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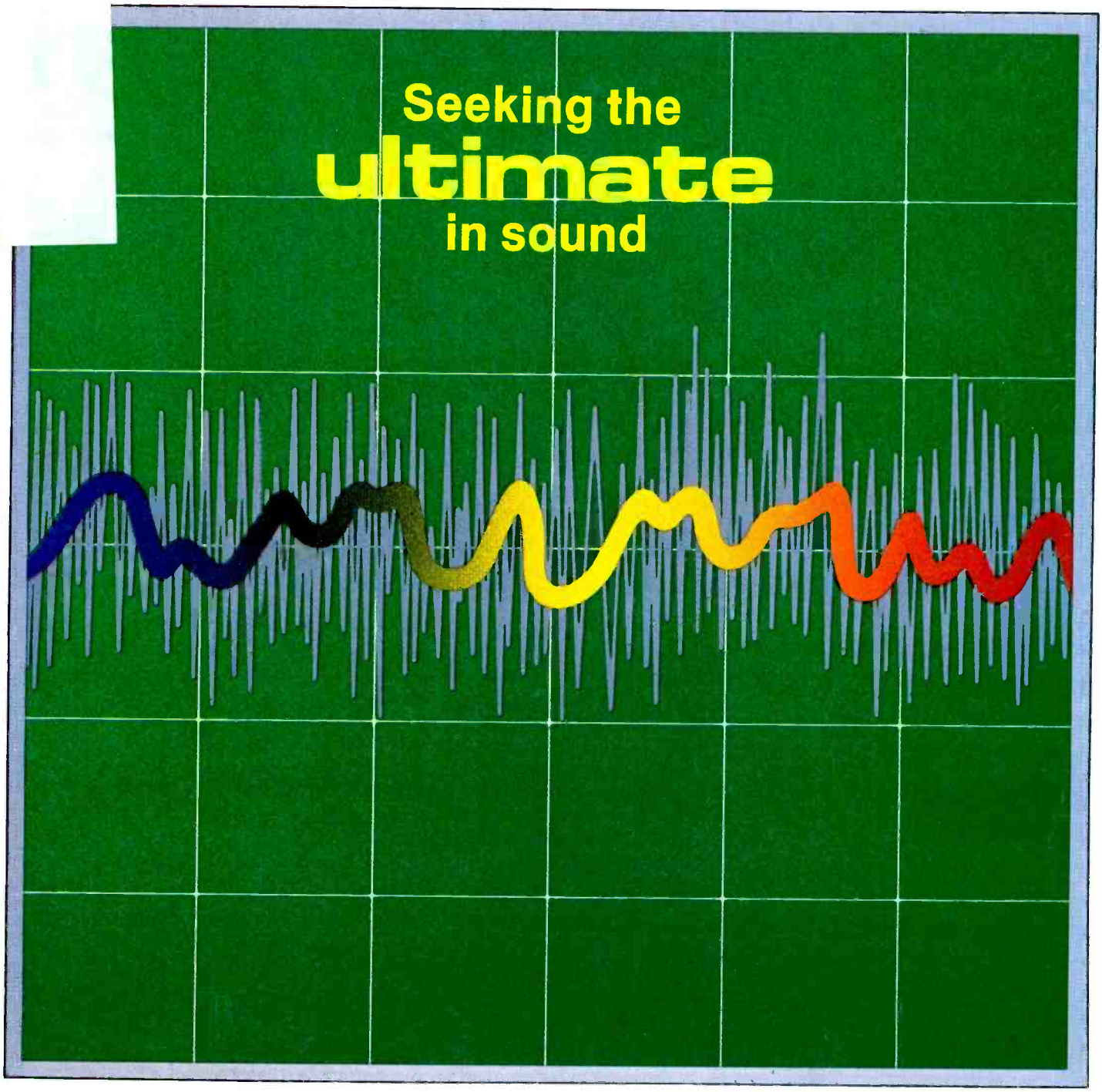
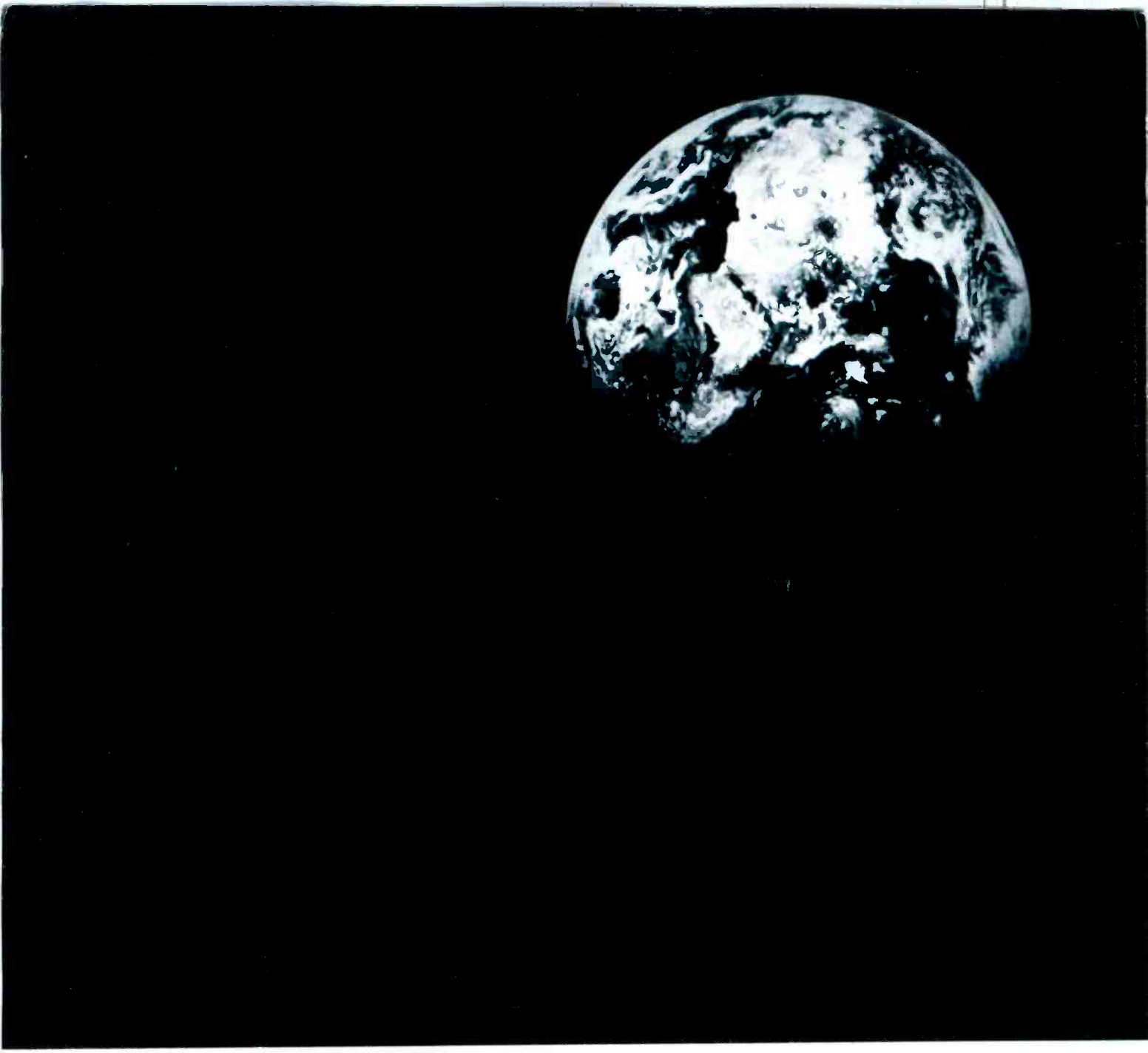
APRIL 1982 / $2.25

Noise reduction and masking

Stereo amplifier repair





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Editorial, advertising and circulation correspondence should be addressed to: P.O. Box 12901, Overland Park, KS 66212-9981 (a suburb of Kansas City, MO); (913) 888-4664.

EDITORIAL
Bill Rhodes, *Editorial Director*
Nils Conrad Persson, *Editor*
Carl Babcoke, *Consumer Servicing Consultant*
Rhonda Wickham, *Managing Editor*
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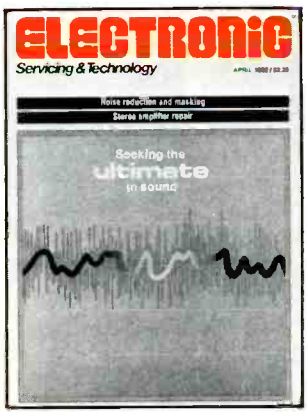
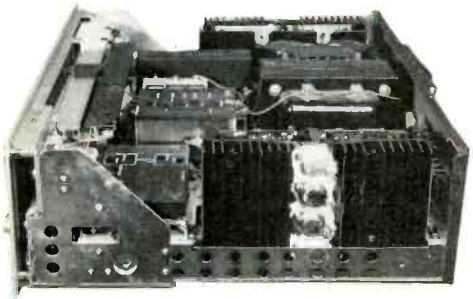
April 1982
Volume 2, No. 4



National Semiconductor Corporation has developed a universal noise reduction system for AM and FM radio, audio and videocassettes, records and videodisc.
See story on page 50.
(Illustration courtesy of National Semiconductor.)



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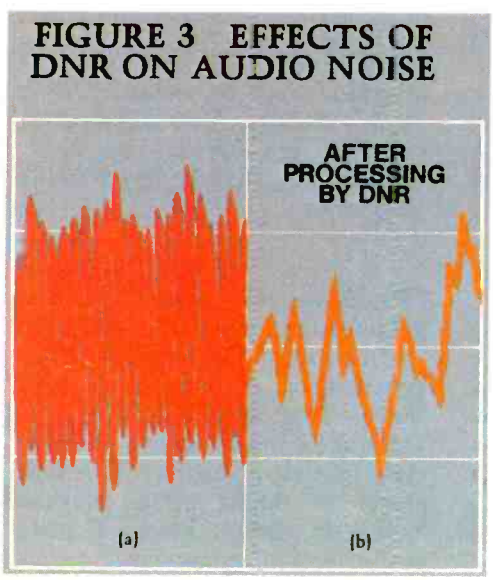

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DEPARTMENTS

ELECTRONIC SCANNER

Hitachi offers seminar on 1-inch VTRs

Hitachi Denshi America held its first training seminar on their HR-200 1-inch type C studio VTR at their National Training Facility in Woodbury, NY. The training session, offered to dealers and end users of the Hitachi 1-inch VTR, is designed to provide an in-depth understanding of operations procedures, circuit operation and adjustment techniques required for maintenance of the VTR.

"Hitachi Denshi recognizes that in today's world of fast-paced electronic technology, it is not only important to design products utilizing this technology but also to provide training on its operation and maintenance," said Fred Scott, director of VTR engineering. The course is "structured to give an understanding of the principles used in Hitachi's VTRs, while enabling the student to closely study each sub-system required in the total system operation."

Training seminars are limited to 12 people, last two weeks and are given every other month. A similar course is offered on Hitachi 1-inch type C portable VTRs with the same requirement, but one week in length.

For more information, contact Fred Scott, Hitachi Denshi America, 175 Crossways Park West, Woodbury, NY 11797, 1-516-921-7200.

Telecommunications conference to be held in June

The 1982 "Telecommunications Trends & Directions" seminar, by the Communications Division, Electronic Industries Association (EIA), is designed to give securities analysts and industry leaders an executive overview of the telecommunications industry. The 7th annual "Hyannis Conference" will be held June 1-3 at Dunfey's Hyannis Hotel and Conference Center, Hyannis, MA.

Among the industry leaders appearing at Hyannis, Motorola Chairman and CEO Robert Galvin will present the major dinner address. In addition to Galvin's address, three half-day sessions led by prominent telecommunications analysts will feature speakers from the forefront of the telecommunications operating and manufacturing industries.

Additional information on the program may be obtained from Jeanne Stovall, EIA Communications Division, 2001 Eye St., N.W., Washington, DC 20006, 1-202-457-4937.

"Wireless cable" systems proposed for urban centers

Microband Corporation of America, a subsidiary of Tymshare, has proposed that the Federal Communications Commission (FCC) grant authority to construct in major urban markets "wireless cable" systems using cost-effective microwave, rather than coaxial cable.

These systems would deliver a

wide range of premium TV programming (pay television), as well as information and transactional services, directly into urban homes and to small businesses.

Microband's proposal seeks to satisfy the significant unmet demand for these multimedia services in urban areas by expanding the capacity of currently licensed Multipoint Distribution Service (MDS) common carriers from one to five channels and authorizing three such carriers in each of the top 50 markets.

MDS is a low-power, omnidirectional microwave transmission medium that has been operational since 1973. Within a radius of 20-25 miles from its transmission site, MDS signals are received by special antennas and downconverted to unused VHF channels on ordinary TV sets.

Cordless telephone sales expected to almost double

This year may be the year of the "cordless telephone boom" in the United States. In 1981, cordless telephone sales rang up a record number of sales to dealers, totaling almost 600,000 units. According to Roy Mulhall, vice president-general manager of Extend-A-Phone Division of Uniden Corporation of America (UCM – formerly American Radio Corporation) sales of cordless phones in 1982 are expected to be approximately one million units, almost double the 1981 figure.

The market has been hardly "scratched" to date. Less than one million cordless phones have been sold in the United States to date, while the customer potential is in the millions.

Mulhall said that cordless telephones are the fastest growing segment of the retail phone industry. Increased sales for the upcoming year are expected due to a variety of factors including anticipated telephone company deregulation, increased customer awareness, improved technology, new models and accelerated advertising and promotional campaigns.

Graphics software package included in ICS course

A take-home graphics software package is a key feature of a computer graphics course to be offered this spring and summer by Integrated Computer Systems (ICS).

The 4-day course, entitled *Consumer Graphics*, is designed to provide a comprehensive overview of state-of-the-art computer graphics hardware and software and to present an integrated approach to implementation of a graphics application. Topics include technology fundamentals; raster scan, vector and color techniques; software and hardware availability and selection criteria; and equipment selection and implementation of graphics applications.

The course will be held in Washington, DC, June 15-18; San Diego, June 22-25; Boston, June 29-July 2; and Washington, DC, Sept. 21-24.

For more information, contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., P.O. Box 5339, Santa Monica, CA 90405, 1-213-450-2060.

Satellite communications users to meet in Denver

The 4th Annual Satellite Com-

munications Users Conference (SCUC '82) will feature Sidney Topol, president and chairman of the board of Scientific-Atlanta, as keynote speaker. The annual conference and trade show will be held August 11-13, 1982, at the Regency Hotel in Denver.

Technical, policy and business sessions will be moderated by leading experts on the various aspects of satellite communications. Expanded and refined panel sessions will retain the flavor of informality established at previous conferences. In addition to the panel discussions, more than 140 booths will exhibit state-of-the-art satellite hardware and services. Outside exhibits will feature antennas of varying size and shape, as at last year's show.

Sponsored by *Satellite Communications* magazine, the international trade journal of this industry, SCUC '82 registration will cost $245 at the door. Advance registration is available until mid-July, for $195. Registration forms are bound into each issue of the magazine, and are also available by contacting its business office at 6430 S. Yosemite St., Englewood, CA 80111, 1-303-694-1522.

Bell & Howell offers service seminars

Bell & Howell Company will be offering a series of service seminars for technicians. The seminars will be held June 8-10 in Kansas City, MO; June 29-July 1 in Anaheim, CA; Aug. 3-5 in Jackson, WY; Aug. 10-12 in Colorado Springs, CO; Aug. 17-19 in Chicago; Sept. 28-30 in Hartford, CT; Oct. 26-28 in Salt Lake City, UT; Nov. 16-18 in San Antonio, TX; and Dec. 14-16 in Anaheim, CA.

The cost for the 3-day session is $95. For complete details and registration information, contact June Schultz, Dept. 4354, Bell & Howell Company, 7100 McCormick Road, Chicago, IL 60645.

New designation system for TV picture and monitor tubes

A new worldwide-type designation designed to promote international standardization of picture tubes and monitor tubes went into effect on April 1, 1982. The new system, developed by Electronic Industries Association (EIA) of Japan and Pro Electron of Europe, will replace the type designation presently in use.

The system is based on the screen diagonal measurement in centimeters instead of inches as in the present U.S. system. Each type designation consists of nine or 11 symbols coded into five or six symbol groupings. The first symbol is either an A for TV picture tubes or an M for monitor tubes; the second symbol is a 2-digit number that is the screen diagonal measurement in centimeters; a 3-letter third symbol defines a general family of tubes; the fourth symbol is a 2-digit number for color tubes and a 1-digit number for monochrome tubes, which distinguishes minor tube variations within a family; the fifth symbol is the phosphor designation where a single letter is assigned for color tubes and two letters for monochrome tubes; a 2-digit sixth symbol is added for tubes having integral yokes.

Detailed procedures and a new registration format for the new worldwide system have been developed and will be used by the three type assignment agencies. Additional information concerning the new system may be obtained by contacting Type Administration Office, Electronic Industries Association, 2001 Eye St., N.W., Washington, DC 20006.

ES&T

ASSOCIATION NEWS

Electronic companies to aid job training of disabled youth

The Electronic Industries Foundation (EIF) will undertake a project to enhance job skills training for disabled and disadvantaged high school students through linking vocational education programs with high technology electronic companies.

The new program, Jobs through Education and Training (JET), will be directed by Victor C. Knorr, EIF program manager.

Support for JET is provided by the U.S. Department of Labor's Employment and Training Administration, Office of Youth Programs through the Institute of Economic Development (IED), a Washington based non-profit corporation that provides a variety of services to communities to assist them in expanding job opportunities and encouraging economic growth.

The new program will be conducted in Massachusetts where EIF's successful Project With Industry (PWI) is already in operation. PWI seeks to place disabled persons in jobs in private industry and also includes a component for training solderers, assemblers and technicians specifically for jobs in electronics.

Schools in Lawrence and Springfield will be selected to participate in the development of the model program. An industry/education advisory committee will be formed in liaison with the Massachusetts Rehabilitation Commission, the Department of Manpower Development, the local Private Industry Councils and the Massachusetts Department of Vocational Education.

A subcommittee of industry engineers, technicians and personnel staff will work with academic and vocational instructors to upgrade skill training programs within the targeted schools. Work-study opportunities will be offered so that students can experience real work situations and services will be provided to help graduates with job placement.

ES&T

The $1100 scope. Only Tektronix could make so much performance so affordable!

The 60 MHz Tek 2213 and 2215 introduce a scope design so radically different, it delivers full-range performance at prices well below what was ever possible before.

Not surprisingly, it is from Tektronix, the world's largest and most respected scope manufacturer, and a legend for instrument reliability and value.

Design for the 2213 ($1100) and dual time base 2215 (just $1400) includes some 65% fewer mechanical parts. Fewer circuit boards. Fewer electrical connectors and cabling. Result: a lower purchase price for you plus far greater reliability.

Performance is pure Tektronix: there's the bandwidth for digital and high-speed analog circuits. The sensitivity for low signal measurements. The sweep speeds for fast logic families. A complete trigger system for digital, analog or video waveforms. And, with the 2215, you get fully calibrated delayed sweep for fast accurate timing measurements. New high-performance 10X Tektronix probes are included!

2213/2215 PERFORMANCE DATA

Bandwidth: Two channels, dc—60 MHz from 10 V/div to 20 mV/div. (50 MHz from 2 mV/div to 10 mV/div).

Sweep speeds: Sweeps from 0.5 s to 50 ns (to 5 ns/div with X10 mag).

Sensitivity: Scale factors from 100 V/div (10X probe) to 2 mV/div (1X probe). Accurate to ± 3%. Ac or dc coupling.

Delayed sweep measurements: 2213: standard sweep, intensified after delay, and delayed. 2215: A only, B only, or A and B alternately with A intensified by B.

Complete trigger system: Modes include TV field, normal, vertical mode, and automatic; internal, external, and line sources; variable holdoff; separate B sweep trigger on 2215.

Probes: High performance, positive attachment, 10-14 pF and 60 MHz at the probe tip.

The price: Just $1100 for the 2213 and $1400 for the dual time base 2215*. Order direct from the Tektronix National Marketing Center, your hotline for the 2200 Series and all Tektronix accessories. Phones are staffed by sales engineers who can answer your technical questions.

Your direct order includes a 15-day return policy and full Tektronix warranty. Call today. You can't buy a more advanced scope for less.

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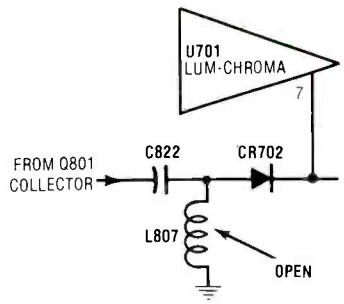
SYMCURE

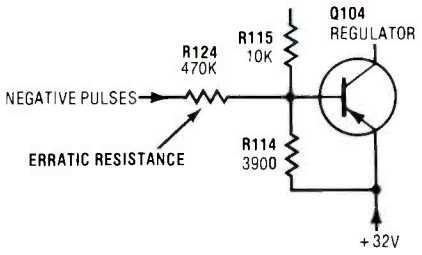
Symptoms and cures compiled from field reports of recurring troubles

Chassis – RCA CTC109 1
PHOTOFACT – 1952-1



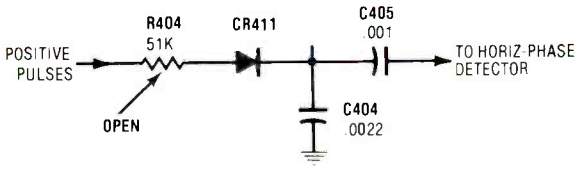
Symptom – Very low brightness or no video
Cure – Check L807 and replace it if open

Chassis – RCA CTC109 2
PHOTOFACT – 1952-1



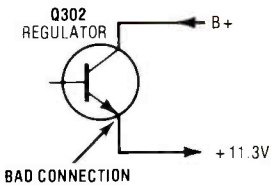
Symptom – Erratic shut-down
Cure – Check resistance of R124 and replace it if out of tolerance or varying

Chassis – RCA CTC109 3
PHOTOFACT – 1952-1



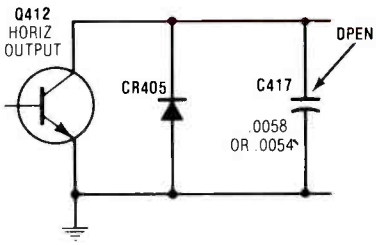
Symptom – Horizontal cannot be locked
Cure – Check R404 and replace it if open or increased in value

Chassis – RCA CTC109 4
PHOTOFACT – 1952-1



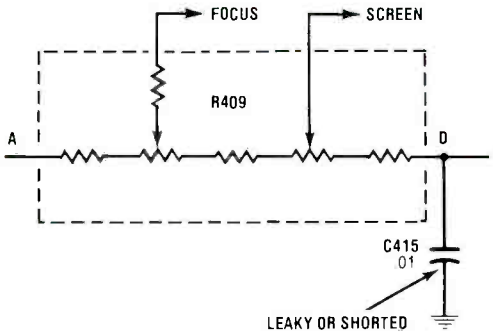
Symptom – Intermittent color
Cure – Check soldering at emitter of Q302 and resolder if needed

Chassis – RCA CTC109 5
PHOTOFACT – 1952-1



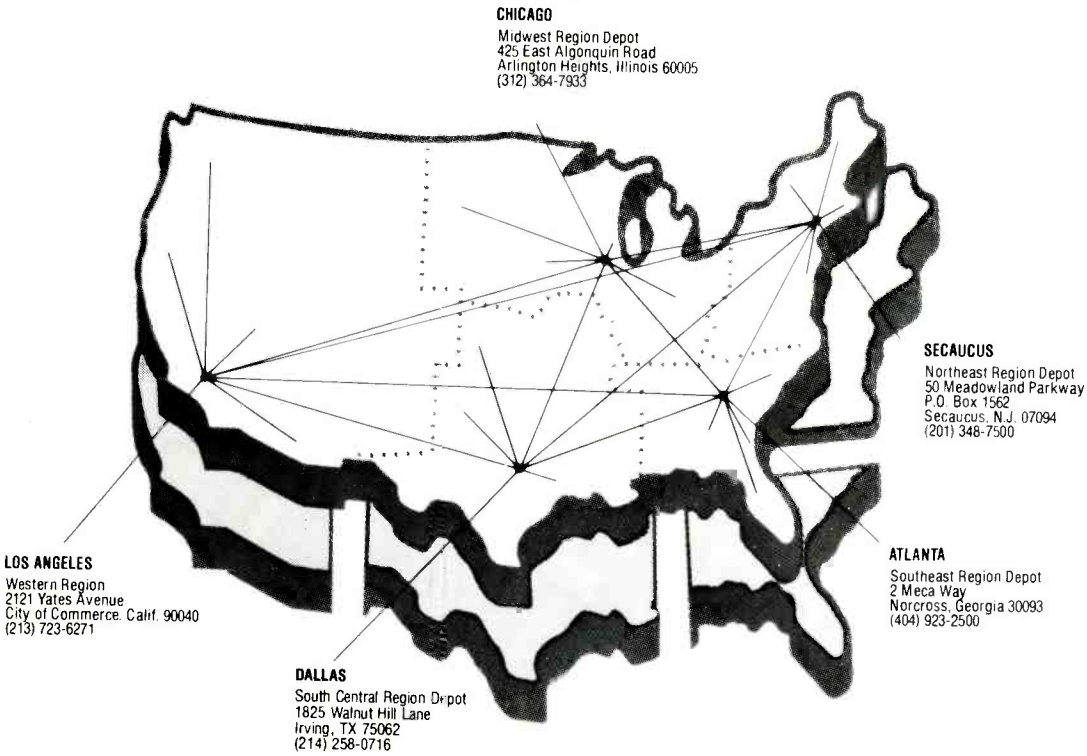
Symptom – Narrow picture with foldover and excessive high voltage
Cure – Check retrace capacitor C417 and replace it if open

Chassis – RCA CTC101
PHOTOFACT – 1945-2



Symptom – No raster
Cure – Check capacitor C415 and replace it if leaky or shorted

Ten years ago we split the country today we've got it all together and we made it smaller



The Panasonic Consumer Parts Division made the following improvements in its computerized distribution network:

- **Automatic drop shipment from any one of our five regional depots regardless of where the order originates from**
- **Automatic substitutions**
- **Automatic replenishment of regional stocks**
- **On line status information**
- **Panafax facsimile network linking the regional depots together**

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- **A central parts depot with 152,000 individual parts on file and in addition four regional parts depots with 25,000 part numbers in stock**
- **Toll free calls connect Panasonic distributors and authorized servicenters to automatic facsimile machines located at regional parts depots, thus orders can be received 24 hours a day, 7 days a week**
- **One hundred independent part distributors conveniently located to bring needed parts and accessories closer to the customer**
- **Plus a toll free number (800-447-4700) for the location of the nearest authorized Panasonic parts distributor. Except for Illinois: (800-322-4400).**

Our system is designed to get parts to a customer more quickly and easily than ever before. First we got the country together, then we made it smaller.

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Today's inaccurate counters and slow search methods are far from perfect.

What's Wrong With Cassette Recording

Today's better cassette recorders have attained a performance level that rivals many reel-to-reel machines with significantly higher tape speeds. Competition in this area is enormous. In addition to their pursuit of further performance improvements, which tend to be ever more difficult to achieve, most manufacturers are also concentrating on enhanced operating convenience. Several systems are offered that allow for winding the cassette to a specified tape position or to the beginning of the fifth song, for scanning the tape and playing the first few seconds of each recording, or even for playing recorded songs in a particular order.

So far, so good; but in practice these systems are far from perfect:

- Because tape counters are usually not coupled to the capstan, they move fast at the beginning and tend to become slower toward the end of the tape. Moreover, they are not very accurate and are usually incompatible among different machines.
- The automatic search for individual songs, as promoted with microprocessor-controlled recorders, is rather cumbersome and not reliable. It requires silence periods of about five seconds, which is inconvenient for most users. Even so, problems with pianissimo sequences on classical recordings are common.
- All systems use the beginning of the tape as their reference position (reset counter to zero, start of first song, etc.). Therefore, using the programming features means rewinding the cassette.

