightness limiter, AGC, AFT, and even the DC clamping level of the video output. Of course, the horizontal AFC circuit still uses the same old principle that we've seen for so long. This is actually a phase-locked loop, and the horizontal oscillator is a VCO (*V*oltage *C*ontrolled *O*scillator). For that matter, so is the 3.58-MHz color oscillator in practically all sets.

Servicing

You'll find two basic types of circuit used for these control applications. In one, the DC voltage will be picked up from the DC power supply and fed through a voltage divider. One section of the voltage divider is a variable resistor for the manual controls, and the other section is an adjustable resistor for the setting of automatic circuits. The voltage from the control goes to one terminal of the IC.

In the other type of control circuit, the DC control voltage actually comes through the IC internal circuitry. Sometimes from a voltage regulator or current-mirror, sometimes from internal voltage-dividers. These can be made up of resistors, or with diodes or transistors.

To check either type, read the DC supply voltage first. With the external-divider type, be sure that all of the resistors are within tolerance. Leaky bypasses or drifting resistors can cause problems. With the types where the DC voltage is developed inside the IC, check the DC supply voltage to the IC and then check all DC voltages that are supplied by the IC. Also, check for the presence of the normal *signal* input; video, sync, keying pulses, etc. In many circuits, such as the IF-AGC-video amp IC's, all of the "action" takes place inside the IC itself. **R-E**

(Reader Questions are on page 96.)

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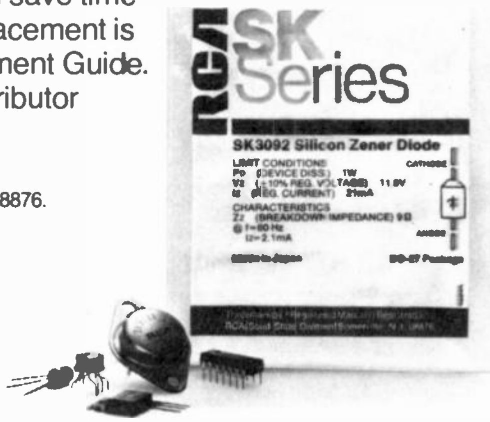


It's OK if it's sk

Circle 22 on reader service card

QS MATRIX

(continued from page 30)

essential characteristics of a sound source signal, especially its density, need to be all encoded in the first and second transmission channels, so long as the compatibility of the encoded signals with 2-channel stereo and monophonic playback remains a prime requisite. Then the third, fourth and any other higher-order channels will be available for use mainly to define the directionality of the reproduced signal with greater sharpness.

On the other hand, once two transmission channels are secured, the directionality, or the information pertaining to the location of a sound source in the original live sound field, can be transmitted in the form of amplitude and phase relationships as explained earlier. And once that is done, certain advanced calculations can be performed on the playback end to unscramble the transmitted signal and reproduce it with nearly the same sharply defined directionality as if four entirely separate transmission channels were utilized.

Directionality enhancement

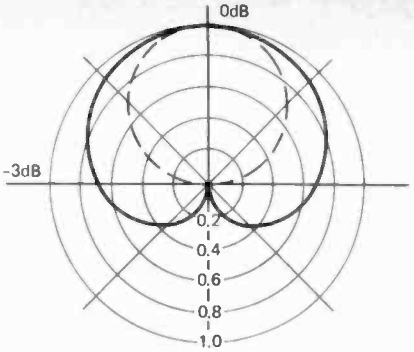
There are two methods to sharpen the directionality of a signal reproduced by a matrix 4-channel system. One is a so-called gain control method which uses an AGC (automatic gain control) circuit to reduce the gain in those channels where the unwanted crosstalk appears. The other method does not tamper with the gain in the four channels but instead adjusts the parameters of the decoding matrix automatically and continuously so as to eliminate only the unwanted crosstalk. The QS variomatrix circuit is representative of the second method.

When a QS-encoded signal is decoded through a basic QS decoder it yields a sound field that fairly accurately reflects the original sound field. But insufficient separation among the reproduced channels prevents the directionality of the signal from being clearly defined.

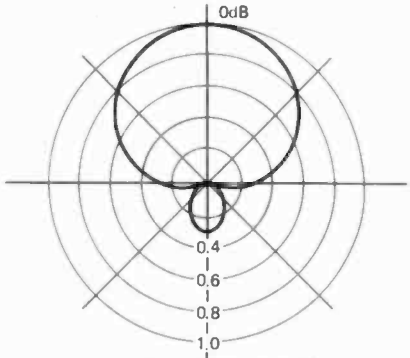
The QS variomatrix technique rectifies this condition. It increases the interchannel separation to place the reproduced signal more sharply in focus. In an actual QS decoder, the technique is implemented in the form of a QS variomatrix circuit consisting of three functional blocks (Fig. 9): a phase discriminator block, a control block, and a decoding matrix.

The phase discriminator block phase-discriminates the phase difference and level difference between the LT and RT encoded signals to detect the location of the input signal. It then converts this information into DC levels and passes it

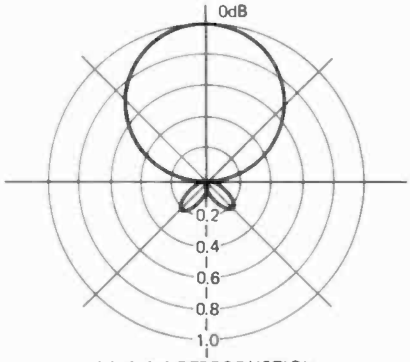
(continued on page 74)



(*DOTTED LINE INDICATES QS VARIO-MATRIX)
(a) 4-2-4 REPRODUCTION



(b) 4-3-4 REPRODUCTION



(c) 4-4-4 REPRODUCTION

FIG. 8—SOUND PRESSURE RESPONSE of a QS-encoded signal transmitted via (a) two, (b) three, and (c) four transmission channels.

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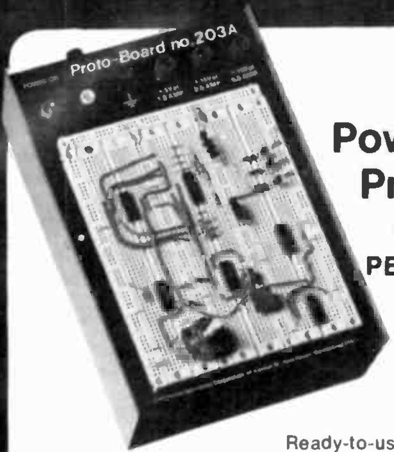

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Load Regulation	Better than 1%

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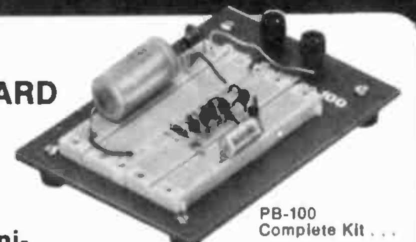

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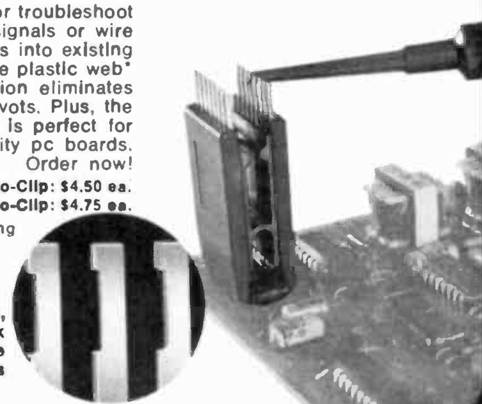

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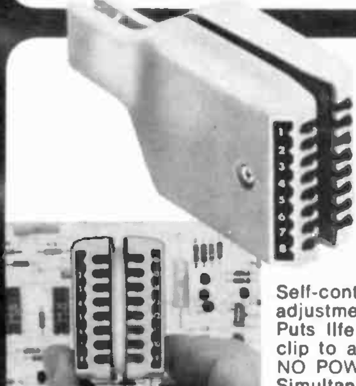

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QS MATRIX
(continued from page 72)

on to the control block. The latter receives input signals pre-arranged in the form of an LT + RT sum signal and an LT — RT difference signal; and it instantaneously adjusts the level of either the sum or difference signal according to the information received from the phase discriminator block, determining from moment to moment the four matrix parameters or coefficients (f, b, l, r) that will enable the matrix block to create maximum inter-channel separation when it compounds the sum signal and the difference signal to retrieve the original sound source signal.

In other words, if an LF signal in the original sound field is encoded by the QS system and then decoded by simple calculations, it will yield a sound pressure response pattern as shown by the solid line in Fig. 3. This indicates crosstalk of —3db in each of the two adjacent channels. The QS variomatrix circuit, however, varies the LB' matrix coefficient in the RB' direction to reduce the crosstalk of the LF signal in the LB' channel and eventually bring it down to =∞ (0) at a point where the LB' matrix coefficient coincides with the RB' matrix coefficient. Simultaneously, the QS variomatrix circuit also controls the RF' matrix coefficient in the RB' direction, and eventually accomplishes a circular sound pressure response pattern (shown by the dotted line in Fig. 10) that is devoid of any crosstalk, just as in the reproduction of a discrete 4-channel tape recording.

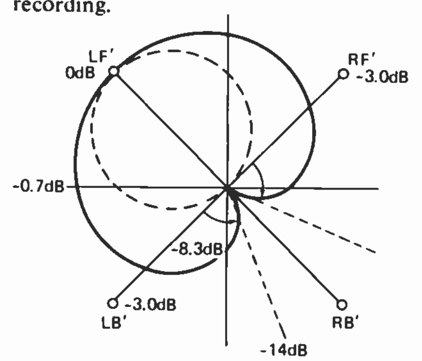


FIG. 10—CHANGE in sound pressure response created by variomatrix circuit.

Should there be a concurrent signal of a lower level, it will be reproduced with maximum inter-channel separation if it is located in the same direction as the predominant signal LF; if it is located in a different direction, it will be reproduced in such a way that its directionality is more and more obscure as it moves farther away in direction from the LF signal in the original sound field. Even then, however, the level of the signal will be entirely preserved so that, due to the directional masking effect of the human ear**, the listener will perceive the predominant signal and the concurrent lower-level signal in much the same way as he would have heard them had he been present in the original sound field. Thus, what the QS variomatrix circuit does is to reproduce sound signals generated in the original sound field with accuracy and
(text continues on page 76)

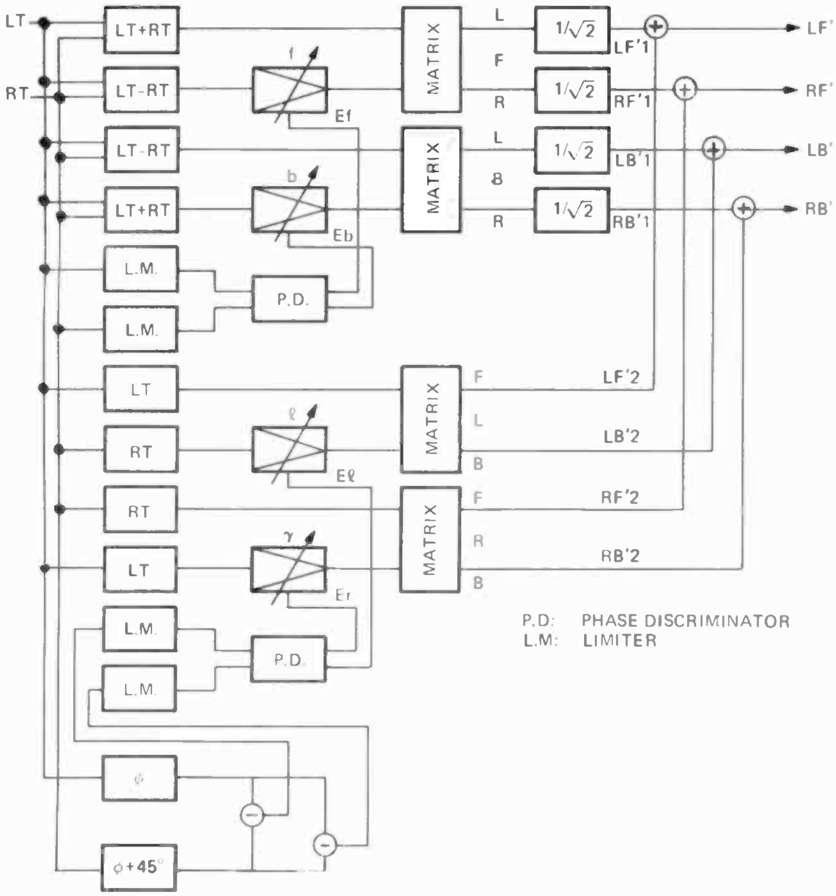


FIG. 9—QS VARIOMATRIX decoder that increases the interchannel separation.

QS MATRIX
(continued on page 74)

with clearly defined directionalities.

Furthermore, the QS variomatrix circuit may be combined with a simple peripheral circuit to create a QS synthesizer circuit (Fig. 11) for converting conventional 2-channel stereo records into 4-channel media. Or, with another simple peripheral circuit, the QS variomatrix circuit can be easily adopted into a phase matrix circuit for the decoding and reproduction of CBS SQ 4-channel records. In each application, the QS variomatrix circuit works to enhance the inter-channel separation, without affecting the tonal quality in any way. Each application is already widely available to the consumer in QS variomatrix equipped high fidelity components.

For manufacturers of home audio equipment around the world, the QS variomatrix circuit is available today as an IC. This makes it practical and economical to offer the many QS advantages in their own 4-channel components. **R-E**

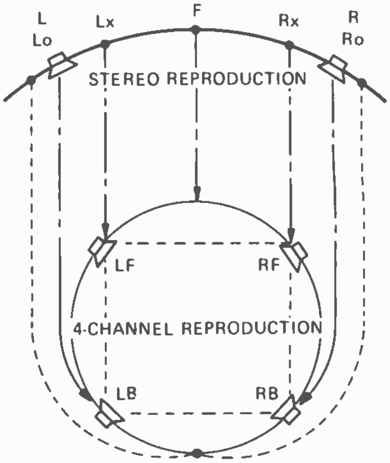


FIG. 11—4-CHANNEL REPRODUCTION of 2-channel signals by QS synthesizer.

Notes

QS is a trademark of Sansui Electric Co., Ltd. The phenomenon in which, when a loud sound and a weak sound differing in level by more than a certain margin reach the human ear simultaneously from different directions, the directionality of the weak sound is masked by that of the loud sound to the extent that the ear does not perceive the directionality of the weak sound.

SQ is a trademark of CBS Laboratories.

The QS System is protected by U.S. Patent No. 3,777,076, U.S. Patent No. 3,872,249 and other patents.

(continued from page 51)

are actuated) to the meter. When the DB/VOLTS switch is depressed, it connects the variable output from the buffer amplifier directly to the attenuator at the input of the distortion amplifier and hence to the meter.

That extra option

Externally, the only difference between the basic 1700A and the version of the instrument that includes the self-adjusting 100% reference feature can be found by examining the ADJUST knob on the front panel (See Fig. 3). When the option is included, this switch includes an AUTO position. When the knob is rotated fully counterclockwise, past the CAL position, the automatic level setting circuitry is activated (See Fig. 4).

The input signal to the notch filter (or the variable output of the buffer amplifier) is connected to an AC to DC converter. The DC signal from this converter is directly proportional to the notch filter input signal level and drives a voltage-to-current converter that regulates the controlling current of a multiplier IC stage. This multiplier IC is used as a variable-gain amplifier (with a gain variation of from 1 to 3.16). The gain is inversely proportional to the controlling current and the magnitude of the AC signal to the notch filter. A simplified block diagram of this optional circuitry (which can be retro-fitted to older models of the 1700A) is shown in Fig. 5.

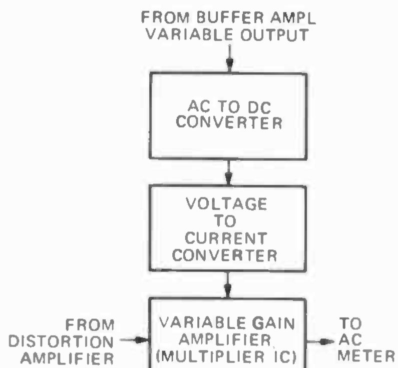


FIG. 5—CONTROL SIGNALS applied to variable gain amplifier for direct reading of THD without 100% reference settings.

Whenever distortion measurements are made, it is useful to be able to examine the distortion products themselves on an oscilloscope display. Often, noise voltages or unexpected beats (as between recovered FM multiplex audio signals and subcarrier products, or between the bias oscillator of a tape deck and incoming signal frequencies) may be mistaken for harmonic distortion unless a visual display accompanies the readings. It is also helpful to be able to define the nature of the distortion and what harmonics predominate (e.g., 2nd harmonic, 3rd harmonic etc.). A front panel jack delivers the distortion voltages for viewing on any oscilloscope, and Fig. 6 illustrates the distortion viewed while testing a Pioneer CT-9191 (lower trace) while viewing the

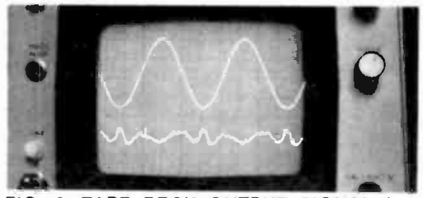


FIG. 6—TAPE DECK OUTPUT SIGNAL (upper trace) and distortion products (lower trace) as observed from the DISTORTION OUTPUT jack on the 1700A distortion measurement system.

total audio signal (upper trace) for frequency reference.

