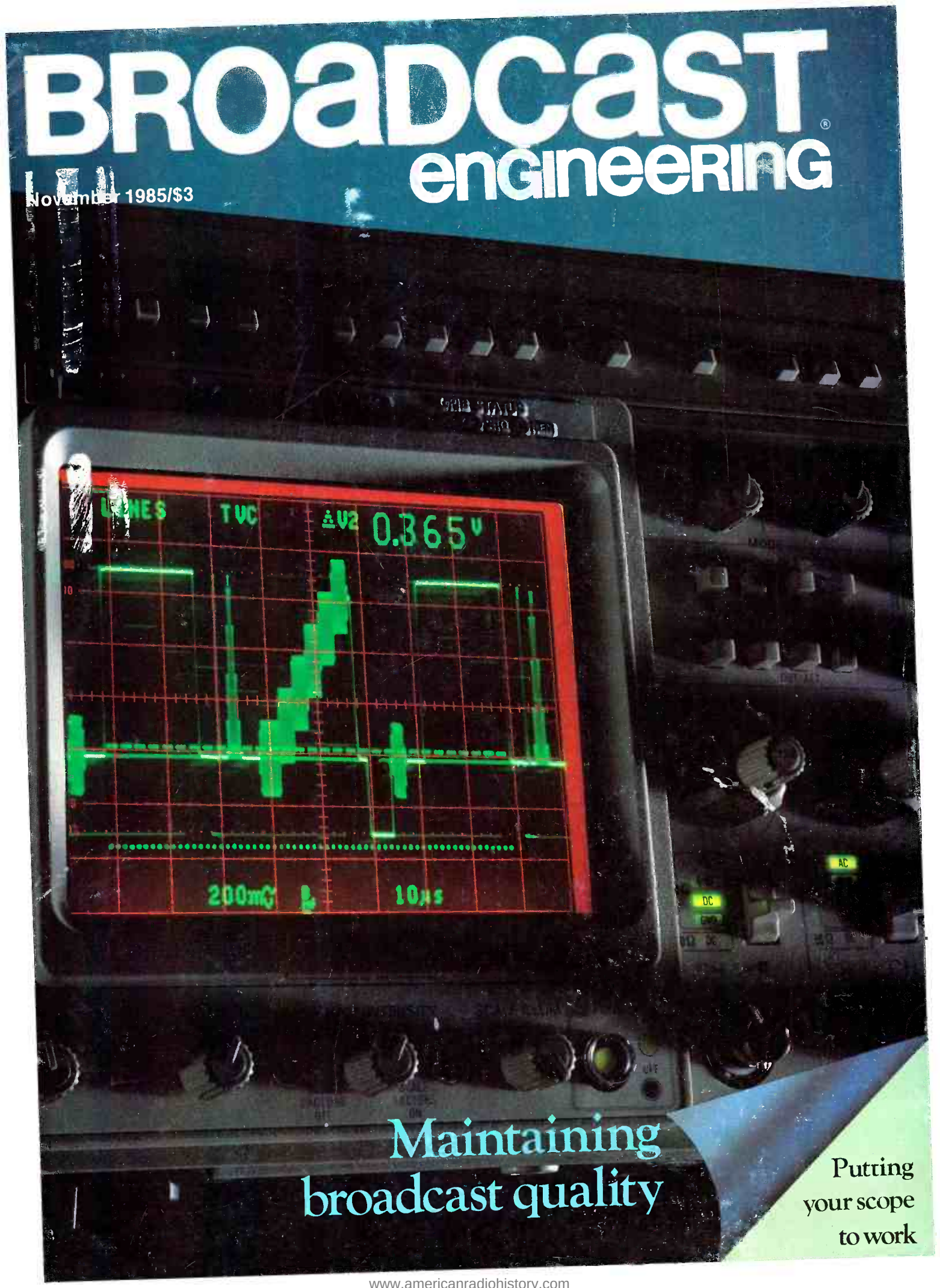
BROADCAST engineering

November 1985/$3



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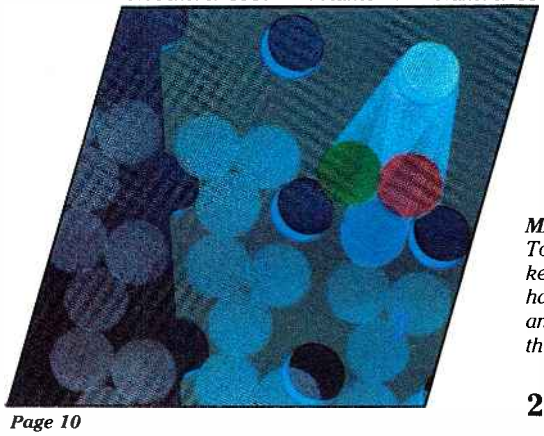
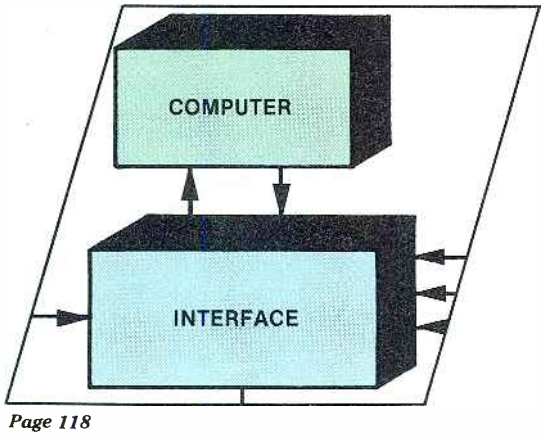
Contents

November 1985 • Volume 27 • Number 11



Page 10

Page 78



Page 118

ON THE COVER
Two items essential in any TV maintenance project are a signal waveform generator and a test oscilloscope. The traces displayed on our cover this month (using a Tektronix 2465 oscilloscope) are only a few of the standard signals that are commonly used to determine transmission system performance. Wide bandwidth oscilloscopes are required to observe the ever-shortening rise times of digitally generated signals. On-screen scope parameter displays are becoming the norm to increase operator productivity. (Photo courtesy of Tektronix.)

BROADCAST ENGINEERING

MAINTENANCE SPECIAL ISSUE:
To a radio or TV engineer, the most important part of the job is keeping the equipment working and on the air. For broadcast hardware, the best way to prevent an on-air failure is through an aggressive preventive maintenance program. We address this need in our second annual Maintenance Special Issue.

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Digital recording format approved

After several years of discussion, fundamental parameters for a standard digital videotape recording format have been approved by the SMPTE working group on digital TV tape recording. The format, named type D-1, will be submitted to a formal ballot in accordance with SMPTE and ANSI procedures.

Type D-1 defines a component recording system for 525-line digital video signals conforming to CCIR recommendation 601. The advantages of the format include 10 to 20 recording and playback generations without significant signal degradation. Four digital audio channels are included, and production versatility is comparable to that achieved with type C analog recordings.

The SMPTE drafts recommend dimensions of magnetic patterns recorded on tape, characteristics of the magnetic medium, design of the cassette housing and electrical characteristics of digital video and audio signals placed on the tape, as well as control-track and time code specifications.

The digital recording group expects to begin evaluation of prototypes in 1986, and to see production models available in 1987. Several scanner diameters and data head arrangements will be considered for different applications.

Input and output processing of 525- and 625-line signals will differ. However, type D-1 recorded video signals will conform to 4:2:2 (13.5:6.75:6.75MHz) sampling with Y, R—Y and B—Y components. Digital audio signals will follow EBU and AES specifications.

Components off their pedestals

SMPTE working groups on component TV standards for analog and digital systems are considering the elimination of *NTSC setup* or pedestal levels in combined composite/component video facilities. Difficulties in maintaining video levels result from multiple encoding and decoding of signals in such mixed video systems.

Video component systems, as they are being formulated, do not use setup. Integration of components with composite video complicates matters because setup must be added or deleted accurately during the encoding and decoding processes. Decoding has proved the more difficult, resulting from variations in setup level on recorded material.

If setup of NTSC video is eliminated, more constant blacks may be achieved without operator intervention. A technical benefit of a slight improvement in signal-to-noise ratio or dynamic range of about 0.75dB also is possible. With production and editing phases completed, the facility would then add the setup increment before transmission or interchange of the video material.

NRSC studies AM improvements

The National Radio Systems Committee (NRSC), representing broadcasters and receiver manufacturers, has announced plans to study the feasibility of voluntary industry standards of pre-emphasis and de-emphasis for AM radio.

As outlined in a resolution by the NRSC, the joint NAB and EIA committee is soliciting proposals for transmitter and receiver systems from interested parties. A subgroup of the committee will establish methodologies to evaluate all proposals received.

BROADCAST ENGINEERING

Editorial and advertising correspondence should be addressed to: P.O. Box 12901, Overland Park, KS 66212-9981 (a suburb of Kansas City, MO); (913) 888-4664. Telex: 42-4156 Intertec OLPK. Circulation correspondence should be sent to the above address, under P.O. Box 12937.

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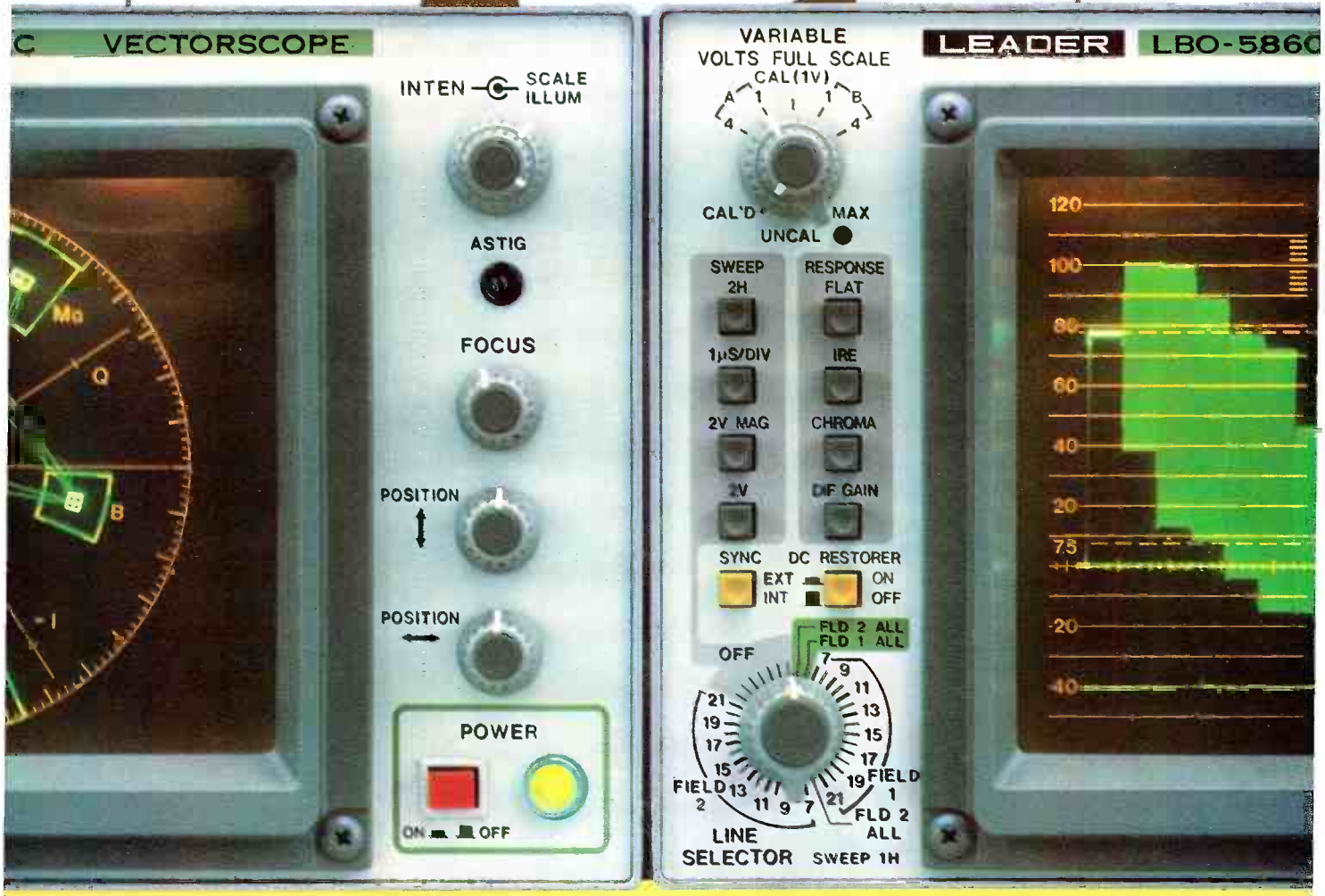

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Editorial

Three cheers for McKinney!

We've got to hand it to FCC mass media bureau chief James C. McKinney. It is indeed time for a "new look at AM radio." McKinney, in a speech to the recent IEEE Broadcast Symposium in Washington, DC, outlined steps that he felt would help save AM radio from further audience loss to FM. McKinney's ideas were bold and interesting, reflecting a frank assessment of the plight of AM radio. Three cheers for honesty!

The problems now facing AM broadcasting, the grandfather of our industry, are no secret. Stations have tried a number of approaches to stem the tide of audience shift to FM. Some plans have worked. Others (most notably, loudness wars) have not.

For long-term survival, AM radio needs a quality on-air sound, innovative programming and, we feel, a reshuffling of the regulatory cards held by the commission. In his IEEE speech, McKinney suggested we do just that. His ideas may be controversial, but they are certainly worthy of careful consideration. In part, here is what McKinney had to say:

"I am a strong believer in the old adage, 'If it ain't broke, don't fix it.' But I believe AM radio is broke. And some AM stations are, in fact, *broke* in the monetary sense. Pressures brought on by the public's demand for improved audio quality have fostered intense development in FM radio. FM may have taken 30 years to get up to flying speed, but now it's soaring and all measures reflect its remarkable success.

"In New York City, 12 of the top 20 stations are now FM. In Washington, DC, only five AM stations are now ranked in the top 20. And things don't get much better as markets get smaller. In the 50th market, Albany, only three of the top 10 stations are AM; and in the 100th market, Stockton, the same number (three of 10) are AM.

"One of the problems with AM radio is that broadcast operators seem to want to compete head to head no matter what. Well, let me warn program directors all across the country that AM radio simply cannot win a head-to-head fight with FM when the station acts as nothing more than an extension of the record industry. Music simply sounds better on FM, and there is not a 13-year-old in any of your households who won't understand that.

"But you (engineers) don't need to worry about formats and, beyond doing your utmost to see that current AM stations are putting out the best possible signals they can, there is little you can do in the short run to help the future viability and profitability of AM radio. I do warn you that many of the directional antenna arrays installed in the 1950s and many of the ground systems buried in the 1940s are so severely deteriorated in the 1980s that complete rebuilds are probably required. But there is much more that could and should be done now to prepare for the future and engineers can play a very positive role in that effort.

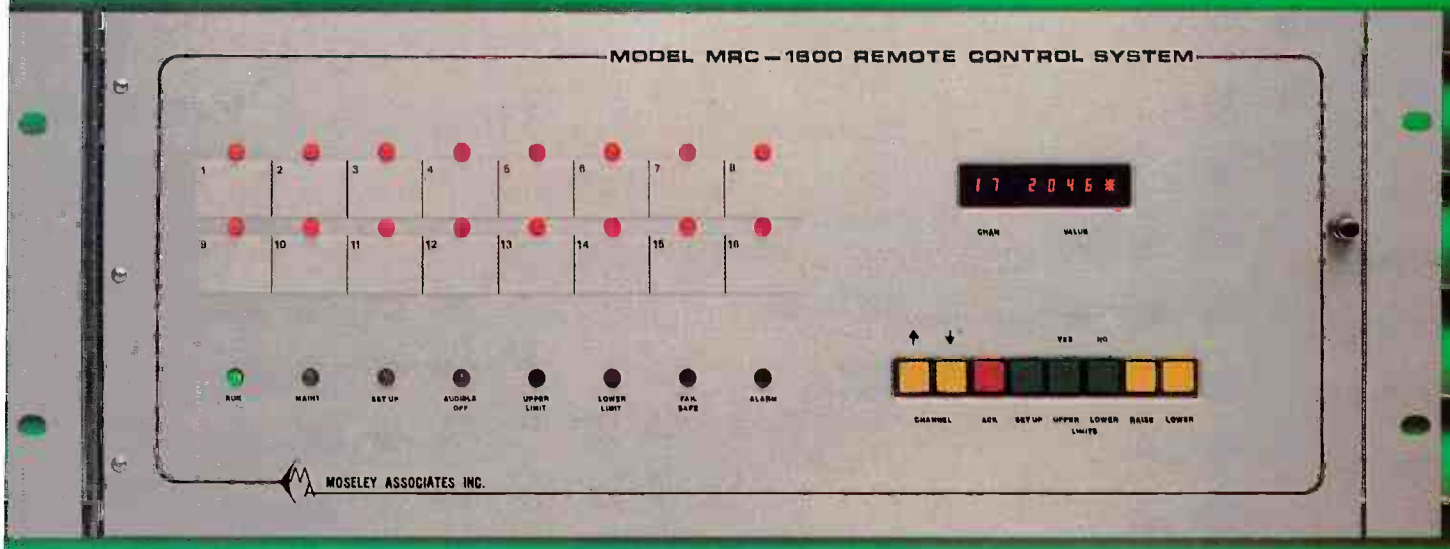
"First let me compliment and congratulate all of those who are cooperating in the industrywide effort to achieve an improved AM service through technical measures to enhance the quality of AM audio. The NAB, transmitter and receiver manufacturers, and consulting engineers are all voluntarily committing personnel and funding in this very important endeavor. Special recognition should be given to the National Radio Systems Committee and the NAB's AM Improvement Subcommittee.

"But I would like to challenge you to think more broadly, to view the problem as if the regulatory slate were clear and we had the ability to start fresh with AM. What kind of service would we develop today if FM had come first? How would we now design a competitive AM service if there were nothing but blank pages in Part 73 where AM rules appear?

"AM radio remains a unique resource for this nation. It provided for the beginning of modern mass communication . . . an enormous amount of cash made in AM provided the funding to construct FM and TV stations in this country. And AM, more than any other service, is the child of *engineering*. It was not invented by lawyers, programmers or record company executives. It belongs to the engineering community first and, once again, it needs and deserves our attention."

We couldn't have said it better.

Although McKinney cautioned that his remarks were more philosophical than a "re-evaluation of an impending FCC policy," we can hope that they will stimulate serious discussion on ways to save the AM band. Wasting no time, the NAB has already petitioned the commission to initiate a rulemaking proceeding on several of the ideas proposed by the mass media bureau chief. Three cheers for McKinney!



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FCC update

Chief offers some fresh ideas for AM

By Harry C. Martin

As discussed in this month's "Editorial" on page 6, Jim McKinney, chief of the FCC's Mass Media Bureau, has suggested that the commission take a fresh look at its regulatory scheme for AM radio. McKinney has asked his staff to turn its attention to the present state of the AM band and to report on options for future rulemakings that could help to revitalize the service. Among the options being considered are:

- Allowing AM stations to duplicate FM programming in all markets where AM and FM stations are co-owned. McKinney believes struggling AM stations would remain viable if production costs could be curtailed through simulcasting.
- Deleting the duopoly rule as it applies to AM. McKinney said that AM's unique role has been to provide regional, rather than local, service and that the duopoly rule stifles that potential.
- Permitting the use of synchronous transmitters. McKinney envisions the placement of several AM transmitters along a narrow corridor (such as a 200-mile stretch of interstate highway) to provide the traveling public with continuous news, entertainment and travelers' information on a single frequency.
- Reconsidering the role of clear channels. McKinney believes the commission should consider alternatives such as providing for a small number of superpower AM stations capable of serving large portions of the country.
- Restricting AM bandwidth at night to reduce adjacent channel interference.
- Limiting RF noise being generated by non-broadcasting devices.

These are suggestions only. Rule changes generally may be accomplished only after a rulemaking notice is adopted by the commission and comments from the public are taken into account.

Court eliminates must-carry

Effective Sept. 10, the FCC suspended enforcement of its rules requiring cable systems to carry the signals of all local broadcast stations.

In July, the United States Court of Appeals for the DC Circuit held that the must-carry rules violate cable operators' rights under the First Amendment. Subsequently, the National Association of

Broadcasters and other parties sought a stay of the Court of Appeals ruling pending Supreme Court review. The Court of Appeals refused to grant such a stay, however. NAB then sought a stay from the Supreme Court, but that effort, too, was unsuccessful. As a result, the mandate of the Court of Appeals eliminating the rules became effective on Sept. 10.

In spite of their failure to obtain temporary relief, the NAB and other parties have requested the Supreme Court to reverse the Court of Appeals decision invalidating the must-carry rule. As indicated in last month's "FCC Update," the chances of the Supreme Court taking the case are slim, given the fact that the commission did not join in the appeal.

In the meantime, efforts are under way in Congress to convince the commission to institute a new proceeding in regard to adoption of some new form of must-carry. However, cable industry representatives have questioned whether the commission could fashion new rules that would meet constitutional muster.

As a result of the deletion of the must-carry rules, the commission has dismissed as moot more than 500 pending proceedings related to the rules. These include requests filed by cable companies for special relief from the requirements of the rules, and the requests by TV stations for changes to the commission's list of hyphenated TV markets and for enforcement actions against cable systems.

EEO provisions implemented

In another cable-related action, the commission has amended its rules to implement the equal employment opportunity (EEO) provisions of the Cable Communications Policy Act of 1984. The new law requires the commission to certify on an annual basis that each cable entity is in compliance with FCC EEO policy and program requirements. The act also requires the commission to investigate each cable entity for EEO compliance at least once every five years.

To comply with the investigative requirements of the new law, the commission will conduct random on-site audits to verify the statistical data submitted in annual reports. Cable entities will be required to file additional EEO information in the year in which they are investigated.

The FCC will certify compliance if a cable entity is making "reasonable and good faith efforts" in the EEO area. Certification will be granted irrespective of any disparity between the numbers of minorities and women employed in specific job categories and their respective proportions in the relevant labor market.

This is a different approach than the commission uses to review a broadcast renewal applicant's EEO performance. Generally, broadcasters are required to demonstrate statistically that the percentages of females and minorities they employ are at least half of the percentages of females and minorities in the work force. In the top four categories (managers, professionals, technicians and sales representatives), broadcasters must employ 25% of the workforce percentages of minorities and women.

Forfeiture actions

In recent weeks, the commission has imposed the following fines for violations of its rules:

$3,200 *Section 17.56(a)—failure to replace or repair tower lights, automatic indicators or control systems; 73.49(a) (8)—failure to maintain a locked fence gate at antenna tower; and 73.1860(a)—failure to have at least one licensed operator on duty.*

$4,300 *Section 73.44(a)(3)—emission of spurious signals; 73.49(a)(8) failure to enclose an antenna tower within a locked fence; 73.932 (a) and (d)—failure to have an operating EBS receiver and failing to log EBS tests; 73.1590(a)(6)—failure to make equipment performance measurements for two years; and 73.3526(a)—failure to make the public inspection file available.*

$10,000 *Sections 73.1125(b)(2) and 73.1690(b)(3)—relocation of main studio, transmitter and antenna outside the principal community without approval; 73.1870(b)(3)—failure to post a copy of the chief operator designation with the operator's license; and 73.3525(a)—not making available the complete public file.*

Repeated violation of rules concerning remote control operation.

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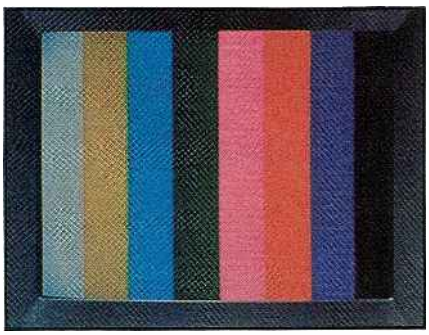
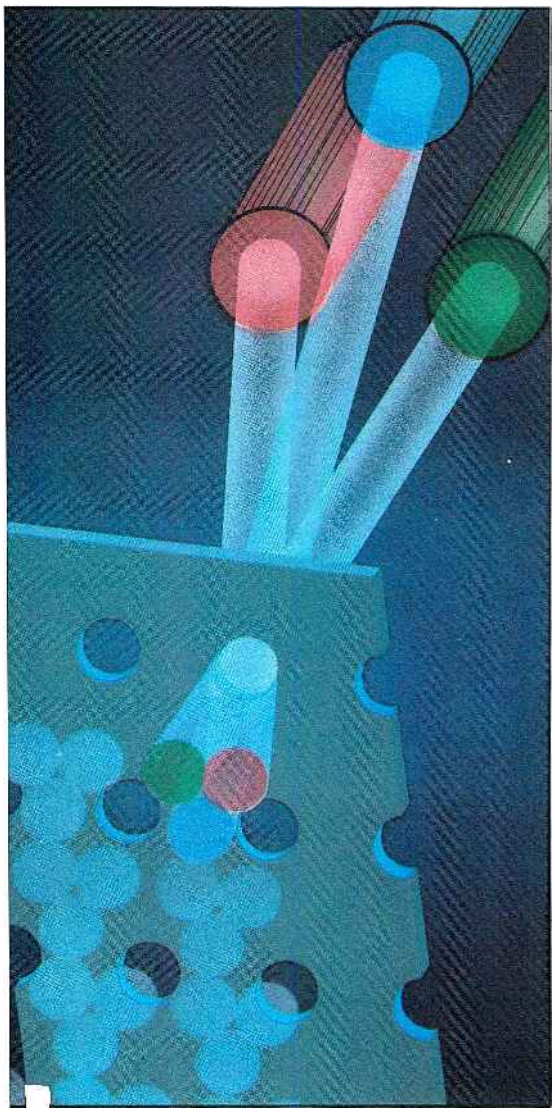
Inside CRTs

By Carl Bentz, TV technical editor

If you've ever converged a color TV monitor, you know it's not necessarily a simple process. You try to adjust three deflection currents that will cause three electron beams to trace a specific path across the faceplate of the tube. For proper convergence, the three beams must come together at the shadow mask, pass through one hole of the mask simultaneously, then diverge slightly as they fall onto a faceplate phosphor triad. With misconvergence, color fringes appear along edges of images because one or more beams have passed through the wrong hole.

Convergence difficulties usually result from sweep and deflection circuit instabilities and differently aged components. Three deflection circuits each involve *tilt, pin-cushion, lateral* and *vertical* adjustments. Each adjustment for a color may interact with other adjustments for that color, and sometimes with other colors.





Submillimetric

Placement of the CRT phosphors during manufacture is even more critical. Surprisingly, however, preparation of the phosphor layer on the faceplate has not changed significantly since Dr. Harold Law developed the first practical color TV picture tube in 1950 at RCA Research Labs. Law used photographic methods to produce phosphor dot triads on the faceplate.

Today, photography is combined with computer control accuracy to produce both dot and stripe CRTs. Distances between the centers of the dots measure less than 1mm on most tubes. For high-resolution or HDTV images the distance is 0.33mm or less.

Because the phosphors emit only small amounts of light, a means to increase the apparent light output is necessary. Viewing in a darkened room helps. Increasing the apparent contrast between the phosphor dots and their immediate surroundings is the illusion used by the *black matrix* CRT.

Exposing developments

The process begins with a glass faceplate blank and a shadow or dot mask. The thin metal mask contains an array of pinpoint holes through which the three electron beams of the tricolor CRT will simultaneously illuminate only one triad of phosphor dots at a time.

A slurry of light-sensitive black masking material is poured onto the inside surface of the faceplate and allowed to dry. With the shadow mask in place, the material is exposed through the holes in the mask. Exposures are made from light sources at the locations corresponding to the electron gun positions of the completed CRT.

The masking material compound becomes soluble at those points exposed to the light. Unexposed material solidifies into a *matrix* that will surround the phosphor dots to be placed in later steps. The soluble material is washed away, leaving triads of pinholes corresponding to each of the holes in the shadow masks.

R, G & B

The procedure is repeated three times, using slurries of the red, green and blue phosphors. With the red mixture on the faceplate, an exposure is made from the position of the red gun. Exposed material chemically hardens, leaving dots of red phosphor filling only those positions illuminated from the red gun position. Unexposed red slurry is washed away and replaced by mixtures for blue and green. In each case, an exposure is made from the precise electron gun position for that color.

With the phosphor dots in place, an ultrathin reflective layer (such as aluminum) covers the matrix-phosphor layer. The aluminum forces the minute phosphorescence to come through the faceplate, rather than going back into the tube. The aluminum must be thin (only a couple of atoms thick) for easy penetration by the electrons to the phosphors, but must be thick enough to reflect the light efficiently.

The same procedure applies to other tricolor tubes. With the delta-gun arrangement, an *in-line* gun structure may be used. In-line means that the electron guns are positioned in a straight line across the neck of the tube. The designation PIL (precision in-line) indicates an in-line gun design, which often produces fewer dynamic convergence problems.

Stripes

Other CRTs use phosphor stripes on the faceplate. In some, a *slot mask* is similar to the dot mask of the delta-dot design. The dots become short vertical stripes. In another stripe CRT, a wire grid replaces the mask. Potentials on each grid element deflect the electrons to their appropriate targets.

With the phosphor material in place, the tube is precisely assembled. All air is pumped from the glass envelope, leaving a hard vacuum environment for the electrons. Air or gas would be detrimental because it would not only cause the filaments to disintegrate, but it also would impede the electrons heading to their minute targets.

To predictably hit the right targets, the electrons must be totally under the control of magnetic and electrostatic fields of deflection coils and tube elements.

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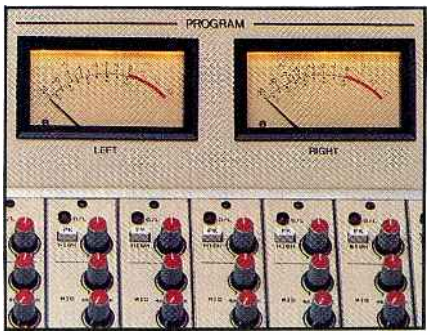
Skywave interference

By John Battison

Most AM radio engineers are familiar with groundwave and its propagation. However, the mere mention of *skywave* (the other type of AM broadcast signal) often panics even stout-hearted AM engineers. To help clear up some misconceptions about skywave propagation, we will discuss this phenomenon in this month's and next month's "re: Radio" column.

AM reception relies primarily upon groundwaves. The groundwave is comprised of three components: the direct wave, reflected wave and a surface wave. Of the three, the direct wave and surface wave provide the most reliable reception. Unfortunately, the range of the groundwave is limited.



Skywave reception depends on the ionosphere, a set of layers of ionized atmosphere surrounding the earth. These layers begin about 25 miles above the earth's surface and extend approximately 350 miles. The ionization of these layers changes according to the time of day, the season and the intensity of the sun's radiation.

The layers of the ionosphere are usually referred to as the D, E, F1 and F2 layers. The D layer is present only during the daytime, absorbing most of the AM band signals before they reach the E and F layers for refraction. At night, the D layer disappears.

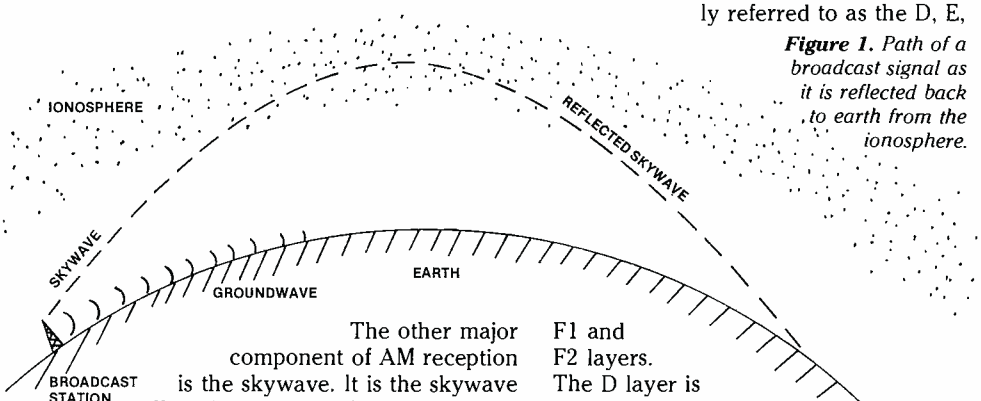
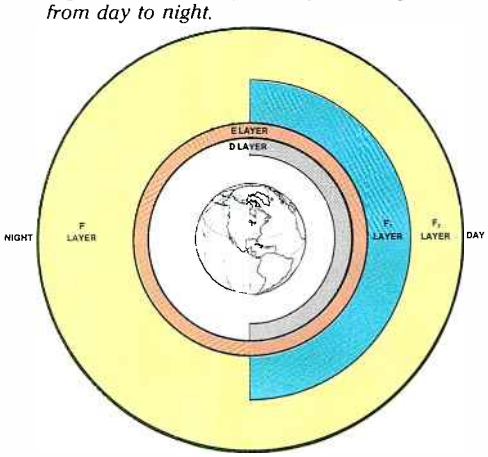


Figure 1. *Path of a broadcast signal as it is reflected back to earth from the ionosphere.*

The other major component of AM reception is the skywave. It is the skywave effect that accounts for long-distance reception of AM stations. Without the skywave, only high-powered stations could be heard consistently over long distances. The skywave behaves differently from the groundwave and is less reliable.

Figure 2. *The ionosphere layers change from day to night.*



The two separate F layers are present only during the daytime. At night, they combine into a single F layer. It's the E and F layers that provide the mirror effect that reflects AM broadcast signals back to earth. Whether the broadcast signals are bounced back to earth depends upon a number of factors, such as the frequency of the signal, the angle at which the signal enters the ionosphere and the density of the layer itself.

This reflection of broadcast signals presents a significant problem for the AM broadcaster. During the day, the broadcaster has to worry about interference from nearby stations, but at night, additional interference can be caused by facilities located hundreds or even thousands of miles away. FCC experiments have demonstrated that although weak skywaves can exist in the daytime, their effects are not normally considered significant.

Skywave prediction

The commission provides several charts to help predict the interference level from skywave signals. Three charts (Figures 1, 1A and 2) from section 73.190 are used to predict this interference, broken down for two classes of stations. Figures 1 and 1A are used in interference calculations for clear-channel stations. Regional and local stations use Figure 2. The primary difference between the charts is that Figure 2 takes into account the effect of latitude on skywave propagation.

It has been only within the past 20 years that serious attention has been paid to the effect of latitude on skywave signals. Many different types of skywave measurement programs have been undertaken in an attempt to better understand and to predict skywave. One such study produced a set of skywave curves known as the *Cairo curves.* Developed just prior to World War II by the International Radio Consultation Committee (CCIR), the Cairo curves take into account the differences in skywave based on latitude paths. The high-latitude paths pass near the magnetic poles and the low-latitude paths are near the equator.

Although the CCIR curves proved useful in the early days, they are far from being accurate. One of their primary drawbacks is that they tend to indicate low field strengths in low-latitude locations and high field strengths in high-latitude locations. Even the FCC curves are not perfect. Developed in the mid-1930s, they are somewhat out of date with respect to current AM broadcast conditions.

New FCC curves

The FCC has been trying to update its prediction curves on skywave interference. It recently approved a new propagation curve for Class I-N stations located in Alaska. For propagation calculations involving signals inside and outside Alaska, a combination of the new and old curves is used.

Although using these new curves isn't difficult, some engineers find them intimidating. The secret to developing skill in the use of the skywave curves is *practice.* Next month, we will discuss how these curves are used to calculate nighttime skywave signal strengths. Until then, study sections 73.185 to 73.190 of the FCC rules. They will provide the background for December's "re: Radio."

Battison is **BE**'s consultant on antennas and radiation.

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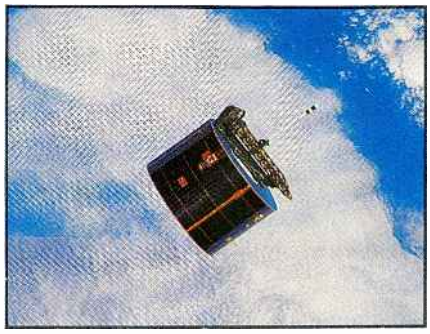
Preparing for winter

By Elmer Smalling III



The annual TVRO maintenance check is due. As winter approaches, many broadcasters can expect at least three or four months of conditions that test the performance of the best satellite earth station equipment. Most affected by bad weather are the outside system components—antenna, support base, de-icer, feedhorn and support, LNA (low-noise amplifier) and cable.

If you've experienced video noise and jitter, your satellite system may need attention. You expect a 50dB to 52dB signal-to-noise ratio from a studio camera or first generation 1-inch videotape. Your satellite signal quality should be just as good. Take time to winterize your equipment now.

Dish watching

The antenna dish should be inspected for tears, dents, bends, corrosion and loose petals (sections). Surface disturbances greater than one eighth of an inch can affect the received signal quality. Because the space signal loss from satellite to TVRO antenna is about −192dB, you need all the gain you can get. An irregular reflector surface does not concentrate the weak signals as it should.

Make certain that the dish is attached securely to the base and cannot be moved by forceful pushing or pulling on the lip. A stiff breeze should cause no movement.

Two adjusting screws between the antenna and base help to secure the dish and to determine how well the unit is *boresighted* (aimed at the satellite to be received). These adjustments should have been made properly at the time of installation. If the adjusting screws were not tightened, or if the dish has been exposed to high winds, ice or vandalism, the antenna may have moved off boresight enough to degrade reception.

On target

If you are unfamiliar with satellite operations, you may elect to hire a qualified dish technician to make alignment adjustments. If you wish to make the adjustments yourself, the first setting to check is the azimuth, or the horizontal (east-west) movement control.

Antennas on azimuth-elevation (AZ-EL) mounts are carefully positioned and their base tripods are set in cement during installation. This type of mount prevents any significant azimuth changes. For an antenna mounted on a kingpost base, which allows it to swivel, loosen the horizontal lock and move the dish slightly east to west until you get a maximum reading on the receiver signal-strength meter. If your receiver does not have such a meter, use a portable meter or connect a VOM to the receiver AGC test point for this reading.

After you find the position for the maximum signal strength, tightly lock the horizontal adjustment. Make a scratch or paint a mark on the adjustment bolt to show the setting for future reference.

Next, check the elevation adjustment, usually a long threaded screw-jack at the back of the antenna, connected between the dish and base. This adjustment tilts the dish up and down. While turning the screw slightly, watch the signal-strength meter for a maximum indication. When you find the peak reading, tightly lock the adjustment, again marking the location for reference. (If the elevation control involves adjustment screws on each leg of the base, be aware that any change of one leg affects the others.)

Get in focus

The next checkpoint should be the feedhorn and its support. On prime focus feedhorn antennas, the horn and LNA are supported in front of the reflector on a pole or tripod structure. The support and LNA cover should be tight and secure.

For best reception, the main reflector focuses the signal into the open port of the feed assembly. If a feedhorn is positioned slightly too close to or too far from the main reflector, the signal will be out of focus and seriously degraded. If a tripod support uses adjustable turnbolts, make sure that all three legs are precisely the same length.

In some antenna designs, the feedhorn and LNA are located on a *hook* in front of the dish. The hook must be tightened securely to the dish. Check all LNA cables and connectors carefully for integrity. There should be no sign of moisture invasion at the connectors.

If you have a Cassegrain feed (the LNA is behind the center of the dish and a subreflector is located at the prime focus point), be sure that the subreflector (on its tripod support) is smooth. It shouldn't have any bumps or bends. The feedhorn and LNA behind the dish should be dry and clear. Look for signs of wasps or birds that have nested in the feedhorn or on the subreflector.

Many LNAs include a transparent window to cover the input port. The cover keeps dirt and moisture out of the high-gain amplifier. If the window is damaged, a new part should be ordered and installed as soon as possible. If a pressurized LNA system does not maintain proper pressure, this may be an indication of window problems.

Polarize with care

With any feed system, the feedhorn orientation is critical. Some transponders transmit vertically polarized signals; others are horizontally polarized. The feedhorn should have been matched to the selected transponder signal when your system was installed, as a means to avoid interference. If the feedhorn assembly is loose, carefully rotate it for a maximum signal on the meter. After the peak reading is found, fasten the assembly tightly in place.

De-icing on

Ice that forms in the TVRO dish acts as an attenuator to RF signals, and its surface replaces the smooth curve of the antenna with an irregularly reflecting layer. A properly working de-icer on your antenna prevents icing problems. Check the components of the de-icer system, but first disconnect the ac power. Observe the heating coils and blower lubrication and make certain that ventilation holes and air-discharge ports are not obstructed. Inspect flexible hot-air feed ducts for integrity. You may check the airflow with a simple manometer. An ammeter can be used to check for the specified current-draw to ensure that the heating system is doing its job.

Next month, we'll discuss maintenance of the indoor components.

Smalling, **BE**'s consultant on satellite/cable systems is president of Jenel Systems and Design, Dallas.

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Thyristor servo systems

By Jerry Whitaker, editor

Thyristor control of ac power has become a popular method of regulating high-voltage transmitter power supplies. The type of servo system employed depends on the application.

Background

The term *thyristor* identifies a general class of solid-state silicon-controlled rectifiers (SCRs). These devices are similar to normal rectifiers, but are designed to remain in a blocking state (in the forward direction) until a small signal is applied to a control electrode (the gate). After application of the control pulse, the device

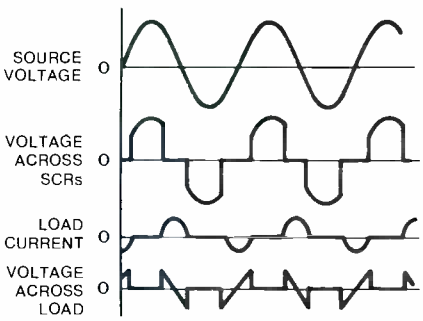


Figure 1. *Waveforms in an ac circuit using thyristor power control.*

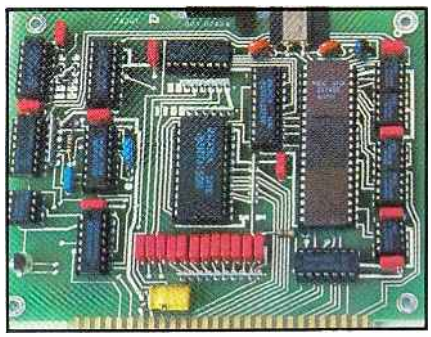
conducts in the forward direction and exhibits characteristics similar to a common silicon rectifier. Conduction continues after the control signal has been removed and until the current through the device drops below a predetermined threshold or until the applied voltage reverses polarity.

For ac power control applications, a means must be provided for triggering the gate after a particular delay in the alternating line voltage waveform zero crossing. By varying the *phase* of the trigger with respect to the ac waveform, power control of the output voltage can be accomplished. Device switchoff is obtained by the natural reversal of the supply voltage every half cycle in ac systems. The waveforms of Figure 1 illustrate the effects of ac phase control on an inductive load (without filtering of the dc supply output).

Ratings

The voltage and current ratings for thyristors are similar to the parameters used to classify standard silicon rectifiers.

Editor's note: Background information on thyristor operation is from the Howard W. Sams publication, *Reference Data for Radio Engineers, Sixth Edition.*



Some of the primary device parameters are:

- *Peak forward blocking voltage*

The maximum safe value that may be applied to the thyristor while it is in a blocking state.

- *Holding current*

The minimum anode-to-cathode current that will keep the thyristor conducting after it has been switched on by application of a gate pulse.

- *Forward voltage drop*

The voltage loss across the anode-to-cathode current path for a specified load current. Because the ratio of rms to average forward current varies with the angle of conduction, power dissipation for any average current also varies with the device angle of conduction. The interaction of forward voltage drop, phase angle and device case temperature are generally specified in the form of one or more graphs or charts.

- *Gate trigger sensitivity*

The minimum voltage and/or current that must be applied to the gate to trigger a specific type of thyristor into conduction. This value must take into consideration variations in production runs and operating temperature. The minimum trigger voltage is not normally temperature-sensitive, but the minimum trigger current can vary considerably with thyristor case temperature.

- *Turn-on time*

The length of time required for a thyristor to change from a non-conducting state to a conducting state. When a gate signal is applied to the thyristor, anode-to-cathode current begins to flow after a finite delay. A second switching interval occurs between the point at which current *begins* to flow and the point at which full anode current (determined by the instantaneous applied voltage and the load) is reached. The sum of these two times is the turn-on time.

- *Turn-off time*

The length of time required for a thyristor to change from a conducting state to a non-conducting state. The turn-off time is composed of two individual periods: the storage time (similar to the storage interval of a saturated transistor) and the recovery time. If forward voltage is reapplied before the entire turn-off time has elapsed, the thyristor will conduct again.

Application considerations

A thyristor can break over into a conducting state regardless of gate drive if an excessively high positive voltage is applied between the anode and cathode or if a positive anode-to-cathode voltage is applied too quickly (dv/dt rating). If the leading edge is sufficiently steep, a small voltage pulse can turn a thyristor

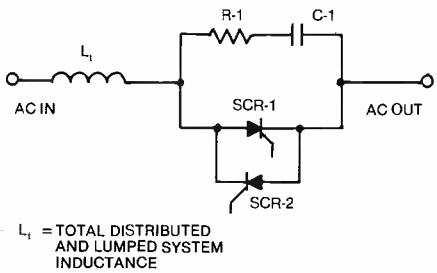


Figure 2. *The basic R-C snubber network commonly used to protect thyristors from fast rise time transients.*

on. This represents a threat not only to the device, but to the load it controls.

Any application of a thyristor must take into account the device's dv/dt rating and the electrical environment in which the unit will operate. A thyristor controlling an appreciable amount of energy should have protection against fast rise time transients that may cause the device to break over into a conducting state.

The most basic method of softening the applied anode-to-cathode waveform is the resistor/capacitor snubber network shown in Figure 2. This standard technique of limiting the applied dv/dt relies on the integrating capability of the capacitor. In Figure 2, C-1 shunts the excess transient energy, while R-1 defines the applied dv/dt with L, the external system inductance.

An applied transient waveform (assuming an infinitely sharp transient wavefront) will be impressed across the entire protection network of C-1, R-1 and L. The total distributed and lumped system inductance, L, plays a significant role in determining the capability of C-1 and R-1 to effectively snub a transient waveform.

In this month's "Troubleshooting" column, we examine transmitter ac power control problems.

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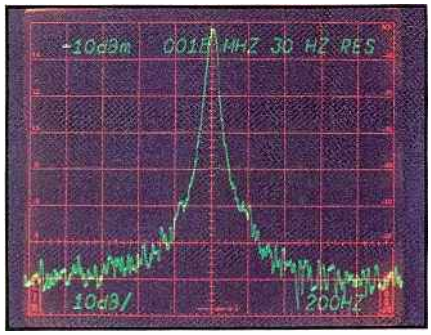
Part 3

Troubleshooting

Power supply failures

By Jerry Whitaker, editor



Preventive maintenance for the primary ac power system of a broadcast transmitter usually involves checking for loose connections and overheating of individual components. Although primary ac distribution methods differ in various transmitters, some generalizations can be made with respect to maintenance.

Maintenance routine

During each maintenance session (after all ac power has been removed from the unit), check all connections in the primary power system for tightness. Because of the high currents normally associated with the primary ac supply, secure connections are important. Inspect the system wiring for any signs of overheating or insulation breakdown. Gently tug on wires terminated in crimp connectors to confirm tightness. Be careful, however, not to stress the connectors.

Inspect all power contactors for any signs of wear. Experience will tell how often (if at all) the contact points of each contactor need to be cleaned. Whenever cleaning relays or contactors, be certain to use the proper tools. Cleaning kits are available that make the job quick and easy. Inspect the mechanical linkage of all power contactors to confirm proper operation. The contactor arm should move freely, without undue mechanical resistance.

Vacuum contactors should be inspected for free operation of their mechanical linkages and for any indications of excessive dissipation at the contact points and metal-to-glass (or metal-to-ceramic) seals. Contactors, vacuum or conventional, should never run hot.

Just after signoff (and after all ac power has been removed) carefully check individual components in the primary ac supply for overheating. Most devices should run warm, but not hot, to the touch. Check vacuum and conventional contactors, transient suppression components, fuse holders and circuit breakers. Excessive heating of a circuit breaker can be an indication of impending failure. If appreciable heating is detected, contact the factory to ask whether this condition is normal. Replace any parts found to be defective or damaged.

Power transformers and reactors normally run hot to the touch. Check both the transformer frame and the individual windings. On a 3-phase transformer, each winding should produce about the same amount of heat. If one winding is found to run hotter than the other two, further investigation is warranted. Be careful when checking transformer heating because some units can run quite hot to the touch. For this reason, stations that sign off at night should run the transmitter for 15 minutes or more, with filaments only, to allow controlled cooling of the power transformers.

Check the mechanical operation of circuit breakers. They should provide a definite snap to the off position (all ac power should, of course, be removed for this test) and they should firmly reseat when reset. A circuit breaker that is difficult to reset should be replaced.

Regular inspection of the primary ac power system is important to prevent potentially catastrophic transmitter failures. When a failure occurs, your operators should walk into the transmitter room and briefly check for signs of smoke before trying to manually restart. Repeated attempts to bring up a transmitter with a serious fault condition may lead to expensive and time-consuming repairs.

Protection circuits

Many engineers enjoy a false sense of security with transmission equipment because of the protection devices included in most designs. Although conventional overload circuits provide protection against most common failure modes, they are not foolproof. The first line of defense in the transmitter, the ac power system circuit breakers, can allow potentially disastrous currents to flow under certain fault conditions.

Consider the thyristor ac power servo system shown in Figure 1. This common type of voltage-regulator circuit adjusts the condition angle of the SCR pairs to achieve the desired dc output from the high-voltage power supply. An alternative configuration could have the output voltage sample derived from a transmission line RF pickup and amplifier/detector. In this way, the primary power control is adjusted to match the desired RF output from the transmitter.

If one of the high-voltage rectifier stacks of this system failed in a short circuit condition, the output voltage (and RF output) would fall, causing the thyristor servo circuit to increase the conduction period of the SCR pairs. Depending on the series resistance of the failed rectifier stack and the rating of the primary side circuit breaker, the breaker may or may not trip.

Remember that the circuit breaker was chosen to allow operation at full transmitter power with the necessary headroom to prevent random tripping. The primary power system, therefore, can dissipate a significant amount of heat under reduced power conditions, such as those that would be experienced with a drop in the high-voltage supply output. The difference between the maximum designed power output of the supply (and, therefore, the transmitter) and the failure-induced power output of the system can be dissipated as heat without tripping the main breaker.