In the worst case, to locate a song near the end of the tape, the tape is first rewound to the start, then again wound in the fast forward mode. With a C-90 cassette this can take up to four minutes.

Now Gretag Ltd. has come up with a new concept and filed a patent application that overcomes all these disadvantages: Take a cassette that is wound to any arbitrary position, insert it in the machine, key in the desired position code or codes, and the cassette will wind itself in the correct direction and in the shortest possible time to the desired location. Not only that, but as soon as the tape starts to wind or play, the tape counter will immediately display its correct position, which is directly related to the remaining tape time.

Gretag achieves this by printing an optically readable code on the back of the tape, which supplies the required information during all tape movements automatically and with split-second accuracy.

Why is the code printed on the back of the tape? Gretag recommends the back side in order to avoid even the smallest degradation in head tape contact due to the additional printing.

Compatibility is not a problem if cassette manufacturers agree on the same code. The cassette housing remains unchanged. Code reading is accomplished via a sensor that automatically moves into a cassette opening; if it finds no code, the tape counter is controlled via conventional means.

The sensor uses optical fibers and straightforward detectors and should be relatively cheap in mass production. Coded cassettes will sell at a slight premium, but the technology is available; Gretag uses a bar code similar to the one used on groceries sold in supermarkets.

Gretag is practically unknown in the audio field because its products are not related to that market. Its activities are in professional high-end electronics, secure communications, Eidophor large-screen TV projection, photofinishing and color densitometry.

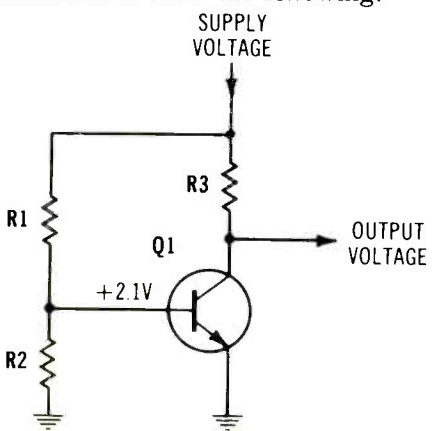
Courtesy of Gretag Ltd.

ES&T

Quick Quiz

Test Your electronic knowledge
By Wayne Lemons, CET

Only one voltage is shown in the schematic. It is the base-to-emitter forward bias, because the emitter is grounded. Why does the stage have no amplification? Why is the forward bias so high? Choose the correct answer from the following:



(1) The transistor is biased to saturation.
(2) R2 is open.
(3) Q1 has an open B-E junction.
(4) R1 resistance has decreased.
(5) Q1 has collector-to-base leakage.
(6) The bias is normal.
(7) The supply voltage is reversed for this NPN transistor.

(Answer on page 26.)

Coming in

ELECTRONIC *Servicing & Technology*

The RCA Selectavision videodisc system. The videodisc program has been under way at RCA for about 16 years. The system that has evolved from the work has resulted from many trade-offs, including technical, marketing and economic considerations.

Tips for repairing 16mm projectors. Thousands of 16mm sound-on-film movie projectors are constantly in use, particularly in schools and churches. These require regularly scheduled preventive maintenance and occasional repairs.

Stereo-amplifier repair

By Carl Babcoke, CET

One of the persistent myths in the electronic-repair industry is that troubleshooting video or RF/IF problems is difficult, but it is easy to diagnose and repair all audio defects. That statement never was totally true, but it certainly is incorrect when applied to state-of-the-art audio products. Much of the newer audio equipment contains sophisticated circuits, including microprocessor-control systems.

Crowded circuit boards with inaccessible areas cause many problems for technicians trying to perform measurements on individual components. A larger impediment is the common practice of direct-coupling several consecutive stages, so the slightest variation of dc voltage in the first stage can saturate the last stage or drive it to cut-off. Defects of this nature are very difficult to analyze and repair. Intermittent symptoms multiply the difficulties.

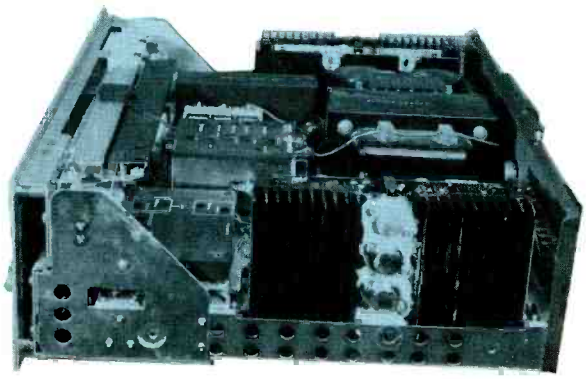


Figure 1 The large fins of a cast heat sink identify the right-channel amplifier in the Marantz model 2325 AM/FM-stereo radio that also has inputs for a magnetic phonograph pickup and an external source such as a tape deck. Two PNP and two NPN power transistors are used in each audio channel. The accompanying circuitry is on a board fastened to the back side of the heat sink.

Both of these headaches were present in this repair. The right-channel power amplifier had *seven* transistor stages with 100% direct coupling. Several transistors apparently were included for compensation of thermal drift. However, when a compensation stage has a defect, it can produce problems equally serious to those from defective signal-amplification transistors. To make the situation worse, the unwanted symptom occurred so seldom that logical testing was nearly impossible.

Marantz stereo radio

Following a home service call, a technician brought to the audio test bench a Marantz model 2325 (Figure 1), which is a large AM/FM-stereo radio with Dolby noise-reduction circuits for FM, stereo magnetic-phono preamps and three tone controls. Each audio power channel has four large TO-3 transistors, and although the rated audio power is not listed in Photofact Modular Components Volume MHF-97, each of the two channels probably could produce approximately 100W. This guesstimate is strengthened by the huge power transformer; it is several times larger than any used in color TV receivers. The sheer bulk and weight might intimidate a technician who is not familiar with similar large units.

The potential audio and power-supply power is so large that all technicians (beginners and veterans alike) should use all precautions against tests or accidents that might result in expensive failures of large components.

Erratic crackling noises

Originally, the complaint was about a loud, intermittent popping and crackling noise in the right-channel speaker only. Figure 2 shows the complete schematic; Figure 1 shows the large heat fins and about 3½ output transistors on the right-channel amplifier. The circuit board can be unbolted from the frame and disconnected by a plug, when removal of the entire amplifier is desirable during testing. Figure 3 reveals many details of the component side of the board.

These preliminary facts suggest that this repair could be difficult and frustrating.

Basic circuit operation

Circuit operation of the power amplifier will be described only briefly, because active amplifier stages are mingled with stabilizing stages in a bewildering fashion.

However, some operations can be understood easily. Transistors H701 and H702 make up a differential-pair amplifier stage, which first amplifies the incoming low-level audio signal. Their emitters

return to ground through transistor H703, so the emitter-to-ground voltage of the pair is determined by the H703 B/E bias. This is the classic differential pair, having excellent gain and dc-voltage stability. Transistors H701 and H702 are held together physically by a plastic covering so the same heat is applied to both.

Signal output from the H702 collector is direct coupled to the H705 base. Output from the H705 collector travels through separate resistor/capacitor networks to the PNP H706 base and the NPN H707 base (for phase inversion). From the H706 collector, the signal is direct coupled to the NPN H708 base. H708 collector signal drives the paralleled bases of H005 and H006 PNP power transistors, which are half of the push-pull output stage.

Going back to the other side of the circuit, output from the H707 collector is direct coupled to the H709 base. The H709 collector signal in turn is direct coupled to the paralleled bases of H007 and H008 NPN power transistors, which comprise the second half of the power-output stage that drives the right speaker.

Notice the two separate positive and negative power supplies in Figure 2. This allows 100% direct coupling between all stages without requiring dc-blocking coupling capacitors, even to the speaker. Also, there are zener-regulated +20V and −20V supplies for two stages.

All other transistors in Figure 2 perform negative-feedback or stabilizing functions, and do not directly affect the power amplification.

Amplifier adjustments

Two variable controls on each power amplifier are provided for proper setup. This is the correct method:

- Turn down the volume completely and disconnect all speakers from the amplifier terminals.
- Connect a sensitive dc voltmeter (VTVM or digital multimeter on the 0.5V, 1.5V or 2V most-sensitive range) across the right-channel output terminals.
- Adjust trimming control R713 to obtain zero dc volts across the terminal.
- Expect a positive reading at one side of zero volts and a negative reading at the other.
- Repeat this for the left channel.

(Note that all components have the same callouts on both right and left channel circuit boards; only the external power transistors of right and left channels have different identification callouts.)

- Connect the sensitive dc voltmeter between output transistor terminals J702 and J708 of one channel.
- Adjust trimming resistor R740 CCW and then CW until the meter reads 15mV (0.015V). This is an idling current of 75mA for two transistors.
- Repeat the same procedure for the other channel.
- Transfer the meter to the output terminals again and recheck the dc voltage.
- Readjust R713 slightly, if the other adjustment has shifted the balance.
- Connect both speakers and operate the machine, noticing volume and tone quality.

Many other models will have

equivalent controls, particularly those models having separate positive and negative supply voltages. The R713 adjustment that provides zero output voltage (and zero dc current) is important to protect the speaker from overheating because of any unwanted steady voltage and current. Adjustment of R740 affects crossover distortion. Obviously, this is important. With another model having unknown specifications for the cross-over adjustment, monitor the harmonic distortion at about 1W of audio output and adjust R740 (or its equivalent) for minimum total harmonic distortion (THD).

In this case, these adjustments were made after repairs had been completed.

Playing the waiting game

Many intermittent problems demand patience, and patience certainly was required for the Marantz repair. Two test speakers in small baffles were connected, and the radio was played at moderate volume with FM-stereo music. Occasionally, after 15 to 30 minutes, a loud, erratic crackling noise could be heard in the right-channel speaker. The left channel was not affected.

Intermittent noises of this kind often are triggered by specific temperatures, so a heat lamp and canned coolant were used alternately on all components, but without definite results. Mild blows from the plastic handle of a screwdriver against the circuit board and individual components did not trigger the crackling noise.

These hot/cold and vibration tests can be very helpful when they produce results by identifying a sensitive area. However, it is a complete waste of time to continue with them exclusively when they don't work.

A volt-ohm-meter (VOM) was connected permanently to the right channel speaker terminals, in parallel with the speaker. When the crackling noise began, the meter indicated some variable positive dc voltage. Evidently the defect was affecting the dc voltages in that channel and also upsetting the delicate zero-voltage output condition.

Finally, the receiver was left unattended for several minutes while it continued to play music and when I came back, the right channel speaker had no sound.

Several minutes of intensive tests were required to determine that the speaker itself was the cause of no sound. Another test speaker was connected, and it produced normal sound. As the second speaker played, I examined the defective speaker, finding that the voice coil was immovable. That is unusual, because the most common cause of complete loss of sound usually is an open voice coil lead at the connecting lug.

Excessive heating of the voice-coil winding is the most likely cause of a frozen voice coil. Such extreme heating can occur when excessive audio levels (of several times the speaker rating) are applied for several moments. Also, a voice coil can operate so hot when supplied with a considerable steady dc voltage and current that

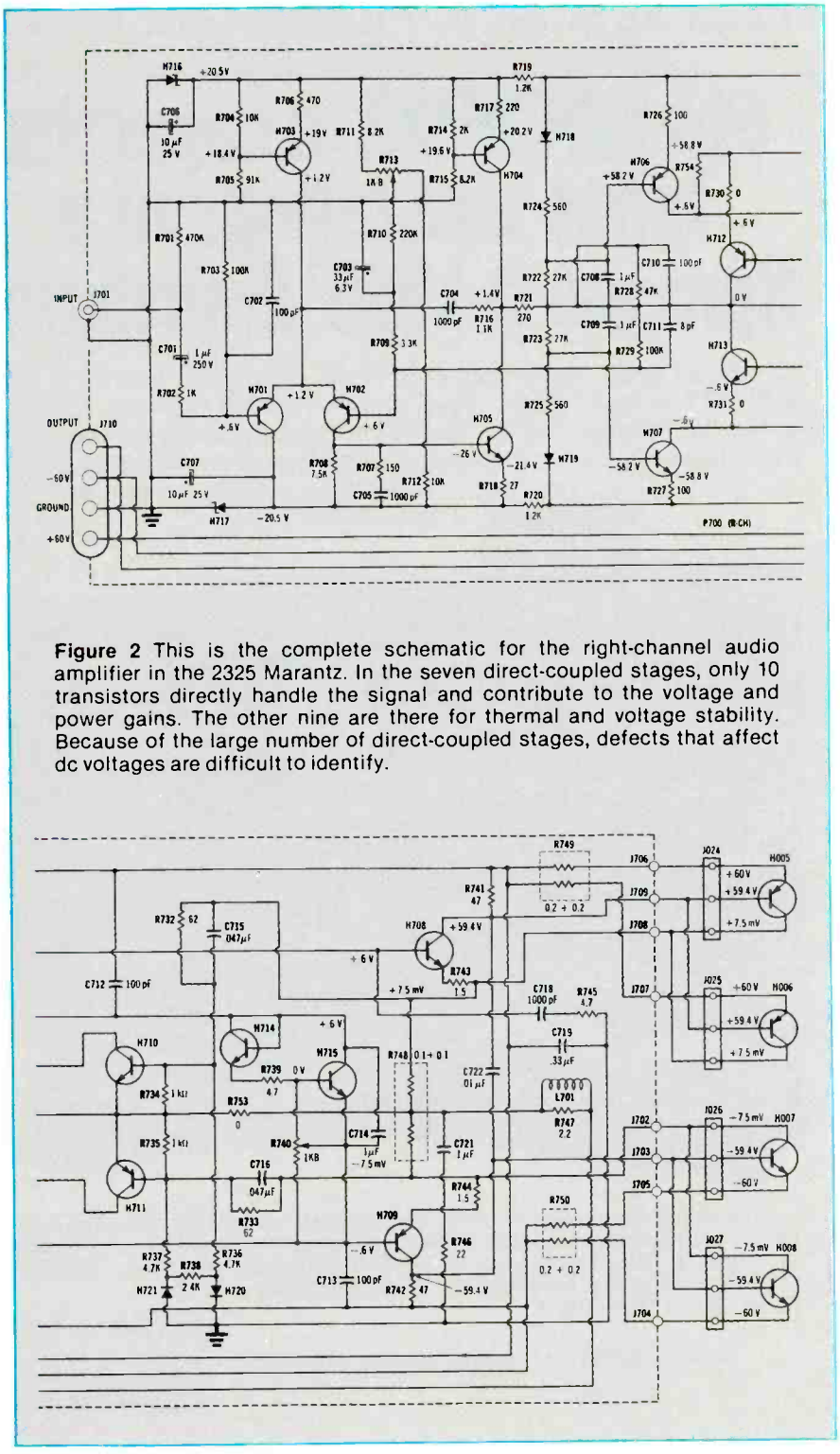


Figure 2 This is the complete schematic for the right-channel audio amplifier in the 2325 Marantz. In the seven direct-coupled stages, only 10 transistors directly handle the signal and contribute to the voltage and power gains. The other nine are there for thermal and voltage stability. Because of the large number of direct-coupled stages, defects that affect dc voltages are difficult to identify.

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Photograph of test bench taken at Orien-Tech, Inc. a factory authorized service center.

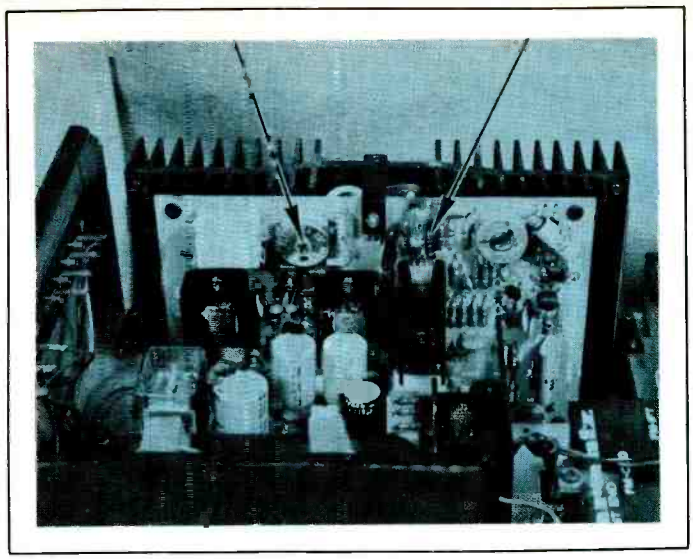

Figure 3 The left arrow on this picture of the right-channel circuit board points to R740 which was noisy and erratic. The right arrow shows where the two defective components were located. In the foreground is the small board containing the speaker-protection circuit, while the speaker terminals are at the extreme left.

it warps the coil form and stops all motion. In this case, excessive music power was not a factor, since it would have been heard and noticed. The only other explanation was that a massive overload of dc power had come from the amplifier.

However, there was no dc voltage across the second speaker now. A series capacitor would block the dc current, I reasoned, slipping back into an idea that is a trap for many technicians. A 1500μF capacitor (the handiest large value) was connected in series with one speaker wire, as I thought that the large capacitance would pass bass music frequencies without attenuation. The music was unaffected by the capacitor. Unfortunately, the capacitor did not deliver the imagined protection.

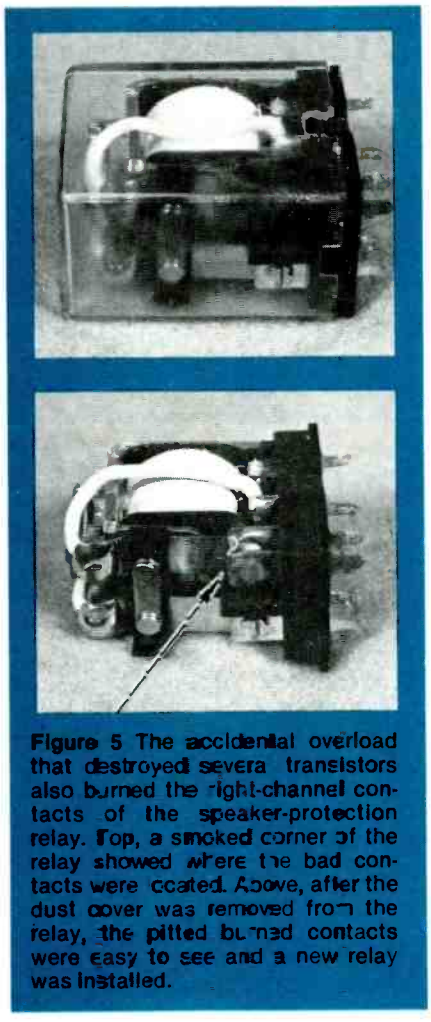

Figure 5 The accidental overload that destroyed several transistors also burned the right-channel contacts of the speaker-protection relay. Top, a smoked corner of the relay showed where the bad contacts were located. Above, after the dust cover was removed from the relay, the pitted burned contacts were easy to see and a new relay was installed.

Later I came back to find an absence of sound from the right-channel speaker, and again, tests showed a frozen voice coil in the replacement test speaker.

For a few seconds, I could not imagine any explanation. Then I remembered tests made several years ago when Sam Wilson was arousing controversy with his articles about capacitors. Short bursts of dc voltage from the amplifier would pass through the uncharged capacitor as though it were a piece of wire. These pulses would not sustain long enough to charge the capacitor and stop the large dc current. (Write to me in care of **Electronic Servicing & Technology** if this short explanation is not sufficient.)

A high-wattage 8Ω resistor (acting as a dummy load) was connected across the receiver-output terminals, then the speaker was connected in parallel with the resistor, but in series with an 8μF capacitor (to eliminate steady dc current) and a current-limiting resistor (Figure 4). The large dummy-load resistor could dissipate the full 60Vdc of any unbalanced channel without damage, while the series capacitor and resistor would limit the speaker current, preventing failure of a third speaker. This circuit attenuated the bass response and reduced the volume somewhat, but the volume was adequate for testing.

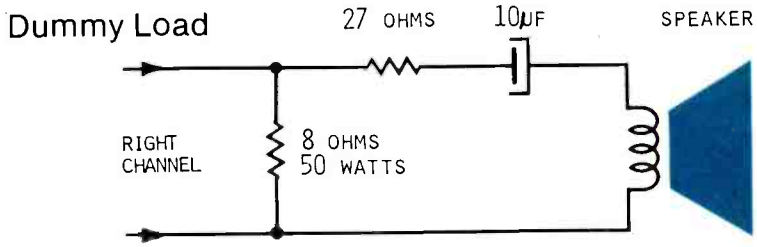

Figure 4 Because the right-channel amplifier emitted 50V pulses of dc voltage when the erratic noise and amplification occurred, this dummy load was connected to the output. The series resistor and capacitor reduces the ac and steady dc current through the speaker to prevent ruining another test speaker.

As an added precaution, the line voltage was reduced to about

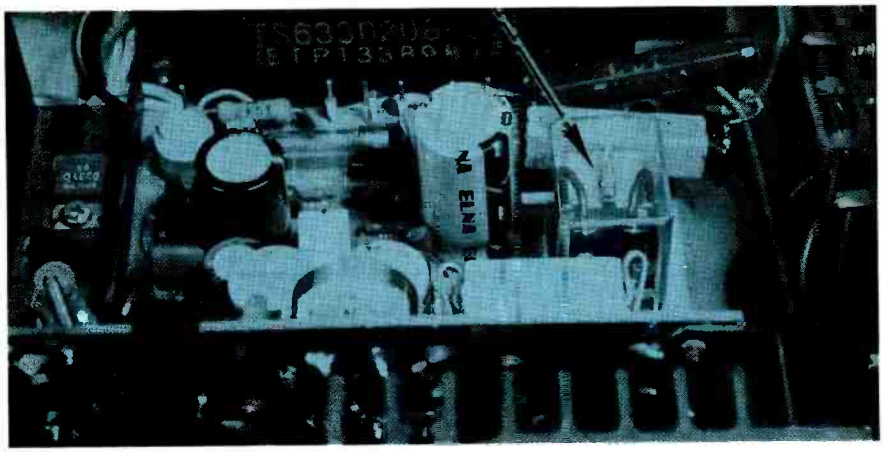

Figure 6 An arrow points to the new relay on the speaker-protection circuit board. Do not defeat this safety feature.

80Vac. Both speaker and amplifier now were protected, but the defect still had not been located.

To monitor the output constantly, a VOM was selected because of the faster indication of dc voltages and connected across the right-channel at the circuit board. If it had been connected across the dummy load, the speaker-protection relay would have disconnected the meter and load after perhaps half a second, thus preventing voltage readings. Also, without the load, any unbalanced dc voltage becomes larger and easier to measure.

The VOM would show about +50V at times when the defect became steady for a second or more. These tests proved transistors H005 and H006 were being biased to near saturation when the problem occurred, while transistors H007 and H008 are biased to cut-off. The important question remained unanswered: Why were these biases being changed?

Another disaster

Next, I checked the possibility of erratic contacts in controls R740 and R713 by rocking the adjustments slightly. R740 produced popping noises when adjusted, so a replacement was obtained and installed. The control was not an exact replica, so the board required drilling to make the control tabs fit.

Unfortunately, the new R740 did not eliminate the erratic popping noises and unbalanced output dc voltages.

I was testing dc voltages at pins of all small transistors when somehow contact was made between two incompatible points, small bits of transistor cases flew across the room, a loud pop was heard and all sound ceased.

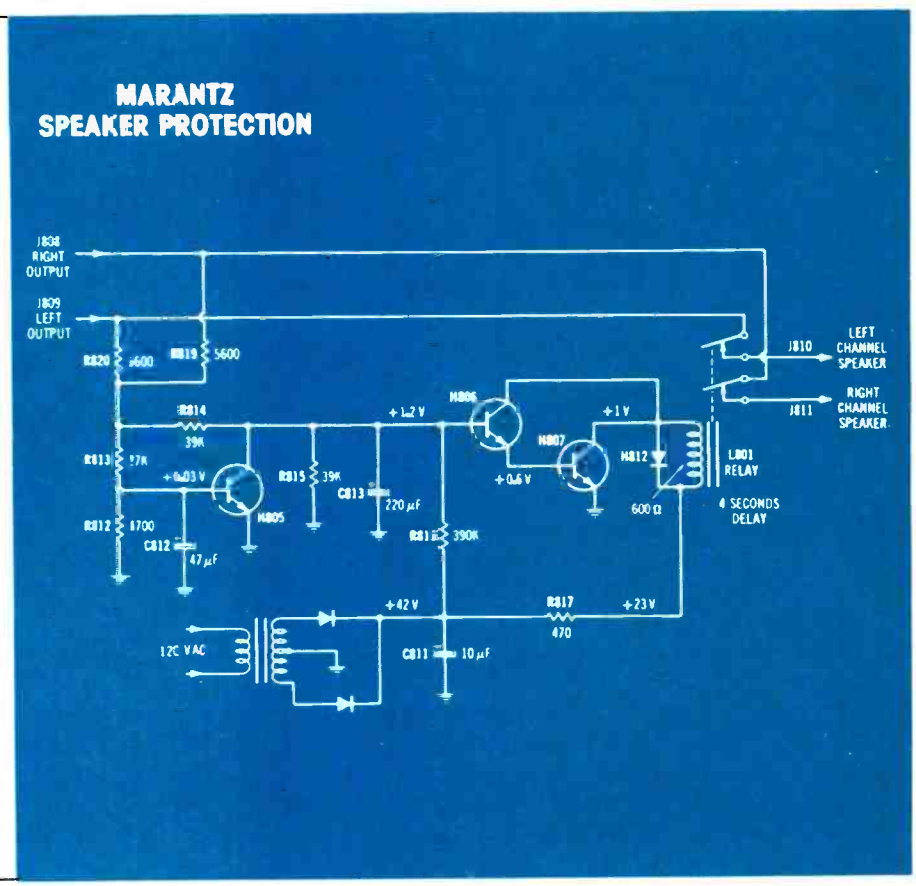

Figure 7 The Marantz speaker-protection circuit disconnects the amplifiers from the speakers under certain conditions. Both relay contacts are normally open types. When power is first applied, the speakers are disconnected from the amplifiers. This prevents any turn-on thumps from being heard or damaging the speakers. Capacitor C813 charges through R816 from the +42V supply. After about four seconds, the C813 voltage has reached about +1.2V, the Darlington transistors (H806 and H807) have saturation bias, and H807 acts as an *on* switch to activate the L801 relay coil. L801 relay closes both switch contacts to connect the speakers. If a negative voltage comes from either amplifier output, it cancels the +1.2V at the H806 base, and the relay opens the contacts thus protecting the speaker. If a positive voltage comes from either amplifier output, transistor H805 has full saturation bias and it conducts completely, shorting out the H806 bias. H806 stops conducting the relay contacts open to protect the speaker. Without this protective circuit, a massive short in the amplifier can apply about 60V to the speaker, and some speakers will burst into flame. *Do not defeat this protective action.*

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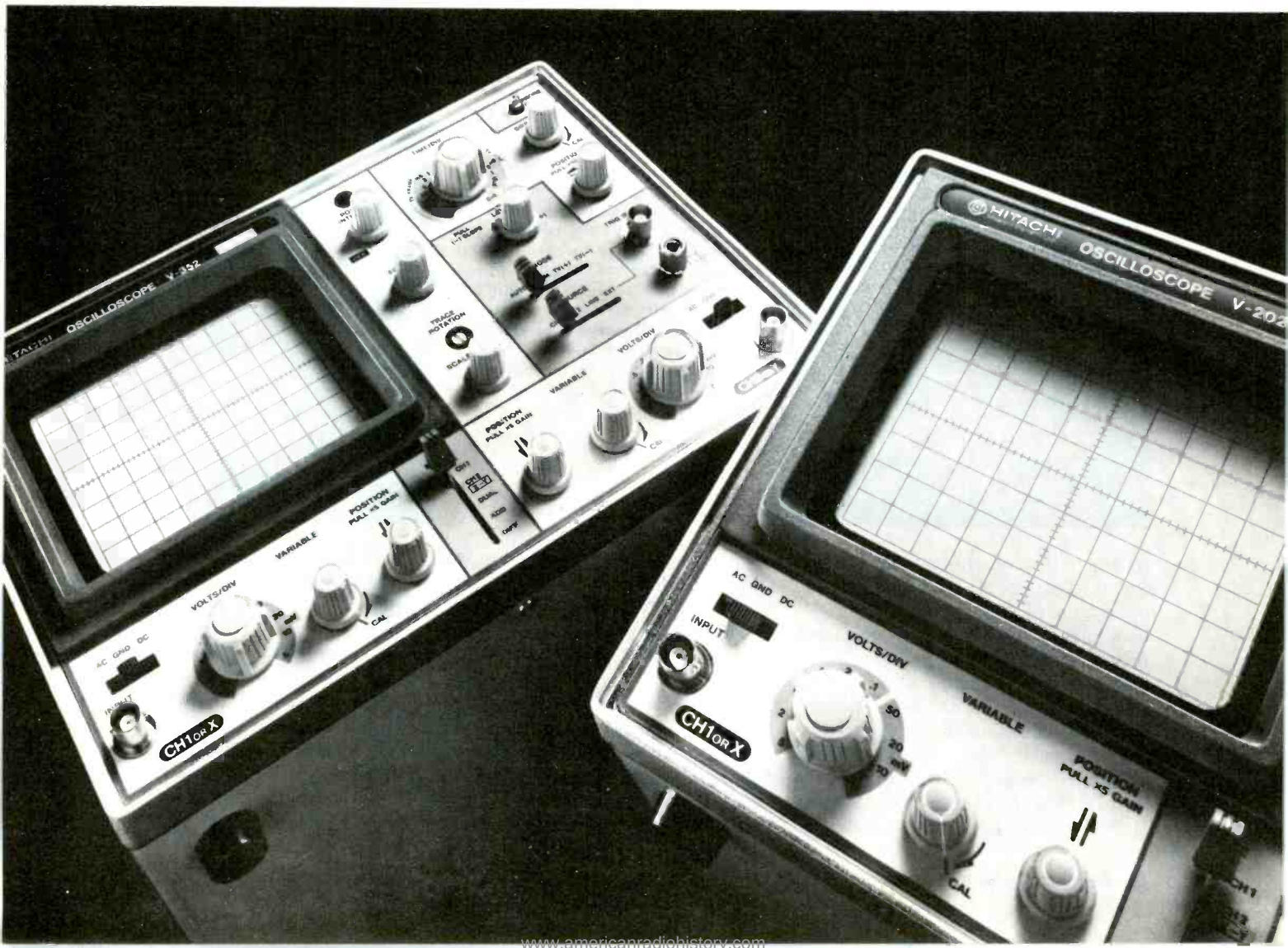


After locating all the defective components (one fuse; two output transistors; two driver transistors; and transistors H710, H711, H712 and H713), the job of finding suitable replacements began. The driver transistors were identical, except one was a PNP and the other a NPN. Also, the T0-3 power-output transistors were PNP and NPN complements. Several catalogs listed suitable replacements, but the distributors were out of stock. Finally, by going to transistors of higher ratings, the necessary pairs were obtained and installed.