The audio oscillator

The built-in audio oscillator of the Sound Technology 1700A is basically a Wein bridge type with an ultra-low distortion amplitude control circuit. This circuit provides wide frequency range, fast settling-time, flat frequency-response and very low residual-distortion. The oscillator has two operating modes; FAST RESPONSE and LOW DISTORTION. When fast response is selected the oscillator settles fairly rapidly after a frequency change is punched in on the front panel frequency selector buttons. When the low distortion mode is selected, the oscillator settling time to 0.002% distortion is less than 5 seconds. Built-in circuitry automatically controls the oscillator through these modes whenever there is an amplitude disturbance, such as a change of frequency settings. The combination of multiplier buttons and numbered buttons on the front panel permit selection of frequencies from 10 Hz to 110 kHz in four overlapping ranges with three-digit resolution (a frequency of 442 Hz could, for example, be chosen with accuracy to 1 Hz, while a frequency of 20,200 Hz could be chosen to accuracy of 100 Hz). A closeup of the frequency selector section of the front panel of the 1700A is shown in Fig. 7.

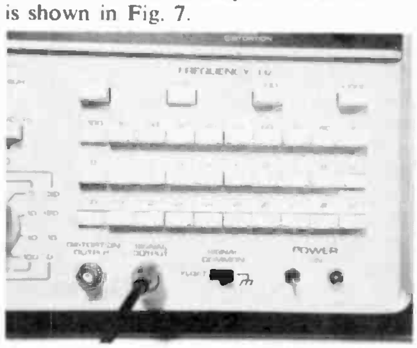


FIG. 7—FREQUENCY SELECTOR section on front panel of 1700A.

Manufacturers of high-powered, high quality audio amplifiers who have previously boasted of unmeasurable disortion figures had better re-phrase their future advertisements. With sophisticated measuring equipment such as the Sound Technology 1700A around, just about the lowest distortion these fine products deliver can now be measured—accurately.

This makes three months of R-E Lab Tested reports on hi-fi equipment. We'd like to know how you like them. Drop us a postcard and let us know. Write Hi-Fi Test Reports, Radio-Electronics, 200 Park Avenue South, New York, NY 10003.

R-E

HI-FI ACCESSORIES

(continued from page 57)

with all the traditional "little" items needed to keep sound reproduction systems in order—record brushes, wipers, tape head cleaning kits, stylus pressure gauges, head demagnetizers, strobescopes, etc. But there are a few more.

Pickering, for example, has a stylus timer that helps keep a check on how long your stylus has been used. Mountable on virtually any turntable or player, the timer features a "coulometer," a mercury-filled, hermetically sealed, capillary tube whose indicator dot travels at a rate proportional to the flow of electric current that passes through the instrument. It measures elapsed time in 100 hour increments, up to 1,000 hours. It is then reversed to start another "watchdog" cycle. Pickering advises a first inspection of a new stylus after 250 hours of use, subsequent inspections after each 100 hours additional use. The company says that stylus life varies with usage, quality of the diamond and its finish, the cleanliness of record grooves, and even the quality of the records played. A stylus "likely would exhibit considerable wear even under ideal conditions" at about 1,000 hours, says Pickering. A stitch in time . . . can save a lot of records from stylus destruction. The price, $13.95.

A fairly recent entrant in the maintenance products arena is the "Vac-O-Rec," an electric-powered record vacuum cleaner priced at $24.95. Slip a record into its slot and the record begins to revolve; as it moves, mohair brushes loosen particles on the record surface, and these are removed through vacuum cleaning. Simultaneously, a static reduction circuit reduces the record's dust-attracting electromagnetism "from as high as 20,000 volts to a low, near-neutral, voltage," the company's literature for the cleaner states.

The audio buff who has moved up the scale to very high powered equipment can—careful as he may be—run into the problem of blowing out speakers because of power overloads. Two companies have auxiliary products to prevent this. One is Robins with its "Stereo Speaker Protector" at $29.50, and Hartley Products with its "Stereo Speaker Sentry" at $35. In use, the buff sets controls to maximum power levels (up to 100 watts). Any burst of power beyond the control figure are instantly limited, preventing them from damaging the speakers.

The final add-on is also a protective device. It is the HR "Control 1" that prevents a HI-FI system from being left on accidentally. Plug the amplifier and any other units of the rig into the outlets of the control; if no signal comes out of the amplifier for 10 minutes, the HI-FI system is shut down. Price, $39.95 from HR Mfg. Co., Sarasota, Fla. **R-E**

NATIONAL ASSOCIATION FOR MENTAL HEALTH

BUILD MATRIX SYNTHESIZER
(continued from page 35)

board is in Fig. 6. After it is completed, check it out and make sure it delivers proper voltages before connecting it to the synthesizer.

After you've built and added your synthesizer to your hi-fi system you'll have to consider the question of how to position your speakers for the most effective sound reproduction. There are several different approaches that you can take.

First there is the conventional 4-corner approach shown in Fig. 7. This

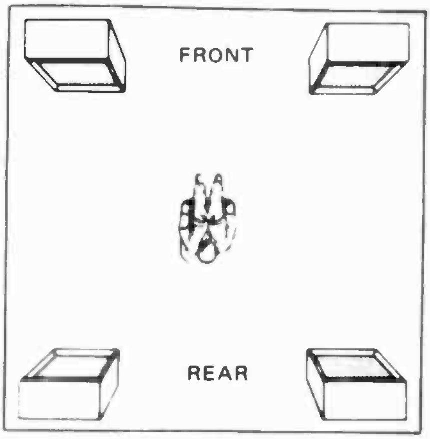


FIG. 7—CONVENTIONAL 4-CORNER speaker placement approximates live sound field.

is the most widely accepted speaker setup for 4-channel listening. It surrounds the listener with sound closely approximating the live sound field. This speaker placement is particularly effective for playback of modern music, rhythm and blues, popular music and some varieties of modern music. When live recordings are played back, audience sound and hand clapping are often heard from the rear speakers and help make the listener feel that he is a part of the audience.

By having the rear speakers up front and having them face the front speakers as in Fig. 8, the sound field becomes similar to that of a stage sitting in front of you. Now you are placed in the position of the original audience. Listening to classical music with this speaker arrangement is particularly effective.

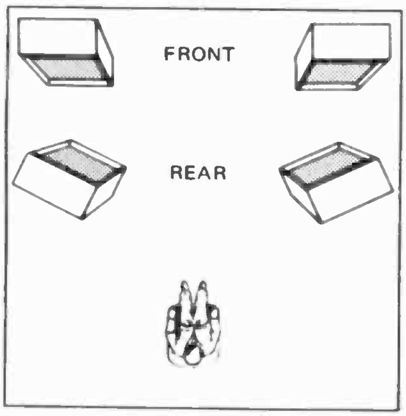


FIG. 8—SPEAKER PLACEMENT places listener in position of original audience.

Since this 4-channel synthesizer derives its information for reorganizing the information already present in the original 2-channel stereo program material, the effectiveness of the sound you will hear is determined by the amount of directional information that is present and available for synthesizing in your 2-channel source.

Most stereo program sources are suitable for synthesizing with the effectiveness of the conversion being limited only by the method by which the original material was prepared. Occasionally using the synthesizer rear channel sound may be "shakey" while that from the front channels is not.

Overall, the synthesizer is a great way to turn your current library of 2-channel music into 4-channel surround sound at a reasonable cost. Naturally, synthesizing 2-channel sound into 4-channel sound is not the same as listening to 4-channel music, but it does come close; close enough, in my opinion, to make it a worthwhile project that will deliver real satisfaction to the experimenter and hours of listening pleasure. **R-E**

new products

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

DISTRIBUTION AMPLIFIER, *model IDA-45,* for use in Master Antenna TV (MATV) systems with up to 35 channel capability. The new amplifier meets or exceeds FCC rules Part 76. It is fully adaptable to 2-way communications systems as required for a CATV/MATV interface amplifier. Radiation shielding exceeds 90 dB. Gain is at least 45 dB over a range of 50 to 300 MHz. Push-pull output circuitry cancels second harmonic distortion. Used to interface with CATV, output levels

can be as high as +48 dBmV per channel in 35 channel systems or up to +54 dBmV per channel in 12-channel systems. At these levels, cross modulation does not exceed −57 dB, second order beat −68 dB and triple beat −72 dB. In standard MATV applications where cross modulation specs are −46 dB, output level can be as high as +52.5 dBmV with 30 channels or +57 dBmV with 12 channels. Noise figure is 8 dB and response is flat with ±0.4 dB. Plug-in accessory modules make the new amplifier versatile. Overload control compensates for input signal level fluctuations. $438.00. — **Jerrold Electronics Corp.,** 200 Witmer Rd., Horsham, PA 19044

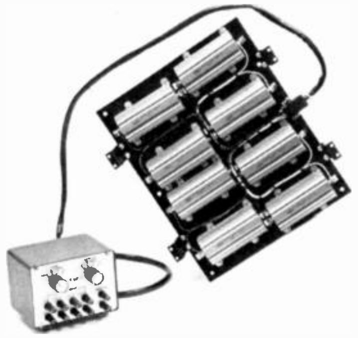
Circle 31 on reader service card

STEREO RECEIVER, *model* 525, features a quadrature FM detector, zero-center tuning meter. FET front end. IF section using solid-state, tuned filters and integrated circuits. Multiplex detector uses phase-locked-loop circuitry and the AM section has a high usable sensitivity. Power amplifier uses trans-

formerless, complementary-symmetry output circuit to insure wideband response and low distortion at all power levels up to the unit's rated 25 watts per channel (Min. RMS, both channels driven into 8 ohms, from 20 to 20 kHz with no more than 0.5% total harmonic distortion). $349.90.—**Pilot Radio Sales,** 165 West Putnam Ave., Greenwich, CT 06930

Circle 32 on reader service card

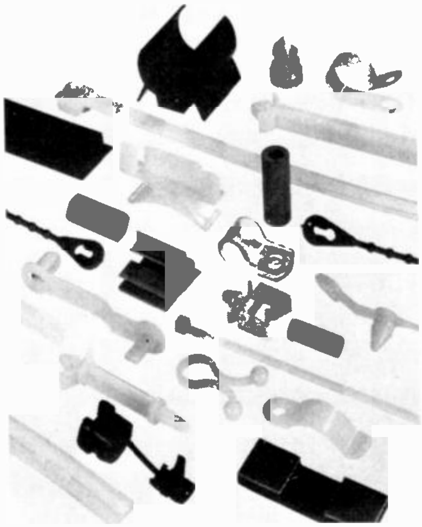
AUDIO DUMMY LOAD, the *model 250,* for audio power amplifiers under test. It features 4, 8 and 16-ohm loads composed of 1% resistors. Power handling capability is 1000 watts RMS in monaural mode, 500 watts RMS in stereo and 250 watts RMS per channel in



4-channel mode. The load resistors are on a heat sink that can be mounted on or under the service bench. Input terminals and mode and selector switches are connected to the load through a cable. A switch position is provided for by-pass operation and jacks are provided for scope monitoring. $250.00 FOB. —**B.P.I.,** 7853 Balboa Ave., San Diego, CA 92111

Circle 33 on reader service card

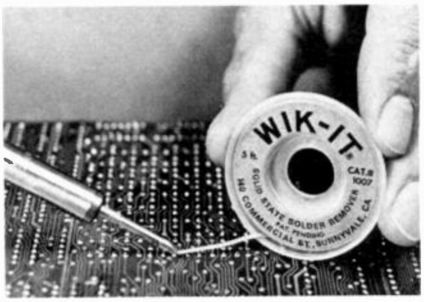
FASTENING AND HOLDING DEVICES made of nylon or flame-retardant plastic are now available for use in electrical and electronic applications. The family of devices includes



printed-circuit board guides, circuit board supports, plastic spacers, cable clamps and hangers, component clips, tension clips, strain-relief bushings, wire ties, wire saddles, continuous grommets and spiral wrappings. —**Mallory Distributor Products Co.,** 3029 E. Washington St., Indianapolis, IN 46206

Circle 34 on reader service card

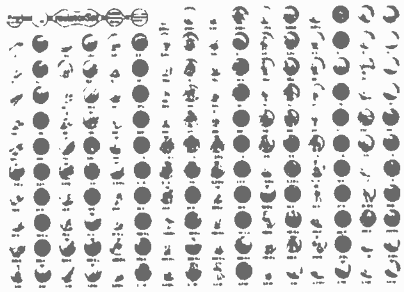
DESOLDERING AID, *Wik-It,* is a special chemically treated metal braid which, when laid on the soldered joint and then heated with the soldering iron, will suck up the molten solder by capillary action; leaving a joint that is now clean and free of solder. When the solder is removed from the joint,



you just snip off about ½ inch of Wik-It which is then ready for use again. The braid comes in different sizes to suit transistor and IC applications as well as vacuum tube circuits and heavy wire work. Lengths range from 5 to 100 feet. Typically, *Wik-It* is a 5-foot length in a handy plastic spool with prices ranging from $1.59 to $1.79, depending on width.—**Wik-It Electronics Corp.,** 140 Commercial St., Sunnyvale, CA 94086

Circle 35 on reader service card

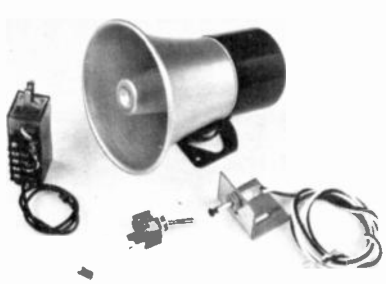
RESISTOR SET, *RS-10,* is designed so the experimenter, lab technician, service technician or electronic designer will never be delayed by the lack of a specific carbon-film resistor. The *RS-10* contains 2725 ¼-watt, 5% carbon-film resistors in 170 different values ranging from 0.51 ohm to 5.6 meg-



ohms. The quantity of each resistor value supplied has been determined by service-industry use analysis. Quantities range from five-of-a-kind for seldom-used values to twenty each of the most popular resistances. $126.00—**Energy Electronic Products Corp.,** 6060 Manchester Ave., Los Angeles, CA 90045

Circle 36 on reader service card

KEYLESS VEHICLE ALARM, *model 612-K.* Electronic burglar alarm kit can be installed in any vehicle in 30 minutes. Wailing police-type sound. Unit uses solid-state components



and draws less than 1 ampere of battery power. Arming the system is a throw of a hidden switch within the vehicle. The hidden switch must be turned off within 15 seconds of entering the vehicle or alarm will sound. Unit can be provided with automatic turn-off and reset features. No fender hole or lock. Built to withstand all weather conditions. Components are guaranteed for 90 days. **Wolo Manufacturing Corp.,** 37 Jefry Lane, Hicksville, NY 11801

Circle 37 on reader service card

DIGITAL RECEIVER, *model RD 1000*, the manufacturer's top-of-the-line unit uses a true digital frequency synthesis tuner coupled with a conservatively designed power amplifier section rated at 100 watts minimum continuous power per channel with both channels driven into 8 ohms at a maximum of 0.15% total harmonic distortion. Tuner section includes the phase-locked-loop and quartz crystal frequency standard and has the addition of a memory section programmable by the user. Up to ten FM station frequencies may be entered through the tuner section's keyboard. These selections are retained in the memory and any one may be called up at any time by pressing a single button. The memory is non-destructive, retaining the programmed station selections. Even when the unit is turned off or disconnected from the power line.

