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AN INTERTEC PUBLICATION

May 1990/$4.50

RF transmissions systems special issue

Planning a security system p. 70

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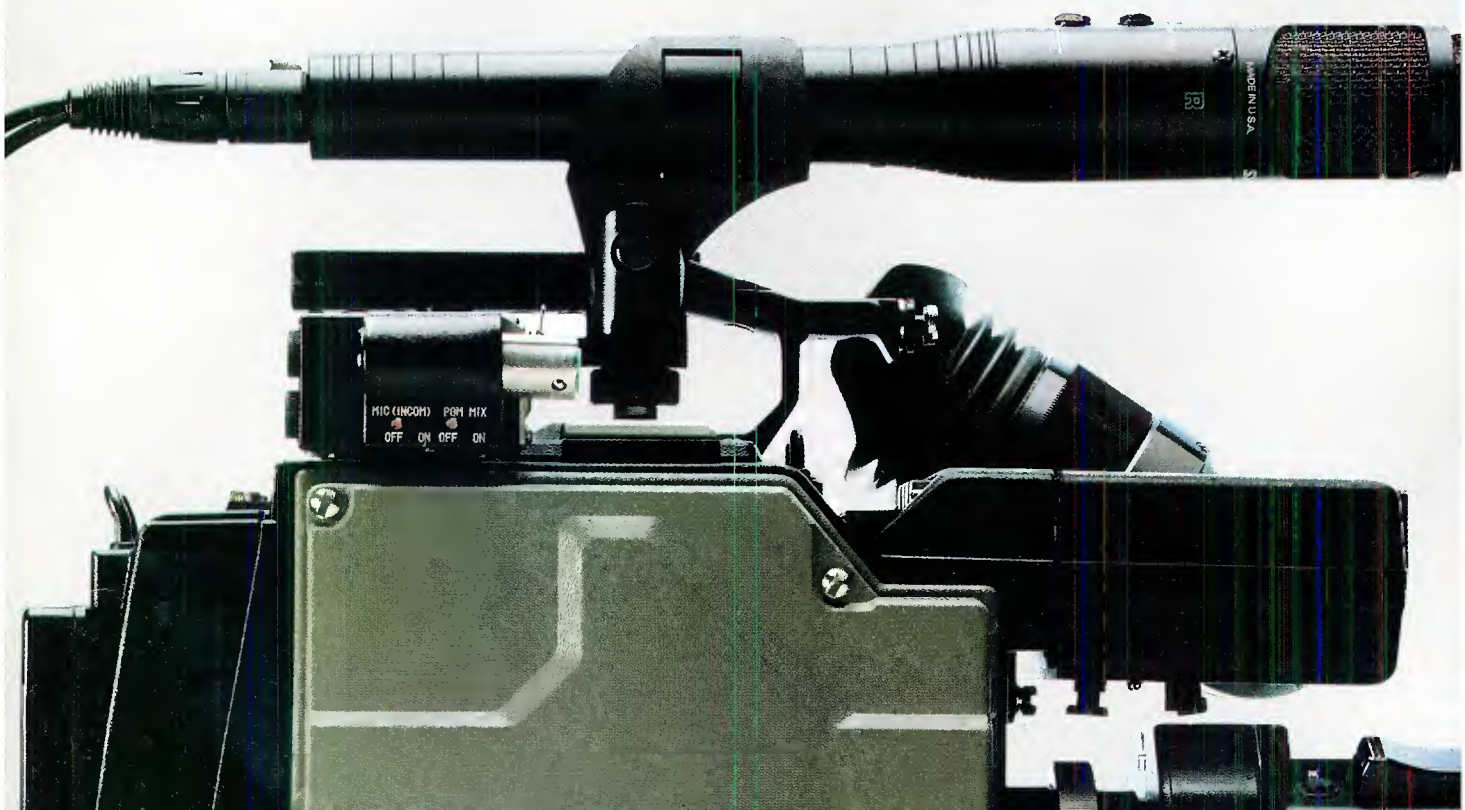

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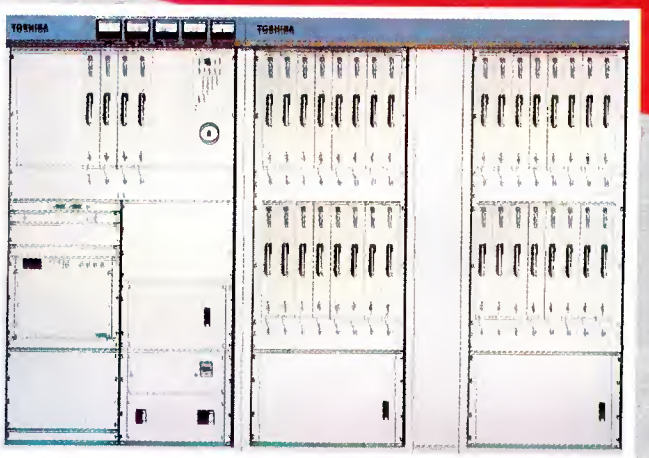