At last all damaged components were replaced, and the radio again operated as it did before troubleshooting began, except for erratic output of the right channel that was traced to burned contacts in the speaker-protection relay (Figure 5). The relay was replaced.

Speaker protection

The speaker-protection circuit is on a small circuit board mounted to the right of the power transformer (Figure 6). During normal operation of the Figure 7 protection circuit when either channel has a steady dc-voltage output, transistor H805 has insufficient forward bias, so it has no C/E current and in effect is open, having no action in the circuit. Transistors H806 and H807 (connected as a Darlington stage) have saturation forward bias that produces full C/E conduction, which activates the L801 relay coil, thus closing the normally open contacts that connect the power amplifiers to the proper speakers.

If a defect or thermal drift causes either amplifier to emit a dc *negative* voltage, the voltage comes through R814 to the H806 base where it cancels the +1.2V of saturation bias. Transistors H806 and H807 become cut-off, which deactivates relay coil L801, allowing the contacts to open and disconnecting the amplifiers from the speakers, preventing speaker damage.

At the other extreme, if a defect or thermal drift causes either amplifier to emit a steady *positive* voltage, the protection action is different. The positive voltage passes through voltage divider R813/R812 to the H805 base, causing it to conduct between collector and emitter. This conduction shorts to ground the H806 positive forward bias. Without forward bias, H806 (and H807) become open and without conduction, the relay opens and disconnects amplifiers from speakers.

Incidentally, technicians *never* should defeat similar protection circuits in any amplifier. Amplifiers with positive and negative power supplies that eliminate output coupling capacitors can become serious safety hazards. If one of the output transistors shorted between collector and emitter, either +60V or −60V would be applied to the output. If the protection circuit did not instantly disconnect the speakers, the woofer speaker of that channel would overheat so rapidly that perhaps in less than 10 seconds the woofer cone and voice-coil form could be on fire. Don't take chances; be certain the protective circuit operates correctly.

Back to the erratic noise

Again, an intensive series of tests were made with caution and care. An effort was made to locate the circuit area where the dc voltages varied the most. Suspicion was drawn to the −20V supply that was formed by series resistor R720 and zener diode H717 with C707 as the filter capacitor. Temporary substitution of these components did not eliminate the erratic noise and volume. Substitution also was made of the equivalent components (H716, C706 and R719) in the +20V supply without success.

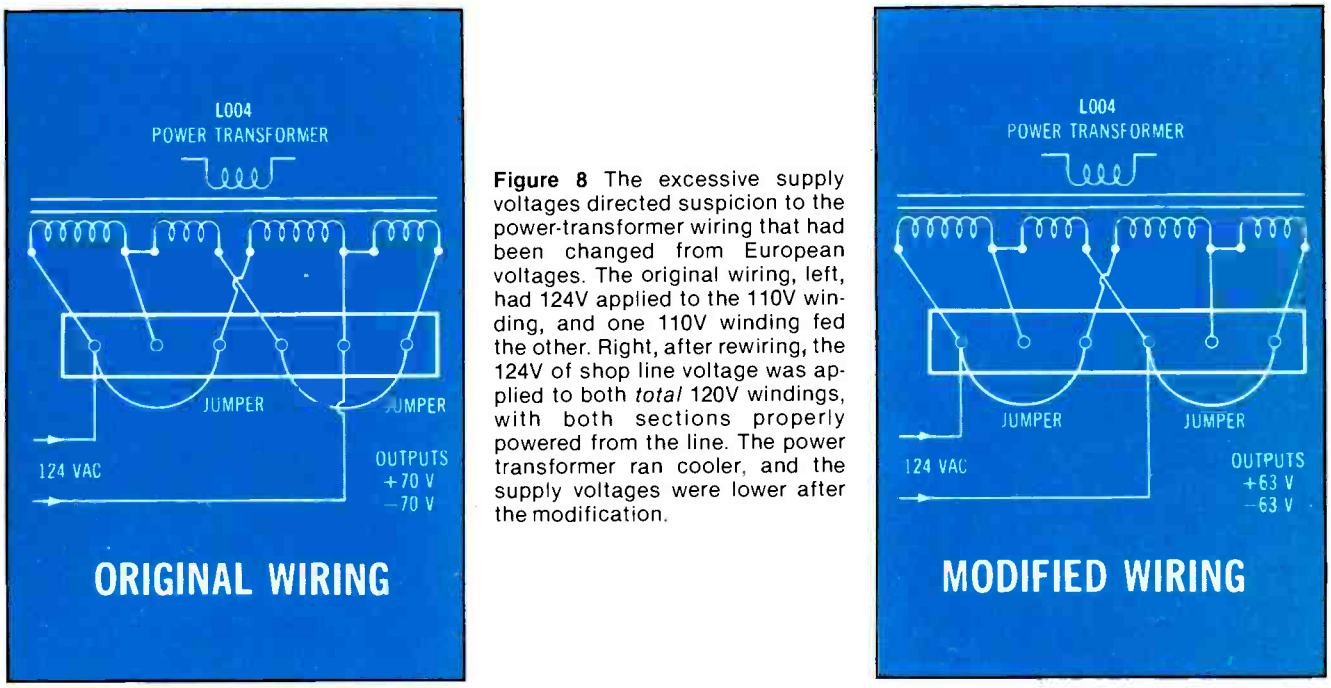


Figure 8 The excessive supply voltages directed suspicion to the power-transformer wiring that had been changed from European voltages. The original wiring, left, had 124V applied to the 110V winding, and one 110V winding fed the other. Right, after rewiring, the 124V of shop line voltage was applied to both *total* 120V windings, with both sections properly powered from the line. The power transformer ran cooler, and the supply voltages were lower after the modification.

Finally, hot and cold tests appeared to show a thermally triggered problem around diode H718 and series resistor R724. These two components were replaced and the receiver/amplifier time tested again. The time test continued for hours and days without the former intermittent noise and volume.

I am always suspicious of electronic circuits that *appear* to be

normal after a long history of intermittent operation, but after the dummy load was removed and the line voltage increased to the normal 120Vac, *both channels continued to operate perfectly.*

Line voltage vs. dc voltages

When the line voltage was adjusted to precisely 120Vac, the two principal power supplies measured +66V and −66V. At the bench line voltage of 124Vac, these voltages became +70V and −70V. Since the factory specifications called for +60V and −60V at 120V line voltage, these voltages implied that something undesirable was increasing the supply voltages. Of course, the danger of ruining power transistors is multiplied by excessive supply voltages.

The outside technician had said the radio/amplifier came from Europe, but had been converted for use with United States' power. A quick glance at the terminal strip on top of the power transformer verified that it had the extra windings for low or normal 120Vac or 220Vac line voltages. Had the power-transformer taps been connected properly or not? The schematic in Photofact MHF-97 showed an untapped primary for American power.

The power transformer was huge and had three secondary windings. Finding a replacement would have been almost impossible, and incorrect strapping of the terminals easily could have burned-out the transformer. The choices were to leave the wiring as it was (with the possibility of a future failure) or to attempt rewiring, with the possibility of burning out the transformer or the main diodes and filter capacitors.

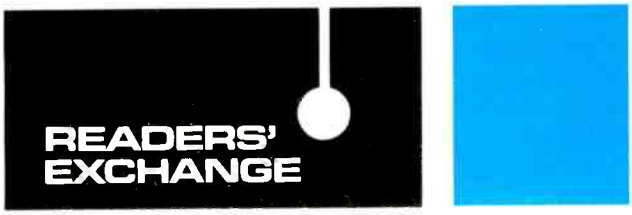
Resistances and ac voltages of all four power-transformer primary windings were checked carefully, and phasing of the windings was verified. Finally, the schematic of Figure 8A was sketched. From the sketch, several possibilities were examined on paper. The wiring of Figure 8B appeared to be *theoretically* correct, and the wires were moved to correspond to it.

When I reduced the line voltage to about 75V and (with one hand on the power plug) switched on the power, the dial lights came on and the FM radio began to play. The line voltage was increased to 120Vac and the main power supply voltages measured +60V and −60V, just as the schematic called for. The radio was operated at moderate volume for several hours as the temperature of the power transformer and the two amplifier heat sinks were monitored by touch. All components operated at a moderate temperature rise.

Comments

Although this solid-state repair incident involved only one model of one brand, the lessons can be applied to other models. Solid-state audio amplifiers demand extra attention to overvoltage or overcurrent conditions that can produce unexpected failures in transistors, ICs and diodes. Solid-state junctions continue to fail faster than fuses and circuit breakers can protect them.

Use good techniques and extreme care for solid-state audio repairs.



Needed: 800-880 Zenith or CK3000 Sylvania Color TV test reg, Data Precision 938 capacitor meter and Fluke 8020 or 8024 DMM. State condition and price. *Phil Shrock, 84343 Hilltop, Pleasant Hill, OR 97401.*

For Sale: Variable autotransformer, Powerstat, 0-140V, 20A, manufactured by Superior Electric Company, $42 plus shipping (25 lbs.). *D. Pollock, 178 Pinckney Rd., Little Silver, NJ 07739.*

Needed: A wiring diagram for an airline radio with the following specs: C.C. #62-74, MG-24, series 572, form 431T. This was manufactured in the 1930s. Will pay $5 for a good schematic. *Lou Wollaston, Wollaston Radio & TV, 1504 Big Horn, Alliance, NE 69301.*

Needed: Hickok model 388 CB in-line tester, B&K model 1077 TV analyst, and schematic and service manual for an EMC model 700 RF/AF crystal marker/generator. *Caswell Davis Jr., 601 Delmar, Apt. 2, San Antonio, TX 78210.*

Needed: Ratio detector coil for Zenith Ch.IN29T20. Part #95-2318 or #95-2415 (alternate). New or used. *Frank Nelson, Pacific Empire Electronics, 2033 N.E. 52nd Ave., Portland, OR 97213.*

Needed: Circuit on a touch-on/touch-off switch for a table lamp. This unit is sealed and the manufacturer is not available. 120Vac, touch base-on, touch ring-off. *Joseph Shway, 2729 Bendemeer Drive, Columbia, SC 29209.*

Needed: Supremes Vol. R-6, Symcure Vol. 1 and Sams Photofact TR-82. *C. T. Huth, 146 Schonhardt St., Tiffin, OH 44883.*

Needed: Three new or used #G51 and 2 #45 tubes. Will pay a reasonable price. *Gus A. Green, 12692 Green St., Boron, CA 93516.*

Needed: Back copies of **Electronic Servicing** from 1974 to 1980. *Frank Yurgan, c/o Frank's TV, 7800 Shore Front Pway., Rockaway Beach, NY 17693, 1-212-474-0827.*

Needed: Service manual for AIWA AM/FM tape player, model TPR 3010A. Will buy or copy and return. *McGinty's Electronics, Rt. 1, Box 91, Leonardville, KS 66449.*

Needed: Heathkit MM-1 VOM and Finco VM-100K meter movement or complete VOM with good movement. Send condition and price. *J. Max Koone, Rt. 5, Box 32, Rotherfordton, NC 28139.*

Needed: 12DKP4 picture tube in good condition. *Jiranek TV, Farmington, IA 52626.*

Needed: Sankyo SY200R15 12Vdc motor for TDK-305 8-track tape deck in Olympic TG32721 receiver. *David W. Dana, P.O. Box 44, Plaistow, NH 03865.*

Needed: Schematic for old radio; Philco model #38. *Cyrus P. Howell, 57 Cedar Knoll, Tucsaloosa, AL 35405.*

Needed: Manual for Eico Model 368 sweep generator/marker or current address of Eico. *C.R. Wilson, K1GVA, 61 Warwick, Portland, ME 04102.*

Needed: Sencore VA 48. Must be in excellent condition. *M. Burkhard, 21440 Iglesia Drive, Woodland Hills, CA 91364, 1-213-347-3748.*

Needed: 15-30MHz oscilloscope, triggered sweep. Portable preferred, but not mandatory. *George Campbell, 4445 13th St. E., Lancaster, CA 93534.*

Needed: Power transformer for Eico #425 scope and also one for Precision signal generator, model E-200. Send price. *C. Morlok, 319 Edmund St., Aberdeen, MD 21001.*

Needed: Audio output transformer for a Sherwood S550 III stereo amp and a repair manual for a Tennelec programmable scanner (will buy or copy and return). *Bob Mendall, Bob's Communications, RFD #2, Box 2082, Coopers Mills, ME 04341, 1-207-845-2310.*

Needed: 5-inch wideband scope and signal generator. Will trade or sell Sencore CRT tester model 143 and magnifier lamp. *George E. Pullen, 6722 Botetowrt Drive, Ft. Washington, MD 20744, 1-301-449-7348.*

For sale: RCA RF signal generator, type WR-50B, $85; RCA constant voltage dc power supply, type WP-704B, $60; RCA Master Chro-Bar generator, type WR-515A, $175. *William Shevtchuk, 1 Lois Ave., Clifton, NJ 07014, 1-201-471-3798.*

For sale: Sencore MU-150 mutual conductance tube tester, brand new condition, $225. *Rusco Electronic Systems, 2408 E. AZ Biltmore Circle, Suite 101, Phoenix, AZ 85016.*

For sale: Color generator and vectorscope, model V-7 Lectrotech, with manual, $75. Also Sencore model TF 151 transistor and FET tester with manual, $75. *H. W. Oats, Rt. No. 5, 8359 Harding Highway, Lima, OH 45801, 1-419-229-2322.*

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For Sale: Sencore SM 152 sweep and marker generator, $300; B&K 1076 TV analyst, $295; Sencore CR 143 CRT tester, $125. *John Bordan, 1781 Aurora Rd., Melbourne, FL 32935, 1-305-259-2146.*

For Sale: Sams Auto Radio Series 19-157, $200; Sams Transistor Service Manuals 24-148, $200. Call or write for list of RCA, Zenith and Magnavox manuals. *Sunrise TV, 408-A North Caldwell, Brevard, NC 28712, 1-704-883-3425.*

For Sale: B&K 415 sweep/marker generator with test leads and manual. Almost new, $375. Will insure and ship. *George W. Davenport, Box 204, Trenton, NC 28585, 1-919-448-4561.*

For Sale: Sencore VA48, nearly new, best offer over $600. *Frank Knight, RFD 1, Box 675, New Gloucester, ME 04260, 1-207-926-3323.*

For Sale: Many Sams folders below #1000, $1.50 each, Electronic Servicing and others. Send SASE to *Robert Ireland, RFD 4, Box 140, Pleasant Valley, NY 12569.*

For Sale: B&K 415 generator in A-1 condition with all cables, etc. $250 by money order or certified check, you pay UPS charge. *L. E. Luckenbill, 325 Kenwood, Argenta, IL 62501.*

For Sale: Admiral modules 70% off; write for list. Also B&K 467, like new, $200. *Harold Cressler, Box 232A R.D. 6, Carlisle, PA 17013.*

For Sale: Used but good pix, 17BP4, 21AMP4A and 21FLP4, $10 each or all for $25. You pay shipping. *George Otto, 1045 Magnolia Ave., Beaumont, TX 77701.*

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BOOK REVIEWS

Editor's note: *Periodically* ***Electronic Servicing & Technology*** *presents reviews of books dealing with subjects of interest to our readers. Please direct inquiries and orders to the publisher at the address given in each review rather than to us.*

The Complete Handbook of Amplifiers, Oscillators and Multivibrators, by Joseph J. Carr; Tab Books Inc.; 364 pages; $15.95 hardbound, $8.95 paperback.

From theory and design to applications and operations, this book is designed for anyone involved in an electronics field, from ham radio to professional communications or engineering.

Covered is basic semiconductor and transistor theory, plus fundamentals of solid-state amplification. Also covered are classifications and the various methods of coupling bipolar transistors, plus FETs, JFETs and MOSFETs, and their uses in amplifier design.

In addition, the book takes a practical look at RC monostable multivibrators or one-shots for digital electronics and computer experimenters.

Published by Tab Books Inc., Blue Ridge Summit, PA 17214.

Beginner's Handbook of IC Projects, by David L. Heiserman; Prentice-Hall; $18.95.

The 152 illustrations, schematics, parts lists and descriptive notes in this book help you construct and test more than 100 IC projects. Light-flashing circuits, time-delay circuits, audioamplifier circuits, electronic musical instruments, electronic games, radio frequency circuits and control circuits are included in the instructions, along with advice on power sources, LED displays and miscellaneous control devices.

Most of the projects can be completed in one evening and cost only a few dollars, according to the publisher.

Published by Prentice-Hall, Englewood Cliffs, NJ 07632.

Analog Instrumentation Fundamentals, by Vincent F. Leonard, Jr.; Sams Books; 448 pages; $19.95.

A detailed book on basic analog instruments – how they work, how to design them and how to use them – has been released by Sams.

Fundamental measurement concepts are fully covered and all the basics from the importance of measurement to analog and digital signals are stressed. Analog meter movements, including the D'Arsonval, taut-band and other movements are also presented.

The author concentrates on explaining dc ammeters, dc voltmeters, ohmmeters, rectifier-type ac voltmeters, peak-type ac voltmeters, dc bridges, transducers, and electronic instruments, passive RC filters and attenuators.

Many practical, hands-on, lab-type experiments and worked-out examples enhance the value of this new book. Thought-provoking questions to answer and problems to solve are also provided for self-testing purposes.

To fully understand the text, you need only a knowledge of fundamental electronics and elementary algebra.

Published by Howard W. Sams & Company, 4300 W. 62nd St., Indianapolis, IN 46268.

Practical TV Troubleshooting Using a Video Analyzer, by Robert L. Goodman; Tab Books; 308 pages; $18.95.

The development of modular, super-circuit-board television and video equipment, coupled with the proliferation of video devices for use in computer systems, video games, industrial applications and other technical equipment, has produced an increased demand for fast and efficient troubleshooting and repair service. This book is designed to make that job easier for technicians and service engineers dealing with all types of video devices; it's a compendium of all the technical info, operating instructions and professional experience that's been developed on test and troubleshooting procedures for the Sencore Video analyzer.

Loaded with shortcuts and practical techniques needed to help technicians and service engineers trail precise and minute digital and analog signals through a maze of "black boxes" and circuit panels, it takes the guesswork out of the troubleshooting process and puts repair procedures into a scientific context that's consistent with the needs of modern technology. Readers will learn how to use each test signal as a quick means to finding the cause of specific problems, how to set up and perform each test, how to monitor the test signals, interpret the results, and the techniques for repairing defects in each stage of typical video circuitry.

Published by Tab Books, Blue Ridge Summit, PA 17214.

Handbook of Simplified Radio, Phono and Tape Recorder Repairs: An Illustrated Troubleshooting Guide, by James Edward Keogh and Ben Suntag; Parker Publishing Company; 236 pages; $16.95.

The car radio keeps fading in and out, the tape recorder playback is on the blink and the pickup arm on the stereo refuses to lift. For most people, these three repairs would add up to an expensive bill at the repair shop.

But not for hobbyists, experimentors and do-it-yourselfers who use this new handbook.

Without an elaborate workshop or a lot of fancy test equipment, readers will be able to locate defects in equipment within a few minutes by following the instant analysis troubleshooting charts. To make it even easier, malfunctions are listed according to the most likely occurrences. Not only are readers told what component to check, but also how to make the necessary tests so they can narrow

the problem down to its primary cause.

Once readers have correctly identified the malfunctioning component, they simply follow the clearly outlined repair procedures to correct or replace the malfunctioning part. Through the use of troubleshooting tables and flow charts, readers will discover exactly what to do if the signal on the FM radio is too weak, how to check for shorts on the radio amplifier, how to check circuits in 10 easy steps, what to do when a turntable does not move and how to read the most complicated schematics.

Published by Parker Publishing Company, West Nyack, NY 19004.

An Introduction to Microprocessors: Experiments in Digital Technology, by Noel T. Smith; Hayden Book Company; 176 pages; $10.95.

This is a "learn-by-doing" guide to the use of integrated circuits that provides a foundation for understanding the underlying hardware actions of programming statements.

The book's seven chapters contain 35 experiments that encourage the reader to construct electronic projects using integrated circuits. The experiments are reinforced with more than 150 schematic diagrams that illustrate key design principles.

Beginning with the simplest gates and timers, the book introduces the fundamental parts of integrated circuits, details and benefits and pitfalls of major integrated circuit families and, in the final chapters, covers the ultimate in integrated complexity – the microprocessor. Also, the use of microprocessors in microcomputers is stressed, with emphasis on construction, function and programming.

Published by Hayden Book Company, 50 Essex St., Rochelle Park, NJ 07662.

Webster's Microcomputer Buyer's Guide, by Tony Webster; Haden Book Company; 326 pages; $25.

This guide will help those microcomputer enthusiasts who wish to obtain detailed information on the broad range of different microcomputers and microcomputer systems available. The book also provides extensive information on operating systems, high level languages, application packages, CRT displays, printers and printing terminals for microcomputers.

The book is divided into four sections:

- microcomputer theory and applications
- independent software products
- microcomputers and microcomputer systems
- CRT displays, printers and printing systems

Published by Hayden Book Company, 50 Essex St., Rochelle, NJ 07662

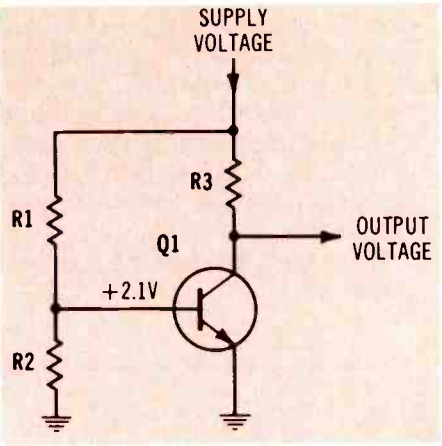
ES&T

Answer to Quick Quiz

(From page 11.)

By Wayne Lemons

Apparently, Q1 transistor has +2.1V of forward bias. The voltage polarity is correct for an NPN-type transistor. But, it is impossible to develop more than about 0.8V of forward bias between a normal base-and-emitter junction of a small silicon transistor (almost 1V with some large power transistors). Any attempt to raise the forward bias above this plateau will ruin the B/E junction. Therefore, *the base-to-emitter junction in Q1 is open.*



A non-defective diode is a good voltage regulator (within its wattage rating) because its forward-bias resistance varies rapidly with applied voltage across the junction. Of course, the B/E junction of a transistor has some characteristics of a diode.

Remember this troubleshooting advice: If more than 0.8V forward bias is measured from base to emitter, the B/E junction is open.

The only correct answer is #3: *the base-to-emitter junction is open.*

Quick Quiz ...In depth

By Carl Babcoke, CET

The circuit was connected using 56K for R1, 18K for R2, 1K for R3, and a 9V battery measuring 8.9V as a supply.

When the emitter lead was opened to simulate an open B/E junction, the base-to-ground voltage measured +2.19V. With a normal B/E junction, the forward bias measured +0.642V.

Values of R1 and R2 were varied, producing the following results:

- When R2 was open, the forward bias measured +0.653V.
- When R1 was reduced to 28K, the forward bias increased only to +0.671V.

Obviously, major variations of the voltage-divider resistances (that connect to the base) cannot vary the forward bias much.

However, there is a larger mystery. In an effort to simplify the theory of some circuits, many electronic teachers describe solid-state diodes as on/off switches. Although that helps technicians understand circuits, it distorts the truth about diodes. A base-to-emitter junction is a type of diode. If this *diode* in Q1 is an *on* switch, the base voltage would be zero. If it is an open circuit, the base-to-ground voltage (according to Ohm's Law) must be more than 2Vdc. Because the base voltage measures in between these two extremes, there must be an appreciable internal diode resistance when forward bias is applied. Further, it can be demonstrated that the internal resistance changes (producing a variable voltage drop) in step with the current flow.

To illustrate the voltage-regulating characteristics of diodes, two digital multimeters were connected to read diode current and diode voltage drop simultaneously. A resistor between the diode and the variable-voltage power supply allowed a gradual increase of current. The supply voltage was increased gradually from zero until the current reached 0.001mA (the smallest current the DMM could measure). Then the voltage drop across the diode was written down. The current was increased to a higher value and the diode voltage recorded. This was repeated many times, producing the following results:

voltage	current	resistance
0.500V	0.000mA	unknown
0.528V	0.001mA	528
0.536V	0.002mA	268
0.554V	0.004mA	138.5
0.573V	0.008mA	71.6
0.582V	0.012mA	48.5
0.596V	0.020mA	29.8
0.623V	0.050mA	12.5
0.644V	0.100mA	6.44
0.665V	0.200mA	3.32
0.677V	0.300mA	2.26

Notice that varying currents produced those voltage drops across the diodes; the voltages did not cause the currents. When the current was increased by a factor of 300, the voltages increased by a factor of only 1.28.

A diode gives excellent voltage regulation across itself over a wide range of currents. Of course, the wattage is very low. And regulation at higher voltages can be achieved only by adding diodes in series.

It should be clear now why the base-to-emitter forward bias can be reduced by varying the base voltage-divider resistances, but the forward bias *cannot* be increased above about +0.8V (without damaging the transistor). A small increase of forward bias causes a much larger B/E current; thus the B/E junction (or a diode) acts as an efficient voltage stabilizer.