Additional tuning modes include manual selection by punching in the desired FM station frequency, and scanning up or down the FM band in either STEREO ONLY or ALL STATION modes. The digital display is a solid-state 7-segment unit which can be read from across the room. Signal strength is indicated by a series of four LED's instead of a conventional meter. Another LED indicates whether a stereo signal is being received and yet another lights up if multipath reception occurs. Specifications include: Tuner Section—Tuning accuracy within 0.001%, sensitivity for 30 dB signal to noise ratio, 15 kHz deviation 0.9 μV, IHF sensitivity 1.7 μV, sensitivity for 3 dB below full quieting 4.8 μV, frequency response 20 to 15,000 Hz $\pm$ 1 dB, total harmonic distortion, mono 0.2%, total harmonic distortion, stereo 0.3%, stereo separation at 1 kHz 40 dB, selectivity 100 dB, capture ratio 1 dB, cross modulation rejection 95 dB, spurious response rejection 100 dB, image rejection 85 dB, AM suppression 75 dB, subcarrier suppression 65 dB, warm-up drift 0.001%, station acquisition time 10 milliseconds, automatic scanning speed 5 channels per second, FM deemphasis 25, 50 or 75 μs switch selectable. Amplifier Section—minimum continuous power output per channel, both channels driven into 8 ohms across 20 to 20,000 Hz at no more than 0.15% total harmonic distor-

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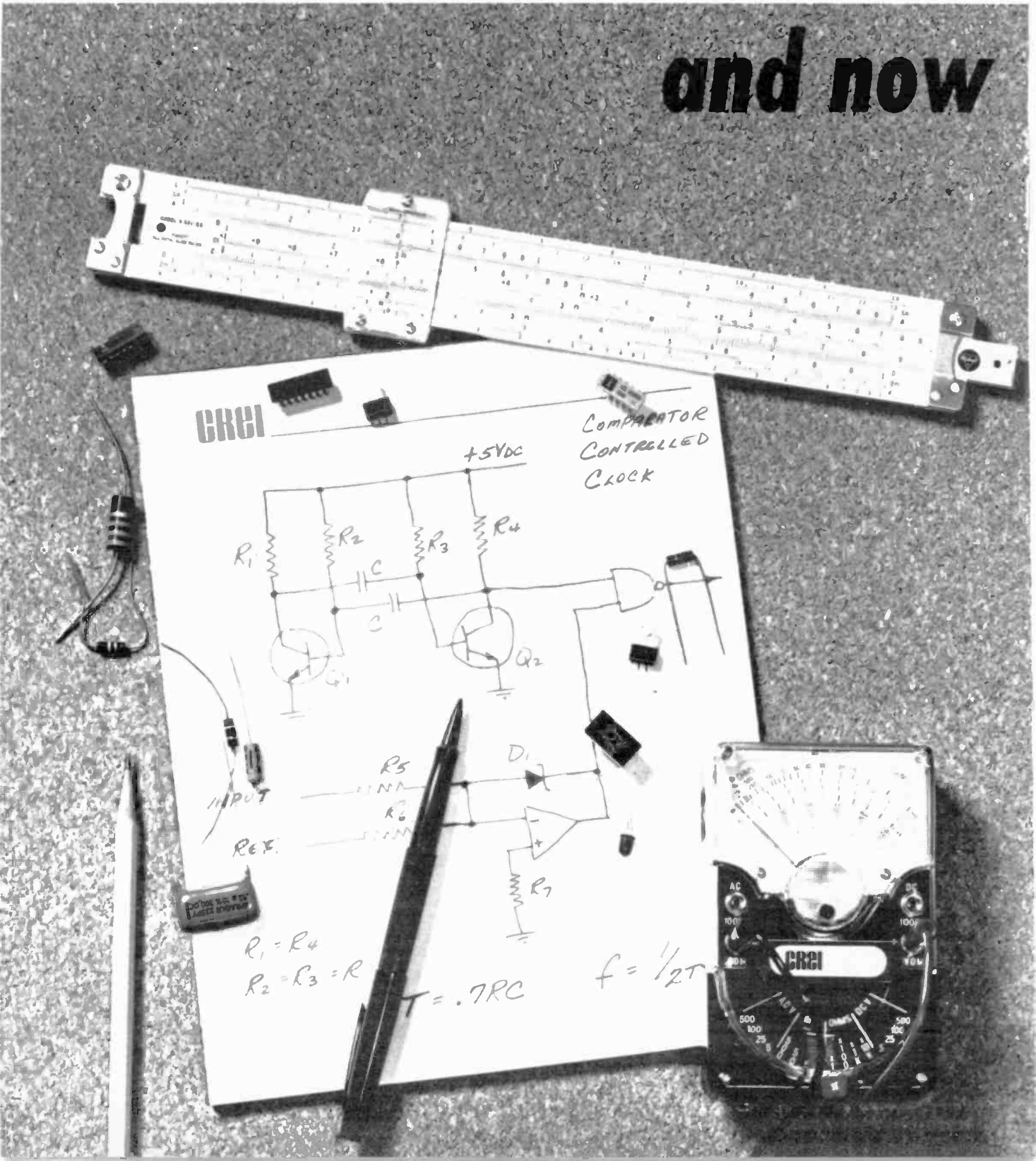

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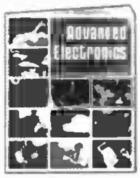

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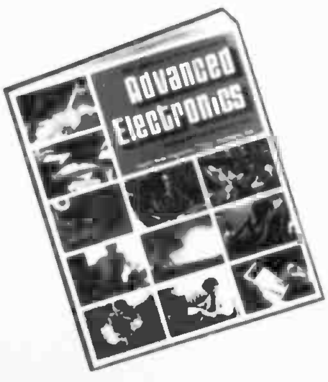

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NEW PRODUCTS

(continued from page 81)

tion 100 watts, intermodulation distortion at rated output maximum 0.1%, frequency response at 1 watt 8 to 25,000 Hz ± 1 dB, power consumption 400 watts max. $1500.00. Size 21¼ × 6⅝ × 13. Weighs 42 lbs.—**H. H. Scott, Inc.**, 111 Powdermill Rd., Maynard, MA 01754

Circle 38 on reader service card

AM-FM/STEREO CASSETTE PLAYER, the *model CP650*, is a complete ca rentertainment system with many convenience features. It offers a built-in AM-FM/Stereo radio, AM/FM slide bar selector, fast-forward control, pushbutton cassette ejector, FM local-distant control, AM/FM indicator and stereo balance control.

Pushbuttons provide finger-tip tuning of any five preselected AM or FM stations. Can be mounted in almost any dashboard without the need for any kits or alterations.—**Audiovox Corp.**, 150 Marcus Blvd., Hauppauge, NY 11787

Circle 39 on reader service card

FM/AM STEREO TUNER, *model TX-7500* contains new internal circuit innovations for improved selectivity, sensitivity and stable stereo FM performance. Features include: 4-section variable capacitor and phase-linear FET in FM front end; 6-stage limiter, three double-tuned phase-linear ceramic filters, monolithic IC with wide-band quadrature detector in FM IF section; phase-lock-loop stereo multiplex decoder; center-of-channel and signal strength meters; positive acting reed-relay FM muting circuit; switchable noise filter.

Specifications: IHF sensitivity—1.9 μV, 50 dB quieting—4 μV mono; 50 μV stereo, signal-to-noise ratio: 73 dB mono; 68 dB stereo, total harmonic distortion: (1 kHz mono) 0.2%; 1 kHz stereo) 0.3%; (10 kHz mono) 0.2% (10 kHz stereo) 0.6%. Capture ratio 1 dB, selectivity 80 dB, stereo separation 40 dB (1 kHz); 35 dB (50 Hz to 10 kHz). Image rejection 85 dB, IF and spurious rejection 90 dB, AM suppression 55 dB and sub-carrier suppression 65 dB. Muting threshold: 2.2 μV. Output level: (fixed) 650 mV; (variable) 50 mV to 1.5 V. Power requirements: 120 V 60 Hz, 20 watts. Dimensions: 16½" wide by 5⅞" high by 14⅜" deep. Net weight: 18 lbs. 2 oz. Price: $249.95. Case in walnut is $34.95 additional. —**U.S. Pioneer Electronics**, 75 Oxford Drive, Moonachie, NJ 07074

Circle 40 on reader service card

DIGITAL CLOCK/THERMOMETER, *model ES 142*, displays 12- or 24-hour time in six digits, and Fahrenheit or Celsius temperature in three digits, from −50°F to +150°F. Displays are planar gas discharge, .55 in. in height. Included is a temperature probe and 25 feet of cable. Any cable length up to 500 feet may be ordered. Unit is housed in an aluminum case with simulated walnut sides and sells for $225. The Thermometer may be purchased separately at a cost of $150. The part number is ES 240.—**ESE**, 505½ Centinela Ave., Inglewood, CA 90302

Circle 41 on reader service card

POWER AMPLIFIER, *model D-150A*, replaces the earlier Crown D-150. Can drive any load safely, even those below 4 ohms. Unit has a power rating of 90 watts per channel into an 8-ohm load over a bandwidth of 1 Hz—20 kHz, at a rated RMS sum total harmonic distortion of 0.05%. Front panel level control for each channel; on-off switch and pilot light. Rear panel stereo-mono switch permits user to change from stereo to mono with no internal wiring changes. Output stages include class AB + B configuration. No quiescent bias current is used in the output transistors for better efficiency and wide band response.

Specifications include: frequency response: ±0.1 dB from DC—20 kHz at 1 watt into 8 ohms; ±1 dB DC—100 kHz. At 1 kHz power output is 90 watts RMS into 8 ohms, per channel, both channels operating, 0.1% total harmonic distortion. Damping factor greater than 400. Output Impedance less than 15 milliohms in series with less than 3 microhenries. Input Sensitivity 1.19 volts ±2% for 80 watts into 8 ohms.—**Crown International**, 1718 W. Mishawaka Rd., Elkhart, IN 46514

Circle 42 on reader service card

FM DEVIATION MONITOR, the model 205D, measures peak carrier modulation deviation of 2-way radio transmitters. Carrier frequency range 25—1000 MHz. Frequency deviation measurement is 5% of full-scale and is measured on three deviation scales: 0—2.0 kHz (for tone squelch, etc.), 0—6.0 kHz (for upper reading at 5 kHz) and 0—20.0 kHz (for wide-band modulation). The precision discriminator is linear to 2% over a 100 kHz bandwidth. RF sensitivity is 15 mV or better to 450 MHz. FM limiting holds to within 2% or less over a 100:1 range of input voltage. The 205D operates from 12 VDC or 120 V, 50 to 400 Hz. $525.—**Lampkin Laboratories, Inc.**, PO Box 9048, Bradenton, FL 33506

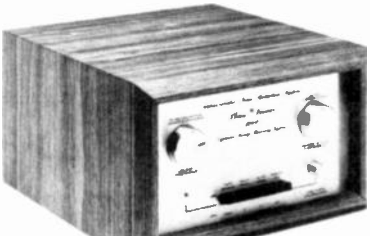
Circle 43 on reader service card

ULTRASONIC CLEANERS for bench-top installations are available in sizes ranging from 1½ to 8 quarts. The *Ultra-Clean* units are compact in design with the tank and generator in one integrated unit. Automatic self-tuning maintains a uniform power level for rapid, thorough cleaning action. The stand-

ard units operate from 120 VAC, to 60 Hz. Accessories include self-suspending trays, baskets and covers. Prices start at $98 for the 1½ quart model to $317 for the 8-quart model.—**Tooltronics, Inc.,** 710 Ivy St., Glendale, CA 91204

Circle 44 on reader service card

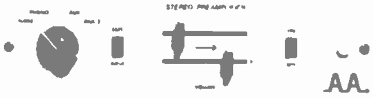
NOISE REDUCTION SYSTEM. The *Autocorrelator model 1000* is an outboard unit that may be inserted into the tape-monitor path of almost any hi-fi system. It features noise reduction of up to 10 dB on any stereo source without high-frequency loss or the need for pre-encoding—a dynamic range-recovery system that selectively expands any



program material 7.5 dB without audible ill-effect—a dynamic low-pass filter which removes low-frequency noise without affecting the program material. An additional tape-monitor circuit replaces the one occupied. Price $349. — **Phase Linear,** PO Box 1335, Lynnwood, WA 98036

Circle 45 on reader service card

STEREO PHONO PREAMP, designed without tone controls, is for use with an equalizer. Phono sensitivity is 10 mV for 1 volt output; 47K input impedance, hum and noise 76 dB below 10 mV input. RIAA equalization ±0.5



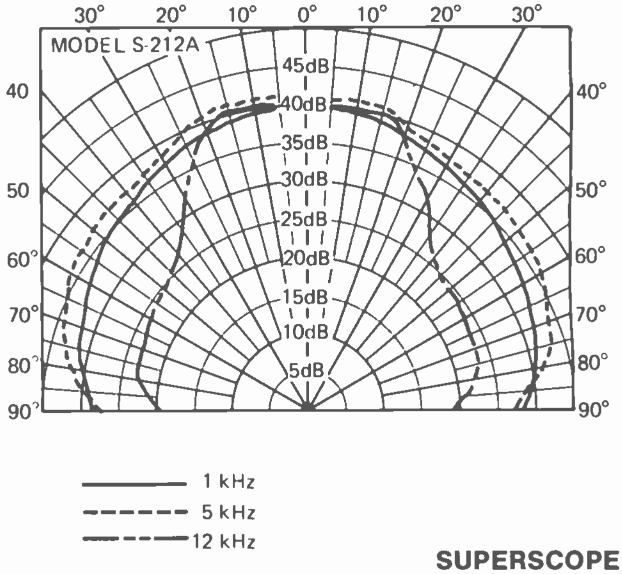
dB. The high-level inputs (FM, AUX 1, AUX 2) are passive. Input impedance is 50K without output load, 25K with 50K output load. Output impedance 0 to 12.5K, varies with volume control setting.—$74.95 kit; $99.95 wired.—**Ace Audio Co.,** 25 Aberdeen Drive, Huntington, NY 11743

Circle 46 on reader service card

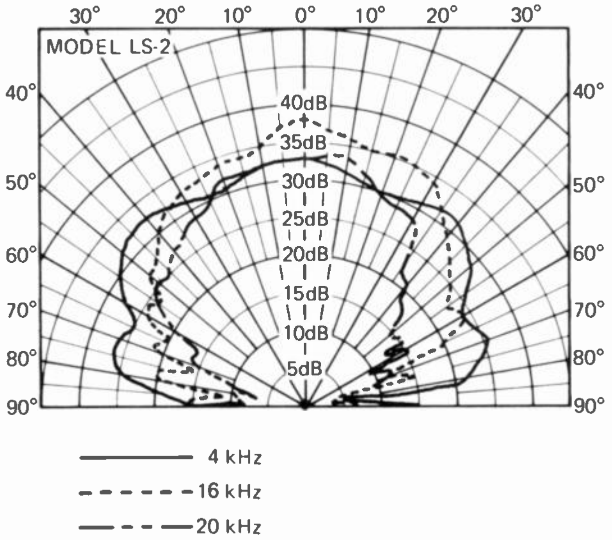
BOOKSHELF SPEAKERS
(continued from page 49)

sound that is lacking in the realistic concert hall qualities.

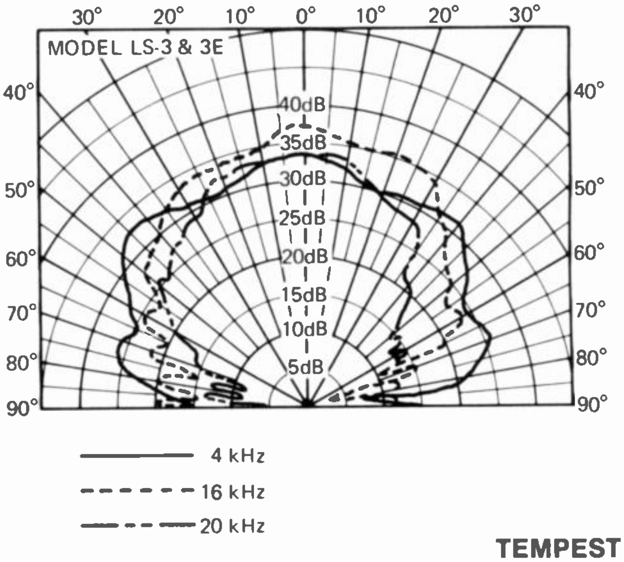
Different types of high-frequency drivers produce different dispersion patterns. Remember, dispersion is a measure of the ability of a speaker to radiate sound energy in different directions. This includes both the vertical and horizontal directions. A dome



SUPERSCOPE



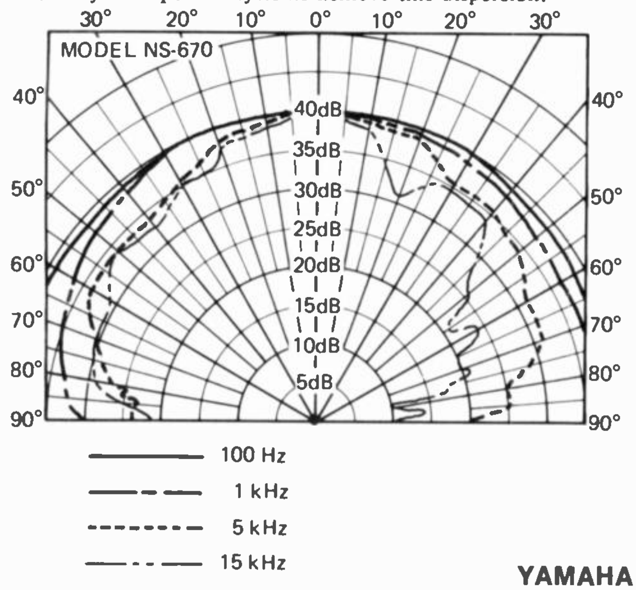
TEMPEST



TEMPEST

tweeter for example, will produce a symmetrical dispersion pattern while a horn tweeter will produce an unsymmetrical pattern —wider in one direction than the other. Due to space limitations, it is impossible to provide both (vertical and horizontal) sets of dispersion graphs. Always assume that the manufacturer has provided the widest dispersion graph if the direction is not specified.

Choose a speaker system with maximum dispersion. The more dispersion a speaker system has, the more realistic sounding it is. A speaker system with an excellent dispersion characteristic will be between 5-dB to 10-dB down from the on-axis output at 15 kHz. Very few speaker systems achieve this dispersion.



YAMAHA

Frequency response and dispersion are important specifications, but there's more. Next month, such specifications as distortion, linearity, efficiency, power handling capacity, maximum output and impedance will be discussed. A table listing these specifications—and others—from many manufacturers will be presented.

And that's not all. The third and concluding part of the article covers listening tests, room acoustics and speaker placement.