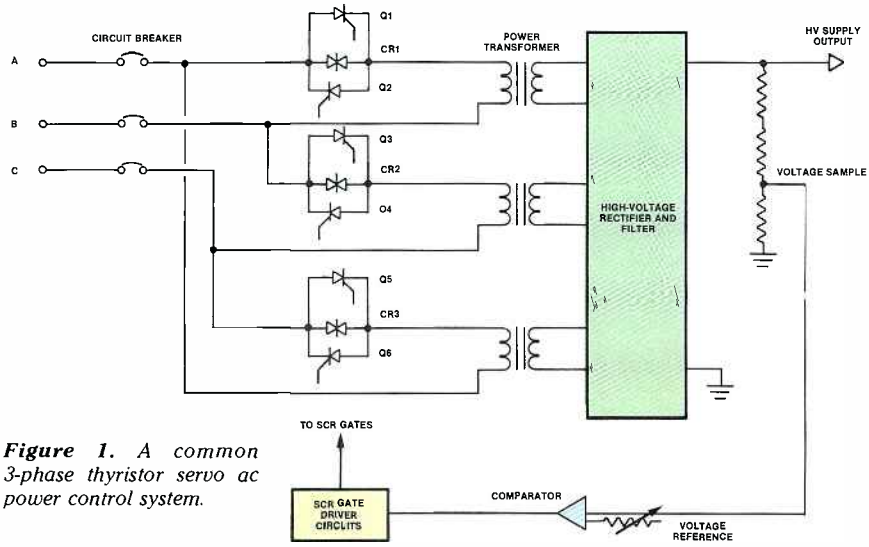


Figure 1. A common 3-phase thyristor servo ac power control system.

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Maintaining UHF transmitters

By Andrew H. Whiteside

To properly maintain your transmitter system, see it...hear it... feel it.

It is a generally accepted fact that the transmitter is the single most expensive item for a TV station. Its operating cost is also high on the monthly budget, especially in the case of the UHF station.

In many cases, the transmitter is located some distance from the main center of operations, the studio site, and quite often in a hostile environment that is difficult to access during certain times of the year. "Out of sight, out of mind," however, does not apply. When ol' faithful finally stops producing a reasonably accurate copy of what the studio puts into it, the engineer is expected to correct the problems that careful routine maintenance might have prevented, or foretold. The engineer may feel just as qualified to perform a miracle or two.

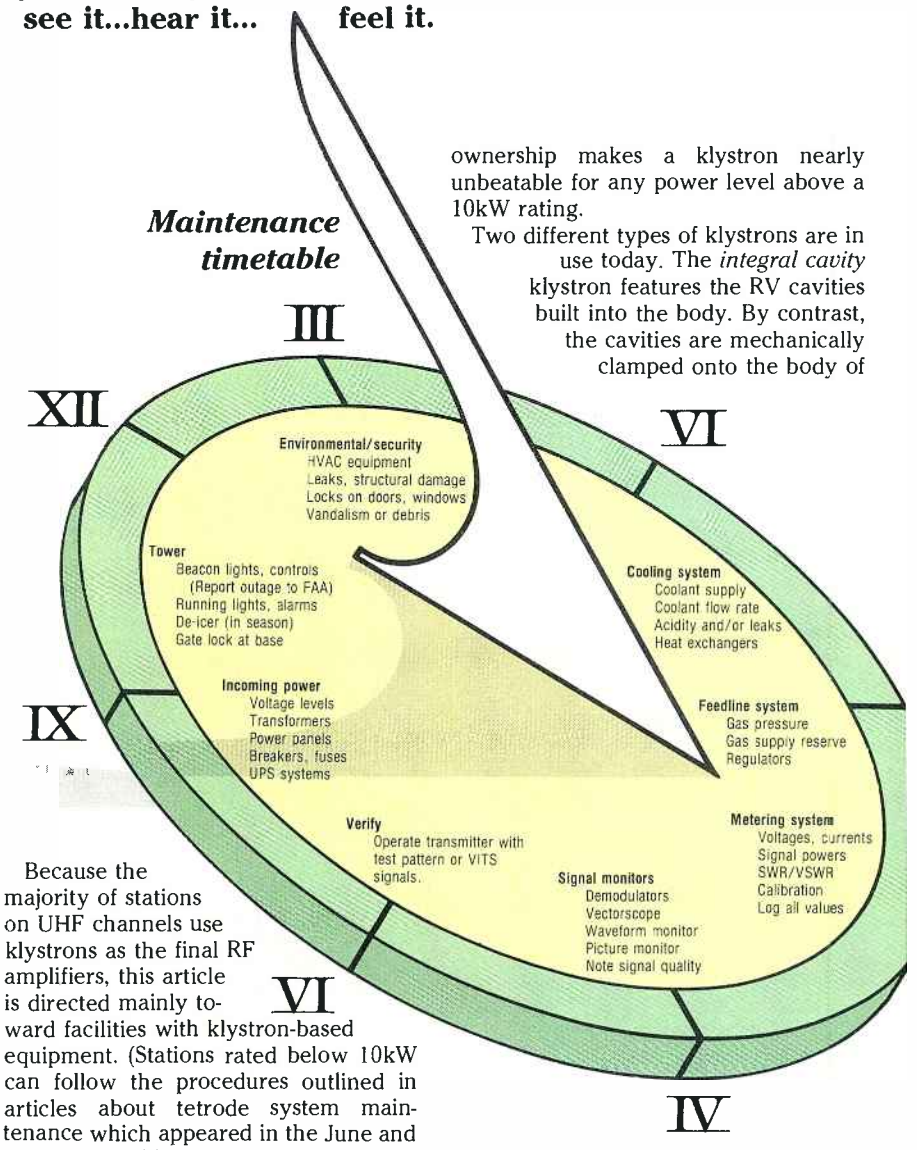
There is nothing mysterious about maintenance. It requires careful thought about your transmitter and its needs. If you have questions, the customer service and engineering departments of the equipment manufacturer should be consulted. With their help, a written procedure should be prepared and religiously followed.

UHF transmitters

Most new TV stations signing on-air are operating on UHF assignments. Consequently, many of the technical personnel working at these stations have previous experience on VHF equipment, but are unfamiliar with the aspects of UHF system maintenance.

Signal-propagation characteristics at UHF frequencies lead to several major differences in equipment choices and system layout. To achieve coverage comparable to a VHF neighbor, for example, the UHF transmitter must put out a higher-power signal from an antenna that is, typically, mounted on a taller tower.

Whiteside is engineering manager at Comark Communications, Southwick, MA.



Because the majority of stations on UHF channels use klystrons as the final RF amplifiers, this article is directed mainly toward facilities with klystron-based equipment. (Stations rated below 10kW can follow the procedures outlined in articles about tetrode system maintenance which appeared in the June and November 1984 issues of **Broadcast Engineering**.)

Klystrons are expensive to buy and to operate. Compared to tetrodes, they require larger auxiliary components (such as power supplies and heat exchangers), and are physically larger. Yet, they are quite stable with high gain and may be driven by solid-state circuitry. They are simple to cool and are capable of long lives with a minimum of maintenance. In fact, the overall cost of ownership makes a klystron nearly unbeatable for any power level above a 10kW rating.

Two different types of klystrons are in use today. The *integral cavity* klystron features the RV cavities built into the body. By contrast, the cavities are mechanically clamped onto the body of the *external cavity* klystron and are outside the vacuum envelope of the device. This difference in construction calls for different maintenance requirements.

Although the klystron gun is generally air-cooled, the collector, body and cavities (the RF region) may be air- and/or liquid-cooled. At powers above 5kW, most klystrons depend upon liquid-cooling of the collectors, either through vapor-phase or conduction cooling. Both

methods have advantages and disadvantages and warrant some discussion regarding maintenance requirements.

Because increased losses occur at UHF frequencies, comparably sized coaxial components exhibit more heating and require careful attention in any maintenance program. The increased power needed for adequate UHF coverage demands larger, more efficient coaxial transmission line or, at higher frequencies of the band, waveguide. In addition, tower heights often exceed 1,000 feet to reach the desired coverage. The overall result of these UHF factors include more parts, more heat and, potentially, more problems.

Due to the cost and size of the transmitter system, few UHF stations own a standby transmitter. It is vitally important that the one and only main transmitter is well maintained in a well-controlled environment.

Good housekeeping practice

Excellent articles on the subject of general transmitter maintenance have been published. The principles outlined are valid for any transmitter, and need only a brief review before you get to specifics on UHF transmitters.

1. Know your transmitter.

You should regularly spend time at the transmitter site. Read the instruction manual thoroughly. Become familiar with the control functions and know where components are located *before* an emergency occurs.

Take complete sets of meter readings at least once a week. Include those that are located away from the front panel, such as transmission line pressure. Periodically review these readings. If a meter indication changes, it may be a sign. Do not ignore it.

The first thing a good service engineer will do is to request a full set of meter readings taken before and after a problem occurs. Even relatively small changes in readings may show that a trend is developing. Don't wait until something fails. Investigate.

An example of meter information in the UHF system involves the body-current system. A typical reading with average picture content is 50mA. Suppose that over a 4-week period the reading drops gradually to 30mA. No other indications show anything amiss. Yet, the decrease in the reading indicates an alternate path (besides the normal body-current circuitry) by which the electrons are returning to the beam power supply. (See Figure 1.) Several factors could cause the body-current variation. Eventually, each could have disastrous consequences, if allowed to run its course.

Water leaking onto the body-to-collector insulation of the klystron causes partial bypassing of the body-current circuitry. In time, this water corrodes the klystron envelope. Such corrosion may lead to a loss of vacuum and obvious klystron failure.

The body-current circuit is one of the more important protection circuits in the transmitter. It is essential that the circuit functions normally at all times and at full sensitivity in order to detect change when a fault condition occurs. Without the constant protection afforded by the body-current system, a momentary non-destructive condition eventually may lead to the loss of a klystron.

Pay particular attention to changes in meter readings. If such changes are found, consult the manual and/or the factory service department for advice.

Develop a feel for the sound of a healthy transmitter and all of its blowers, pumps and other components. There is no substitute for wandering around at the transmitter site with your eyes and ears open.

2. Take the patient's temperature regularly.

Maintaining the transmitter includes metering of vital temperatures, but take a look elsewhere, beyond the meters. Get to know how hot components feel to the touch when they operate normally. Ideal candidates for touch are motor housings, coaxial and waveguide transmission line and components, power supplies and circuit breakers.

Use caution, of course, and don't attempt to check items that normally run too hot to touch. The collector coolant outlet, for example, whether a vapor or liquid type, will be hot enough to burn the skin. Adhesive temperature labels (such as Omega labels) may indicate hot spots in such areas.

Look for and smell for overheated components. A good time to do this is just after sign-off, when you can turn everything off and get into areas that are normally interlock-protected.

3. Keep the transmitter clean.

The UHF transmitter final amplifier runs at higher voltages and currents (dc and RF) than its VHF counterpart. For example, a typical 60kW peak visual amplifier operates with an effective 25kV collector potential and 5.5A beam current. Dirt and dust accumulation on HV components quickly breaks down at these levels. Use isopropyl alcohol and a soft cloth to thoroughly clean insulators, ceramics and other HV components where the dirt tends to collect.

Check the air inlet filters on a regular basis and clean or replace them as

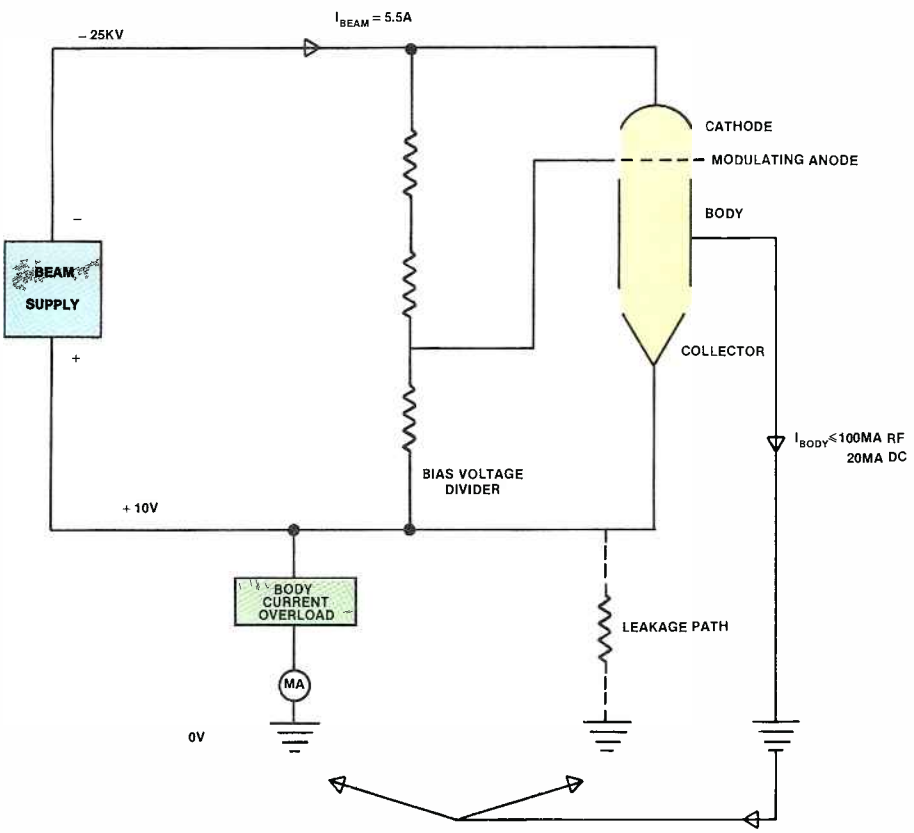


Figure 1. *Simplified HV schematic of a klystron amplifier shows the parallel leakage path, which causes a reduction in protection sensitivity of the body-current circuit. Leakage may result from high coolant conductivity or coolant leakage onto collector insulation or RF radiation shielding.*

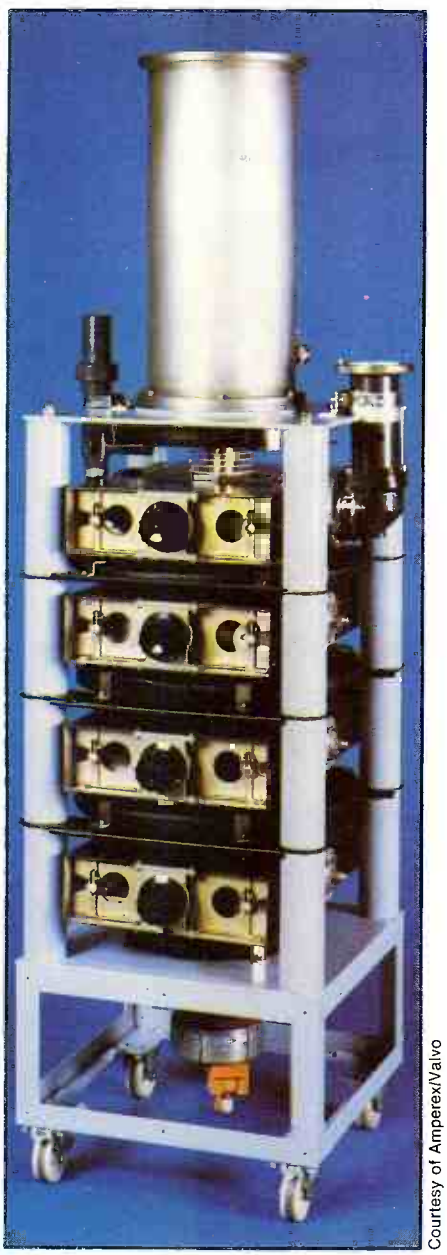
necessary. Ensure that cooling air flow is not restricted in any way.

4. Provide a healthy environment.

The transmitter building should be temperature-controlled and should provide protection against weather. Temperature extremes should be avoided, because exaggerated thermal cycling will accelerate aging in many components.

Be sure that the transmitter is adequately grounded and that incoming ac power is clean and reliable. Recurring overvoltage and undervoltage conditions may not trip the transmitter control circuitry, but will certainly cause unnecessary stress on components, insulation and motors.

A modern broadband external cavity 60kW klystron in its compact circuit assembly.



Courtesy of Amperex/Valvo

If random, unexplained component failures occur, consider installing some form of line protection and regulation. The added equipment may be expensive, but the cost will be made up in increased component life and reduced off-air time.

UHF system maintenance

• *The exciter*

With adequate ventilation and a clean ac power feed, this part of the transmitter is relatively maintenance-free. Visual and temperature checks are mandatory. Power-supply voltages and signal levels must be monitored regularly. Periodically tighten RF connectors, which may loosen due to vibration and temperature cycling.

Check the manual to determine whether the exciter can operate in a multiplex mode in the event of a failure in either the visual or aural signal chain. If multiplexing is possible, learn how the change is made.

• *Klystron amplifier needs*

The klystron and its support equipment represent the major difference between UHF and VHF transmitters. Most of the practical routine maintenance revolves around good housekeeping practices. However, certain areas deserve special attention for extended trouble-free transmitter operation.

First, obtain the manufacturer's data sheet on the klystron. The document contains invaluable information about the device and its operating conditions.

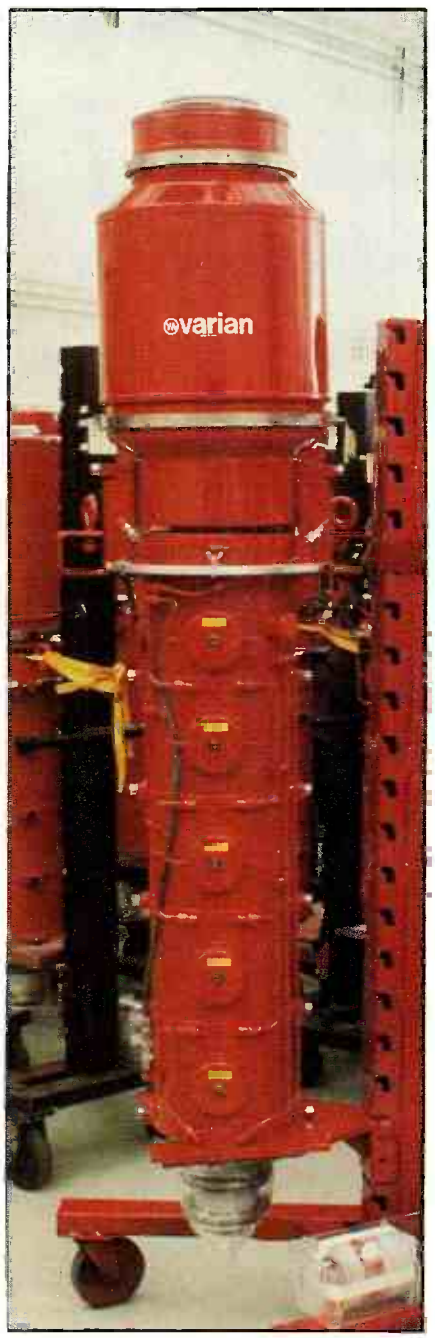
The *filament voltage* is as important a factor in klystron life as it is for a tetrode. The recommended voltages must be followed and checked on a regular basis. Measure the voltage at the filament terminals and calibrate the front panel meter accordingly.

Unless specifically recommended in the data sheet, do not reduce the voltage above the knee of the emission curve. Such a setting may cause uneven emission from the surface of the cathode with little or no improvement in the cathode life.

Do not leave voltage on the filaments for periods of more than two hours if no beam voltage is applied. The net rate of evaporation of emissive material from the cathode surface is greater without beam voltage. Subsequent condensation of the material on gun components may lead to voltage holdoff problems and an increased body current.

Check all control circuits to ensure that metering and protective circuits are fully operational.

Transmitter control logic will almost certainly be configured for two states. An *operational* level requires all the life-support systems to be present before the HV command is enabled. An *overload*



An integral cavity klystron showing RF region structure and cooling tubing.

level removes HV when one or more fault conditions occur. Inspect the logic for correct operation at least once a week.

At longer intervals, perhaps annually, check the speed of the trip circuits. (A storage oscilloscope is useful for this.) Most klystrons require an HV removal time of less than 100ms from the time of an overload. If the trip time is longer than this, you may be ordering another klystron sooner than expected.

Pay particular attention to the body-current overload circuits. Occasionally check the body current without applied drive to ensure that the dc value is

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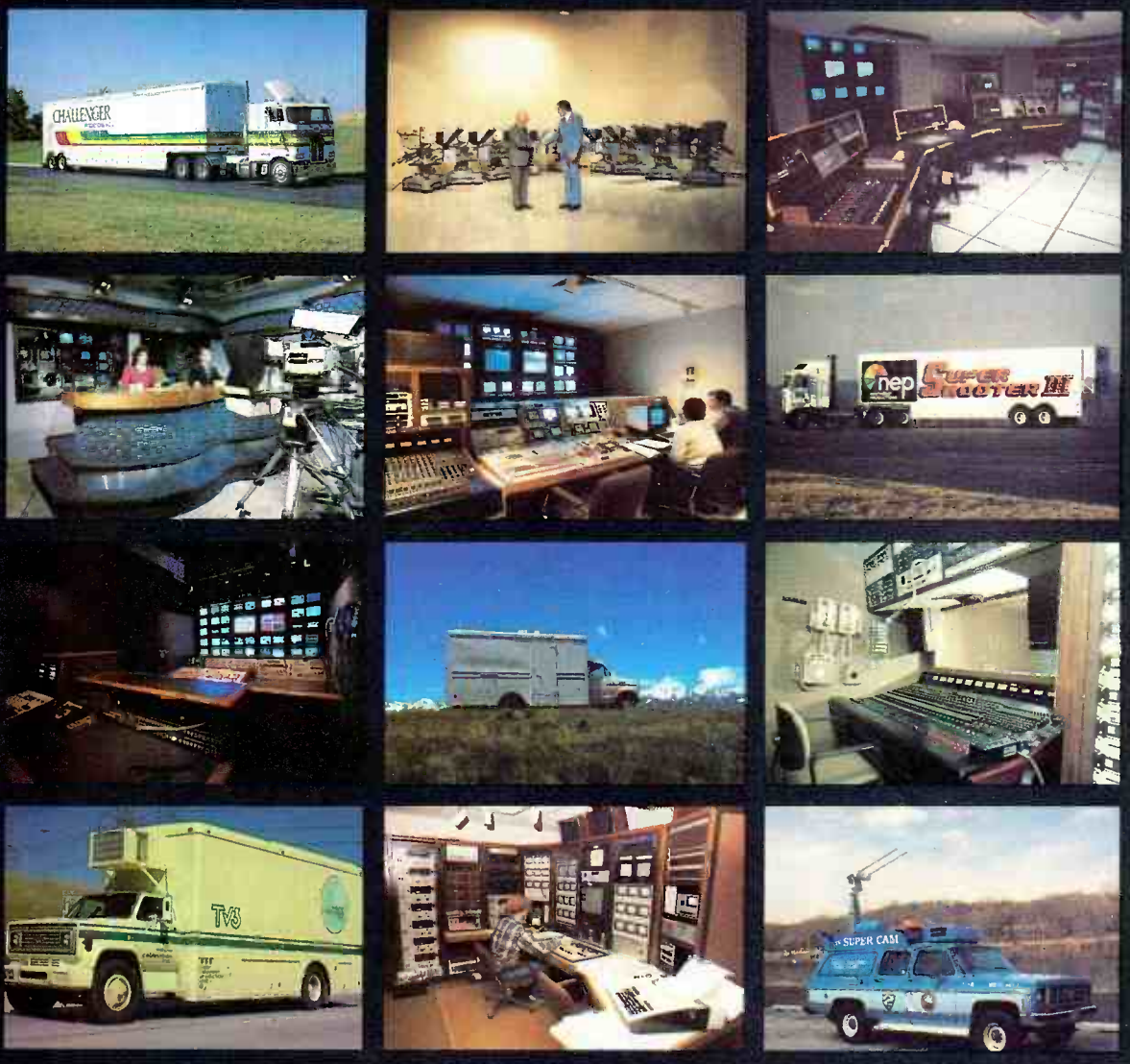

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stable. Relatively small increases in dc body current can lead to overheating problems. With no drive, all the electrons are moving at full velocity and, therefore, have maximum energy. The normal increase in current, caused when RF is applied, is due to slower electrons from the output region traveling with reduced energy and, as a result, is less likely to cause damage.

Other overload circuits requiring periodic monitoring are the *RF arc detectors.* External cavity klystrons generally have one detector in each of the third and fourth cavities. Integral devices use one detector at the output window.

A number of factors cause RF arcing: overdrive, mistuning, poor cavity fit (external type only), undercoupling of the output and high VSWR. Regardless of the cause, arcing can destroy the vacuum seal, if drive and/or HV are not removed quickly.

A lamp is included with each arc detector photocell for test purposes. If the lamp fails, a flashlight can provide sufficient light to trigger the cell until a replacement can be obtained.

A change in either amplitude or phase of output VSWR can lead to problems in the klystron output cavity, and may indicate potential problems in the high-power RF system. VSWR circuits should be calibrated and functionally checked regularly in the maintenance program. If changes occur in VSWR readings, determine the cause immediately.

The klystron body, or the RF interaction region of the integral cavity klystron, is cooled by the same liquid that is fed to the collector. The required maintenance involves checking for leaks and ensuring adequate flow is present.

Although the cavities of the external cavity unit are air-cooled, the body may be water- or air-cooled. Uncorrected leaks in a water-cooled body can lead to cavity and tuning-mechanism damage. Look inside the magnet frame with a flashlight once a week. Correct any leaks immediately and clean away any coolant residues.

The air-cooled body requires only sufficient air flow. The proper supply of air can be monitored with one or two adhesive temperature labels and close visual inspection. Look for discoloration of metallic surfaces.

The external cavities need a clean supply of air. Dust accumulation inside the cavities will cause RF arcing. Therefore, inlet air filters are used and should be checked regularly. Some cavities have a mesh filter at the actual inlet flange. This should be inspected regularly.

It is possible to take a look inside the cavities by removing the loading loops and/or air loops. This is recommended only when unusual behavior is experienced, and not as part of routine maintenance. Generally there will be no need to remove a klystron from its magnet frame and cavities during routine maintenance.

At one end of the heat exchanger system, coolant plumbing, pressure monitoring and pump powering arrangements are visible.

The heat exchanger system, on its concrete pad, allows unrestricted airflow. In the background are the feedline support structure and ice protection bridge.

Words on water

The cooling system is vital to the transmitter. In a UHF system, the cooling system must dissipate an average of 70% of the input ac power in the form of waste heat in the klystron collector. For vapor phase-cooled klystrons, pure (distilled or demineralized) water must be used. Because the collector is only several volts above ground potential, it is not necessary to use de-ionized water.

The collector and its water jacket act like a distillery. Any impurities in the water will eventually find their way into the water jacket and cause corrosion of the collector. It is essential to use high-purity water with low conductivity (less than 10mS/cm) and to replace the water in the cooling jacket every few months.

Efficient heat transfer from the collector surface into the water is essential for long klystron life. Oils, greases, soldering flux residues and pipe sealants containing silicone compounds must be excluded from the cooling system. This applies to both vapor- and liquid-conduction cooling systems, although it seems more critical in the vapor-phase type.

The sight glass in a vapor-phase water jacket allows a useful checkpoint on coolant condition. Look for unusual residues, oil on the surface, foaming and discoloration. If any of these appear, contact the manufacturer for advice on how to flush the system.

The quality of the water is essential to the liquid-cooled klystron as well. In general, greater flows and greater pressures are inherent in this device, and when leaks occur, large quantities of coolant can be lost before anyone realizes the problem. Inspect the condition of gaskets, seals and fittings regularly. A good opportunity for the inspection is during the spring system flush.

Most liquid-cooled klystrons use a

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distilled water and ethylene glycol mixture. Do not exceed a 50:50 mix by volume. The heat transfer of the mixture is lower than that of pure water, requiring the flow to be increased, typically by 20% to 25%. Greater coolant flow means higher pressure, and suggests that observation of the cooling system should be made after adding the glycol. Allow the system to heat and cool a few times. Then check all plumbing fittings for tightness.

The action of heat and air on ethylene glycol causes the formation of acidic products. The acidity of the coolant can be checked with litmus paper. Buffers can and should be added with the glycol mixture. Buffers are alkaline salts that neutralize any acid forms and prevent corrosion. Because they are ionizable chemical salts, the buffers cause conductivity of the coolant to increase. The collector-to-ground resistance should be measured periodically. If the resultant collector-to-ground resistance caused by the coolant is greater than 20 times the resistance of the body-metering circuitry, coolant conductivity is acceptable.

Experience has shown that the only practical way to ensure good condition of the coolant is to drain, flush and recharge the system every spring. The equipment manufacturer can provide advice on how this procedure should be carried out and can recommend types of glycol to use.

Maintain unrestricted airflow over the heat exchanger coils and follow manufacturers' instructions on pump and motor maintenance. Inspect any filters in the system after a flush is carried out.

Monitoring of incoming power and its distribution should be part of any maintenance program. Visual checks are generally sufficient. Look closely at all high-current contacts. If there is evidence of corrosion and excessive heat, remake the contact after cleaning the components.

From amp to antenna

The high-power RF system of virtually any high-power UHF station is externally diplexed after the final RF amplifiers with either coaxial or waveguide-type diplexers. Maintenance of combining sections is largely a matter of careful observation and record keeping, although you should monitor the reject loads on diplexers and power combiners regularly to ensure adequate cooling.

Check the temperature of the transmission line and components, particularly coaxial ones. Don't be surprised to find that coax of the same size runs warmer at UHF than at VHF stations. This occurs because the reduced skin or penetration depth of UHF signal current causes greater losses, thereby generating more heat in the material.

Hot spots in the transmission line can be caused by poor contact areas or by high VSWR. If they are the result of a VSWR condition, the hot spots will be repeated every ½-wavelength toward the transmitter.

Monitor the reverse power/VSWR meters closely. Some daily variation is not unusual, in small amounts. Greater variations that are cyclical in nature are an indication of a long-line problem—probably from the antenna. The fact that the lines are long at UHF (the taller tower allows greater coverage) and the wavelength is small leads to large phase changes of a mismatch at the antenna.

Mismatches inside the building do not cause the same cyclical variation. If the reverse power starts varying significantly, immediately arrange for an RF sweep of the line. You may be able to avoid major failure. Before you get into the sweep procedure, however, run the system with

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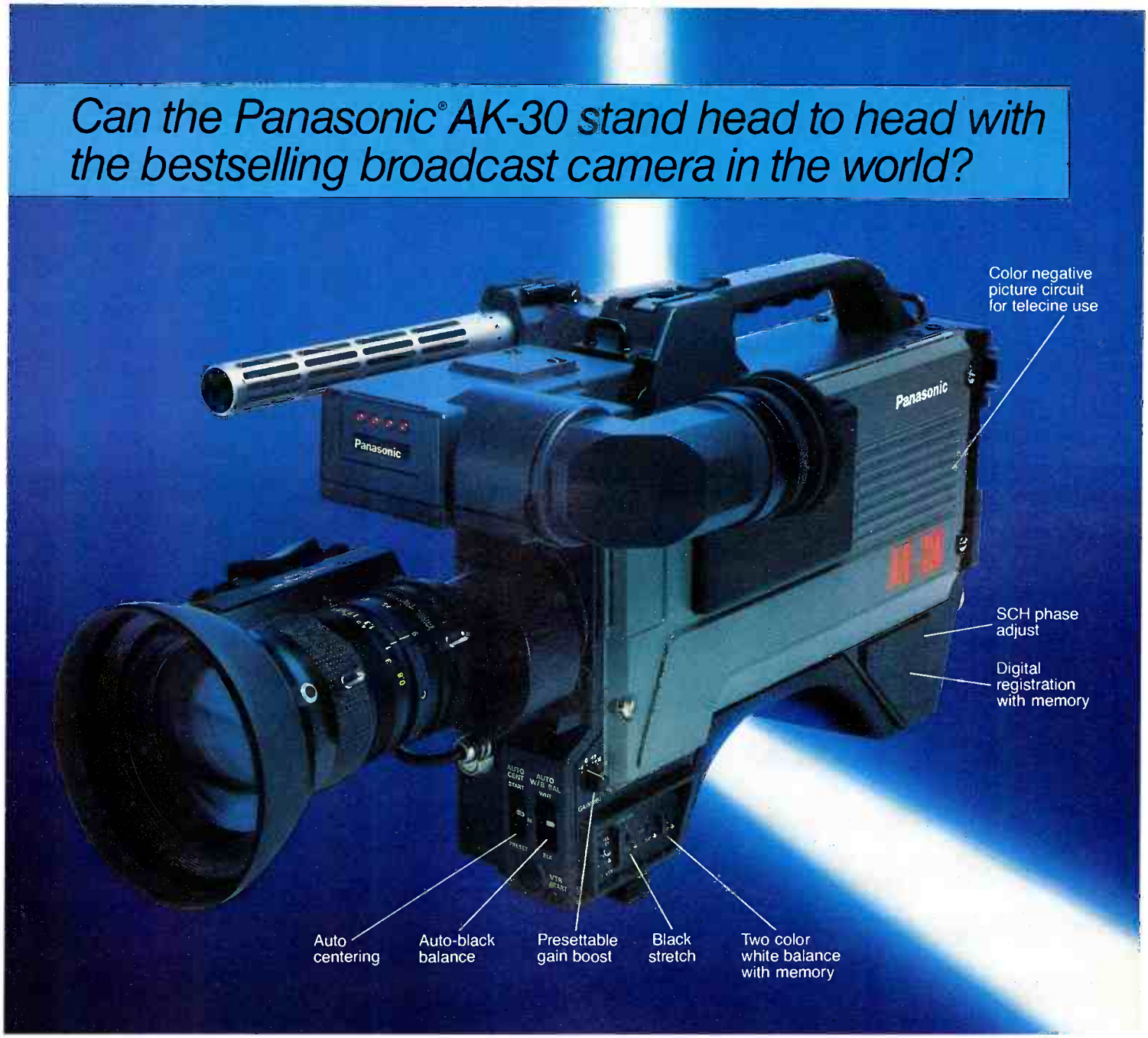

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the test load to see whether the problem disappears.

Another effect of VSWR variation is change in klystron output power. The output coupler transforms the line characteristic impedance upward to approximately match the beam impedance, for a maximum power transfer from the cavity. Large VSWR phase variations associated with long lines change the impedance that the output coupler sees. This causes the output power to vary, sometimes more significantly than the reverse power metering indicates.

Another indication of antenna VSWR problems that occur in long-line systems is ghosting on the output waveform. If the input signal is clean and the output has a ghost, call for an RF sweep procedure.

Always maintain positive pressure on the transmission line and antenna (if pressurized). Feedline pressurization keeps moisture out of the system and subsequently prevents oxidation. Disastrous burnups may occur when water collects on an insulator, causing oxidation and resulting increased attenuation. Check the feedline pressure at least once a week.

The final area to mention is the RF system test load. Although it probably isn't used very often, be sure you can use it when you need to. Occasionally check the filters and flow, as well as the resistance of the load element. It might have been damaged the last time you used it.

Preventing problems

It is not difficult to keep a UHF transmitter in good working order. It is a matter of discipline. Prepare a carefully thought-out maintenance procedure and follow it without exception. You'll probably find it infinitely more pleasant to tell your manager how you *avoided* a failure at the transmitter, rather than how you're going to *correct* one.

Finally, do not hesitate to call upon the factory customer service personnel for advice on maintaining equipment. They are familiar with a wider cross-section of problems than a station engineer is likely to encounter. They may be able to solve your problem based on their experience with another system.

Some customer service groups offer preventive maintenance programs. Factory-trained personnel are available to visit your station during large-scale maintenance checks (maybe twice a year) and to assist or to supervise the procedures. Because they see many different models of transmitters, they may be able to identify potential problems as well as to keep station personnel updated on the latest advances in transmitter maintenance.

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Cooling broadcast transmitters

By Jeffrey H. Steinkamp, P.E.

Thermal management is a critical aspect of transmitter maintenance, and a practical insurance policy against catastrophic failure.

An overheated transmitter is serious business. Excessive heat can cause shortened component life, or worse, immediate catastrophic failure. Even if the transmitter room or building is not occupied by station personnel, it is essential that the environment is properly controlled. The environment in which the transmitter operates will have a significant effect on the overall system reliability.

Design requirements

When setting out to develop a new transmitter design, the RF design engineer must try to create an environment that will be suitable for all the amplifying devices. The greatest environmental concern is thermal management. Without proper heat control, amplifying devices—tubes or transistors—are prone to failure. Although tubes can withstand a much wider range of operating temperatures than solid-state devices, they too have definite limits. Because most high-power radio and TV transmitters use tubes as the primary power-amplifying devices, our discussion will focus on dealing with the heat generated by tubes.

Many variables are involved in the internal transmitter cooling system. The fluid (or air) flow characteristics and the heat-transfer coefficient of a tube depend upon the flow path within the equipment. Also, increased flow velocity interactively affects these heat transfer functions.

Requirements external to the transmitter and power amplifier enclosure are more easily understood than the actual internal heat-transfer mechanisms. They are also factors over which the user has control.

For the external system, cooling design involves the selection of blowers and appropriate ducting to deliver and to remove a specified volume of air. Equipment commonly used in HVAC (heating, ventilating and air conditioning) systems is used to supply fresh air and to exhaust heated air. HVAC equipment is appropriate because, usually, another function of the external cooling system is to treat the air in the transmitter room.

Steinkamp is mechanical engineering manager at Broadcast Electronics, Quincy, IL.

At the crux

The heart of any transmitter is its power amplifier. Certainly exciters, power supplies and other components are essential, but these sections typically are not major sources of excessive heat. Cooling these sections is important, but not critical to the system.

The PA is a heat producer and must operate properly within the environment it creates. The cooling system, using forced air in many lower- to medium-power transmitters, helps to maintain a controlled environment for the PA so that it can operate reliably despite its heat output. Liquid and vapor-phase heat removal may be employed as the power output increases into the tens and hundreds of kilowatts.

The critical points of almost every PA tube type are the metal-to-ceramic junctions or seals. At temperatures below 250°C these seals remain secure, but above that temperature, the bonding in the seal may begin to disintegrate. Warping of grid structures may also occur at temperatures above the maximum operating level of the tube. The result of prolonged overheating is shortened tube life or catastrophic failure.

The hot spots

Special precautions are usually taken to prevent damage to tube seals under normal operating conditions. A look through your transmitter will reveal several air directors or sections of tubing that provide spot-cooling to critical surface areas of the PA tube. Close observation may show airflow sensors, specially designed actuators for microswitches, associated with the directors.

Checking for hot locations on the tube envelope is most easily done with temperature-sensitive paint. Available in a range from 125°C to 250°C (in approximately 10°C steps), the paint melts and changes appearance from dull to glossy when its thermal limit is reached. Dots of paint, in several sensitivities, can be placed around a tube to indicate possible temperature gradients.

In some cases, a thermocouple is ideal for measuring the temperature around the filament stem. (See Figure 1.) The thermocouple operates on the principle that as the junction between two dissimilar metals is heated, a dc voltage proportional to the temperature is produced. A DVM measurement of this voltage allows precise temperature readings. Care must be used to avoid all contact with potentially dangerous voltages, currents and RF radiation.

Coolant flow

Transmitter cooling system performance is not necessarily related to airflow volume. The cooling capability of air is a function of its mass, not its volume. The designer must determine an appropriate airflow rate within the equipment and establish the resulting resistance to air movement. A specified static pressure that should be present within the ducting of the transmitter can be a measure of airflow.

For any given combination of ducting, filters, heat sinks, RFI honeycomb shielding, tubes, tube sockets and other elements in the transmitter, a specified system resistance to airflow can be determined. It is important to realize that any changes in the position or number of restricting elements within the system will change the system resistance and, of course, the effectiveness of the cooling.

The altitude of operation may be a consideration in cooling system design. As altitude increases, the density (and cooling capability) of the air decreases. A calculated increase in airflow can maintain the cooling effectiveness the system was designed to achieve. With this infor-

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mation, the designer can select the proper blower for the transmitter.

The transmitter room

The external portion of the cooling system includes both the supply and exhaust air systems. Requirements of these systems will vary widely, depending upon the facility and the location of the transmitter installation.

The supply side of the system brings fresh, cool air into the transmitter room. The primary component needed is a fan and motor assembly capable of supplying a volume of air that is one and one-half to two times greater than the amount of air that actually flows through the transmitter. The blower, filters, louvers and dampers used will depend on the size of the room and the position of the transmitter, as well as on altitude, fluctuations in outside temperature and prevailing wind direction at the transmitter site.

Additional cooling capability may be required at some locations. Often, a simple window-mounted air conditioner may answer the requirement. Higher-power transmitters usually require the installation of a dedicated environmental control system. Such cooling units should be activated only if the transmitter room temperature exceeds an acceptable limit.

To determine the capacity required of additional cooling equipment, calculate the sum of all heat sources. Take into account heat generated by the transmitter, lighting, test equipment, station personnel, heat exchangers and other sources.

The exhaust side

For efficient operation, the heat generated by the transmitter must be removed from the room. An exhaust fan draws heated air through a capture hood or canopy located above the transmitter. Ducting, such as that used with HVAC systems, directs the airflow from the fan to the exhaust louvers and moves it outside the building.

Certain considerations are basic to the design of an exhaust system. Ducting and other components must not significantly restrict airflow. Unnecessary or excessively sharp turns increase the resistance to air movement and should be avoided. All components used in the system should be capable of withstanding temperatures of approximately 200°F, or 100°C. This includes motor windings, bearings and lubricants.

One restrictive element, a bypass damper, may be purposely placed in the exhaust system. In localities where winter temperatures plunge, some stations direct the transmitter exhaust into other rooms of the transmitter building to reduce energy costs. The bypass damper regulates movement of the exhaust air and may be automatically positioned through electrical, mechanical or pneumatic methods. This concept is illustrated in Figure 2.

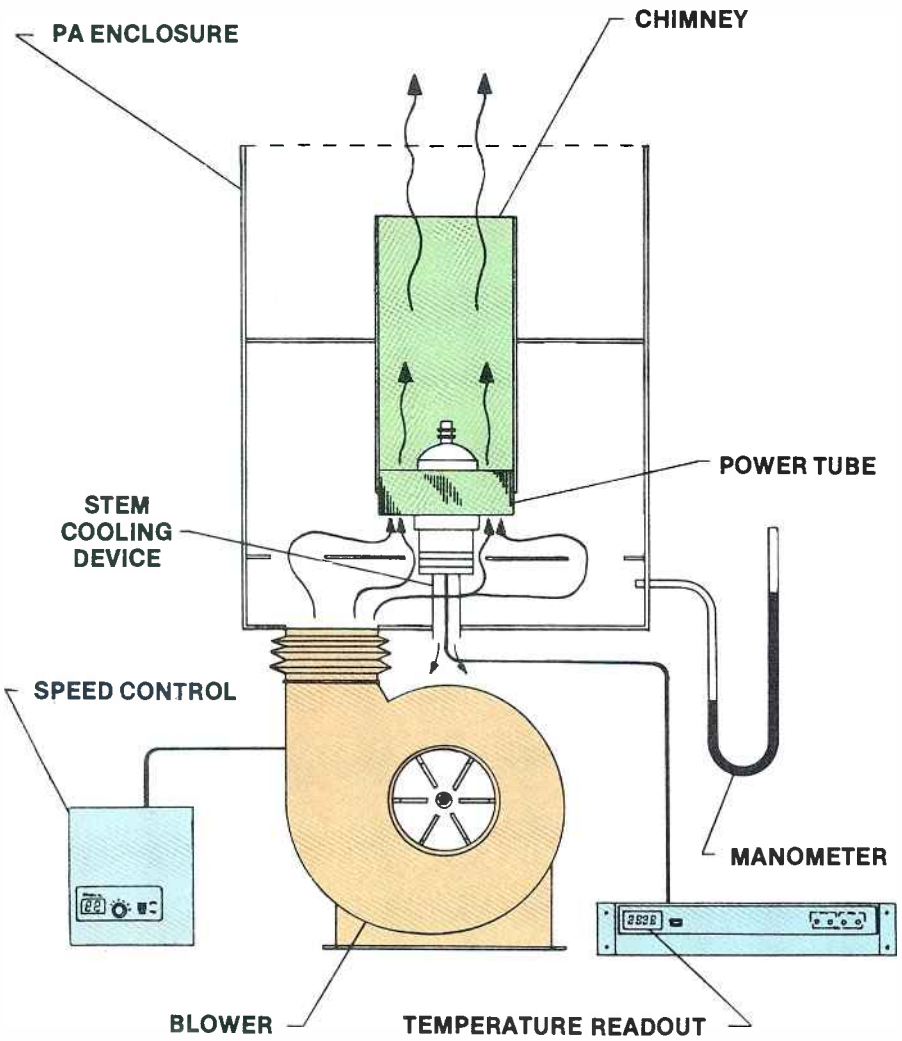


Figure 1. Effective cooling of the PA system is determined by the manufacturer using pressure and temperature measurements in conjunction with blower speed control.

Keeping cool

Keeping the transmitter operating at peak efficiency requires that all power amplifier stages are properly adjusted and tuned. To the engineer who is fully acquainted with the cooling needs of the transmitter, it is obvious that transmitter PA efficiency is critical to proper operation. A program of maintenance (similar to that used to maintain the electronic system) should be developed for the air- and/or water-cooling equipment. In your maintenance efforts for the airflow system, you should strive to retain the designed blower CFM (cubic foot per minute) flow and motor RPM ratings.

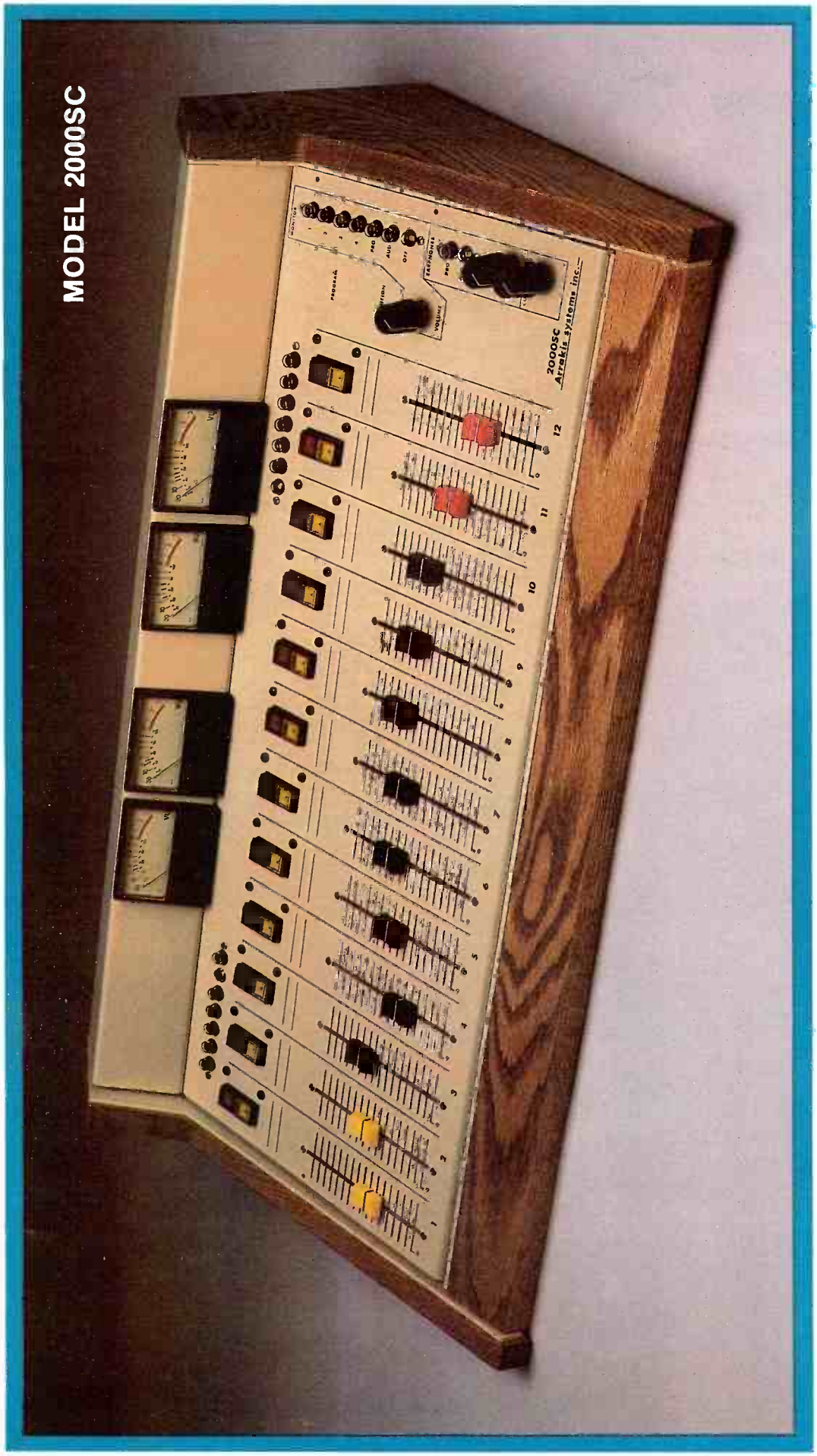
Airflow system problems can be avoided if preventive maintenance work is performed on a regular basis. For example, keep all fans and blowers clear of dirt, dust and other foreign material that might restrict airflow. Check the fan blades and blower impellers for any imbalance conditions that could result in undue bearing wear or damage. Inspect belts for tension, wear and alignment.

Bearings and other moving parts normally require some lubrication. Follow the manufacturer's specifications for suggested frequency and type of lubrication. Carefully follow any special instructions on operation or maintenance of the cooling equipment.

Inspect motor-mounting bolts periodically. Even well-balanced equipment experiences some vibration, which can cause bolts to loosen over time. Transmitter failure caused by a fan motor that has moved from its moorings is difficult to explain to management.

Movement of air throughout the system causes some static electrical charges to develop. Static charges can result in buildup of dust and dirt in ductwork, dampers and other components of the system. Filters should remove the dust before it gets into the system, but no filter traps every dust particle.

Inspect air filters weekly and replace



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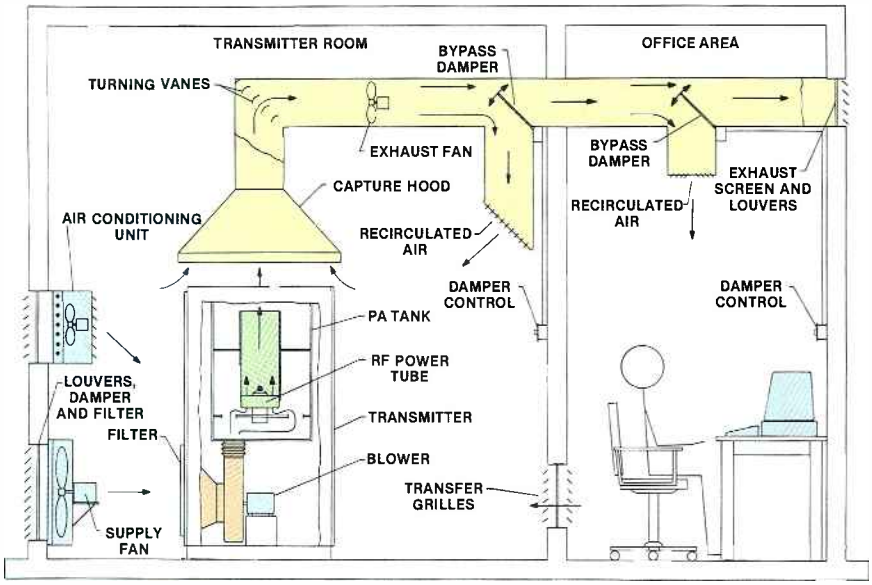

Figure 2. *A typical broadcast transmitter cooling arrangement using PA exhaust recycling for building temperature control.*

or clean them as necessary. Replacement filters should meet original specifications. Be aware that using two filters of the same type will not necessarily improve air cleanliness, and might impede airflow and produce component overheating.