Remember that transistor voltage gain and collector current vary more rapidly than does the base-to-emitter current. Minor variations of base-to-emitter *voltage* forward bias that are almost impossible to measure on a DMM can produce huge changes of transistor voltage gain and collector current. Transistors operate by input-vs.-output *currents*—not voltages. Because the voltage forward bias is produced by current flow through the B/E junction, *there can be no definite bias voltage specified for either gain or collector current.*

Therefore, typical forward-bias *voltages* shown on schematics can be taken only as a general but not specific figure. Do not change any resistor values to produce a certain bias voltage.

TROUBLE-SHOOTING TIPS

Circuit breaker trips
RCA CTC46
(Photofact 1243-2)

The customer explained that for a few days the color receiver would operate for a varying time before the circuit breaker would trip. He reset the breaker each time, and it would operate again before the breaker tripped. Finally, the breaker tripped instantly when the receiver was switched on.

Initial tests indicated the overload was in the horizontal-sweep circuit. The majority of similar symptoms are caused by defective SCRs, trace or retrace diodes, or capacitors on the PW400 board. However, all these and L108 checked normal.

Finally, the cause of the overload was found visually by accident. While I was observing the PW400 board in subdued light, I noticed an arc at TP211 each time the power was switched on. The solder pad for the secondary winding of T5 at the TP211 location (directly under the transformer) was charred. An ohmmeter measurement confirmed an open connection on the circuit board.

A jumper wire was connected from the TP211 terminal of the transformer to the appropriate end of the other half of the secondary winding, thus eliminating the open circuit. That cured the overload and allowed dependable operation without breaker tripping.

E. Patrick Harrigan
New Berlin, WI

Send your tips to:
Troubleshooting Tips
ES&T
P.O. Box 12901
Overland Park, KS 66212

CALENDAR OF EVENTS

April

14-18
Electronic Home Entertainment Show, Arlington Park Race Track Exposition Hall, Chicago. Contact Expo Management Inc., Suite S2-132 Arcade, The Apparel Center, Chicago, IL 60654, 1-312-329-1191.

23-25
Hamvention '82, Dayton Hara Arena, Dayton, OH. For more information call 1-513-277-5314.

29-May 1
1982 Electronic Distribution Show and Conference, New Orleans Hilton, New Orleans, LA. Contact David L. Fisher, Electronic Industry Show Corp., 222 S. Riverside Plaza Suite 1606, Chicago, IL 60606, 1-312-648-1140.

May

10-12
The 32nd Electronic Components Conference, Sheraton Harbor Island Hotel, San Diego, CA. Contact program chairperson D. J. Bendz, IBM Corp., Dept. 649/014-4, 1701 North St., Endicott, NY 13760.

18-20
Northcon/82 Show and Convention, Seattle Center Coliseum, Seattle, WA. Call 1-800-421-6816 for more information.

25-27
Electro '82, Hynes Auditorium, Boston, MA. For more information, call 1-800-421-6816.

June

6-9
Summer CES '82, McCormick Place, Chicago, IL. Contact Consumer Electronics Shows, Two Illinois Center, Suite 1607, 233 North Michigan Ave., Chicago, IL 60601, 1-312-861-1040.

7-10
National Computer Conference '82, Astro Arena, Houston, TX. For more information call 1-703-558-3600.

August

2-7
Joint convention of National Electronic Service Dealers Association, International Society of Certified Electronic Technicians, The Texas Electronics Association, the Louisiana Electronic Service Dealers Association and Television Service Association of Arkansas at the Hilton in New Orleans, LA. Contact The National Electronic Service Dealers Association, 2708 W. Berry St., Ft. Worth, TX 76109, 1-817-921-9061.

26-29
National Association of Television & Electronic Servicers of America (NATESA) Annual Convention, Indian Lakes Resort, Bloomingdale, IL. Contact Frank J. Moch, 5930 S. Pulaski Road, Chicago, IL 60629, 1-312-582-6350.

September

14-16
Wescon '82, Anaheim Convention Center, Anaheim, CA. For more information call 1-800-421-6816.

October

11-13
EIA Fall Conference, Century Plaza Hotel, Los Angeles, CA. For more information, contact the Electronic Industries Association, 2001 Eye Street N.E., Washington, D.C. 20006.

November

1-2
15th Annual Connector Symposium, sponsored by the Electronic Connector Study Group with cooperation of more than 50 connector manufacturers, Franklin Plaza Hotel, Philadelphia, PA. Contact Electronic Connector Study Group, P.O. Box No. 167, Fort Washington, PA 19034.

NEW LITERATURE

The 1982 Catalog of EIA & JEDEC Standards & Engineering Publications is now available from the **Electronic Industries Association's** (EIA) Engineering Department. This free catalog contains more than 500 EIA standards and publications for electronic components and equipment developed by the more than 250 standing committees of the Association's Engineering Department. The catalog also includes:

- interim standards and engineering bulletins
- proceedings of nationwide technical conferences and workshops sponsored by EIA Engineering Department committees.
- EIA/NEMA Joint Electronic Device Engineering Council (JEDEC) standards, publications and semiconductor registration lists, plus other publications in this area
- TV studio equipment test charts (described in a separate TV test chart catalog)
- assorted other technical materials

The catalog includes prices and detailed ordering information for all documents listed.

Circle (61) on Reply Card

The new 12-page catalog just published by **Lista International Corporation** completely describes their new and expanded line of workbenches and work stations. These units are for use in offices, laboratories, assembly areas, workshops, inspection or shipping areas, data processing centers, printing plants, machine shops, warehouses and maintenance shops.

The catalog outlines the features and gives all dimensions for five different cabinet housings and 10 drawers and shelves. All accessories are shown and explained, as well as 37 standard drawer layouts being itemized. To simplify ordering, there are 40 examples of standard work center combinations and 42 standard cabinet combinations shown.

Circle (64) on Reply Card

The "whats" and "whys" of True RMS for the **Beckman Instruments** line of digital multimeters are answered in this new brochure.

Primarily, it addresses the question, "Do you think an *RMS calibrated* meter is as functional as an *RMS responding* meter?"

Have you wondered what the advantages of ac + dc coupled true RMS measurements are? These questions and more about true RMS measurement are answered in the brochure.

Circle (63) on Reply Card

ES&T

Each report about an item of electronic test equipment is based on examination and operation of the device in the **Electronic Servicing and Technology** laboratory. Personal observations about the performance and details of new and useful features are spotlighted, along with tips about using the equipment for best results.

By Carl Babcoke, CET

Figure 1 Tektronix model 2336 is a full-featured 100MHz portable scope. The hinged front cover locks in the open position (as shown) while the scope is raised by the handle. A plastic pouch for probes, books and tools is fastened to the top. Model 2336 was designed to resist hostile environments for field service.

Tektronix model 2336 scope

Model 2336 (Figure 1) is basically a portable, 100MHz, dual-trace, delayed-sweep portable scope, but it has two unusual features. An LCD readout in the panel's protective cover shows the time between two user-selected points on a waveform. One simple application is measuring the repetition rate. The time of one cycle is found by placing the two intensified points at the beginning and ending of the cycle. Then, the time shown by the LCD is divided into one to produce the rep rate.

The second feature is extreme ruggedness of case, electronics and CRT. A hinged panel cover provides protection during transportation (and serves as additional space for B-triggering and delta-time circuitry). Model 2336 equals or exceeds MIL-T-28800 Class-3 environmental requirements (except for the LCD display, which required a slight derating) for military and aerospace qualifications. Test samples are subjected to three shocks in both directions along each axis with accelerations of 50 Gs at ½ sine. Other tests apply specific humidity percentages and vibrations for certain time periods.

However, the most dramatic durability test has not been publicized by Tektronix. When Bill Rhodes, **ES&T** editorial director, visited the Tektronix factory, an

Figure 2 The scope CRT controls and an on/off switch are located at the CRT screen's left.

Burglar Alarm

NOW THERE IS A RADAR BURGLAR ALARM FOR YOUR HOME OR OFFICE. IT REQUIRES NO INSTALLATION AND PROTECTS LIKE A THOUSAND DOLLAR PROFESSIONAL SYSTEM.

The Midex 55 alarm system measures only 4" x 10½" by 7" yet protects you like much larger and expensive security systems.

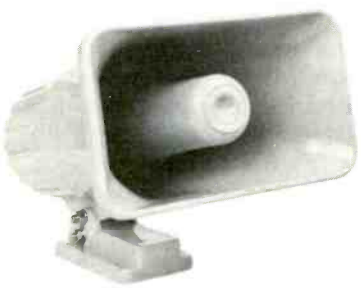
The concept is simple. Provide all electronic functions of a professional wired together system. Put sensing and control into one easy-to-use device. Use large scale integration of solid state components to achieve lower cost and greater reliability. Here are some of the exciting features:

Invisible Protection. The Midex 55 protects your home using exactly the same technology that police radars use to catch speeding cars and trucks. When you are not at home, the Midex 55 generates a low energy radar field that detects anyone who moves in a designated area of your house. The protection pattern is an adjustable tear drop shape with maximum dimensions of 50 x 20 feet.

Loud Alarm. When the system detects an intruder, it turns on a loud police type electronic siren. The sound is loud enough to cause pain. It is loud enough to drive a burglar away before he can steal or damage your valuables. It is loud enough to alert your neighbors and, more important, loud enough to warn you not to enter your home before the police arrive.

Computerized Controls. To turn the system on, you punch in your personalized 4 digit access code. You now have 30 seconds to leave your home or office. When you return, you enter and disarm the system with your access code. You have 30 seconds to do that also.

When the Midex senses an intruder, it remains silent for 30 seconds. It then sounds the alarm until 8 minutes after the burglar leaves. The alarm then shuts off and resets, once again ready to do its job. This shut-off feature, not found on many expensive systems, means that your alarm won't go wailing all night long while you're away.



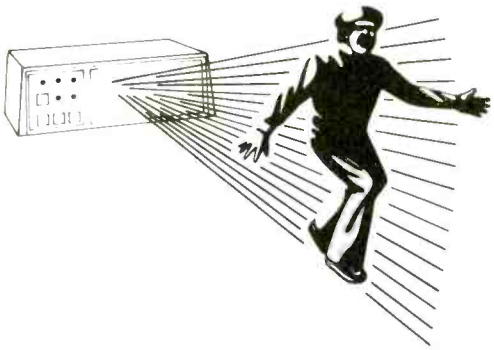
The powerful blast horn has a 120 dB output and makes a sound so loud it causes pain.

Standby Power. Should AC power fail or a smart burglar cut your AC power lines, the Midex 55 automatically switches to FAIL-SAFE operation using a built-in rechargeable battery pack. You are protected no matter what.

EXPANDABLE SYSTEM

You can set up the Midex in your own home in minutes. It looks like a stereo component. Just plug it into a wall socket, aim and adjust its protection pattern and connect two wires to the powerful alarm blast horn SP-30. If you wish, you can connect two alarm blast horns. If you connect 2 blast horns, we recommend one outside and one inside. A test light allows you to easily determine the area of coverage of the protection pattern. A thumb wheel lets you adjust it to your needs.

As an extra security measure, you can connect one or more panic buttons to the Midex. The panic buttons activate the alarm even with the radar protection pattern turned off. But even if you don't use the expansion features, the Midex is complete, ready to protect you, just as it arrives in its well-protected carton.



The adjustable pattern has a range up to 50 feet.

NO MORE FALSE ALARMS

Compared with other burglar alarms like ultrasonic systems, the Midex has almost no chance of false alarms, since it is not affected by traffic noise, plane noise, air conditioner turbulence, telephones or strong outside winds.

COMPARED AGAINST OTHERS

The Midex compares with much more expensive professionally installed systems. Yet it costs no more than do-it-yourself alarms purchased at retail. In a recent article, a leading consumer magazine rated the Midex tops in space protection, alarm siren power and immunity from false alarms. Don't be confused. There is no system under $1000 that provides you with the same protection.

U.L. LISTED SYSTEM

If you have owned a burglar alarm for more than a year, there's a good chance that it has required service. The Midex, however, is solid state and built with the same heavy duty components in industrial systems. The Midex is made by Solfan Systems, Inc., the leader in the production of radar detectors for commercial and industrial security systems. Solfan has made more than half a million industrial radar sensors and over 100,000 Midex 55. Will the Midex ever need service? No product is perfect. If you ever have a problem, call us on our toll free "help line" at (800) 227-8167. The product has a limited 1 year parts and labor warranty.

STANDING BEHIND A PRODUCT

The Midex protects more than 100,000 American homes. But the true test of how it performs is in your home or office. That is why we provide a one month trial period. We give you the opportunity to see how fail safe and easy to operate the Midex system is and how thoroughly it protects you and your loved ones. Decide after one month whether you want to keep it. If you decide to keep it, you'll own the best. If not, return your unit for a full and prompt refund. There is no risk.

Purchase the Midex 55 now for **$199.95** and the SP-30 blast horn for **$39.95.** We recommend the purchase of two blast horns. To order, simply send your check to the address shown below. California residents add 6% sales tax. Credit card buyers may call our toll free number below. There are no postage or handling charges. The unit will be sent to you complete with all instructions.

Midex gives you everything you could possibly expect from a burglar alarm: 1) a professional grade system at a very reasonable price, 2) toll free telephone assistance, 3) the chance to buy a unit in complete confidence, knowing that you may return it if it's not exactly what you want. You can't lose.

Computer technology has produced the ultimate security system. Order your Midex 55 without obligation today.

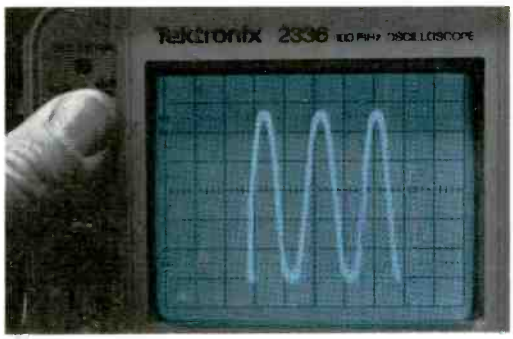
midex

665 Clyde Avenue
Mountain View, CA 94043
Call toll free . . . . .(800) 227-8167
In Calif. call . . . . .(415) 964-7020

Circle (20) on Reply Card

Figure 3 An internal graticule eliminates all parallax. Shown here is the probe frequency-compensation square waveform after the probe was calibrated correctly. The high brightness allows good viewing in bright ambient lighting, as pictured.

Off-the-screen waveforms can be identified by pressing the beamfinder switch button, which compresses the waveform, including both ac and dc components.



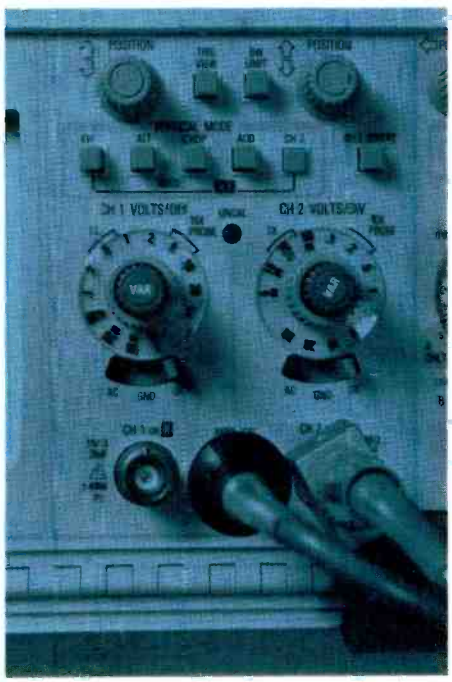


Figure 4 Controls for the two identical vertical channels are located at the right of the screen. Notice the range marks for X1 and X10 probes near the volts/div switches. Two unusual push-buttons are supplied. The TRIG-VIEW button substitutes the triggering waveform for the signal waveform. The BW-LIMIT button restricts the bandwidth to about 20MHz. It is useful when unwanted high frequencies obscure desired low frequencies. One probe is shown plugged into the calibration jack.

engineer demonstrated the ruggedness of an unmounted 2336 CRT by holding the neck and hammering the faceplate on a desk! Now, my mind rebels at the thought of doing that to any tube, large or small, and, I'm certain Tektronix does not recommend that anyone try this durability demonstration in the field. It does illustrate the extreme measures taken to produce test equipment that will be dependable in unfavorable environments.

CRT and controls

The cathode-ray tube (CRT) has internal graticule markings (Figure 2) that eliminate parallax errors. No edge lighting is supplied. Accelerating voltage of 18kV to the new-type CRT provides high trace brightness with a smaller spot for improved sharpness. The CRT screen has 8-by-10 divisions of 80mm per division plus the percentage markings needed for rise-time measurements.

A clear plastic cover protects the CRT screen, however, it can be removed without tools if required. Figure 3 shows the waveform provided for X10 probe adjustments.

Controls at the left of the CRT screen include intensity adjustment, beamfinder switch, focus adjustment, on/off switch and screwdriver adjustments for trace rotation (trace leveling) and astigmatism.

Vertical channels

Two identical vertical channels are provided. They can be operated in chopped or alternate dual-trace modes, or either channel can be used alone. Maximum calibrated sensitivity of each channel is 5mV/div. However, an uncalibrated variable control can increase the sensitivity to 2mV when needed. (Figure 4).

Minimum sensitivity is 5V/div. Two reference points are provided for direct probe and 10X probe. Therefore, calibrated sensitivity with a 10X probe ranges from 50mV/div to 50V/div.

An LED lights when either

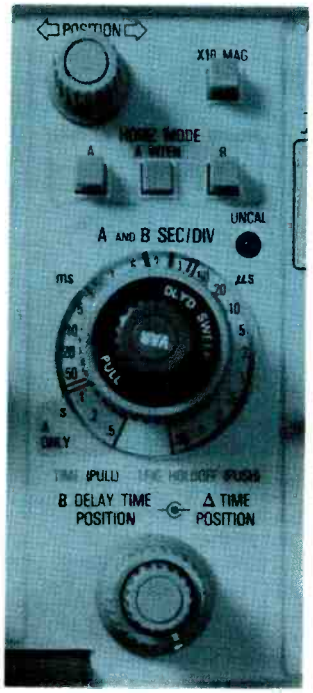


Figure 5 Controls for sweep mode and sweep times are clearly labeled and placed for easy operation.

channel is operated in the uncalibrated mode.

When activated, a non-locking push-button (located between the positioning controls) places the triggering waveform on the screen.

Sweep specs and modes

Figure 5 shows the few sweep controls. Sweep times can be selected between 0.5S/div and 0.05μS/div. Pressing the X10 push-button decreases the *effective* minimum sweep time to 50nS/div. Rotation of a concentric variable control can decrease all calibrated settings by a factor of 2.5. An LED lights when the sweep time is uncalibrated.

Push-buttons are provided for A (normal) mode, A-intensified (locating the waveform area to be expanded) or B-mode (delayed and expanded sweep). This delayed sweep operates the same as in previous Tektronix scopes that had the feature.

A dual control (below the time/div switches) adjust the B-delay time during delayed sweep operation, or the reference point for delta-time operation (in conjunction with the delta-time position). This delta-time mode is explained later.

Triggering

The triggering controls include triggering polarity (slope), auto or manual triggering, single sweep, coupling and frequency response, source selector and external-sync input. Similar controls (Figure 6) have been used successfully by Tektronix for many years, but the internal triggering circuitry is new, giving improved locking.

B triggering and delta time

B triggering from an external signal is possible from the slope, level and source controls that are mounted in the protective front cover (Figure 7). Suitable signals were not available to check this feature during the Test Lab operation.

A second (and very interesting) feature is the delta-time measurement, which determines the precise time between specific points on a waveform. First, the horizontal mode is set for A-intensified and the B-trigger source switch (in the lid) is slid to delta-time position. Two sections of the waveform now should be brighter (intensified). The leading edge of the intensified zone is moved to the desired location by rotation of the B-delay-time position control and the other intensified zone is moved by the delta-time position control until its leading edge is located at the second desired point. The time between those two intensified zones is displayed by the LCD digital readout on the left half of the protective front cover. (Figure 7B).

Obviously, this type of measurement is very convenient and accurate for measuring the repetition rate of regularly recurring waveforms. However, it is not limited to rep-rate tests. Pulse *widths* in milliseconds or microseconds can be determined directly.

Figure 8 waveforms show the probe-compensation waveform as it normally is viewed and also with the intensified zones placed at the falling edges of the square wave. In Figure 7B, the digital readout showed 1.009ms. Therefore, the repetition rate was 991.1Hz (1 divided by 0.001009 = 991.1).

Comments

Tektronix model 2335 is similar to model 2336 just described, except the LCD readout and B-triggering controls are not included in the front cover. Model 2337 also is similar but it has the LCD readout, the B-triggering controls and a *digital multimeter* in the front cover. Each scope weighs about 17 pounds.

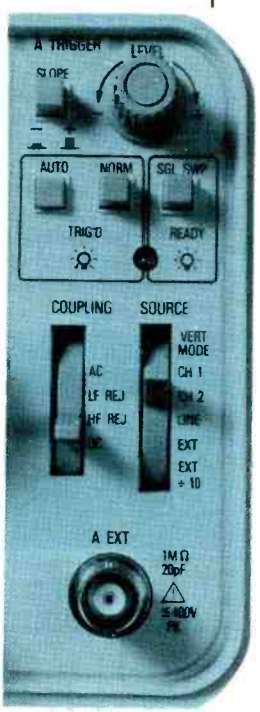


Figure 6 Triggering controls are located on the panel at the far right.

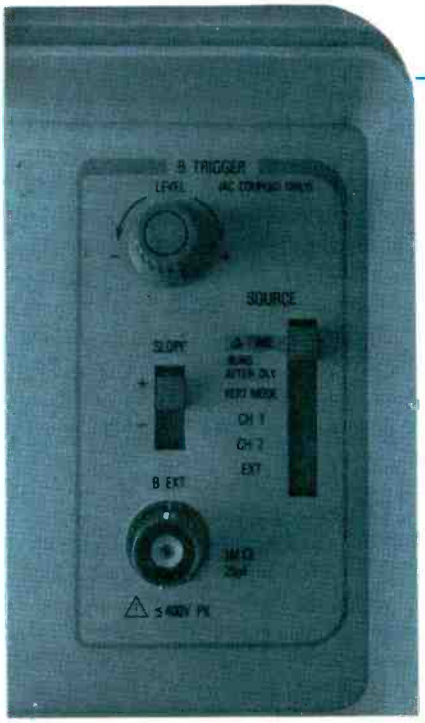


Figure 7 Inside the hinged front cover in model 2336 are the controls for an external B-trigger function (above) and a sliding switch that can select B-triggering or delta-time functions. Located farther to the left (below) is the LCD digital readout that shows the time between intensified zones during the delta-time measurements.

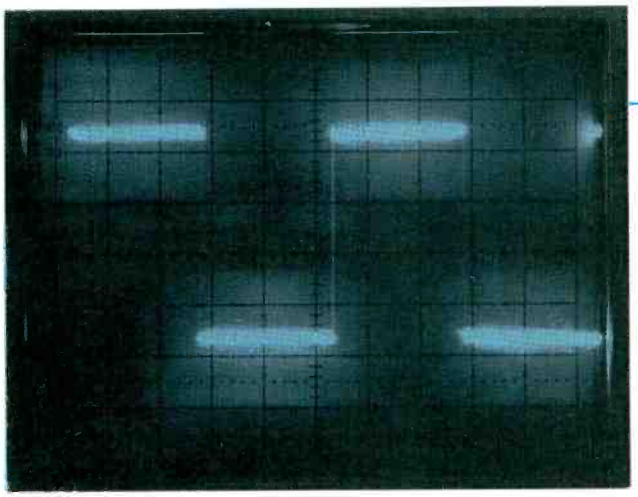
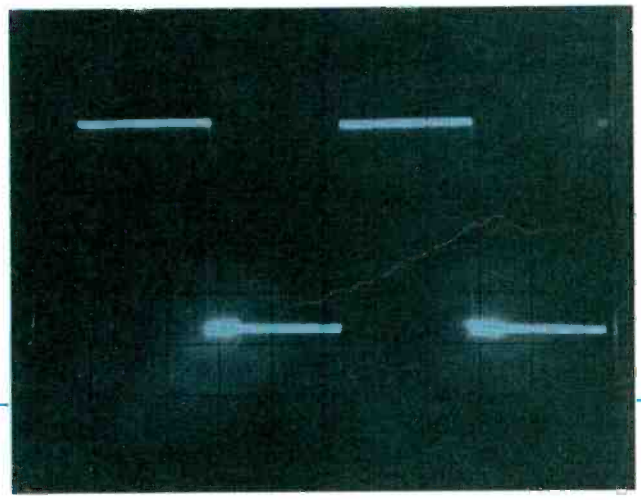


Figure 8 These photographs show the probe-adjustment waveform without and with delta-time trace intensification. Above, in normal sweep mode, the horizontal sections of these square waves are very bright, while the fast rise and fall lines are dim. Below, delta-time trace intensification has brightened the square waves immediately following successive falling edges. Best accuracy was achieved here by moving each intensified area to the left until the falling edge *barely* was brightened.



Tektronix expects the 2300 series scopes to complement rather than compete with sales of the 465B because the 465B has a larger CRT, alternate sweep and faster sweep speeds.

The unit also features a plastic pouch fastened to the scope's top that is large enough to contain both test probes, the instruction book and other needed items.

Only one feature needed for efficient video and television measurements is missing: An internal composite-sync separator is required for scope locking at vertical frame rate. Although the knobs and push-buttons are slightly smaller than those on some larger lab scopes, no problems were experienced when using these 2336 controls.

Accuracy of model 2336 is better than the standards in our Test Lab, but it was operated as a dual-trace scope during several measurements. Waveforms had excellent brightness and sharpness, no positioning drift was noticed, and the locking was steady.

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Circle (18) on Reply Card

Servicing excessive high voltage

Part 2

Operation and servicing of high-voltage regulators in solid-state color TV receivers are explained this month.

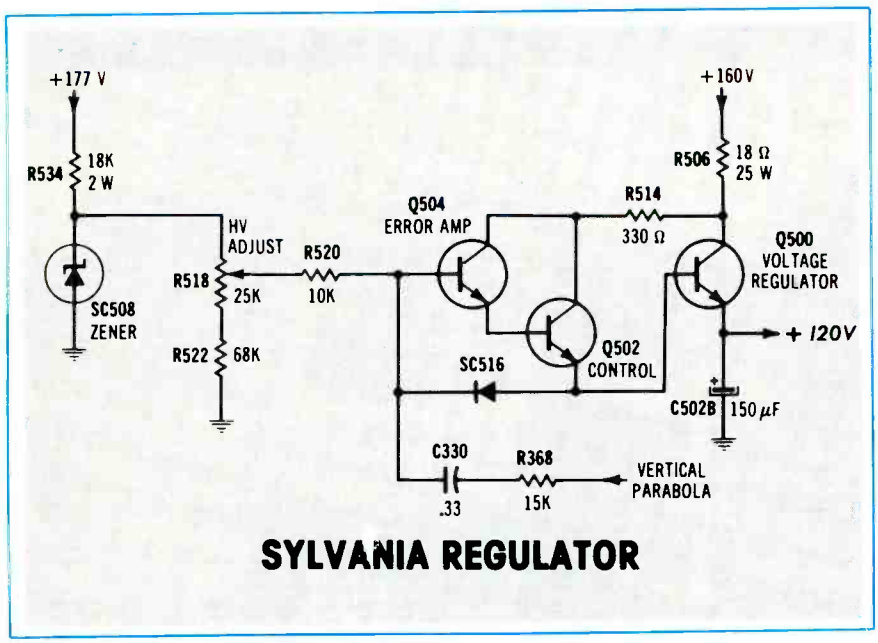


Figure 1 Sylvania E02 (Photofact 1324-3) regulates the high voltage by regulating the +120V supply that powers the collector of the horizontal-output transistor. Zener SC508 provides a stable reference voltage for R518, which adjusts the Q504 base voltage. Q504 and Q502 function as one transistor, but with a higher input impedance (Darlington stage). The Q502 emitter voltage tracks with the Q504 base voltage, thus supplying the needed positive voltage to the Q500 base. The regulated voltage comes from the Q500 emitter. When the load on the +120V supply varies, the resulting voltage change is a bias variation for Q500, so the transistor changes C/E resistance to restore the +120V emitter voltage. That is voltage regulation. The circuit has one more function: side pincushion correction. A sample of vertical-rate parabola is fed to the Q504 base. This signal varies the +120V supply voltage to a lower voltage when the scanning lines are at the top and bottom of the raster. Thus the side pincushioning produced by the wide-angle CRT is corrected.