(continued next month)

MATCHED PAIR OF FET'S

After accidentally applying too much voltage to my FET VOM, the needle now pegs to the left in all positions except battery-check and DC current. I had trouble with this a while back, and the factory said it was a bad FET. What do you think?—E.D., Tappan, NY.

I think you're right. I did the same thing to one of mine and blew one of the FET's. You'll probably have two, since this is almost certain to use a bridge circuit. I got a matched pair of FET's and fixed mine.

Now, you can get "dual FET's"; these are in the same case and isolated from each other. They're made on the same substrate so that they almost have to match characteristics. I do not mean the dual-gate type FET, but two FET's in one package. Incidentally, if you can't locate this, RCA's SK-3116 FET's match very well, on testing.

PURPLE AND GREEN SCREEN

The screen of this RCA CTC-38 has a purple band about 5 inches wide and the rest of it is green. Voltages all seem to check out. Picture tube OK. Where do I go from here?—C.B., Bronx, NY.

Check No. 1. Turn the color control off. If this is a permanent thing, start checking some bypass and filter capacitors. Most likely cause would be some kind of screwball feedback through the demodulators or bandpass amplifiers. Check that electrolytic on the +140 volt line. Scope points that are *bypassed*. If you see anything there, check the bypass.

new lit

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CREATIVE COMPUTING, a new magazine that looks at the effect of the computer on privacy, automation and jobs, medical care, pollution control, space exploration and people in general. In education, it treats computers as tools for teaching math, science, english and social studies. An emphasis on classroom activities contains book reviews, games, puzzles, fiction, poetry, cartoons and humor. Published bi-monthly, subscriptions $8.00 a year, $6.00 for students. Sample copy, $1.00.—**Creative Computing,** P.O. Box 789M, Morristown, NJ 07960.

ELECTRICAL PRODUCTS, in this 1975 mail order catalog, items range from tool connector boxes to stripping tools, insulated terminals and splices, connectors of several varieties, indicator lamps, cable straps, cable cutters and much, much more. A 24-page catalog by a company new to the mail order business.—**AMP Special Industries,** Valley Forge, PA 19482.

Circle 47 on reader service card

TAPE PLAYER PARTS CATALOG #5. A 48-page catalog devoted exclusively to tape player parts. Lists a full line of tape player parts for almost all manufacturers and the illustrated parts section enables the user to select the parts he needs quickly. The only one of its kind that we know of and is available only from PTS Electronics, Inc. Copies are available from all branches for $2.00 each.—**PTS Electronics, Inc.,** P.O. Box 272, Bloomington, IN 47401.

Circle 48 on reader service card

R-E LAB TEST REPORT

(continued from page 40)

right channel. (Later, the channels on the record are reversed.) Even without a sound-level meter, you can compare the level heard as each third-octave is played against the reference tone and move the levers, one at a time, until equal apparent volume is heard. If you do own (or can borrow) a sound-level meter, you can disregard the reference tone (by rotating your balance control so that you hear only the pink noise bands, octave by octave) and move the levers until the sound level meters reads the same for each octave on the recording. Using either method, we were able to complete the entire job (both channels) in under twenty minutes. Surprisingly, using the simpler method with no test equipment, our results were within 2 dB of the settings obtained using a sound-level meter. In our case, we were using fairly small speaker systems which are known to roll off below about 50 Hz, and sure enough, our final settings on the RP-2212 confirmed this fact. The 20/40 lever ended up at +6, while the 40/80 lever was set to +2. Room acoustics accounted for some of our other octave by octave settings which ranged from +3 dB to —4 dB. Since the RP2212 is equipped with a bypass feature (both equalize buttons in the OUT position) it is a simple matter to compare equalized with unequalized results.

Insertion of the RP2212 into our listening system introduced absolutely no degradation of signal-to-noise ratio. Our measurement of S/N for the RP-2212 itself was —96 dB referred to a 1 volt input and output, quite a bit better than claimed, and certainly better than the limitations imposed by our phono system and our other components.

An overall product analysis of the Soundcraftsmen RP2212 equalizer, together with our summary comments, appears in Table I. **R-E**

TROUBLESHOOTING

(continued from page 68)

voltage reading, while still hooked up to the pix tube. The raster will be out and the high-voltage will be zero or very low. Service-switch test helps here too, since it takes much less beam current to make three lines than a full raster. Confirm by disconnecting the high-voltage lead and measuring.

Contrast problems

If the picture has ample brightness, *very* good fine-detail but is pale and washed-out looking, you have poor contrast. First step, check to see if the CONTRAST control has any effect at all. If it does not, the big capacitor on the video output cathode is probably open. This, of course, can be intermittent since it is a low-voltage electrolytic.

The picture is pale but the CONTRAST control does have a reaction. This shows a loss of video *gain* in one or more of the stages. The video signal doesn't have enough amplitude to cut the beam off completely and give you good blacks. Quick-check: feed an audio signal into the input of the video amplifier stage and make signal-tracing tests through the whole circuit with a scope. You do *not* have to have a calibrated scope; just look for a stage where you have a good input and less output than input. (Look out for cathode-followers!) Check peak-to-peak amplitude of the video detector output signal. This kind of problem can also be due to AGC trouble, weak IF tubes, etc.

The picture is weak, the CONTRAST control reacts and there is horizontal smearing. This type of trouble can be caused by an open peaking coil somewhere in the video amplifier. If it is in the grid or input circuits, the DC voltages won't be too badly upset but the loss of fine detail will be very obvious. (Use a vertical lines pattern from a bar-dot generator, etc.)

Delay line problems

The delay line used in these sets is simple, and causes few problems. If the coil should open, you'll lose the video. If it has been replaced by the wrong part, you may see two or three very sharp "rings" just to the right of any sharp vertical lines in the picture. Always use an oscilloscope to check delay lines. The video signal in and out should be the same amplitude.

Oddball problems

We can have "picture problems" in a video amplifier which is working perfectly. This sounds odd, but it's true. The troubles will be due to something that is being *fed into* the video stages, upsetting the picture. The most common of these is in the blanking circuits.

Other faults in blanking circuits can cause the normal blanking pulse to be distorted. For example, they may be flattened and widened. This will make it "hang over" into the picture. This usually blanks out part of the picture on the left. Look for leaking capacitors or diodes, and resistors which have drifted off-value, thus changing the time-constants. R-E

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reader questions

LOSS OF VERTICAL SWEEP

I replaced a bad 820-ohm vertical output tube cathode resistor in this CTC25 RCA, and fixed the complaint of loss of vertical sweep. (I thought.) After about 30 minutes of cooking, out went the same resistor! The raster and sound went with it this time. After waiting a while, I turned it on again. Same thing, about half vertical sweep and the 820-ohm resistor was burned up. This happened on the set, and also on my test-jig. I'm baffled. Any suggestions?—A.C., Cleveland, OH.

Thanks to the test-jig, you've eliminated the yoke, etc. Let's see. Something is causing the 6GF7 tube to draw too much current (or is it?) With a new tube, a short isn't too likely. So let us look elsewhere.

Follow the 6GF7 cathode circuit; it goes through the 820-ohm resistor, and *also* through a pair of resistors which are connected to the suppressor grid of the 6JE6 horizontal output tube. (This is done to feed a little positive voltage to this grid to get rid of UHF snivets.)

These are, of course, a part of the vertical output tube's cathode circuit. However! If you have an intermittent short *in the 6JE6*, this can burn up the 820-ohm resistor in the vertical. So, you lose vertical sweep. Your loss of raster and sound could be trying to tell us this is the cause. Try a new 6JE6. This has been known to happen.

PM MAGNET FOR TAPE ERASE?

I tore up an old electric generator and found a couple of big magnets. These are powerful enough to fully erase a 10½" reel of recording tape. Do you think this method will hurt anything?—R.G., Baltimore, MD.

I really don't think so. After all, there are quite a few small tape recorders which use a little PM magnet as the erase head, and others that use an electromagnetic head with a DC supply. Can't see any difference.

WHY WAS THE GRID VOLTAGE NORMAL?

I wrote you a short while ago about a problem with a Sylvania D0-5-1. The horizontal output grid was approximately 20 volts positive, with all of the resulting symptoms that this causes. I strongly suspected the regulator stage, 6CL8, but I had checked everything in the plate and cathode of that stage. Also checked the few components in the grid circuit of the 42KN6 all to no avail. I didn't go into the grid circuit of the regulator, since I had +18 volts DC and the 50-volt P-P proper waveform on the grid.

Sounds like the grid cricuit is fine, doesn't it? WRONG! Anyway, I followed your suggestions of checking X3, the resistors in the 42KN6 grid circuit, etc. Still had the same problem.I was stumped. Then, I sat down and thought. As a last resort, I'd go into the grid circuit of the 6CL8 regulator. There it was.

Resistor R119, 270K 5%, had increased to 300K. Resistor R120, 27K up to 29K, and R121, 3.9 megohms was up to 7 megohms.

Change these three resistors, and the set works fine. What confused me from the start was the fact that I did have +18 volts on the grid of the regulator. Well within the ballpark. The proper waveform was there, but a little high; 50 volts when it should have been 34 V P-P.

So I thought I'd take time to give you some field feedback on this weird problem and let you know what it was. I still have one question. I'd like to find out *why* the grid voltage of the regulator was so close to normal.—Mike McDaniel, Patrick AFB, FL.

(So would I, Mike. If any of our readers know, let me know.) **R-E**

next month

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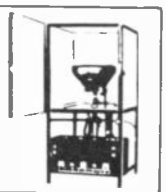

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7496	.79	74265	.85
74100	1.25	74273	2.75
74104	.43	74278	2.45
74105	.43	74279	.95
74107	.34	74283	1.75
74109	.74	74284	4.50
74110	.54	74285	4.50
74111	.74	74290	.85
74116	1.98	74293	.85
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XR-567M	Tone Decoder	9.71
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XR-1310P	Stereo Demodulator	2.39
XR-1310EP	Stereo Demodulator	2.39
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2N3703	.17
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74LS55	.42	74LS248	1.25
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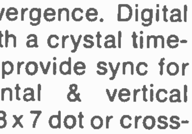

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7460	Dual 4 input expander	.10
7493	4 bit binary counter	.51
74175	Quad D flip flop	1.25

TTL

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

LOW POWER TTL

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

HIGH SPEED TTL

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

8000 SERIES

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

9000 SERIES

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

CMOS

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

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

MEMORIES

1101	256 bit RAM MOS	$ 1.50
1103	1024 bit RAM MOS	3.95
2102	1024 bit static RAM	5.55
5203	2048 bit UV eras PROM	17.95
5260	1024 bit RAM	2.49
5261	1024 bit RAM	2.69
5262	2048 bit RAM	5.95
7489	64 bit ROM TTL	2.48
8223	Programmable ROM	3.69
74200	256 bit RAM tri-state	5.90

CALCULATOR & CLOCK CHIPS

5001	12 DIG 4 funct fix dec	$3.45
5002	Same as 5001 exc btry pwr	3.95
5005	12 DIG 4 funct w/mem	4.95
MM5725	8 DIG 4 funct chain & dec	1.98
MM5736	18 pin 6 DIG 4 funct	4.45
MM5738	8 DIG 5 funct K & mem	5.35
MM5739	9 DIG 4 funct (btry sur)	5.35
MM5311	28 pin BCD 6 dig mux	4.45
MM5312	24 pin 1 pps BCD 4 dig mux	3.95
MM5313	28 pin 1 pps BCD 6 dig mux	4.45
MM5314	24 pin 6 dig mux	4.45
MM5316	40 pin alarm 4 dig	5.39

LED's

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

MULTIPLE DISPLAYS

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

SHIFT REGISTERS

MM5013	1024 bit accum. dynamic	mDIP	$1.75
MM5016	500/512 bit dynamic	mDIP	1.59
SLS-4025	Dual 64 bit static	DIP	1.39

DTL

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

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

LINEAR CIRCUITS

300	Pos V Reg (super 723)	TO-5	$ .71
301	Hi Perf Op Amp	mDIP TO-5	.29
302	Volt follower	TO-5	.53
304	Neg V Reg	TO-5	.80
305	Pos V Reg	TO-5	.71
307	Op AMP (super 741)	mDIP TO-5	.26
308	Micro Pwr Op Amp	mDIP TO-5	.89
309K	5V 1A regulator	TO-3	1.35
310	V Follower Op Amp	mDIP	1.07
311	Hi perf V Comp	mDIP TO-5	.95
319	Hi Speed Dual Comp	DIP	1.13
320	Neg Reg 5.2, 12, 15	TO-3	1.19
322	Precision Timer	DIP	1.70
324	Quad Op Amp	DIP	1.52
339	Quad Comparator	DIP	1.58
340K	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V)	TO-3	1.69
340T	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V)	TO-220	1.49
372	AF-IF Strip detector	DIP	2.93
373	AM/FM/SSB Strip	DIP	.53
376	Pos V Reg	mDIP	2.42
377	2w Stereo amp	DIP	1.16
380	2w Audio Amp	DIP	1.13
380-8	.6w Audio Amp	mDIP	1.52
381	Lo Noise Dual preamp	DIP	1.52
382	Lo Noise Dual preamp	DIP	.71
550	Prec V Reg	DIP	.89
555	Timer	mDIP	.89
556A	Dual 555 Timer	DIP	1.49
560	Phase Locked Loop	DIP	2.48
562	Phase Locked Loop	DIP	2.48
565	Phase Locked Loop	DIP TO-5	2.38
566	Function Gen	mDIP TO-5	2.25
567	Tone Decoder	mDIP	2.66
709	Operational AMPL	TO-5 or DIP	.26
710	Hi Speed Volt Comp	DIP	.35
711	Dual Difference Compar	DIP	.26
723	V Reg	DIP	.62
739	Dual Hi Perf Op Amp	DIP	1.07
741	Comp Op AMP	mDIP TO-5	.32
747	Dual 741 Op Amp	DIP or TO-5	.71
748	Freq Adj 741	mDIP	.35
1304	FM Mulpx Stereo Demod	DIP	1.07
1307	FM Mulpx Stereo Demod	DIP	.74
1458	Dual Comp Op Amp	mDIP	.62
1800	Stereo multiplexer	DIP	2.48
LH2111	Dual LM 211 V Comp	DIP	1.70
3065	TV-FM Sound System	DIP	.62
3075	FM Det-LMTR & Audio preamp	DIP	.71
3900	Quad Amplifier	DIP	.35
7524	Core Mem Sense AMPL	DIP	.71
8864	9 DIG Led Cath Drvr	DIP	2.25
75150	Dual Line Driver	DIP	1.75
75451	Dual Perepheral Driver	mDIP	.35
75452	Dual Peripheral Driver	mDIP	.35
75453	(351) Dual Periph Driver	mDIP	.35
75491	Quad Seq Driver for LED	DIP	.71
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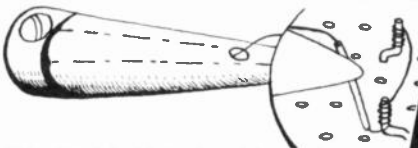

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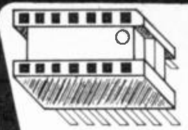

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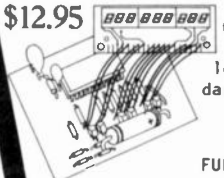

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2SC482	1.75	2SC797	2.50	2SC1239	3.50	MRF8004	3.00		
2SC495T	.90	2SC798	3.10	2SC1243	1.50	4004	3.00	3SK40	4.50
2SC517	4.75	2SC781	3.00	2SC1306	4.75	4005	3.00	3SK45	4.50
2SC710	.70	2SC789	1.00	2SC1307	5.75	40080	1.25	3SK49	4.50
2SC711	.70	2SC799	4.25	2SC1377	5.50	40081	1.50		
2SC735	.70	2SC1013	1.50	2SC1449	3.50	40082	3.00	RECTIFIERS	
2SC756	3.00	2SC1014	1.50	2SC1678	5.75	SK3048	3.25	IN34	.25
2SC773	.85	2SC1017	1.50	2SC1679	5.75	SK3049	4.75	IN60	.25
2SC774	1.75	2SC1018	1.50	2SC1728	3.75			IS1555	.35
2SC775	2.75	2SC1173	1.25	2SC1816	5.50	2SK19	1.75		
2SC776	3.00	2SC1226A	1.25	2SC1957	3.50	2SK30	1.00		