Clean dampers and all ducting to avoid airflow restrictions. Lubricate movable and mechanical linkages in dampers and other devices as recommended. Check actuating solenoids and electromechanical components for proper operation.

Check the power-tube fins and tube socket for any blocked air passages. A shop vacuum cleaner or high-pressure air can be used to remove obstructions. Many equipment manuals indicate, however, that high-pressure air can force foreign matter into motor bearings. To avoid this, use air only around the tube socket or the tube fins after the device has been removed from the transmitter.

As you clean, note any tube or socket discolorations. Discoloration can be a forewarning of a major problem.

Check thermal sensors and temperature system control devices for proper operation. If you have questions about the operation of the cooling system control circuits, contact the transmitter manufacturer.

Proper design, operation and maintenance of the transmitter cooling system are essential for a reliable broadcast facility. The maintenance engineer must make sure that the cooling system provides an acceptable environment for the power amplifier device. Attention to the transmitter building design and a common-sense approach to repairs will keep the cooling system running at peak efficiency. |:(-))))|

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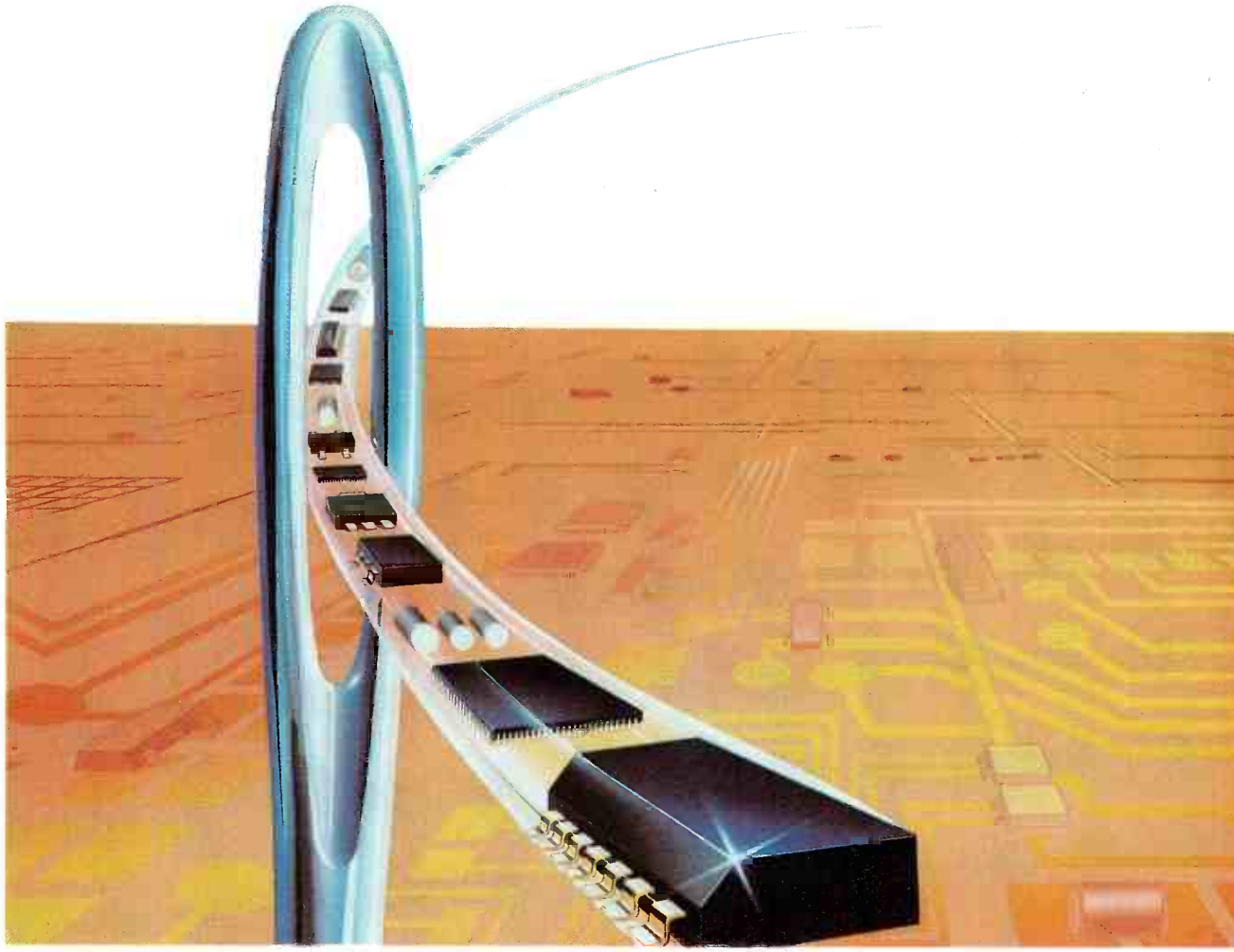

Replacing surface-mount components

Edited by Carl Bentz,
TV technical editor

To maintain broadcast equipment that uses surface-mount components, you may have to learn new soldering techniques.

The move toward the use of surface-mount components, instead of devices that solder into holes in printed circuit boards (PCBs), requires different soldering tools and techniques than used in the past. The reason is that a surface-mount component may be removed or installed only when all solder connections between component and board footprint are in the molten state.

Two methods allow efficient removal and replacement of surface-mount devices. Most applicable to the broadcast station is melting of solder by heat conduction. Convection heat transfer seems to be more practical in the manufacturing facility.

Conductive heating

Standard soldering irons transfer heat conductively through direct contact with the solder. A similar approach can be used with surface-mount components, but even 2-leaded devices require that heat is simultaneously applied to both connections. To apply the necessary heat for removal of a surface-mount device, a special soldering hand tool with two nickel tips should be used.

Continued on page 42

Ampex versatility, long appreciated by over 6100 users of the famous Ampex VPR-2, is part and parcel of its successor, the new VPR-6. But the VPR-6 brings you state-of-the-art performance and even more flexibility with multi-point search-to-cue, comprehensive integral editing, variable speed True-Frame™ playback, stereo audio, serial communications, and precision handling of everything from short spots to two-hour reels.

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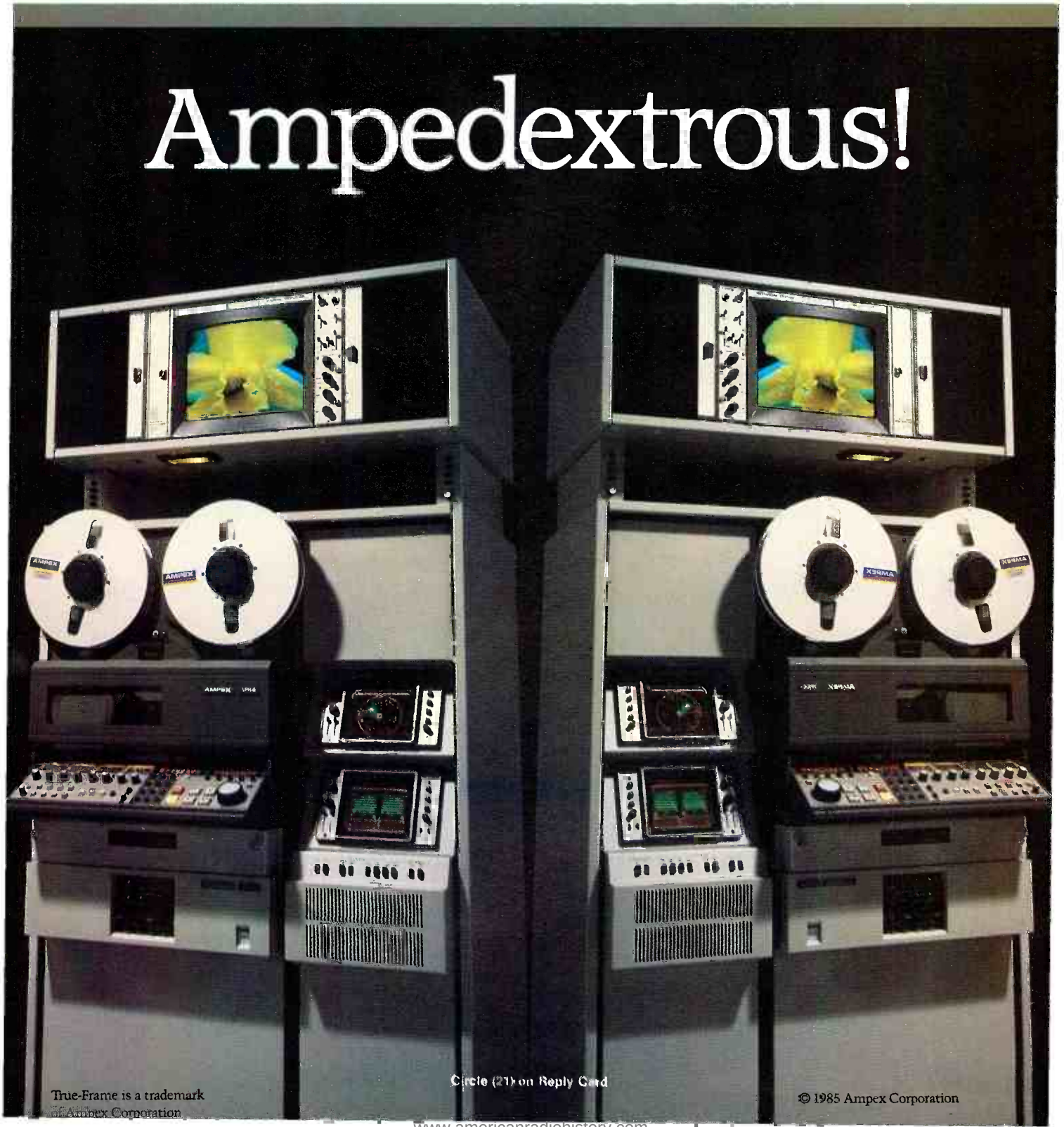

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You demanded reliability. Not wanting to tamper with success, we borrowed the tape transport and mechanical design of our reliable and proven VPR-80. We also eliminated most wire harnesses in favor of more reliable printed wiring boards and backplane connectors throughout. The modular package allows convenient access to any part of the VTR for easy maintenance.

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Continued from page 38

Each tip, connected to its own heating element, is shaped to contact and melt the solder on two adjacent surfaces of the carrier at the same time. The heating elements are mounted on hinged handles, permitting the tips to be aligned easily to the connections of chip carriers of various dimensions.

To accommodate various devices, the tool is available in sizes from 0.185 to 1.3 inches, and in square or rectangular shapes. The proper sized tool for any component should be slightly smaller than the device to be replaced.

Device removal

Whenever you are working with static-sensitive components, you must protect the PCB and its components from electrostatic discharge. As a precaution, place the PCB on a grounded work surface. The technician should wear a grounded safety wristband.

Inspect the board and its components to determine if a special approach is necessary to make the repair. With leadless components, solder fillets at the component lead and board footprint junction are important. If the fillets are small (or missing), solder should first be added to the juncture. The additional solder will provide better heat transfer to the junction from the soldering tool.

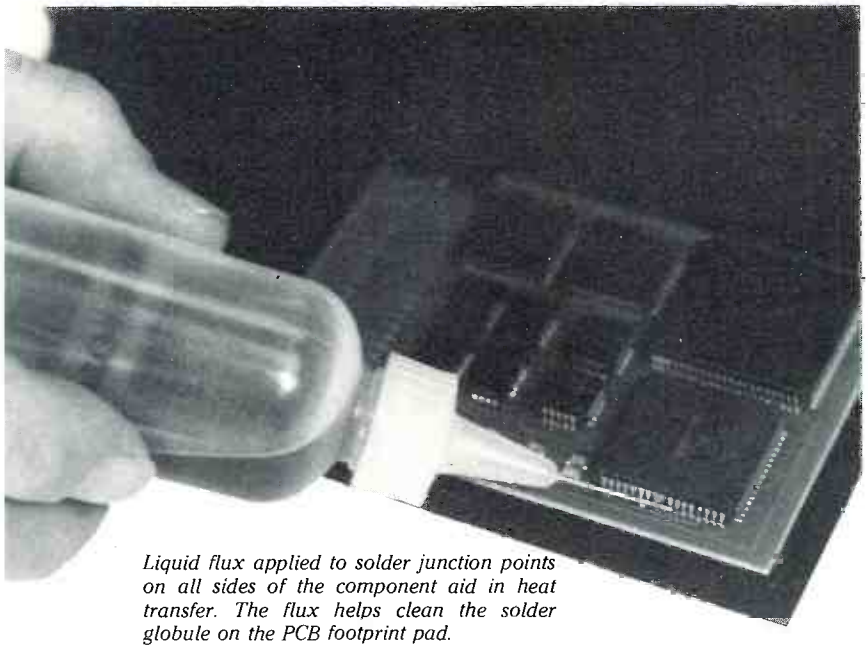
Rectangular tips with a heat-range control simplify removal and replacement of larger chip devices.

Some boards may require preheating before the removal of components. For circuits mounted on heavy heat sinks, preheating counteracts the heat-drain effect of the board material and the heat sink. Preheating some ceramic-based PCBs can prevent board damage from localized thermal expansion.

To remove a surface-mount device, the board may be secured in a holder on the grounded surface, or it may be held in your hand. Apply liquid flux to the solder junction points on all sides of the component. The flux aids heat transfer and provides a clean, ready-to-use solder globule on the board footprint pad surface when the device is replaced. Place the tips of the tool around the device flush with the board surface. Apply gentle, but firm pressure on the soldering tips to contact all four sides of the component simultaneously. When the solder is melted on all connections, lift the component away from the PCB. At this point, the tool functions like a pair of tweezers.

For surface-mount resistors and capacitors, a tool with two parallel tips must be used. The method of operation, however, is the same as for removal of 4-sided devices.

The soldering tool may be powered from a standard ac outlet. A solder-controller unit, available for some units, allows temperature-range adjustment and tailors heat settings to various board materials. The controller base also provides a convenient holder when the tool is not being used.



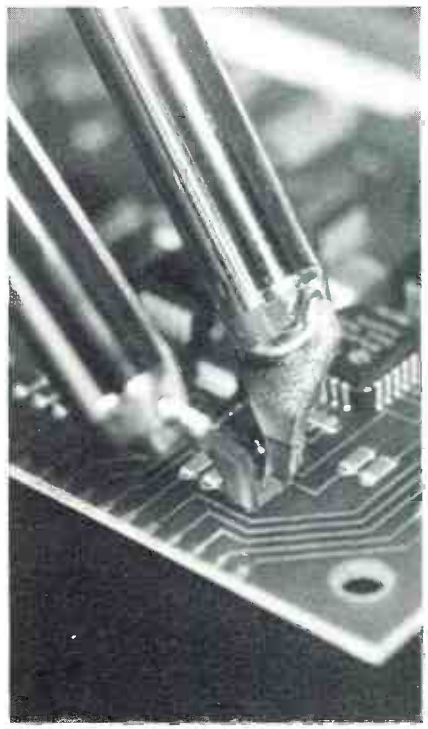
Liquid flux applied to solder junction points on all sides of the component aid in heat transfer. The flux helps clean the solder globule on the PCB footprint pad.

Device replacement

Replacement components should be pre-tinned to ensure maximum solder flow and strong connections between the board and component. Inspect the footprint for acceptable solder globules. If more solder is needed, apply solder cream to the PCB footprint pads. Use the cream sparingly to prevent bridging and uneven globule heights. Liquid flux may be used as an alternative.

To replace the component, align the new part with the PCB pad. While holding the component to the PCB surface with a probe, position the tips of the tool flush with the board surface and

Small components are removed with a parallel-type solder tool.



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around the component. For good heat transfer, apply slight pressure on the component. When the solder is melted, remove the tool and the probe. Allow the component to settle in place on the solder globule.

Device removal and replacement takes only three to five seconds. Replacement of the component requires a bit more dexterity than for removal, but both procedures can be learned quickly.

Tool care

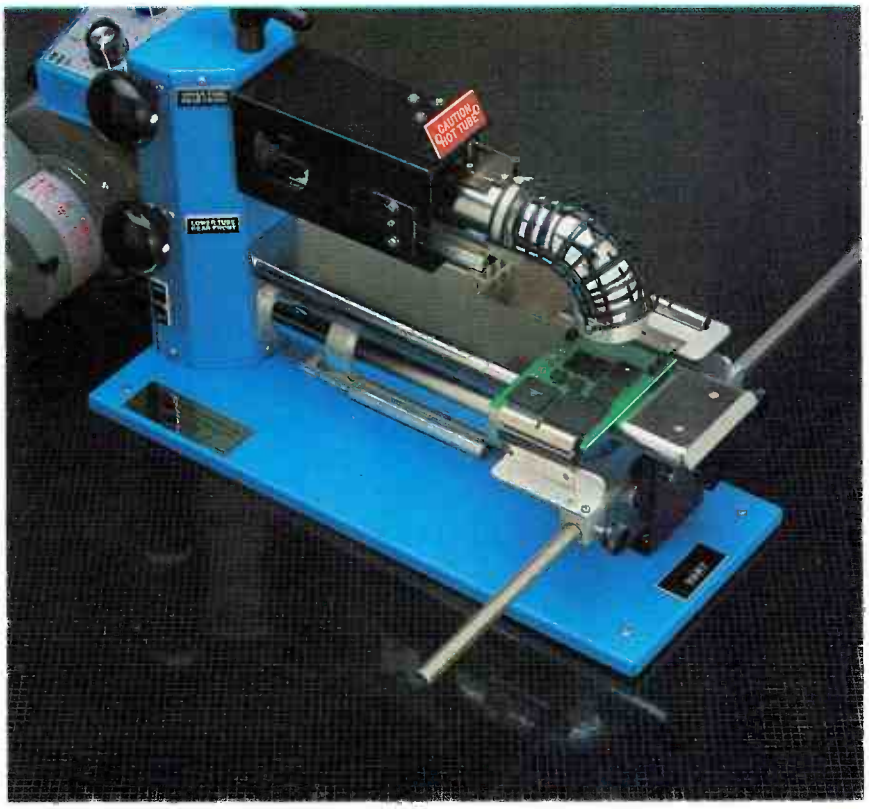
Occasional re-tinning of the tool tips is needed. The area to be tinned is approximately one-eighth of an inch up from the bottom inside edges of the tips, where component leads are contacted. Tinning also should be applied to the bottom edge, where leads or board footprints are contacted.

During re-tinning, clean the tips with a reconditioning stone, sandpaper or a fine jeweler's file. Flux and solder should be applied during the tool turn-on cycle. With normal use, no other maintenance is required.

Convection heating

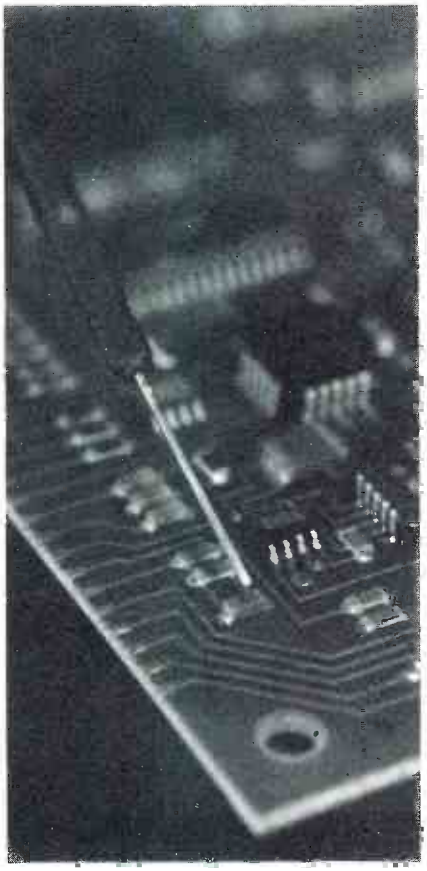
Repair and rework stations at the factory generally use convection heat transfer for removal and reinstallation of all sizes and types of components. The technician may preheat the board and components, if necessary, with the convective solder equipment.

The station uses low-pressure hot air directed at the component and component area to melt the solder connections. Normally, heat is applied to both sides of the circuit board through independently controlled heat tubes. Different sized air-tube orifices control the heated airflow. The tubes, mounted on ball bearing slides, are positioned with control knobs.



A hot-air repair terminal, based on convective heat transfer, is particularly useful in rework and major repair stations, and may be used with surface-mount or through-hole PCBs.

During component replacement, a probe is used to hold it in place.



A platform holds the PCB in place between the air tubes. An X-Y plotting scheme positions the board to place the faulty component in the hot air stream. A temperature-control setting for the particular component is made, and a drop of temperature-indicating fluid is placed on the device. The indicator fluid solidifies quickly, but as the component and solder are heated, the thermal indicator material becomes a clear liquid within 1% of a given temperature. (Three thermal materials are specified, for 363°F, 388°F and 400°F.) When the thermal material liquifies, the solder is melted, and the component is removed with tweezerlike tongs.

Although machine warmup time averages seven to 10 minutes, average component removal time is approximately 25 seconds.

Before replacing a component, the PCB is inspected for the proper amount of solder on the footprint pad. If additional solder is needed, solder cream may be applied as the PCB heats in the machine. If component pre-tinning is needed, solder cream may be applied to an overturned component on a plate in the heated air stream.

When prepared, the board is clamped in the machine, the component is aligned and the board is moved with the X-Y positioning system. During resoldering, the operator may use a probe for additional alignment.

As the solder becomes molten, its surface tension causes the carrier to float into final alignment automatically. The heat tubes are then withdrawn and the replacement is complete.

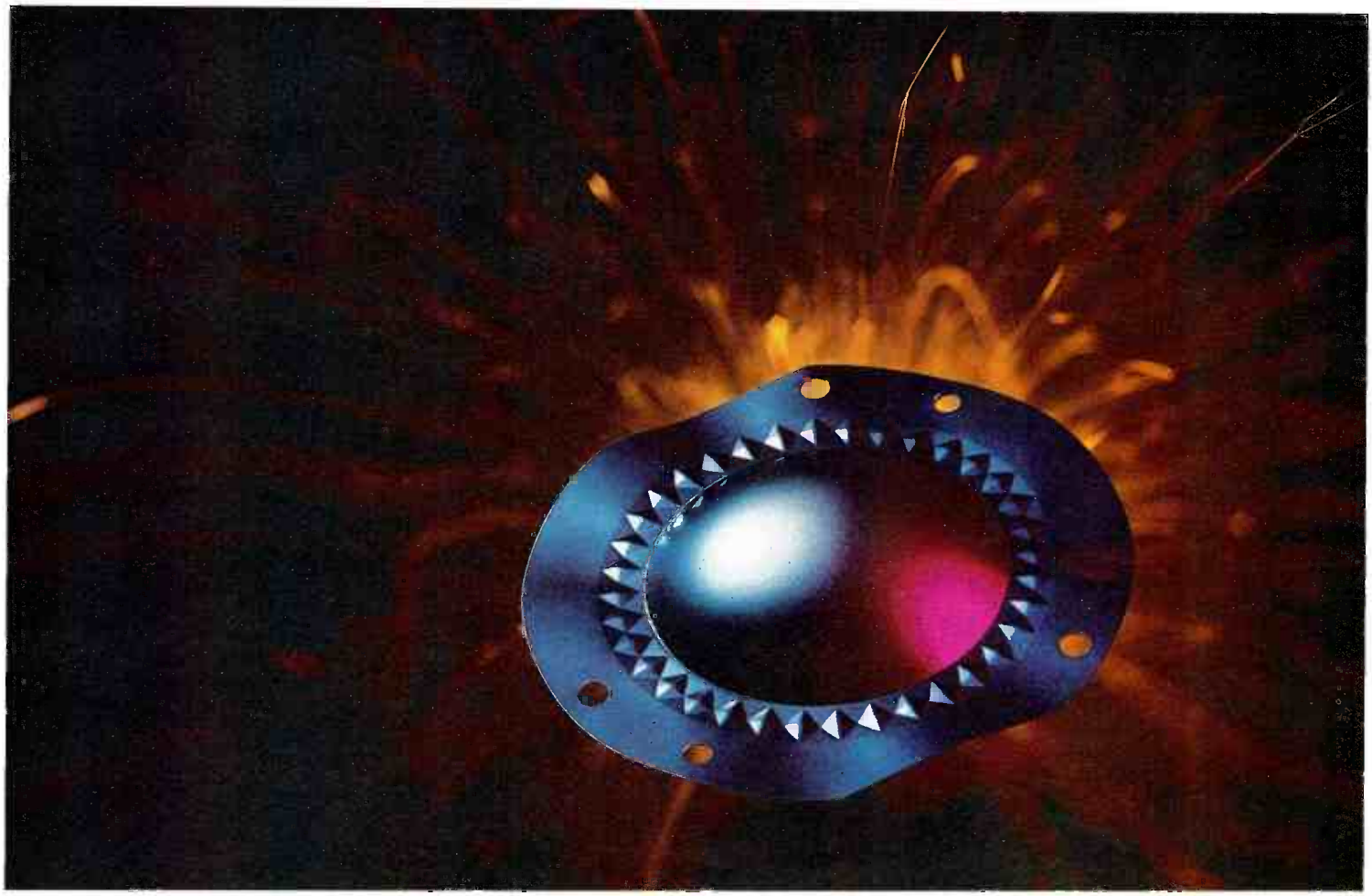
In a convection heating unit, adjacent components may be subjected to some heated airflow. Unless the board or components are subjected to temperatures higher than those used at their initial installation, no damage should result. To reduce heating of adjacent components, fashion simple shields of aluminum foil to deflect the airflow.

Here to stay

The repair of faulty surface-mount circuit boards is inevitable. High component density PCBs, whether repaired at the factory or the broadcast station, require equipment and methods designed for efficiency and component safety.

With the increasing use of digital components and chip packaging in broadcast equipment, surface-mount devices are becoming more prevalent. The simple soldering iron and braid must give way to new techniques.

Editor's note: This is adapted from an article by H.F. Vandermark, president of Nu-Concept Computer Systems, Colmar, PA. The article appeared in the April 1985 issue of *Microservice Management* magazine, an Intertec publication.



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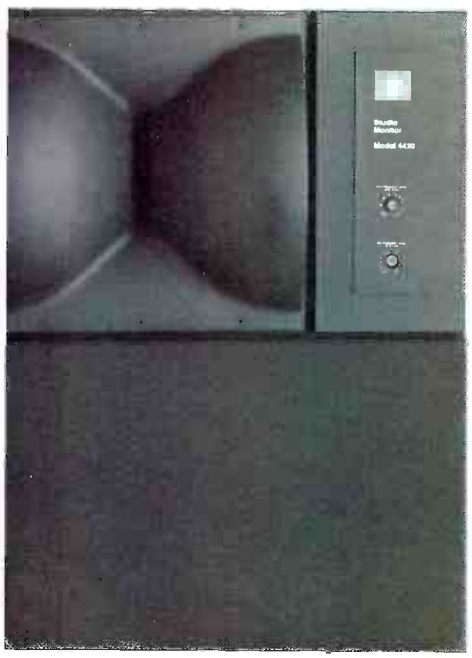

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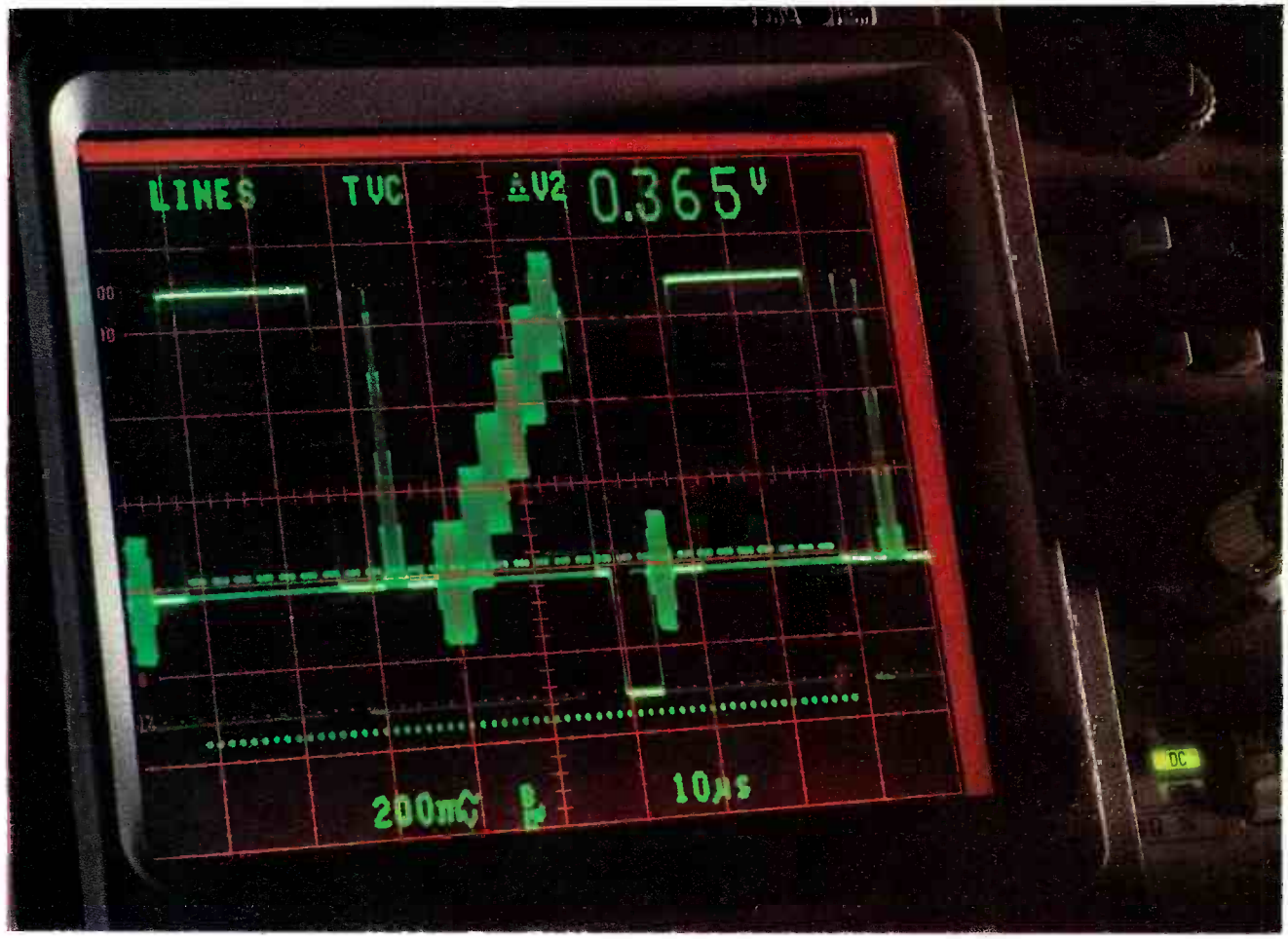

Using the oscilloscope

By Marge Gustafson, Chet Heyberger and Larry Johnson

If you can't see it, you can't fix it. Repair of today's complex broadcast equipment requires much more than a simple voltmeter.

To the untrained, the proper use of an oscilloscope in repairing equipment seems almost magical. Strange waveforms dance on a green CRT screen and the engineer or technician swears they actually mean something. Finally, after poking around inside the defective equipment, the engineer shouts, "Aha, that's it!" All the time, the casual observer wonders what those funny things on the green screen really mean.

Today's broadcast engineers must be familiar with the proper use of an oscilloscope if they are to have any chance of repairing modern broadcast equipment. Analog and advanced circuits, typical in equipment today, require sophisticated troubleshooting procedures. Many times the oscilloscope provides the best, and sometimes the only, method for repairing studio and transmission equipment.

Gustafson, Heyberger and Johnson are members of the portable oscilloscope division of Tektronix, Beaverton, OR.

Scope background

The oscilloscope has been in use for almost 50 years, in a variety of applications. This general-purpose instrument presents far more information than is available from any other single piece of test equipment, such as a frequency counter or multimeter. It gives you the capability to analyze signal parameters (including frequency, amplitude, phase, rise time and dc offset) in a succinct visual form.

There are a variety of oscilloscopes available on the market today. A traditional real time oscilloscope can be compared to a chart recorder. The electron beam simply draws the waveform on the CRT in two dimensions. Most commonly, these are voltage (vertical axis) vs. time (horizontal axis).

A sampling oscilloscope, as the name implies, takes samples of the waveform repetitively and builds the entire picture of the waveform from these discrete samples. With this technique, the frequency response of the oscilloscope can be extended to as high as 14GHz.

Storage oscilloscopes are divided into two technologies: CRT storage and digital storage. In a CRT storage scope, the waveform is either captured on a special CRT phosphor or on a charged mesh. This technology allows the acquisition of transients as fast as 2ns. In a digital storage scope, the analog signal is first converted into a digital representation through an A-D conversion process. This digital signal can then be stored almost indefinitely in the scope's digital memory.

Because the oscilloscope is so versatile,

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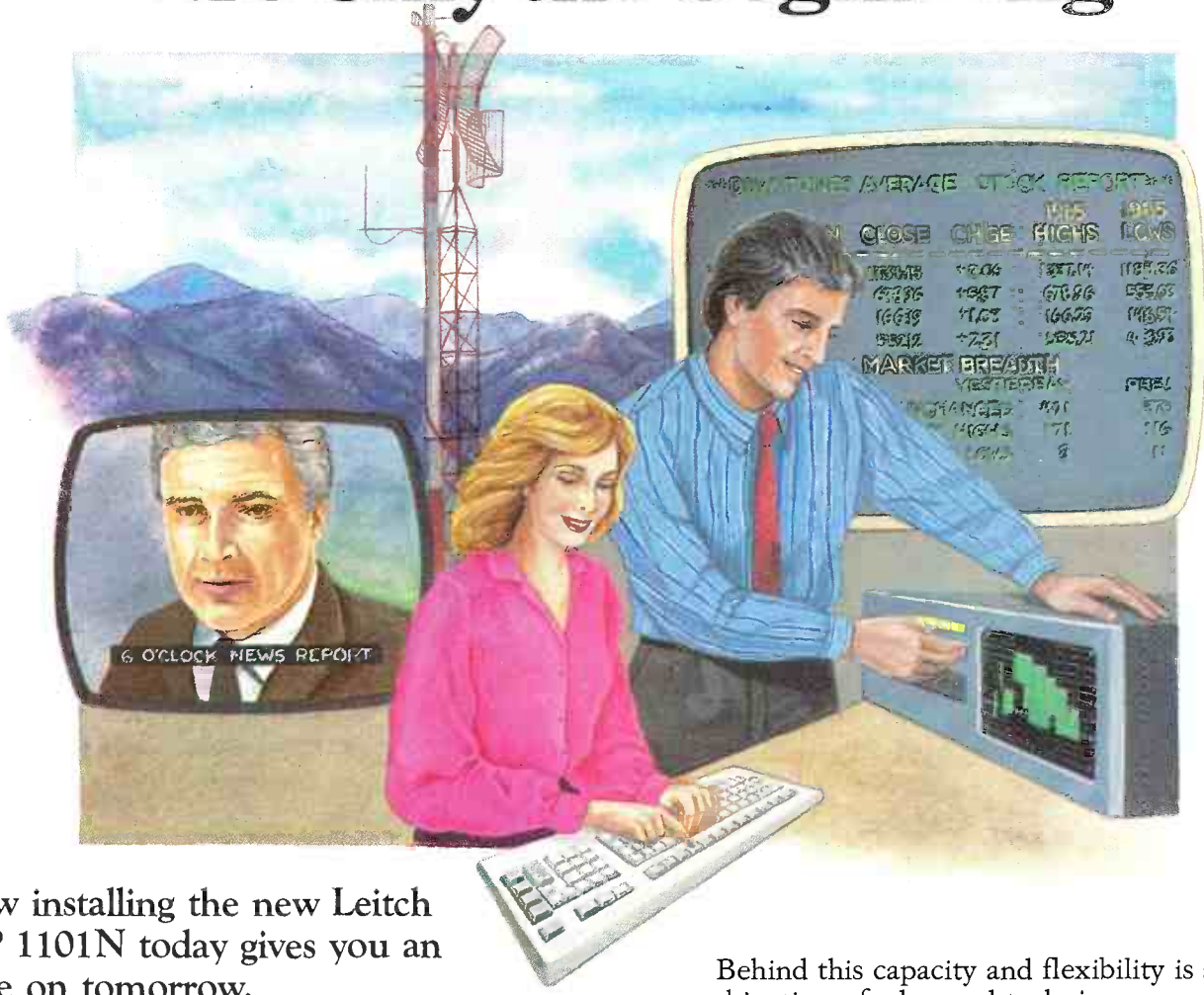

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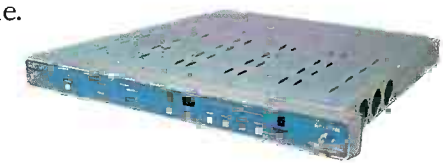

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it finds application in a variety of situations. Oscilloscopes are used in research, design, manufacturing and, of course, broadcast maintenance applications. Modern scopes can provide not only pictures of signals, but when coupled to internal digital meters, they can provide direct digital displays of various signal parameters.

Oscilloscope circuits

Making measurements with an oscilloscope is easy if you understand the fundamentals of how an oscilloscope works. The best way to think of the instrument is in terms of the functional blocks illustrated in Figure 1.

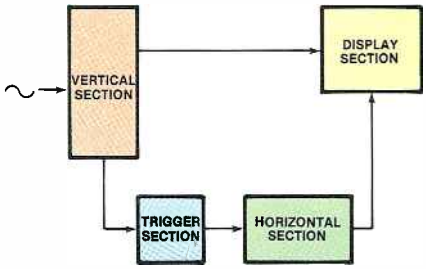

Figure 1. *In its most basic form, the oscilloscope has only four functional blocks.*

The vertical system controls the vertical axis of the graph (representing changes in the amplitude of the signal). The horizontal system controls the left-to-right movement of the beam (representing the time in which voltage changes occur). The trigger system determines when the oscilloscope starts to draw, and triggers the beginning of the horizontal sweep across the screen. The display system contains the CRT and its controls.

CRT displays

The oscilloscope draws a graph by moving an electron beam across a phosphor coating on the inside of the CRT. As the beam strikes the phosphor, it glows for a short period of time, tracing the path of the beam.

The graticule is a grid of lines typically etched or silk-screened onto the inside of the CRT faceplate (see Figure 2). This grid serves as the reference for all of the scope's measurement. Although different sized CRTs may be used, graticules are usually laid out in an 8 x 10 pattern. Each of the nine vertical and 11 horizontal lines blocks off major divisions of the screen. The labels on oscilloscope controls always refer to major divisions. Other markings on the graticule may include subdivisions and dashed lines for 0%, 10%, 90% and 100% amplitude values. These percent markings are used when making rise time and fall time measurements.

Writing rate

An important characteristic of the oscilloscope is its *writing rate*. This term indicates the fastest single-shot transient that can be displayed on the scope's CRT. Many factors affect an oscilloscope's writing speed, including the horizontal sweep setting, the intensity setting, the ambient light conditions and the ability of the user to discern light. Because of the subjective nature of the last factor, it has become common practice to measure the writing rate with a scope-mounted camera. The scope's writing rate is commonly referred to as the *photographic writing rate.*

The vertical system

The vertical system of the scope supplies the display system with the Y axis (vertical) information for the graph on the CRT screen. To do this, the vertical channel takes the input signal and develops deflection voltages that control, or deflect, the electron beam.

The vertical system is typically composed of two identical channels. (See Figure 3.) Each channel has circuits to couple the input signal, attenuate it when necessary, pre-amplify it, delay it and then boost the signal for use by the CRT display system.

Bandwidth

The vertical channels of an oscilloscope are designed for a broad bandpass, generally from dc to 10MHz or more. The oscilloscope's bandwidth is specified by the frequency at which a sinusoidal input signal is attenuated to 70% (−3dB) of its original amplitude.

The bandwidth specification gives you an idea of the instrument's capability to handle high-frequency signals within a specified attenuation. The bandwidth parameter is derived from the instrument's capability to display sine waves. A 60MHz scope will display a 60MHz sine wave with an attenuation of −3dB. However, the effects on a square wave at

Continued on page 52

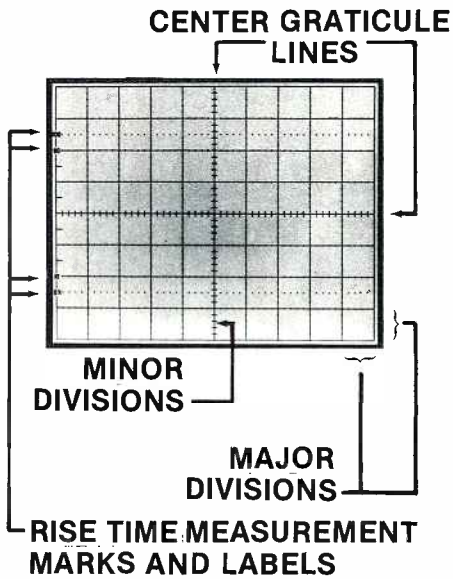

Figure 2. *Because the graticule is on the inside of the CRT faceplate, it is on the same plane as the trace, eliminating measurement inaccuracies called parallax errors.*

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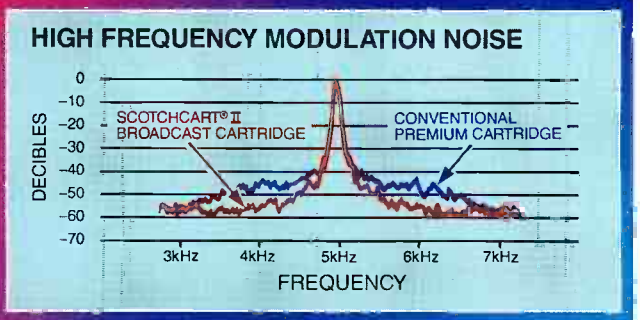

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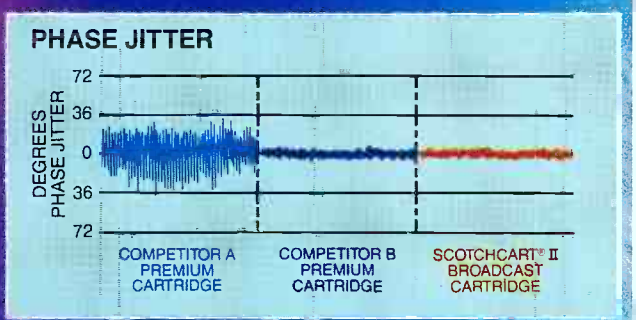

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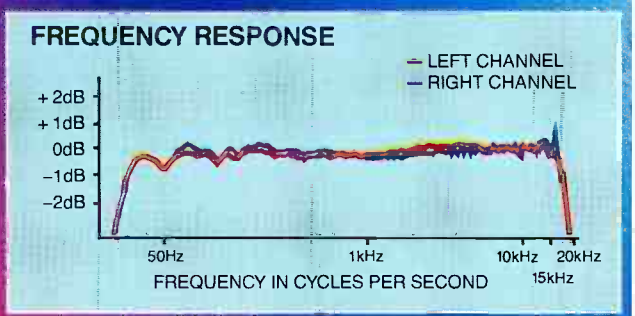

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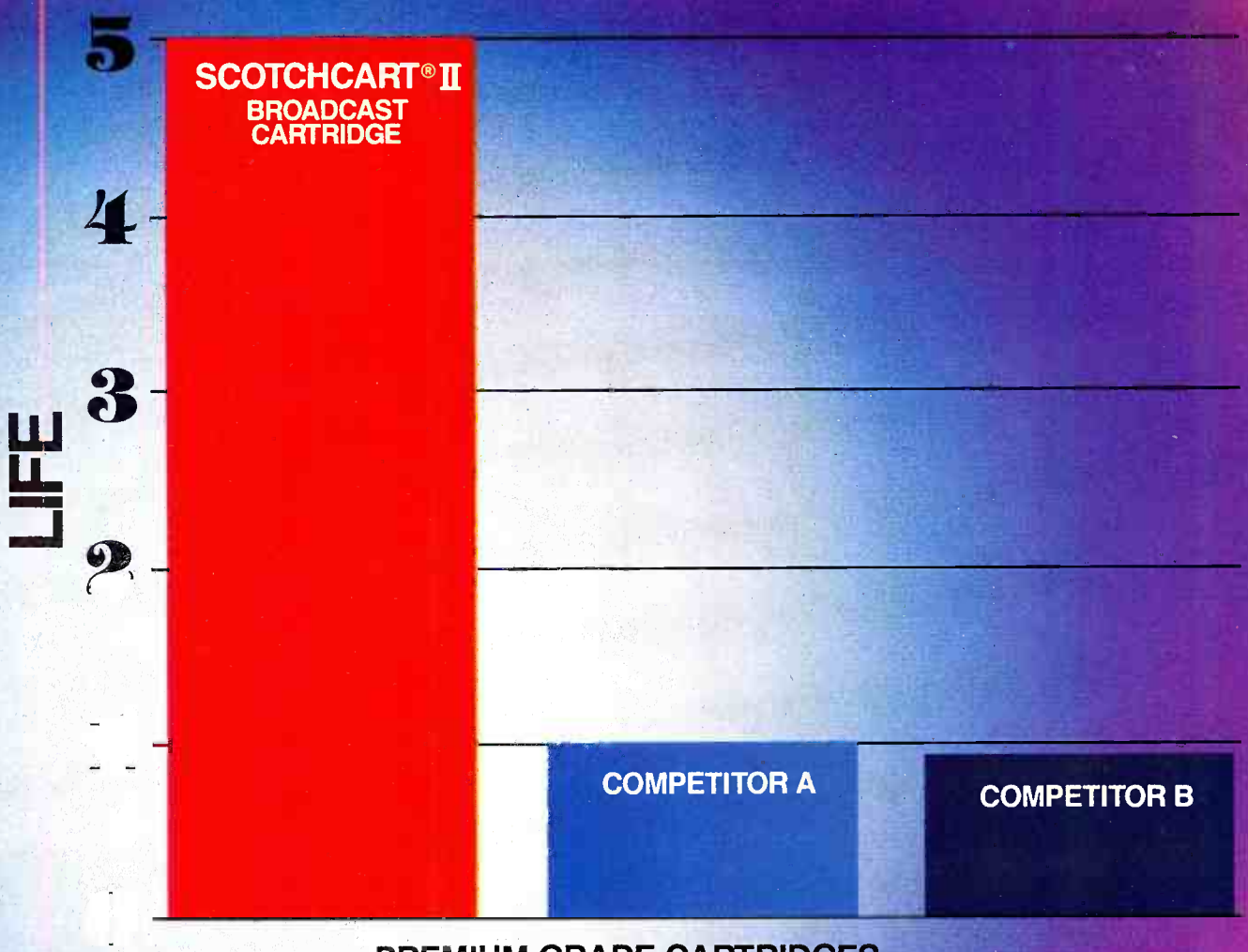

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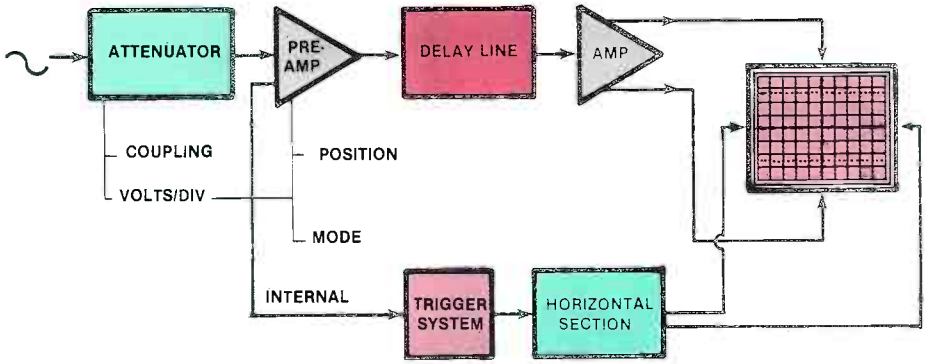

Figure 3. *The vertical system of an oscilloscope usually consists of dual input channels. The input channels amplify or attenuate the signal as necessary for proper display on the CRT.*

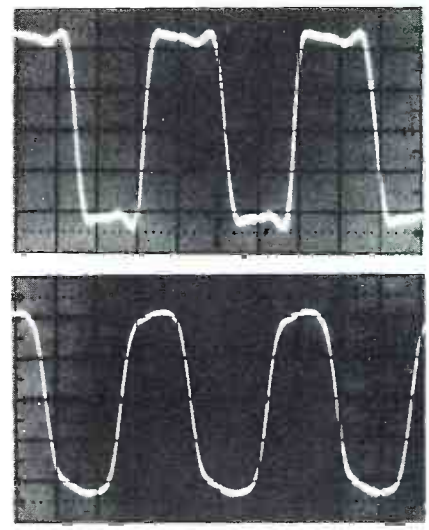

Figure 4. *Bandwidth specifications are based on the scope's capability to reproduce sine waves. Square waves, however, have a great deal of high-frequency information in their rising and falling edges. Shown here is a 15MHz square wave reproduced by a 35MHz scope (top) and a 60MHz scope (bottom).*

Continued from page 48

or near the scope's upper bandwidth will be much more severe because high-frequency information in the square wave will not be accurately reproduced by the scope. (See Figure 4.)

Vertical system controls

Some of the vertical system controls tyically found in an oscilloscope include positioning, input coupling, sensitivity (volts/division), display modes and polarity inversion.

The position controls allow the user to place the trace at the desired position on the screen. The vertical position control (there is usually one for each channel) changes the vertical placement of the trace for each vertical channel. The horizontal position control changes the horizontal position of both channels simultaneously.

The input coupling switch for each vertical channel lets you control how the input signal is coupled to the vertical circuit. The dc input coupling lets the user see all elements of an input signal. The ac coupling mode, on the other hand, blocks the dc signal components, permitting only the alternating components of the input signal to reach the channel. Another coupling setting is the ground mode. This position disconnects the input signal from the vertical system and displays a horizontal baseline indicating the ground reference location. Switching from dc to ground and back is a handy way to measure the amount of dc offset that a signal may have.