By Homer L. Davidson and Carl Babcoke

In tube-equipped color receivers, the high voltage in most models is regulated by automatic variation of the horizontal load current. When the picture tube required increased current, the regulator-tube current was decreased to maintain a constant load on the horizontal-output stage. Or decreased CRT current was countered by increased regulator current. Although these systems provided excellent regulation, they were costly to build, required frequent tube replacements and consumed extra electrical power. Therefore, variable-current regulators were not included in solid-state horizontal-sweep systems.

When no high-voltage regulation circuits are provided, solid-state sweep and HV systems produce better high-voltage regulation than tube systems do. Small-screen models often have no high-voltage regulation circuits.

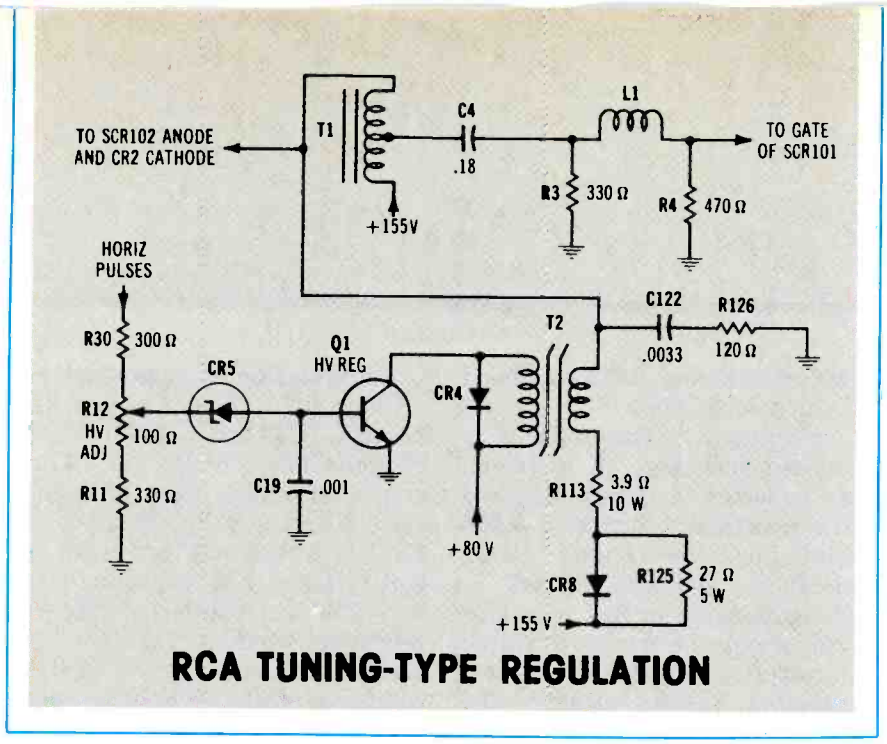


Figure 2 High-voltage regulation in RCA receivers that have trace and retrace SCRs is accomplished by Q1 collector current which varies the T2 secondary-winding inductance. The inductance is tuned primarily by C122, so the varying inductance changes the resonant point. In turn, the varying resonant point changes the SCR102 anode voltage. SCR102 anode voltage when conduction begins determines the horizontal power and high voltage.

Evidently the designers believe the moderate amount of picture-size variation will be tolerated in small receivers.

Larger solid-state models regulate the high-voltage sufficiently by regulating the B+ supply to the horizontal-output transistor (or SCR in some RCAs). Two basic types of regulation were common a few years ago. Voltage-regulation power transformers stabilized *all* ac voltages in models that included them. Other models regulated only the dc-voltage supply applied to the output transistor.

Also, regulation of the B+ supply for the horizontal-output transistor has been accomplished by several methods. One simple way is to use a large power transistor as a variable series resistance between rectified line voltage and the regulated B+. The disadvantages are that the transistor must dissipate considerable heat, a higher input voltage must be used and a shorted transistor will drastically increase the high voltage.

More efficient systems vary the amount of time during each horizontal cycle when power is gated to the output B+ supply. Examples of this method are found in new Zenith System-3 models (duty cycle of the output transistor is varied) and some new RCAs (those using an SCR to gate dc power). Explanations of the Zenith System-3 regulation system were given in October 1981 issue of **Electronic Servicing,** while the RCA SCR regulation was covered in the March and April 1980 issues. Practical servicing of other regulator systems will be discussed here in detail.

Sylvania E02

Horizontal-sweep and high-voltage regulation in the Sylvania E02 chassis is accomplished by regulation of the B+ that supplies the horizontal-output transistor collector (Figure 1). Zener SC508 provides a stable reference voltage that does not vary appreciably when the B+ voltage changes. HV-adjust control R518 is included to allow adjustment of the +120V regulated voltage, which in turn determines the high voltage. R518 provides the dc base voltage for Q504. Q504 and Q502 are connected as a Darlington current amplifier, having a very high input impedance and a low output impedance, and giving no voltage gain. The Q502 emitter drives the Q500 power-transistor base. Therefore, the Q500 base voltage is essentially the same as the dc voltage at the wiper of R518.

With an unchanging voltage at the Q500 base, any variation of the +120V supply at the Q500 emitter represents a change of Q500 bias. Therefore, the internal resistance is increased and decreased as necessary to maintain the +120V supply at a relatively constant voltage. A decrease of Q500 emitter voltage is a higher forward bias, which in turn decreases the C/E resistance and raises the emitter voltage. Of course, any increase of Q500 emitter voltage is a reduced forward bias that decreases the emitter voltage.

This circuit also has a secondary function: elimination of side pincushioning. A sample of vertical-rate parabolic signal (from the vertical-sweep circuit) passes through R368 and C330 to the Q504 base, where it adds to the dc-voltage bias. Polarity of the parabolic signal reduces the +120V supply when the horizontal-sweep lines are near the top of the picture and near the bottom of the picture but not near the center of vertical deflection. Values of resistors R520 and R368 produce the desired amount of pincushion correction. Therefore, these resistors should be tested when the side-pincushion correction is insufficient or excessive.

Defects in the regulation circuit can produce either lower or higher regulated voltage. Decreased +120V-supply voltage reduces the picture size and brightness. Extremely low supply voltages can

eliminate the raster, of course. Any of these symptoms indicate a need for checks of the +120V supply.

Increases of the regulated voltage are more likely to produce damage to other components. Sometimes the first hint of a regulator problem is a shorted horizontal-output transistor, a shorted tripler unit or arcs around or inside the picture tube. Again, these symptoms call for measurement of the +120V supply.

The most likely causes of excessive +120V-supply voltage are a collector-to-emitter short in Q500 or an open SC508 zener diode. Other possible sources are a shorted Q504 or Q502, an open R522 or a shorted R534 combined with an open SC508.

Low voltages can be produced by increased resistance in R534, an open collector in Q504, increased R514 resistance, increased R506 resistance, decreased R522 resistance or leakage in SC508.

Measurements in this regulator circuit should be made with a dc voltmeter and an ohmmeter. Remember, always measure the +120V supply voltage *first* when any symptom hints at horizontal or vertical sweep problems. After the receiver is repaired and the +120V supply voltage adjusted correctly, the high voltage should be checked to make certain it is within proper limits.

Regulation by resonance

Older RCA color receivers (between CTC40 and CTC68) that included two SCRs or ITRs employed a rare form of regulation. As shown in Figure 2 for CTC46, a resonant (or tuned) circuit is formed by capacitor C122 and the inductance of the T2 secondary winding. This tuned circuit is shorted-out when SCR102 conducts. When SCR102's anode current ceases suddenly, a damped wavetrain (sinewaves that decrease in amplitude) is created at the SCR102 anode. However, before less than a half cycle of ringing wavetrain has occurred, SCR102 again conducts, ending the ringing. The sequence is

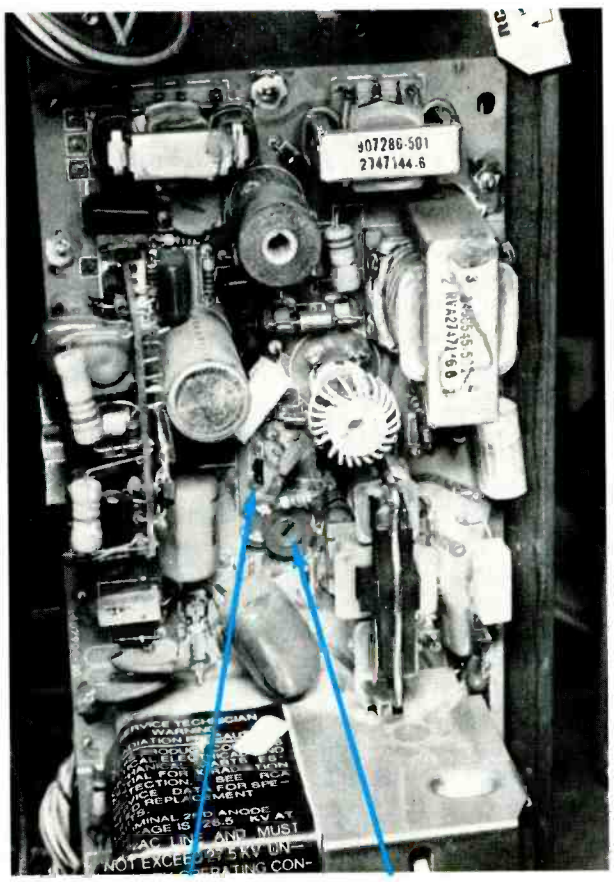
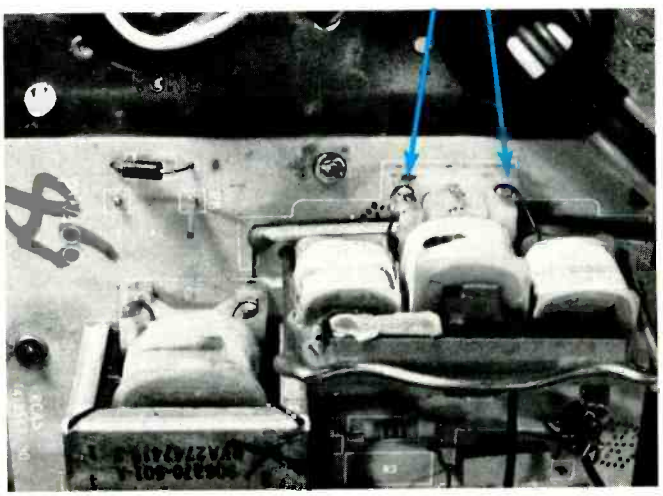


Figure 3 On the RCA CTC46 PW400 circuit board, the arrow at left points to CR5, while the arrow at right identifies the high-voltage-adjust control location.

Figure 4 Arrows point to two lugs on the T2 regulator transformer where bad soldering joints are likely to be found by visual examination on the board's wiring side. In fact, it is wise to check all transformer joints on the entire board. These have caused many problems in the past.



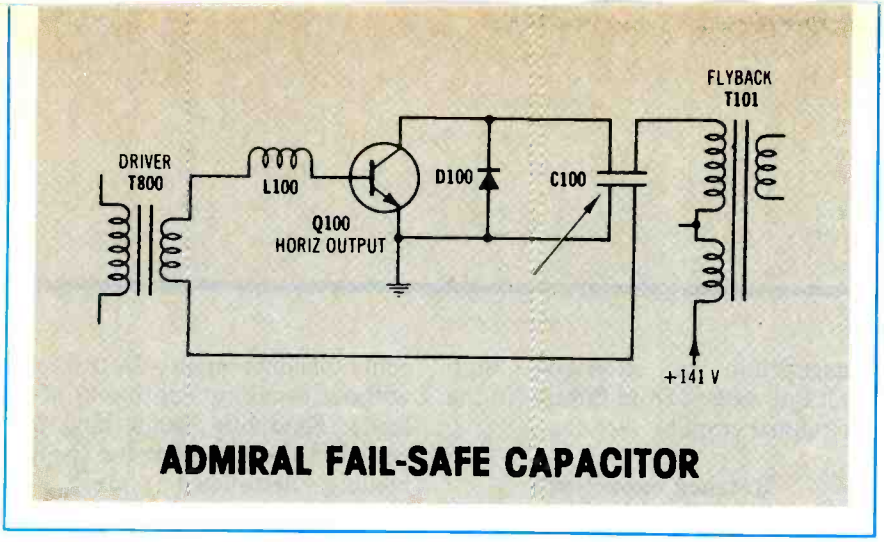


Figure 5 Retrace-tuning capacitors with four leads are used in many color receivers now for safety reasons. If an open occurs in either internal plate of C100, the output stage is weakened or killed, thus preventing operation of the receiver until it is properly repaired. Carefully select a replacement capacitor. See text for details.

repeated each horizontal cycle.

Regulation is produced by adjustment of the peak voltage at the SCR102 anode when it begins to conduct. This peak voltage is varied as needed by automatic adjustment of the T2 inductance. Increased Q1 collector current decreases the T2 inductance (decreased current increases the inductance). Decreased T2 inductance raises the tuned frequency (increased inductance lowers it). A higher tuned frequency allows the peak voltage to decrease more before SCR102 conducts, thus reducing the horizontal power and high voltage. A lower tuned frequency does not allow so much drop of peak voltage before SCR102 conduction begins, thus the horizontal sweep has more power and higher high-voltage.

Given those conditions, it is necessary only to provide a way for the Q1 collector current to increase with higher sweep power and HV. This is done by applying horizontal pulses and dc voltage from the flyback to the R30/R12/R11 variable voltage divider. Adjustable output from R12 high-voltage control passes through zener diode CR5 when the positive peak voltage exceeds the zener rating. The positive pulse signal reaches the Q1 base where it produces C/E current. Therefore, a higher pulse-and-dcV signal from the flyback increases the Q1 C/E current, decreasing the T2 inductance, raising the tuned frequency and reducing both the horizontal-sweep power and the high voltage.

This method of regulation, as used in the CTC58 chassis, was explained in the March 1976 issue of **Electronic Servicing.** In the present article, the operation has been simplified by omission of several auxiliary capacitors and inductances. Even so, the theory is correct.

The SCR-sweep circuit has many resonances and therefore is greatly affected by the operating frequency that is determined by the horizontal oscillator. Therefore, many mysterious problems (when there are no defective components in the SCR circuits) can be solved by replacing the oscillator module or restoring the horizontal oscillator to the correct frequency.

When an RCA CTC46 chassis is operating correctly, it is very easy to adjust the high voltage. Connect a high-voltage probe to the picture-tube anode and ground it securely to the CRT shield, turn down the brightness to eliminate the picture, and rotate high-voltage-adjust control R12 (shown in Figure 3) to obtain 26.5kV on the high-voltage meter.

The CTC46 has a safety circuit that prevents horizontal locking when the high voltage is excessive. If the horizontal cannot be locked, first measure the high voltage. Repair or adjust the high-voltage regulator or sweep circuits as needed to restore normal high voltage, before checking the horizontal-oscillator circuit. Failure to lock is one result of excessive high voltage.

One critical component in the regulator circuit is zener CR5. When the high voltage is intermittent (or the picture erratically goes out of lock), give CR5 a heat/cold test by warming it and then spraying canned coolant on it. Any reaction during this test is sufficient reason to replace CR5 with a new one. Use an RCA replacement or substitute a universal 6.8V zener of 1W rating. Do not replace with one of another wattage.

The following are the approximate high voltages expected with different zener diodes:

Zener Voltage	High Voltage	Symptom
5.6V	20kV	Narrow pix
6.2V	24kV	Normal
6.8V	26kV	Normal
8.2V	29kV	No locking

The previous information assumed a normal line voltage of 120Vac. If the high voltage is left at the top of tolerance, a sudden increase of line voltage can trigger loss of horizontal locking. Use a variable-line-voltage transformer or autoformer when checking for this possibility. Increase the line voltage to at least 125V. If the horizontal jumps out of lock at the higher voltage, repair or readjust the high-voltage regulator.

Erratic contact inside R12 high-voltage adjust control at the wiping contact can vary the high voltage and produce intermittent horizontal locking. In that event, clean or replace R12.

Defects in Q1 high-voltage-regulator transistor or CR4 (across T2 primary) also can cause loss of high voltage or produce ex-

cessive high voltage. They should be removed from the PW400 board for accurate tests out-of-circuit.

Loose solder connections at the lugs of T2 regulator transformer (Figure 4) probably are the most common causes of intermittent raster or excessive high voltage that causes loss of horizontal locking (from the safety circuit). Visual examinations of the wiring side of PW400 board can usually locate bad joints far quicker than meter tests can. Most of these soldered joints were normal when the board was manufactured, but they become defective with time because of strains from heat and cold cycles. Also, the high currents there tend to make the joints brittle, producing cracks.

It is good practice to observe that board area through a magnifying lens while you flex the board slightly. This will force any cracks to expand and contract enough to be seen. Of course, the joints should be resoldered carefully. Melt away the old solder or remove it with a vacuum device, add a small amount of noncorrosive soldering paste, and resolder carefully with high (but not excessive) heat. A temperature-controlled iron is recommended to prevent board damage.

Incidentally, the Figure 2 schematic shows wiring and several components that can produce puzzling symptoms. A signal from the T1 tap is filtered and phase shifted by C4, R3, L1 and R4 before it reaches the gate of trace SCR101. An open in L1, C4 or a crack in the wiring can reduce the drive amplitude but allow enough signal at the SCR101 gate to produce false triggering. A narrow raster is obtained, but with erratic flashing lines and several inches of foldover in the horizontal center of the screen. Use an ohmmeter to locate the open, and repair it.

These RCA sweep circuits having retrace and trace SCRs are not susceptible to excessive high voltage, except from failures in the regulator circuit.

Retrace capacitors

The possibility of excessive high voltage (up to 50kV at low brightness) is present in all horizontal-sweep circuits that use a single power transistor to drive the yoke and flyback. Each of these circuits has an appreciable total capacitance (ranging from 0.005μF to 0.01μF) connected between collector and emitter of the output transistor. Models manufactured several years ago often included three or four capacitors connected in parallel.

There were two reasons for using several capacitors, rather than just one of the proper value. First, if one capacitor became open, the high voltage might rise 2kV or 3kV, but not enough to trigger arcs or damage other components. Each capacitor was wired to a different point physically (although electrically in parallel) to prevent a capacitor bad ground from giving the effect of an open in all capacitors. Second, the use of several paralleled capacitors allowed the manufacturer an easy way to vary the high voltage for various sized picture tubes. A smaller capacitance increased the HV to the higher level needed for larger screens.

Later, most manufacturers began using a single capacitor of the required total capacitance. However, each capacitor was a four-wire safety type, as shown in Figure 5. According to the rationale, if an open developed inside the capacitor plates or in any of the external wires, it would open the collector or emitter circuit of the output transistor and completely eliminate the horizontal sweep and high voltage.

In most cases, this safety feature has been effective. However, Zenith learned the hard way a few years ago that these capacitors could become open electronically without breaking continuity of the leads. Evidently, something happened to the dielectric (or the self-healing metallized plates). The high voltage climbed to almost 50kV, often ruining the picture tube from powerful internal arcs, shorting the horizontal-output transistor (the collector pulses also increased in proportion to the HV change), and sometimes ruining the tripler or the flyback transformer.

Therefore, all technicians should remember to *check these retrace-tuning capacitors when the high voltage is excessive.*

Those capacitors that parallel the transistor and damper diode are properly called *retrace-tuning capacitors* because they affect the performance only during retrace time. During deflection of the CRT electron beam from center of the screen to the right edge, the output transistor is drawing current, so it is a virtual short circuit across the capacitors during the second half of trace. During retrace from the right edge of the screen to the left, neither the damper nor the output transistor is conducting. The retrace capacitors form a resonant circuit with the yoke and flyback total inductance during retrace time. Larger capacitances reduce the ringing (horizontal pulse) amplitude, thus giving reduced high voltage. Smaller total circuit capacitances increase or multiply the ringing amplitude, giving high excessive high voltage. During the first half of trace (from the left edge to the center of the CRT screen), the damper diode is conducting. This gives the equivalent of a short circuit across the retrace-tuning capacitors, again leaving them without any effect on the operation.

Several minor variations of the 4-wire safety capacitor have been used. In Figure 5, the Admiral chassis 10M55 (Photofact 1830-1) does not channel the emitter cur-

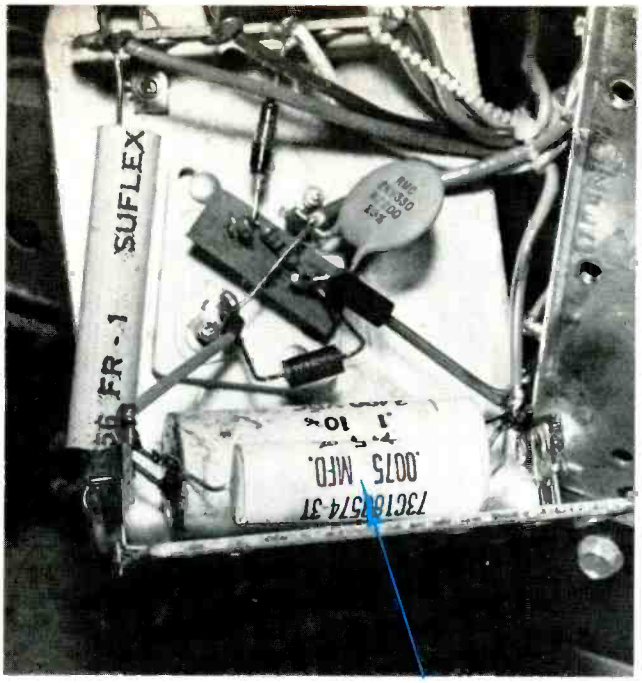
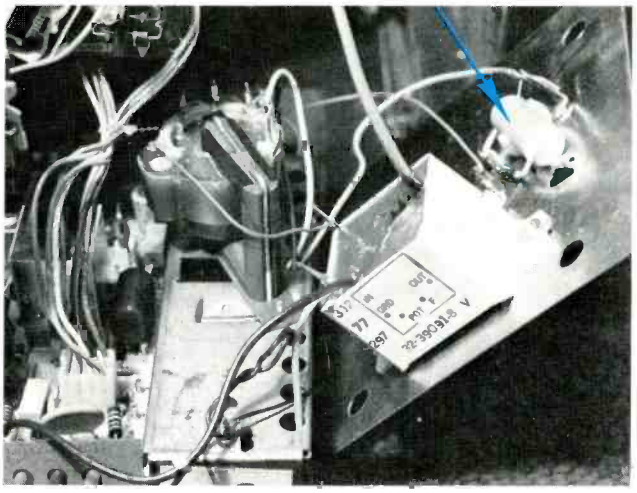


Figure 6 The arrow points to a 2-wire retrace-tuning capacitor in a color chassis (probably an older General Electric). These capacitors usually are connected in parallel with the damper diode.

Figure 7 The 4-wire safety-type capacitor in a Sylvania color receiver is identified by the arrow.



rent through the 4-wire capacitor (as is done in most other models). Instead, the cold end of the T800 base-drive transformer winding returns to the Q100 output-transistor emitter through two capacitor wires. An open circuit between those two wires would greatly reduce the amplitude of drive signal to the Q100 base, decreasing the high voltage, and probably giving center foldover as well.

A conventional 2-wire 0.0075μF retrace-tuning capacitor is shown in Figure 6. A 4-wire capacitor is pointed out by the arrow in Figure 7.

These retrace-tuning capacitors are subjected to high-amplitude spikes of voltage, requiring ratings of 2kV for any replacements. Also, high currents at fast repetition rate flow through them. Not all general-replacement capacitors can meet these specifications, and they could fail prematurely. Therefore, it is recommended that any replacement capacitor should be either from the original manufacturer or a replacement designed especially for these severe conditions.

Comments

Excessive high voltage should be suspected whenever sustained arcing is present in picture tube, tripler or flyback. Also, excessive high voltage in a suspect in the failure of a horizontal-output transistor that develops a collector-to-emitter short.

The first diagnostic step is to determine the type of high-voltage regulation used in the brand and model of color receiver being repaired. If tube-type shunt regulation is used, the regulation circuit should be tested as discussed last month in part 1. If the high voltage is stabilized by regulation of the B+ supply for the horizontal-output transistor, the regulated-supply voltage should be measured first. This also applies to the newer RCA circuit that uses one SCR to regulate by gating current through the SCR for varying lengths of time during each horizontal cycle. In most cases, the regulated voltage can be measured at the output-transistor collector (or the collector pin of the socket, if the transistor has been removed). Then, if the regulated voltage is too high, the regulator circuit must be repaired before the high voltage is given a final adjustment.

With models that do not regulate the B+ supply voltage (or after the B+ regulator has been cleared from suspicion), the next cause of excessive high voltage is one or more retrace-tuning capacitors. Ideally, each capacitor should be tested by disconnecting one wire (two if there are four wires) to isolate it from other components. Then it should be tested for precise capacitance. Remember, this value is critical in almost all cases. If the capacitor is open, shorted or leaky, you should install a new exact-replacement type.

After all defective components have been replaced, the effects of regulator adjustments on the high voltage should be checked. With a high-voltage probe properly connected to CRT anode and ground, rotate the high-voltage adjust control and notice the lowest and highest voltages obtained. If the limits and range of the high-voltage are acceptable, adjust the control for either the recommended high voltage or the specified regulated voltage, according to manufacturer specifications.

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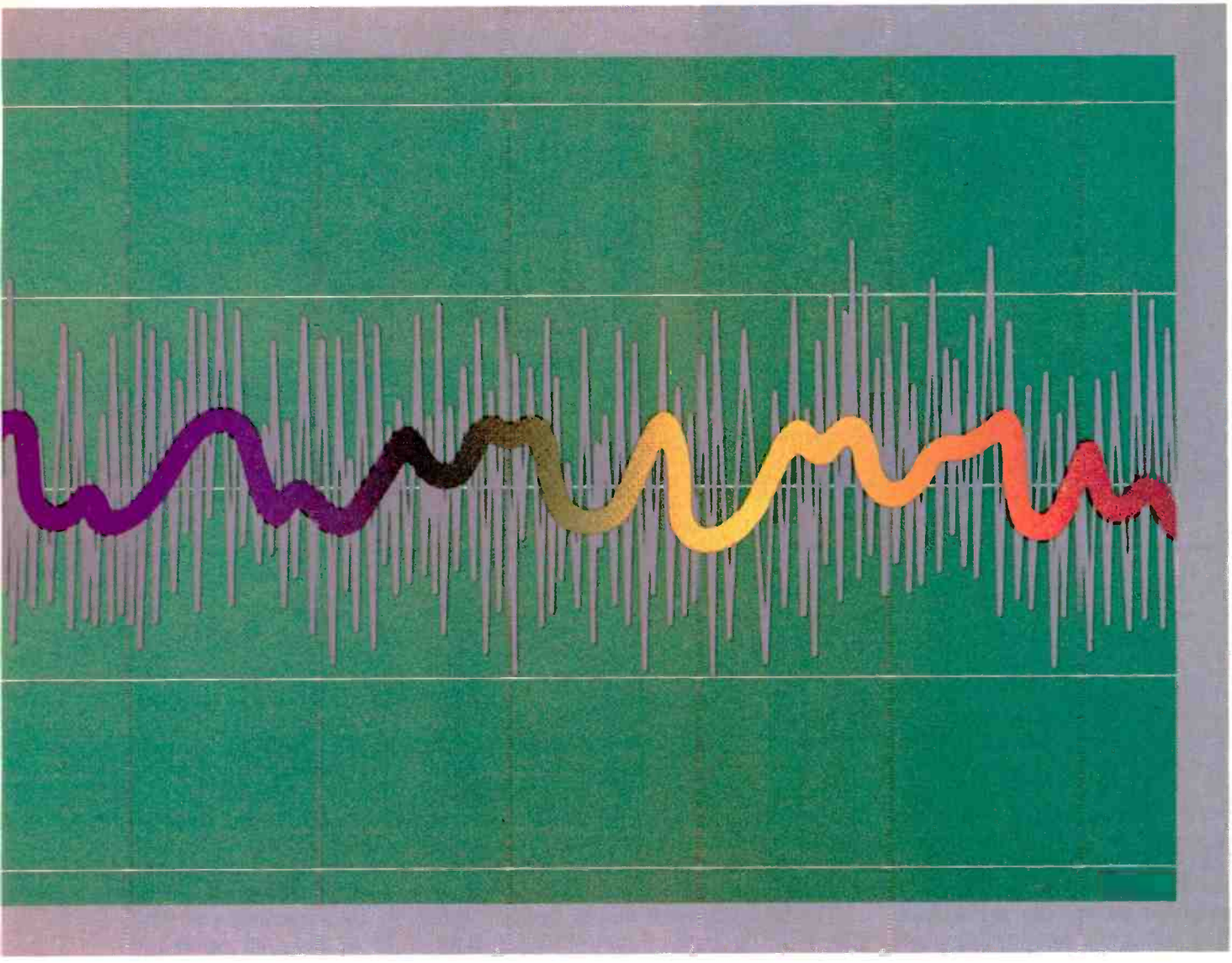


Audio noise reduction and masking

By Martin Giles, manager – Consumer Linear Applications, National Semiconductor Corporation, Santa Clara, CA

Illustrations courtesy National Semiconductor Corporation.