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2SA473	.75	2SB303	.65	2SC478	.80	2SC828	.75	2SC1756	1.25
2SA483	1.95	2SB324	1.00	2SC491	2.50	2SC829	.75		
2SA489	.80	2SB337	2.10	2SC495	.70	2SC830	1.60	2SD30	.95
2SA490	.70	2SB367	1.60	2SC497	1.60	2SC839	.85	2SD45	2.00
2SA505	.70	2SB370	.65	2SC515	.80	2SC945	.65	2SD65	.75
2SA564	.50	2SB405	.85	2SC535	.95	2SC1010	.80	2SD68	.90
2SA628	.65	2SB407	1.65	2SC536	.65	2SC1012	.80	2SD72	1.00
2SA643	.85	2SB415	.85	2SC537	.70	2SC1051	2.50	2SD88	1.50
2SA647	2.75	2SB461	1.25	2SC563	2.50	2SC1061	1.65	2SD151	2.25
2SA673	.85	2SB463	1.65	2SC605	1.00	2SC1079	3.75	2SD170	2.00
2SA679	3.75	2SB471	1.75	2SC620	.80	2SC1096	1.20	2SD180	2.75
2SA682	.85	2SB474	1.50	2SC627	1.75	2SC1098	1.15	2SD201	1.95
2SA699	1.30	2SB476	1.25	2SC642	3.50	2SC1115	2.75	2SD218	4.75
2SA699A	1.75	2SB481	2.10	2SC643	3.75	2SC1166	.70	2SD300	2.50
2SA705	.55	2SB492	1.25	2SC644	.70	2SC1170	4.00	2SD313	1.10
2SA815	.85	2SB495	.95	2SC681	2.50	2SC1172B	4.25	2SD315	.75
2SA816	.85	2SB507	.90	2SC684	2.10	2SC1209	.55	2SD318	.95
		2SB511	.70	2SC687	2.50	2SC1213	.75	2SD341	.95
2SB22	.65			2SC696	2.35	2SC1226	1.25	2SD350	3.25
2SB54	.70	2SC206	1.00	2SC712	.70	2SC1243	1.50	2SD352	.80
2SB56	.70	2SC240	1.10	2SC713	.70	2SC1293	.85	2SD380	5.70
2SB77	.70	2SC261	.65	2SC732	.70	2SC1308	4.75	2SD389	.90
2SB128	2.25	2SC291	.65	2SC733	.70	2SC1347	.80	2SD-390	.75
2SB135	.95	2SC320	.75	2SC739	.70	2SC1383	.75	2SD437	5.50
2SB152	4.50	2SC352	.75	2SC756	2.00	2SC1409	1.25		
2SB173	.55	2SC353	.75	2SC762	1.90	2SC1410	1.25	C106B1	.50
2SB175	.55	2SC371	.70	2SC783	1.00	2SC1447	1.25		
2SB178	1.00	2SC372	.70	2SC784	.70	2SC1448	1.25		
2SB186	.60	2SC394	.70	2SC785	1.00	2SC1507	1.25		

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OEM SPECIALS

1N270	.10	2N960	.40	2N2219A	.25	2N2913	.75	2N3740	1.00	2N4401	.20		
1N914	.10	2N962	.40	2N2221	.20	2N2914	1.20	2N3771	1.75	2N4402	.20		
		2N967	.40	2N2221A	.20	2N2916A	3.65	2N3772	1.90	2N4403	.20		
2N173	1.75	2N1136	1.15	2N2222	.20	2N3019	1.20	2N3773	2.10	2N4409	.20		
2N178	.90	2N1142	1.85	2N2222A	.20	2N3053	.30	2N3819	.25	2N4410	.25		
2N327A	1.15	2N1302	.25	2N2270	.30	2N3054	.70	2N3823	.55	2N4416	.75		
2N334	1.20	2N1305	.30	2N2322	1.45	2N3055	.75	2N3856	.20	2N4441	.85		
2N336	.90	2N1377	1.15	2N2323	1.50	2N3227	1.90	2N3866	.85	2N4442	.90		
2N338A	1.05	2N1420	.20	2N2324	1.85	2N3247	3.40	2N3903	.20	2N4443	1.20		
2N398B	.90	2N1483	.95	2N2325	2.00	2N3250	.40	2N3904	.20	2N4852	.55		
2N404	.20	2N1540	.90	2N2326	2.85	2N3375	4.80	2N3905	.20	2N5061	.25		
2N443	1.00	2N1543	2.70	2N2327	3.80	2N3393	.20	2N3906	.25	2N5064	.40		
2N456	1.10	2N1544	.80	2N2328	4.20	2N3394	.20	2N3925	4.25	2N5130	.20		
2N501A	3.00	2N1549	.95	2N2329	5.75	2N3414	.20	2N3954	4.35	2N5133	.15		
2N508A	.30	2N1551	3.20	2N2368	.25	2N3415	.25	2N3954A	4.80	2N5138	.15		
2N555	.45	2N1552	3.25	2N2369	.20	2N3416	.30	2N3955	2.45	2N5198	3.75		
2N652A	.85	2N1554	1.70	2N2484	.20	2N3417	.30	2N3957	1.25	2N5294	.60		
2N677C	4.85	2N1557	1.50	2N2712	.25	2N3442	1.85	2N3958	1.20	2N5296	.40		
2N706	.20	2N1560	2.80	2N2894	.40	2N3553	1.50	2N4037	.60	2N5306	.20		
2N706B	.35	2N1605	.35	2N2903	3.30	2N3563	.20	2N4093	.85	2N5354	.25		
2N711	.35	2N1613	.30	2N2904	.20	2N3565	.20	2N4124	.20	2N5369	.25		
2N711B	.50	2N1711	.30	2N2904A	.25	2N3638	.20	2N4126	.20	2N5400	.50		
2N718	.20	2N1907	4.10	2N2905	.20	2N3642	.20	2N4141	.20	2N5401	.50		
2N718A	.25	2N2060	1.85	2N2905A	.25	2N3643	.15	2N4142	.20	2N5457	.35		
2N720A	1.30	2N2102	.40	2N2906	.20	2N3645	.15	2N4143	.20	2N5458	.35		
2N918	.20	2N2218	.25	2N2906A	.25	2N3646	.10	2N4220A	.95				
2N930	.20	2N2218A	.30	2N2907	.20	2N3730	1.10	2N4234	1.20				
2N956	.20	2N2219	.20	2N2907A	.25	2N3731	1.60	2N4400	.20				

SILICON UNIJUNCTIONS

2N2646	To-18	.50
2N2647	To-18	.60
2N6027 PUT	To-92	.55
2N6028 PUT	To-92	.70
D5E37	To-18	.25

INTEGRATED CIRC.

UA703C	.40
709C OP. AMP.	.25
741C OP. AMP.	.25
CA3066	3.90
CA3068	6.35
MC1305	1.45
7400	.15

RECTIFIERS

	10	100
IN4001	.60	5.00
IN4002	.70	6.00
IN4003	.80	7.00
IN4004	.90	8.00
IN4005	1.00	9.00
IN4006	1.10	10.00
IN4007	1.20	11.00

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SN7400N	16	SN7451N	27	SN74151N	1 25
SN7401N	16	SN7453N	27	SN74153N	1 35
SN7402N	21	SN7454N	41	SN74154N	1 25
SN7403N	16	SN7459A	25	SN74155N	1 21
SN7404N	21	SN7460N	22	SN74156N	1 30
SN7405N	24	SN7470N	45	SN74157N	1 30
SN7406N	45	SN7472N	39	SN74160N	1 75
SN7407N	45	SN7473N	45	SN74161N	1 45
SN7408N	25	SN7474N	45	SN74163N	1 65
SN7409N	25	SN7475N	80	SN74164N	1 65
SN7410N	20	SN7476N	47	SN74165N	1 65
SN7411N	30	SN7480N	50	SN74166N	1 70
SN7412N	42	SN7482N	1 75	SN74167N	5 50
SN7413N	85	SN7483N	1 15	SN74170N	3 00
SN7414N	70	SN7485N	1 12	SN74172N	18 00
SN7416N	43	SN7486N	45	SN74173N	1 70
SN7417N	43	SN7488N	3 50	SN74174N	1 95
SN7418N	25	SN7489N	3 00	SN74175N	1 95
SN7420N	21	SN7490N	59	SN74176N	90
SN7421N	39	SN7491N	1 20	SN74177N	90
SN7423N	37	SN7492N	82	SN74180N	1 05
SN7425N	43	SN7493N	82	SN74181N	3 55
SN7426N	31	SN7494N	91	SN74182N	95
SN7427N	37	SN7495N	91	SN74184N	2 30
SN7429N	42	SN7496N	91	SN74185N	2 20
SN7430N	26	SN74100N	1.25	SN74187N	6 00
SN7432N	31	SN74107N	49	SN74190N	1 50
SN7437N	47	SN74121N	55	SN74191N	1 50
SN7438N	40	SN74122N	49	SN74192N	1 50
SN7439A	25	SN74123N	1 05	SN74193N	1 40
SN7440N	21	SN74125N	60	SN74194N	1 45
SN7441N	1 10	SN74126N	81	SN74195N	1 00
SN7442N	1 08	SN74132N	3 00	SN74196N	1 25
SN7443N	1 05	SN74141N	1 15	SN74197N	1 00
SN7444N	1 10	SN74142N	6 50	SN74198N	2 25
SN7445N	1 10	SN74143N	7 00	SN74199N	2 25
SN7446N	1 15	SN74144N	7 00	SN74200N	7 00
SN7447N	.89	SN74145N	1 15	SN74251N	2 50
SN7448N	.99	SN74148N	2 50	SN74284N	6 00
SN7450N	26	SN74150N	1 10	SN74285N	6 00

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CD4001	25	CD4035	1 85	74C20N	65
CD4002	25	CD4040	2 45	74C30N	65
CD4006	2 50	CD4042	1 90	74C42N	2 15
CD4007	25	CD4044	1 50	74C73N	1 50
CD4009	59	CD4046	2.51	74C74	1 15
CD4010	59	CD4047	2 75	74C90N	3 00
CD4011	25	CD4049	79	74C95N	2 00
CD4012	25	CD4050	79	74C107N	1 25
CD4013	47	CD4051	2.98	74C151	2 90
CD4016	56	CD4053	2 98	74C154	3 00
CD4017	1 35	CD4060	3 25	74C157	2 15
CD4019	55	CD4066	1 75	74C160	3 25
CD4020	1 49	CD4069	45	74C161	3 25
CD4022	1 25	CD4071	45	74C163	3 00
CD4023	25	CD4081	45	74C164	3 25
CD4024	1 50	74C00N	39	74C173	2 60
CD4025	25	74C02N	55	74C193	2 75
CD4027	69	74C04N	75	74C195	2 75
CD4028	1 65			80C97	1 50
CD4029	2 90				

LINEAR

LM100H	15 00	LM373N	3 25	LM1310N	2 95
LM106H	2 50	LM377N	4 00	LM1351N	1 65
LM171H	3 75	LM380N	1 39	LM1414N	1 75
LM212H	7 00	LM380CN	1 05	LM1458C	65
LM300H	80	LM381N	1 79	LM1496N	95
LM301H	3 1 00	LM382N	1 79	LM1556V	1 85
LM301CN	3/1 00	NE501K	8 00	LM2111N	1 95
LM302H	75	NE510A	6 00	LM2901N	2 95
LM304H	1 00	NE531H	3 00	LM3065N	69
LM305H	95	NE536T	6 00	LM3900N	55
LM307CN	35	NE540L	6 00	LM3905N	60
LM308H	1 00	NE550N	79	LM5556N	1 85
LM308CN	1 00	NE553	2 50	MC5558V	1 00
LM309H	1 10	NE555V	75	LM7525N	90
LM309K	1 25	NE565H	1.25	LM7528N	2 20
LM310CN	1 15	NE565N	1.95	LM7534N	2 20
LM311H	90	NE566CN	1 95	LM7535N	1 25
LM311N	90	NE567H	1 25	8038B	4 95
LM318CN	1 50	NE567V	1 95	LM75450	49
LM319N	1 30	LM703CN	45	75451CN	39
LM319D	9 00	LM709H	29	75452CN	39
LM320K 5	1 35	LM709N	29	75453CN	39
LM320K 5 2	1 35	LM710N	79	75454CN	39
LM320K 12	1 35	LM711N	39	75491CN	79
LM320K 15	1 35	LM723H	55	75492CN	89
LM323K 5	10 50	LM723N	55	75494CN	89
LM324N	1 80	LM733N	1 00	RCA LINEAR	
LM339N	1 70	LM739N	1 29	CA3013	1 70
LM340K 5	1 95	LM741CH	3 1 00	CA3023	2 15
LM340K 12	1 95	LM741CN	3 1 00	CA3035	2 25
LM340K 15	1 95	LM741 14N	39	CA3039	1 35
LM340K 24	1 95	LM747H	79	CA3046	1 15
LM340Tn 5	1 75	LM747N	79	CA3059	2 46
LM340To 6	1 75	LM748H	39	CA3060	2 80
LM340To 12	1 75	LM748N	39	CA3080	85
LM340To 15	1 75	LM1303N	90	CA3083	1 60
LM340To 24	1 75	LM1304N	1 19	CA3086	59
LM350N	1 00	LM1305N	1 40	CA3089	3 25
LM351CN	65	LM1307N	85	CA3091	8 75
LM370N	1 15			CA3123	1 85
LM370H	1 15			CA3600	1 75

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26 Awg RIBBON CABLE

1 Ft. Minimum	1 9 ft.	10 ft
4 Cond	49 ft	39 ft
8 Cond	89 ft	69 ft
16 Cond	1 49 ft	1 19 ft
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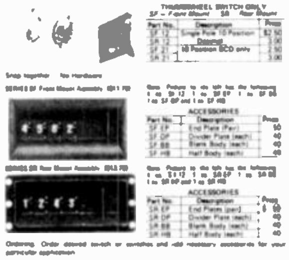

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18 pin	29	28	27	40 pin	63	62	61
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14 pin	$ 30	28	26	28 pin	$ 99	90	81
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18 pin	42	39	37	40 pin	1 59	1 45	1 30
24 pin	59	54	49				

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8 pin	$ 30	27	24	24 pin	$ 70	63	57
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16 pin	43	42	41	36 pin	1 59	1 45	1 30
18 pin	75	68	62	40 pin	1 75	1 55	1 40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

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ASST 4	5 ea	3 3K 3 9K 4 7K 5 6K 6 8K 8 2K 10K 12K 15K 18K	1/4 WATT 5% = 50 PCS
ASST 5	5 ea	22K 27K 33K 39K 47K 56K 68K 82K 100K 120K	1/4 WATT 5% = 50 PCS
ASST 6	5 ea	150K 180K 220K 270K 330K 390K 470K 560K 680K 820K	1/4 WATT 5% = 50 PCS
ASST 7	5 ea	1M 1 2M 1 5M 1 8M 2 2M 2 7M 3 3M 3 9M 4 7M 5 6M	1/4 WATT 5% = 50 PCS.

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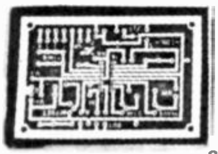
IC'S EXAR KITS

FUNCTION GENERATOR KIT



features sine, triangle and square wave THD 0 5% typ. AM FM capability

XR 2206KA SPECIAL $17.95
Includes monolithic function generator IC, PC board, and assembly instruction manual

XR-2206KB SPECIAL $27.95
Same as XR 2206KA above and includes external components for PC board

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CA3130	Super CMOS Op Amp	1 49	2524	3 50	8826	3 00
MC1408L7	A/D	9 95	2525	6 00	8880	1 35
F3341	FIFO	8 95	2527	5.00	7497	5 00

ZENERS—DIODES—RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
IN746	3 3	400m	4/1 00	IN4003	200 PIV	1 AMP	10
IN751A	5 1	400m	4/1 00	IN4004	400 PIV	1 AMP	10
IN752	5 6	400m	4/1 00	IN3600	50	200m	6/1 00
IN753	6 2	400m	4/1 00	IN4148	75	10m	15 1 00
IN754	6 8	400m	4/1 00	IN4154	35	10m	12/1 00
IN965B	15	400m	4/1 00	IN4734	5 6	1w	28
IN5232	5 6	500m	28	IN4735	6 2	1w	28
IN5234	6 2	500m	28	IN4736	6 8	1w	28
IN5235	6 8	500m	28	IN4738	8 2	1w	28
IN5236	7 5	500m	28	IN4742	12	1w	28
IN456	25	40m	6/1 00	IN4744	15	1w	28
IN458	150	7m	6/1 00	IN1183	50 PIV	35 AMP	1 60
IN485A	180	10m	5/1 00	IN1184	100 PIV	35 AMP	1 70
IN4001	50 PIV	1 AMP	09	IN1186	200 PIV	35 AMP	1 80
IN4002	100 PIV	1 AMP	10	IN1188	400 PIV	35 AMP	3 00

TRANSISTORS

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MPS A06	5/$1 00	PN3568	4 $1 00	PN4250	4/$1 00
2N2219A	3/$1 00	PN3569	4 $1 00	2N4400	4 $1 00
2N2221	4 $1 00	2N3704	5 $1 00	2N4401	4 $1 00
2N2222A	5 $1 00	2N3705	5 $1 00	2N4402	4 $1 00
2N2369	5/$1 00	2N3706	5 $1 00	2N4403	4/$1 00
2N2369A	4/$1 00	2N3700	5 $1 00	2N4409	5/$1 00
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2N2906A	4 $1 00	2N3724	$ 65	2N5088	4/$1 00
2N2907A	5 $1 00	2N3725	$1 00	2N5089	4/$1 00
2N2925	5 $1 00	2N3903	5 $1 00	2N5129	5/$1 00
2N3053	2/$1 00	2N3904	4 $1 00	2N5138	5/$1 00
2N3055	$ 89	2N3905	4 $1 00	2N5139	5/$1 00
MJE3055	$ 89	2N3906	4 $1 00	2N5209	5/$1 00
2N3392	5 $1 00	2N4013	3 $1 00	2N5951	5/$1 00
2N3398	5/$1 00	2N4014	3/$1 00	C106B1 SCR	2/$1 00

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50 VOLT CERAMIC DISC CAPACITORS