A volts/division switch controls the sensitivity of each vertical channel, thereby extending the range of the scope's applications. This switch allows a multipurpose scope to accurately display signal levels from millivolts to hundreds

Thanks, Gerry

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of volts.

Using the volts/division switch to change sensitivity also changes the scale factor (the value of each major division on the screen). Each setting of the control knob is marked with a number that represents the scale factor for that channel. For example, with a setting of 5V/division, each of the eight vertical major divisions represents 5V and the entire screen can show 40V from top to bottom. With a volts/division setting of 2mV, the screen can display 16mV.

Scale factors are also affected by the use of an attenuator probe. For example, if a 10X probe is used on an oscilloscope, the signal being measured is actually 10 times the amplitude that is displayed on the CRT.

Vertical operating modes

Scopes are more useful if they have more than one vertical display mode. Most scopes include the following display features in their vertical systems: a display mode for each vertical channel, any combination of the input channels in either the alternate or chop mode, and the algebraic sum of any of the channels.

Both the chop and alternate modes are usually provided so that the user can look at two or more signals at any sweep speed. The alternate mode first draws one trace and then the other, but not both at the same time. This works well at high sweep speeds at which the eye cannot see the trace alternating between the channels.

The chop mode is provided for slower sweep speeds when the flashing displays would be visually objectionable. Basically, the chop mode alternates, at a set rate, between the signals being viewed. In this mode, then, both of the channels are drawn during each sweep.

The add mode allows you to see two signals added together on the screen. This is especially useful for making differential measurements. In order to make a differential measurement, depress the CH2 invert button and select the vertical add mode. Essentially, this process will subtract the channel 2 signal from the channel 1 signal. This feature is useful for subtracting unwanted noise from a signal or measuring a voltage drop across a passive component.

The horizontal system

To display a signal, your scope needs horizontal as well as vertical data. The horizontal system of the scope supplies the deflection voltages to move the electron beam horizontally. The horizontal system also contains a sweep generator that produces a sawtooth waveform, or ramp, that is used to control the scope's sweep rates. (See Figure 5.)

Because the sweep generator is calibrated in time, it is often called the time

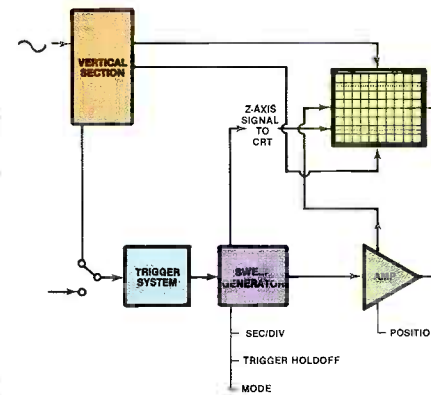

Figure 5. *Horizontal system components include the sweep generator and the horizontal amplifier. The sweep generator produces a smooth sawtooth waveform that is processed by the amplifier and applied to the horizontal deflection plates of the CRT.*

base. Time base controls allow the user to select the required time units for displaying the signal. The horizontal sweep rate determines how much (or how many) of the signal(s) will be displayed.

The seconds/division switch allows the user to select the rate at which the beam sweeps across the screen. Like the vertical system volts/div switch, the control's markings refer to the screen's scale factors. If the sec/div setting is 1ms, that means that each horizontal major division represents 1ms and the total

Continued on page 58

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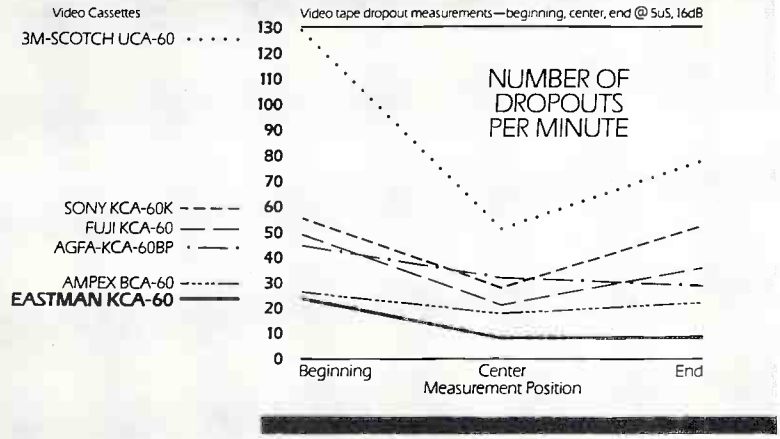

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Continued from page 54
screen represents 10ms.

Dual time base scopes

Conventional oscilloscopes are available with single or dual time base features. Delayed sweep is normally found on dual time base oscilloscopes with two totally separate horizontal sweep generators. In dual time base instruments, one sweep is triggered in the normal fashion and the second sweep is delayed by a user-determined length of time. The usefulness of delayed sweep is demonstrated in the example shown in Figure 6.

Dual time base oscilloscopes offer the user all the measurement capabilities of single time base instruments, plus:

- convenient comparison of signals at two different sweep speeds,
- jitter-free triggering of delayed sweeps and
- increased resolution and accuracy in differential timing measurements.

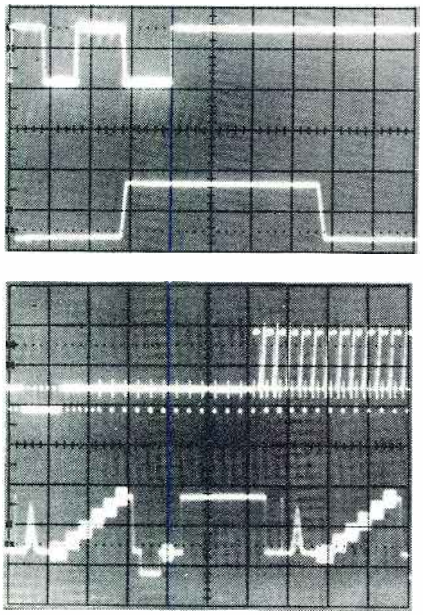

Figure 6. *With alternate delayed sweep capability, it is possible to measure the width of a particular pulse in a pulse train such as the one shown here. The slower sweep rate allows you to see the entire pulse train. The faster sweep allows you to pick out the desired pulse.*

The trigger system

The trigger system determines the point at which the scope begins to display information (see Figure 7). Typically, the graph drawn on the CRT screen changes from one trace to the next. If the time base is set at 0.05μs/div, the scope is drawing one full screen every 0.5μs (0.05μs/div multiplied by 10 screen divisions). That's two million graphs per second. Imagine the jumble on the screen if each sweep started at a different point on the signal.

Each sweep will start at the same time, however, if the proper trigger system controls are selected. The trigger circuit

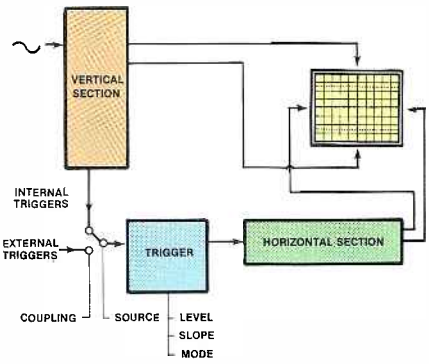

Figure 7. *The trigger circuit and its controls are illustrated. Trigger source describes whether the trigger signal is internal or external to the scope. Coupling controls the connection of an external trigger to the circuit. The level and slope controls determine where the trigger point will occur.*

is set to recognize a particular voltage level on the selected trigger signal with slope and level controls. Then, every time that level occurs, the sweep generator is turned on. The process is diagrammed in Figure 8.

The trigger slope and level controls define the trigger point. The slope control determines whether the trigger point is found on the rising or the falling edge of a signal. The level control determines where on that edge the trigger point occurs. (See Figure 9.)

Most portable oscilloscopes offer a variety of trigger controls. In addition to those already mentioned, features may also be included that determine how the trigger system operates (trigger operating mode) and how long the scope waits between triggers.

Not every trigger event can be accepted as a trigger. The trigger system will not recognize a trigger during the sweep, the retrace time, or for a short time afterward, called the *holdoff* time. The holdoff period provides additional time beyond the retrace to ensure a stable display, as illustrated in Figure 10.

Sometimes the normal holdoff period isn't long enough to ensure that a stable display is obtained. This possibility exists when the trigger signal is a complex waveform with many possible trigger points. Though the waveform is repetitive, a simple trigger might yield a series of patterns on the screen instead of the same pattern each time. Digital pulse trains are an example. Each pulse is similar to any other, resulting in a number of possible trigger points, not all of which would result in the same display.

The variable trigger holdoff feature provides the capability to control the time at which a trigger point is accepted. The control is actually part of the horizontal system because it adjusts the holdoff time of the sweep generator, but its function interacts with the trigger controls. Figure 11 illustrates a situation in which the variable holdoff control is useful.

Trigger sources

Trigger sources are grouped into two categories, depending on whether the trigger signal is provided internally or externally. The source of the trigger makes no difference in how the trigger circuit operates, but internal triggering usually means that the scope is triggering on the same signal that it is displaying. Internal triggering has the obvious advantage of letting the user see where the triggering is occurring.

Triggering on the displayed signal, however, is not always sufficient to properly display a waveform. External triggering often gives the user more control over the display, and is typically useful in digital design and repair. In these cases, the user might want to look at a long train of similar pulses while triggering with an external clock or a signal from another part of the circuit.

Line (60Hz) triggering is useful any time the user is looking at circuits that are dependent on the power-line frequency. Power supplies and power-line monitoring are examples.

Trigger operating modes

Most trigger circuits operate in at least four modes: normal, automatic, television and single sweep.

One of the more useful is the normal trigger mode. The normal mode permits a trace to be drawn on the screen only if there's a trigger. When low-frequency signals are applied to the trigger circuit, the normal mode provides a stable display. The normal mode gives the widest

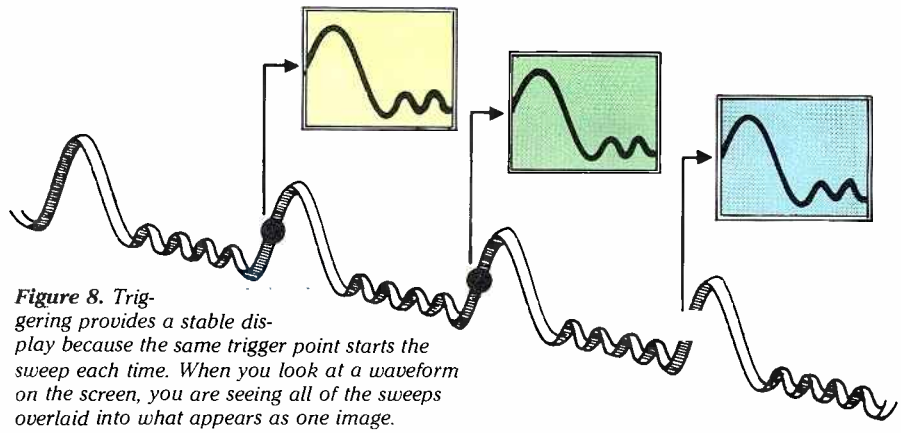

Figure 8. *Triggering provides a stable display because the same trigger point starts the sweep each time. When you look at a waveform on the screen, you are seeing all of the sweeps overlaid into what appears as one image.*

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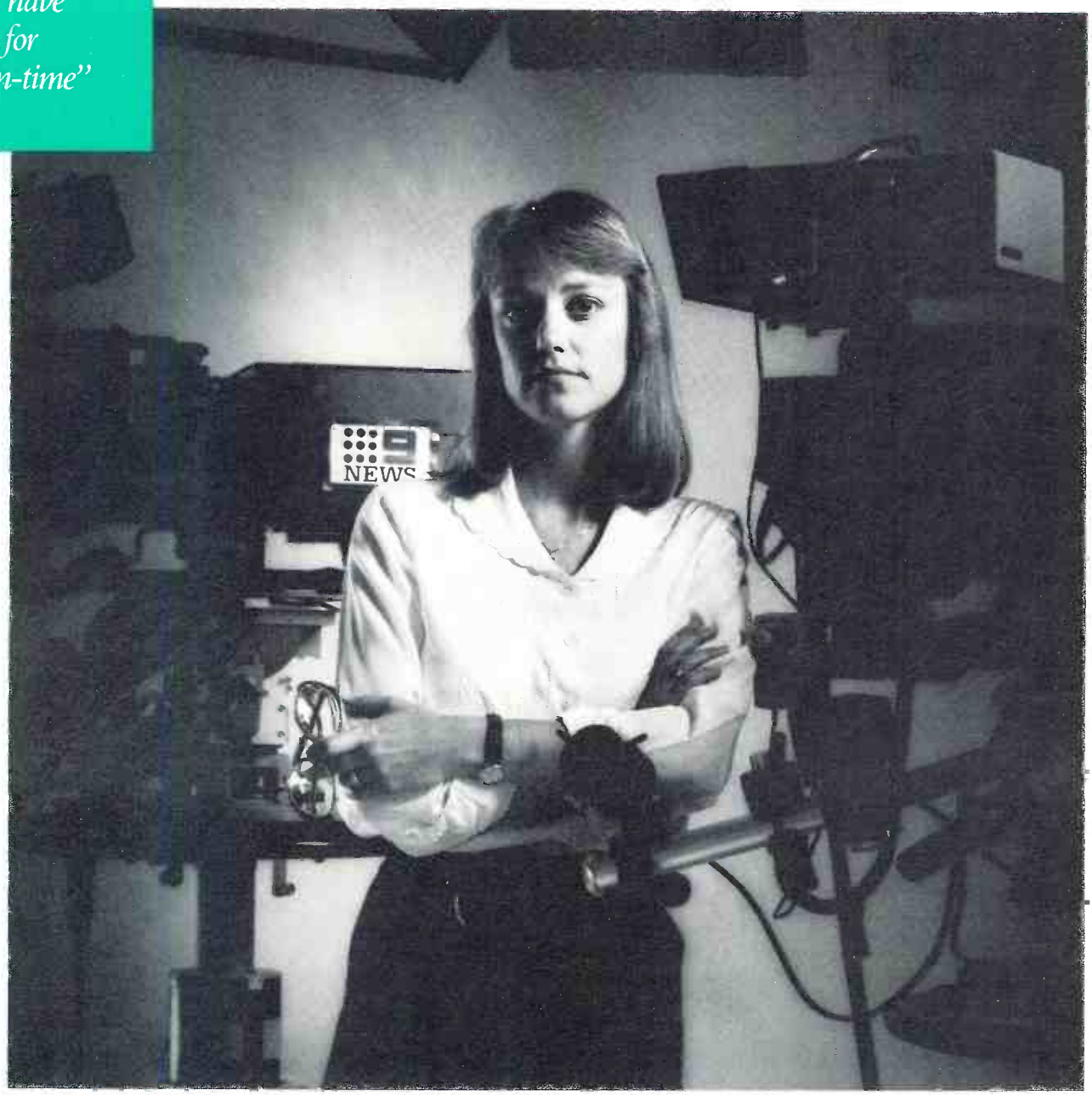

"I run a small studio. But to me, it's a big operation. Everything has to work right all the time. One thing we can't afford is to waste time fooling around with our intercom system.

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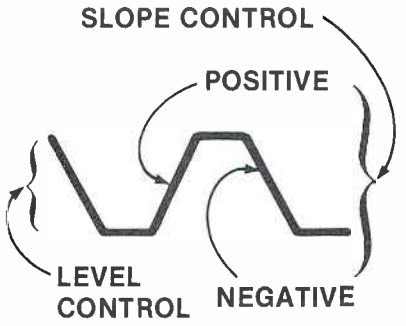

Figure 9. *The slope control specifies whether a positive or negative edge is used for the trigger. The level control allows you to choose where the trigger will occur on that edge.*

range of triggering signals, from frequencies close to dc up to the oscilloscope's bandwidth.

In the automatic mode, a trigger starts the sweep, the sweep ends and the holdoff period expires. At that point, a timer begins to run. If another trigger isn't found before the timer runs out, a trigger is generated anyway, causing a baseline to appear even when there is no signal applied to either channel.

Another useful trigger operating mode is TV triggering. Most oscilloscopes offer two such modes: TV field and TV line. With TV field, the user can trigger on the vertical interval sync pulse. With TV line triggering, the user can trigger on the horizontal sync pulse. These modes are especially useful in VITS and VIRS analysis, TV and VCR servicing and other video applications.

The other trigger mode that is conventionally offered is the single sweep feature. In this mode, the user can manually arm the sweep circuit so that when a trigger occurs, only one sweep waveform will be generated. This feature is useful in photographic applications. The user enables the single sweep mode and places a scope camera, with its shutter open, on the CRT bezel. When the event occurs, a single sweep is triggered and the trigger light is extinguished. When the indicator light goes off, the user knows that the scope was triggered and that a copy of the signal was recorded by the camera.

The trigger circuit provides both ac and dc coupling, similar to the vertical input circuits. Table 1 summarizes the characteristics and advantages of each type of coupling.

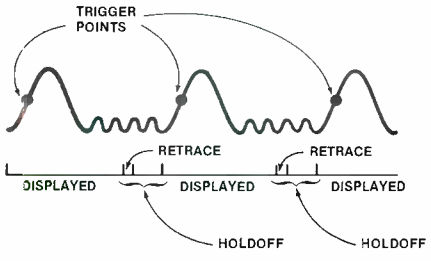

Figure 10. *The trigger holdoff time ensures valid triggering. Only the points labeled in the drawing start the display because no trigger can be recognized during the sweep retrace or holdoff period.*

Probes

To connect the circuit measurement test points to the scope, use a probe designed to work with the particular instrument. Although the circuit under test could be connected with just a wire, the connection would likely do more harm than good to effective troubleshooting. The connection would load the circuit and the wire would act as an antenna, picking up stray signals from 60Hz power lines and nearby transmitters. These undesirable signals would be displayed on the screen along with the desired signal.

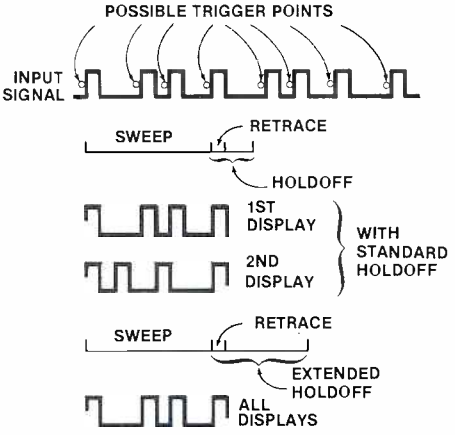

Figure 11. *All possible trigger points are shown here. Changing the holdoff time is the best way to make sure the trigger point appears on the same pulse, thereby providing a stable waveform.*

Circuit loading

Using a probe instead of a bare wire minimizes interference from stray signals, but there is still a circuit-loading effect. Circuit loading can be resistive, capacitive and/or inductive. For low-frequency signals, the most important component of loading is resistance. To avoid significant circuit loading, use a probe with an input resistance that is significantly higher than the circuit resistance.

For making measurements on high-frequency signals, inductance and capacitance are important. You can't avoid added capacitance when making connections, but you can limit that added capacitance by using an attenuator probe. Instead of loading the circuit with capacitance from the probe tip, plus the cable, plus the scope's own input, a 10X attenuator probe introduces about 10 times less capacitance (as little as 10pF to 14pF). Although the probe also reduces the amplitude of the measured signal, usually this is not a problem.

Remember, when measuring high-frequency signals, that the probe's impedance (reactance) changes with frequency. The probe's specification sheet or manual should contain a chart, like the one shown in Figure 12, which indicates this change. When making high-frequency measurements be sure to properly ground the probe with a short ground lead.

Measurement system bandwidth

Bandwidth is another probe characteristic to consider. Just as scopes have bandwidth limitations, so do probes. The probe's bandwidth is the specified range in which attenuation does not exceed

COUPLING	APPLICATION
DC	Couples all elements (both ac and dc) of the triggering signal to the trigger circuit.
AC	This coupling blocks dc components of the signal and couples only the ac components.
HIGH-FREQUENCY REJECT	This is a trigger-filtering mode in which all high-frequency signals above a set point (typically 40kHz) will not be triggered.
LOW-FREQUENCY REJECT	In this coupling mode, all low frequencies below a set point (typically 40kHz) will not be triggered on.
EXT DIVIDE BY 10	If the signal required to be triggered on is too large for the trigger system level range, an attenuation factor of 10 is used to reduce the signal amplitude to an acceptable level.

Table 1. *It's important to select the correct type of trigger coupling if the display is to remain stable. This table outlines the types of trigger coupling and the advantages of each.*

−3dB (70% of the original value). Don't assume that a 60MHz probe and a 60MHz scope provide a 60MHz measurement capability. The combination will approximately equal the square root of the sum of the squares of the rise times of the scope and the probe. For example, if both the probe and scope have rise times of 5.83ns:

$$Ts = \sqrt{To^2 + Tp^2}$$

Where Ts = system rise time (ns)

To = oscilloscope rise time specification (ns)

Tp = probe rise time specification (ns)

Example:

$$Ts = \sqrt{5.83^2 + 5.83^2} = 8.25ns$$

That works out to 8.25ns, the equivalent to a bandwidth of 42.43MHz because:

$$BW\ (MHz) = \frac{350}{T(ns)}$$

To get the full bandwidth from the scope, a wider bandwidth probe is needed. (Often, probes that are sold with scopes as a package are designed to perform to the scope's bandwidth performance.)

Probe types

Probes are generally divided by function, into voltage-sensing and current-sensing types. Voltage probes can be divided further into passive and active designs. One of these should meet almost any measurement requirement. Typical probe specifications are as follows:

- *1X passive, voltage-sensing:* no signal reduction, allowing maximum sensitivity at the probe tip; limited bandwidths (4MHz-34MHz); high capacitance (32pF-112pF); and signal handling to 500V.
- *10X/100X/1000X passive, voltage-sensing:* attenuator probe with extended bandwidths to 300MHz; adjustable capacitance; and signal handling to 500V (10X), 1.5kV (100X) or 20kV (1000X).
- *Active, voltage-sensing:* field effect transistor-based probe with switchable attenuation; capacitance as low as 1.0pF; more expensive, less rugged than other types; limited dynamic range; bandwidths to 1.5GHz; and minimal circuit loading.

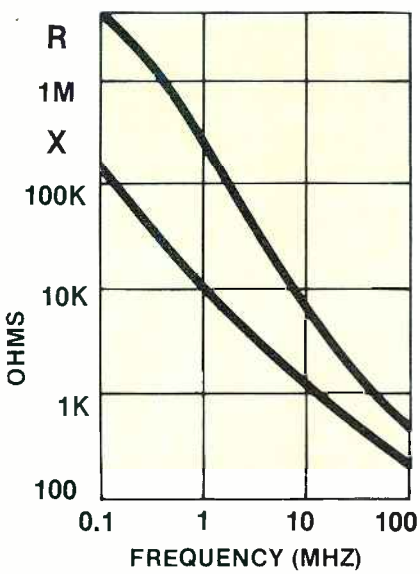

Figure 12. Probe impedance is related to frequency. The curves shown here plot both resistance (R) and reactance (X) in ohms against frequency in megahertz.

Compensating the probe

Most troubleshooting is done with an attenuator probe, which must be compensated before use. The process is straightforward and requires a test signal from the scope coupled through the probe to the input of the vertical channel that will be used. The test signal is usually a square wave with a fast rise time. While observing the trace on the CRT, adjust the compensation control until the square wave is properly displayed. (See Figure 13.) After the probe is compensated, don't use it with another input channel or oscilloscope without again going through this process.

Common mistakes

The most common error in making oscilloscope measurements is forgetting to compensate the probe. The second most frequent source of inaccuracy is failure to check the controls to make sure they are properly set. The following hints (arranged according to the functional blocks of the scope) should aid the user in initializing the scope:

- *Check all the vertical system controls:* variable gain controls (CH1 and CH2 volts/div cal) should be in their detent positions; make sure CH2 isn't inverted (unless this is desired); check the vertical mode switches to make sure the signal from the proper channel(s) will be displayed; adjust the vertical system gain control (volts/div) switches as needed (don't forget to use a volts/div scale factor that matches the probe, either 1X or 10X); and check the input coupling levers.
- *Check the horizontal system controls:* switch the magnification off; set the variable sweep ratio (sec/div) control in its calibrated detent position; make sure the horizontal mode switch is properly set; and adjust the delayed sweep controls as needed (if the delayed sweep mode is to be used).
- *Check the trigger system controls:* select the desired trigger slope; check the coupling and operating mode selected; position the trigger variable holdoff control at its minimum position. Most scopes will have a trigger indicator that will light when the scope is properly triggered. This convenience feature will aid you in setting up your scope.

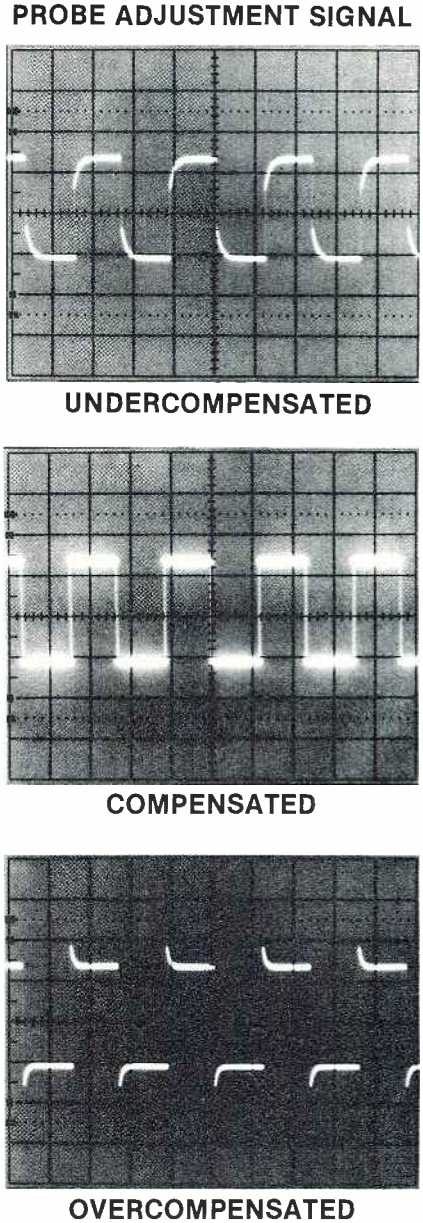

Figure 13. Improperly compensated probes can distort the waveforms you see on the screen of your scope. The probe adjustment signal is shown as it would appear with proper and improper compensation.

Study the manual

The oscilloscope is a complex piece of equipment that is essential at any repair or broadcast facility. Although the proper use of the scope's available features requires a certain degree of expertise, the oscilloscope is often the only tool that can help you service a complex piece of equipment. By spending some time with the scope manual and learning how the waveforms should look, you will be taking meaningful steps toward acquiring the skills of an effective troubleshooter.

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There probably isn't a radio engineer on the planet who isn't familiar with the outstanding performance of our esteemed Tomcat cart machines. We've built and delivered more than 2,000 "Cat's" since we introduced them in 1981.

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MICROMAX IS MORE THAN THE "HIGH-TECH" LOOK.

With Micromax, our Maxtrax® heads come standard. Maxtrax is now widely accepted as THE performance standard because it delivers a half-track signal without quarter-track noise. With nearly twice as much track width, you get a quantum leap in sound quality, which, by our way of thinking, is the real bottom line. If your library is quarter-track (the NAB standard), no problem. Micromax can be ordered with an optional set of NAB stereo playback heads for immediate library use.

THE MECHANICS: TOUGH, LIKE A TOMCAT.

The D.C.-controlled capstan runs in sealed microfine bearings and is driven by a servo/belt system developed from computer disk drives. The result is superb wow & flutter specs. The conventional pinchroller solenoid was eliminated (and thus the damaging heat), and replaced with a simple, reliable D.C. servomotor which assures optimum, adjustable capstan-to-tape pressure and remarkably rapid starts and stops. Center-supported by a floating ball bearing race, the pinchroller self-aligns to prevent tape skew.

The cartridge guides guarantee accurate, repeatable positioning. The deckplate is thick alluminum alloy, precision milled and surfaced. Naturally, the heads are fully adjustable and mounted in beefy, precision cast assemblies.

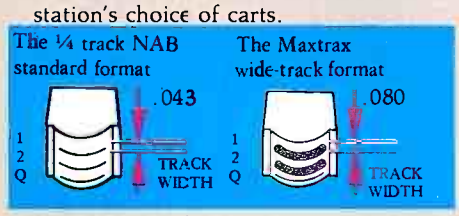
THE ELECTRONICS: ADVANCED, LIKE A TOMCAT.

With Micromax you've got lot's of headroom, better transient response and +24 dBm active, balanced program outputs. We've even designed efficient low-noise CMOS control logic.

Micromax has the standard two auxiliary cue tones and high-speed recue (22.5 ips). You can set a replay inhibit, and assign a machine number to the front panel LED display (which also doubles as the power indicator).

IT SOUNDS AS GOOD AS IT LOOKS.

The superlative specs can't tell you the whole story of Micromax. You have to hear it. Micromax has a red-hot, crystal-clear top-end. And a clean, punchy low-end. Everything in-between jumps right out in front of your ears too. Micromax can instantly put much better sound on-air for you. Now. Regardless of your station's choice of carts.



Maxtrax. The proven, superior format that delivers nearly twice as much track width for better sound.

BUILT RUGGED FOR THE REAL RADIO WORLD.

All of the electronics are contained on three easily accessible circuit boards and the elegantly simple mechanics couldn't be easier to get at for routine inspection and maintenance. Micromax is totally RFI immune, and consumes only 7 watts — running. Because the attractive chassis doesn't require any ventilation slots and screens, there's less outside world that gets into the inside. Because of the compact design, you can get two reproducers side-by side in a rack with just 3½" required. Of course, Micromax is pin-for-pin connector compatible with the Tomcat.

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A Tomcat sits comfortably above the rest of the pack, but the new Micromax could be the purr-fect alternative for you. Either way, you can't lose.

Call us now or circle the bingo. We'll be happy to rush you technical brochures that fill-in all the other details we couldn't cover here.

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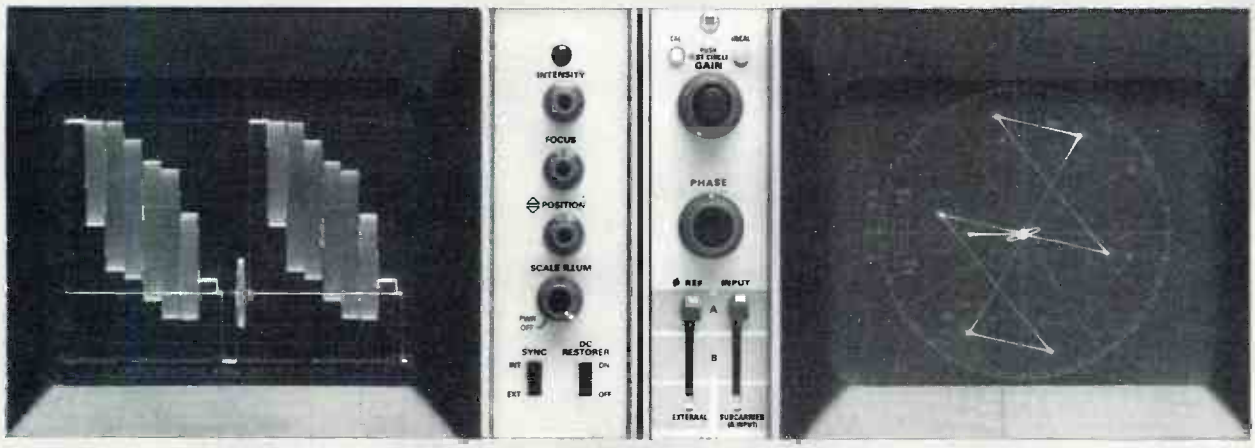
Specialized scopes



Scopes come in a wide selection of shapes and sizes. The choices range from versions with only a few control knobs to sophisticated units featuring multiple plug-in modules and many controls. Despite the wide variety, scopes can be classified as either general purpose or specialized.

Video scopes

The most common specialized scopes used in broadcast work are TV waveform monitors and vectorscopes. (See Figure 1.) The waveform monitor is usually rack-mounted next to the equipment it will be used to monitor. The waveform monitor's CRT screen is typically calibrated in IRE units and differential phase. The monitor usually displays a demodulated chrominance signal on the vertical axis along with the selected sweep on the horizontal axis (R-Y).

The vectorscope displays the relative phase and amplitude of a chrominance signal on polar coordinates. The graticule is marked according to the proper phase and amplitude of the primary and complementary colors: red, blue, green, cyan, yellow and magenta. The polar display permits measurement of the hue of a signal in terms of the relative phase of the chrominance signal with respect to the color burst. The amplitude of each color is displayed by the distance from the center of the screen toward the particular color point.

Logic analyzers

Logic analyzers are used to display various types of digital signals. Although a general purpose scope can be used for digital troubleshooting, the logic scope can provide much more information for the technician. Logic scopes have from four to 72 input channels. The analyzer displays can range from signal traces such as those shown on a scope (see Figure 2), to actual text information.

Figure 1. The waveform monitor (left) is used primarily for amplitude measurements and the vectorscope (right) is used for phase-related measurements.

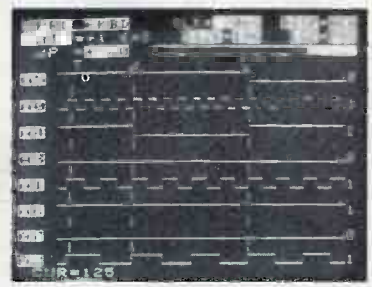


Figure 2. The logic scope is used in analyzing complex digital equipment. The CRT displays eight or more inputs so that a number of data lines can be monitored at one time.

Logic analyzers often rely on other equipment and software to provide the necessary test signals. These complex analyzers are sometimes coupled to other digital test equipment through RS232C and GPIB (general purpose interface bus) interfaces, which can provide automatic testing features. Some analyzers can even conduct tests on equipment by remote control over a telephone line.

TDR cable testers

The basic oscilloscope display principle can also be adapted for other uses, such as a time domain reflectometry (TDR) cable tester. When the unit is connected to a coaxial or twisted-pair cable, it sends out a pulse with a fast rise time. Any faults in the cable will cause the pulse to be reflected back to the tester. The type of the fault can be identified by the shape of the display on the CRT. The distance from the test instrument to the fault can be read directly from a front panel indicator. Some cable testers provide a hard-copy printout of the CRT waveform display.

Spectrum analyzer

There is another type of scope that we have yet to discuss. All of the equipment we've considered so far operates in the time domain. In other words, the display uses time as a reference for the horizontal axis. A spectrum analyzer uses frequency as the horizontal axis reference. Figure 3 represents the display of identical signals on both an oscilloscope and a spectrum analyzer. These two types of displays each have their own particular uses. In many cases, the scope display is adequate. In more specialized cases, only the spectrum analyzer can provide the kind of information needed.

High-tech features

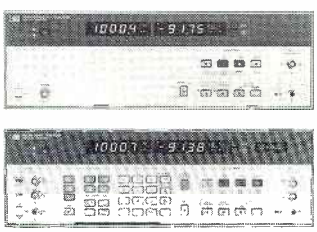
Today's modern oscilloscope offers features that make servicing equip-

Continued on page 68

What are the lowest-priced audio analyzers doing in a Hewlett-Packard ad?

Hewlett-Packard? That's quality. Performance. Top of the line.

True. But it's also a fact that HP programmable audio analyzers cost less than any others on the market. At $5800* they do more, too. They carry out full frequency range testing. Fast. Tests that used to take hours now take you minutes. Just push a button, and the analyzer measures both distortion and frequency.



The HP 8903B packs a lot of instruments in one low-cost box. Besides the analyzer, there's a source, an ac/dc voltmeter, a frequency counter, signal-to-noise meter and a sweeper.

If you already have a signal source, use it with the HP 8903E. It costs just $3900*

Now that you know what our analyzers are doing here, contact your local HP sales office. And put them to work for you.

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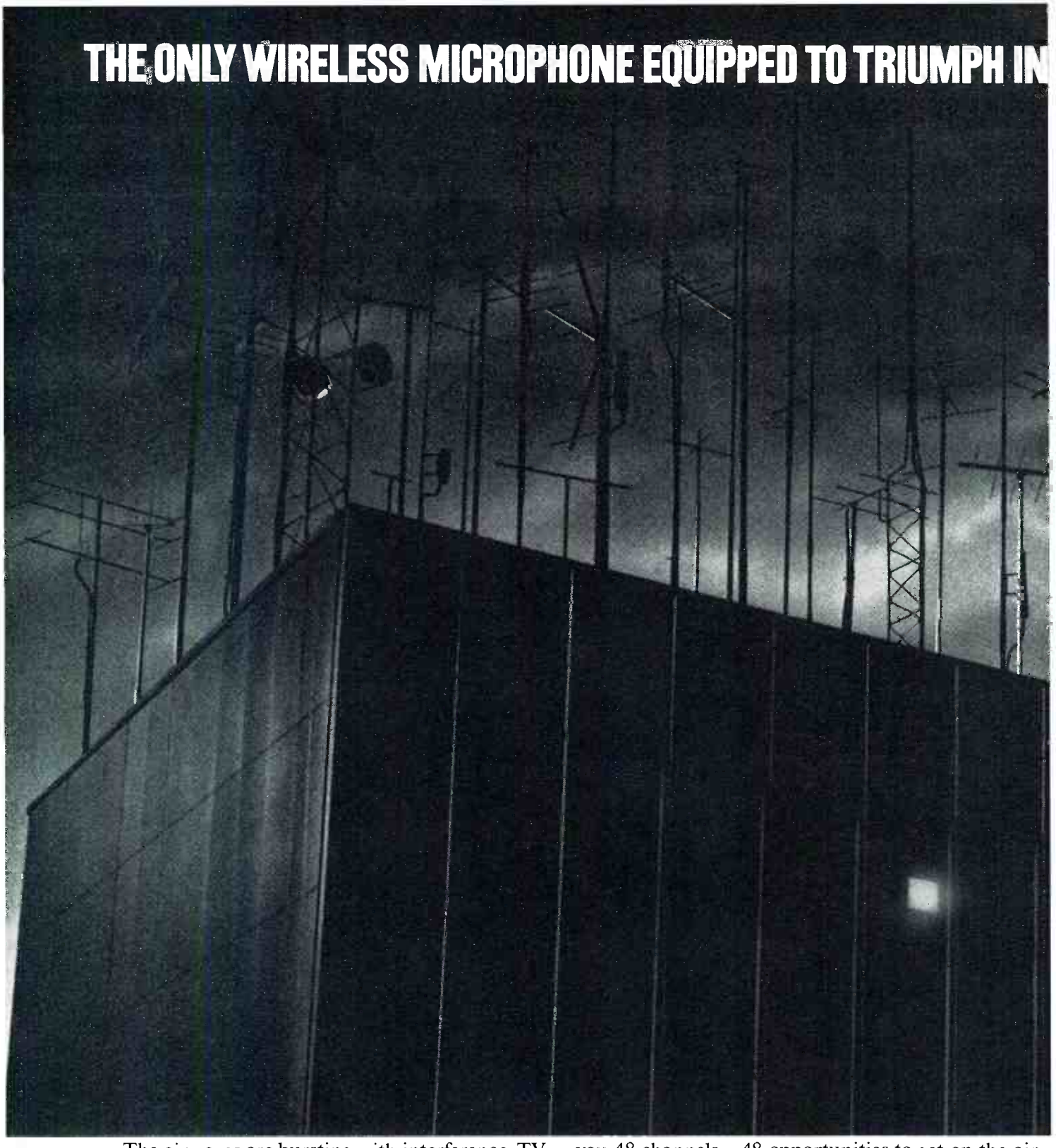


The airwaves are bursting with interference. TV broadcasts, police emergency calls, taxi dispatches, even other wireless microphones.

All of which can make a performer look bad, and an engineer look worse. But fortunately, Sony has created an effective alternative to the anxiety of conventional wireless microphones. The VHF Synthesized Wireless System.

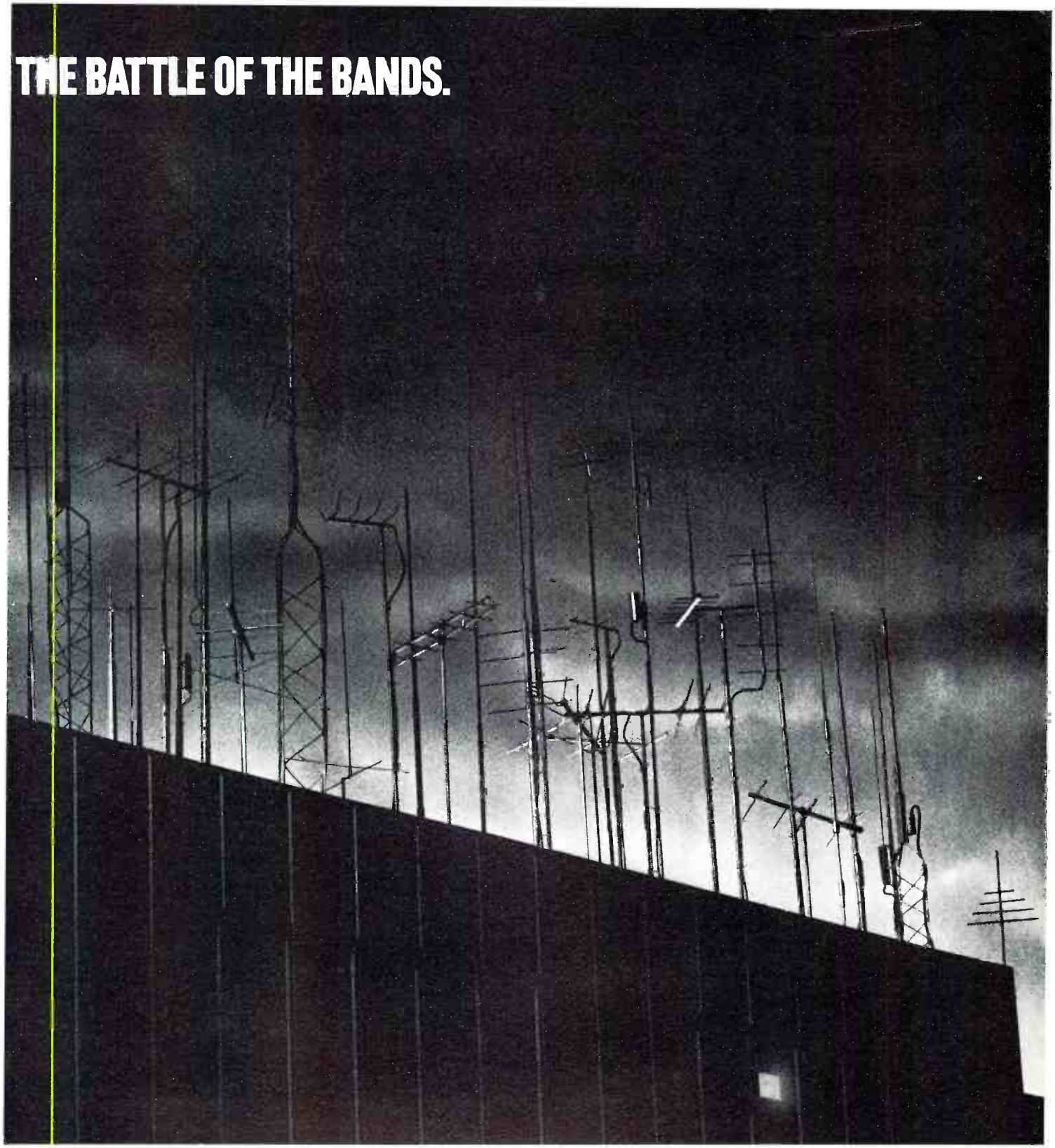
TUNE YOUR WAY OUT OF A JAM.

Other wireless microphones are pre-tuned to just one channel. Each electronically synthesized Sony VHF wireless microphone, on the other hand, gives you 48 channels—48 opportunities to get on the air without interference. With a mere push of a button.

In fact, with as few as 4 Sony wireless microphones and a tuner, you can reach 168 microphone channels. And the Sony Wireless System makes it possible to use up to 13 microphones in the same place at the same time. Also, Sony's tuner gives you an easy-to-read LCD display. Which is an indispensable asset when you happen to be in a big hurry.

In addition, Sony's wireless microphones won't leave you wincing at poor dynamic range. Thanks to a companding technique which yields a dynamic range

THE BATTLE OF THE BANDS.



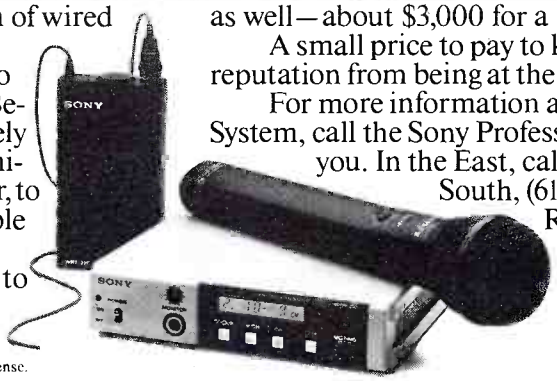
in excess of 94dB. Well within the realm of wired microphone performance.

The Sony system is also designed to withstand the rigors of live recording. Besides being lightweight, it's also extremely sturdy. Including everything from the microphones, to the body pack transmitter, to the tuners, to the shock-resistant portable cases and rack-mounting brackets.

An arsenal of equipment designed to be invaluable to you in the battle of the bands. And to be an exceptional value as well—about $3,000 for a full-diversity system.

A small price to pay to keep a respected engineer's reputation from being at the mercy of a taxi dispatcher.

For more information about the Sony Wireless System, call the Sony Professional Audio office nearest you. In the East, call (201) 368-5185; in the South, (615) 883-8140; in the Central Region, (312) 773-6002; and in the West, (213) 639-5370.



SONY.
Professional Audio

in Part 74 subpart H of the FCC regulations and requires an appropriate license.

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Continued from page 64

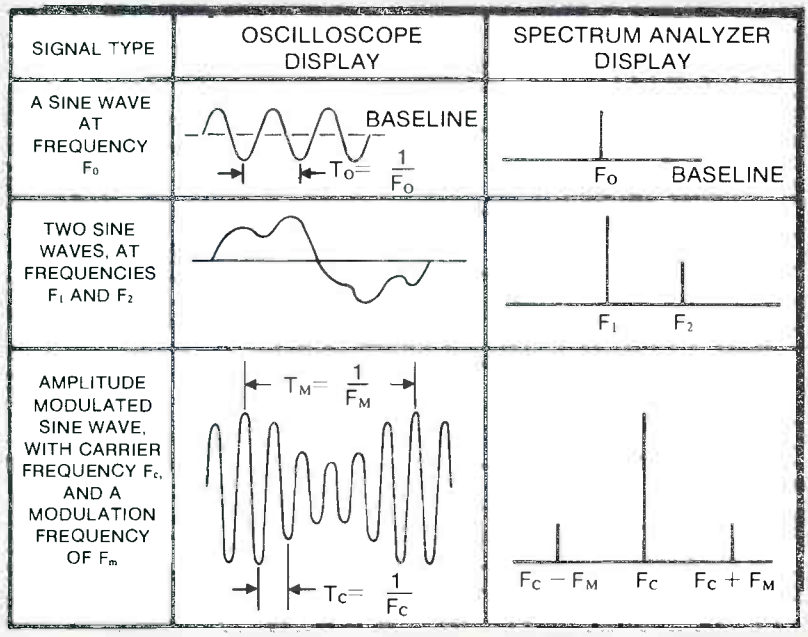


Figure 3. Each type of display provides unique information about signals. Notice how an oscilloscope and a spectrum analyzer display different information about the same signals.

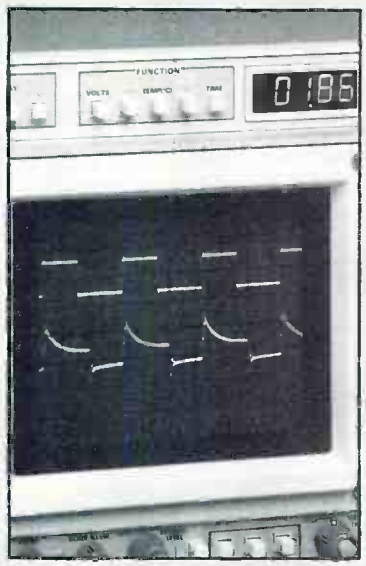


Figure 4. The added convenience of having a DVM coupled to the oscilloscope can speed troubleshooting.

ment easier than ever before. Some scopes provide a digital multimeter (DMM) as a part of the unit. (See Figure 4.) The DMM can provide numeric data on various parameters of the signals being applied to the scope. On some scopes, the meter can display dc volts, peak-to-peak and rms voltage, frequency, delta time or frequency, ratios, temperatures and even resistance.

The use of the DMM can be simplified by having the data displayed directly on the CRT screen rather than on a separate readout. There are two advantages to this method. One is that the operator does not have to look away from the CRT screen to read the data. More importantly, if a photograph of the display is taken, all of the important parameters are automatically included on the photograph.

Microprocessor features

The addition of microprocessors to oscilloscopes has further enhanced the capabilities of the scope. Not only can the microprocessor generate a variety of digital readouts for the CRT screen, but it also can provide interactive measurements. The microprocessor continually senses the positions of all of the front panel control knobs. Therefore, as the user sizes the waveform to the CRT screen, the microprocessor is constantly updating the information for the DMM functions.

By adding user-controlled marking cursors to the CRT display, the microprocessor can measure any of a number of specialized parameters. For instance, the operator can tune a cursor across a displayed waveform and instruct the microprocessor to display the frequency of the waveform at the cursor point. By using a pair of marking cursors, measurements between two points on a waveform can be made.

Figure 5 shows two horizontal cursors placed above and below a colorburst signal. Notice how the ratio of the amplitude of the colorburst to the reference signal (100 IRE units) is automatically calculated and displayed. In this case, the scope has calculated the amplitude of the colorburst to be 40%, or 40 IRE units. Vertical cursors can be used to measure the timing or widths of signals. Figure 6 shows a pair of cursors set to measure the horizontal-blanking width of a TV signal.

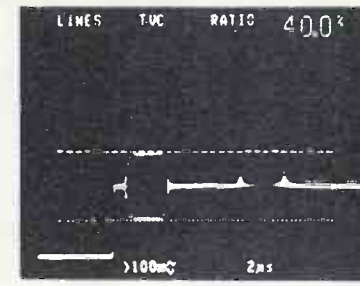


Figure 5. A microprocessor-based scope can provide many specialized measurements. In this display, a pair of user-adjusted cursors have been set to measure the ratio of the amplitude of the burst reference signal. The scope stores the reference amplitude and calculates the ratio of any other signals to that reference.