Audio noise reduction systems can be split into two major divisions – the complementary type involving signal encoding before transmission or recording, with decoding performed on playback, and the noncomplementary or single-ended type, which operates on playback only and does not require signal encoding.

For consumer equipment, the most popular system has been the complementary-type Dolby B, which is a low level compandor-based system. Other compandors are now becoming available with the introduction of integrated circuits such as the Telefunken U-401B IC for HiCom and HiCom II, and the LM1111 from National Semiconductor for Dolby C, which now offers more noise reduction by cascading two Dolby B-type circuits. On the noncomplementary or single-ended side, we have a new

IC, the LM1894 from National, which operates on the same principle as Burwen's Dynamic Noise Filter.

Compandor limitations

Although either type of system is capable of producing a significant reduction in the audible noise level, compandors are inherently capable of the largest reduction and, as a result, have found the most favor in studio-based equipment. This would appear to give compandors a distinct edge when it comes to translating noise reduction systems from the studio to the consumer marketplace. Yet there are certain aspects of the consumer marketplace that tend to counterbalance this advantage.

The first, perhaps most obvious, problem is that of cost. Studio compandors, to avoid audible control problems such as transient overloads and noise pumping, divide the audio frequency spectrum into multiple bands with circuits optimized to each individual band. Such a costly approach is not well suited to consumer applications. To translate Dolby A from the studio to the consumer version meant reduction from four frequency bands down to a single frequency band. A similar reduction occurred with Telefunken's Telecom C4 in the development of the consumer version, HiCom. Although extensive use of custom integrated circuits has helped, the cost per channel is still high and can involve use of close tolerance external components.

A second major problem is compatibility. It is difficult to get the consumer to accept an innovation when it obsoletes the equipment that he may have recently purchased. This problem should be considered in the context of the program material rather than the design of the actual playback unit.* If, in order to realize a significant reduction in audible noise levels, the program material is encoded to such an extent that undecoded playback is unacceptable, then the system faces a formidable obstacle to becoming widely used. The Dolby B system successfully avoided this by using a relatively small degree of compression for low level, high frequency signals only. A reduction in noise by 9-10dB (weighted) proved to be enough to make audio cassettes part of most hi-fi systems and prerecorded, encoded tapes could be satisfactorily played on non-Dolby equipped playback systems. In fact many listeners, particularly those with more modest speakers, prefer the emphasized high frequency content of Dolby encoded tapes. Compandors with high compression levels (HiCom with 30dB or Dolby C with 20dB) produce tapes that must be decoded for satisfactory playback and therefore face a period of time for which most prerecorded material will not be encoded.

A third limitation of compandors, from the consumer viewpoint, is that many sources are not encoded at all – radio broadcast and the vast majority of phonograph discs for example. Also compandors are designed to prevent the tape from adding *more* noise to the program material. They are not designed to eliminate noise that is already present in the source. When the need is to remove or reduce the level of noise present in the program material, a noncomplementary type of noise reduction system is the only effective alternative. Because source encoding is not required, full compatibility will be obtained.

DNR** is a noncomplementary noise reduction system based on a single integrated circuit, the LM1894, which gives up to 14dB noise reduction in stereo program material. The operation of the IC is dependent on two principles: that the noise output is proportional to the system bandwidth, and that the desired program material is capable of "masking"

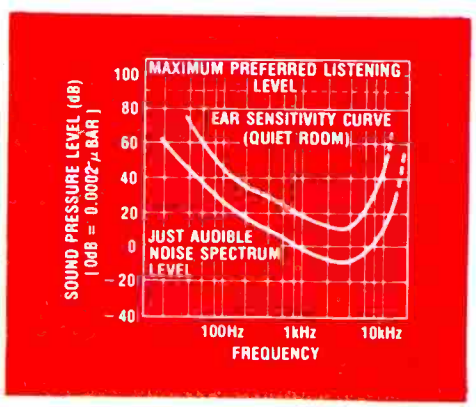


Figure 1. Typical hearing threshold level for pure tones (quiet room).

*One of the most prominent examples of this occurred during the early '60s in the United States with the conversion from monochrome to color TV broadcasting. The NTSC encoding system had to provide *compatible* monochrome TV reception for all the monochrome receivers then in existence.

**"DNR" System is licensed to National Semiconductor Corporation under U.S. Patent No.'s 3,578,146 and 3,753,159.

the noise when the signal-to-noise ratio is sufficiently high. DNR automatically and continuously changes the system bandwidth in response to the amplitude and frequency content of the program. Restricting the bandwidth to less than 1kHz reduces the audible noise and a special spectral weighting filter in the control path ensures that the bandwidth is always increased sufficiently to pass any music that may be present. Because of this ability to analyze the auditory masking qualities of the program material, DNR does not require the source to be encoded in any special way for noise reduction to be obtained.

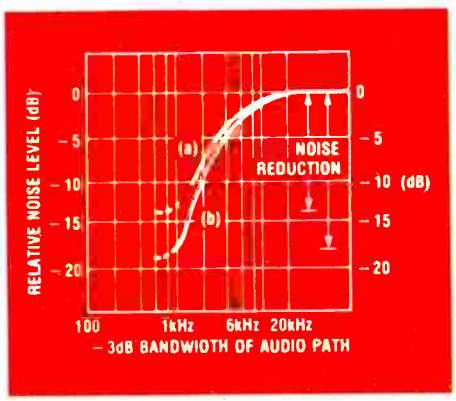


Figure 2. Reduction in noise level with decreasing bandwidth. (a) DNR configured as a single-pole, low-pass filter (-6dB/octave). (b) DNR configured as a 2-pole, low-pass filter (-12dB/octave). (Cassette tape noise source—CCIR/arm weighted measurement.)

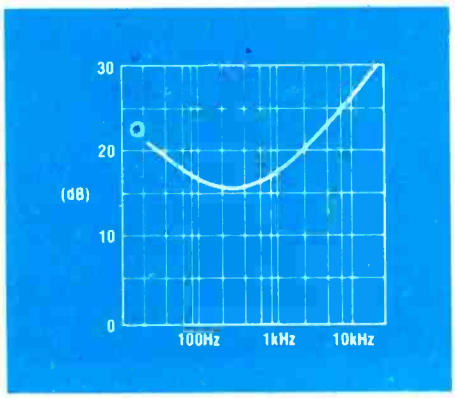


Figure 3. Difference between tone intensity and noise spectrum level at the tone frequency for masking.

Auditory masking is not a newly discovered phenomenon. It has been investigated for many years, primarily in connection with noise masking the ability of the listener to hear tones. These measurements have been made under steady-state conditions and are reasonably quantitative, but in the case of music or speech the program material can be described as anything but steady-state. Unfortunately this means that the data on masking for transient conditions are more qualitative and less repeatable. Even so, several broad conclusions can be drawn from the available data, which will help us in an evaluation of the effectiveness of DNR in suppressing audible noise.

Noise reduction by bandwidth restriction

The first principle upon which DNR is based—that a reduction in system bandwidth is accompanied by a reduction in noise level—is rather easy to show. If our system noise is assumed to be caused solely by resistive sources then the noise amplitude will be uniform over the frequency bandwidth. The total or aggregate noise level e_{NT} is given by the formula:

$$\bar{e}_{NT} = \sqrt{4KTBR} \qquad (1)$$

Where K = Boltzmanns constant, T = absolute temperature, B = bandwidth, and R = source resistance.

At any single frequency, the amplitude measured in a bandwidth of 1Hz is e_n, and therefore

$$\bar{e}_{nT} = \bar{e}_n \sqrt{B} \qquad (2)$$

This shows that the total noise, and hence the signal-to-noise ratio, is directly proportional to the square root of the system bandwidth. For example, if the system bandwidth is changed from 30kHz to 1kHz, the aggregate signal-to-noise ratio changes by

$$20\log_{10}\sqrt{1 \times 10^3} - 20\log_{10}\sqrt{30 \times 10^3} = \underline{-14.8dB}$$

In actual practice, we may neither measure nor hear an almost 15dB reduction in noise with this

bandwidth change. Most audio systems have a generally smooth noise spectrum similar to white noise, but the amplitude is not necessarily uniform with frequency. In audiocassette machines where the dominant noise source is the tape itself, the frequency response does not always extend much past 12kHz. On the other hand, the frequency range of the noise spectra is not always indicative of its obtrusiveness. The ear is most sensitive to noise in the frequency range from 600Hz to just above 6kHz. (Figure 1) Because of this, a weighting filter inserted into the measurement system, which gives emphasis to this frequency range, produces better correlation between the signal-to-noise "number" and the subjective impression of noise audibility. Generally speaking, for cassette machines the combination of the tape noise spectrum and a weighting filter such as CCIR/ARM will yield noise reduction numbers between 14dB and 18dB when the system bandwidth is restricted to 1kHz with single-pole and 2-pole low-pass filters.(Figure 2)

Auditory masking

The second principle upon which DNR is based is also simply defined—whenever one sound is being heard it reduces the ability of the listener to hear another sound—but this is not as easily quantified. In the case of steady-state white noise masking the audibility of pure tones, useful and repeatable data is available. White noise raises the threshold of hearing for pure tones by a level that is dependent on the frequency of the tone. A curve showing this increase in the audible threshold is shown in Figure 3.

Another way of interpreting this curve is to assume that the tone becomes just audible at an energy level that matches the energy of the noise spectra contributing to the masking effect. Therefore the conversion factor (in decibels) at a given frequency can be translated to the band of frequencies of the noise spectra contributing to masking. For example, from Figure 3, at 1kHz the threshold increase is 17dB, which is equivalent to a frequency band (From Eq. 2) of 63Hz—at 10kHz the critical bandwidth is 500Hz. The curve shows a general trend. At higher frequencies, the tone has to be increased in amplitude compared to a 1kHz tone in order to be heard. More noise spectra are contributing to masking as the frequency goes up. Although not equally apparent from the curve, only noise spectra in a frequency band centered on the tone contribute to masking that tone.

These results are well supported by the physical evidence. The hearing mechanism in the ear in-

The LM1894 is a stereo noise reduction circuit for use with audio playback systems. The DNR system is noncomplementary, meaning it does not require encoded source material. The system is compatible with virtually all prerecorded tapes and FM broadcasts. Psychoacoustic masking and an adaptive bandwidth scheme allow the DNR to achieve 10dB of noise reduction. DNR can save circuit board space and cost because of the few additional components required.

Typical Application:

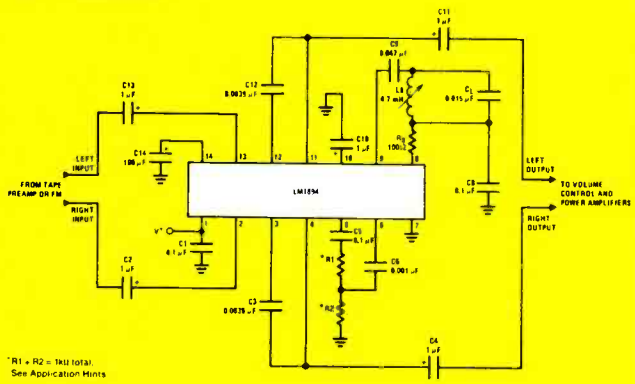


FIGURE 1. Component Hook-Up for Stereo DNR™ System

Features

- Noncomplementary noise reduction, "single ended"
- Low cost external components, no critical matching
- Compatible with all prerecorded tapes and FM
- 10dB effective tape noise reduction CCIR/ARM weighted
- Wide supply range, 4.5V to 18V
- 1Vrms input overload
- No license requirements

Applications

- Automotive radio/tape players
- Compact portable tape players
- Quality hi-fi tape systems
- VCR playback noise reduction
- Videodisc playback noise reduction

volves the basilar membrane, which is approximately 30mm long by 0.5mm wide. The nerve endings giving the sensation of hearing are spaced along the membrane so that the ability to hear at one frequency is not masked at another frequency when the two frequencies are well separated. White noise can excite the entire basilar membrane because it has spectral components at all frequencies. For any single frequency therefore, there will be a band of noise spectra capable of simultaneously exciting the nerve endings that are responding to the single frequency – and masking occurs.

When we reverse these results to assess the ability of tones (i.e., the desired program material) to mask the undesired noise, things are not as straightforward. A single tone will stimulate only a specific part of the basilar membrane and will be unable to mask the stimulation of other sections caused by the presence of broadband noise. Experimental measurements of the ability of pure tones to mask noise show that extremely high sound pressure levels (SPLs) are required to raise the noise threshold level and provide masking. The most effective tone frequencies are between 700Hz and 1kHz, near the natural resonance of the ear, and even then SPLs higher than 75dB are needed for masking noise at a 16dB SPL. However, this data applies to pure tones – as soon as the tone acquires distortion, frequency modulation or transient qualities, the masking ability increases dramatically. Typical music and speech can be regarded as excellent masking sources. The broadband spectral components and high concentration of energy around 1kHz for most musical instruments (Figure 4) improves the noise masking ability by more than 30dB compared to a pure 1kHz tone. By comparing the frequency spectrum of musical instruments with the ear sensitivity curve (Figure 1), we can see that this high energy content is precisely where it needs to be to provide effective masking. Most of the ear's subjective response to noise is within the region from 1kHz to 6kHz. Above 6kHz the response of the ear decreases rapidly.

From all of this we can conclude that if the source material is at least 29dB above the noise floor, adequate masking will usually be obtained. Therefore a noise reduction system that can dynamically restrict the audio bandwidth will ensure that this source signal-to-noise is perceived to be better than 43dB without audible impairment of the music. In the instance of a conservatively recorded cassette tape with the mean signal level of about -10VU (40-45dB) above the noise), the noise reduction system can improve this to a perceived signal-to-noise of 55dB to 60dB. At 0VU, the improvement can be a signal-to-noise ratio of better than 65dB.

DNR – Audio filters

Armed with this data, a noise reduction system designer would probably not take very long to come

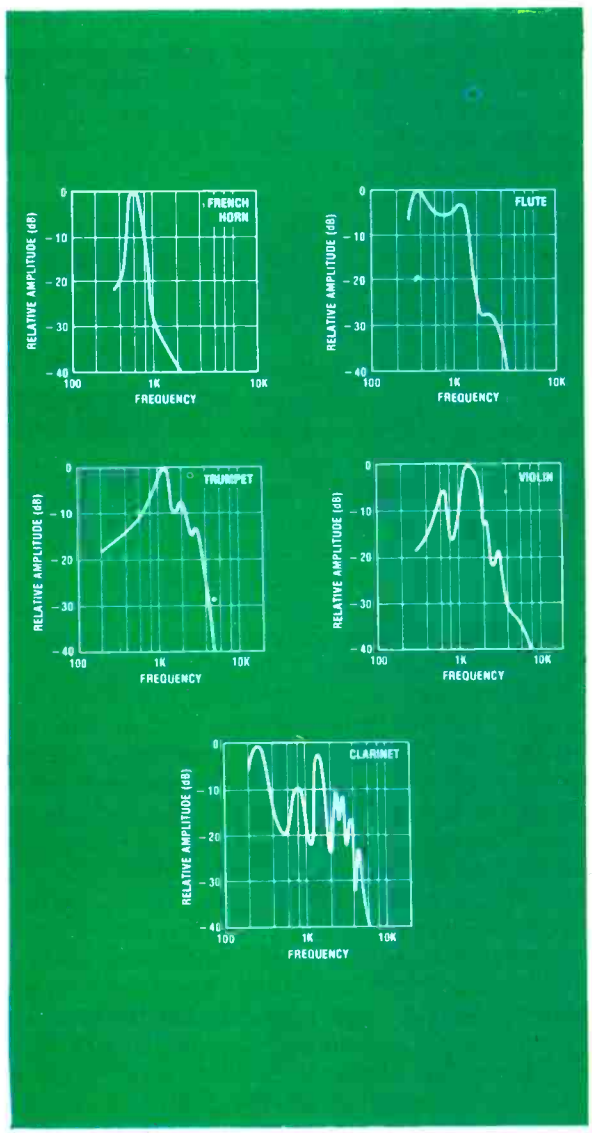


Figure 4. Typical spectrums of musical instruments.

up with a system block diagram similar to that shown in Figure 5(a). This is, in fact, the general arrangement of DNR. Two low-pass filters (for stereo) are placed in the audio path with -3dB bandwidths controlled by the amplitude and frequency of the incoming signal. Both low pass filters are inherently well matched because they are implemented on the IC chip. Each filter response is flat below the cut-off frequency (f-3dB) with a smooth single-pole roll-off above the corner for any control setting. This -6dB/octave slope produces the most satisfactory results with modern and classical music possessing a wide frequency range. Steeper slopes are capable of producing a larger noise reduction for a given bandwidth but are more suited to material that does not have a substantial high frequency content. Cascading the two filters in a single DNR IC will give a -12dB/octave slope – at the same time the minimum bandwidth corner frequency for each filter should be increased by a factor of 1.56 so that the resulting 2-pole low-pass filter still has a minimum -3dB bandwidth at 800Hz. Now the noise reduction can be as much as 18dB (Figure 2)

DNR – Control Path

Although the block diagram of Figure 5a is fairly obvious, the precise composition of the side chain is not. A first approach might be simply to provide a wideband gain block driving a peak detector circuit. Because the spectra of musical instruments and the ear sensitivity curve (Figure 5b) imply that masking is most effective at relatively low frequencies, a reasonable filter for the control path might be low pass. This is *not* the case as shown by Figure 6, which gives the frequency/amplitude response of the DNR IC control path. DNR uses a *high pass* filter with a -3dB corner at 6kHz and a -12dB/octave roll-off slope. An optional notch at 19kHz is included when the source material contains the FM pilot tone, which would otherwise increase the minimum bandwidth above 800Hz when the detector threshold is set at the noise floor.

The control path amplitude/frequency response is weighted in this way because the program material will vary substantially in harmonic content, depending both on the relative loudness and on the particular instruments being played. To take a worse case situation (from the viewpoint of masking), when a French Horn is the dominant source, most of the energy is at frequencies below 1kHz. If we were detecting this energy through a low-pass filter, the control path would respond to the high amplitude and cause the audio filters to open to full bandwidth. Noise in the 2kHz and above region would be promptly unmasked and audible. To avoid this, DNR instead looks for high frequency energy in the music source and uses the presence of this energy to control the audio bandwidth. In the case of the French Horn, the absence of higher frequency harmonics means that only a small increase in audio bandwidth

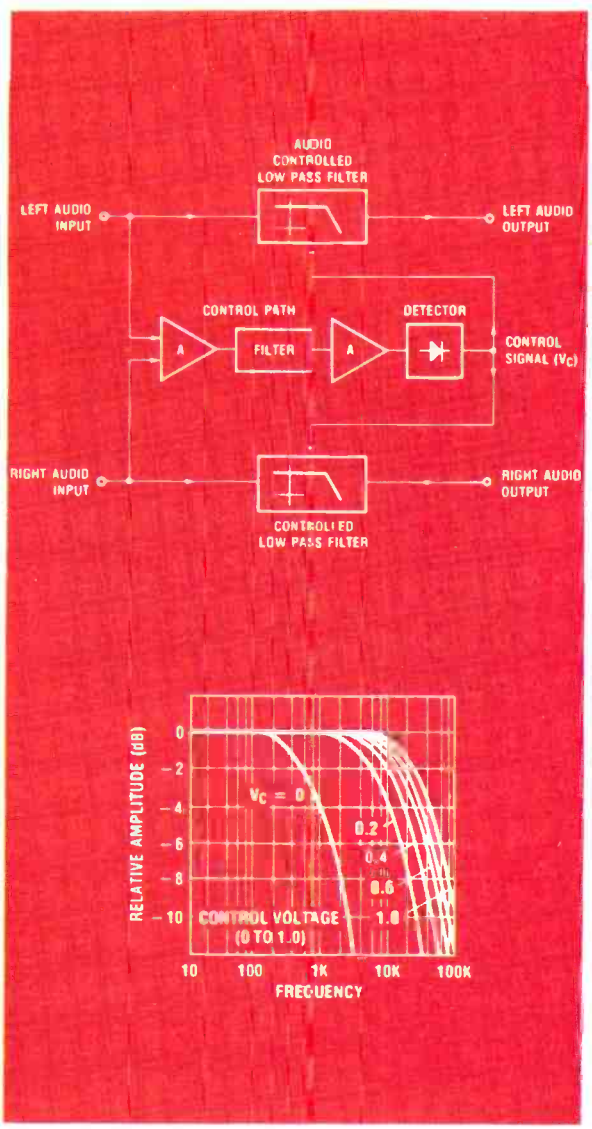


Figure 5a. (Top) Stereo noise reduction system.
Figure 5b. Audio controlled filter response.

would occur (depending on the sound level), and the noise would remain filtered out. Contrasted with this, multiple instruments, or solo instruments such as the violin or trumpet, can have significant energy levels at frequencies above 1kHz that not only provide masking but also require wider audio bandwidths for fidelity transmission in the audio path.

Put another way, when the presence of high frequencies is detected in the control path, we know that simultaneously large levels of energy are present in the critical masking frequency range. Therefore the audio bandwidth can be safely increased as necessary to prevent audible impairment of the music while the noise remains completely masked. To compensate for the relatively fast decrease in spectral energy with increase in frequency, the control path response is increased at 12dB/octave. A careful combination of the low frequency -3dB corner for the high pass filter and the ability to adjust the control path midband gain allows DNR to accommodate a wide variety of music sources.

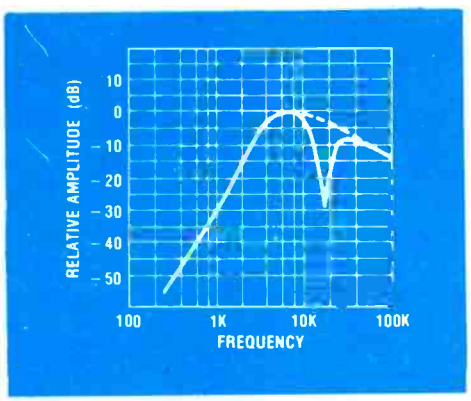


Figure 6. Frequency/amplitude response of DNR control path.

Transient response

Even with the control path frequency/amplitude response optimized for our music source masking capabilities, the design of the control path is not yet completed. If the detector is allowed to respond instantaneously to any input signal, ticks or noise bursts that are short duration but with fast rise times would be able to force the audio bandwidth open without concomitant masking. The slower detector fall time (discussed later) will keep the audio bandwidth increased appreciably longer than the duration of the noise burst, converting it from a "click" to a midfrequency "thump." Even so, if the detector cannot respond to the leading edge transient in the music, then distortion in the audio path will be the result of the initial loss of high frequency components.

As might be expected, the rise time of any musical selection will again depend on the instruments that are being played. An English horn is capable of reaching 60% of its peak amplitude in 5ms. For other instruments, rise-times can vary from 50ms to 200ms, whereas a hand clap can be as fast as 0.5ms. With this data in mind, DNR has been designed with an attack time of 0.5ms in order to minimize any potential loss of high frequency transients – but this does mean that the system is susceptible to impulse noise interference.

Impulse noise, characterized by fast rise and fall times and large high frequency energy, requires other electronic techniques for its satisfactory elimination. A distinction should be made in the audible effects of long detector attack times for DNR compared to a companding noise reducer. If the compandor does not respond immediately to an input transient, then instantaneous overload of the audio path can occur, with an overshoot amplitude as much as the maximum compression. Depending on the audio amplifier recovery time, this overload could cause audible effects lasting longer than the period of the overshoot. The DNR filters simply cannot produce such an overshoot by failure to respond to the input rise time. Because the ear has difficulty registering sounds of less than 5ms duration and can tolerate severe distortion if it lasts less than 10ms, DNR has considerable flexibility in the choice of detector attack time.

Attack time is only half the story. Once the detector has responded to a musical transient, it needs to decay back to the quiescent output level at the cessation of the transient. Again a compromise in parameters is required. A slow decay time would mean that for a period following the end of the transient the system bandwidth would still be relatively wide. The noise in this bandwidth would not be masked and a noise "burst" could be heard at the end of each musical transient. Conversely, if the decay

time is increased to ensure a rapid decrease in bandwidth, a loss in musical "ambience" will occur with the suppression of harmonics occurring at the end of a large signal transient. To avoid this, DNR uses a natural decay to within 10% of the final value in 50ms. The inability of the ear to recover sensitivity for 100ms to 150ms following a loud sound, prevents the noise that is present (until the bandwidth is closed down) from being heard. DNR takes similar advantage of psychoacoustics for handling signal dynamics as it does for steady-state masking.

System measurements

Although the major thrust of this article was to describe the relationship between auditory masking phenomena and the operation of DNR, some comments on system measurements are worthwhile. The presence of noise is not necessarily indicative of its audibility, so a weighting network such as the CCIR/ARM is recommended for use in noise reduction measurements. The precise amount of noise reduction achieved by a bandwidth restriction technique will depend on the noise spectrum of the source, particularly in the 1kHz to 6kHz frequency range.

DNR depends heavily on a dynamic variation in system bandwidth for the effective reduction of noise. As a result, static measurements that are conventional with other electronic audio systems can be misleading. This is particularly true when the measurement signal is a single frequency input to both the audio and control paths. If it is remembered that the control path output in normal operation is the aggregate of all the spectral components of a program source (and *not* the result of any *single* frequency component that may be present in the audio path) then a better understanding is obtained. For conventional measurements of frequency amplitude response, THD and signal-to-noise, separation of the audio and control path inputs is recommended.

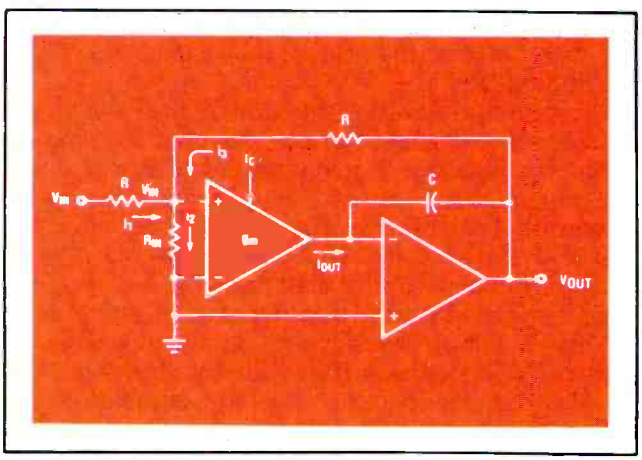


Figure 7. DNR low-pass filter.