	1 9	10 49	50 100		1 9	10 49	50 100
10pf	05	04	03	001	05	04	035
22 pf	05	04	03	0047	05	04	035
47 pf	05	04	03	01	05	04	035
100 pf	05	04	03	022	06	05	04
220 pf	05	04	03	047	06	05	04
470 pf	05	04	035	1	12	09	075

100 VOLT MYLAR FILM CAPACITORS

001mf	12	10	07	022mf	13	11	08
0022	12	10	07	047mf	21	17	13
0047mf	12	10	07	1mf	27	23	17
01mf	12	10	07	.22mf	33	27	22

+ 20% DIPPED TANTALUMS (SOLID) CAPACITORS

1 35V	28	23	17	1 5 35V	30	26	21
15 35V	28	23	17	2 2 25V	31	27	22
22 35V	28	23	17	3 3 25V	31	27	22
33 35V	28	23	17	4 7 25V	32	28	23
47 35V	28	23	17	6 8 25V	36	31	25
68 35V	28	23	17	10 25V	40	35	29
1 0 35V	28	23	17	15 25V	63	50	40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

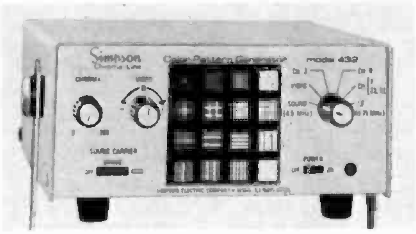
Axial Lead					Radial Lead				
47	50	15	13	10	47	25	15	13	10
1	50	16	14	11	47	50	16	14	11
3 3	50	15	13	10	1	16	15	13	10
4 7	25	16	14	12	1	25	16	14	11
10	25	15	13	10	1	50	16	14	11
10	50	16	14	12	4 7	16	15	13	10
22	25	17	15	12	4 7	25	15	13	10
22	50	24	20	18	4 7	50	16	14	11
47	25	19	17	15	10	16	14	12	09
47	50	25	21	19	10	25	15	13	10
100	25	24	20	18	10	50	16	14	12
100	50	35	30	28	47	50	24	21	19
220	25	32	28	25	100	16	19	15	14
220	50	45	41	38	100	25	24	20	18
470	25	33	29	27	100	50	35	30	28
1000	16	55	50	45	220	16	23	17	16
2200	16	70	62	55	470	25	31	28	26

Circle 92 on reader service card

equipment reports

Simpson Model 432 "Chroma-Line" Generator

THE FIRST THING I THOUGHT WHEN I UNpacked the newest thing from Simpson, the Model 432 "Chroma-Line" Generator was "Hey! Isn't that a cute little thing." It's not as big as a cigar box. The second thing I thought was "Oh, shucks. They forgot to send the cables and line cord!" This was an early model, and even the instruction book was a pre-release copy. Searching the packing didn't help, so I settled down to read the manual. That did it. During the first quick look, I found the page that cleared up the mystery.



Circle 103 on reader service card

Despite the very compact size, and all of the things it can do, they have still managed to find space to put a 23-cubic-inch storage compartment in it! It's on the bottom of the case, with a cover held by two snap fasteners. Taking this off, there was the line cord and all of the hookup cables. So, don't write to the factory when you get one; just pull the two little black knobs to get at it.

This is a very versatile instrument. A 4 × 4 matrix of pushbuttons can give you any of *sixteen* different patterns. You can have a single dot in the center of the screen, a 7 × 11 pattern or a 15 × 21 pattern of dots. Same with vertical or horizontal lines. You can start out with a single "cross-hair" pattern, one vertical and one horizontal line, go through a 7 × 11 line pattern, and wind up with a 15 × 21 crosshatch. Three color patterns are used; an unkeyed rainbow, three-bar color, and the standard 10 bar keyed rainbow. Last, a very handy one; a white "blank raster" for making purity adjustments.

Any of these signals can be fed into the TV set from the antenna input. Special cables provide either 300-ohm balanced or 75-ohm RF input. You can use any of three VHF channels, 3, 4 or 7. By using the 3rd and 5th harmonics of the channel 7 signal, two UHF channels, 23 and 52 can be used. The RF oscillators used for these are all crystal controlled.

The same patterns can also be fed directly into the IF input of the TV set. This is also a crystal-controlled signal. There is also a video-frequency output, which can be fed directly into the video stages. A 4.5-MHz sound IF signal, again crystal controlled, can be used, modulated or unmodulated. The amplitude of all signals can be adjusted by the level control on the back panel. The sync polarity of the video signal can be set to whatever is needed to match the TV set, and its level adjusted.

On the back panel of the Model 432, beside the RF/IF/video/sound BNC jack, and its level control, there is a banana jack. This can provide trigger signals at either horizontal or vertical frequency for the External Trigger of scopes.

The Model 432 is powered from the AC line, through an isolating transformer. An IC voltage regulator controls all of the IC operating voltages. Short-circuit protection and temperature compensation are also taken care of in this department.

I tried the Model 432 out on some of the dog TV's with which my bench is usually covered, and it came through. (I almost said "with flying colors" but this wasn't the case at all; they were stable as a rock. Beside that, I got roundly chewed out for using this phrase with reference to another color bar generator, a long time ago!)

The compact size of the Model 432 and the logical control arrangement makes it very easy to use, in the home or on the bench. It's small enough to be carried in a tube caddy. Quite an instrument, and one that should give you good service for a long time. **R-E**

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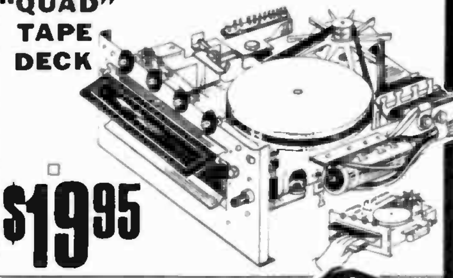

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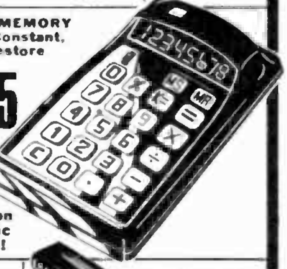

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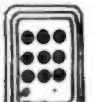

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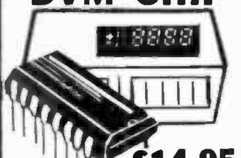

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☐	SLA-1	.33	Green	1.95	5.00
☐	SLA-1	.33	Yellow	1.95	5.00
☐	SLA-3	.7	Green	4.95	12.00
☐	SLA-3	.7	Yellow	4.95	12.00
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A—Common Cathode, others Common Anode
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Circle 93 on reader service card

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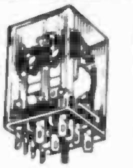

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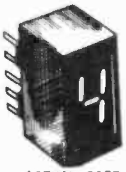
Numeric Display ¼" Single Digit GaAsP LED



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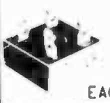

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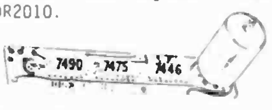
Unit includes board, 7490, 7475, quad latch, 7447 seven-segment driver, and RCA DR2010.



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

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7401	.30	74L54	.25
74H01	.25	74L55	.25
7402	.25	7460	.16
7403	.25	74L71	.25
7404	.25	7472	.40
74H04	.30	74L72	.60
7405	.30	7473	.25
7406	.40	74L73	.75
7408	.30	7474	.45
7410	.15	74H74	.75
7413	.75	7475	.80
7417	.40	7476	.55
7420	.20	74L78	.70
74L20	.30	7480	.50
74H20	.30	7483	.70
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7430	.15	7490	1.00
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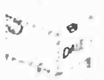

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Circle 94 on reader service card

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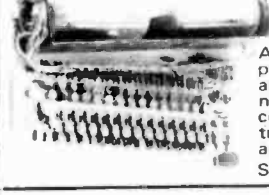

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Circle 96 on reader service card

LINEAR INTEGRATED CIRCUITS

		1-24	25-99	100 up
GENERAL PURPOSE AMPLIFIERS				
SL201B	GP amplifier	4.01	3.51	3.01
SL201C	GP amplifier	1.87	1.64	1.40
MATCHED NPN TRANSISTORS				
SL301A	Matched pair	2.72	2.46	1.40
SL301B	Matched pair	2.30	2.01	1 72
SL303A	Matched triplet	5.47	4.78	4.09
SL303B	Matched triplet	3.93	3.43	2 93
SL305B	Dual matched pairs	7.37	6.44	5.52
SL312B	Matched pair w/tail	2.85	2.56	2 27
SL354B	Matched quad	4.22	3 70	3 17
SL360C	2.6GHz matched pr.	10.93	9.56	8.18
SL362C	2.5GHz low noise pr.	16 26	14.20	12.14
SL3045C	Transistor array	2 77	2.43	2.09
SL3145C	2.5GHz trans. array	14.78	12.94	11.09
AUDIO CIRCUITS				
SL414A	3W audio amplifier	4 22	3 70	3.17
SL415A	5W audio amplifier	5.49	4.81	4 12
POWER CONTROL CIRCUITS				
SL440	Power control circuit	5.49	4.81	4 12
TRANSISTOR ARRAYS				
SL3046	Five transistor array	1 85	1.61	1 37
LINEAR RF AMPLIFIERS				
SL501A	RF amplifier	19.25	16 84	14.44
SL501B	RF amplifier	5 91	5 17	4.44
SL502A	RF amplifier	14.55	13.04	11.54
SL502B	RF amplifier	3.88	3.49	3 09
SL503A	RF amplifier	16.50	14 78	13 07
SL503B	RF amplifier	4.12	3.70	3.27
SL551A	RF amplifier	18.82	16.87	14 92
SL551B	RF amplifier	5.89	5 28	4.67
SL552A	RF amplifier	18.82	16.87	14.92
SL552B	RF amplifier	5 89	5.28	4.67
SL553A	RF amplifier	21 09	18 90	16 71
SL553B	RF amplifier	6.26	5 62	4.96
SL510C	RF det.& video amp.	25.34	22.18	19 00
SL511C	RF det & video amp.	25 34	22 18	19.00
LIMITING WIDEBAND AMPLIFIERS				
SL521A	Limiting RF amp	27 72	24.26	20.80
SL621B	Limiting RF amp	17.58	15 58	13 57
SL521C	Limiting RF amp.	10.59	9 27	7.95
SL571A	Limiting RF amp.	37.80	33.08	28.35
SL571B	Limiting RF amp.	23.39	20.46	17 53
SL571C	Limiting RF amp.	17.48	15.29	13.09
SL525C	Wideband amplifier	5 80	5 20	4 60
SL530C	Logarithmic amp.	17 58	15.58	13 57
SL550C	200MHz widebd amp	26 19	21.81	18 16
SL1030C	200MHz widebd amp	29.57	25.87	22.18
RADIO COMMUNICATIONS CIRCUITS				
SL610C	RF amplifier	4 07	3.56	3 06
SL611C	RF amplifier	4.07	3.56	3 06
SL612C	IF amplifier	4.07	3.56	3 06
SL613C	Limiting amp/det	8.66	7 58	6 49
SL620C	VOGAD	6 15	5 39	4 62
SL621C	AGC generator	6 15	5.39	4 62
SL622C	AF amp/VOGAD sidetone amplifier	15 21	13.31	11 41

PLESSEY SEMICONDUCTORS

SL623C	AM det./AGC amp/ SSB demod.	11.19	9.79	8.40
SL624C	Multimode det. AF amp	5.70	5.00	4.28
SL630C	AF amplifier	3.85	3.38	2.90
SL640C	Dbl bal. modulator	7.55	6.60	5.65
SL641C	Receiver mixer	7.55	6.60	5.65
SL645C	Square law device	7 55	6.60	5.65
SL650B	Mod./phase loc. loop	10.86	9.31	7.76
SL650C	Mod./phase loc. loop	6.80	5.83	4.86
SL651B	Mod./phase loc. loop	12.06	10.34	8.62
SL651C	Mod./phase loc. loop	7.56	6.84	5.40
OPERATIONAL AMPLIFIERS				
SL701B	Op. amplifier	7.13	6.23	5.39
SL701C	Op. amplifier	3.56	3.12	2.67
SL702B	Op. amplifier	7.13	6.23	5.39
SL702C	Op. amplifier	3.56	3 12	2.67
SL717A	Dual comparator	10.35	9.06	7.76
SL717C	Dual comparator	6 57	5.76	4.94
SL751B	Op amplifier	8.37	7.50	6.63
SL751C	Op amplifier	4.81	4 30	3.80
TELECOMMUNICATIONS CIRCUIT				
SL1001A	Linear mod/demod	3.22	2.83	2 43
SL1001B	Linear mod/demod.	3.22	2.83	2.43
SL1020A	Lin amp. remote DC control	7 15	6.26	5.36
TELEVISION CIRCUITS				
SAA570	Limit. IF amp/FM det.	4.22	4.22	3.30
SAA661	Limit. IF amp/FM det.	4.73	4.73	3.70
SAA700	Signal processor	10 14	10.14	7.92
SBA550	Signal processor	10.14	10.14	7.92
SBA750	Limit. IF amp/FM det	4.73	4.73	3.70
SL432	Limit. IF amp/FM det.	4 73	4.73	3.70
SL437C	IF & AGC for PNP tuners	13.52	13.52	10.56
SL437D	IF & AGC for NPN tuners	13 52	13.52	10.56
SL442	Switch mode power supply control	9.24	7.92	6.60
SL450	Power sup. & Syn. sep.	11 09	9.50	7.92
SL456A	TV IF system	7 39	6.34	5.28
SL456B	TV IF system	7 39	6.34	5.28
SL457A	TV IF system	7.39	6 34	5 28
SL457B	TV IF system	7.39	6.34	5.28
SL901	Color demodulator	10 14	10.14	7.92
SL917	Color decoder	13.52	13.52	10.56