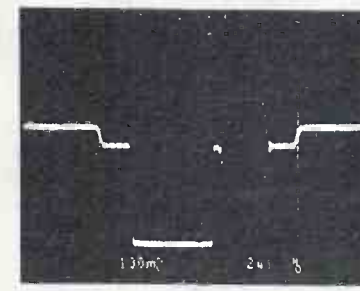
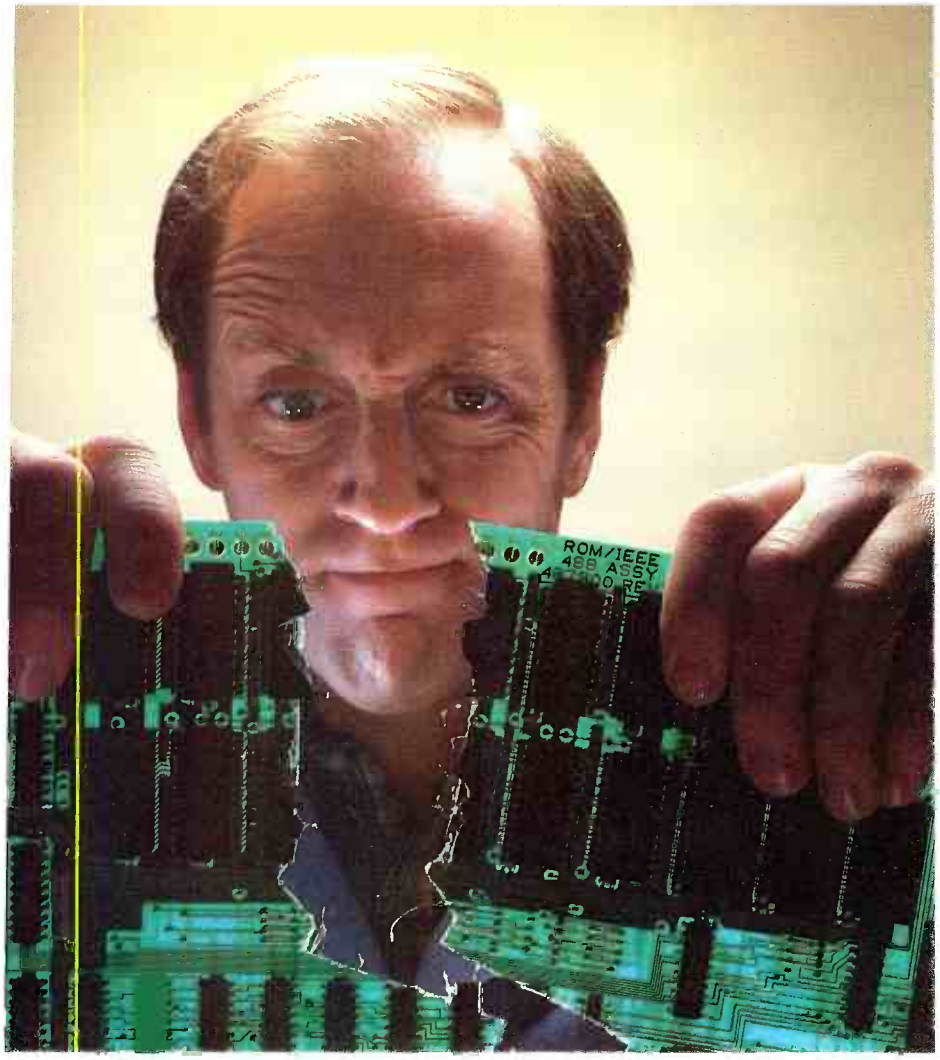


Figure 6. The user-controlled cursors can also be used in the vertical mode. Here, the cursors have been set to measure the width of a horizontal blanking signal (11.460μs).

Modern oscilloscopes offer the user many features that can simplify equipment service and repair. The first step in using this sophisticated equipment is to get some hands-on experience. The effective use of a scope comes with practice. Although studying books and manuals on the use of scopes is beneficial, no amount of reading can replace practical training. Today's scopes, although complex, are easy to use and relatively hard to damage. Some scopes automatically disconnect the inputs if you apply excessive voltages.

The next time you see an engineer or technician using a scope, don't become green with envy. Grab a probe and try your hand with the green one-eyed monster. |:-)))|

If you can't fix your board with the enhanced 9000 Series, it's beyond repair.



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Circle (41) on Reply Card

Troubleshooting microprocessor-based equipment

By David Montgomery

Today's technology requires that you know how to repair microprocessor-based equipment.

Many broadcast equipment manufacturers have begun using microprocessor technology in their products. New designs developed during the past decade have afforded manufacturers a high degree of flexibility in equipment functions while preserving the ever-important cost-value relationship. Microprocessors and their attendant circuitry have provided manufacturers a means to increase functions, improve accuracy, lower parts counts, offer greater user flexibility and maintain long-term reliability. Microprocessor-based systems seem highly complex but, with a little patience and effort, you can easily learn to troubleshoot these marvels.

Montgomery is technical service manager for International Tapetronics Corporation/3M, Bloomington, IL.

Static electricity

Microprocessors (and their support circuits) can be damaged or destroyed by static electricity discharges. Industry research has shown that static damage is most likely during field service. However, even common service procedures (such as PC board removal or insertion) can cause static damage that may weaken a semiconductor junction or result in a complete electrical failure. Therefore, the first rule in servicing is: follow to the letter proper electrostatic grounding procedures.

Walking across a carpeted floor in low humidity can generate as much as 39,000V of static charge. (See Tables 1 and 2). Don't forget that the synthetic materials in your clothing, the chair you're sitting in or even the tie you're wearing can generate static electricity too. Depending upon the humidity and other conditions, the generation of extremely high-voltage electrostatic charges is possible.

To protect your static-sensitive equipment (almost any circuit using microprocessors), use static-suppression techniques. These include a well-grounded workbench, anti-static work mats for the floor and countertop, and grounded wrist straps. Before you begin servicing, attach the strap to your wrist while you're standing on the grounded mat. This procedure will ensure that the electrostatic charges have been safely bled to ground. Most electronic supply houses carry several lines of static-suppression and static-elimination equipment and accessories.

Test equipment

Most manufacturers of digital equipment will be happy to recommend types and models of test instruments suitable for checking their hardware. This test equipment may range from simple to sophisticated, and from inexpensive to extravagant. One thing is certain, though, when it comes down to making purchase decisions for test equipment that will be used on modern broadcast equipment: The days of using a simple voltmeter are almost gone.

STATIC VOLTAGE 15%-36% RH MEANS OF STATIC GENERATION	COMMON VOLTAGE READING	HIGHEST VOLTAGE READING
WALKING ACROSS CARPET	12,000	39,000
WALKING OVER VINYL FLOOR	4,000	13,000
ICs IN PLASTIC BOX	3,500	12,000
PICKING UP A PLASTIC BAG	5,000	9,000

Fundamental requirements for static protective containers, James Huntsman, Donald Yenni Jr. and Gerald Mueller, 3M, Static Control Systems, presented at the 1980 Nepcon/West Conference, Anaheim, CA. Copyright ISCM.

Table 1. *High static voltages can be generated through countless everyday activities.*

STATIC SUSCEPTIBILITY OF SEMICONDUCTOR DEVICES	ELECTROSTATIC DISCHARGE VOLTAGE REQUIRED FOR DAMAGE SUSCEPTIBILITY
EPROM	100+
OP-AMP	190–2,500
CMOS (INPUT PROTECTED)	250–3,000
FILM RESISTORS	300–3,000
BIPOLAR TRANSISTORS	380–7,000
ECL (PC BOARD LEVEL)	500
SCR	680–1,000
SCHOTTKY TTL	2,000–2,500
JFET	140–7,000

A model for the failure of bipolar silicon integrated circuits subjected to electrostatic discharge, Thomas S. Speakman, Western Electric. Copyright 1977 by IEEE.

Table 2. *The sensitivity of various electronic components to damage from static voltages.*

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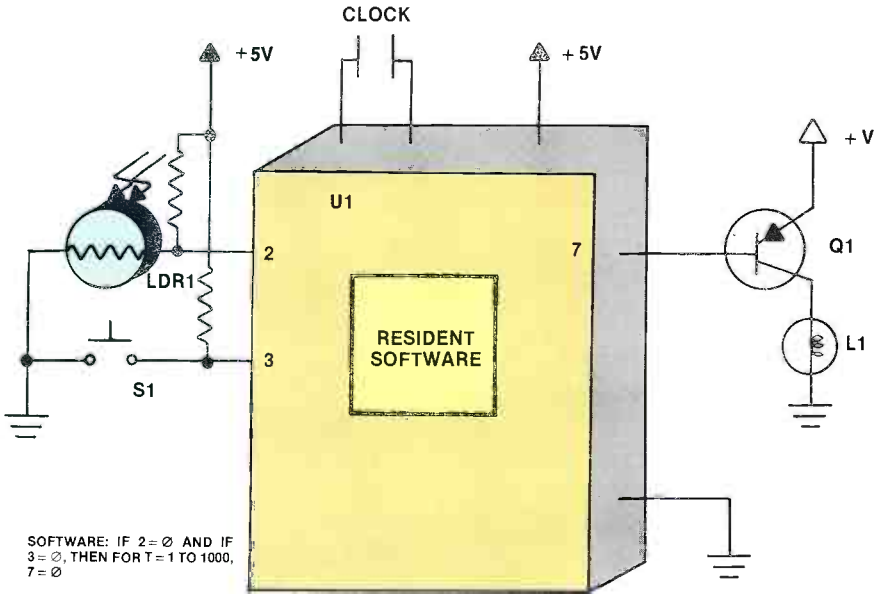

Figure 1. *A simple microprocessor-based light switch is used as a troubleshooting example. (See text for details.)*

Microprocessor technology and sophisticated digital and analog circuitry have made high-speed oscilloscopes mandatory troubleshooting items. This new technology, with integrated circuits and LSI construction techniques, has put 100MHz dual-trace scopes within the price range of even modest broadcast facilities. Besides digital troubleshooting, the scope can be used for setting head azimuth and phase on audio tape recorders and for adjusting the FM stereo exciter. A modern dual-trace wideband oscilloscope will become your single most important tool in assuring the technical integrity of the operation.

An additional item of great value to digital troubleshooting is a digital voltmeter (DVM). When used in conjunction with an oscilloscope, the DVM can help you gain a better understanding of voltage levels and logic states or conditions. In reality, the DVM will usually end up being used as a third eye during explorations with the oscilloscope. Voltages (or currents) may change or fluctuate as logic states shift, and a DVM is a handy tool to hang on a power-supply rail or logic line while troubleshooting the equipment.

Know the hardware

The troubleshooter must have a working knowledge of the device (and its proper operation) before serious troubleshooting can begin. Equipment using microprocessors performs seemingly simultaneous tasks. In reality, microprocessors perform single tasks in rapid sequence. It will be a big help to you if you know which operations they perform in relation to which inputs they have received.

The first point I stress in my troubleshooting training classes is to think of the microprocessor unit as nothing more than a many-input, many-output smart gate. The software in residence does nothing more than cause output functions to occur when certain input conditions exist. For this reason,

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troubleshooters seldom need to know the software program or the architecture of a microprocessor-based system. A working knowledge of its hardware functions is usually sufficient to allow you to perform component-level troubleshooting and parts replacement.

For purposes of illustration, we will discuss a microprocessor-based light switch. The circuit shown in Figure 1 consists of a mechanical switch, a microprocessor for decision-making, a light sensor and a lamp. This smart switch will only allow the lamp to be on during low light conditions. Therefore, the switch saves electricity and preserves lamp life.

The software design of this circuit sets up a table of conditions that must exist before an output occurs. These conditions state that the input pins (pin 2 from the LDR and pin 3 from the switch) are examined once each machine cycle. In order for a true condition to exist (a low on output pin 7), pins 2 and 3 must be low simultaneously. In real world conditions, the only time that lamp L1 can come on is after dark (pin 2 is low) and when S1 is depressed.

Obviously, this function could be accomplished with a simple gate. However, in our microprocessor-based light switch, the light will stay on one-half hour and then turn itself off. Software determines that after x number of machine cycles, pin 7 returns high, biases Q1 off and allows the lamp L1 to extinguish. The energy-saving light switch is born. It will not allow lights to be turned on when sufficient ambient light is present, and it will shut off the flow of electricity to the light after a predetermined time period.

Troubleshooting

Now that we have an operational understanding of the circuit, troubleshooting is simple. Assume that the lamp won't illuminate. Begin troubleshooting at the lamp:

1. Is the lamp filament open?
YES: Replace the lamp
NO: Go to 2
2. Is Q1 functional?
NO: Replace Q1
YES: Go to 3
3. Does U1 pin 7 go low when pins 2 and 3 are low?
NO: Replace U1
YES: Go to 4
4. Does U1 pin 3 go low when S1 is depressed?
NO: Replace S1
YES: Go to 5
5. Does U1 pin 2 go low when it is dark?
NO: Replace LDR

You can readily see that we have taken a logical and methodical approach to troubleshooting this circuit. Although this example is greatly simplified, the concept is the same for much more sophisticated circuits. After the circuit is divided into functional blocks, each block or leg can be analyzed for proper operation of its unique function.

Now that we have a basic understanding of the circuitry, the same approach can be used to explore a more realistic situation. The block diagram of a microprocessor-based cart machine (see Figure 2) may be used to gain an understanding of how the microprocessor can take the place of many discrete components.

In this example, the processor monitors all front panel and deck switches for a low condition on any line. Depending on the state of the switches, the processor will output a signal to the lamps, motor, solenoid or reproduce amplifier to control specific functions. Those functions all occur in a certain predefined order. This logical organization of events is controlled by the software, but in most instances the pattern is quite sensible. See Table 3.

As you go through your equipment, observe voltages and waveforms and their relationships with other circuits. Record what you find. Make your notes as legible and complete as possible because there's a good chance you may need that information in the future. Most of all, try to gain a complete understanding of normal circuit operation. In microprocessor-based designs, there is a relationship between activity on the inputs that produces distinct and predictable results on the outputs. Identify these

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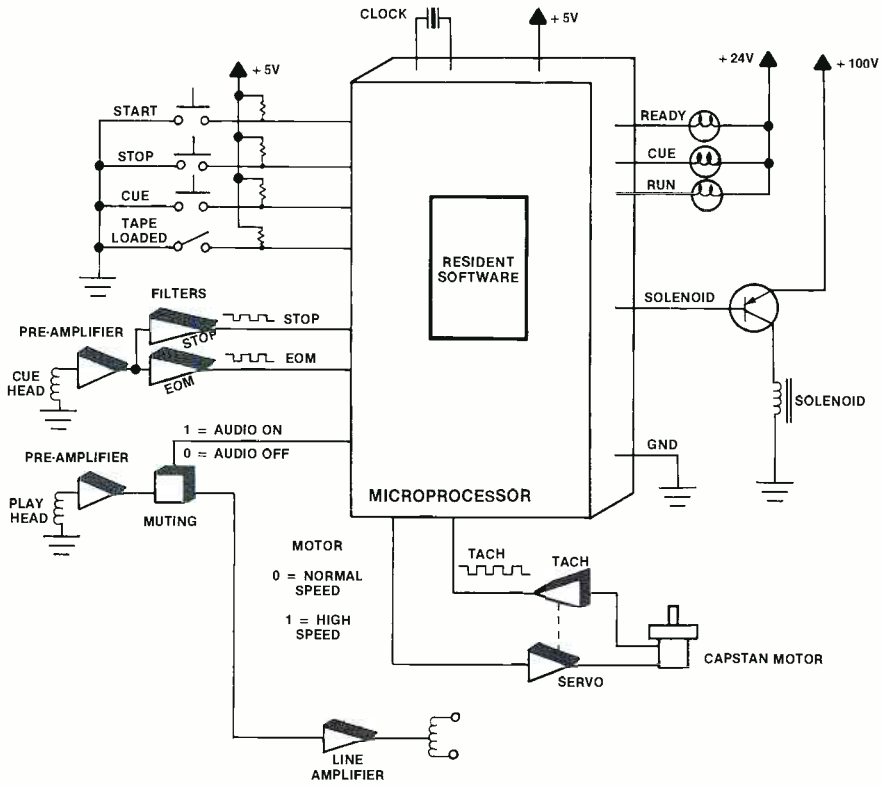

Figure 2. *Simplified schematic diagram of a microprocessor-based audio cartridge machine.*

ACTION	RESULTS
• Cart is loaded into machine.	• TAPE LOADED line to the processor goes low; READY line goes low, turning on the READY lamp. AUDIO line is low, keeping audio output muted. MOTOR line is also low, keeping motor at normal running speed.
• START switch is pressed.	• START line goes low. READY line goes high. RUN line goes low, turning on the run lamp. SOLENOID line goes low, engaging the pressure roller; tape begins movement. AUDIO line goes high, unmuting audio. During this time, the processor is monitoring the TACH line, measuring the motor frequency and making any necessary corrections to maintain accurate motor (tape) speed. To monitor the two cue lines, STOP and EOM, the processor measures the time (number of machine cycles) between the zero crossings. The cue signal square waves are produced by rectifying the analog cue tones at the output of the filter circuits.
• CUE switch is pressed.	• CUE line goes low, turning on the cue lamp. All other lamp lines go high. The AUDIO line goes low, muting audio output, and the MOTOR line goes high, putting the motor into high speed. When the STOP tone is detected by the processor, the software executes an internal STOP command.

Table 3. *A prerequisite to successful troubleshooting of microprocessor-based gear is a thorough knowledge of the proper operation of the equipment. A cart machine in good working order would follow the sequence shown here.*

relationships and carefully note them in your equipment manual. Use your oscilloscope to monitor logic levels (voltage shifts). The oscilloscope also can serve as a voltmeter for observing power-supply rails or measuring high or low logic levels. Use the DVM to monitor voltage-regulated power supplies and more conventional analog portions of the circuit.

When you call for help

- *Narrow down the problem as much as you can and then be prepared to troubleshoot. Although factory reps are good at what they do, help them out by taking the problem as far as you can before you call.*
- *Provide as much detail as possible about the symptoms or failure. If the problem is with only a portion of the circuit, a subassembly or subcircuit, point it out.*
- *Offer all the details about what has been done so far to resolve the problem (component exchanges, adjustments attempted or voltages or waveforms measured).*
- *Organize your documentation, notes and schematic diagrams for reference during the call. Fumbling for drawings only slows the problem-solving process.*
- *Be objective. Even though you may be under a lot of pressure to resolve the problem, a short temper won't get your problems repaired any more quickly. Clear thinking and objective input will guide you to a solution.*

Call the factory

When troubleshooting a difficult problem, you can do yourself a huge favor by following this advice: Don't feel too proud to call the manufacturer for assistance. Some engineers feel that contacting the manufacturer for help is a sign of weakness or ignorance. Actually, the opposite is true. Professionals know when they need help, and they ask for it. Reputable manufacturers operate technical service departments whose sole purpose is to assist customers in solving problems.

When you call, be prepared to give as much detail about the problem as possible. In particular, describe the symptom and explain what actions you have taken so far to find a solution. The service representatives may be familiar with the problem, and may be able to provide a solution quickly.

Working with microprocessors requires study and patience. Microprocessors perform the same types of functions as previous technologies; they just perform more of them, at a faster rate, from one location. A few simple precautions and a logical, step-by-step approach to troubleshooting could transform you from engineer or technician to M.D. (MicroDoc).

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Maintaining studio acoustics

By Eric Neil Angevine, P.E.

Can you hear the sounds of silence in your studio? Preventive maintenance can help you hold down the noise.

An old-timer in the acoustical materials business tells the story of the building owner who had an acoustic ceiling installed in his office. At first, the owner was impressed with the improved acoustical environment. As he became accustomed to it, however, the improvement didn't seem so great. He called and asked the installer, "How long does it take for that acoustic tile to get so filled up with sound that I have to replace it?"

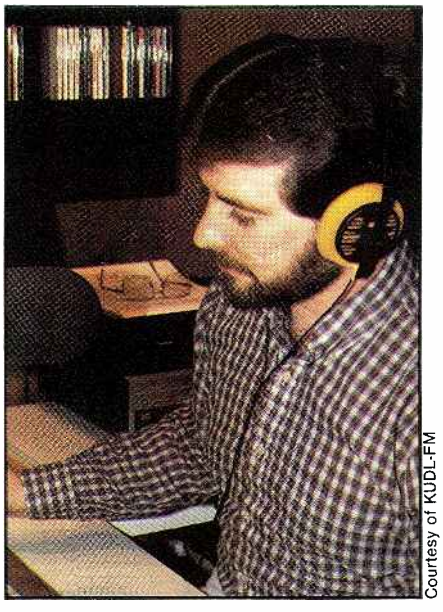
It's laughable that the man so completely misunderstood the principles of acoustics. What isn't so funny, however, is that a lot of people in the business of sound don't understand the principles of proper maintenance of acoustical materials.

Acoustic absorption

Like everything else, acoustic tile and other acoustically absorptive materials eventually become dirty. When hard walls and ceilings begin to show dirt or age, they can be repainted. Unfortunately, when acoustic tile and most other acoustical materials are painted, their sound absorption effectiveness is reduced.

Sound-absorptive materials are usually fibrous or porous. Even a thin layer of paint can fill the porosities on the surface, forming a reflective barrier to incidental sound.

There is one sound-absorption product that can be painted. Cane fiberboard (such as Tectum) is so open that spray painting will not fill its porosities. (Because the material is not as absorptive as fiber glass or mineral fiber products, however, it is necessary to place one or two inches of fibrous absorption behind cane fiberboard to make it as absorptive as other acoustical products.)



Courtesy of KUDL-FM

In master or production control rooms, the audio operator often wears headphones to better hear the signal. Appropriate acoustical design in the control room and studio further aids listening.

Some acoustically absorptive products can be cleaned, however, which suggests that long-term maintenance should be considered before a studio is constructed. Some fiber-glass ceiling panels have a thin film facing that can be washed with soap and water. Absorptive wall panels can be constructed with facings of open-weave fabric that can be removed for cleaning. Perforated metal or other grillework used to cover acoustic absorption material can be painted (with care).

Cleaning and painting

When sound-absorptive materials are already in place and still have a useful life ahead, some maintenance may be desirable to restore an acceptable appearance. As mentioned previously, film-faced fiber-glass ceiling panels can be cleaned with soapy water. Most products, however, cannot be cleaned so easily. One method of cleaning acoustic tile ceilings uses a mist-extraction system similar to do-it-yourself carpet cleaning machines. Unlike carpet cleaning, though, this is not a project you should try to do yourself. Inappropriate materials or methods can destroy an acoustic ceiling.

It is sometimes difficult to find a qualified contractor who cleans acoustic ceilings. A commercial carpet cleaner or acoustic ceiling installer may be able to refer you to a local qualified ceiling cleaner.

Occasionally, there is no choice but to repaint an acoustic ceiling, even though any paint you use will reduce the sound absorption qualities of the acoustic tile. Any advertisements for an *acoustic paint* that *increases* sound absorption should be ignored.

If you must paint, do so with extreme caution. Use a minimum number of thin coats of spray paint. Be content to just tint the finish and try to avoid filling

Angevine, **BE**'s consultant on broadcast acoustics, is an associate professor at Oklahoma State University's School of Architecture, Stillwater, OK.

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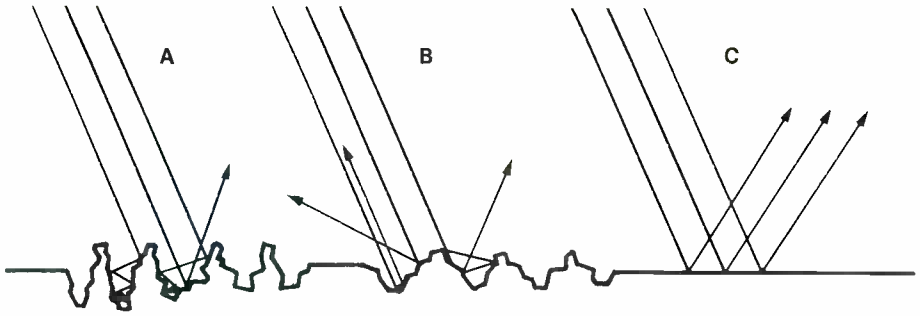

Figure 1. *Three different surfaces, (A) porous, (B) dirty/painted porous and (C) smooth or non-porous, affect reflection of sound differently. The more irregular the surface, the more diffused the reflections are. Acoustical material actually traps sound within the surface.*

fissures or perforations in the tile. Do not apply paint with a roller or a brush.

Because painting will reduce the effective acoustic absorption, you may want to consider adding a small quantity of new acoustical material to make up for the sound absorption you will lose.

Doors and windows

Maintenance in the studio should involve the preservation of sound seals on doors and operable windows. Many sound-rated doors use drop seals at the threshold. These drop seals require regular attention. Each seal has an adjusting screw that regulates its protrusion when the door is closed. Adjustment is required at least once a month to keep drop seals working properly.

The remaining sound seals on doors and windows do not require adjustment, but must be maintained if they are to perform properly. Neoprene, rubber and many plastics may lose their plasticity and become hard, or they may shrink slightly. The result is small gaps that become sound leaks, rendering the seals ineffective.

Both problems are caused by dehydration of the material. It may be possible to retard this deterioration by periodically applying a small amount of lubricant and working it into the material. This should not be done too often, however, because an overapplication of lubricant can destroy many synthetic products.

The interior of double-glazed windows must be cleaned periodically if the windows are not permanently sealed. After removal and cleaning, carefully reseat the glass to minimize sound transmission through the window.

Mechanical system noise

A major consideration in the construction of a new studio is the control and reduction of mechanical equipment noise. This noise propagates down ducts that cannot be closed. Its control requires special efforts during building.

Most machinery creates more noise as it ages and wears. The mechanical equipment noise level may gradually increase in the studio unless a regular maintenance program is undertaken.

Mechanical equipment should be checked periodically for wear in bearings, gears and sheaves. Also check to ensure that nothing has been allowed to interfere with equipment vibration isolation. Test units are available that can quickly analyze the health of a machine by examining its natural vibration spectrum. As is often the case, good preventive maintenance will save money in the long run.

A studio constructed to be state-of-the-art does not remain so for long without proper maintenance. The *art* is likely to change, as technology offers new machines and new methods. The *state* in which the art is maintained, however, is entirely up to us.

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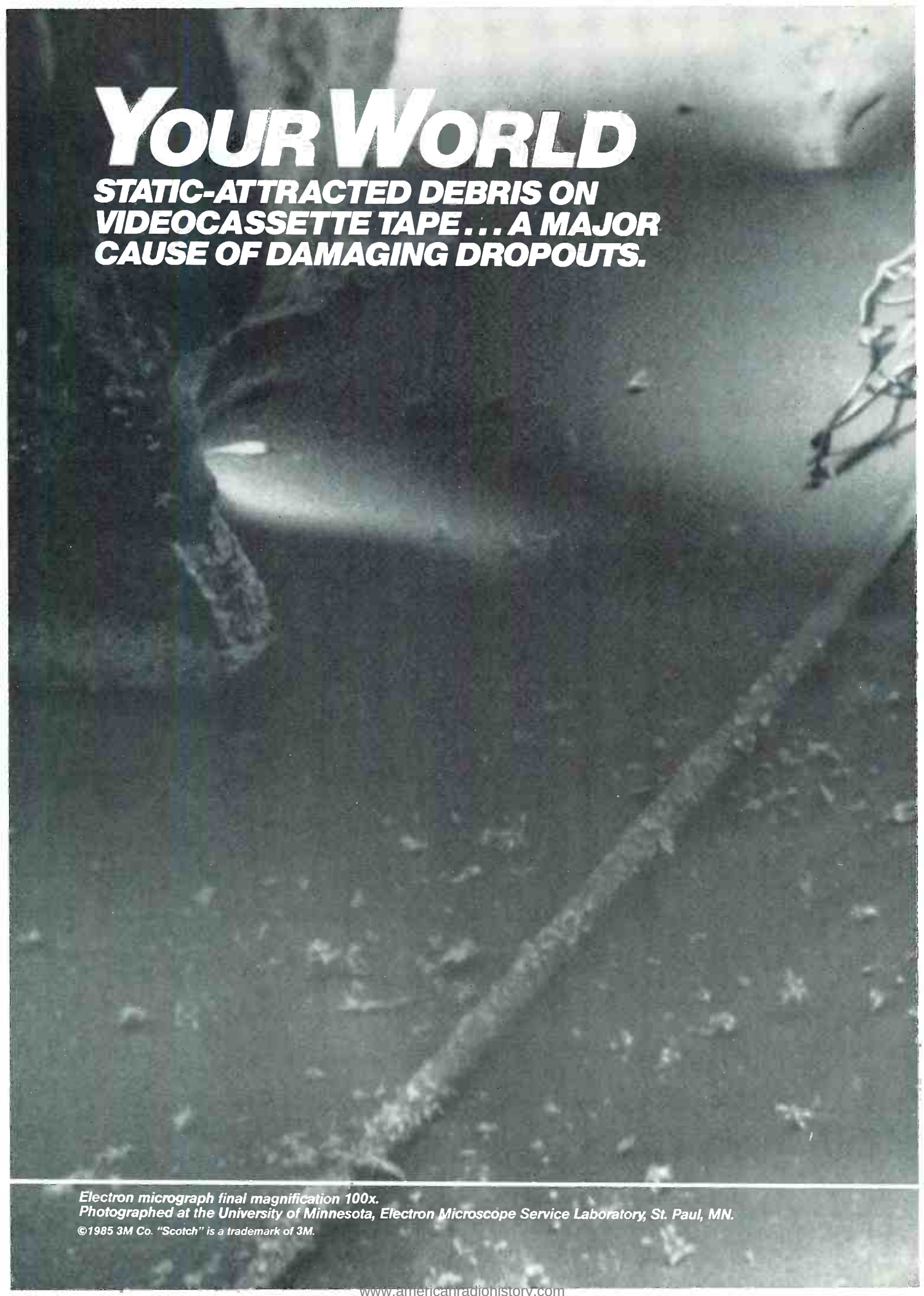

Electron micrograph final magnification 100x.
Photographed at the University of Minnesota, Electron Microscope Service Laboratory, St. Paul, MN.

You're looking at an electron micrograph of videocassette tape. It dramatically shows the debris that a videocassette's inherent static charge can attract. Hair. Dust. Fibers. Cigarette ashes. Note the size of these particles in relationship to the read head. Is it any wonder they can cause dropouts and picture quality problems?

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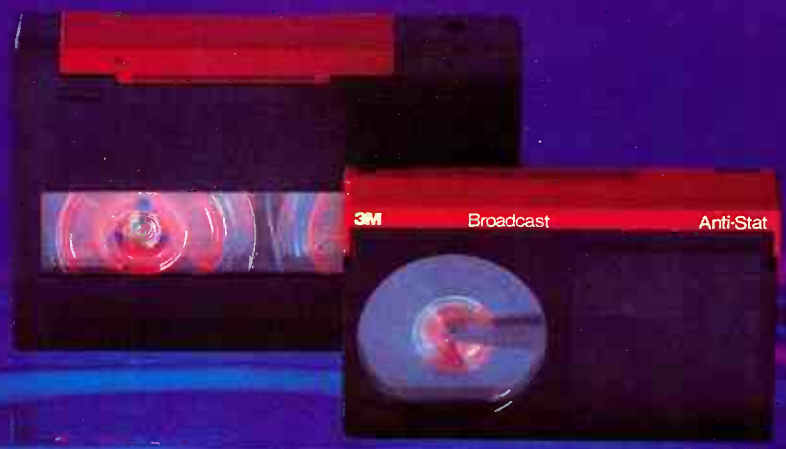

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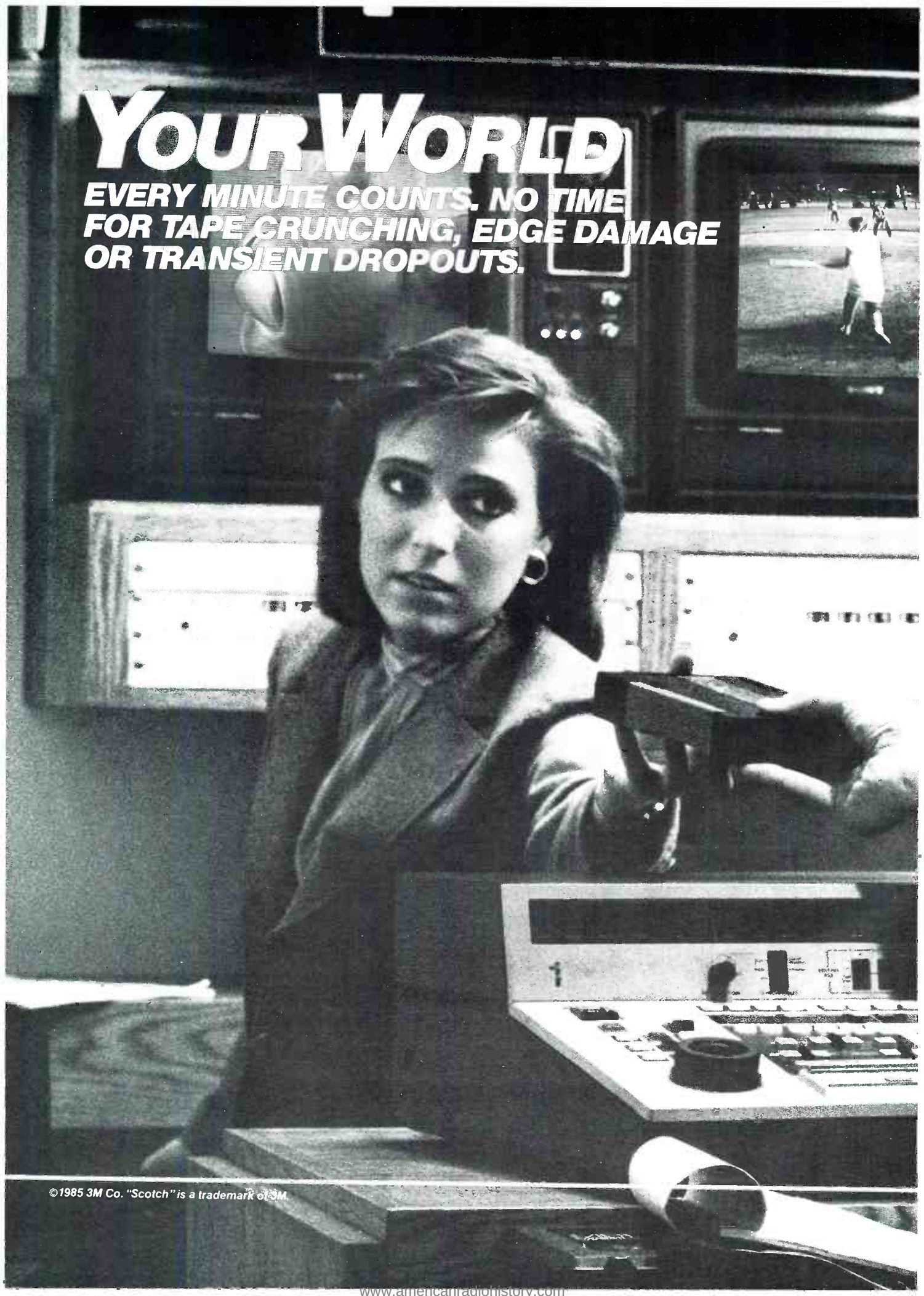

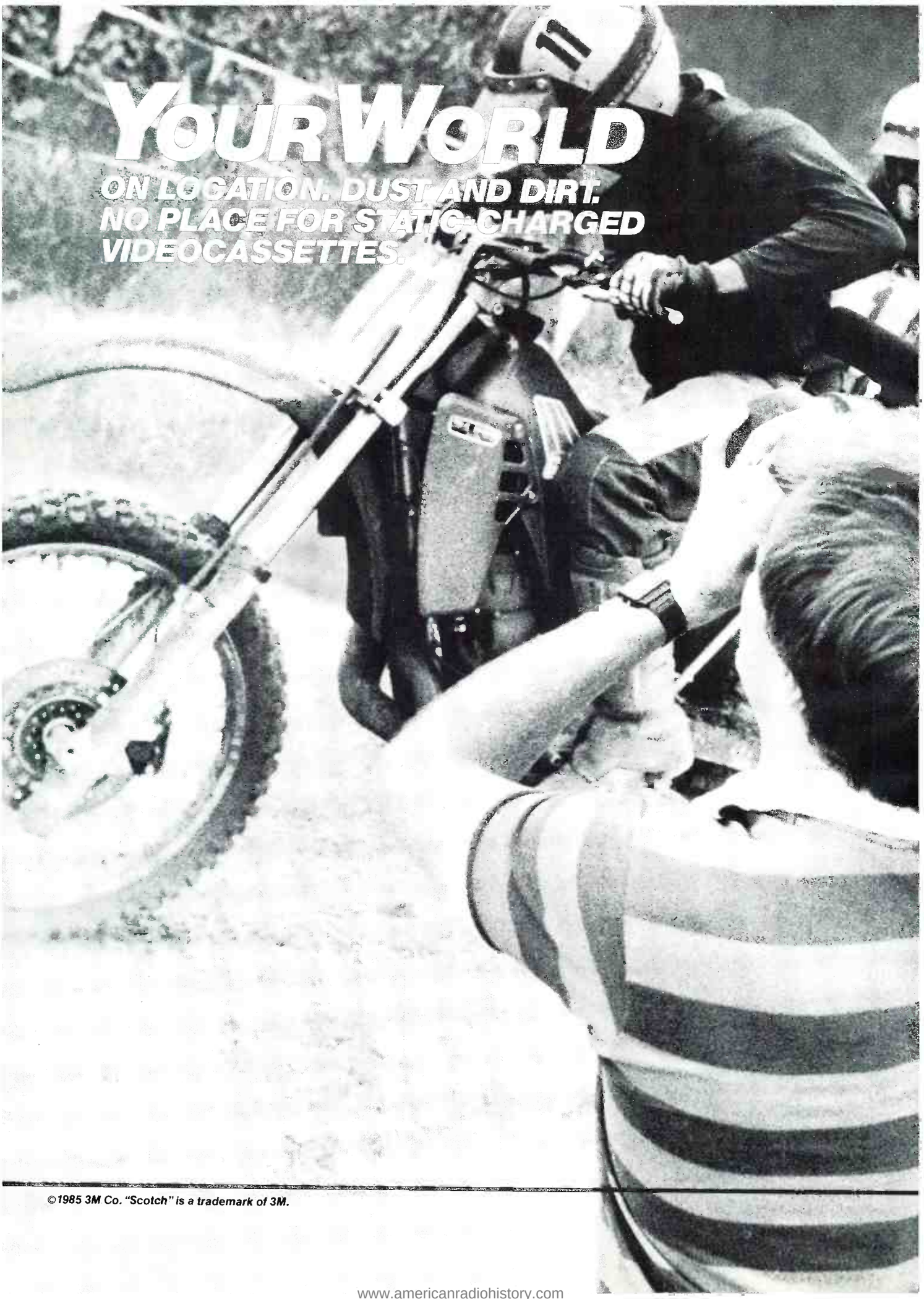

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Part 2

Maintaining cartridge systems

By Douglas Fearn

To achieve the high-quality audio you expect from your equipment, take a good look at your station's procedures for cartridge recording.

In Part 1 of our series on cartridge systems (see page 44 in the August issue of **BE**), we discussed a procedure for aligning the mechanical and electrical elements of the cartridge machine. We also looked at a method by which you can evaluate tapes to choose the one that is best suited to your station. Let's say you have properly aligned the cartridge machine and selected the ideal tape. Now, you must properly transfer the source material to the cartridge. To do this, you should establish a consistent recording procedure that maximizes the capabilities of the equipment.

After transferring about 10,000 songs to tape cartridge over the years, I think I have a broad perspective on the problems from both the engineering and operational points of view. Although the procedures I use primarily apply to transferring music from disc to cartridge for maximum fidelity on FM, they also apply to any cartridge recording.

At most radio stations today, non-technical personnel perform most of the production studio work. The vast majority of these people do not have the depth of knowledge about magnetic tape recording that an engineer should have. They may have discovered that certain procedures produce poor results, but they are not quite sure why. It's our job to teach them how to make a good recording. Sometimes, it's simply a matter of helping them break bad habits.

Consider, too, the benefits of having one operator make all the cartridges at your station. This may not be practical for commercials, but if your station's music is on cart, assigning one person the responsibility for all of the recording will help ensure consistent high-quality results.

Cleaning any tape-handling device may seem too elementary for discussion, but proper cleaning is often left to chance. I have successfully used the following procedure on tape decks ranging from cassette recorders to 24-track, 2-inch machines.

The tape path can be cleaned with 91% isopropyl (rubbing) alcohol you find at any supermarket or drugstore. When there is only about one-fourth left, throw the bottle away. The water content that builds up is not as important as the contamination of the alcohol by dirty swabs. Use cotton swabs with wooden handles because they are stronger than cardboard ones.

After the cotton swab is dipped into the alcohol, wring it out on the inside lip of the bottle neck. The swab should be damp but not soggy. Alcohol running down into motor bearings is a major cause of early bearing failure.

To properly clean the machine, it must be opened so the heads are accessible. First, clean the playback head by scrubbing it. Use moderate pressure. Repeat the procedure for the record head, or dummy head. After the heads are clean, activate the machine in the play mode and scrub the pressure roller as it turns. Only after the roller is clean can the capstan shaft be cleaned. You may have to repeat the procedure several times to completely clean both the pressure roller and capstan.

While you're cleaning, observe the general condition of the machine. Does it need to be vacuumed out? Is the pressure roller in good shape, and the pressure roller tension correct? Give the machine a thorough visual inspection. Many potential problems can be spotted through this simple process.

How often do heads require cleaning? At WKSZ, the main music machines are each used more than 100 times in 24 hours, representing more than six hours of playing time. With good tape, daily cleaning appears to be adequate for these machines. If you find that more frequent cleaning is necessary, it probably means that your machine has worn parts, a misaligned tape path or defective tape.

It's often hard to determine how many hours have elapsed since the last cleaning of the heads in the production studio. Because of this, our policy is to clean the tape path before each recording session.

Stereo phasing

Maintaining the proper phase relationship between left and right channels has been a headache since stereo cartridge machines were introduced. However, a properly aligned and maintained machine, used with high-quality tape and cartridge shells, can consistently deliver reasonably good stereo phasing. The key is maintenance. A regular check of all machines, using a standard head-alignment cartridge, should reveal problems long before they become audible.

Some cartridge machines have either an automatic or manual method for aligning the record head to match the characteristics of the individual cartridge. For non-technical operators, an automatic system seems to be fairly foolproof. Regardless of which system is used, make sure the operators are consistent in their procedures.

Record levels

Proper recording levels depend not only on the board level set by the operator making the cartridge, but also on the record level calibration of the machine.

Continued on page 92

Fearn is chief engineer at WKSZ-FM, Media, PA.

Create a room

w th a view.

We'd like to open your eyes to the incredible REV-1 digital reverb. Because it gives you unheard-of control over virtually all reverb parameters. And something that has never been seen in any type of reverb: the capability to "look" at the sound as well as hear it.

The remote unit that controls the nineteen-inch rack-mountable unit has a lighted high-resolution LCD display that graphically depicts the results of the adjustments you make.

So getting just the right reverb sound is no longer a question of trial and error.

"EARLY REFLECTION" display mode showing room size and relative level and time of discrete reflections.

"REVERB DENSITY" display mode showing level and relative time of subsequent reverberation.

"REVERB TIME" display mode showing difference in reverb time in each of four frequency bands.

"MEMORY TITLE" display showing the titles of internal ROM memories.

The logical grouping of the parameter controls on the remote also makes it easy to create any effect you like. Then store it in any of 60 memories for instant recall.

The remote also contains 9 additional RAMs so you can store programs and carry them with you to use anywhere there's an REV-1.

And there are 30 additional ROMs with factory preset sounds. Many of which can be completely edited (as can the user-programmed sounds) by using the LEDs to tell you the set value or indicate in which direction to move the control so you can easily and precisely match the value of the originally programmed sound.

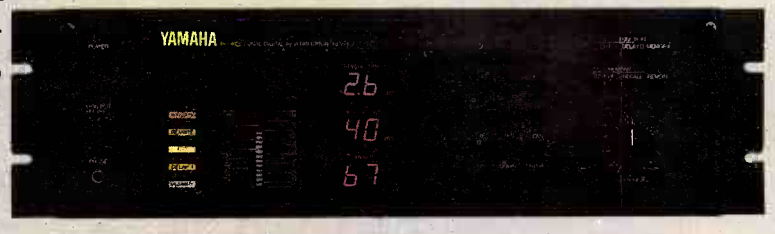
And the sound itself is far superior to any other digital reverb. The REV-1 uses specially developed Yamaha LSIs to create up to 40 early reflections and up to 99.9 seconds of subsequent reverberation. So the effect can be as natural (or unnatural) as you want it to be.

We could go on about the REV-1. Tell you about its 44.1 kHz sampling rate that provides a full 18 kHz bandwidth to prevent the natural frequency content of the input signal from being degraded.

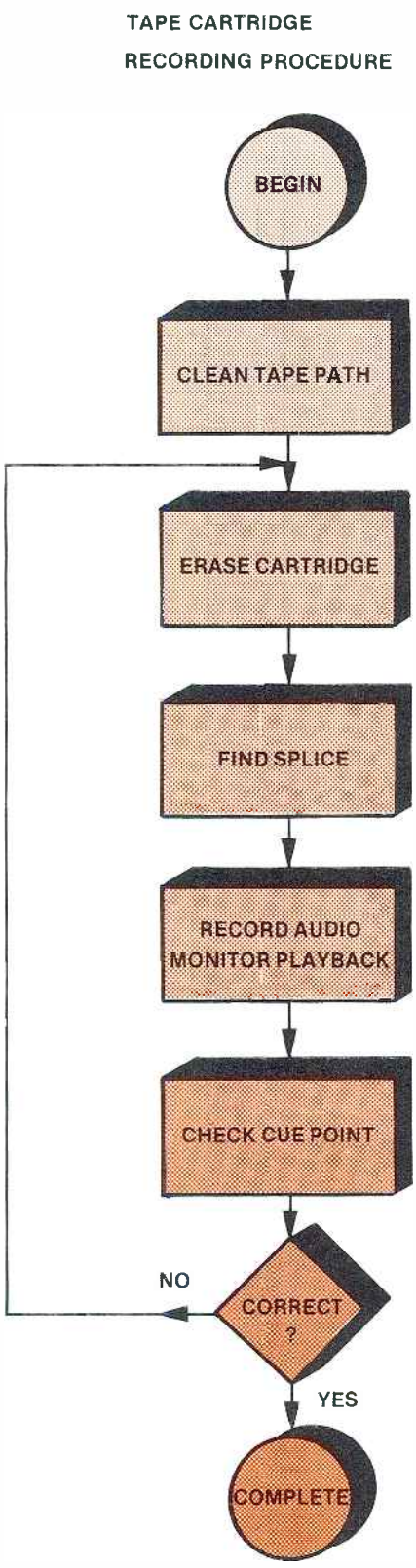
How it has a dynamic range of more than 90 dB for the delay circuitry and more than 85 dB for the reverb circuitry.

But why not take a closer look at the REV-1 at your authorized Yamaha Professional Audio Products dealer. Or for a complete brochure, write: Yamaha International Corporation, Professional Products Division, P.O. Box 6600, Buena Park, CA 90622. In Canada, Yamaha Canada Music Ltd., 135 Milner Ave., Scarborough, Ont. M1S 3R1.

YAMAHA



Circle (51) on Reply Card



Continued from page 89

The bias adjustment procedure described in Part 1 provides a recording flux level of 160nWb/m (nanowebers/meter). This level provides plenty of headroom and an acceptable noise level. With the machines and tape used at WKSZ, the 3% THD point occurs about 11dB above 0VU at 1kHz. Our machines have a built-in peak indicator light that is set 10dB above 0VU. This setting allows the VU meter to approach and occasionally exceed 0VU while keeping distortion to an inaudible level.

If your operators are in the habit of running the meters into the red (or worse), a reduction in the record level calibration of the cartridge machine will help. On most machines the meter calibration can be adjusted independently of the actual recording level. If you do this, make sure the console meters and the cartridge meters agree or the operators might crank up the board to distortion-causing levels.

On-air operators often let the station's processing equipment correct for their inconsistent levels. In the production studio, this isn't possible. For highest quality audio, there is one optimum record level, neither too high nor too low. This is a simple concept, but it's often overlooked by non-technical personnel.

At the start of each recording session, use a 0VU tone at 1kHz to balance the left and right channels and to calibrate the recording machine. The few seconds it takes to check the calibration may save hours of work.

The playback audio from the cartridge should be monitored while the cart is being recorded. This procedure eliminates the need to play back the entire cartridge later. The monitoring process must be done on a high-quality audio channel if any problems are to be detected. It's useless to listen on the cue channel because most cue systems provide poor audio quality. Better audio is usually available from the *audition* or *program 2* channels.

While you're setting up the board and machines with a tone, also set your monitoring channel for playback of the tape. Set the board program meters to 0VU and check to see that the cartridge record meters also read 0VU. Begin recording with the machine output fed into the monitoring channel. Switch the console meters to the monitoring channel and, if necessary, set the level to 0VU. This process ensures that the levels will be matched when switching between record and play on the monitor speakers.

Testing the cart

At WKSZ, we never reuse a music cartridge. After the cartridge is pulled from service, it is sent back for rebuilding. All non-music carts are tested before they are returned to the shelf to be reused.

Our test of the carts is simple and quick. The console is configured as previously described, but with one difference. The record level (program) is set to −10VU rather than 0VU and the monitoring channel, during recording on a new cartridge, is brought up to read 0VU. This new record level prevents tape saturation at the higher frequencies used in the test. The cartridge to be tested is first erased and then placed in the recording machine. A 1kHz tone is recorded and the playback level is observed. The 1kHz level should be within 1dB of 0VU. If the cartridge passes this test, a 10kHz tone is then recorded. Any cartridge that is more than 2dB down at 10kHz, or that has an unstable 10kHz tone, is rejected. A person who is properly trained in this procedure can easily check two dozen cartridges in about 20 minutes.

Preparing the cart

There seems to be some concern in the industry about the safety of high-speed cartridge-erasing systems. Although I cannot offer any evidence to refute or to confirm that concern, I agree that the less time the tape spends under this condition, the better. Therefore, we do not test new cartridges at our station. We do, however, use both an outboard cartridge eraser and machines that provide the high-speed erase feature.

Even without such units, it is possible to adequately erase cartridges manually. It seems every operator has a favorite procedure for erasing tapes, but some of these procedures don't address the requirements for proper erasure of a cartridge. The actual amount of time spent in the erasing procedure is not important, as long as all the parts of the tape are covered by the bulk eraser's field. To prevent residual thumps and noises from remaining on the tape, the erasing field must diminish gradually. Remember the inverse square law in this regard. The first fractions of an inch separating the tape and the eraser are more important than the next several inches. It's hard to imagine the bulk eraser having any effect at arm's length. Experiment, find a procedure that works, and stick with it.