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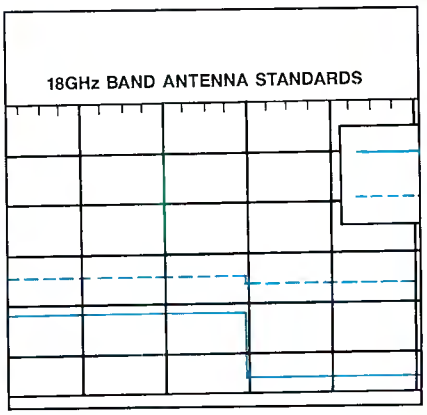

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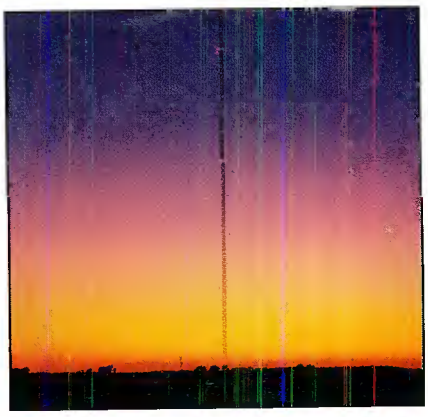

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RF TRANSMISSIONS SYSTEMS SPECIAL ISSUE:

The transmission plant of a radio or TV station is the critical link in the broadcast chain. Without a reliable system, the station cannot effectively compete in the marketplace. With the increased sophistication of equipment today, it is becoming more difficult for engineers and technical managers to keep up with the state of the RF art. This month, we take a detailed look inside the RF equipment that makes transmission of radio and TV programs possible.

DEPARTMENTS

FEATURES:

ON THE COVER

The best audio and video systems are useless in a broadcast environment if the RF link doesn't work. Fortunately, today's tube and solid-state transmission systems are more efficient and reliable than ever before. (Cover credits: Solid-state RF amplifier modules supplied by Harris/Allied, design by MediaScan.)

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News

First Varian VISTA transmitter on air

The first of Varian TVT division's energy-efficient VISTA series of UHF-TV transmitters went on air March 2 at KVDA Channel 60, San Antonio. Early results indicate an electrical consumption of 147kW for the 120kW station, half of what would be expected with a conventional transmitter.

Network frequency coordination

The upcoming economic summit July 9-11, at Rice University, George R. Brown Convention Center, Houston, requires frequency coordination. To coordinate frequencies for this event, please contact any of the following numbers:

1. 2-way, 713-438-3838 (Bill Cordell).
2. TV auxiliary, 713-974-4848 (Blane Huhn or John Harvey).
3. SBE BBS, 713-974-3912 (Frequency Coordinator Conference).

Agreement for private investment in TTC

At the NAB convention in Atlanta, an agreement for a major private placement investment in TTC was announced. The investor group, The Partnership, is led by Dirk Freeman, who has assumed the presidency of TTC from Byron St. Clair, the founder of TTC. St. Clair will remain active in the company as chairman.

Order of the Iron Test Pattern to be revived

The recently inactive Order of the Iron Test Pattern will be revived in 1990 as an independent non-profit organization, according to E.G. Gramman, chairman and CEO of Dynair Electronics, San Diego.

Robert N. Vendeland, marshal of the order, who retired from Dynair in 1987, is presently organizing industry support to continue the association as an independent entity.

The order was started by Dynair in 1979 and has honored more than 2,400 members in 23 countries by presenting them with membership certificates that document technical service in television. Officer appointments are made after 15 years of service, and commander ranks are earned after 25 years of service. Approximately half of the members are commanders.

A committee is being formed to arrange for incorporation, financial support and the formal transfer of the association from Dynair to the new corporation.