DIGITAL INTEGRATED CIRCUITS

	Description	1-24	25-99	100 up
PROCESS CONTROL CIRCUITS				
SP520	Gray code counter	13 94	12.49	11.04
SP521	Binary rate multip.	13.94	12.49	11.04
SP522	Phase loc.dw & com.	13 94	12.49	11.04
PECL II – SP1000 SERIES				
SP1004B	Dual 4 I/P OR/NOR gate	1.71	1.48	1.25
SP1005B	Dual 4 I/P OR/NOR gate	1 71	1.48	1.25
SP1006B	Dual 4 I/P OR/NOR gate	1.71	1.48	1.25
SP1007B	Triple 3 I/P NOR gate	1.71	1.48	1 25
SP1008B	Triple 3 I/P NOR gate	1.71	1.48	1 25
SP1009B	Triple 3 I/P NOR gate	1.71	1.48	1 25
SP1010B	Quad 2 I/P NOR gate	1 71	1.48	1 25
SP1011B	Quad 2 I/P NOR gate	1 71	1.48	1.25
SP1012B	Quad 2 I/P NOR gate	1 71	1 48	1 25
SP1023B	Dual 4 I/P clock drv	2.80	2 40	2 00
SP1039B	PECL to sat. logic trans.	6 07	5.20	4.33
SP1204B	Dual 4 I/P OR/NOR gate	2.17	1.86	1.55
SP1205B	Dual 4 I/P OR/NOR gate	2.17	1.86	1.55
SP1206B	Dual 4 I/P OR/NOR gate	2.17	1.86	1.55
SP1207B	Triple 3 I/P NOR gate	2.17	1.86	1.55
SP1208B	Triple 3 I/P NOR gate	2.17	1.86	1.55
SP1209B	Triple 3 I/P NOR gate	2 17	1.86	1.55
SP1211B	Quad 2 I/P NOR gate	2.17	1.86	1.55
SP1223B	Quad 4 I/P clock drv	3 50	3.00	2.50
SP1239B	PECL to sat. logic trans.	7.60	6 51	5 42
PECL III – SP1600 SERIES				
SP1660B	Dual 4 I/P gate Hi Z	15.00	12.00	10.00
SP1662B	Quad 2 I/P NOR gate Hi Z	16.50	13.20	11 00
SP1664B	Quad 2 I/P OR gate Hi Z	16.50	13.20	11.00
SP1670B	Single D F/F Hi Z	27.00	21 60	18 30
SP8000 SERIES HIGH SPEED DIVIDERS				
SP8600A	÷ 4 at 250MHz	25.20	21 60	18.00
SP8600B	÷ 4 at 250MHz	11 06	9.48	7.90
SP8601A	÷ 4 at 150MHz	15 96	13.68	11 40
SP8601B	÷ 4 at 150MHz	10.08	8.64	7 20
SP8602A	÷ 2 at 500MHz	95.00	81.43	67.86
SP8602B	÷ 2 at 500MHz	26 82	22.99	19.16
SP8603A	÷ 2 at 400MHz	71.68	61 44	51 20
SP8603B	÷ 2 at 400MHz	20.29	13 39	14.49
SP8604A	÷ 2 at 300MHz	34.58	29 64	24.70
SP8604B	÷ 2 at 300MHz	15.40	13.20	11.00
SP8607B	÷ 2 at 600MHz	40.99	35.14	29 28
SP8613B	÷ 4 at 700MHz	49 00	42 00	35.00
SP8614B	÷ 4 at 800MHz	56.00	48.00	40.00
SP8615B	÷ 4 at 900MHz	67 20	57 60	48 00
SP8616B	÷ 4 at 1GHz	81 20	69.60	58 00
SP8616D	÷ 4 at 950MHz	74 20	63.60	53.00
SP8620B	÷ 5 at 400MHz	45.92	39 36	32.80
SP8621B	÷ 5 at 300MHz	31 78	27 24	22.70
SP8622B	÷ 5 at 200MHz	25 13	21 54	17 95
SP8630B	÷ 10 at 600MHz	69.82	59 84	49 87
SP8630D	÷ 10 at 550MHz	58 80	50.40	42 00
SP8631B	÷ 10 at 500MHz	53 20	45.60	38 00
SP8632B	÷ 10 at 400MHz	42 00	36.00	30.00
SP8634B	÷ 10 BCD) at 700MHz	81 20	69 60	58.00
SP8635B	÷ 10 BCD) at 600MHz	70.00	60.00	50.00
SP8636B	÷ 10 (BCD) at 500MHz	60 20	51 60	43.00
SP8637B	÷ 10 (BCD) at 400MHz	50.40	43 20	36.00
SP8640A	÷ 10 11 (ECL) at 200MHz	28 00	24 00	20.00
SP8640B	÷ 10 11 (ECL) at 200MHz	12 99	11 14	9.28
SP8641A	÷ 10/11 (ECL) at 250MHz	32.20	27.60	23.00
SP8641B	÷ 10/11 (ECL) at 250MHz	19.04	16.32	13.60
SP8642A	÷ 10/11 (ECL) at 300MHz	58.80	50 40	42.00
SP8642B	÷ 10/11 (ECL) at 300MHz	25.20	21 60	18.00
SP8643B	÷ 10/11 (ECL) at 350MHz	35.00	30.00	25.00
SP8650B	÷ 16 at 600MHz	70 00	60.00	50.00
SP8651B	÷ 16 at 500MHz	53 20	45.60	38.00
SP8652B	÷ 16 at 400MHz	42.00	36.00	30.00
SP8655A	÷ 32 at 100MHz	63.00	54 00	45.00
SP8655B	÷ 32 at 100MHz	21 00	18.00	15.00
SP8657A	÷ 20 at 100MHz	63 00	54.00	45.00
SP8657B	÷ 20 at 100MHz	21.00	18.00	15.00
SP8659A	÷ 16 at 100MHz	53.20	45.60	38.00
SP8659B	÷ 16 at 100MHz	18.90	16.20	13.50
SP8665B	÷ 10 at 1.0GHz	98.00	84 00	70.00
SP8666B	÷ 10 at 1.1GHz	107.80	92.40	77.00
SP8667B	÷ 10 at 1.2GHz	119.00	102.00	85.00
SP8670B	÷ 8 at 600MHz	63 00	54 00	45.00
SP8671B	÷ 8 at 500MHz	49 00	42.00	35.00
SP8672B	÷ 8 at 400MHz	37 80	32.40	27.00
SP8685A	÷ 10/11 at 500MHz	116.20	99.60	83.00
SP8685B	÷ 10/11 at 500MHz	35.00	30 00	25.00
SP8690A	÷ 10/11 at 100MHz	63 00	54 00	45.00
SP8690B	÷ 10/11 at 100MHz	19 60	16 80	14 00
MNOS NON-VOLATILE MEMORY ELEMENTS				
NOM201C	Single MNOS trans.	4.44	3.80	3.17
NOM202C	MNOS transistor pr.	7 39	6 34	5.28
NOM204C	Quad MNOS trans.	12.94	11.09	9.24
NOM401C	8x8 MNOS array	33.26	28.51	23.76
INTERFACE CIRCUITS				
SP701A	MOS analog switch drv	14 15	12.38	10.61
SP701B	MOS analog switch drv.	10 56	9 24	7.92
SP702A	MOS logic driver	14.15	12 38	10.61
SP702B	MOS logic driver	10 56	9 24	7.92
SP703A	MOS logic & clock driv	14 15	12.38	10 61
SP703A*	MOS logic & clock driv	18.32	16.03	13.73
SP703B	MOS logic & clock driv	10.56	9 24	7.92
SP703B*	MOS logic & clock driv	14.78	12 94	11.09
SP704A	MOS logic & clock driv	14 15	12 38	10.61
SP704A*	MOS logic & clock driv	18.32	16 03	13.73
SP704B	MOS logic & clock driv	10.56	9 24	7.92
SP704B*	MOS logic & clock driv	14 78	12 94	11.09
SP721B	Balanced line driver	8 26	7 23	6 20
SP721B*	Balanced line driver	12 67	11.09	9.50
SP722B	TTL driver	8 26	7 23	6 20
SP722B*	TTL driver	12 67	11 09	9.50
SP723B	TTL driver	9 40	8 24	7.05
SP723B*	TTL driver	13 73	12 01	10.30
SP724B	Dual TTL driver	11 83	10.35	8.87
SP724B*	Dual TTL driver	16.47	14 41	12.36
SP740B	Current comparator	30.41	26 61	22.81
SP740B*	Current comparator	37 83	33.11	28 38
SP741B	Current comparator	30 41	26 61	22 81
SP741B*	Current comparator	37 83	33 11	28.38
SP751A	MOS analog switch drv.	18 32	16 03	13.73
SP751B	MOS analog switch drv	14 78	12 94	11 09

* FLAT PACK

EXAR ICs

		1-9	10 up	100 up
XR 100K	XR chip cust. IC des. kit	$80 00	$80 00	$80.00
XR B101	NPN trans array, sm sig	3 50	3 50	3 50
XR B102	PNP array	3 50	3 50	3 50
XR C101	NPN array, sm sig.	3 50	3 50	3 50
XR C102	PNP array, lat. & subs.	3 50	3 50	3.50
XR C103	NPN array, pwr & schottky	3 50	3.50	3 50
XR-C104	Diffused resistor array	3 50	3 50	3 50
XR C105	Diffused & pinch resis. array	3 50	3 50	3 50
XR C106	Bal mod & NPN,PNP cur source	3.50	3 50	3 50
XR S200	Multi function IC	28 00	23 00	21 00
XR 205	Waveform gen IC	8 40	7 35	6 30
XR 205K	Waveform gen kit	25 00	25 00	25 00
XR 210	FSK mod demod.	5 20	4 55	3 90
XR 210M	FSK mod demod	10 40	9 10	7 80
XR 215	Gen purpose PLL	6 56	5.74	4 92
XR-320	Timing circuit	1 52	1.33	1 14
XR 555CP	Timing circuit	1 07	94	80
XR-556M	Dual timing circuit	10.56	9 24	7 92
XR 556CN	Dual timing circuit	2 88	2 52	2 16
XR-556CP	Dual timing circuit	1 82	1 60	1 37
XR 567M	Tone decoder	12 96	11 34	9 72
XR 567CN	Tone decoder	1 84	1.61	1 38
XR 567CP	Tone decoder	1 68	1.47	1 26
XR 1310P	Stereo demod.	3.20	2.80	2 40
XR 1310EP	Stereo demod	3.20	2.80	2 40
XR 1468CN	±5V tracking VR	3.84	3.36	2 88
XR 1468CP	±5V tracking VR	2.54	2.23	1 91
XR 1488N	Quad line driver	5 76	5 04	4 32
XR 1488P	Quad line driver	5 20	4.55	3 90
XR 1489AN	Quad line rec	4.80	4 20	3 60
XR-1489AP	Quad line rec	4 32	3.78	3 24
XR 1568M	±15V track VR	14 32	12 53	10 74
XR 1568N	±15V track VR	7 20	6 30	5 40
XR 1800P	Stereo decoder	3.20	2.80	2.40
XR 2206N	Monolithic funct. gen.	$11 20	9 80*	8 40
XR 2206P	Monolithic funct. gen.	10.24	8 96	7 68
XR 2206CN	Monolithic funct. gen.	6.16	5.39	4.62
XR 2206CP	Monolithic funct gen.	5 12	4.48	3.84
XR 2207M	VCO	15 44	13.51	11 58
XR 2207N	VCO	7 76	6.79	5 82
XR 2207P	VCO	6 72	5 88	5 04
XR 2207CN	VCO	4 80	4.20	3 60
XR 2207CP	VCO	3.84	3 36	2 88
XR 2208M	Op multiplier	17 76	15.54	13 32
XR 2208N	Op multiplier	8 88	7 77	6 66
XR 2208P	Op multiplier	7 92	6.93	5 94
XR 2208CN	Op. multiplier	5 60	4 90	4 20
XR 2208CP	Op multiplier	5.20	4 55	3.90
XR 2211CN	FSK demod./tone decoder	7 57	6.62	5 68
XR 2211CP	FSK demod./tone decoder	6 88	6.02	5 16
XR 2240M	Prog. timer/ctr.	19 52	17.08	14 64
XR 2240N	Prog. timer/ctr.	8 80	7 70	6.60
XR 2240P	Prog timer/ctr.	7 20	6 30	5 40
XR 2240CN	Prog timer/ctr	6 24	5.46	4.68
XR-2240CP	Prog timer/ctr.	4 80	4.20	3 60
XR 2556M	Dual 555 timer	10 56	9.24	7 92
XR 2556CN	Dual 555 timer	3 52	3.08	2 64
XR 2556CP	Dual 555 timer	3 20	2.80	2 40
XR 2567M	Dual 567 tone decoder	16 94	14.83	12 71
XR-2567CN	Dual 567 tone decoder	7.90	6 92	5 93
XR 2567CP	Dual 567 tone decoder	5 18	4 54	3.89

The Function Generator Kit features sine, triangle and square wave, THD 0 5% typ , AM/FM capability

XR-2206KA FUNCTION GENERATOR KIT $18.95
Includes monolithic function generator IC, FC board, and assembly instruction manual

XR-2206KB FUNCTION GENERATOR KIT $28.95
Same as XR 2206KA above and includes external components for PC board

STANDARD MICROSYSTEMS

		1-9	10 up	100 up
COM2502	Universal asynchronous receiver transmitter	$13.20	$10 60	$ 8 80
COM2502P		8 00	6 85	5 95
COM2017		13 20	10.60	8 80
COM2017F		8 00	6 85	5 95
COM2502H		25.00	20 00	16 00
COM2017H		25 00	20 00	16.00
COM2601	Univ sync rec /trans	30 00	24 00	20 50
COM5016	Dual baud rate gen prog div	12 00	9 60	8.00
	Keyboard encoder ROM			
KR2376 ST	Keyboard encoder ROM	20 00	17 50	15.00
KR3600 ST	10 channel multiplexer	20 00	17 50	15 00
NMX5010	10 channel multiplexer	12 00	9 50	8 00
CAL1022	12 digit print cal sgl. chip MOS/LSI circuit	60 00	52 00	45 00

ELECTRONIC ARRAYS

1024 BIT READ/WRITE RANDOM ACCESS MEMORY N-CHANNEL, SILICON GATE

	1-24	25 up	100 up
EA 1500AJ	$21 00	$16 80	$14 00
EA 1500ASJ	16.00	14 40	12 00

PREMIUM QUALITY TRANSISTORS

2N173	2.15	2N877	2.50	2N1921	3.00	2N2600	7.10
2N178	1.00	2N894	2.00	2N1924	1.30	2N2604	1.80
2N293	.60	2N918	.20	2N1934	9.40	2N2605	.50
2N293B	.65	2N956	.40	2N1990	.80	2N2646	.70
2N321	.50	2N960	.60	2N2060	2.10	2N2648	4.00
2N327A	1.40	2N962	.50	2N2065A	1.80	2N2658	7.00
2N334	1.40	2N967	.50	2N2080	5.00	2N2708	.25
2N336	1.00	2N981	2.00	2N2081A	2 50	2N2712	.30
2N338A	1.25	2N984	1 00	2N2100	3.00	2N2713	.15
2N389	9.00	2N1015B	16.00	2N2102	.50	2N2715	.18
2N393	2.70	2N1016B	18.00	2N2148	.70	2N2716	.18
2N398B	1.00	2N1026	1.50	2N2192A	.66	2N2754	95.00
2N404	.20	2N1035	2.00	2N2193	.45	2N2802	9.80
2N417	.50	2N1136	1.50	2N2193A	.90	2N2808	9.00
2N420	1.20	2N1137A	2.00	2N2218	.26	2N2833	4.00
2N424	9.00	2N1142	2.20	2N2218A	.30	2N2880	11.00
2N439	1.00	2N1143	2.00	2N2219	.30	2N2890	4.60
2N443	1.15	2N1168	.75	2N2219A	.38	2N2892	6.70
2N456	1.30	2N1204	1.50	2N2221	.25	2N2893	9.80
2N497	1.40	2N1234	15.00	2N2221A	.26	2N2894	.50
2N501A	4.00	2N1302	.30	2N2222	.24	2N2895	1.00
2N508A	.40	2N1305	.35	2N2222A	.30	2N2903	4.00
2N512B	2.90	2N1377	1.50	2N2259	1.10	2N2904	.30
2N555	.50	2N1404	50	2N2270	.40	2N2904A	.36
2N586	1.00	2N1408	.60	2N2289	3.70	2N2905	.32
2N594	1.50	2N1420	.50	2N2290	6.00	2N2905A	.34
2N630	3.50	2N1483	1.20	2N2297	1.00	2N2906	.18
2N652A	1.00	2N1485	1.60	2N2322	1.80	2N2906A	.20
2N677C	5.50	2N1523	5.00	2N2323	1.90	2N2907	.20
2N681	2.00	2N1534	1.00	2N2324	2.40	2N2907A	.30
2N682	2.50	2N1540	1.10	2N2325	2.60	2N2913	.90
2N683	2.70	2N1543	3.50	2N2326	3.40	2N2914	1.40
2N685	3.40	2N1544	.90	2N2327	4.60	2N2916A	4.05
2N686	4.00	2N1549	1.35	2N2328	5.00	2N2925	.20
2N689	7.00	2N1551	4.00	2N2329	7.00	2N2926	.15
2N697	.25	2N1552	4.00	2N2356	6.00	2N2947	14.50
2N700	4.00	2N1554	2.00	2N2356A	7.00	2N2949	6.00
2N705	.60	2N1557	1.70	2N2359	16.00	2N2950	6.50
2N706	.20	2N1560	3.30	2N2368	.30	2N2969	31.00
2N706B	.40	2N1595	1.50	2N2369	.20		
2N711	.40	2N1596	1.60	2N2382	4.50		
2N711B	.60	2N1597	2.20	2N2440	3.50		
2N718A	.30	2N1598	2.00	2N2453	3.00		
2N720A	.50	2N1599	2.30	2N2465	7.50		
2N741	1.50	2N1605	.45	2N2475	.60		
2N744	.35	2N1613	.50	2N2476	.80		
2N759	1.00	2N1671	2.00	2N2484	.25		
2N759A	1.00	2N1693	15.00	2N2511	1.50		
2N760	.50	2N1711	.50	2N2518	6.00		
2N760A	.70	2N1715	.70	2N2526	4 50		
2N829	3.00	2N1720	5.00	2N2527	5.50		
2N834	.35	2N1899	69.00	2N2537	1.30		
2N859	5.00	2N1907	5.00	2N2538	2.50		

2N3019	1.50	2N3502	1.40	2N3693	.21
2N3022	18.00	2N3503	1.60	2N3694	.22
2N3053	.35	2N3506	7.50	2N3702	.18
2N3054	.80	2N3544	4.00	2N3705	.25
2N3055	.95	2N3548	2.80	2N3707	.17
2N3060	3.00	2N3549	3.00	2N3710	.20
2N3066A	1.20	2N3553	1.80	2N3711	.18
2N3070	1.30	2N3563	.15	2N3725	.36
2N3107	.80	2N3564	.14	2N3730	1.50
2N3109	.75	2N3565	.18	2N3731	2.00
2N3117	1.00	2N3567	.19	2N3740	1.20
2N3130	5.00	2N3568	.30	2N3763	5.00
2N3133	.80	2N3569	.17	2N3771	2.20
2N3202	16.00	2N3584	1.80	2N3772	2.30
2N3209	.90	2N3599	38.00	2N3773	2.40
2N3227	2.40	2N3614	1.10	2N3789	3.00
2N3239	3.00	2N3616	1.25	2N3793	.25
2N3247	3.90	2N3617	2.50	2N3796	3.00
2N3250	.50	2N3634	8.00	2N3799	3.20
2N3371	4.00	2N3638	.18	2N3805	10.50
2N3375	5.50	2N3642	.19	2N3807	4.80
2N3390	.50	2N3643	.14	2N3819	.30
2N3393	.20	2N3645	.15	2N3823	.70
2N3398	.25	2N3646	.10	2N3843	.30
2N3442	2.20	2N3656	8.60	2N3856	.25
2N3445	5.00	2N3657	9.00	2N3865	7.00
2N3467	1.50	2N3680	6.00	2N3866	1.10
2N3468	1.90	2N3684	1.25	2N3903	.20
2N3500	4.00	2N3685A	1.50	2N3904	.22
2N3501	6.50	2N3692	.20	2N3905	.20