No matter how carefully it is made, the splice in the continuous loop of a cartridge will cause an audible dropout if audio is recorded over it. It may sound fine on the first playback, but eventually the splice will open up, causing a dropout.

Machines that automatically find the splice are terrific, but the splice can also be found manually. If you don't have a splice finder, just watch the tape. When

INTRODUCING AN AUTOMATIC CAMERA DESIGNED TO BEAT THE COMPETITION HANDS DOWN.

The new Sharp XC-A1 weight distribution and shoulder fit are so exceptional, it can balance on your shoulder without being held. (Something we suggest you don't try with the competition.)

And weight isn't the only thing well-balanced about it.

The XC-A1 has the most advanced 2/3" compact tube technology in the business. With three Low Capacitance Diode Gun/Mixed Field Saticons;* to give you 750 lines of resolution. Plus a high 57db signal-to-noise ratio, for an amazingly quiet picture even when you go to 9db or 18db gain.

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Like computer controlled auto-centering, auto-white and auto-black. A new auto-iris with NAM, to handle those intense color fields. Plus center weighting, so the iris isn't fooled by off-center light sources, reducing the need to manually override.

What the XC-A1 can't do alone, it coaches you to do. With step-by-step instructions that appear in the viewfinder, then disappear or move to one corner automatically.

Instructions that don't block your view.

The most advanced 2/3" compact tube technology.

It's virtually rainproof and immune to radio frequency interference, too. And with a rugged die-cast frame, crack-resistant glass epoxy circuit boards and gold-plated connectors, it'll take great pictures for years to come.

All of which makes its suggested list price of under $6,500 truly remarkable.

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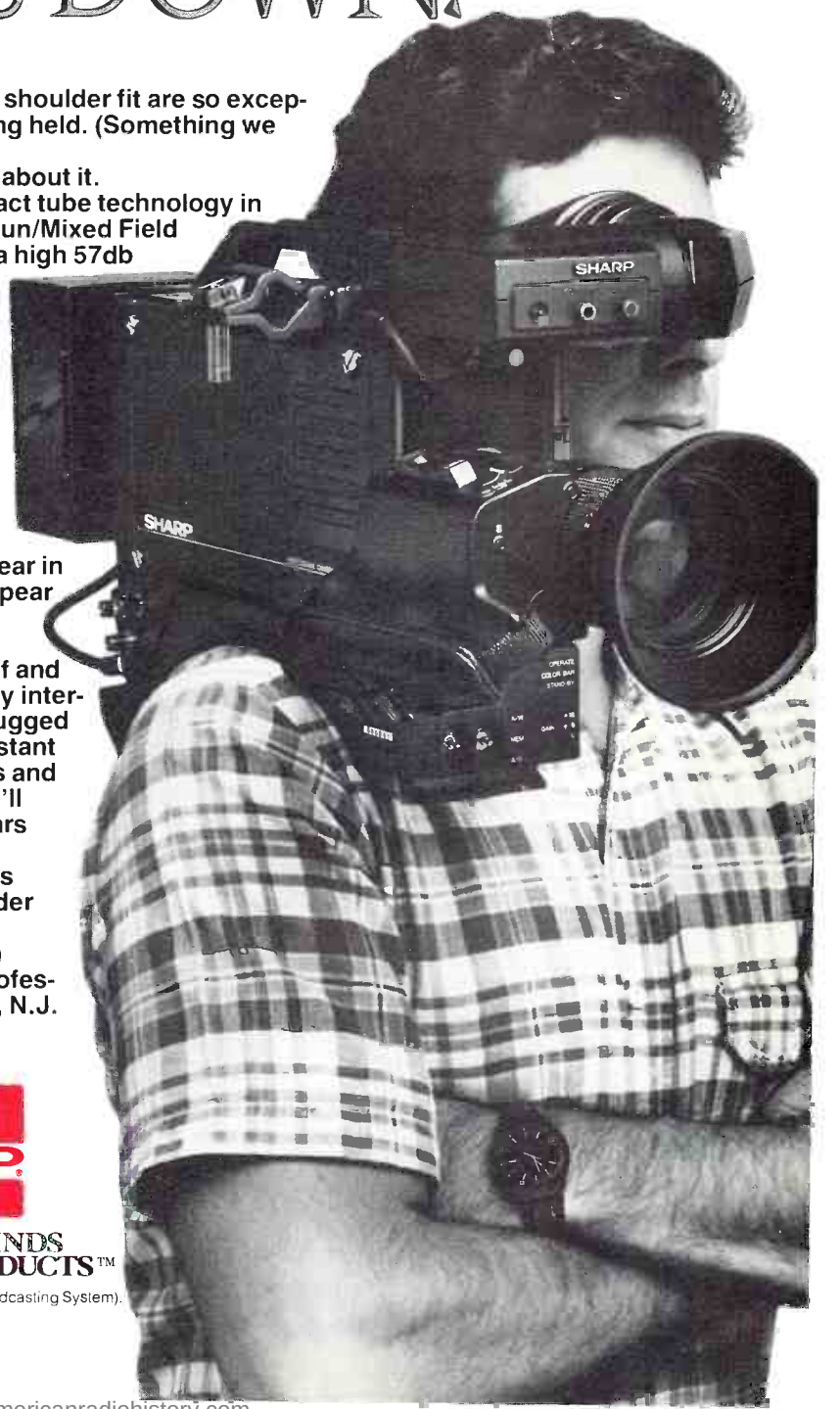

the splice goes by, stop the machine.

Starting the machine

Recording on cartridges seems like simplicity itself: just enable the record mode and start the machine. On playback, push the start button and the audio begins. But how much time elapses, after you push the start button, before the audio begins? Consistent start times are vital in tight formats in which operators depend on consistency for the proper on-air sound. It would seem that an instantaneous start would be ideal. I have found, however, that a pause of about 100ms is essential with music to eliminate any anomalies at the beginning of the song. At worst, the opening note will be chopped. Or more subtly, the first note may wow or fluctuate in pitch slightly. Because a 100ms pause is approximately half the starting time delay of most turntables, it's easy for the production operator to work with this spacing.

Splice finders usually run the tape at a faster-than-normal speed. Consequently, when they stop, the tape may have some slack in it. This slack can produce poor tape-to-head contact, or even momentary wow, when the cartridge is started. To prevent these problems, run the tape at normal speed for a few seconds before recording.

On playback machines with a fast-cue mode, this slack in the tape can affect the quality of playback even when the cartridge is properly recorded. For this reason, some stations refuse to use the fast-cue feature. I have found that you can use fast cue if adequate start time is provided in the recording process.

After the cartridge is recorded and recued (fast-cued if this feature will be used on the air), the cart should be played again to check for proper starting. If it does not conform to the standards, the cart must be recorded again. With fast-cue machines, be certain to wait until the capstan motor returns to normal speed before performing this test.

About Part 3

We've covered how to adjust the cartridge machine for proper operation and performance. We've also examined how to record consistent quality audio onto the cartridge. There remains one other area for us to discuss. The next topic in this series will outline the advantages, and sometimes the necessity, of using equalizers when producing cartridges. There are specific instances in which source material should be equalized before it is recorded onto cartridge. The next article will discuss how to take advantage of those situations to produce higher-quality audio cartridges.

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These new U's range from 10 kw to 120 kw, with maximum output power to 240 kw (parallel running). And feature new, high efficiency Amperex or EEV Klystrons. To cut your power consumption, maintenance, and replacement costs.

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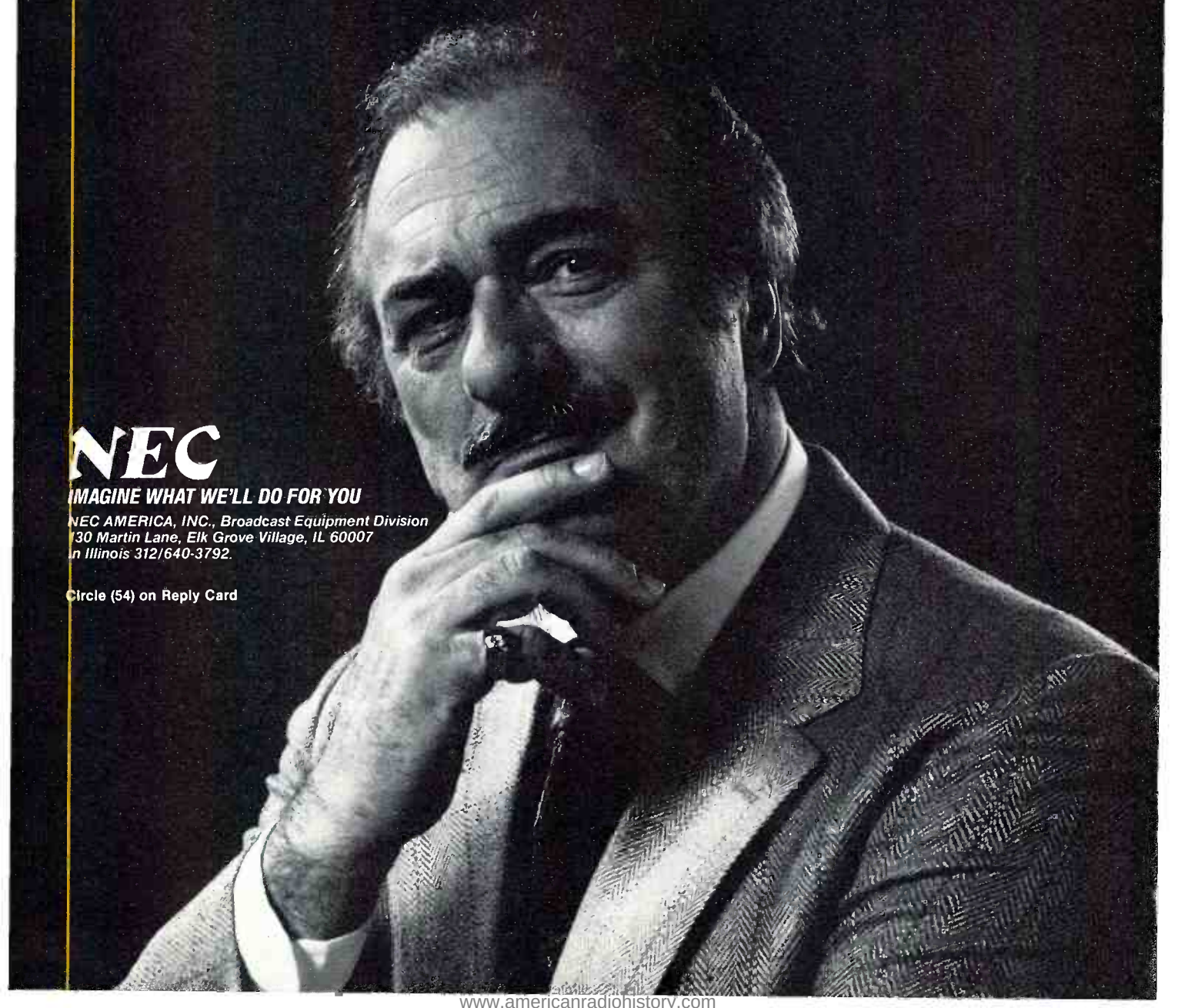
For more information, call Joe Engle toll free at 1-800-323-6656.



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Managing a maintenance program

By Mark W. Timpany

A structured communications program can heighten your visibility and improve your on-the-job performance.

The largest part of an engineer's day is spent on projects that involve quantitative measurement. A broad range of equipment is readily available for measuring frequency levels, distortion and other parameters. There are no such tools, however, for station management to measure the engineer's effectiveness.

Management can gauge the sales department activity directly from advertising revenue coming into the station. Audience research can be used to rate the program department's performance. However, management has a more difficult time evaluating the engineering department. It is easy to see whether equipment is working, but it's not always so easy for managers to assess an engineer beyond the role of *Mr. Fix-It.*

Standardized reports

Early in 1984, the engineers in the Shamrock Communications group began developing a program to improve communications. Although the program is still evolving, a lot has been learned about achieving effective interdepartmental communications.

Timpany is chief engineer at WQFM-FM, Milwaukee.

Our first objective was to establish some type of report for the station manager, to highlight the activities of the engineering department on a monthly basis. A similar report was already being used by the sales and programming departments. The monthly engineering report that we designed provides a timely means of informing management on the status of construction projects and day-to-day activities. The reports are also a valuable resource to the engineers by helping to identify unreliable equipment that needs replacement.

A group newsletter developed from these monthly reports. Assembled at WQFM, the newsletter consists of the collected monthly engineering reports from the five group locations and contributions from the station engineers. The newsletter helps to identify technical problems that may be common to the group of stations, and provides a means for regularly distributing solutions. Evaluations of new equipment at one station are passed along to the other stations. One engineer can share the details of a design or interface project; another engineer in the group who duplicates it will save valuable time. Just as important, the newsletter reminds the separate engineering staffs that their work is part of a group effort, and is supported by this group.

Test standards

Once the lines of communication were established, a number of standardized test procedures were developed. The first step in implementing these procedures was to equip each station with identical test equipment. After careful evaluation, the group selected a single test system that would measure all of the important parameters for a radio station.

Next, a package of standard test

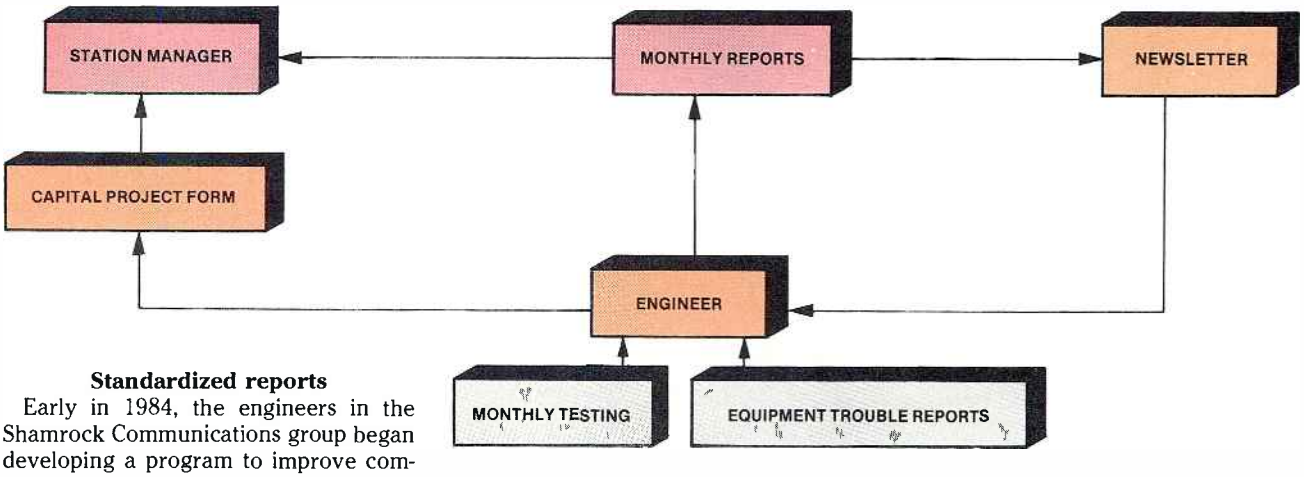

Figure 1. *This diagram shows how maintenance information flows between the operators, the engineer and the station manager.*

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Genesis 1 ACT 1, Microtime's high quality, low-cost digital effects system increases creative capabilities to your imagination's limit. Create through self-prompting, icon-driven menus and instructions for sequences involving moves, freeze, flips, tumbles, posterize, shadow, variable aspect ratio, XY mosaic, strobe, and source change.

Genesis 1 ACT 1 offers:

- ☐ 3-Axis joystick control
- ☐ Keyframe creation of sequences
- ☐ Smooth curvilinear movement
- ☐ Frame accurate duration of a sequence
- ☐ Routing switcher interface for dual input switching when flipping and tumbling
- ☐ Three levels of sequence storage: RAM, internal and portable

Genesis 1 ACT 1...A user-friendly digital effects system for your video productions. An ACT not to be missed at $27,990.

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materials and forms was distributed to each station. Every station in the group now uses the same test record and tapes. Using standard test forms ensures that the regular testing is efficient, and that the results can be easily compared within the group. Each piece of equipment that contributes to on-air quality is tested on a monthly basis, using the equipment manufacturer's specifications as the performance standard. The concept of monthly testing has been well received by station managers in the group. The engineers now feel confident that they would be able to identify a problem before it could seriously deteriorate the air sound.

It's interesting that the implementation of our monthly testing program coincided with the FCC's elimination of annual proof of performance. In the Shamrock procedure, all elements that contribute to air quality are tested monthly. Time spent with on-air measurements of the full audio chain has been minimized, because we found that only a few checks are needed to spot problems. A few intermodulation distortion measurements of the total audio/RF chain provide more information than numerous THD measurements.

In order to provide a method for station personnel to report on the status of equipment, an equipment trouble report form was developed. This form is available in each studio of the station. An operator who encounters a problem with

CONSOLE PARAMETERS

IM DISTORTION (%)
LEFT _____
RIGHT _____
NOISE (DB)
LEFT _____
RIGHT _____
CONSOLE OUTPUT (DBM) AT CLIPPING AT 1KHZ
LEFT _____
RIGHT _____

PHASE (DEGREES) AT 8KHZ _____

RESPONSE ROLLOFF POINTS (HERTZ-KILOHERTZ)

LEFT 3DBLF _____
1DBLF _____
1DBHF _____
3DBHF _____

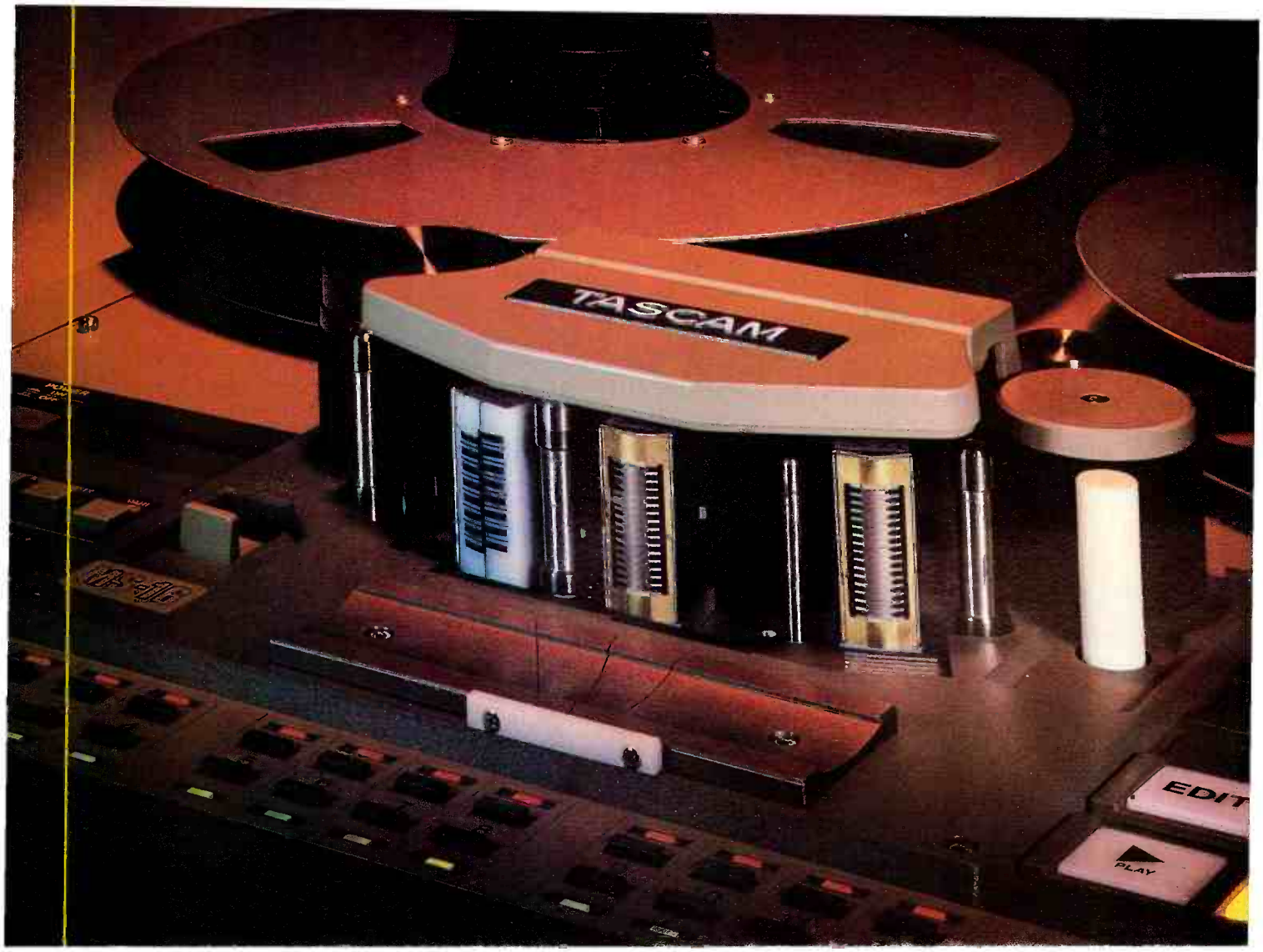
RIGHT 3DBLF _____
1DBLF _____
1DBHF _____
3DBHF _____

HARMONIC DISTORTION (%)

RIGHT	LEFT	
		40
		400
		4K
		10K
		15K

Device _____ Date _____ Time _____ Performed by _____

Figure 2. *The console performance test form outlines the capabilities of a console in a succinct, easy-to-understand format.*



FINISH UP ON TIME WITHOUT SACRIFICING QUALITY.

You want it quick and you want it good. In today's competitive post-production audio/visual scene, the rewards go to those who can produce results that are quick *and* good. That's why TASCAM designed the MS-16 1" 16-track recorder—to bring together top-notch audio quality plus premium features that streamline production and move you ahead of schedule.

Quality reproduction starts with the heads, and TASCAM has three decades of design experience behind the MS-16's new micro-radii heads. They bring "head bumps" under control and ensure flat frequency response. And unlike most tape machines, the MS-16 record/sync and playback heads are identical in performance. Because sync response equals repro response on the MS-16, you can make critical EQ and processing decisions on overdubs or punch-ins without having to go back and listen a second time. You get what you want sooner and with fewer headaches.

The MS-16 cuts down on the time you spend locking up with other audio and video machines as well. A 38-pin standard SMPTE/EBU interface affords speedy, single-cable connection with most popular synchronizers and editing systems. It's the easy, efficient way to get the most out of today's sophisticated synchronization equipment. The MS-16's new Omega Drive transport is tough enough to stand up to long days of constant shuttling... while handling tapes with the kid-glove kindness they deserve.

Record/Function switches for each track allow effortless, one-button punch-ins. Input Enable allows instant talkback during rewinds, fast forwards and cue searches. These features speed you through sessions and let you concentrate on the project at hand... not on your tape machine.

Take a closer look at the MS-16. See your TASCAM dealer for a demo or write us for more information at 7733 Telegraph Road Montebello, CA 90640.

THE TASCAM MS-16 SIXTEEN TRACK

TASCAM THE SCIENCE OF BRINGING ART TO LIFE.

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a particular piece of equipment completes the report form and routes it to the station engineer. After the engineer has checked and repaired the equipment, a copy of the report and the engineer's reply is returned to the originator of the trouble report. For employees, especially those who work a night shift or seldom see the engineer, the trouble report provides a method of 2-way communication. Also, it provides the engineer with a permanent record of equipment and operator problems.

Another form was designed for quarterly measurements of FM station field strength. A single field-strength meter is rotated among the stations to perform the tests. The meter provides a useful method to check the field strength of each FM station on a regular basis. Any deterioration in the antenna system can be spotted early and, if necessary, an outside consultant can be called in.

With monthly testing of each piece of equipment at our station, the system's weak links are obvious. Equipment reliability is documented in the compilation of equipment trouble reports and monthly reports to the general manager. This system provides more information than the previous annual proof and repair-as-necessary maintenance procedures.

Budgeting

Through the creation of a capital proj-

CBS LABS STR-151 TEST RECORD

NOISE (DB) LEFT _____
(BAND 5B) RIGHT _____
WOW AND FLUTTER (%)
(BAND 1A) _____
CONSOLE CONTROL SETTING AT 0 VU
(BAND 2A) _____
THD (%) AT 400HZ LEFT _____
(BAND 2A) RIGHT _____
PHASE (DEGREES) AT 8KHZ
(BAND 4A) _____

RESPONSE (DB)

RIGHT	LEFT		RIGHT	LEFT	
		1K			800
		20K			600
		18K			500
		16K			400
		14K			300
		12K			200
		10K			150
		8K			100
		6K			80
		5K			60
		4K			50
		3K			40
		2K			30
		1.5K			25
		1K			20

Device _____ Date _____ Time _____ Performed by _____

Figure 3. *The turntable test form makes it easy to keep track of the performance of a crucial piece of equipment.*

F·I·E·L·D R·E·P·O·R·T

"Partners in Performance"

Panasonic and Anton/Bauer

AK-30 performs in the field.
Picture quality, innovative features and versatility make the Panasonic AK-30 an outstanding performer. At 650 lines (center) horizontal resolution and a S/N ratio of 62dB (–6dB gain)—the highest in the industry—the AK-30 produces a superrefined video image.

The AK-30's circuitry allows you to customize the video image: the auto-white balance remembers two color temperature settings; a knee circuit provides variable dynamic range, and black stretch can be preset.

An impressive list of the AK-30's automatic features includes a centering circuit with selectable preset mode, auto black balance, and a feedback beam control (FBC) circuit to provide the beam current necessary to stabilize scene highlights. For versatility, the AK-30 offers dual outputs for standard NTSC as well as component recording.

Anton/Bauer's Snap-On® system provides powerful field support.
Anton/Bauer batteries are the leaders in the field through reliability and adaptability. The SQ13F, 4AH NiCad battery is warranteed by Anton/Bauer for a full two years because it uses premium fast charge cells, individual cell monitoring for total charge protection, unique cold temperature protection and 100% computer tested quality assurance. Coupled with the advanced logic-controlled charging technology of the Anton/Bauer Lifesaver® chargers, the battery system ensures consistently high performance over years of operation. For versatility, the SQ13F battery powers VTRs and monitors—including the new Panasonic BTS700N portable monitor—as well as the Anton/Bauer UltraLight lighting system.

New Anton/Bauer UltraLight.™ optimal lighting performance.
UltraLight puts high quality portable lighting in a modular, compact and lightweight package. Available in single or dual models, UltraLight can be used interchangeably as a fill, spot or flood light through a wide choice of bulbs and snap-in filters and focus adapters. Extra quick-change lighthead modules house alternate or spare bulbs for instant bulb changes in the field without direct handling. An UltraLight Power Adapter snaps directly onto the AK-30's factory installed bracket and allows the SQ13F camera battery to power the lighting system and camera simultaneously. UltraLight can also be operated in the low voltage mode from a compact AC power supply (ULAC) or, with simple bulb and cable changes, from a 30 volt belt, such as Anton/Bauer's 30/13.

Anton/Bauer and Panasonic®—partners in performance.
In the fast-paced video industry, quality and versatility are perhaps the two most critical factors in achieving outstanding performance. Both Anton/Bauer and Panasonic have designed their products specifically to meet these demanding criteria. The proof of their success is in the field.

Write for complete information on the Panasonic AK-30 and Anton/Bauer power and lighting systems.

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CAPITAL EXPENSE PROJECT FORM

PROPOSED CHANGE

BENEFITS EXPECTED

EXPECTED COMPLETION DATE AND CONTINGENCIES
(NOTE EQUIPMENT DELIVERY AND INSTALLATION SCHEDULE)

CAPITAL COSTS OF PROJECT AND CONSTRUCTION

CONTINUING COSTS OR SAVINGS FROM PROJECT

OPERATIONAL EFFECT OF PROPOSED CHANGE

OPERATIONAL EFFECT OF CONSTRUCTION PERIOD

SUBMITTED (CHIEF ENGINEER) DATE REVIEWED (GENERAL MANAGER) DATE

Figure 4. *A capital expense project form allows the engineer to list all of the important elements to be considered during the planning of a major purchase.*

ect form, we were able to modify the annual capital equipment budget procedure. The form lists initial equipment and construction costs and continuing costs or savings, describes the operational effect of a proposed change and estimates the proposed construction period. The form also lists completion contingencies so that delivery and installation schedules don't present any surprises. The capital project form is submitted by the chief engineer and reviewed by the general manager. This process ensures that when the item comes up during budget discussions, there are no misunderstandings about the possible effects of the project. Together, the written equipment trouble reports and the monthly testing schedule make it easy to decide when a piece of gear needs to be replaced.

No plan for communication really works without face-to-face dialogue. The engineers in our group meet together at least once a year. One of these meetings takes place at the WOSU Broadcast Engineering Conference. These meetings provide each engineer with the opportunity to report on the success of the overall communications plan, and to participate in a team approach to revising those forms and procedures that are not producing the desired results.

Benefits

As a package, the communications program has been a success. The standardization of testing and reporting procedures has made the engineers function as a group, rather than as isolated individuals. The use of standard forms and practices has brought about better interaction with management and among the engineers.

This simple communications program has provided many benefits to our company. Each engineering staff is better able to control its station's sound through more effective testing procedures and documentation. The group's owners support the program because of the increased confidence they have in their engineers and facilities. The equipment and materials that were purchased to implement the program are in constant use, not stored away on the shelf. The engineers in the group have adopted a role beyond that of *Mr. Fix-It*, which increases their visibility within the stations. The results of their work are regularly communicated to the station managers, so that management is constantly updated and aware of problems and successes in the engineering department.

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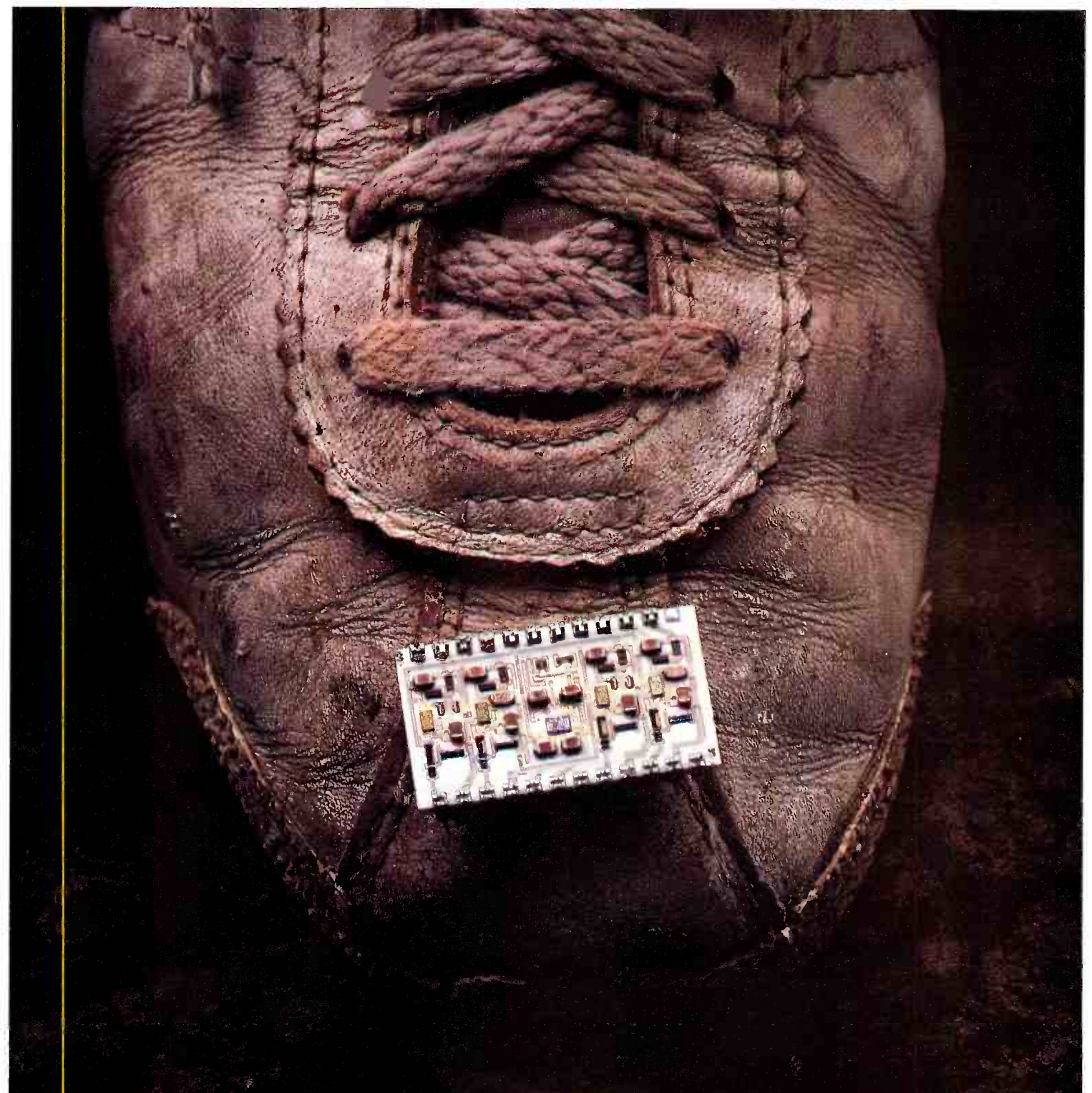

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Finding maintenance engineers

By Brad Dick, Radio Technical Editor

*Last month's report on the **BE** salary survey showed that the broadcast industry is concerned that the number and quality of broadcast engineers is dwindling. Although few broadcasters would argue that we need more qualified engineers, a question remains on where the next crop of engineers is going to receive training.*

There are at least four ways to obtain electronics training: attend a technical school, complete a correspondence course in electronics, enlist in the military and request electronics training, or attempt to learn electronics on your own. The latter option is probably the most difficult, because there are no teachers to answer your questions and you have to develop your own curriculum. Finally, even if you are motivated enough to learn electronics on your own, you'll still miss out on the hands-on experience.

Military education

The military option is one that can open many career doors. The high quality of military electronics training is widely recognized. Those who complete their military training can usually find jobs within the broadcast industry as maintenance technicians or members of technical production crews. Although the broadcast elements are not included in most military programs, the solid electronics training provided can help you get that first broadcast job.

Correspondence schools

For years, correspondence schools have provided broadcast engineering training. Usually, their programs are patterned around a core of basic electronic theory and practical troubleshooting. The latter portion of the course usually emphasizes broadcast technology.

Becoming trained at a correspondence school costs far less than it would at an on-campus technical school. A correspondence school offers the advantage of a structured study program, including regular examinations and review sessions. Some of these schools offer a 1- or 2-week on-campus training session at the conclusion of the correspondence portion of the program. This additional training provides the hands-on experience that is missing from the rest of the course.

There are, however, potential pitfalls with correspondence school training programs. The assumption is that you have sufficient motivation to complete the course work on your own. Although instructors are available to assist you, a letter or telephone call cannot provide the same motivation that a one-to-one teacher-student relationship can offer. If you want to consider this alternative, examine your own personality and make an honest assessment of your persistence. If you do not have the drive to complete the training, you may waste a lot of time, effort and money.

On-campus training

Probably the best way to receive electronics training is to attend a technical school that offers classroom instruction. The formal classroom method provides a much stronger motivation factor than the self-paced methods. Also, on-campus training allows the student to receive direct assistance from instructors.

There is another, sometimes overlooked advantage to classroom instruction: the rapport and interaction with other students. A bond usually develops among the members of the class. Knowing that each student faces the same problems, members of the class tend to help each other with projects and studies. This mutual support and encouragement is often critical to the successful completion of the program. Non-classroom settings cannot provide this type of support.

Another advantage offered by on-campus training is the hands-on experience with broadcast equipment. Students often use broadcast equipment as a part of their educational program. The combination of classroom instruction and practical experience with broadcast equipment make this type of education valuable.

Self study

If you cannot afford the money or time for one of the classroom or correspondence schools, the only alternative is self study. The Society of Broadcast Engineers maintains a certification program for broadcast engineers and technicians. This program offers a list of suggested reading materials that may be helpful to you in developing your own study program. There are also a number of structured electronics courses offered by publishing companies. These materials are available at your local library or bookstore.

Need more information?

Locating the various schools can be a bit of a problem. If you decide on correspondence school training, look in any of the various electronics magazines. Contact several of the schools before you decide on which one to attend. You should also ask for a list of recent local graduates whom you can contact.

If you want information on technical schools providing on-campus training, call your state board of education. As we found in preparing this article, identifying these schools is difficult. To get you started, here is a list of schools you may want to contact. This list is by no means complete, but it does represent those schools that responded to our request for information.

- *Hocking Technical College, Nelsonville, OH*
- *John Wood Community College, Quincy, IL*
- *Cleveland Institute of Electronics, Cleveland, OH*
- *NRI Schools, Washington, DC*
- *Grantham College of Engineering, Los Alamitos, CA*
- *DeVry Electronics, Evanston, IL*
- *Central Texas College, Killeen, TX*
- *Mercer College, Trenton, NJ*

Editor's note: If you are aware of other schools that offer training in broadcast technology, please drop us a note identifying them and describing their programs. From time to time, we will run updates on broadcast engineering schools in our monthly "Business" column.

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KEY SPECIFICATIONS:
Focal Length: 6-48mm
Max. Relative Aperture:
f1.7 through 33mm, f1.9 at 48mm
Angular field of view:
72.5° at 6mm, 10.5° at 48mm
Minimum Object Distance: 11″

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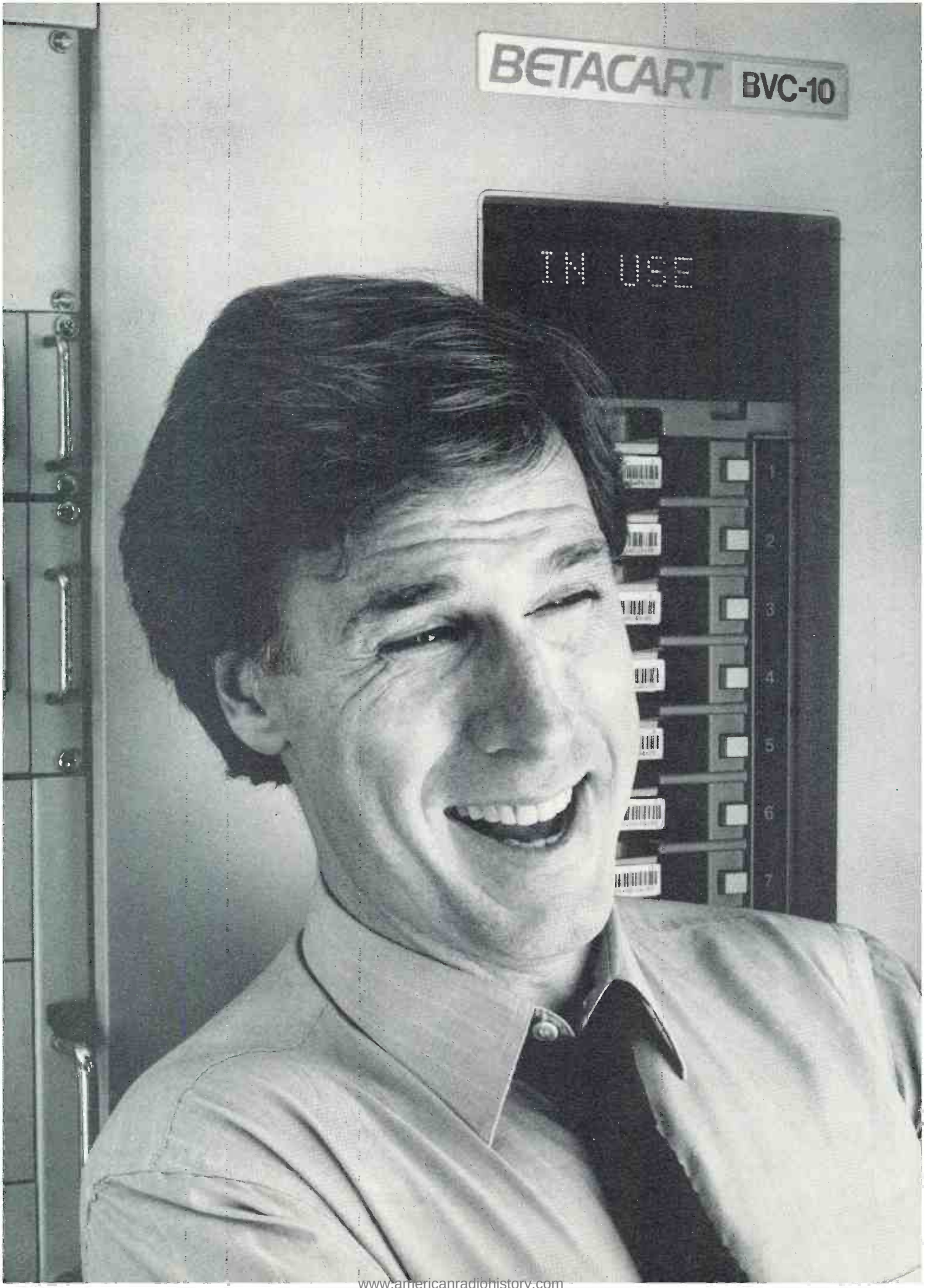

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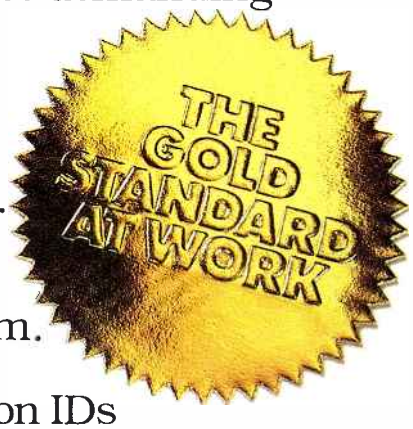

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Field report

Nakamichi MR-1

By Brad Dick, radio technical editor

The Nakamichi MR-1 is a professional quality audiocassette recorder well suited to broadcast applications. Housed in a standard 19-inch rack enclosure, the front panel measures 5 3/16 inches high, including the mounting feet. Although at least one other manufacturer states that its recorder is ready for rack-mounting, if you attempt to rack-mount its recorder on top of another piece of equipment, you find that the actual dimensions of the chassis are larger than the front panel. That is not the case with the MR-1. It will directly mount in a rack.

Main features

The unit includes front panel bar-type VU meters that are calibrated in 2dB steps from −20dB to +10dB. At first glance, the linear calibration may appear strange, but you will come to appreciate the precise calibration that is possible with these meters.

An advantage that this machine has over many others is its professional input and output capability. It provides both front panel ¼-inch and back panel XLR-balanced connectors for +4dBm levels. Back panel unbalanced input and output ¼-inch connectors also are available.

Any cassette machine is only as good as its transport, and this recorder excels in that area. It uses an *asymmetrical dual-capstan diffused-resonance* transport. In English, that means the two capstans have different diameters and rotate at slightly different speeds. Therefore, they don't resonate and concentrate wow at one specific frequency.

The unit uses three separate tape heads to maximize the performance of each head. The record and play heads can be individually positioned by height, zenith and azimuth with the front panel adjustments shown in Figure 1. No disassembly of the transport is required.

Dick wrote this article while he was director of engineering at KANU/KFKU, Lawrence, KS.

Performance at a glance

- *Frequency response ±3dB 20Hz-20kHz*
- *Wow and flutter < 0.027% Wrms*
- *THD < 0.9% (ZX tape)*
- *Separation > 36dB at 1kHz*
- *3-head, 2-track stereo configuration*
- *3-motor drive assembly*
- *XLR input and output connectors*
- *Internal Dolby B/C and external noise-reduction provisions.*

The transport mechanism has three motors: one for the dual capstans, one for the reels and a third for the cam assembly that positions the head block. This unusual arrangement works well.

The capstan motor drives the takeup capstan directly and the supply capstan through a belt. The single-reel motor drives the tape in both directions through a reversing gear assembly. The reel motor and microprocessor provide cartlike capability when used in conjunction with the *memory stop* feature.

Unlike other cassette recorders, which rely on solenoids to move the head assembly, the MR-1 uses a motor-driven cam connected to the head block. The cam motor is controlled by the main microprocessor. For example, when the *play* button is pressed, the microprocessor causes the heads to approach the tape extremely fast. However, just before the heads contact the tape, the speed of the head block is reduced so that the heads are placed gently against the tape. Only after the heads contact the tape are the capstan pressure rollers engaged. Although this may seem to be a simple process made complicated, the advantage is that the smooth cam action reduces the vibration normally encountered by the head block in a solenoid-driven assembly.

A convenience feature is the electronic counter display. Although it does not display actual tape time, it is coupled to the microprocessor, which provides several extra features. Because the microprocessor tracks the position of the tape through the takeup reel rotation, it can use the reel motor to shuttle the tape to a predetermined position. Therefore, if you reset the counter to zero at a particular point on the tape, the recorder can find that same location later.

With memory stop activated, you merely press the appropriate *rewind* or *fast forward* button and the machine automatically finds the zero point. Because the recorder overshoots the zero point in the fast-wind mode, the microprocessor shuttles the tape back and forth until it finds the exact zero point. I used the memory stop feature many times and found it to be useful and accurate. In a production room setting, cartlike capabilities can be achieved with this feature.

Both Dolby B and C noise reduction are available through a front panel switch. If desired, an external noise-reduction system can be selected by the same switch and coupled through RCA pin jacks on the back panel.

The recorder provides easy selection of three tape formulations and two tape equalization settings. The MR-1 features internal adjustments that allow you to customize these settings for your particular tapes.

Performance

The recorder surpassed the manufacturer's specifications in all of the tests I performed. The −3dB points were 12Hz and 21kHz as measured on a ZX series cassette. The A weighted noise level was 67dB below operating level using Dolby B noise reduction. This is the lowest noise level of any cassette machine I've tested. The wow and flutter measured 0.015%Wrms and the separation was greater than 45dB at 1kHz.

Documentation

Documentation for the recorder consists of two manuals and is similar to the

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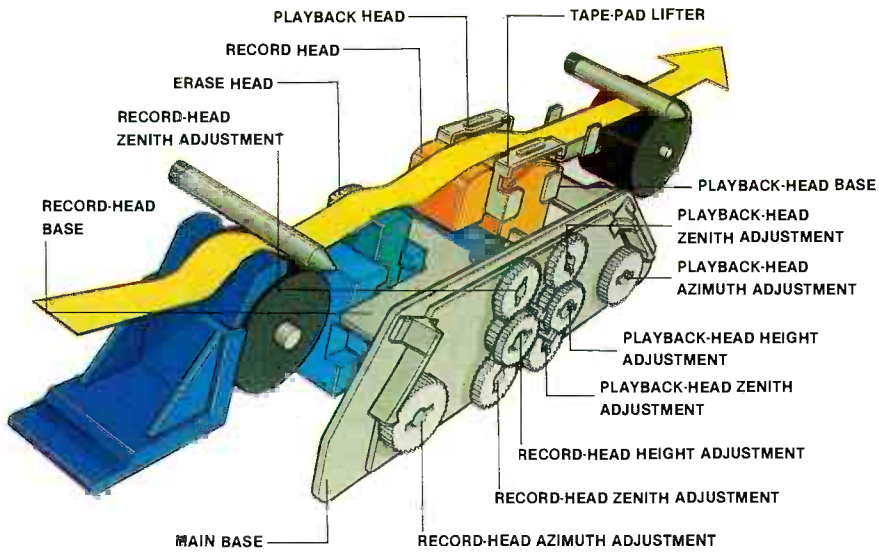

Courtesy of Nakamichi

Figure 1. *Discrete 3-head mounting arrangement showing the adjustments for each head.*

literature supplied with the company's consumer products. One of the manuals contains the principles of operation for some of the circuits. It would be particularly helpful if you ever developed problems with the control circuitry. The other is called the *provisional* service manual. I'm told the company is in the process of developing new documentation appropriate for the professional user. The two manuals should lead you through most of the problems that might crop up. However, the literature is not designed for novices, and assumes that the user knows a fair amount about maintaining audio equipment.

Typical of consumer electronics, servicing the recorder can be time consuming. The additional circuit boards and connectors for the balanced inputs and the external noise-reduction system are mounted on the back panel.

Because of this complex wiring harness, and the number of screws that must be loosened, access to the main circuit board is a little tough. It appears that the leads are long enough to permit access, but you will have to cut many of the tie wraps to open the unit completely.

If you are in the market for a top-quality audiocassette recorder, the Nakamichi MR-1 should be among the models that you consider. The advantage of balanced inputs and outputs makes installation of the recorder in a professional setting a breeze. The recorder may be difficult to find because it is sold only through selected distributors. Your local stereo shop can't supply you with one. However, I'm told that some broadcast distributors will be carrying the deck in the near future.

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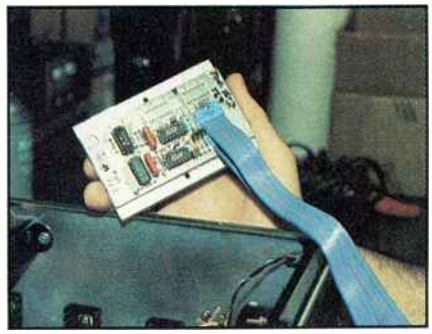
TFT Spike Stopper

By Ben Weiss



To say that today's broadcaster is in a competitive situation is an understatement. The station that does not find itself constantly at war to maintain its market share is truly unique. In some markets, the listenership war is waged in ongoing loudness battles. In years past, stations occasionally looked over their shoulders to see if anyone was checking on their modulation levels. However, with the reduction in FCC regulatory efforts, some stations don't seem to care how often their peak lights come on. This places the station that wants to comply with the rules at a real disadvantage.

Additional demands

As if it isn't enough of a problem to have to compete with those types of stations, another factor has appeared on the horizon. With the proliferation of additional SCA services, stations can now generate appreciable amounts of income by carrying these new signals. The drawback of adding new SCAs is the loss of one-half of 1% of main-channel modulation for every 1% of SCA injection added. Under the current rules, a station can maintain 110% total modulation if the total SCA injection does not exceed 20%.

Even with this additional modulation, there is a real loss in main-channel modulation capability. Some stations, concerned about the trade-off between loudness and income, have sought help in accurately measuring their modulation. The Spike Stopper, a printed circuit board modification for TFT monitors (models 763, 730a and 753), is designed to aid in this effort.

Weiss is director of engineering at KLSI-FM, Kansas City, MO.

Performance at a glance

- *Modification to TFT 763, 753 and 730/730A modulation monitors. The circuit provides a means of reducing the peak modulation indicator sensitivity at audio frequencies of approximately 2kHz and above by increasing the number of audio cycles required to trigger the peak flasher LED*
- *Contained on one small circuit card, connects to monitor through two ribbon-IC cables*
- *User-adjustable to trigger on one to 14 10kHz cycles*
- *Factory-set to trigger at 10 10kHz cycles*

Operation

With modern digital circuits, it is easy to detect, and even to count, signals with excessively short durations and fast rise times (spikes). The Spike Stopper uses a *peak modulation duration differentiating* circuit that separates the spikes, which could falsely trigger the peak flashers, from the real modulation peaks.