World Telecommunications call for papers

A limited number of papers will be accepted for presentation at the Technical

Continued on page 97

BROADCAST ENGINEERING

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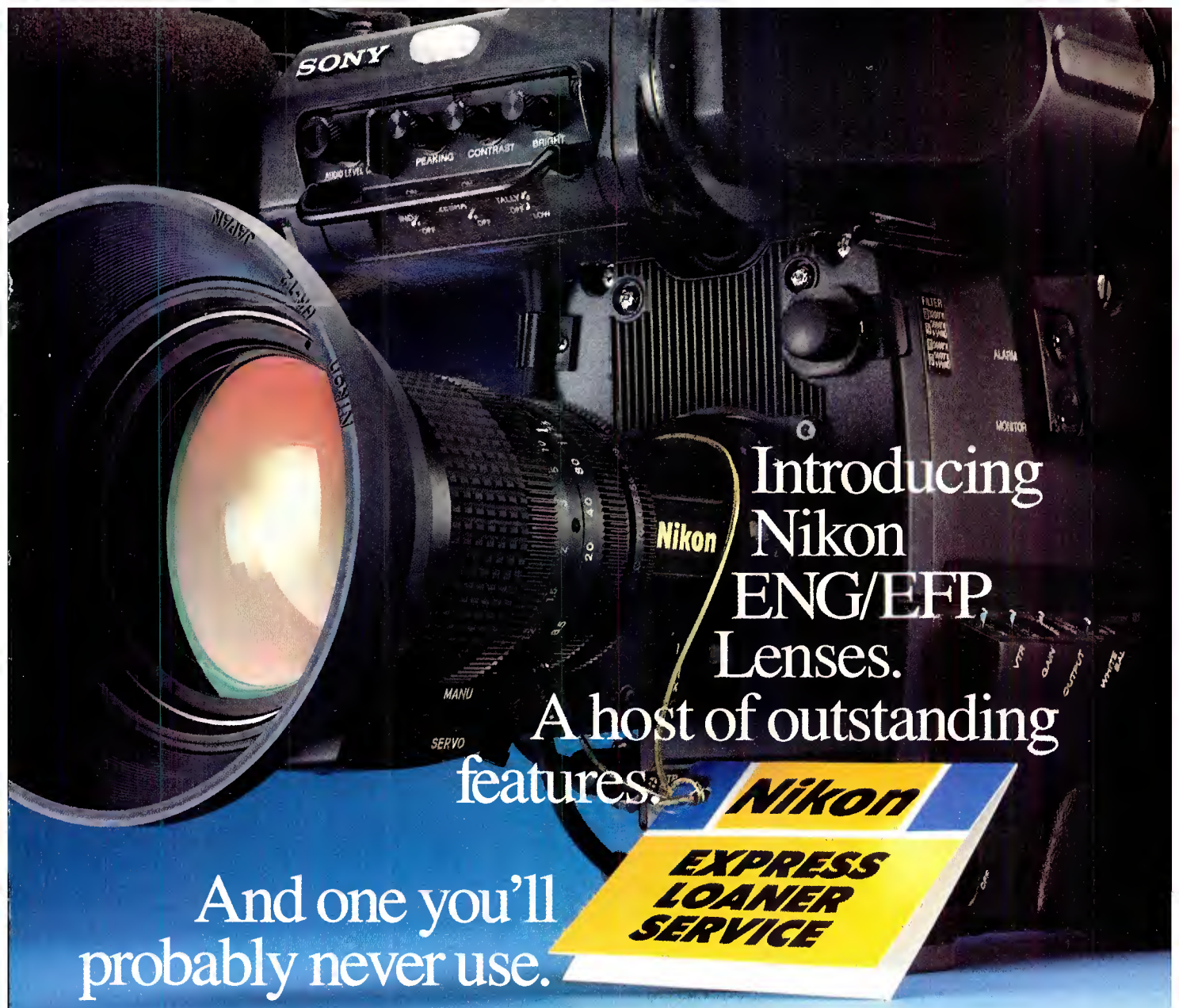

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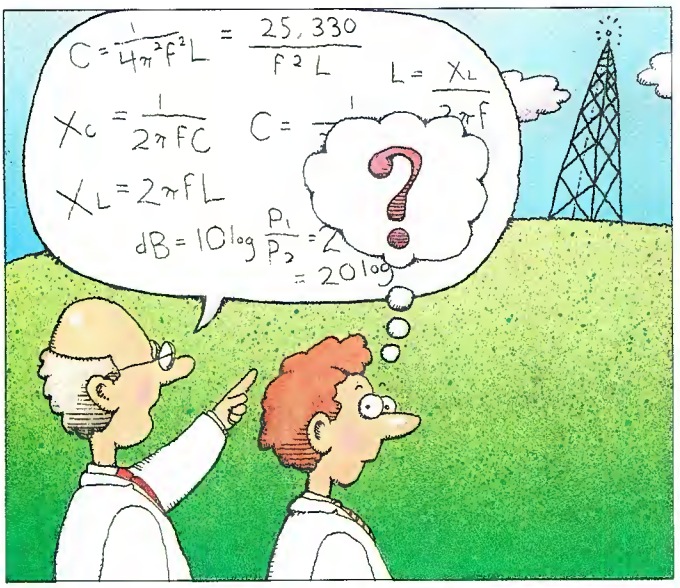
The RF mystique

A guest editorial

I've spent most of the past 20 years maintaining many different types of transmitters. I've been chief operator and director of engineering for radio and TV stations for the past 15 years. I find the work so fascinating that I've passed up several higher-paying career opportunities just so I could remain in my element of transmitters, antennas and various other analog disciplines.