2N3906	22	2N4303	.30	2N4890	.90	2N5407	29.00
2N3909	.80	2N4341	1.35	2N4898	1.10	2N5409	32.00
2N3924	3.50	2N4347	1.60	2N4905	2.00	2N5414	6.50
2N3925	4.80	2N4348	2.00	2N4922	1.00	2N5449	.25
2N3945	.90	2N4352	2.00	2N5016	12.80	2N5453	5.10
2N3954	5.00	2N4356	.30	2N5036	1 18	2N5457	.40
2N3954A	5.50	2N4395	1 30	2N5061	.32	2N5458	.40
2N3955	2.70	2N4399	6.40	2N5064	.48	2N5467	32.00
2N3955A	3.20	2N4400	.30	2N5086	.30	2N5562	12.50
2N3957	1.60	2N4401	.32	2N5088	.40	2N5563	9.00
2N3958	1.40	2N4402	.34	2N5089	.46	2N5636	13.50
2N3964	1.10	2N4403	.40	2N5105	3.10	2N5637	27.00
2N3971	1.00	2N4416	90	2N5127	16	2N5655	.85
2N3972	1.40	2N4429	6.00	2N5130	.20	2N5657	1.20
2N4012	10.50	2N4430	8.60	2N5133	.16	2N5679	1.40
2N4037	.70	2N4441	.95	2N5138	.16	2N5742	41.00
2N4045	1.95	2N4442	1.10	2N5154	7.10	2N5778	.55
2N4093	1.05	2N4443	1.40	2N5157	9.90	2N5923	12.80
2N4120	3.90	2N4852	.80	2N5198	4.30	2N6027	.50
2N4124	.20	2N4858	1.10	2N5202	2.20	2N6028	.65
2N4126	.26	2N4859	1.20	2N5294	.70	2N6076	.20
2N4141	.26	2N4863	5 50	2N5306	27	2N6099	.95
2N4142	17	2N4870	.60	2N5354	.30	2N6101	.85
2N4143	16	2N4878	3.90	2N5369	.25	2N6103	.90
2N4208	2.05			2N5397	2 90	2N6155	1.50
2N4220A	1.00						
2N4225	3.80						
2N4226	3.95						
2N4227	.35						
2N4228	.50						
2N4234	1.50						
2N4235	1.90						
2N4248	.17						
2N4249	.18						
2N4250	.22						
2N4258	.34						
2N4291	.35						
2N4293	.50						

NEW Solar Powered Watch with 100-YEAR CALENDAR

Solar cells draw power from the sun (10 to 15 minutes per day) or from ambient light (slightly longer) to keep batteries fully charged. Batteries operate up to 10 years. LSI circuitry is programmed to provide a calendar to the year 2100, automatically adjusting for 30 and 31 day months, even leap years. Automatic brightness control adjusts LED for perfect viewing even in outdoors. Shows minutes and hours, counts out seconds or shows the date. Easily adjusts to reset hour or date without affecting calendar. Shock and water resistant. Accurate to 5 seconds per month. Price: $500.00 each.

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Circle 97 on reader service card

Circle 98 on reader service card

ADVERTISING INDEX

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MARKET CENTER

For faster service USE ZIP CODE on all mail

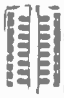
Circle 73 on reader service card

NEW PRODUCTS

PROTO BOARDS

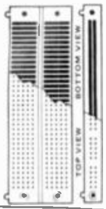
Build & test circuits as fast as you think!

PB100	10 IC cap breadboard kit, 4.5 x 6.0 x 1.35"	$19.95
PB101	10 14-DIP cap, 5-way post, 940 solderless tie points, 5.8 x 4.5"	$29.95
PB102	12 14-DIP cap., like PB101 with 1,240 tie points, 7.0 x 4.5"	$39.95
PB103	24 14-DIP cap., 4 5-way posts, 2,250 tie points, 6.0 x 9.0"	$59.95
PB104	32 14-DIP cap., 3060 solderless tie points, 8.0 x 9.76"	$79.95



LOGIC MONITOR Simultaneously displays static and dynamic logic states of DTL, TTL, HTL or CMOS DIP ICs. Pocket size. $84.95.

PROTO-CLIP For power-on/hands-off signal tracing. Bring IC leads up from PC board surface for fast trouble-shooting.
PC14 14-pin $4.50
PC16 16 pin 4.75



SOCKETS & BUS STRIPS

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

PN/Description	1.3"	Hole-to-Hole	Term'ls	Price
QT59S Socket	6.5"	6.2"	118	$12.50
QT59B Bus	6.5"	6.2"	20	2.50
QT47S Socket	5.3"	5.0"	94	10.00
QT47B Bus	5.3"	5.0"	16	2.25
QT35S Socket	4.1"	3.8"	70	8.50
QT35B Bus	4.1"	3.8"	12	2.00
QT18S Socket	2.4"	2.1"	36	4.75
QT12S Socket	1.8"	1.5"	24	3.75
QT8S Socket	1.4"	1.1"	16	3.25
QT7S Socket	1.3"	1.0"	14	3.00

7400N TTL

7400N	$.13	7443N	.95	74104N	1.20	74165N	1.30
7401N	.16	7444N	1.05	74105N	.50	74166N	1.30
7402N	.14	7445N	.90	74107N	.30	74170N	2.50
7403N	.16	7446N	.90	74109N	.90	74173N	1.50
7404N	.19	7447N	.80	74110N	.72	74174N	1.10
7405N	.20	7448N	.80	74114N	.93	74175N	1.20
7406N	.29	7450N	.16	74118N	1.52	74176N	1.25
7407N	.29	7451N	.16	74121N	.45	74177N	1.40
7408N	.18	7453N	.16	74122N	.45	74180N	.73
7409N	.20	7454N	.16	74123N	.70	74181N	3.00
7410N	.18	7460N	.16	74125N	.50	74182N	.70
7411N	.26	7470N	.30	74126N	.50	74184N	2.00
7412N	.33	7472N	.30	74128N	.90	74185N	2.29
7413N	.58	7473N	.37	74132N	1.00	74188N	4.80
7414N	1.23	7474N	.32	74136N	.95	74190N	1.20
7416N	.28	7475N	.59	74141N	1.20	74191N	1.20
7417N	.33	7476N	.32	74145N	1.00	74192N	1.20
7420N	.17	7480N	.59	74147N	2.40	74193N	1.00
7421N	.33	7481N	1.18	74148N	1.80	74194N	1.15
7422N	.50	7482N	.89	74150N	1.00	74195N	.80
7423N	.50	7483N	.65	74151N	.80	74196N	1.70
7425N	.34	7484N	3.00	74152N	1.40	74197N	.80
7426N	.25	7485N	1.20	74153N	1.00	74198N	1.75
7427N	.31	7486N	.35	74154N	1.40	74199N	1.40
7428N	.50	7489N	2.30	74155N	1.00	74200N	5.60
7430N	.20	7490N	.50	74156N	1.18	74221N	1.70
7432N	.24	7491N	.90	74157N	1.00	74251N	2.00
7433N	.60	7492N	.55	74158N	1.20	74278N	2.95
7437N	.35	7493N	.58	74160N	1.30	74279N	.90
7438N	.33	7494N	.80	74161N	1.20	74293N	1.00
7439N	.38	7495N	.80	74162N	1.40	74298N	2.20
7440N	.16	7496N	1.50	74163N	1.40		
7441N	.95	74100N	1.00	74164N	1.30		
7442N	.50						

HIGH SPEED TTL

74H00N	$.33	74H20N	.33	74H53N	.36	74H73N	.90
74H01N	.25	74H21N	.33	74H54N	.36	74H74N	.87
74H02N	.30	74H22N	.33	74H55N	.36	74H76N	.90
74H04N	.33	74H30N	.33	74H60N	.36	74H101N	.80
74H05N	.33	74H40N	.36	74H61N	.36	74H102N	.80
74H08N	.40	74H50N	.36	74H62N	.36	74H103N	1.10
74H10N	.33	74H51N	.33	74H71N	.80	74H106N	.95
74H11N	.33	74H52N	.36	74H72N	.74		

LOW POWER TTL

74L00N	$.31	74L10N	.33	74L51N	.34	74L90N	1.62
74L02N	.33	74L20N	.33	74L73N	.69	74L93N	1.74
74L03N	.39	74L42N	1.49	74L74N	.90	74L95N	1.62
74L04N	.33						

74LS

74LS00	$.50	74LS21	.58	74LS76	.92	74LS157	2.10
74LS01	.58	74LS22	.58	74LS78	.92	74LS158	2.40
74LS02	.58	74LS27	.64	74LS100	.92	74LS160	2.70
74LS03	.58	74LS30	.58	74LS109	.92	74LS161	2.70
74LS04	.60	74LS32	.64	74LS112	.92	74LS170	5.92
74LS05	.63	74LS38	.65	74LS113	.92	74LS174	3.02
74LS08	.58	74LS51	.58	74LS114	.92	74LS175	2.90
74LS09	.58	74LS54	.58	74LS138	2.38	74LS181	3.72
74LS10	.58	74LS55	.58	74LS139	2.38	74LS251	2.55
74LS11	.58	74LS73	.92	74LS151	2.10	74LS253	3.05
74LS15	.58	74LS74	.92	74LS153	2.38	74LS260	.58
74LS20	.58						

SCHOTTKY TTL

74S00N	$.44	74S51N	.80	74S140N	.80	74S189N	4.40
74S02N	.60	74S64N	.80	74S151N	2.20	74S194N	3.30
74S03N	.75	74S74N	1.20	74S153N	3.40	74S195N	3.30
74S04N	.65	74S85N	6.10	74S157N	2.40	74S251N	2.20
74S08N	.80	74S86N	2.50	74S158N	2.20	74S253N	2.40
74S10N	.55	74S112N	1.00	74S160N	3.90	74S257N	2.40
74S11N	.65	74S113N	1.50	74S161N	4.70	74S258N	2.40
74S20N	.65	74S132N	3.60	74S174N	3.30	74S260N	1.20
74S30N	.80	74S133N	.80	74S175N	2.90	74S280N	5.70
74S32N	.80	74S138N	2.20	74S181N	8.40	74S289N	4.00
74S40N	.65	74S139N	2.20				

9300 SERIES

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

AUDIO AMPS

TYPE	V	W	Ω	PRICE
LM352	6-15	1.15	8	1.60
LM354A	6-27	2.80	8	2.50
TAA611B12	6-15	1.15	8	1.60
TAA621A12	6-27	1.40	8	2.00
TAA641B11	6-18	2.20	4	3.00
TBA800	5-30	4.70	8	2.20
TBA810AS	4-20	2.50	4	3.00
TBA820	3-16	0.75	4	1.70
TCA830	5-20	2.00	4	2.20
TCA940	6-24	6.50	8	4.40

IC SOCKETS

SOLDER-TIN DIP

PIN	1-24	25	100
8	.21	.19	.17
14	.25	.22	.20
16	.28	.25	.23
24	.67	.61	.55
28	.88	.80	.72
36	1.09	.98	.89
40	1.24	1.12	.92

WIRE-WRAP GOLD

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

SOLDER - GOLD

PIN	1-24	25
14	.34	.28
16	.37	.31

TEFLON TO-5

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

LEDs

.125" dia. / .160".dia. / .200" dia.

209 RED	$.25	216 RED	$.25	220 RED	$.25
209 YELLOW	.35	216 YELLOW	.30	220 YELLOW	.30
209 GREEN	.35	216 GREEN	.30	220 GREEN	.30

LOW PROFILE

226 RED	$.25	5053 RED	$.35	MV50 RED	$.30
226 YELLOW	.30	5053 YELLOW	.40		
226 GREEN	.30	5053 GREEN	.40	*216 = MV5024*	
226 ORANGE	.30	5053 ORANGE	.40	*5053 = MV5053*	

DISPLAYS

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SLA1 RED 2.25
SLA11 GREEN 3.50

XCITON
XAN72 RED 2.00
XAN52 GREEN 2.00

OPTOISOLATORS
MONSANTO
MCT2 1.35

LITRONIX

DL80	RED	6.00
DL81	RED	6.00
DL10	RED	6.00
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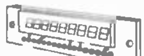
DL57	RED	9.90
DL61	RED	12.00
DL33	RED	4.00
DL44	RED	6.00
DL402	RED	4.00
DL701	RED	3.40
DL704	RED	2.25
DL707	RED	2.35
DL747	RED	2.50
IL1		1.30
IL12		1.40
IL16		1.80
IL74		1.35
ILD74		1.75
ILQ74		3.40



EP 9125
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1/8" Character Ht. Compact, Thin PC Pkg., Wide Viewing Angle

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75452N	1.00
75453N	1.00

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7524N	2.00
7525N	4.50

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1506	4.00
1507	4.00
1602	33.00
1702	33.00
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C2102 1	8.00
P2102 1	5.40
C2102-2	8.00
P2102-2	5.50
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2512K	5.50
2521V	4.00
2524V	3.40
2525V	5.30
2533V	8.50
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4001AE	.26	.22	4023AE	.26	.22	4052AE	1.34	1.33
4002AE	.26	.22	4024AE	.90	.88	4053AE	1.34	1.33
4004AE	5.83	5.82	4025AE	.26	.22	4055AE	2.68	2.00
4006AE	1.35	1.34	4026AE	3.72	3.70	4056AE	2.43	1.86
4007AE	.26	.22	4027AE	.60	.50	4060AE	1.50	1.25
4008AE	1.79	1.78	4028AE	.98	.90	4066AE	.90	.72
4009AE	.60	.50	4029AE	1.27	1.16	4069AE	.38	.34
4010AE	.59	.50	4030AE	.44	.37	4071AE	.26	.22
4011AE	.26	.22	4033AE	3.01	3.00	4076AE	1.58	1.48
4012AE	.26	.22	4035AE	1.27	1.16	4081AE	.26	.25
4013AE	.47	.40	4040AE	1.49	1.25	4508AE	2.30	2.20
4014AE	1.49	1.25	4041AE	4.06	4.05	4510AE	1.98	1.46
4015AE	1.26	.90	4042AE	.75	.64	4516AE	1.98	1.46
4016AE	.56	.45	4043AE	.60	.50	4518AE	1.28	.98
4017AE	1.20	1.00	4044AE	.60	.50	4520AE	1.28	.98
4018AE	1.49	1.25	4047AE	3.54	3.53	4528AE	2.30	2.20
4019AE	.52	.44	4048AE	1.43	1.42	4901AE	.43	.36
4020AE	1.49	1.25	4049AE	.52	.50	4011AE	.43	.36
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APS5-6	5	6	$48.45	$46.05
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APS15 3	15	3		
APS24-2.2	24	2.2		
APS28-2	28	2		
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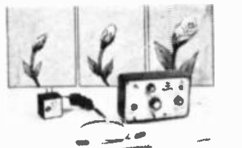

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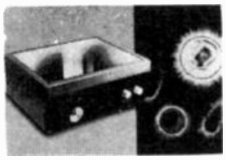

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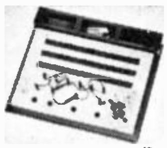

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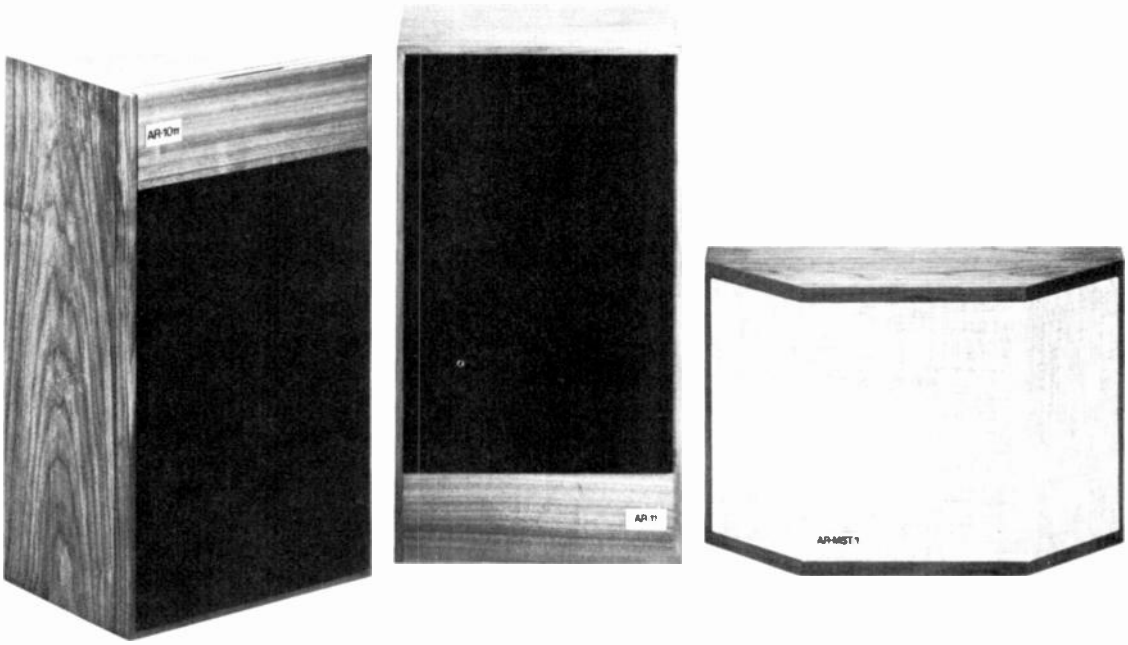

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