How DNR works

By automatically restricting the audio bandwidth to the minimum necessary to pass the signal, DNR reduces the source noise level. Because most audible noise occurs in the region from 800Hz upward, low-pass filters with controlled corner frequencies are used. These filters maintain smooth, single-pole responses with −6dB/octave slopes above the corner frequencies, which can be varied continuously between 800Hz and 30kHz. An ac equivalent circuit for such a low pass filter is shown in Figure 7, and it consists of a variable transconductance (gm) block driving an op-amp integrator. For an input signal V_{IN}, control current I_C giving transconductance of gm, and output signal V_{OUT}, we have:

$$i_3 = i_1 - i_2 = \frac{V_{IN} - V'_{IN}}{R} - \frac{V'_{IN}}{R_{IN}}$$

$$V_{OUT} = i_3 R = \frac{(V_{IN} - V'_{IN})R}{R} - \frac{V'_{IN}R}{R_{IN}}$$

$$\therefore V_{OUT} = V_{IN} - V'_{IN}\left(1 + \frac{R}{R_{IN}}\right) \quad (1)$$

$$\text{Now } I_{OUT} = -wC\ V_{OUT} = gmV'_{IN}$$

$$\therefore V'_{IN} = \frac{-wC\ V_{OUT}}{gm} \quad (2)$$

Putting $k = \left(1 + \frac{R}{R_{IN}}\right)$ and substituting (2) in (1)

$$V_{OUT} = V_{IN} + \frac{wC\ V_{OUT}\ k}{gm}$$

$$\therefore \frac{V_{OUT}}{V_{IN}} = \frac{-1}{\left(1 + \frac{wC\ k}{gm}\right)}$$

Because the filter gm is controlled by I_C, we have a variable single-pole low pass configuration with unity gain below the corner frequency.

FIGURE 1 DNR: NON-COMPLEMENTARY NOISE REDUCTION SYSTEM

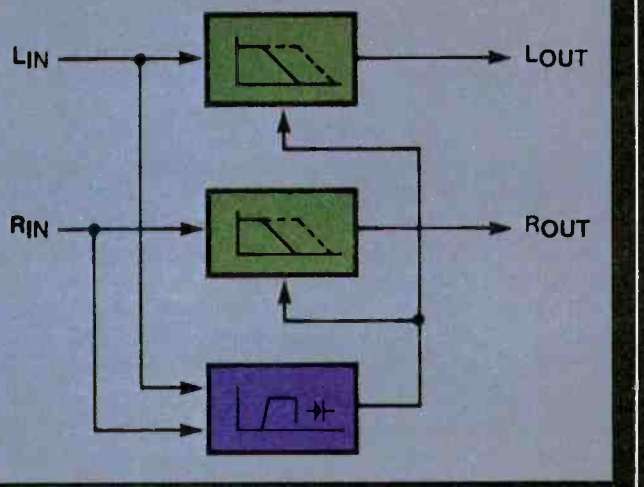
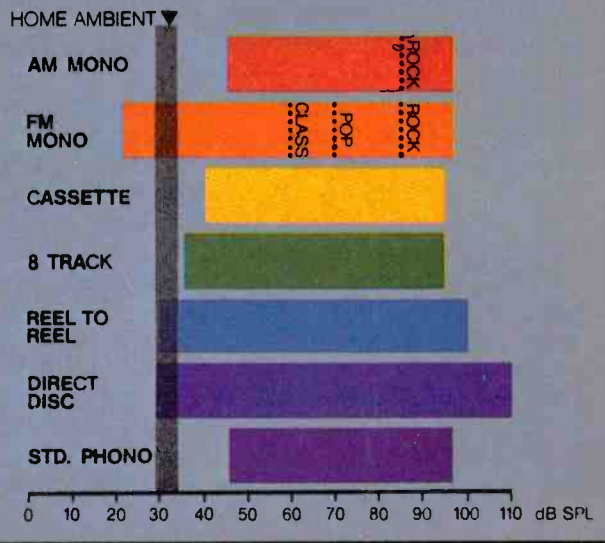


FIGURE 2 PROGRAM SOURCE SUMMARY



The universal noise reduction system

1. DNR is an IC implementation of a dynamically variable low pass filter. This filter attenuates mid and high frequency noise under no audio signal conditions. As the audio signal level increases, bandwidth is rapidly increased until the response characteristic is flat, out to -3dB point of 30kHz. Up to 14dB of noise reduction is possible with this technique.

2. Until now there has been no widely used technique for getting rid of the noise that inevitably accompanies FM radio broadcasts, video source material and phonograph playback. Now, using new linear circuit technology and special circuit designs, a single IC chip has been developed that can be incorporated in tape players, automobile radios, component hi-fi systems and video recorders and that effectively reduces the hiss and noise in the program material.

3. DNR depends on two relatively well known principles for its operation. The first is that the level of noise we hear from our audio system depends directly on the system bandwidth. For example, try turning the treble control to full cut while listening to the unrecorded segment on a cassette tape. You will notice a sharp reduction on the background hiss. All the noise components at frequencies above 1kHz are being attenuated (reduced) by the action of the treble control.

On some hi-fi systems, the scratch filter will give a similar effect. Car radios have long used a restricted frequency response to minimize the effects of noise. Of course, there are limits – decreasing the audio bandwidth below 1kHz will not usually produce a significantly better noise reduction, and increasing the bandwidth above 20kHz does not give a corresponding increase in audible noise by as much as 14dB.

This is shown visually in the oscillograms of Figure 3. Notice that with a wide bandwidth (a), the noise appears denser and has a large number of high intensity spiked vertical lines. These are high frequency noise components giving rise to hiss. When the bandwidth is reduced (b), the hiss disappears and we are left with more tolerable low frequency noise components, which are changing in amplitude more

FIGURE 3 EFFECTS OF DNR ON AUDIO NOISE

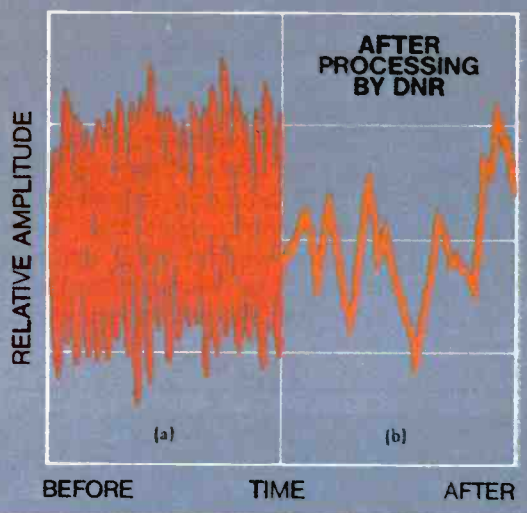
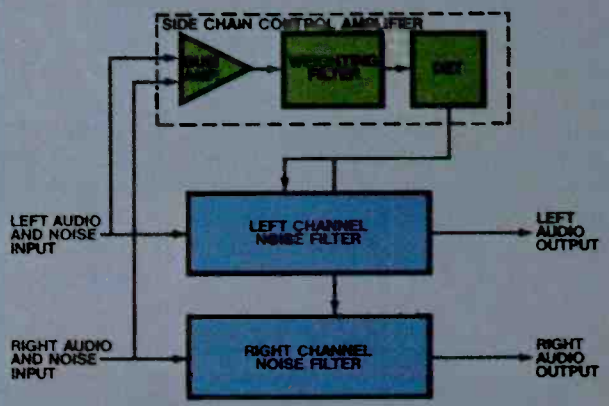


FIGURE 4 THE DYNAMIC NOISE REDUCER-DNR



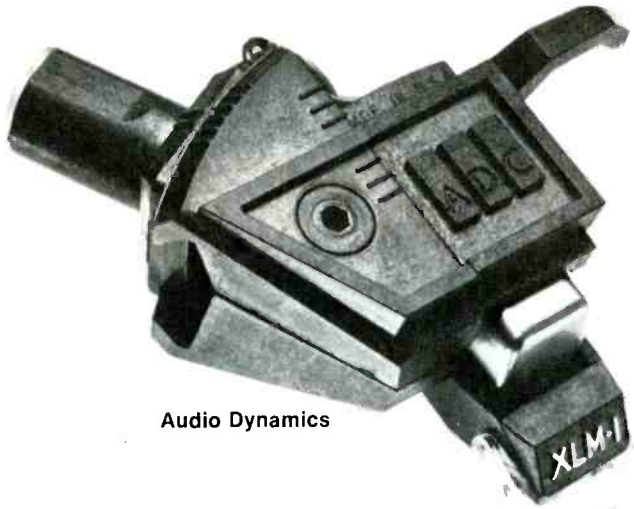
slowly. In fact, the audible effect is much more dramatic than these pictures would imply, because our ears are not as efficient at low frequencies, and we cannot hear those low frequency changes as well as we can hear those that occur between 2kHz and 6kHz.

Restricting the frequency response, by itself, is not satisfactory. If we keep the bandwidth limited, the music sounds dull and lifeless. To avoid this, DNR employs a second principle, known as auditory masking: Our ability to hear noise is strongly dependent on the program material that is simultaneously present. With no other sound present, we can hear very faint noises – the proverbial pin dropping. But as the program sound level increases, it masks any low level noise. The threshold of hearing for noise is raised. Now the system bandwidth can be increased to allow all the program harmonics to be faithfully reproduced.

DNR automatically recognizes the masking ability of the program material, and extends the bandwidth so that all the music passes through the system. This is done on a dynamic (continuous) basis, so that anytime the noise could become audible the bandwidth closes down again to eliminate the noise.

4. The DNR system includes special weighting features. If we simply detect the presence of audio and open up the noise filters to full bandwidth, the music wouldn't always sound noise free. This is because music with predominantly low frequencies cannot mask noise components that are at much higher frequencies. Masking occurs only for a limited frequency range about the tone that is providing the masking. As the music source becomes richer in harmonic content (higher frequencies), its masking ability improves.

The DNR weighting filter recognizes this, allowing high frequency tones to open the noise filters much wider than low frequency tones of comparable amplitude. This also ensures that the system bandwidth is tailored – always wide enough to pass the higher harmonics in the program material.



Audio Dynamics

Audio General

Audio update

The pace of advancement of electronic technology shows no sign of slowing. In fact, if anything it is accelerating. The most visible advancements these days seem to be in the areas of computers and video. As computers get smaller and more affordable, more individuals are taking the plunge, buying one, and finding out that they can indeed do marvelous things. On the video front, there are cable, satellite earth stations, the controversy over disc vs. tape for home use and the legal tangle surrounding the right to tape TV programs off the air.

Somewhat less obtrusive is the ongoing revolution in the audio scene. The most obvious example of the state of today's audio is the portable radio. Dozens of manufacturers have turned to pouring out personal stereos of either the belt-mounted, headphone-output type, or the hand-carried AM/FM/tape unit with speaker output.

Such units are only a small part of the much larger story of what's going on in audio today. The revolution appears to be taking place at a number of levels. Not only is the technology changing, but the way people look at audio equipment is changing, as well. For example, it used to be important to disguise the function of the equipment, to hide it, to make it look like furniture. Over the past several years that has changed to a great extent. The components have been given a functional look, and in many cases are stacked in racks that proclaim unabashedly that this is high-technology audio equipment.

Microprocessor leads the trend

Although the technological advancement contributing to the changes in audio are many, the most significant would appear to be the incorporation of microcomputer technology. Microcomputers are showing up in tape decks, turntables, amplifiers and receivers. At least one receiver for 1982 has no rotary knobs or mechanical switches. All operations are accomplished by a microcomputer chip. A linear-tracking microcomputer-controlled turntable offers programming of a number of selections on a record for playback in any order. Also featured is automatic computerized selection of record size and playing speed.

The advances in audio in the past few years, those that have been announced for 1982, and those expected to occur within the decade of the '80s will surely combine to offer the audiophile a situation that approaches the ultimate in convenience, reliability, and most important, fidelity. These pages contain a random selection of equipment from among the current offerings of audio manufacturers. It is not intended to be a buyer's guide or a definitive listing. It merely contains a handful from among the hundreds of high quality, technologically advanced audio components and systems available. To the consumer, it is intended to suggest what might be found on a shopping trip for audio equipment today. To the technician it is meant to be an early warning of the sophisticated, modern electronic circuitry that will soon be turning up on the bench for service.

Adcom

Aiwa

Akai

Adcom matching preamplifier

Adcom's new GFP-1 preamplifier has been introduced as a companion to the company's recently unveiled GFA-1 power amplifier. The unit also matches the firm's GFA-1A and GFA-2 power amplifiers, as well as the GFT-1 tuner.

The GFP-1 is a compact preamp/control center designed as a "silent partner" for the company's other electronics. The unit is virtually noise and distortion free, according to the manufacturer.

Special attention was given to the design of the phono input stage, a problem area even in more costly preamp designs. In place of bipolar devices, Adcom employs FETs (field effect transistors), which are inherently quieter than bipolar transistors, as well as being more linear in low-current preamp applications.

A professional-type stepped attenuator with precision-trimmed resistor pads provides accurate tracking between channels and absolutely repeatable settings.

Circle (80) on Reply Card

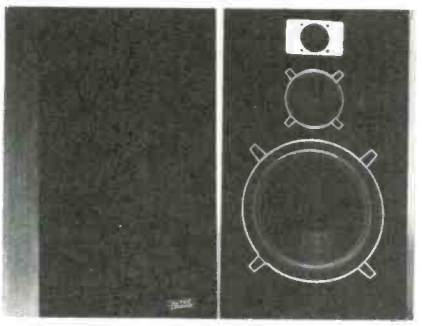
Aiwa cassette deck

Until now, the convenience of using cassette tapes for stereo reproduction meant a compromise somewhere along the line; in set-up adjustments, maintenance time or quality sound performance. Aiwa contends that their new AD-3800 cassette deck should convince even the most critical audiophiles that these days are finally over.

The microprocessor-controlled DATA (Digital Automatic Tape Adaptation) system automatically checks playback output and adjusts the bias level, sensitivity and equalization to extend frequency response, optimize noise reduction performance and enhance high-range reproduction (all within 16 seconds), retaining the same setting, if desired, for up to 24 hours.

The Automatic De-Magnetizing System (ADMS) degausses the heads to ensure noise-free recordings with extended high frequency response each time the unit's power is turned on. Dolby C and B are incorporated to reduce tape hiss and noise from the highest performance CrO_2 and metalloy tapes while providing effective noise reduction for already recorded tapes.

Circle (81) on Reply Card



Altec Lansing

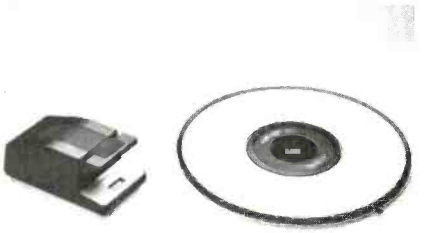
Akai cassette decks

Akai America has introduced two new quick-reverse cassette decks, the GX-F66RC and the GX-F44R, both with Dolby B and C noise reduction systems. An automatic reverse feature allows recording and playback of both sides of a cassette with virtually no loss of fidelity in the reverse mode.

Convenience features found on these decks include Intro Scan and Blank Search; automatic play of one side, both sides or continuous playback; and automatic tape selection, which ensures correct setting of tape bias and equalizer levels.

The Intro Scan consecutively plays back the first 10 seconds of each selection, allowing quick review of a tape and easy location of specific songs. Blank Search makes recording partially recorded cassettes simple by seeking out unrecorded portions of the tape that are more than three minutes long, then laying down four seconds of silence at the end of the last recorded segment before going into recording standby.

Circle (82) on Reply Card



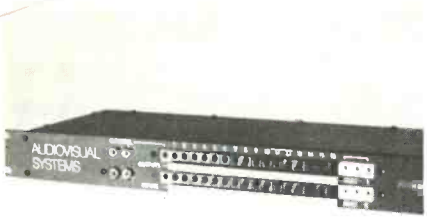
Audio-Technica

Altec Lansing speaker

The newest addition to **Altec Lansing's** expanding hi-fi loudspeaker line is a 3-way system. According to Chuck Garland, consumer sales manager, the new model 312 employs a 12-inch low-frequency driver, 5-inch mid-range, and 2½-inch high-frequency driver.

The 312 delivers up to 100W per channel and incorporates a number of features found in Altec's Professional Series models.

High-temperature, pure copper voice coils in the drivers of the 312 boost power handling and assure crisp, articulate transient response. Highly conductive 100% aluminum low- and mid-range voice coil forms rapidly dissipate



Audiovisual Systems

BSR

Celestion

Beyer

coil-generated heat, prolonging component life and adding to the unit's efficiency. The 312 also uses an internal current-limiting system to prevent speaker blow-out and other system damage during excessive power surges. A multiple element dividing network provides precision power distribution throughout the system.

Circle (83) on Reply Card

Audio Dynamics cartridges

Three new magnetic phono cartridges designed for straight tonearms and featuring built-in adjustments for offset angle, vertical tracking angle and overhang dimension are being introduced by **Audio Dynamics Corporation.**

The cartridges comprise the ADC Integra ST Series and eliminate audible tracking angle distortion throughout the record's play.

All audible tracking angle distortion is eliminated because of the three adjustments incorporated into Integra ST cartridges. These include an adjustment for vertical tracking angle, offset angle and overhang dimension. Nearly all records are cut with a vertical tracking angle of 20 degrees, and are meant to be played at the same 20-degree angle. Integra ST's vertical tracking angle is adjustable enough to compensate for any straight tonearm height.

All Integra ST cartridges feature all-carbon-fibre construction for 50% less mass than conventional head shell/cartridge combinations. This provides extra rigidity to virtually eliminate low-frequency signal loss, resonance and flexing and to provide shielding from external electrical fields.

Circle (84) on Reply Card

Audio-Technica vacuum device

The vacuum-operated **Audio-Technica** AT666 Disc Stabilizer holds a phono record – even though it may be severely warped – firmly against the turntable platter while it is being played.

Consisting of a precision-machined duralumin platter and a manual vacuum pump, the AT666 holds the record with a force equivalent to that of a 551-pound weight, but without placing a harmful load on the platter or on the turntable bearings.

The user merely replaces the rubber mat on the turntable with the platter. A tube connects the platter valve to the pump. The record is placed on the platter, and the pump handle is pressed several times to evacuate the air between record and platter. A few strokes create enough vacuum to hold the disc securely. (An indicator shows when this point has been reached.) After play, a vacuum release valve permits easy removal of the record from the turntable.

Through use of the Disc Stabilizer, company officials point out, record resonance is eliminated, warped records are flattened out during play, and tracking is dramatically improved, while distortion is significantly lowered. An important added benefit is that, in doing all this, acoustic feedback problems are lessened.

Circle (85) on Reply Card

Audio General moving coil phono

Audio General has added an option "M" moving coil phono as a modification to their 511A phono preamp. The unit allows low output moving coil cartridges to be used directly with the preamp, eliminating the need for a transformer or pre-preamplifier.

Besides increasing phono gain, the device offers a 12dB reduction in phono noise, allowing for ultra-quiet playback of recordings with today's low output moving coil cartridges. Also any cartridge load requirement can be accommodated, from 47K down.

The option "M" phono preamp may be ordered already installed in the 511A or can be added at a later time by the factory or with a kit.

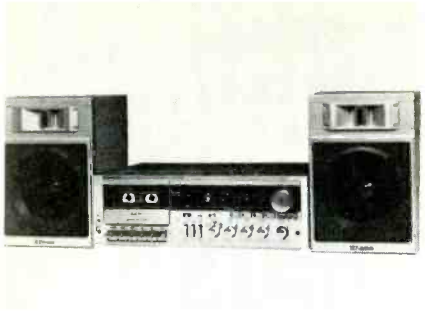
Circle (86) on reply card

Audiovisual Systems patch bays

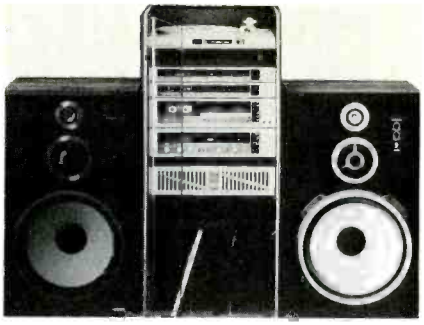
Patch bays are the nerve centers where audio components can be connected, but they can also be a complicated rat's nest of patch cords. **Audiovisual Systems** has designed the patch bay PB289G to operate without dozens of patch cords.

Once internal connections are made, components can be bypassed, relocated or substituted with only one or two cords. Each cord carries both channels of a stereo signal and two cords will enable 95% of the usual patching requirements in a recording system without disturbing the normal connections.

Circle (87) on Reply Card



Emerson



Fisher

Fidelity Research

BSR mini-component system

BSR is now a full-line supplier of high fidelity components. The company's product line includes its first mini-component system, model MCR 200.

The MCR 200 is powered by an AM/FM stereo receiver, model MR-20, which includes such audiophile features as a 12-element LED power level display and signal strength meter. Detents are built into both the volume and balance controls, there is provision for two sets of loudspeakers, and a loudness control, high and low filters and tape monitor switch all appear on the unit's front panel. The MR-20 produces 20W per channel, both channels driven into 8Ωloads, with total harmonic distortion of less than 0.03%.

Complementing the MR-20 is a mini-solenoid cassette deck, model MC-10. This recorder offers consumers the convenience of full-logic solenoid controls and will record and play back all tape formulations, including metal. Dolby B noise reduction circuitry is built into the MC-10.

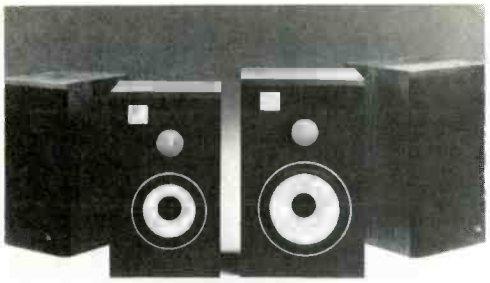
A pair of acoustic suspension mini-speakers, model MS-5, top off this first system of its size from BSR. The 2-way units feature silver-finish enclosures and metal mesh covering the 1½-inch tweeter and 4½-inch mid- and low-range driver.

Circle (88) on Reply Card

Beyer headphone

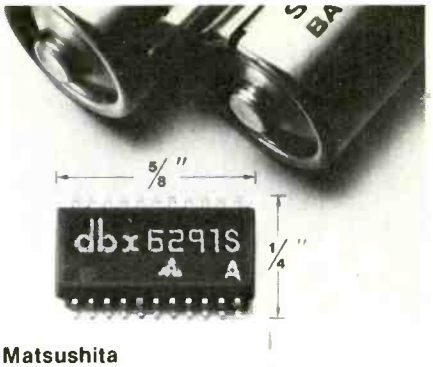
The new **Beyer** DT660 closed-system headphone is the world's first to use an enclosed Bass Reflex System, according to Paul Murphy, Beyer general manager.

"Most closed system headphones utilize artificial equalization, which can cause disturbing resonances



JBL

Koss



Matsushita

Kenwood

that impair listening. The new Beyer DT660," Murphy pointed out, "incorporates a ducted port much like those found in Bass Reflex loudspeakers. It also makes use of a specially designed venting system that also helps to improve the bass response."

The DT660 has a frequency range of 15 to 25,000Hz. Impedance is 600Ω. Maximum continuous power level at 1kHz and a THD of 0.5% is equal to approximately 113dB. Sound pressure level at 1kHz is 96dB. Ambient isolation is greater than -16dB.

Circle (89) on Reply Card

Celestion loudspeaker

Celestion Industries has announced an alternative compact 2-way monitor-quality loudspeaker designed with laser-computer technology. Called the SL-6, it was developed with the company's proprietary ULTRA (Ultra-accurate Laser Topographic Response Analysis) system and incorporates new materials and new manufacturing techniques, as well as radical ideas in the design of both drivers.

"The SL-6 was born of completely new technology," said Robert Shapiro, Celestion's vice-president of marketing. "For the first time ever, our ULTRA laser-computer system let speaker designers actually see the microscopic vibrations of speaker diaphragms. It taught us more about how speakers behave and misbehave than any previous research tool in loudspeaker design. And as a result, ULTRA enabled us to create a loudspeaker that removes barriers between music and the listener at the design stage, rather than compensating for them by conventional trial-and-error design methods later."

Circle (90) on Reply Card

Dynamic Acoustics power monitor

Dynamic Acoustics has announced its new LED power monitor for home and car stereo applications.

A series of newly styled square LED elements affords a visual indication of the power actually being transmitted to the loudspeaker. A fast-acting, resettable circuit breaker is provided to ensure total circuit protection.

The unit is offered in three wattage indications: 1-30, 1-50 and 1-100. The circuit breakers are rated proportionately to the units' power indication. The unit is fully assembled and completely wired in a manner that allows the user the option of circuit-breaker usage.

Circle (91) on Reply Card

Emerson bookshelf series system

Emerson's most recent entry in their expanding Bookshelf Series is the MM877–a "metal" cassette play/record–FM/AM stereo system with digital tuning and three FM radio presets. In addition to metal and CrO_2 tape capability, the deck also has a digital tape counter, automatic recording level control, automatic end of tape stop system and soft eject cassette door.

In the receiver section, the LED digital tuning display does double duty as a full-function clock with sleep and snooze features. LEDs for AM/FM, FM stereo, stereo tuning and record mode are also featured. An automatic sensor adjusts the display brightness level automatically, depending on ambient light levels. A pair of tuned modular speakers and phono input jack for adding a turntable complete the system.

Circle (92) on Reply Card

Fisher remote control system

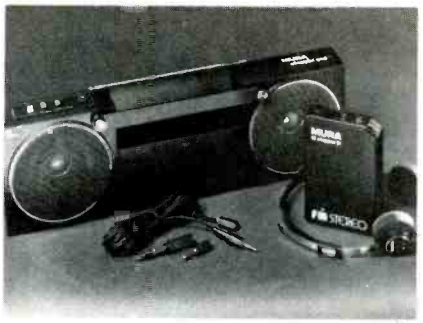
Fisher Corporation has just introduced what they call the most complete audio component system on the market, with the convenience of wireless remote control.

According to David Karron, vice president of sales, system R70 contains everything desired for both the high fidelity enthusiast and the convenience-oriented customer.

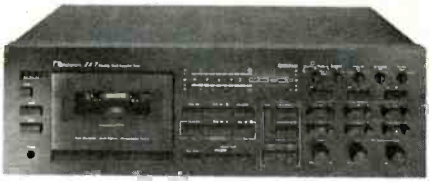
System R70 includes Fisher's 70W-per-channel CA550 integrated amplifier, FM550 Quartz PLL digital synthesizer tuner, MT9000 programmable turntable, DD350 direct drive cassette deck, EQ550 24-band graphic equalizer, ST925 3-way speakers with speaker stands, CB550 remote control center, REM550 remote control module and the RA550 component cabinet.

The CA550 includes Class A-II dc-powered amplifier circuitry and two 9-LED power level meters. Besides synthesized tuning, the FM550 features automatic or manual tuning along with 12 (six AM and six FM) station presets with electronic memory. The

Mission



Mura



Nakamichi

DD350 cassette deck with direct drive operation includes metal tape capability and a full-logic IC electronic solenoid control system. The EQ550 graphic equalizer features 24 slide controls with LED indicators and a tape monitor switch. Fisher's ST925 speakers utilize a 15-inch woofer, 6-inch ferro-fluid midrange and a 4-inch ferro-fluid tweeter.

Circle (93) on Reply Card

Fidelity Research cartridge

Fidelity Research of America has announced the availability of its new MC-202 "Gold" moving coil cartridge.

The cartridge features a Vital stylus, a refined contact, nude diamond rectangular tip that increases the amount of wall contact between stylus and record groove without sitting deep in the groove. The refined tip reduces trace distortion and scratching noise resulting in a clearer signal.

The MC-202 does not use magnetic material in the core of the coil, so only the coil moves to generate the electrical signal and transducer type distortion is eliminated.

The tracking is lighter due to a lightweight cantilever that is ⅔ the size of the cantilevers used in most other MC cartridges.

Circle (94) on Reply Card

JBL loudspeaker systems

James B. Lansing Sound announces the addition of two high fidelity loudspeaker systems to its L Series line: the 2-way, 8-inch L46 and 10-inch L56.