The circuit consists of a digitally controlled window that is adjustable to suit the type of audio processing used by the station. Programs with audio processing will have slow rise and fall times. Conversely, overshoot, multipath noise and interference have narrow, pulselike characteristics.

The detection *window* can be adjusted while the monitor is connected to the antenna feedline at the transmitter. Performing the adjustment there eliminates any possibility of multipath or noise affecting the window setting. After this adjustment is made, the monitor can be moved back to the studio for normal operation.

The manual provides detailed instructions on how to adjust the circuit according to the FCC ATS rules. This procedure requires a sweep generator, function generator, RF generator and, in some cases, an SCA generator. The alignment process uses a 10kHz tone burst of 10 cycles or a 5kHz burst of five cycles to set the window.

Installation

The installation is straightforward. The complete installation procedure is described in only six steps in the instruction manual. Photograph 1 shows the location for mounting the printed circuit card

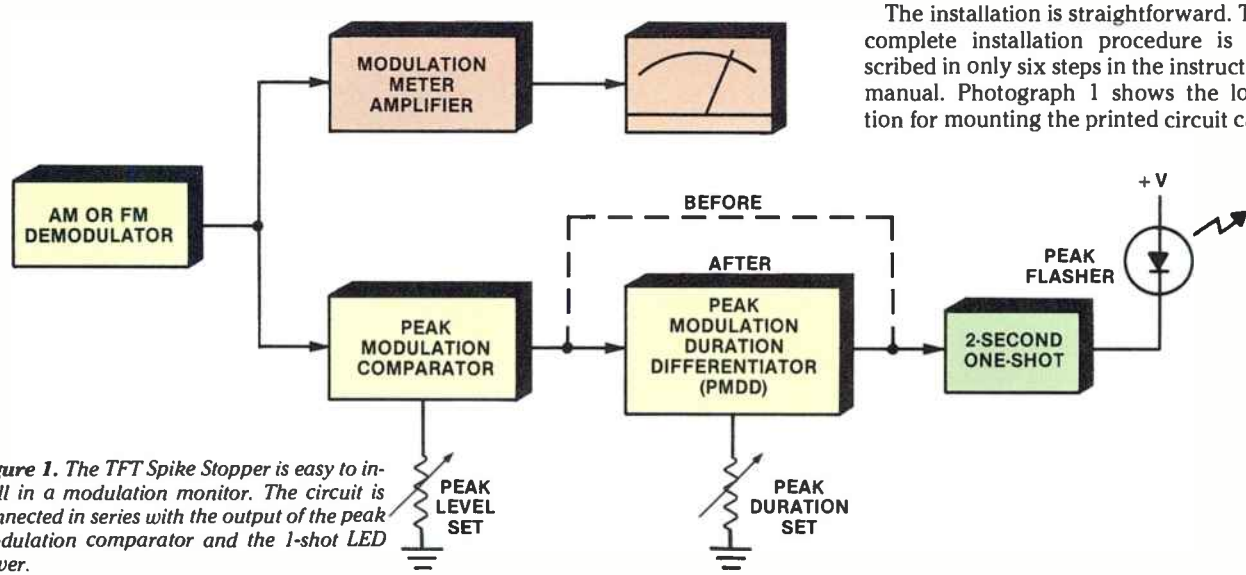


Figure 1. *The TFT Spike Stopper is easy to install in a modulation monitor. The circuit is connected in series with the output of the peak modulation comparator and the 1-shot LED driver.*

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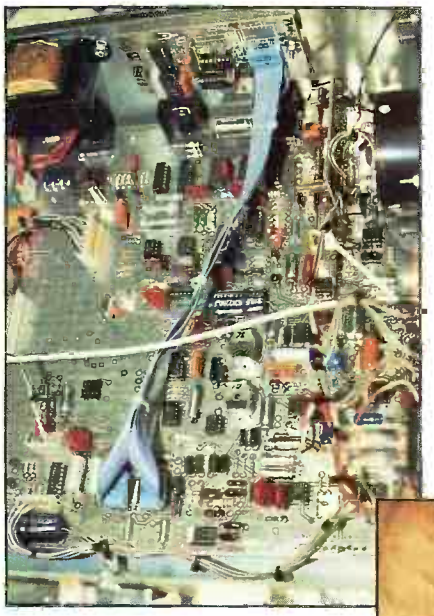

(Above.) Once the circuit card is mounted, the ribbon cable leads can be connected to the main circuit board in the monitor.

(Right.) The location of the Spike Stopper circuit card is not critical.

inside a 763 FM modulation monitor. The printed circuit card is held to the side of the monitor chassis by adhesive pads. With the card securely in place, two LM710CN ICs are removed and the two leads from the card are inserted. Because there is no difference in the two leads, they can be plugged into either IC socket. When the leads are connected, as shown at left, the installation is complete.

Performance

We found that higher modulation levels were possible with the Spike Stopper in use. Visual checks indicated that the unit enabled us to increase the main-channel modulation by about 5%. Also, there were fewer peak lights from noise and interference sources.

Other users reported similar results. One user said the modification allowed him to increase modulation by 2.5dB.

The Spike Stopper seems to be an appropriate solution to a common problem. Almost every station encounters some type of impulse noise, multipath and/or other types of interference. Prior to the Spike Stopper, you could only assume that peak lights indicated excessive modulation. With this modification to your monitor, you have the assurance that your modulation is as high as legally possible and that those peak lights really do indicate overmodulation.

For additional information on the problem of accurately measuring overmodulation, see page 116.

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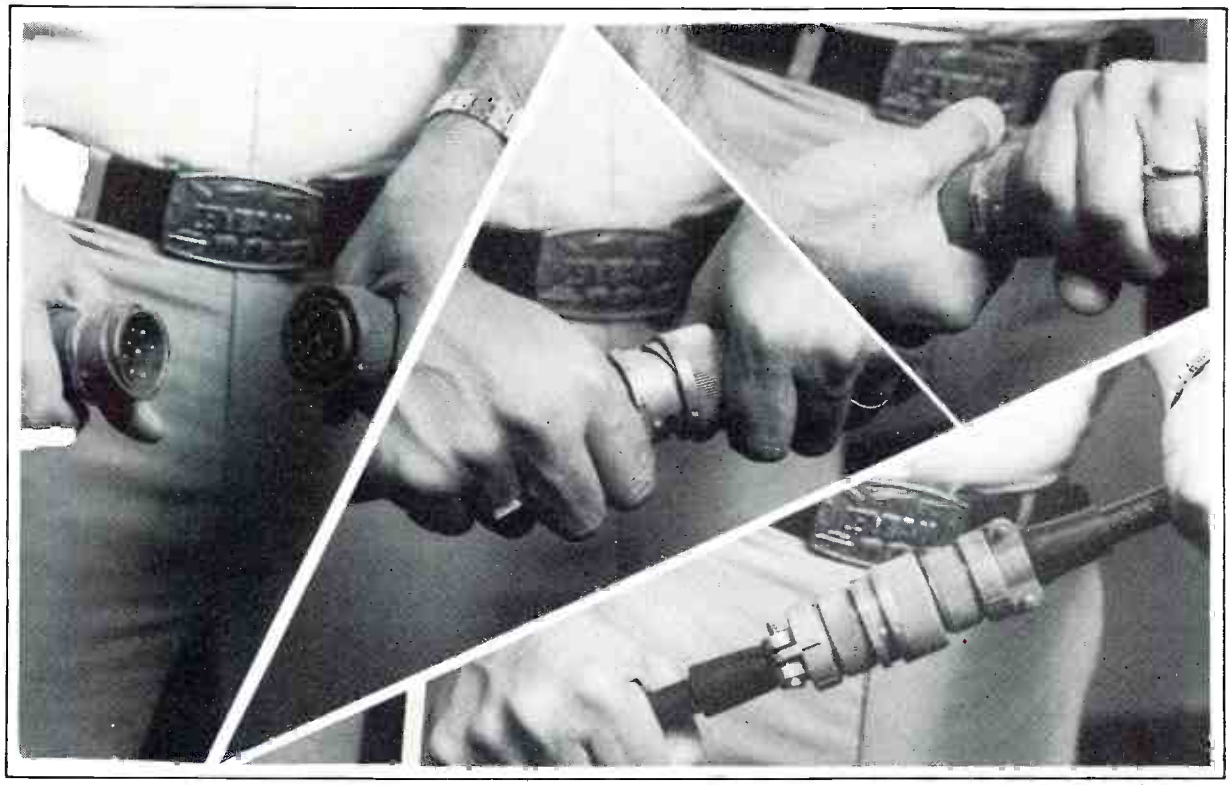

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Overmodulation or spikes?

If you've ever noticed peak lights on the modulation monitor even when the meter is nowhere near a 100% reading, you're not alone. It's not uncommon for spikes to falsely trigger the monitor's peak lamps.

Fast rise time and narrow spikes can falsely trigger the peak flasher on almost any modulation monitor. To comply with the rules, a station's normal response would be to reduce modulation until the peak lights on the monitor go out. If, however, these peak lights are not caused by overmodulation, the station is reducing its modulation needlessly.

Spikes can be caused by a number of factors, such as: overshoot and ringing in the modulation manitor filters, multipath, noise interference, heavy audio processing or RF interference. With the exception, perhaps, of heavy audio processing, these spikes do not actually represent overmodulation. In such cases, reducing the station's modulation might not reduce the number of peaks shown on the monitor.

Monitor design

Modulation monitors rely on band-pass and low-pass filters for proper operation. These filters provide the selectivity and filtering necessary for decoding and measurement purposes. Without filters, the monitor would respond to all kinds of extraneous noise and interference. The proper design of these filters is the key to building an effective monitor.

The criteria used for the design of the filters involves trade-offs among the monitor's transient response, frequency response, stereo separation and signal-to-noise ratio. As the filters become more narrow, it becomes more likely that fast rise time waveforms will cause overshoots (spikes). These overshoots are usually detected as excessive modulation.

Main-channel modulation monitors are not the only ones that are subject to false peak lights. SCA modulation monitors are perhaps even more problematic with respect to filter overshoot. Because of the lower modulation index used with SCA channels, maintaining maximum modulation is a high priority. Even a loss of 5% to 10% of SCA modulation is critical if the station is broadcasting voice material on the subcarrier.

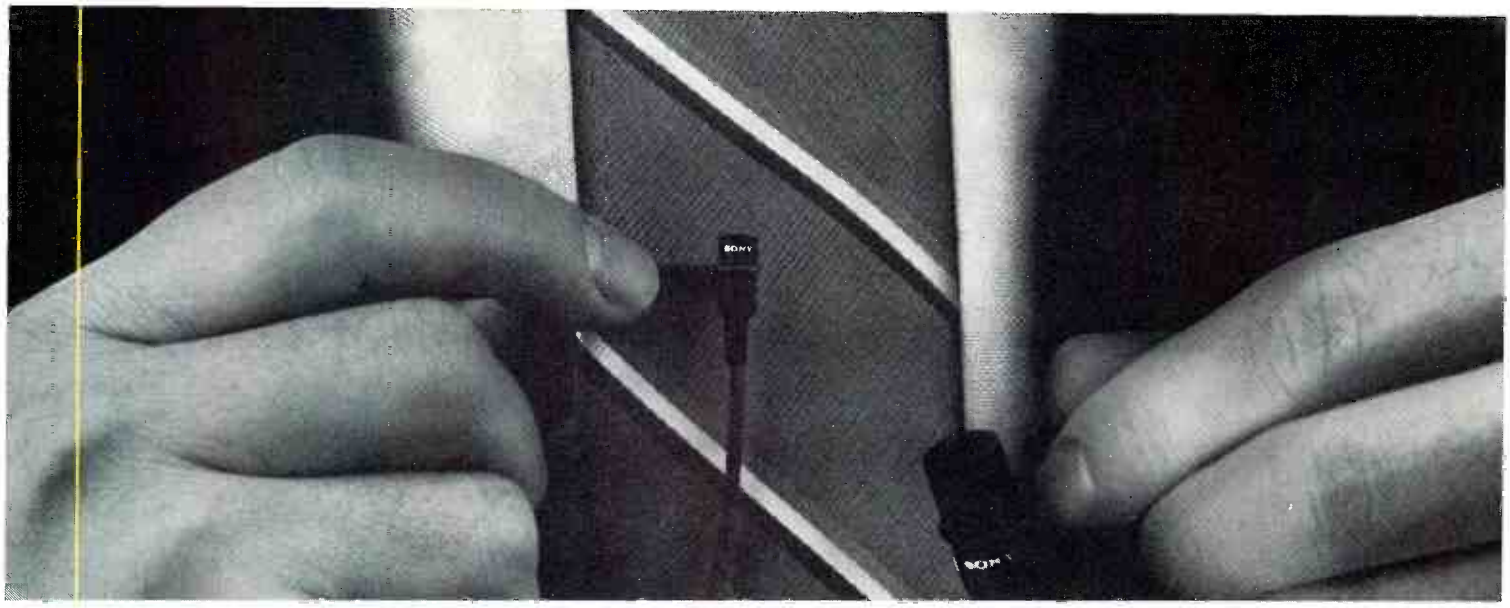
Sources of errors

Even if the modulation monitor has been properly designed, narrow spikes can still trigger the peak flashers. These spikes are not normally considered overmodulation by FCC inspectors. Unless the inspector uses a sophisticated transient recorder, it's unlikely the spike will be seen. A conventional spectrum analyzer will not display these signals because the analyzer relies on repetitive signals for an accurate display.

In an attempt to end false peak lights, some stations have tried to increase the bandwidth of the RF and IF filters in their monitors. Besides the potentially damaging effects of a user modifying a type-approved piece of equipment, there are other serious considerations. Increasing the bandwidth of the filters could degrade the measuring performance of the monitor. This is especially likely in the area of stereo separation measurements. If you cannot modify the filters in your monitor, what is the solution?

The answer lies in the use of modern integrated circuits that can detect the difference between noise spikes and overmodulation. Many modulation monitors can be modified easily by placing the detection circuit in series between the peak modulation comparator and the one-shot LED driver. Once the modification is installed, the station can rest assured that any peak lights represent overmodulation, not noise spikes.

This material is based on the technical paper, *Filter Design and Overshoot In Modulation Monitors*, by Joseph C. Wu, TFT.



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Part 1

Station-to-station

Computer-assisted music rotation

By Michael Hendrickson

The GM just called a meeting to announce a change in your station's format. The station will no longer be "All Talk—Most Of The Time," but rather, "More Music—Most Of The Time." In addition to the format change, it was also announced that the chief engineer (meaning you) is going to design a custom *live-assist* automation system to implement the new format.

Your first reaction might be to head for the door. But don't panic. It is actually possible to construct a system that will assist the announcer and ensure the proper music rotation without bankrupting the station or causing you gray hair.

There are several advantages to a live-assist operation. One is that the rotation of the music is controlled by the system instead of the announcer, thereby ensuring a consistent sound. Another is that it frees the announcer from mundane babysitting chores, enabling that person to take on other duties.

I recently found myself charged with the task of implementing a live-assist operation at our station. After checking into a number of live-assist devices for reel-to-reel recorders, I decided that none of them met our particular needs. I then considered the possibility of designing a custom controller.

My investigation revealed that a hardwired device could provide the necessary control over the music rotation. However, the flexibility of the system was limited. A large number of integrated circuits would be required and whenever the rotation needed to be changed, the system would have to be rewired. Because we wanted to be able to readily adapt to format changes, a hardwired system obviously was not the best solution.

If a hardwire approach was not flexible enough, how about a software approach? Using a personal computer and custom software to control the tape machine seemed like a reasonable solution. Because the rotation scheme would be written in software, changes could be made in the rotation simply by modifying the program. No rewiring would be required. This approach also would allow a new rotation schedule to be developed on another computer and, when completed, to be run on the on-air computer.

The software

I decided to write the program in BASIC. The language is relatively easy to understand, but more importantly, it's easy to debug. However, one disadvantage to the language is its slow speed. In order to meet all of the system requirements, an improvement in speed was needed.

By running the completed program through a BASIC compiler, the program can be translated, or compiled, into a format that the computer understands and can run much faster. The compiled version can be used in the on-air computer.

The hardware

The computer cannot directly control the tape machines, so an interface circuit was constructed. The protection circuit board consists of opto-isolators that isolate the computer from the tape recorder voltages. The input/output circuit board provides 8-bit input and output TTL signals to drive the interface board. It also provides system status feedback to the computer.

The control console provides the announcer with three momentary push-buttons and three toggle switches. With these controls, the announcer can stop, start and run the rotation, and single-step the rotation if desired. The toggle switches disable the tape machines from the computer controller, permitting them to be used for other purposes or for maintenance.

Other possibilities

Our system has been on the air for more than a year without major problems. The use of the PC to control programming has been, for us, effective and inexpensive.

Next month, we'll look at the specifics of the hardware needed to implement a computer-controlled live-assist system. The program used in this system is available through the Society of Broadcast Engineers. For more information on obtaining a copy of the program, circle number 500 on the reader service card at the back of this issue, or contact SBE.

Hendrickson is chief engineer for Hedberg Broadcasting, Blue Earth, MN.

Editor's note: If you have ideas that might be of use to other engineers, pass them on for possible publication in our "Station-to-Station" column. Address your ideas to Technical Editor, **Broadcast Engineering,** P.O. Box 12901, Overland Park, KS 66212.

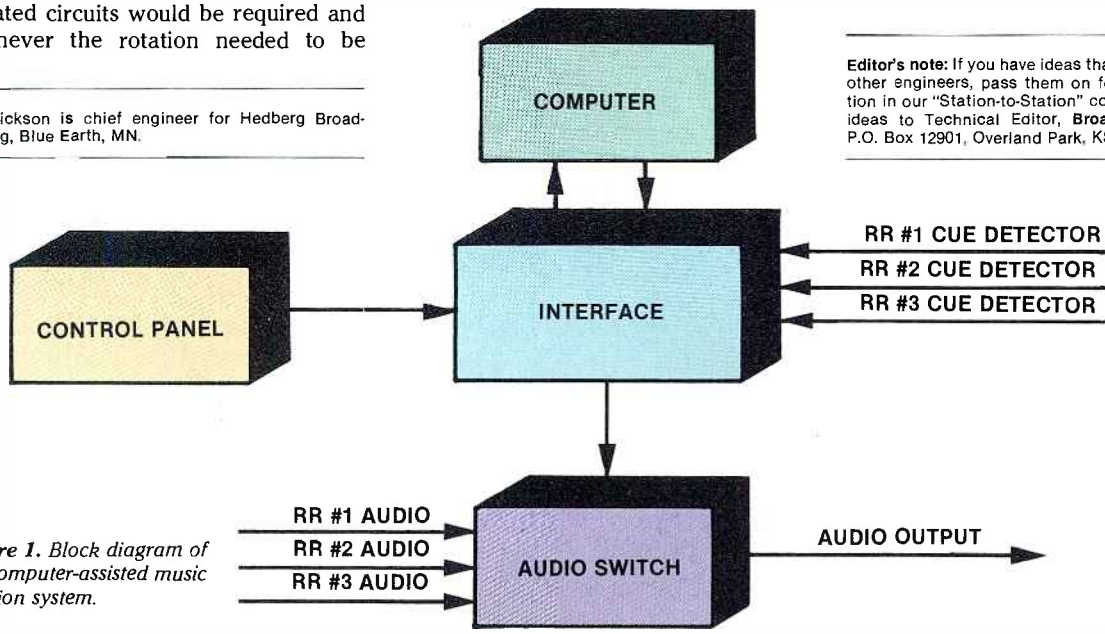

Figure 1. *Block diagram of the computer-assisted music rotation system.*

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People

Cameron Bishop, former publisher of the Electronics Group at Intertec Publishing Corporation, has been promoted to magazine group vice president. He will also serve as publisher for **Broadcast Engineering,** *Video Systems* and *Radio y Television* magazines.

Charles Catalano has been named professional product and audio national product service manager for Sharp Electronics, Paramus, NJ. Catalano's appointment is part of the restructuring of the service department to focus on specific product areas. He joined Sharp Electronics in July 1985, and was previously a national service manager for Teleram Communications.

Lawrence J. Rich has been appointed as broadcast sales manager for Lexicon, Waltham, MA. He has instituted a new broadcast sales system incorporating 13 industry sales organizations to represent the company in the United States and Canada. He will also head the program. Rich was a former customer service manager for Lexicon.

Kevinn Tam has been appointed as applications engineer for TFT, Santa Clara, CA. Tam will act as a liaison between customers and TFT engineering to ensure the customers' use of TFT products is in accordance with their needs. He also will assist with marketing plans, assist TFT dealers, represent TFT at engineering gatherings around the country and maintain open communication channels within the industry. Tam's background includes seven years at Orban Associates where he was responsible for test department operations.

Gerry Brill, Bob Kuczik and **Joe Visslailli** have been appointed positions at Fuji Photo Film, New York, NY. Brill is broadcast markets manager for the Magnetic Products Division. He will be responsible for the development and implementation of marketing programs. Kuczik is national sales manager and will be responsible for developing and implementing sales related activities throughout the United States. Visslailli is regional sales manager and will handle similar responsibilities in the northeast region of the country.

Doug Gordon has been named vice president of marketing for Surcom Associates, Oceanside, CA. Gordon was previously employed with Sprague Electric Company.

Joseph Roizen, president of Telegen, Palo Alto, CA, has been honored by the British Kinematograph, Sound and Television Society by being awarded an Honorary Fellowship. Roizen is the only American currently having fellowships in the Society of Motion Picture and Television Engineers, in the Royal Television Society and in the BKSTS.

Jim Cundiff has been appointed as Eastern regional manager of sales and marketing for BASYS, New York, NY. He will manage sales and marketing efforts in Wisconsin, Michigan, Ohio, West Virginia, Virginia, North Carolina, Maryland, Delaware, Washington DC, Pennsylvania, New Jersey, New York, New England, Ontario, Canada; Quebec, Canada; and the Canadian Atlantic Provinces. Cundiff previously served as Eastern regional sales representative for Jefferson-Pilot Data Systems.

Do you have a crystal ball to help you maintain your camera?

Probably not.
The LDK 6 with total computer control offers you a more practical solution with on-line 24 hour surveillance of the total camera system. Costly downtime is minimised and maintainability is enhanced.

The LDK 6 on-line diagnostics warn of deviations from normal value and approaching out-of-tolerance conditions. It also advises when the deviations are recovered, thereby facilitating correction of 'intermittents'. RS232 Printer output provides hard copy of camera adjustment settings.

The LDK 6 off-line diagnostics (available on demand using signal injection techniques) and back-up LED indication system, complete the industry's most extensive diagnostics.

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These and many other LDK 6 and LDK 26 features are why the LDK 6 family are the fastest selling cameras in their class, with over 350 sold world wide.

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Business

China's first ADS 1 goes to Shanghai TV

A multiplex ADS 1 direct-broadcast telecine and a MK 111C post-production telecine have been delivered to Shanghai Television by *Rank Cintel,* Ware Herts, England. This is the People's Republic of China's first ADS 1. Shanghai Television also becomes the first of China's TV regions to have a MK 111C.

Wolff purchases API audio product line

The API audio product line has been purchased by Wolff Associates. The new company is called *API Audio Products.* The product line ranges from recording consoles to small line cards, including a mic preamp card, a line amp/summing card, a 1x8 distribution amp and modular equalizers such as the 550A. Two new products are a dual 4-band rack-mount 550A equalizer and a motorized moving fader for computerized automation of level control.

Bosch plans to strengthen international sales

Robert Bosch, Video Equipment Division, Salt Lake City, has announced a plan to strengthen international sales of Bosch products. The plan entails sending Carl Gardner, U.S. dealer manager, to Bosch Video Equipment Division in Darmstadt, West Germany, to manage the promotion of distribution-switching equipment, graphics and signal-processing equipment. Gardner's objective will be to strengthen the international dealer network.

LBC orders Marconi transmitters

The Independent Broadcasting Authority has placed an order with *Marconi Communications Systems,* Chelmsford, England, for two 10kW B6040 medium wave transmitters. The transmitters, together with switching and logic circuitry to enable operation in a passive standby configuration, will be used to broadcast the LBC program from the Authority's Saffron Green transmitter station. This is the first sale of the B6040, which is a new design of a 10kW medium frequency transmitter that incorporates two valves in a Doherty grid-modulated circuit.

BBC improves VHF coverage

Marconi Communication Systems, Chelmsford, England, has received an order from the BBC for VHF-FM transmitting equipment to replace existing equipment and to enhance the national VHF coverage. The equipment consists of 24 Marconi (type B6525) 10kW VHF-FM amplifiers. This is in addition to the 34 Marconi (type B6525) 20kW units already in use by the BBC.

Modulation Sciences and Harris sign distribution agreement

Harris Broadcast and *Modulation Sciences,* Brooklyn, NY, have signed an agreement for Harris to distribute the Modulation Sciences TSG stereo generators for television, the Sidekick second audio program and professional channel generators and the new SRD-1 stereo reference decoders. Until recently, Modulation Sciences had sold multichannel TV sound products directly from the Brooklyn plant.

NEC delivers video effects generators

The Broadcast Equipment Division of *NEC America,* Elk Grove Village, IL, has announced that the first six units of NEC's DVE System 10 digital video effects system have been delivered and installed in various facilities across the country. The facilities are Longwood Video and WOR-TV, New York; Alden Video Productions, Glastonbury, CT; TPC Communications, Sewickley, PA; WXLT-TV, Sarasota, FL; and WETO-TV, Greenville, TN.

The DVE System 10 is the most advanced digital video effects system from NEC. Half the size of a combined E-Flex/Optiflex system, it includes push-button convenience for all real time applications.

Dow Jones to use DATS to carry radio network

RCA American Communications, Princeton, NJ, has announced that Dow Jones will be using its digital audio transmission service (DATS) to carry the Wall Street Journal Radio Network to affiliates nationwide. Transmissions from a network studio being built by Dow Jones at its World Financial Center in New York will begin Jan. 1, 1986 via RCA Americom's Satcom I-R, transponder 19.

RCA's digitized radio networking service serves more than 3,500 radio stations across the country and carries programming from ABC, CBS, NBC, United Stations and CNN Radio Networks as well as programming distributed by Westwood One.

Aurora opens two sales offices

Aurora Systems, San Francisco, has announced the opening of two regional sales offices. They are based in Wantagh, NY, telephone number 516-783-3650; and in Atlanta, telephone number 404-365-0844.

Roscor delivers remote production vehicles to Korea

Roscor, Mt. Prospect, IL, has been awarded a contract to design and fabricate two remote TV production vehicles, the Roscor Elite Fleet TV-44. The Korean Broadcast Station will use the vehicles at the 1988 Olympic Games in Seoul, Korea. The contract is one of the largest single orders in Roscor's history. The equipment complement includes six Ikegami HK-357B studio-type TV cameras, two Ikegami HL-79EAL portable TV cameras, four Ampex VPR-6 videotape recorders, two Sony BVU-820 ¾-inch VTRs, a Grass Valley Group model 300 production switcher with 4-channel NEC DVE and a Ward-Beck 36-channel audio console.

CBS purchases M/A-Com encryption equipment

CBS, New York, has purchased equipment to encrypt TV signals transmitted by satellite to CBS TV Network affiliates. CBS will use the M/A-Com VideoCipher I TV encryption system. The VideoCipher I uses digital video processing to individually scramble each horizontal scanning line. Decryption units have been shipped to 56 of the 92 affiliates served by the CBS satellite distribution system. The system is expected to be completed in early 1987.

BBC places order for Ampex VTRs

Ampex, Redwood City, CA, has received a second major order in less than a year for 1-inch videotape recorders from the British Broadcasting Corporation (BBC). This order included 13 VPR-6 machines with time base correctors and one VPR-5 portable VTR. Initial deliveries will be made this fall to the BBC Television Centre in London, with all deliveries to be completed by the end of the year. With this new order, the BBC will employ nearly 200 Ampex 1-inch type C VTRs.

WLBT/TV-3 purchases Shook van

WLBT/TV-3, Jackson, MS, has purchased Shook's Omega van (model 10-20). The van was introduced by *Shook Electronic Enterprises,* San Antonio, TX, at the 1985 NAB convention. It is designed for ENG applications.

New products

PCATS

Magni Systems has introduced the Magni 2015 PCATS. The PCATS unit, when used with an IBM-PC, COMPAQ or IBM compatible PC, is capable of generating signals for testing a wide range of TV systems. The unit can generate signals from 525/60 NTSC to 1,125/60 high definition television (HDTV) and beyond.

Software selectable clock frequencies of 108MHz, 8 x 13.5MHz or 114.5MHz, 32 x 3.58MHz provide compatibility with standard digital sampling frequencies. The unit has 30MHz bandwidth analog outputs. 10 bit digital to analog converters provide precision amplitudes and linearity. Parallel digital output provides a continuous datastream for testing digital video equipment. Up to three channels may be added as options and each channel consists of analog and digital output ports. The unit also has test signal capability for testing time base correctors and frame synchronizers.

Circle (406) on Reply Card

Integrated measurement package

Magni Systems has introduced models 1520/1525 integrated measurement package (IMP). Magni has integrated a precision digitally synthesized test signal generator with a waveform monitor and a vectorscope. The AUTO 'signal follows measurement mode' is a key feature of the IMP. Other features include improved differential gain and differential phase measurement capability, display device flexibility, character overlay of test signals and optional audio tone generator.

Circle (407) on Reply Card

Metal tripod

O'Connor has introduced the model 155M-B heavy duty super claw ball tripod, which weighs 17½ pounds, holds up to 200 pounds and folds down to 36 inches for easy storage. Featuring a glare-free dark polyester finish, the tripod's monocoque leg design gives torsional rigidity. The tripod also has durable interlocking extruded aluminum legs and internal style lock knobs.

Accessories include an adjustable internal spreader that folds with the tripod and retractable spike guards for smooth floors, plus the choice of a super claw ball or Mitchell top mountings. All O'Connor camera systems now incorporate the metal tripod.

Circle (408) on Reply Card

Antenna maintenance computer program

AdVenture Media Services has announced AdaMax (aid for directional antenna maintenance), a computer program that will assist a directional AM station engineer in maintaining directional antenna parameters. Although not for use in directional antenna design, AdaMax will provide information regarding null and lobe formations. Execution time for computation and sorting of up to 360 radials is as little as 90 seconds.

AdaMax is available for a wide variety of microcomputers such as the IBM-PC and compatibles, KayPro, NorthStar and Apple (CP/M). AdVenture Media Services will also custom-design programs for various applications.

Circle (411) on Reply Card

Folded unipole

LBA has introduced a folded unipole kit designed to mount on guyed towers from 12- to 36-inch face dimension with leg diameters from one to three inches. The kit uses a universal mounting system for rapid installation together with advanced construction materials.

Circle (409) on Reply Card

Subcarrier data link

Pegasus Data Systems has developed a high speed subcarrier data link for FM stations. The system transmits data at speeds up to 38.2 kilobaud through a 6.4kHz wide channel. The subcarrier has a data encoder/decoder scheme based on a microcontroller program plus a unique phase modulation method. FM data link uses SCA equipment providing four aural channels of 7kHz each for various background or ethnic broadcasting services, plus one data channel. Optionally, five aural or data carriers can be used, all of the same bandwidth.

Circle (410) on Reply Card

3-channel broadcast monitors

Auratone has introduced the model 5MC 3-channel monitor speaker system, contained in a 3-compartment ultra-compact enclosure (5¼" x 16½" x 8½"). The system can be mounted in standard 19-inch relay racks with optional metal rack ears or may be placed on consoles, desks or wall-mounted horizontally or vertically.

The speaker allows monitoring of separate audio channels for a variety of feeds such as cue, program, emergency channel, talk back, news and sports. They may be stacked for a multiplicity of channels.

Close field A-B comparisons of stereo-mono mixes may be made using the two outside channels for stereo with the center channel for mono. Frequency response closely matches the Auratone 5C super-sound-cubes. Shielded magnet structures reduce flux leakage to minimize deflection of the images on nearby CRTs. Impedance is 8Ω and program power handling is 30W per channel. The unit is finished in black textured vinyl and the black stretch fabric grilles are removable.

Circle (405) on Reply Card

ac prompter system

Vica Associates has introduced the Solar-1 prompter system for use in small studios and corporate offices with minimum space. The system is attached to the tripod with a universal base plate and can be used with most cameras. Because the script appears on a 45° angle screen, the presenter looks directly into the camera lens while reading the script. The unit is small, lightweight and operates off of 115Vac.

Circle (392) on Reply Card

Beta recorder adapter

Ikegami Electronics has introduced the VBA-1 Beta recorder adapter for use with the Ikegami HL-79E ENG/EFP camera. The unit consists of an adapter that attaches directly to the recorder and a special cable to the VTR connector on the camera. The adapter will satisfy Beta recording and production needs.

Circle (390) on Reply Card

Stereo 4-band compressor

Circuit Research Labs has introduced a stereo 4-band compressor, model SEP 800, which replaces the matched pair of SEP 400B's for stereo transmission. The compressor uses a patented CRL circuit that automatically corrects for drifting as circuits age, eliminating internal adjustments. This unit also has a mono support circuit that uses L+R as the control voltage for both left and right channels. This reduces interchannel modulation caused by other techniques. The compressor is flexible and there is a front panel compress/limit switch to select either an open sound or a more dense sound. Another feature is the wideband/multiband switch that permits the unit to be used as either an AGC amplifier or as a multiband processor. The front panel equalization controls allow for shaping of the audio at the output of the four compressor bands.

Circle (387) on Reply Card

VTR battery analyzer

Alexander Manufacturing Company has improved the tri-analyzer battery analyzing device. The TA-3877-II uses a more efficient switching system resulting in savings in weight, with a reduction in heat. The microprocessor has been given a triple spike protection, and there is an automatic reset in the event a surge does get through.

The analyzer determines the remaining capacity in a variety of rechargeable nickel-cadmium VTR batteries. The process, which also dememorizes and charges the cells, is completely automatic and needs no monitoring. At the end of the analyzing process, remaining capacity in milliamp hours is displayed on the LED read-out.

Circle (388) on Reply Card

Video monitors

Sierra Scientific has announced the HD-1200 series of high-performance monochrome video displays. The monitors feature 40MHz video bandwidth, automatic lock to any line rate from 525 to 1,225 and a selection of CRT sizes from 12 to 20 inches in open frame, rack and cabinet mountings. All models have resolution in excess of 100 pixels per inch.

The monitors have a modular electronic chassis to raise picture performance to the limit of the display tube. This chassis delivers 1% combined distortion and nonlinearity. It produces 40V of cathode drive with 40MHz bandwidth and 60dB signal-to-noise ratio. It also holds picture size change under 1% for all combinations of picture brightness, scan rate and power line voltage.

Circle (394) on Reply Card

Second generation pager

SpanTel has announced its second generation pager, the Kit II. The pager operates on either the 67kHz or 92kHz bands from FM radio stations. The increased sensitivity of the unit is due to antenna and shielding modifications, resulting in greater range and building penetration. Several range-extending antenna options including helical, wrist strap and lanyard are available. A recently developed portable recharger is also offered.

Circle (389) on Reply Card

Audio test equipment

Sound Technology has introduced the 3000 series of audio and transmission test systems. The series consists of two separate components including the 3100A generator and the 3200A analyzer. Both microprocessor-based instruments feature front panel programmability that allows storage of extensive automated test sequences. They can also communicate test data through the audio line being tested because of an exclusive frequency shift keying technique. This allows unmanned, automated remote transmission line testing without external computers and modems. Test results are achieved in less than 60 seconds and may be graphed on a standard printer or plotter. The unit may be controlled via RS-232C or GPIB (IEEE-488) communications ports.

The 2-channel electronically balanced and floating generator outputs sine waves, square waves, IMD, toneburst and sine-step waveforms. The 2-channel analyzer will measure level, noise, frequency, harmonic distortion, intermodulation distortion, phase error, channel separation and quantizing noise. Output levels range from +30dBm to −90dBm; system residual distortion is less than 0.001%, measurement speed is 500ms for distortion and 150ms for levels above 50Hz. Both components have extensive RF shielding and are available as separately housed portable instruments or in a single rack-mount or stand-alone chassis.

Circle (403) on Reply Card

Recognition control unit

Studio Technologies has announced the RCU-1 recognition control unit, for use in conjunction with MTS TV broadcast operations. The unit determines and displays the mono/stereo status of broadcast audio programming and automatically switches a stereo simulator into the on-air broadcast chain upon recognition of mono. The unit employs VCA based cross-fading circuitry so that the transition from true to simulated stereo is smooth. Extensive circuitry is used to allow ±45° of phase error (at 1kHz) and channel level difference of 10dB to still be recognized correctly.

The unit also can be used as a dedicated mono/stereo recognition device in a TV broadcast or production facility. Prior to broadcast, videotapes can be monitored to determine the actual status of the audio channels present. The unit is designed as a companion device for Studio Technologies' AN-2 stereo simulator. The unit also is compatible with stereo simulators built by other manufacturers.

Circle (404) on Reply Card

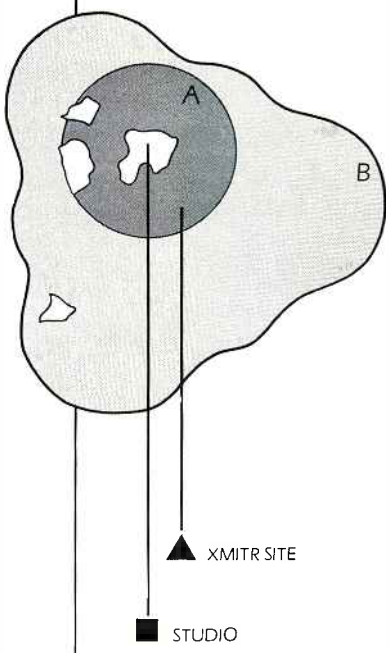
Small powered speaker

Anchor Audio has introduced the AN-1000 small-powered speaker. The speaker input and equalization stages use the latest low-noise, high slew rate and ultra-low distortion op-amps. The 50W fully complementary power MOSFET amplifier offers high thermal stability, wide power bandwidth and low distortion within the audible frequency range. The increased power supply capacity enhances low end reproduction, giving greater impact and detail. All components have been carefully chosen then matched with an acoustically tuned enclosure to produce dynamic, full range sound reproduction. The speaker uses 5¼ inches of rack space.

Circle (402) on Reply Card

IF TRANSMITTER FAILURE HAS CAUSED YOU TO LOSE REVENUE, LET US INTRODUCE OUR INEXPENSIVE EMERGENCY TRANSMITTER.

What happens at your station when your FM transmitter goes down? Or your studio transmission link is disrupted? Or a power loss at the transmitter site occurs?



A — Coverage using QEI studio location transmitter

B — Coverage using station's primary transmitter

QEI has an inexpensive solution. Our low-power FM transmitter designed for studio operation can handle all these emergencies and keep you on the air. In many cases you'll retain the majority of your audience simply because your studio is usually located more central to your market than your transmitter site.

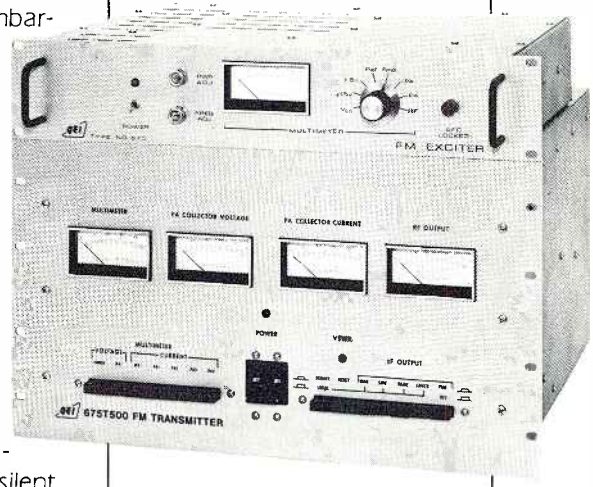
For a small investment your station will gain protection against lost revenues and the embarrassment of discontinued service.

QEI's low-power transmitters are all solid-state and are available in 150w, 300w or 500-watt power output levels. No warm-up is required. They are on the air in less than 10 seconds . . . and have hundreds of thousands of trouble-free hours. Virtually silent in operation, all our transmitters use QEI's famous 675 synthesized exciter.

So cover yourself with a QEI low-power FM transmitter located at your studio site . . .

Solve the problems caused by an STL or main transmitter failure . . . and do it on a modest budget.

For more information contact John Tiedeck at 609 728-2020. He will put a package together to meet your station's needs.



QEI Corporation
One Airport Drive
P.O. Box D
Williamstown, NJ 08094
Phone: 609-728-2020

QEI Corporation

Circle (120) on Reply Card

Dual mono amplifiers

JBL has introduced the 6290 dual monophonic high-power amplifier designed to provide precision reproduction of complex waveforms. The system features high output power, 600W per channel into 4Ω, and 1200W into 8Ω, mono-bridge mode. A low transient intermodulation distortion design efficiently controls audible distortion factors by predriver-stage local feedback. Minimal negative feedback is required to set the gain and establish the operating point.

The amplifier's configuration balances two fully independent, high-power amplifiers. The two audio channels are individually powered and protected so that if interference or failure in one channel occurs, the system will continue to operate at full power capacity through the other channel.

The amplifier is housed in a rugged steel chassis and features fully complementary devices in all predrive, driver and output stages. Input terminations use a standard ¼-inch TRS connector, XL connector or barrier strip; output terminations use 5-way binding posts. The back panel provides ac-fuse accessibility.

Circle (381) on Reply Card

UPS

Nova Electric Manufacturing Company has announced the 3kVA MinTaur uninterruptible power system with internal solid-state ¼-cycle transfer switch. The UPS is designed for operation of various loads including computers, telecommunications equipment, process control systems and security systems.

The system is capable of continuous operation at full load, is a true on-line system and can provide up to 150% overload for five minutes for high inrush loads on startup. Using the static switch, it can deliver up to 10 times overload for starting disc drives, motors and other inductive or capacitive loads. The static switch operates automatically from and to the ac bypass line. Batteries are offered with the system in a 19-inch rack-mountable package or in cabinets or on racks.

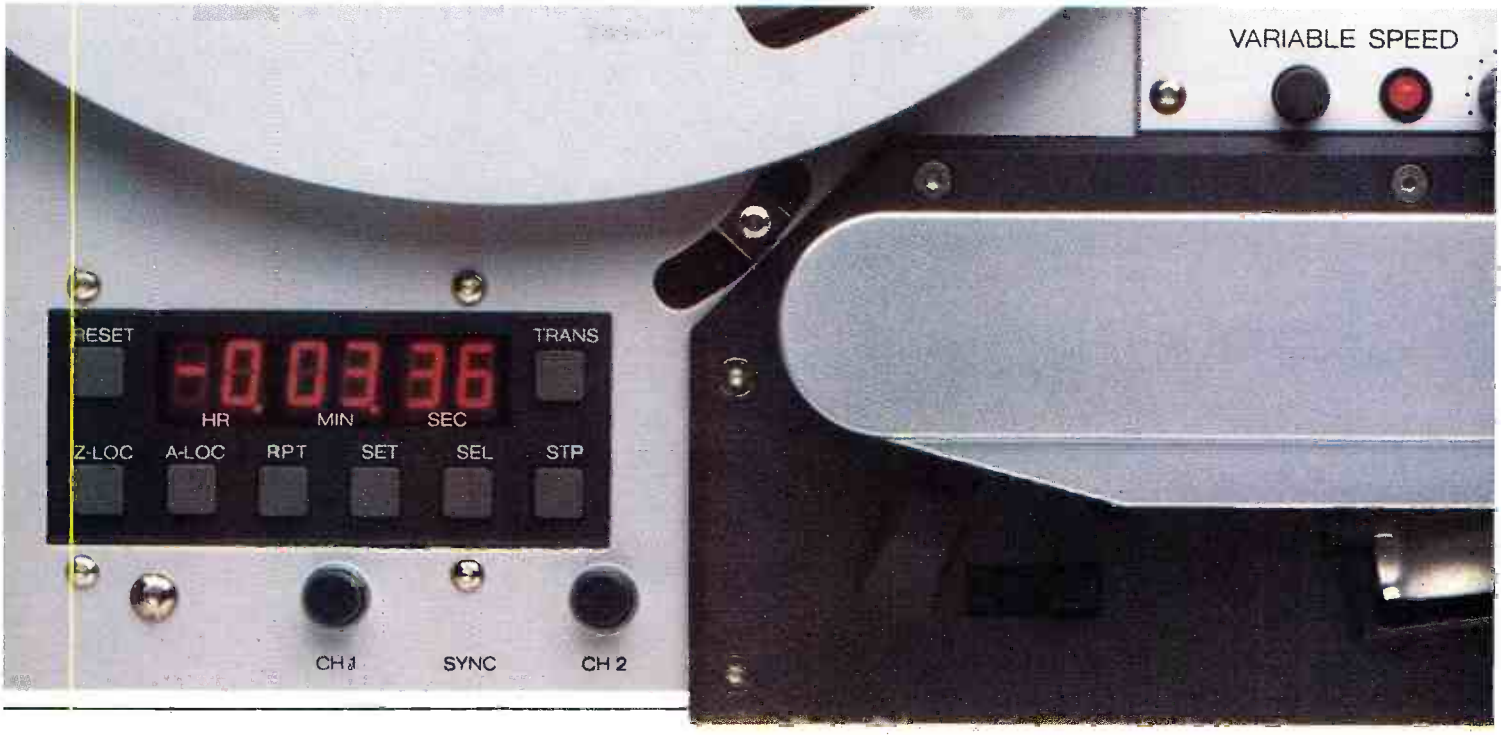
Circle (378) on Reply Card

Broadcast cartridge

International Tapetronics/3M has introduced the Scotch-Cart II broadcast cartridge. The cart offers high output, low noise and lubricated tape for recording at high levels without performance loss. The cart uses no pressure pads, so problems with tape steering, wear and excessive audio sideband noise are minimized. The cart uses a temperature stable, non-rotating hub to eliminate mechanical irregularities of rotating hubs. The cart retains the passive system of internal tape guidance. Concave guides position the tape, allowing the cart machine to do the critical guidance. The cart also retains the patented dynamic tension control system, designed to ensure proper tape-to-head contact and constant tape tension.

The tape exits from the hub center and the cart has an adjustable cam to control the tape loop, which ensures maximum cart life. The cover is made of break-resistant, long wearing, polycarbonate material. Interlocking tabs in the cover and base eliminate sliding when carts are stacked. NAB head and penetrating marks have been added to the cart covers for easy head block and cart guide adjustment.

Circle (400) on Reply Card



On adding time-saving production features to a proven audio recorder design.

The updated PR99 MKII, now offering a microprocessor controlled real time counter, address locate, zero locate, auto repeat, and variable speed control, can improve your audio production efficiency. And, as before, it's built to meet strict Studer standards for long-term reliability.

Welcome to real time. The PR99 MKII's real time counter gives a plus or minus readout in hours, minutes and seconds from −9.59.59 to +29.59.59. Counter error is less than 0.5%, and the microprocessor automatically recomputes the time displayed on the LED counter when you change tape speeds.

Fast find modes. Press the address locate button and the PR99 MKII fast winds to your pre-selected address, which may be entered from the keyboard or transferred from the counter reading. Press zero locate and it fast winds to the zero counter reading. In the repeat mode, the PR99 plays from the lower memory point (zero or negative address) to the higher point, rewinds to lower point, and re-activates play mode for a continuously repeating cycle.

Pick up the tempo? When activated by a latching pushbutton, the front-panel vari-speed control adjusts the nominal tape speed across a −33% to +50% range. The adjustment potentiometer is spread in the center range for fine tuning of pitch.

Future perfect. The PR99 MKII also offers a serial data port for direct access to all microprocessor controlled functions.

Much gained, nothing lost. The new MKII version retains all features of its highly regarded predecessor, including a die-cast aluminum chassis and headblock, balanced and floating "+4" inputs and outputs, self-sync, input mode switching, and front panel microphone inputs.

European endurance. Designed and built in Switzerland and West Germany, the PR99 MKII is a product of precision manufacturing and meticulous assembly. Every part inside is made to last.

To discover more about the world's most versatile and dependable budget-priced recorder, please contact: Studer Revox America, Inc., 1425 Elm Hill Pike, Nashville, TN 37210; (615) 254-5651.

STUDER REVOX

PR99 MKII with optional carrying case and monitor panel. Roll-around console also available.

Circle (35) on Reply Card

Teleproduction special-effects switcher

ECHOlab has introduced the SE/6 switcher. It is built to handle medium-sized broadcast and non-broadcast production studio needs. Forty patterns can be created and positioned by either of the two independent joystick pattern controls. Three separate colors can be generated for background and mattes. The generators can be set to any color with the keyboard or joystick. Digital specification of hue, luminance and saturation allows precise color selection. An optional drop shadow generator is available.

Two built-in Z-80 microprocessors allow front panel programming for as much as 5,000 steps of storage. The front panel control commands are digitized and transmitted to a remote chassis via a cable.

Teleproduction effects include five keys with a downstream keyer that handles full video from character generators. The switcher features five 12-input video buses and three mix-effects amplifiers and interfaces to all popular edit controllers. Chromakey is optional via either RGB or NTSC inputs.

Circle (414) on Reply Card

Professional power amplifiers

Four P-series professional power amplifiers that produce sound characterized by the wide bandwidth, low noise, low distortion and transient definition, have been introduced by *Yamaha* Professional Products Division. All the models share similar packaging, features and circuitry, but differ in power output per channel and in the number of channels. Features common to all four include balanced inputs with both XLR and phone jack connections; binding post and phone jack output connections; dB calibrated input attenuators; and output protection against overload, turn-on transients and dc offset.

The P1150 is a single channel amplifier rated at 100W into 8Ω or 150W into 4Ω. The dual channel P2150 delivers the same power output per channel. The P1250 is a single channel amplifier rated at 170W into 8Ω or 250W into 4Ω. The P2250 is a dual-channel version with the same power output as the P1250.

A back panel switch on both dual channel models rewires them for use in a bridged, mono configuration. In this mode, the power output is doubled. Two stage, temperature sensitive cooling fans pull air through front panel filters to keep the power transformer and heat sinks cool. Further protection is offered by a thermal breaker.

Circle (412) on Reply Card

8-track recorder

Fostex Corporation of America has introduced an 8-track recorder, the model 80, which replaces the model A-8 series. The recorder features a microprocessor-controlled transport. There is a 2-position memory and an automatic repeat function. Record status functions and operational logic are straightforward and easy to use. Punch-ins can be remote-controlled with an optional accessory.

The recorder includes Dolby C noise reduction, is capable of 8-track simultaneous recording; signal-to-noise at 15ips with noise reduction at 72dB, weighted; and crosstalk better than −55dB at 1kHz, adjacent channel. The recorder measures about 14" x 14" x 7" and weighs 29 pounds.

Circle (371) on Reply Card

"The ITC-730A and the new ITC-730AP Plumbicon® version will keep us out in front of the action."

— Mike Shanahan, Vice President Sport View TV, Detroit, Michigan

Your winning tickets to great broadcast quality productions every time are the Ikegami ITC-730A and the ITC-730AP (Plumbicon® version) low cost/high performance 3-tube prism-optics color cameras.

Both cameras offer second to none value in their class and feature high sensitivity, resolution and S/N ratio; with low power consumption, registration error and weight. In addition, the ITC-730AP provides superior highlight handling capabilities.

Keeping you out front with new standards for cost effectiveness, special features of both cameras include: dynamic beam stretch, a 2-H vertical detail correction, and wide dynamic range. For EFP, a small CCU can be operated up to 1,000 feet away in the A/C power mode and up to 300 feet using DC power at the camera head or CCU.

With an Ikegami ITC-730A or 730AP, you play to win.

For a complete demonstration of the ITC-730A and AP and other Ikegami cameras and monitors, contact us or visit your local Ikegami dealer.

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Circle (108) on Reply Card

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B. Paid Circulation		
1. Sales through dealers and carriers, street vendors and counter sales	--	--
2. Mail subscriptions	35,366	35,335
C. Total Paid Circulation	35,366	35,335
D. Free Distribution (including samples) by mail, carrier delivery or other means	2,603	3,935
E. Total Distribution (Sum of C and D)	37,969	39,270
F. Copies Not Distributed		
1. Office use, left-over, unaccounted spoiled after printing	1,726	880
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I certify that the statements made by me above are correct. (Signature of editor, publisher, business manager or owner.)

CAMERON BISHOP
Group Vice President

Corrections

We would like to correct errors that appeared within three of the equations used with the article, "Designing AM Coupling Networks," in our July issue. The corrected equations are as follows:

Equation 1:

$$Q = \sqrt{\frac{R_2}{R_1} - 1} = \left|\frac{X_1}{R_1}\right| = \left|\frac{R_2}{X_2}\right|$$

Equation 16:

$$Y_1 = \frac{-\mathrm{COT}(\Theta)}{R_1 - Y_3}$$

Equation 17:

$$Y_2 = \frac{-\mathrm{COT}(\Theta)}{R_2 - Y_3}$$

We would also like to clarify a point made in "Radio's High Tech Talk," an article that began on page 22 of the June issue. It was indicated that the output of a receive-only satellite terminal downconverter could be used to feed (through interface equipment) a T-1 data line and thereby drive a demodulator at a remote site. This configuration, however, is not compatible with a T-1 line because of bandwidth limitations. (The digital output stream of the receiver is 8.78MHz and T-1 links operate at only 1.544MHz.)

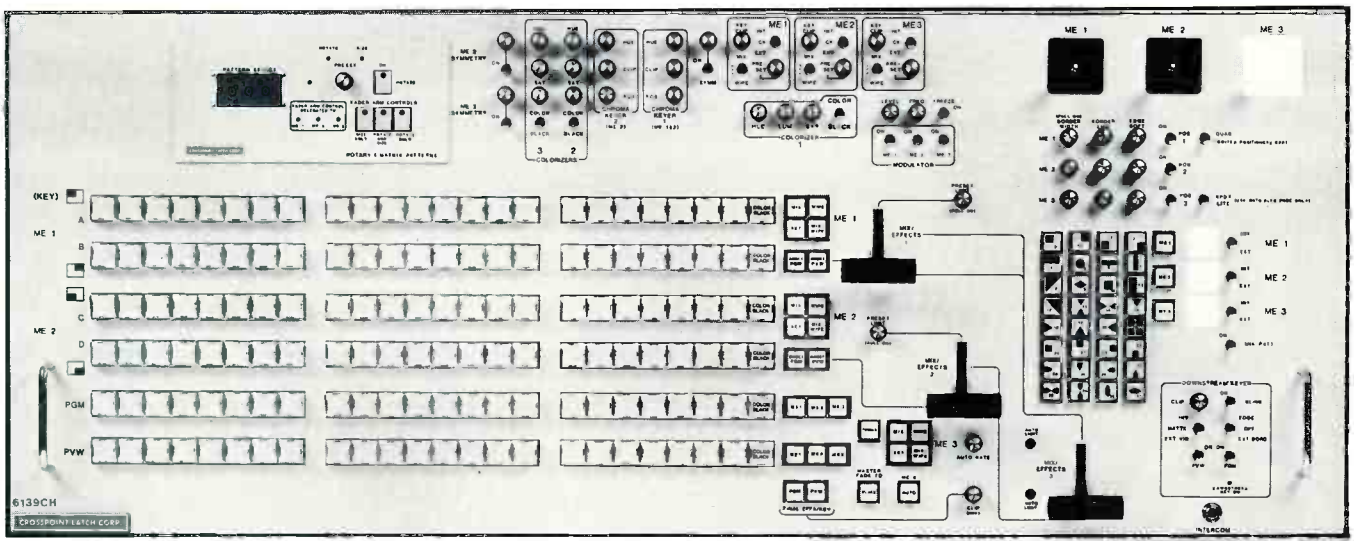
For a station that requires remote location of its receive-only dish and wants to maintain digital transmission over the entire length of the system, two options are available. First, the desired program feeds can be demodulated to audio at the receive site and applied to individual program multiplex transmit cards designed to work into a T-1 carrier line. Such a system can typically carry up to four 15kHz channels. At the studio, demodulators convert the datastreams into analog outputs. This type of equipment is available off the shelf from telephone company equipment suppliers.

A second option involves the use of a heterodyne technique in which the satellite signal is downconverted to an intermediate frequency (such as 70MHz) and then upconverted to a microwave transmit frequency. At the studio, a microwave receiver feeds the standard satellite demodulator/decoder equipment.

The latter method involves more work and licensing of a microwave relay station, but it allows for decoding of any channel on the satellite transponder from the studio location. Critical performance parameters for the microwave equipment, which is available from many telephone equipment manufacturers, include system phase shift and phase noise.

6139 SUPERB QUALITY

THE PRINCIPAL FEATURE



The quality of the 6139 is superb. You could not ask for more. Imagine you had to select a switcher for one feature and one feature alone - quality. If you overlooked the tremendous production power of the 6139, overlooked its ability to be controlled from most editors, overlooked its modular state of the art design, you would still end up selecting the 6139, based on that one single feature - its high quality performance.

8, 16, OR 24 INPUTS LED OR ILLUMINATED PUSHBUTTONS

PRODUCTION

- THREE MIX EFFECTS SYSTEMS
- FIVE LEVELS OF KEYS
- QUAD SPLIT
- DOWNSTREAM KEYER, WITH EDGE, MATTE AND INSERT
- PATTERN MODULATOR WITH FREEZE
- TWO CHROMA KEYERS, RGB OR ENCODED
- THREE COLORIZERS
- MASTER FADE TO BLACK
- AUTOMATIC AND MANUAL TRANSITIONS
- MIX PATTERN MODE (DISSOLVE PATTERNS)
- TOGGLE

THE ELECTRONICS

New state of the art design. Multiple back-porch feedback clamps provide a very high degree of stability. Modular construction, with standardized function oriented plug-in boards facilitate maintenance, and field replacement. We recognize the fact that no matter how reliable a unit is, there is always the possibility that a component can fail. The 6139 has been designed with back-up paths, to reduce the possibility of complete shut down. For instance the PREVIEW system is an exact duplicate of PROGRAM. Several boards are interchangeable, and may be swapped to at least provide essential functions in an emergency.

POST PRODUCTION

THE 6139 INTERFACES WITH MOST EDITORS. It will accept commands directly from their keyboards, when used in conjunction with the CROSSPOINT LATCH 7203 Editor Switcher Interface, or the 7239 AUTO DRIVE™. These are not mere "INTERFACES", nor are they merely "PROGRAMMABLE". They are human engineered devices SPECIFICALLY designed for use in editing. Consider just one point; they allow the operator to set the START and FINISH points of a transition precisely, (in order to obtain FRAME ACCURATE edits) while at the same time leaving the editor full control of the rest of the switcher functions; and the ability to insert and control these other functions from the edit list.

BLANKING PROCESSOR eliminates color shift at the end of a mix or wipe

FIVE LEVELS OF KEYS

ROTARY AND MATRIX WIPE OPTION

HIGHLY EFFICIENT CURRENT MODE AMPLIFIERS INCREASE STABILITY AND REDUCE SIZE OF ELECTRONICS

INTERFACES WITH MOST EDITORS

AUTO DRIVE™ OPTION (COMPUTER CONTROL)

TWO CHROMA KEYERS (RGB OR ENCODED)

UNIQUE "TEST" MODE TO FACILITATE SYSTEM TIMING

Model 6800
STEREO AUDIO FOLLOW OPTION

8 input LED version starts at **$14,935.**
Incandescent Lamp push buttons and options over **$70,000.**

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Circle (102) on Reply Card

Time align studio monitor

UREI has introduced the model 809 time align studio monitor. It features a 12-inch coaxial driver that delivers a true, 1-point sound source, tight bass and stereo imaging. The coaxial driver incorporates a titanium diaphragm compression driver in the high-frequency section which extends the mid-frequency response envelope to beyond 17.5kHz.

The time align technique solves time smear by considering driver placement and adjusting crossover group delay parameters to achieve simultaneous arrival of sound from the voice coils of the two transducers.

The monitor uses the patented UREI high-frequency horn with its diffraction buffer for correct acoustic impedance matching and smooth out-of-band response. Shadow slots eliminate the midrange shadowing common to conventional coaxial loudspeaker horns. Ceramic magnet structures on the drivers assure the sensitivity of the system will not degrade with time or continual use.

Circle (382) on Reply Card

Weather database

Eight graphics and a state-of-the-art weather database has been introduced by *Accu-Weather*. The products allow TV stations to receive all their weather needs from one source. Accu-Weather offers a total weather-date service, including satellite images, national radars, complete alphanumeric weather data reports and forecasts and news, sports and financial graphics. Also available are NAFAX charts for receipt directly into the equipment.

Circle (377) on Reply Card

Audio limiter

Gotham has introduced the EMT 277 DX audio limiter designed for AM broadcast transmitters operating in the short, medium and long wave bands. The transient limiter circuitry of the limiter uses 0.3ms signal delay to prevent overdriving of the transmitter even with extreme wide range program material from compact disks and digital tape. This transient response characteristic prevents the appearance of audible holes in the modulation while release time constants have been optimized to human hearing preferences.

The compressor/expander section uses program dependent release times that are dimensioned to permit the highest possible increase of average modulation. Remote control switching of the compressor parameter settings will allow optimizing day/night operation for differing propagation conditions.

Circle (385) on Reply Card

Video equalizing amplifier

Dynair Electronics offers the model EQ-1076A-30, a 30MHz video equalizing amplifier that provides compensation for loss of display resolution due to attenuation of coaxial cables. The amplifier can be used for cabled high-resolution systems such as computer-generated raster scan video applications allowing the video display unit to be remoted up to 2,000 feet from the source. Monochrome and color (encoded or RGB) systems can be assembled, and make use of the available 22dB at 30MHz adjustable equalization that accommodates a wide range of 75Ω and 124Ω cable types/lengths.

Circle (391) on Reply Card

Automated equalizer system

Gotham Audio has introduced the Neumann AME 591 fully automated equalizer system for multichannel recording. This analog equalizer system for consoles or stand-alone use provides up to 64 audio channels using digital control for all equalizer parameters. Microcassette data storage allows 10 banks of equalizer settings to be recalled instantly from RAM during mix down. The system is modular and the operating panel provides a central control center for the W 591 individual channel equalizers, each with LED indicators.

The system enables the sound engineer to program equalizer settings during a mix and to recall those settings instantly from RAM with automatic crossfade. The crossfade is click free. All equalizer settings for a particular mix can then be stored on data microcassette and saved for later remixing.

Applications for the system include multichannel music mix down, film scoring, sound reinforcement, theater sound with preset cues, sweetening, live and recorded TV production. The system is available in a rack-mountable version with standard input/output connectors or it may be integrated into existing multichannel consoles.

Circle (415) on Repy Card

Digital reverberator

Yamaha Professional Products Division has introduced the REV7 stereo reverberator. It uses Yamaha-developed large scale integration chips for fast, accurate control of all parameters, resulting in stereo reverberation that simulates the acoustic properties of various environments.

The system is capable of creating a wide range of sound enhancement effects. Effects are managed by six early reflection modes, up to 99.9ms of initial delay time and first reflection delay time. Precise tonal coloring is controlled by a 3-band parametric equalizer.

The system incorporates 30 instantly available preset ROM effects and an additional 60 effects programs can be created, stored and instantly recalled. The system also incorporates a MIDI facility for selection of effects from keyboards and other MIDI devices.

Circle (413) on Reply Card

Power conditioner

Topaz has announced its peak-current Line 2 power conditioners to meet the needs of microcomputers that have internal switched-mode power supplies. The conditioners provide protection against problem-causing electrical noise disturbances, and also provide immediate correction of harmful voltage fluctuations that can impair computer performance. The conditioners feature Powerlogic microprocessor-controlled voltage regulation. Output voltage is corrected to within +4% to −8% of nominal rated voltage for input voltage variations of +15% to −25%.

The conditioner provides microcomputers with proper current and voltage on demand. Because of its low forward transfer impedance, the unit provides undistorted power to high-crest-factor loads, such as switched-mode power supplies. Available in power ratings of 250VA, 500VA, 1,000VA and 2,000VA, these power conditioners are compatible with most microcomputers and small business systems.

Circle (393) on Reply Card

Circle (90) on Reply Card

Circle (91) on Reply Card

Circle (105) on Reply Card

Digital clamp multimeter

The Instrumentation Products Division of *Beckman Industrial* has added two digital clamp multimeters that measure up to 200A and 300Aac. The AC30 measures up to 300Aac and 500Vac, and has a built-in continuity beeper. It also features autoranging on both volt and amp scales and comes with a set of test leads for voltage and continuity functions. The AC30's jaws also open for easy insertion of conductors. Another feature is the data hold function that enables the user to freeze the reading on the display.

Both the AC20 and AC30 fit conductors up to 1.1 inches in diameter, and feature a low battery indicator. Case insulation can withstand up to 2,000Vac for up to one minute. The meters' constructions also are fire resistant. The meters are lightweight and easy to handle and come equipped with an operator's manual, safety wrist strap, a pair of button-type batteries that provide up to 150 hours of use and a leather carrying case.

Circle (397) on Reply Card

Ac voltage regulators

Topaz has announced a new line of ac voltage regulators available in power ratings from 1kVA to 100kVA, in portable and stationary models. All models feature 98% power efficiency. The regulators use advanced electronic tap-switching technology that enables them to correct problem-causing voltage fluctuations in less than one cycle of line frequency. The high-speed response ensures protection against sudden, short-term voltage dips, as well as protection against longer-term voltage fluctuations such as brownouts.

Peak-limiting circuitry and low-pass filters also provide protection against noise transients and voltage spikes. Features of the regulators include UL listing, input frequency range of 47Hz to 63Hz, wide input voltage ranges and a choice of output voltage envelopes (±7%, ±5% or ±3.3% of nominal line voltage).

Circle (396) on Reply Card

Logic probe

Beckman Industrial Instrumentation Products Division has added the LP10A logic probe to its Circuitmate product line that is capable of checking all commonly used types of digital circuitry. The logic probe will detect pulses as narrow as 30ns, at speeds up to 17MHz. With a built-in pulse extender circuit, the probe's pulse memory feature can capture one shot, low repetition rate narrow pulses for visible indication. Other features include LED logic level indicators and a slide switch to select TTL (including DTL and HTL) or CMOS operation.

Circle (398) on Reply Card

Tripod washers and sleeves

Karl Heitz has announced its black resin tripod washers and sleeves to permit tripod and monopod leg extensions and center columns to glide smoothly and lock tightly without binding, jerking or slipping. A long sleeve fulfills both functions of gliding and locking for both the rapid sliding and Cremaillere gearlift center columns. The washers and sleeves also are water and temperature proof.

Circle (386) on Reply Card

Weather and information network

Wold Communications and *Environmental Satellite Data* have introduced the Wold/ESD weather information network, WINX, designed to improve weather data transmissions. The Front End, which interfaces with the network, is built on an IBM XT. The Front End is designed to continuously collect, store and access unlimited weather data transmitted via Telstar 301. The Front End will access high-resolution color satellite images, national radar summaries, temperature, pressure and various other weather reports from ESD.

From the Domestic Data Circuit it will access hourly station reports, analysis, forecasts and bulletins. The Front End also will process the Metplan weather chart service designed as an alternative to NAFAX and DIFAX. It is received by Front End for display on a dot matrix printer. Once received by the Front End, this processed weather data can be transmitted to a variety of graphics systems such as Color Graphics, Vidiphont V, Dubner, Chyron IV, PMT-100, McGuinnes-Skinner and Alden.

Circle (380) on Reply Card

Thyristor driver card

Skantronics has announced it is manufacturing the SKT-TTD, a universal thyristor driver card for lighting-intensity control. The card contains all electronics to control triacs or SCR pairs for lamp loads from 10A to 600A rms. Features include square law B transfer characteristics and a feedback network that holds lamp intensity constant regardless of line and load variations. This card may be used in new lamp-dimmer designs or as a service or update component for any thyristor dimmer. An 8-page specification and application bulletin is available from the factory.

Circle (357) on Reply Card

Betacam recorder case

Kangaroo Video Products has introduced the KVP-1 Betacam recorder case to provide users of the Sony BVV-1 Beta format recorder additional equipment protection and portability. The recorder case accommodates either the VA-1 or VA-1V adapter and includes an outboard pocket for the Shure FP-31 mixer or extra field tapes. An attached pocket can hold tapes or the Anton/Bauer or Sony BP-90 battery. Velcro flap closures allow access to controls as well as the attachment of the battery pack and/or a wireless microphone receiver. Cables and connectors are protected by Kangaroo's standard cable strain relief system, and cable ports are hooded. Clear vinyl panels permit viewing of the recorder's controls and tape indicator.

Circle (368) on Reply Card

Phonograph cartridge

Shure Brothers has introduced the V15 type IV-MR, an updated version of the V15 type IV phonograph cartridge. The model is the original V15 type IV equipped with a micro-ridge stylus. The micro-ridge's smaller tracing radius reduces the V15 type IV's second harmonic distortion by 37% and reduces intermodulation distortion by 56%, compared to the model's original hyperelliptical stylus. Features of the cartridge include the viscous-damped dynamic stabilizer and telescoped aluminum stylus shank. Current owners of V15 type IV cartridges can upgrade their systems to V15 type IV-MRs with the VN45MR replacement stylus.

Circle (363) on Reply Card

Digital SCPC transmission products

Wegener Communications has introduced the series 1600 audio SCPC and series 2000 digital SCPC transmission products. The system provides analog audio, digital audio and data channel transmission for C- or Ku-band satellite links.

A modular systems approach, bandwidth efficiency, high stability and ease of expansion combine to allow the flexibility required in implementing an SCPC system. Analog channels for voice through program audio use the Panda II audio processing techniques for 90dB dynamic range with only 180kHz maximum subcarrier spacing. Analog-to-digital conversion in voice, facsimile or other analog circuits and Dolby/Wegener ADM techniques handles full bandwidth program audio. Data transmission of single channels or multiplexed subchannels use the Flexmux system, which provides an aggregate 2Mb/s datastream consisting of multiple asynchronous and synchronous data subchannels at mixed data rates.

Circle (350) on Reply Card

Software packages

Robert Bosch, Video Equipment Division, has added two enhancements to its software capabilities. The smooth shading editor for the FGS-4000 provides two shading models for smoothing the surface of a 3-D object. The gourraud shading gives a matte finish surface to the object, while the phong shading model creates a surface with highlights toned to the light source.

The animation editor has been expanded with the tree grafting program, by which the operator can edit an animation by adding, deleting, replacing or changing the priority of objects. These allow the user to create generic animations that can be re-used with new objects.

The software allows the user to bring objects to life by controlling the time dimension. Control is provided for sizing, translating, rotating and coloring the object. The system automatically interpolates between user-defined keyframe, and the user can control the light source, camera position, lens size and background.

Circle (379) on Reply Card

Test translator data sheet

LNR Communications has released a data sheet describing its line of C- and Ku-band loop test translators. Satellite earth station loop tests can be performed by substituting any of the loop test translators for the satellite path. They are ideal for data, FM and video traffic, as well as for Domsat and Intelsat applications.

Circle (384) on Reply Card

Cart machines

International Tapetronics/3M has introduced the Omega series line of monophonic and stereophonic reproducers and monophonic recorders. The stereophonic reproducers feature 150Hz secondary cue tone detection, long life stereo heads, modular design, dc brushless servo motor, flashing ready lamp to show cartridge has been played and compact design.

The monophonic reproducers and recorders have the same features and components as the stereophonic reproducers. The mono reproducers also are field upgradable to stereo. The monophonic recorders have a selectable 1kHz cue tone defeat and a built-in microphone pre-amp. The cartridge machines use microprocessor technology.

Circle (399) on Reply Card

TV has its Emmy...
Film has its Oscar...
Business Publishing has its Neal...

BE's NEAL Honor Means You're a Winner!

Winner: 1985 Jesse H. Neal Award Certificate of Merit
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Second audio program generator

Orban Associates has announced the Orban 8182A/SAP second audio program generator for TV multichannel sound. The generator is designed to work with the 8182A/SG stereo generator or stand-alone for stations not planning stereo.

The generator incorporates the same multiband audio processing and CBS automatic loudness controller found in the stereo OPTIMOD-TV. Remote control of SAP on/off and loudness controller on/off, as well as remote metering and indication, is provided.

Circle (376) on Reply Card

Reverberation system

Gotham Audio has announced the EMT 252 digital reverberation system. The system provides reverberation through digital processing using high-resolution 16-bit analog/digital conversions and 32kHz sampling of audio. The unit also provides three delay-based effects including straight delay, loop echo and chorusing effects.

The reverberation program provides up to nine individual reflections before reverberant signal, time and amplitude of the reflections adjustable individually, with frequency response of the system adjustable in four separate bands. The main reverberation program, reduced bandwidth (EMT 250) program, Doppler-shifted program and non-linear decay program are designed into the unit.

The system is housed in a 19-inch rack-mount enclosure. Control functions and display settings appear on a separate 8" x 12" console. The console provides 128 memory presets for each of the reverberation and effects programs. The console stores the presets in battery-backed memory.

Circle (401) on Reply Card

2-track stereo mastering recorder

Fostex Corporation of America has announced the model 20, a 2-track stereo mastering recorder with a third, center channel control track. The third track is used to record SMPTE or any other pulse code for use with synchronizers and video editors. The recorder may be used in performance situations as a master sync controller. Pre-recorded effects and sounds may then be added to the live material.

The track format is standard half track and speeds are 7½ips and 15ips. The pitch control works in both record and reproduce modes ±10%; the equalization is standard NAB; either channel of audio can be switched for sync playback. The transport is microprocessor-controlled with a 2-position memory and a shuttle/repeat function.

Specifications for 15ips operation include 30Hz-22kHz, ±3dB, frequency response; 70dB weighted signal-to-noise ratio; better than 70dB crosstalk at 1kHz for the center channel control track with all channels in the record mode.

Circle (383) on Reply Card

Shock-mounted shipping cases

Shock-mounted shipping cases from *Environmental Container Systems* are designed to secure electronic equipment from rough handling and environmental hazard. The cases are constructed of pressure-molded fiberglass-reinforced plastic and feature 8-point shock-mounted aluminum racks, removable front and back covers, recessed handles, gasketed closures and pressure relief valves.

The cases are designed for stacking and are constructed to standard EIA-RETMA dimensions. Ten sizes are available. Cases are provided with an internal frame measuring 18.3" x

18.9" and varying in height from 5.25 inches to 21 inches. External dimensions measure 22.77" x 27.16" with overall height varying from 8.94 inches to 24.69 inches.

Circle (372) on Reply Card

VHF and UHF transmitters

The Broadcast Equipment Division of *NEC America* has announced the PCN-1400 and PCU-900 series, two lines of VHF and UHF TV transmitters with broadband characteristics for TV sound transmission. The transmitters are multichannel sound compatible and can be used with stereo generators without modification to the transmitters.

The PCN-1400 series VHF models feature 10kW, 20kW and 35kW single output powers, and all solid-state aural amplifiers. The PCN-1435AH 35kW model features one vacuum tube (RCA 8984), with a grounded-grid type power amplifier that assures broadband frequency coverage without tuning.

The PCU-900 series of IF modulated high-power UHF transmitters features models ranging from 10kW to 60kW single output powers. The transmitters feature two tubes and can be ordered with Amperex, EEV or NEC klystrons. All VHF and UHF transmitters feature solid-state frequency-synthesized high-performance exciters with 30% fewer parts for greater reliability and less maintenance.

Circle (373) on Reply Card

Video character generator

Aston Electronic Designs has announced the Aston 4 video character generator. Features include a multiplane display, 4,096-color palette, multicolored logos plus 24 displayable colors per page, diagonal writing and positioning of text including overlap and superimposition. The generator also has a resolution of 10ns. More than 15,000 typefaces are fully anti-aliased and can be displayed in any size from 10 to 100 TV lines. Each unit comes with five typeface masters. Automatic kerning is standard.

A disk management system allows instructions to be recorded with each page, that will specify how it will be displayed when recalled. Disks can be copied at a keystroke; directories can be displayed and reviewed; and a help facility is provided. The mainframe unit, which includes the power supply and two disk drive units, is 19¼" x 19" x 19¾". The keyboard is connected to the mainframe with single BNC to BNC video cable.

Circle (374) on Reply Card

Quad expander/gate

Symetrix has announced the 544 quad expander/gate. It is designed for professional studio and live performance applications where distortion-free gating is mandatory. The unit offers a maximum amount of processing power while consuming a minimum amount of rack space. The unit encloses four channels in a 1¾-inch rack space while providing user-variable expander/gate controls including attack time, release time, range/ratio and threshold.

Each channel of the unit can be set to trigger internally or may be keyed from external input signals for special effects. Gate mode response has been optimized for highly transient material such as drums and percussion. The downward expander is exceptionally linear and doubles as an expander and noise reducer. Intelligent automatic time control circuitry works in conjunction with the manual release time control to eliminate low frequency distortion in both gate and expand modes. Each channel provides a 5-segment LED gain reduction display for visual indication of the unit's performance.

Circle (375) on Reply Card

Vocal/instrument microphone

Audix has introduced the OM-1 hypercardioid dynamic microphone. It features off-axis rejection for improved gain before feedback, handcrafted brass body, frequency response of 50Hz to 18,000Hz and a shock-mounted capsule to isolate handling noise. The 200Ω capsule is housed in a removable brass middle ring for easy field replacement. The mic also features two types of interchangeable grille caps: a flat-shaped one for instrument application, and a ball-shaped one for vocals. The OM-1 is available in black or non-reflective matte gray.

Circle (362) on Reply Card

Noise gate/expander

USAudio has introduced the model 904, a single-channel version of its Gatex noise gate/expander designed to be housed in and powered by the dbx F-900 powered frame. The unit employs program dependent attack in its gating mode, to eliminate turn-on pop, and maintains attack times short enough to accommodate all percussion instruments. Program-controlled sustain automatically lengthens the release time as dictated by program content. This allows freedom from distortion when using shorter release times. The model 904 also offers two expansion modes and an expanded 8-segment LED gain-reduction meter.

Circle (352) on Reply Card

Sine wave inverters

Powermark Division of *Topaz* has announced the series Z sine wave inverters for reliable dc-to-ac power conversion. The inverters are designed for applications that require stable ac power with accurate frequency control. Each system includes a constant-voltage transformer that provides a low-distortion sinusoidal output with ±0.5% frequency stability. The transformer also provides primary-to-secondary isolation, current limiting and output voltage regulation.

The inverters feature input circuit breakers, reverse-polarity protection at the input and overload and short-circuit protection with automatic recovery. High and low input voltage detectors turn off the inverter if the ac voltage strays above or below the specified voltage range. The inverters are available in 50Hz and 60Hz models with power ratings from 200VA to 2,000VA. All models feature built-in automatic/manual restart selection and low harmonic distortion.

Circle (369) on Reply Card

Dual mono amplifier

JBL has introduced the JBL 6290 dual monophonic high-power amplifier, designed to provide precision reproduction of complex waveforms. The system features output power of 600W per channel into 4Ω, and 1,200W into 8Ω, mono-bridge mode. A low transient intermodulation (TIM) distortion design controls audible distortion factors by means of predriver-stage local feedback. Minimal negative feedback is required to set the gain and establish the operating point.

The amplifier's configuration balances two fully independent, high-power amplifiers. The two audio channels are individually powered and protected, so that if interference or failure occurs in one channel, the system will continue to operate at full capacity through the other channel. Input terminations use a standard ¼-inch TRS connector, XL connector or barrier strip; output terminations use 5-way binding posts. The back panel provides ac-fuse accessibility.

Circle (370) on Reply Card

Time-code reader/electronic film slate

Denecke has introduced the Dcode (cq) line of time-code readers and electronic film slates. The Dcode TC-1 time-code reader reads SMPTE or EBU time code from VTRs, VCRs, film-editing equipment and/or film synchronizers from 1/10th to 15 times speed in both forward and reverse. It reshapes code for film-to-tape transfers and simultaneously displays code and generates 60Hz pulse tone.

The Dcode ES-1 electronic slate provides users with time-coded visual slating for film and video production. The display is a 1-inch high-intensity LED readout featuring an internal battery-operated clock. No sync cable is required. These units can be used separately, but are designed to work together to provide the convenience of time code-assisted film editing.

Circle (358) on Reply Card

Alternating current clamp

The Instrumentation Products Division of *Beckman Industrial* has introduced the CT-234A ac current clamp. It measures up to 400Aac and 1kHz with 3% accuracy using a 1,000 to 1 current transformer. The jaw opens for cables up to 1 3/8-inches in diameter and for bus bars up to 2½ inches wide. The clamp operates with almost any current-measuring multimeter, and is an accessory to the company's line of digital multimeters.

Circle (365) on Reply Card

Digital measurement system

The Instrumentation Products Division of *Beckman Industrial* has introduced the model 310B digital multimeter to its 300 series of professional meters. The dmm features an audible continuity beeper for repeated continuity checks. The meter can signal continuity with a 100ms response time.

The multimeter also features a 10A current range, 0.25% dcV accuracy diode test function, 10kHz bandwidth and a 2,000-hour battery life. The patented single rotary-function/range/selector switch eliminates friction wear to prolong meter life.

The multimeters, built for continual use, are protected against 6kV transients on each voltage range and against 600V on resistance range. The 2A range is protected with a 2A/600V fuse. The 10A range is unfused and can withstand up to 20A for 30 seconds.

Circle (366) on Reply Card

Optical multiplexer

Veda Vision Limited has introduced the Visionary optical multiplexer which transforms tape/slide audio-visual programs into videos. The multiplexer uses a series of mirrors to combine images from as many as nine 35mm slide projectors. The use of mirrors reduces the loss of light and color in the image when it is transferred onto videotape.

The system is based on a series of modular support frames, each of which has three projector stands and an optical system that combines the three images and reflects them onto a central optical system. Images from three, six or nine projectors can be combined. The projected image is focused by a light-gathering field-lens assembly. It is focused in space, which reduces possible distortions from dust on a lens.

The camera-mounting frame is designed to accept most makes or models of video cameras. Each projector stand has x, y and z adjustments and horizontal tilt. The stands bolt together to form a rigid and compact structure.

Circle (367) on Reply Card

Cable reels

Canare Cable has added the RJ series to its line of cable reels. These 8-, 12-, 16- and 24-channel cable reels have parallel male and female XLRs on the reel flange that are permanently connected to multipair cable. A multipin connector on the other end of the cable joins to a junction box with parallel male and female XLRs. The cable reels are constructed of durable tubular steel, feature an E-shaped brace and include permanently lubricated bearings.

All models include a 3-position brake lever. In the locked position, the reel will not rotate. In the soft-brake position, cable can be pulled from the reel, but friction prevents excess spillage when cable is pulled quickly. In the free position, the cable will pull from the reel easily. A winding handle is included. Multichannel reels come with roll-around casters. Reels for single cables are designed to be stackable, so they take minimum storage space; several cables may be pulled at once while the reels are stacked.

Circle (355) on Reply Card

Automatic de-icer/rain diverter control

Environmental Technology has introduced its APS-8 control, enhanced for outdoor mounting to save shelter space. The unit provides independent automatic control of de-icer heaters and rain diverters for C-, Ku- and Ka-band satellite earth-station antennas. It also features the standard CIT-5 sensor with preset operating and lockout temperatures. A CIT-6 sensor with field-adjustable calibrated temperature settings is optional.

The de-icer heaters operate during precipitation if the temperature is between the operating and lockout limits. The rain diverter also operates during precipitation if the temperature is above lockout, as well as during de-icer operation. Programmable hold-on timers of up to one hour in duration ensure removal of any residual snow or moisture. If precipitation falls while the temperature is below lockout, the hold-on timers will be cycled as the temperature rises through lockout.

Circle (354) on Reply Card

Phase checker

Sounder Electronics has introduced the model 500 phase checker. It consists of a pulse generator that provides a wide bandwidth positive-going reference pulse and a polarity detector that determines and displays the polarity of the tested device. The phase checker tests all audio equipment. It is designed to eliminate bass cancellation, phase distortion and loss of acoustic power.

Circle (350) on Reply Card

Continuity mixer

Robert Bosch GmbH, Television Systems Division (Darmstadt), has developed the RMC, a continuity mixer. The RMC can be used by cable and regional TV companies to put complete video and audio program blocks on the air. It also can be used for dubbing and post-production. The application of the mixer can be extended by a chroma-key stage for presentation, by an input stage for caption insertion during post-production or by a complete mixer stage with chroma-key and electronic masking for production and dubbing work. In addition to variable manual or automatic control of program changes, the option of a fully automatic continuity-control facility can be connected.

Circle (356) on Reply Card

PAL-CNR

Faroudja Laboratories has introduced the PAL-CNR with 12dB reduction in the chroma noise measurement and a 20dB improvement in the moire characteristic on the PAL color standard. The device can be used on various VTRs, including the U-matic format.

Specifications include differential gain at below 1.5%, differential phase under 1.5°, a K factor of more than 1% and a bandwidth of 5.5MHz, +0.2dB. The input is 1V into 75Ω and there are three outputs. Primary power is 220V, 50Hz with 100W power consumption. The unit is 21"x17"x6", weighs 40 pounds and can be rack-mounted. Front-panel controls include on/off power switch, noise reduction on/off switch and a 1-inch or ¾-inch tape format selection switch.

Circle (351) on Reply Card

Portable digital storage oscilloscopes

Tektronix has announced the 2230 and 2220 portable digital storage oscilloscopes (DSOs). The 2230 offers a 100MHz equivalent time storage bandwidth and the 2220 offers a 60MHz storage bandwidth. Each DSO doubles as a dual-channel analog oscilloscope with a real time bandwidth matching its random equivalent time storage bandwidth.

The portable DSOs use a 20 megasample/second, 8-bit, 2-step parallel digitizer. This is implemented with state-of-the-art board design for the sample-and-hold circuit to eliminate custom hybrids. The sample continues to run at 10MHz on even the slowest sweep speeds. This peak detection feature, combined with enveloping and internal signal processing, reduces visual aliasing over the entire range of the oscilloscopes.

Other features include 4K waveform record lengths, signal averaging, pre- and post-triggering, roll mode, post-acquisition positioning with expansion and compression capabilities, full bandwidth X-Y storage and plotter output. The 2230 includes triggered sweep delay, on-screen parameter readout, storage-mode cursor measurements and on-screen menu selection of operating options.

Circle (360) on Reply Card

Digital oscilloscope

Tektronix has announced the 2430 portable oscilloscope, an all-purpose scope with 150MHz equivalent time bandwidth and 100 megasample/second digitizing rate. The scope also features simultaneous acquisition of two channels with 1K record length, 8-bit vertical resolution and enhanced glitch captures. Application areas include analog and digital design and troubleshooting; waveform characterization in research; and automatic test and measurement in manufacturing.

The oscilloscope has the capability to view complex wideband analog or digital signals and to capture, digitize and store fast single-shot analog signals. It is fully programmable via the GPIB and is capable of extensive on-screen parametric measurements of voltage and time.

Circle (359) on Reply Card

Stereo LED meters

Radio Systems has released a series of stereo LED meters. The 3-color high-definition meters are switchable for peak or VU indication and have peak-hold segments. The meters are packaged for stand-alone use or for 1-, 2-, 3- and 5-meter rack-mount assemblies. All meters are equipped with integral power supply and balanced audio input stages.

Circle (353) on Reply Card

Ad index

Advertiser	Page Number	Reader Service Number	Hotline
A.F. Associates	28	103	201/767-1000
ADM Technology, Inc.	IFC	1	313/524-2100
ADM Technology, Inc.	53	31	313/524-2100
Agfa-Gevaert Inc.	31	17	201/288-4100
Alpha Audio	133	80	804/358-3852
Ampex Corp. (AVSD)	37	20	415/367-2911
Ampex Corp. (AVSD)	39	21	415/367-2911
Ampex Corp. (MTD)	40-41	122	415/367-3809
Anton/Bauer Inc.	101	58	203/929-1100
Arrakis Systems, Inc.	35	19	303/224-2248
Asaca/Shibasoku Corp. America	147	95	800/423-6347
Audio-Technologies Inc.	112	67	215/443-0330
Audio-Video Engineering Co.	128	87	516/546-4239
Belar Electronic Labs	134	84	215/687-5550
Benchmark Media Systems	132	78	315/452-0400
Broadcast Video Systems Ltd.	134	63	416/497-1020
BSM Broadcast Systems Inc.	70	42	509/448-0697
C.O.A.R.C.	142	91	518/672-7202
Calvert Electronics Inc.	135	98	800/525-6362
Canon USA Inc., Broadcast Lens	105	62	516/488-6700
Centro Corp.	71	43	619/560-1578
Circuit Research Labs, Inc.	13	10	800/535-7648
Clear-Com Intercom Systems	120	72	415/861-6666
Comark	3	5	215/822-0777
Comsat General Corporation	113	68	202/863-7326
Continental Electronics Mfg. Co.	143	92	214/381-7161
Crosspoint Latch Corp.	136	102	201/688-1510
Datatek, Inc.	79	121	201/654-8100
Delta Electronics	80	48	703/354-3350
EEV, Inc.	109	65	914/592-6050
Eastman Kodak Co.	56-57	34	212/930-750000
Fluke Mfg. Co., Inc.	69	41	206/356-5400
Fortel Inc.	49	29	404/449-4343
Furman Sound	122	75	415/927-1225
Garner Industries	146	97	800/228-0275
Gentner Engineering Co., Inc.	130	81	801/268-1177
Grass Valley Group, Inc.	9	8	916/273-8421
Hannay Reels	114	69	518/797-3791
Harris Corp.	52	26	217/222-8200
Hewlett Packard	65	39	
Hnat Hines Inc.	142	105	203/935-9066
Ikegami Electronics Inc.	133	108	201/368-9171
Ikegami Electronics Inc.	59	107	201/368-9171
International Tapetronics Corp/3M	50-51	30	800/447-0414
JBL Inc.	45	23	818/893-8411
JVC Company of America	21	14	800/582-5825
K & H Productions, Ltd.	148	100	802/442-9118
Karl Heitz Inc.	48	28	718/565-0004
Larcan Communications	104	61	416/245-9970
LEA Dynatech Inc.	98	56	213/944-0916
Leader Instruments Corp.	5	6,7	800/645-5104
Leitch Video Ltd.	47	27	804/424-7290
Lenco Electronics	11	9	314/243-3147
Lerro Electrical Corp.	25		215/223-8200
Lines Video Systems	151	82	800/641-4674
MCG Electronics, Inc.	30	38	516/586-5125
3M	81-88	50	800/792-1072
3M Broadcast & Related Products	103	60	800/792-1072
Maxell Corp. of America	127	110	201/440-8020
MCL, Inc.	94	53	312/354-4350
Microtime, Inc.	97	55	203/242-4242
Microwave Filter Co., Inc.	148	99	315/437-3953
Midwest Communications Corp.	1	4	800/543-1584
Moseley Associates Inc.	7	106	805/968-9621
National Video Service	102	59	415/846-1500
NEC America Inc.	111	66	800/323-6656
NEC America Inc.	149	101	800/323-6656
NEC America Inc.	95	54	800/323-6656
Opamp Labs Inc.	150	112	213/934-3566
Orban Associates Inc.	36	24	800/227-4498
Orban Associates Inc.	17	12	800/227-4498
Otari Corp.	15	11	415/592-8311
P.T.S.I.	121	74	201/529-1550
Pacific Recorders and Engineering	63		619/438-3911
Pag America, Ltd.	143	116	704/274-1438
Panasonic	18-19	13	201/348-7336
Panasonic	27	15	201/348-7336
Panasonic	29	16	201/348-7336
Plastic Capacitors, Inc.	141	88	312/489-2229
Polyline Corp.	142	90	312/297-0955
Potomac Instruments	123	76	301/589-2662
QEI	129	120	609/728-2020
RTS Systems, Inc.	60	36	818/843-7022
Ruslang Corp.	134	85	203/384-1266
Schwem Technologies	119	73	415/935-1226
Sennheiser Electronic Corp.	123	77	212/944-9440
Sescom, Inc.	134	114	800/634-3457
Sharp Electronics Corp.	93	52	201/265-5548
Shure Brothers Inc.	55	33	312/866-2553
Sitler's Inc.	150	111	800/272-6459
Solid-State Logic	73		212/315-1111
Solid-State Logic	75		212/315-1111
Solid-State Logic	77		212/315-1111
Sony Corp. of America (A/V & Pro Aud)	117	71	
Sony Corp. of America (A/V & Pro Aud)	66-67	40	
Sony Corp. of America (Broadcast)	106-107		
Standard Tape Laboratory, Inc.	134	115	415/786-3546
Stanton Magnetics	126	109	212/445-0063
Studer Revox America Inc.	131	35	615/254-5651
Studio Technologies Inc.	54	32	312/676-9177
Surcom Associates Inc.	150	93	619/722-6162
TTC/Wilkinson	125	94	303/465-4141
Tascam division TEAC Corp. of America	99	57	213/726-0303
Tektronix Inc.	43	25	800/452-1877
Universal Elecon	128	86	818/846-6220
Varian	33	18	415/592-1221
Veam Div. Litton Systems, Inc.	115	70	203/274-9681
Videotek, Inc.	110	64	602/997-7523
Videotek, Inc.	72	45	602/997-7523
Ward-Beck Systems Ltd.	BC	3	416/438-6550
Wheatstone Broadcast Group	IBC	2	203/393-0887
Winsted Corp.	141	89	800/328-2962
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Zellan Optics Ltd.	150	104	213-483-8151

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WANTED TO BUY

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HELP WANTED

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TV STUDIO ENGINEER—Production facility needs engineer with experience in installation, operation, and maintenance of HL-79, BVU-110, ¾" VCR, Chyron RGU-1&2, CMX Edge, VPR-2&80, Grass Valley 1600-3F. Electronics degree or appropriate broadcast experience. FCC license desirable. Excellent benefit package. EOE/AA. Send resume to: Director, Telecommunications, Utah State University, Logan, Utah 84322-8500. 11-85-2t

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FIELD ENGINEER: Studioline Cable Stereo, a rapidly growing premium (pay) audio supplier, is looking for a highly motivated individual for the position of field engineer. This person will survey requirements and install proper equipment for our new CATV affiliates and maintain ongoing technical assistance to our established clients across the nation. Position requires a significant amount of travel. Must have heavy experience with all phases of CATV head-end, AML, and mocrowave equipment plus an interest in ultra high quality audio. Two year electronics degree or equivalent is required. In addition to a highly competitive salary/benefits package, we offer to share our scenic community of Reston, Virginia, which offers nature and bicycle trails, health and athletic facilities, outdoor and indoor activities, and easy access to the cultural advantages of Washington, D.C. Send resume including salary history to: Studioline Cable Stereo, 11490 Commerce Park Drive, Reston, Virginia 22091, Attn: Director of Engineering. 11-85-1t

MAINTENANCE ENGINEER for N.Y.C. post-production company. Must have 3-5 years experience in maintaining Sony 1", GVG switcher, Quantel, CMX, Sony ¾", RCA 2" quads and other related equipment. Experience in systems design helpful. Salary commensurate with experience. Video 44, 219 East 44th St., New York, N.Y. 10017 212/661-2727. 2-85-tfn

MAINTENANCE ENGINEER—New independent station with all new equipment; AMPEX videotape, GRASS VALLEY switching, IKEGAMI camera, RCA film, HARRIS RF. Experience in broadcast equipment maintenance and broadcast system construction necessary. Send resumé to Ted Szypulski, Director of Engineering, WTIC-TV, One Corporate Center, Hartford, CT 06103. 9-85-6t

HELP WANTED (CONT.)

ENGINEER FOR TV AND RADIO operation. Five years minimum in maintenance of FM and TV transmitters and studio equipment. Will be chief of FM. Also needed is engineer for location shooting of network production and in-house editing. Experience with Ikegami cameras, Sony 500A VTR, and Ampex VPR-2's, a plus. Send resume to Chief Engineer, Box 416, Corpus Christi, TX 78403-0416. 10-85-2t

WANTED: Chief Engineer for KQIZ AM/FM Amarillo, Texas. Class C FM/Daytime FM. Good Facility, Money, and City. Must be strong on FCC Rules, and Preventative Maintenance. Rush Resume to: D. Alexander, GM, KQIZ, P.O. Box 7488, Amarillo, Texas 79114. E.O.E. 11-85-1t

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CHIEF ENGINEER, Denver Metro Area. Post-production facility needs chief engineer with management/hands on experience. Ampex, Rank Cintel equipment. Salary neg. Resumes to: Wicker-Works Video Productions, 7342 S. Alton Way, Ste. A, Englewood, Colorado 80112, Attn.: T. M. Wickre. 11-85-1t

TV MAINTENANCE ENGINEER: 30 year VHF NBC affiliate seeking maintenance engineer to assist in maintaining studio and transmitter equipment. Harris transmitters, RCA 2-inch, Ampex 1-inch, Sony ¾-inch, Vidifont Graphics V, Collins Doppler radar, Vital switcher. Five years practical experience necessary. Must be able to work unsupervised. Send resume to Bill Holt, CE, KALB-TV, 605-11 Washington St., Alexandria, La. 71301. Phone 318-445-2456. EOE. 11-8-5-1t

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RADIO – CHIEF ENGINEER: Fetzer Broadcasting Service, group owner of two AM and two FM stations in West Michigan, seeking Chief Engineer. Hands-on person with audio and AM directional background desired. Limited travel. Salary plus excellent benefits. Send resume to: Stanton C. Smart, V.P., Fetzer Broadcasting Service, 590 W. Maple, Kalamazoo, MI 49008. We are an EOE. 11-85-1t

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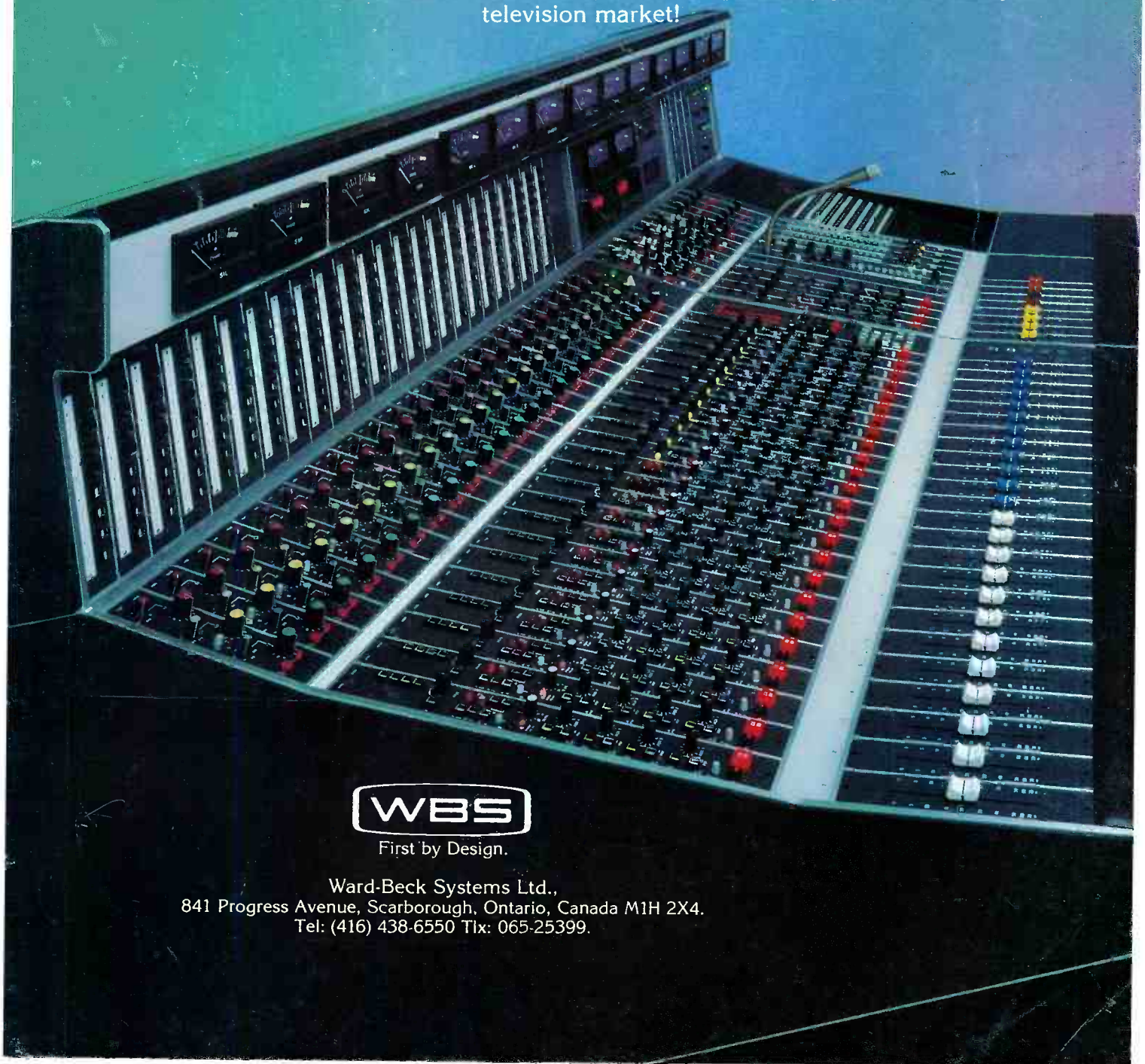

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