Developed with the benefit of laser interferometry and computer modeling in the JBL research and testing laboratory, the speakers

Miller & Kreisel

Optonica

incorporate all-new high frequency and low frequency components, as well as new High Resolution Dividing Networks. Both models offer high efficiency as well as great power handling capability, a combination that provides them with dynamic range to reproduce the source material contained on advanced analog and digital recordings.

The speakers are equipped with low frequency components featuring the firm's Symmetrical Field Geometry (SFG) magnetic structures, for significantly reduced second harmonic distortion. Each model's enclosure has been specifically designed to optimize the performance characteristics of the low frequency components. This engineering objective also contributes to the systems' clean, deep bass.

Circle (95) on Reply Card

Kenwood receiver

The new **Kenwood** model KR-1000 is a stereo receiver that uses computer technology. Except for two miniature fine-tune rotary controls, all operations are controlled by push-buttons and push-pads. Various displays keep the listener apprised of the set's operating status, including mode, peak power output, time, station frequency, speakers in use, relative volume level and graphic equalization positions.

Computer technology enhances operational ease with such features as Kenwood's Program Mode Commander, which retains four different "signal flows" in its memory for instant use; a multi-functional weekly program timer; touch-controlled digital operating keys, including those for volume, muting, and automatic tuning; and digital-key operation of the set's built-in graphic equalizer.

The amplifier section, which delivers 120W of power per channel minimum RMS, both channels driven at 8Ω from 20 to 20,000Hz with no more than 0.01% total harmonic distortion, includes hi-speed, dc-coupled and zero switching circuitry.

Circle (96) on Reply Card

Koss stereophone

Already the company's biggest-selling stereophone, **Koss Corporation** has improved the Sound Partner.

Now the Milwaukee-based consumer electronics firm has structurally redesigned the headset to deliver superior sound reproduction for the listener.

"We've incorporated human engineering into our new KSP-SI (Koss Sound Partner–Sound Improved)," said John C. Koss, company founder and chairman.

"With an improved coupling between the transducer and human ear, sound is more effectively transmitted through the ear canal," added Dave Thomas, Koss vice president, engineering. "Consequently, better sound reproduction for the listener."

Similar to its predecessor, the KSP-SI has two adaptors for audio and video product hookups and the same technical specifications.

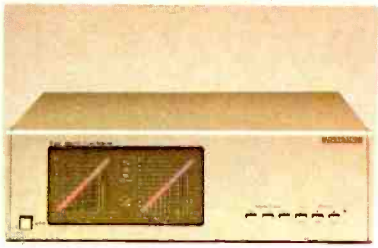
Circle (97) on Reply Card

Miller & Kreisel speaker

Miller & Kreisel Satellite S-1B and S-2B speakers feature a crossover with a pair of rotary switches that dial up to 42 different combinations of tonal characteristics in order to compensate for installation variables.

The speakers readily match individual rooms, source materials

Panasonic



Phase Linear

and electronics—all three major variables between stereo installations.

Another feature of the speaker systems is a new polypropylene driver with exceptional midrange accuracy.

Circle (98) on Reply Card

Matsushita NRX chip

Matsushita Electric Industrial Company Ltd., will produce a new, low-voltage, integrated circuit for the dbx Noise Reduction System for operation in portable cassette units.

In announcing the new NRX chip, developed jointly by dbx and Matsushita, dbx President David Blackmer said, "The chip is a revolutionary development for the booming personal cassette player and autosound markets, enabling this equipment to provide wide dynamic range and full fidelity sound, matching the sonic performance of digital audio systems in many important respects."

With this tiny chip, which measures about 5/8"x1/4"x16", dbx noise reduction for both recording and playback will now be available at such a low cost that it is viable for mass market products. It is also expected to have wide impact on the personal portable market. The dbx NRX chip can operate on as little as 1.8V. This is important because most portable cassette players operate on batteries that provide 3V, but drop in voltage as they age.

Circle (99) on Reply Card

Mission 775 turntable

Three years of research into the associated fundamentals of physics, materials and mechanics have resulted in the **Mission Electronics** 775 turntable.

Mission rejected the idea of non-suspended designs for their excessive susceptibility to feedback. Similarly, the company decided against spring suspension because it is impossible for such systems to be in equilibrium and have critical Q and frequency of resonance in all six rotational and translational axes of vibration.

The Mission turntable employs a rigid chassis/plinth configuration made of constrained-layer-damped, medium-density fiberboard. The system employs Mission's Sorbothane polymer, which combines springs and shock absorbers in the design and absorbs up to 95% of the imparted energy. This, combined with the 775's optimum aerodynamics, eliminates feedback and acceleration resulting from extraneous vibrational forces, minimizing the effect of environmental disturbances such as floor or airborne vibrations.

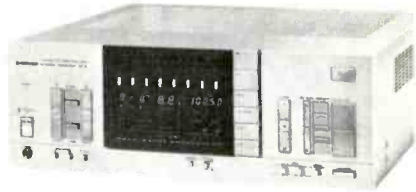
Circle (100) on Reply Card

Mura portable stereo package

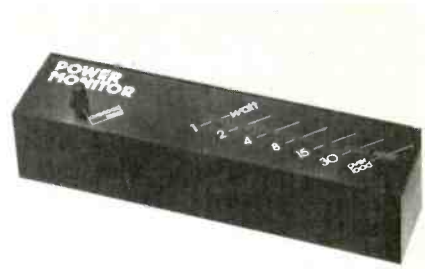
A new portable, multi-use stereo package that serves as both a personal and portable stereo system has been introduced by **Mura Corporation.**

Designated the Giant Stepper, this flexible sound system, which delivers excellent high-fidelity sound indoors and out, includes Mura's Steppin' Out portable stereo speaker amplifier, its FM/FM stereo Hi Stepper personal sound unit, a Red Set model hs2 1.6oz stereo headset, a 12-foot mini stereo extension cord and two adaptor plugs (mini stereo to 1/4-inch stereo and mini stereo to mini mono).

The Steppin' Out portable amplification unit (included in the Giant Stepper) features 4-inch



Pioneer



Dynamic Acoustics

high-compliance aluminated dome speakers, bass/treble enhance control, automatic "off" function, LED "on" indicator, 7-inch cord with 3.5mm stereo plug on each end (to connect unit with any personal stereo unit) and adjustable carrying strap. The Steppin' Out operates on four C batteries or 6Vdc adaptor and weighs 44 ounces (with batteries).

Circle (101) on Reply Card

Nakamichi cassette deck

Nakamichi U.S.A. Corporation has announced the ZX-7 Discrete-Head Cassette Deck, a microprocessor-controlled system designed for the serious recordist who insists upon the performance that comes with individual tape-optimization controls.

The unit provides the user with the means and methodology to accurately adjust azimuth, bias and recording level for the tape being used. Separate manually operated record-level and bias adjustments are provided for each channel and for each of the three major tape types. The adjustment procedure is simplified by several semi-automatic steps (including auto rewind).

The ZX-7 uses the manufacturer's Discrete-Head Technology wherein record, play and erase heads are *mechanically* as well as electrically independent. After optimization via the user-adjustable controls, the unit achieves a frequency response of 20-21,000Hz ± 3dB with ZX (Type IV) tape and 20-20,000Hz ± 3dB with X (Type-II) and EXII (Type-I) tapes. Double Dolby C- and B-type noise reduction is included to realize A-weighted signal-to-noise ratios of 72dB and 66dB respectively on ZX tape (re 3% THD at 400Hz).

Circle (102) on Reply Card

Optonica audio component systems

Citing the increased interest among audiophiles for high quality rack audio component systems at affordable prices, **Optonica High Fidelity Products** has pre-packaged a group of its state-of-the-art components into four new music systems, according to William Yanke, national sales and merchandising manager.

"These pre-packaged systems serve to reinforce our total 'family' look – standard industry width, slim line design with black face and gold trim, and easy access controls," Yanke said, adding that the use of digital technology and cosmetic design rivals any competitive line on the market.

Circle (103) on Reply Card

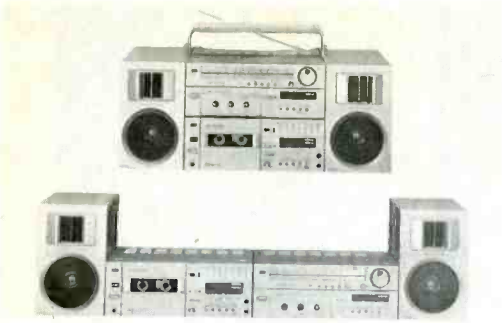
Panasonic compact stereo

The **Panasonic Company** has announced a new compact stereo, model SG-VO3. The unit is complete with phonograph, receiver, cassette deck and speakers.

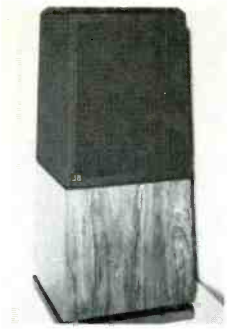
The unit features a fully automatic turntable with belt drive. This reduces wow and flutter as compared to the rim drive mechanism used in most other compact units.

All operations of the stereo unit, including the turntable, are controlled from the front panel. The cassette deck also loads from the front in a vertical position.

With the introduction of this model, Panasonic also unveils a new and unique manufacturing technique called OUT-SERT. For the first time, this operation condenses the combination of plastic and metal parts into one step. Traditionally, plastic and metal components were produced separately and joined to form the



Sansui



Servolinear

final mechanism. Now Panasonic's OUT-SERT method combines the operation into one step.

"This means increased reliability and greater overall accuracy, especially for the turntable," said Jack Weiss, national sales manager, Panasonic High Fidelity. "I feel this process and the SG-VO3 will set a new trend for compact stereos in 1982."

Circle (104) on Reply Card

Phase Linear amplifiers

Phase Linear announces the DRS (Dynamic Range System) Series; three new amplifiers capable of far greater peak power than has been available in conventional high fidelity products to date, according to the manufacturer. Developed in response to the dynamic performance requirements created by advanced analog and digital recording technologies, the series represents a new approach by the manufacturer to high power amplifier design.

The 3-model line consists of two power amplifiers – the 5¼-inch DRS 900, capable of 900W peak power per channel, and the 3½-inch DRS 400, capable of 400W peak power – as well as the DRS 250, a 3½-inch integrated amplifier delivering 400W peak power. (A breakthrough in terms of peak power capacity for an enclosure of its size, the DRS 250 is also Phase Linear's first integrated amplifier.)

Each of the models in this series combines high efficiency with reduced heat dissipation, offering the user clear musical reproduction and long-term operating reliability. The dynamic headroom in each unit is the result of a design using two positive and two negative power supplies, with automatic switching triggered by musical source material.

Circle (105) on Reply Card

Pioneer computer-controlled receiver

U.S. Pioneer Electronics Corporation has unveiled its top-of-the-line SX-8 receiver whose on-board microcomputer brings the personal computer revolution to home audio electronics.

All receiver operations – including volume, loudness, muting, balance, function selection and AM/FM tuning – are accomplished by a microcomputer chip. There are no rotary knobs or mechanical switches on the SX-8. Consequently, the likelihood of equipment failure or decreased performance due to the aging of mechanical switches and potentiometers is decreased dramatically.

Also the use of an on-board microcomputer provides a host of operating conveniences. These include electronic volume control/memory, electronic tone control/memory, electronic balance control and AM/FM tuning memory.

The SX-8's Non-Switching dc power amplifier section is rated at 100W per channel into 8Ω with no more than 0.005% total harmonic distortion.

Circle (106) on Reply Card

Sansui audio systems

Two audio systems that transform from full-feature portables into mini-component systems in seconds, are among the latest products from **Sansui Electronics Corporation.**

Tom Yoda, vice president of sales and marketing for Sansui, said that these systems represent

Troubleshooting Tips wanted

Electronic Servicing and Technology needs additional consumer-product Troubleshooting Tips. Most types of case histories are suitable, especially those with unique, puzzling or misleading symptoms.

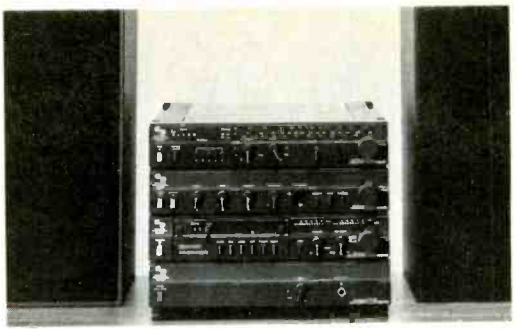
List the brand, model and Photofact number followed by a narrative telling the original conditions or symptoms, the various troubleshooting steps, and the components replaced to restore the original performance. Please include a simple hand-drawn schematic of the stage that has a defect.

$10 will be paid for each Troubleshooting Tips published. Your name and city will be listed, unless you ask to remain anonymous.

Send all Troubleshooting Tips to:

Troubleshooting Tips Department
Electronic Servicing and Technology
P.O. Box 12901
Overland Park, KS 66212

Sanyo



Schneider

an important new product category for the firm.

"Music has an important place in our lives and new technology makes it possible for us to enjoy it wherever we go. These new P-Compo-P for portable-systems offer a multitude of uses. They can be used as a second system in the home, ready to go with us away from home, on vacation or for a weekend. They are perfect for the office and to carry home for the weekend. In effect, they are micro-audio component systems enhanced by portable capability.

Circle (107) on Reply Card

Sanyo audio systems

Sanyo Electric has introduced two additions to its popular Audio Systems line of matched audio components. The two audio packages include the System 5 mini-component audio system and the System 10 component system, featuring an attractive cabinet and matched speaker systems.

System 5 is a compact mini-component system that incorporates the model R5 tuner amplifier, the D5 stereo cassette deck and two model S5 high fidelity speaker systems.

System 10 is a "pre-matched" component system that incorporates a stereo amplifier section; an AM/FM stereo tuner section; a belt-drive auto-return turntable with a stereo magnetic cartridge and diamond stylus; a stereo cassette section with Dolby noise reduction and metal tape capability; two model SS10 high fidelity speakers with 8-inch woofers and tuned passive bass radiators; and model AF10 audio component cabinet with glass door and easy-roll casters.

Circle (108) on Reply Card

Schneider direct contact systems

The new **Schneider** DCS-8025 Direct Contact System offers modular, high fidelity components that link electrically without wiring, either side by side or stacked.

Four pieces comprise the system: a 25W-channel main amplifier; a pre-amp with separate micromix control for recording on cassette via microphone; an analog tuner system with five FM presets and a triple diode system to reduce intermodulation distortion; and a 3-motor, slim, metal-capable cassette deck with Dolby noise reduction and a sliding cassette drawer that perfectly aligns the cassette with the record/playback head. The system includes the model 8040 Schneider/Dual direct-drive turntable and two 3-way speaker systems.

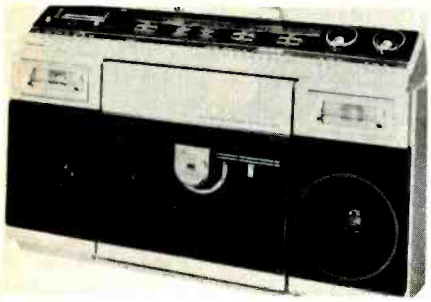
"The key to our various systems-and there is a total of 14-is simplicity. Ease of operation is basic to the Schneider units. Each model is put together to meet particular requirements and price points and each must be purchased as a system," said Phil Welch, president of Schneider North America.

Some unusual features highlight the DCS-8025 units. The cassette deck, for example, features Telefunken's High-Com compandor noise reduction circuitry, in addition to Dolby. The sliding cassette drawer opens and closes at the push of a button, adjusts, and aligns the tape to the record/playback head. All cassette controls operate with the drawer in the open or closed position.

Circle (109) on Reply Card

Servolinear loudspeaker circuit

Servolinear's engineers have been busy developing a new way to look at loudspeaker performance: Servo Dynamic Feedback.



Sharp

Sony

Traditionally, audio engineers have dealt with the amplifier and speaker as separate components of loudspeaker design when in reality they function together. After years of extensive research the company's engineers have developed a radical departure in loudspeaker design, incorporated for the first time in the Periphonic system.

Servo Dynamic Feedback ignores traditional amplifier-speaker relationships by extending the amplifier's negative feedback loop past the output terminals, all the way to the speaker terminals. Servo Dynamic Feedback ties a speaker's behavior directly to the amplifier's performance, which produces damping factor in excess of 400 at the speaker terminals and forces a speaker to behave in perfect sync with the amplifier.

The circuit is a simple, solid state, constant impedance, unbalanced bridge. One arm of the bridge is formed by the loudspeaker, the other by the amplifier. The source material is continuously compared to the activity of the speakers and any misbehavior is immediately detected and adjusted.

Circle (110) on Reply Card

Sharp portable stereo system

The audio department of **Sharp Electronics Corporation** has announced that the company's new portable stereo system has been designated its special "20th anniversary product."

The VZ-2000 features a vertical linear tracking turntable that can play both sides of a record without turning it over.

The unit combines advanced microcomputer, semiconductor, audio and digital technologies in a state-of-the-art integrated portable audio system.

A microprocessor-controlled, vertically mounted linear tracking turntable capable of playing both sides of a record without turning it over, is combined with an AM/FM stereo tuner, a metal-capable cassette deck and matching 2-way speaker system. The compact, integrated portable system measures 28.8" x 18" x 8" and weighs approximately 35 pounds.

It operates on 110/120/220/240 volts ac, internal batteries or external 12V battery and features top controls and handle.

Circle (111) on Reply Card

Sony digital audio processor

Sony is now making digital an affordable reality for the hi-fi enthusiast with the introduction of the portable PCM-F1. This is the world's smallest and lightest digital audio processor, according to the manufacturer. The processor – a device that enables a VCR to record and play digital audiocassettes – provides a level of music reproduction that can only be achieved by digital technology.

According to Osamu Naka, general manager, Sony High Fidelity Products, the Sony PCM-F1 represents "a dramatic improvement over previous digital processors not only in its performance but in design and flexibility as well. The new PCM-F1 works with any NTSC-standard videocassette recorder: U-Matic, Beta or VHS. In particular, Sony has designed the PCM-F1 to be combined with our SL-2000 BetaPak to make a portable, state-of-the-art recording system weighing only 18 pounds," said Naka.

Circle (112) on Reply Card

ES&T

THE MARKETPLACE

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AUTOMOBILE RADIO and tape replacement parts: Delco, Chrysler, Philco-Ford, Motorola, Panasonic and many others. Large inventory. Laran Electronics, Inc., 3768 Boston Road, Bronx, NY 10469. (212) 881-9600, out of New York State (808) 223-8314. 5-79-tf

TV & RADIO TUBES, 36 cents EA!! Free color catalog. Cornell, 4221 University, San Diego, California 92104. 8-76-tf

ELECTRONIC SURPLUS: CLOSEOUTS, LIQUIDATIONS! Parts, equipment stereo, industrial, educational. Amazing values! Fascinating items unavailable in stores or catalogs anywhere. Unusual FREE catalog ETCO-011, Box 762, Plattsburgh, N.Y. 12901. 6-78-tf

SCRAMBLED TELEVISION, encoding/decoding. New book. Theory/circuits. $9.95 plus $1 shipping. Workshop, Box 393ES, Dept. E, Bethpage, N.Y. 11714. 7-80-tf

PRINTED CIRCUIT boards from your sketch or artwork. Affordable prices. Also fun kit projects. Free details. DANOCINTHS INC. Dept. ES, Box 261, Westland, MI 48185. 5-81-tfn

RADIO-TV TUBES INCLUDING ANTIQUES! Many tubes thought to be obsolete are still being manufactured. Write for free discount price sheet of over 1,800 types. Electronic Parts Co., 1015 S. Escondido Blvd., Escondido, CAL 92025, (714) 741-2300. 1-82-6t

PICTURE TUBE REBUILDING EQUIPMENT – Three Welch 1402 vacuum pumps, three diffusion pumps, one 5KW Bombarder, Pierce, Route 4, Box 255, Enterprise, Ala. 36330. 3-82-3t

FOR SALE: RCA COLOR VIDEO CAMERA MODEL CC007. Almost new. $600. Jim Skolka, 18 Springfield Ave., Cranford, New Jersey 07016. Tel. (201) 276-2687. 4-82-1t

INDIVIDUAL PHOTOFACT FOLDERS under 1100. Postpaid $3.00. Loeb, 414 Chestnut Lane, East Meadow, NY, 11554. 3-82-3t

FOR SALE (Cont.)

TEKTRONIC SCOPE – Dual Trace – 50 MHz Model #453 for $900.00. B&K 1077B for $400.00. Woody's TV Service, 3133 8th Street, Meridian, MS 39301, PH: 601-482-3995. 4-82-1t

ATTEN: S.F. Bay Area Technicians. B&K Model 1250 NTSC Generator. Excellent Condition, $650.00. (408)354-5650 or NTSC; Box JC; Los Gatos, CA 95031 4-82-1t

FOR SALE – SAMS PHOTOFACTS #1361 thru 1808. All complete, most unused. Best offer as of July 1, 1982. Clayton's TV Service, Clarkton, Missouri 63837. 4-82-1t

USED TEST EQUIPMENT – Associated Research Breakdown Testers: 1.5 – 3.0 KV – $100.-$200. Ea., Hewlett-Packard 330B Dist. Analyzers – $250.-$350. Ea., Rank & Mincom Flutter Meters – $200.-$250. Ea., General Radio Variacs 2-20 Amps – $25.-$200. Ea. Also much more. Call or write for complete list: Fabrication Industries, Bob Sutton, 6701 Seybold Rd., Madison, Wisc. 53719. 608-274-6960. 4-82-1t

SAMS PHOTOFACTS: 1 THRU 1654, includes Zenith factory manuals. Excellent Condition – $1500 firm. Write John Devich, Box 41, Iron, MN 55751. 4-82-1t

BUSINESS OPPORTUNITY: TWELVE YEAR OLD RADIO & TV SERVICE BUSINESS FOR SALE. Excellent opportunity – little competition. Selling for less than cost of equipment & inventory. Fantastic! Grant, Mich. 616-834-5606. 4-82-1t

FLORIDA'S WEST COAST: Small TV Service Business attached to home. Plus separate rental house. Have certified appraisal. Phone 1-813-541-2039 or write Owner, 7744 46th Ave. North, St. Petersburg, Florida 33709. 4-82-tf

Business Opportunity

TV TECHNICIAN! Increase your income up to $60,000 yearly. Rent-lease-sell TVs new-used, even from comfort of your home. Basic Preliminaries $10.00. Perrys TV Systems, Hwy 181, Box 142, Route #1, Bremen, KY 42325. 12-81-tf

COMPUTERIZE YOUR ENTIRE TV OPERATION. GL-AP-AR-INV. Tubes – Parts – Customer – Vendor & TV rental files-programs. Start small & add to later. For Apple TRS80-NEC-Heath-Zenith. Free details. Perrys Computer Systems, 1467 Hwy 90 West, Milton, FL 32570. 904-994-0068. 11-81-tf

THREE TYPES OF DECODERS. Details, stamp. Trojan Enterprises, 2920 Shelby, Indianapolis, Indiana, 46203. 4-82-1t

TCG REPLACEMENT SEMICONDUCTORS – 73 to 83% off list price. Send orders or price sheet requests on company P.O. or letterhead. Electronic Parts Co., 1015 S. Escondido Blvd., Escondido, CA 92025. (714) 741-2300. 4-82-tfn

Help Wanted

TV and 2-way Technicians wanted. $15K to $22K per year. Benefits include employee stock purchase plan, in the largest Retail Service Center in Northwest Kansas. Friendly community, good schools, short drive to the Rockies. Equal Opportunity Employer. Miller's Electronics Inc., Goodland, KS 67735. 913-899-2386. 10-81-tfn

TV TECHNICIAN WANTED. $30K possible depending on qualifications and experience. Benefits. Prime hunting, fishing and skiing area. Must have 10 + years experience in TV service on Sony, RCA and Zenith. Management position available. Send resume to: McMillan TV Stereo, 244 E. Idaho, Kalispell, MT 59901. 4-82-1t

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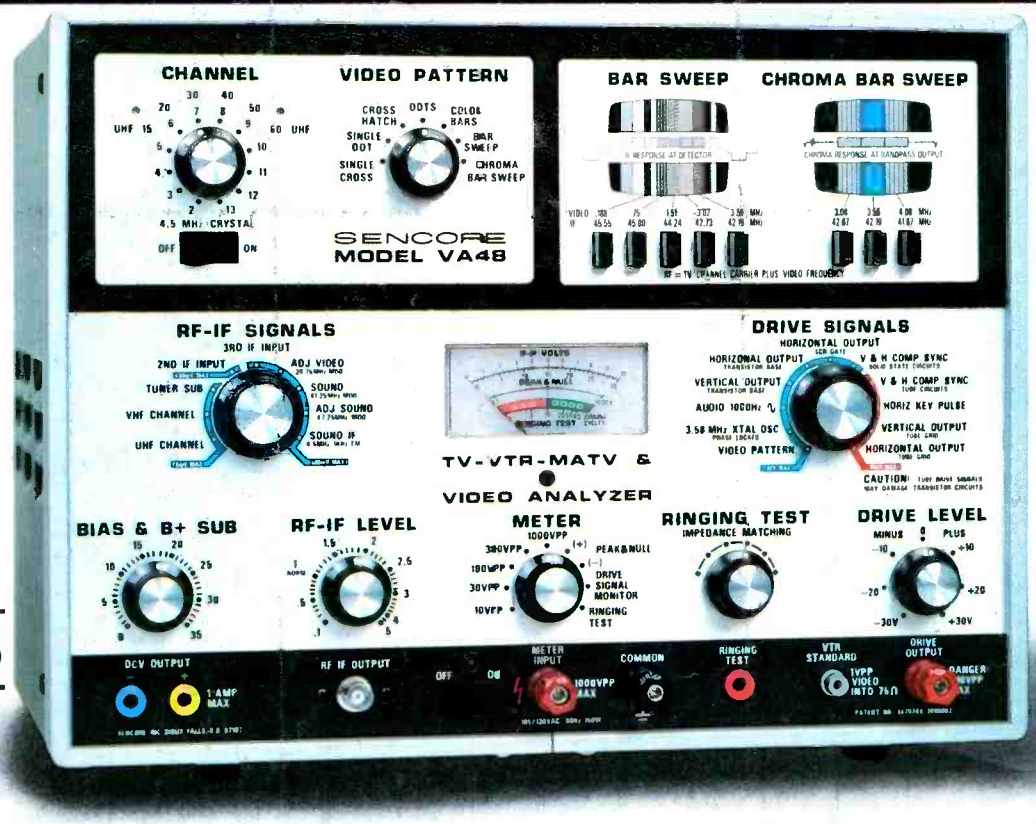
Now Cut Your TV-VCR Service Time Absolutely In Half.



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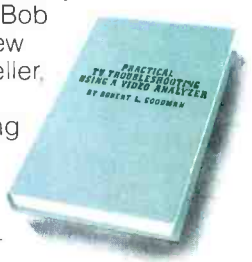
It's a fact. You WILL cut your service time in half with a Sencore VA48 Video Analyzer. Over 1500 VA48 owners nationwide report an average time savings of 54%! These techs quickly and easily learned the VA48's Signal Substitution Method of troubleshooting. It's the key to DOUBLING your service output.

How it works. Our double-patented Signal Substitution Method lets you inject known good signals from the VA48 into any stage of a TV or VCR. If you get a good picture, you know everything is working from that point forward. You back up stage by stage until the defect appears on the screen. You then know you are injecting into the defective stage. It's just that simple, and only the VA48 provides ALL signals necessary to inject from antenna to CRT. It literally cuts your service time in HALF.

The new industry standard. 22,000 VA48 users know this video analyzer is the new standard of the industry. So do manufacturers who are specifying the VA48's patented Bar Sweep patterns on their schematics. Look in Sams Photofact schematics. The VA48 Bar Sweep is there, too.

We DOUBLE Guarantee the VA48. We're so sure you'll cut your TV-VCR service time in half, we offer your money back in 30 days if you're not absolutely satisfied. PLUS, when you call now, you'll receive a FREE copy of Bob Goodman's new $18.95 best seller, "Practical TV Troubleshooting With A Video Analyzer." It's yours to keep FREE regardless.



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SENCORE

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