One of the frustrating aspects of my work, however, has been the fruitless attempt to find competent help. I believe that a discouraging trend is developing. Allow me to state my case in blunt terms: Most of today's electronics technicians don't know a transmitter from a toaster!



The problem is not limited to the so-called license mill graduates. Some of the BSEE graduates who have applied for broadcasting jobs never have had a single class in RF transmission theory.

In an attempt to get to the root of the problem, I called several electronics correspondence schools and asked about their lack of courses specializing in high-power radio transmission techniques. The general response was that there was "no need" for such courses.

This reply shows clearly how out of touch our educational systems really are. All you have to do is spend a minute tuning to various radio bands to discover there are more high-power radio transmitters on the air now than ever before.

The correspondence schools haven't supplied the type of graduates needed because we broadcast engineers haven't demanded that they do so. Our apathy has allowed the mystique of radio to disappear from the public consciousness.

To be fair, I must say I have experienced a few surprises. One recent trade school graduate learned the RF theory with incredible ease, even though it was all new to him. When he had completed my in-house training course, he exclaimed in utter astonishment, "Why didn't anyone ever tell me that radio was so much fun?" Why not, indeed? By asking that question, my young friend had unwittingly supplied the answer.

We have only ourselves to blame for the demise of our profession. Broadcast engineers have done a lousy job of public relations. We have been conspicuously absent from high school and college career guidance programs. In fact, broadcast engineering seldom is represented in the usual places where employers go to display their trades.

Is this trend reversible? I think so. Anyone who has experienced the thrill of working with RF technology will more than likely love it. But we must allow others the experience.

We all enjoy the security of having a rare and valuable skill, but there's no need to feel threatened by the next generation. Go ahead and part with a little of that knowledge. Teach a young person what you know about that RF mystique. Perpetuate your trade. You, the aspiring engineer and the entire industry will be better off.

Eric P. Nichols

Eric Nichols,
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Clarifying the role of FM translators

By Harry C. Martin

In late March, the FCC issued a notice of proposed rulemaking in which it put forth a number of proposals for restructuring its FM translator rules. The principal proposals are as follows:

• FM translators will be classified as either *"fill-in"* facilities or those facilities providing service to *"other areas."* Fill-in facilities will be limited to 1kW ERP, with the additional restriction that the translator's predicted 1mV/m contour may not exceed the protected service contour of the primary station. This type of translator may be owned and operated by the licensee of the primary station. FM translators providing service to other areas also will be limited to 1kW ERP, subject to the further restriction that the distance to the translator's predicted 1mV/m contour may not exceed 16kM. Other area translators may be owned only by independent parties, and a primary station is prohibited from providing financial support to any such facility, either before or after it commences operation.

• Microwave delivery of signals to FM translators would be permitted only for those providing a fill-in service, and no satellite delivery of programs to commercial FM translators would be permitted.

• FM translators will be allowed to operate on all 80 non-reserved channels, and specific criteria will be developed for determining predicted and actual interference.

• The ban on AM rebroadcasts over FM translators would be retained.

• The commission will continue the freeze on the acceptance of applications for new commercial FM translators or major changes to existing ones until 60 days after the effective date of any new rules adopted in the proceeding. This freeze does not apply to applications for NCE-FM translators operating on the lower-20 reserved channels.

The commission set June 15 as the date for comments on its proposals and July 16 as the date for replies.

Martin is a partner with the legal firm of Reddy, Begley & Martin, Washington, DC.

Chairman Sikes' views on FCC's role in the '90s

In a speech delivered April 3 at the NAB Convention in Atlanta, FCC chairman Al Sikes outlined a 4-point program that will guide the agency's regulation of broadcasting during his administration.

First, he wants to strengthen broadcasters' ability to "fully and fairly" compete in today's rapidly changing media environment. He said the need for Congress to eliminate cable's compulsory copyright license is a priority. He affirmed his commitment to the adoption of an HDTV standard by early 1993 so existing TV broadcasters will have a fair opportunity to participate in this technology.

However, Sikes' major points about the commission's role in improving the media marketplace were directed to radio. He cited the commission's initiative in the FM translator area (outlined previously) and its effort to restore the technical integrity of the AM broadcast service as examples of the commission's recognition that improving the quality of existing radio service is a better way to promote competition than by creating more new, but substandard stations. Sikes also said streamlining the commission's processing procedures has reduced application backlogs, thereby speeding improvements in existing radio services.

Sikes' second policy goal is to expand individual opportunity in broadcasting. In this connection, he said the commission will continue to aggressively pursue its policies favoring equal employment opportunity. He also pointed out the need for more industry initiatives such as BROADCAP, an industry-funded venture capital company that helps minorities become station owners.

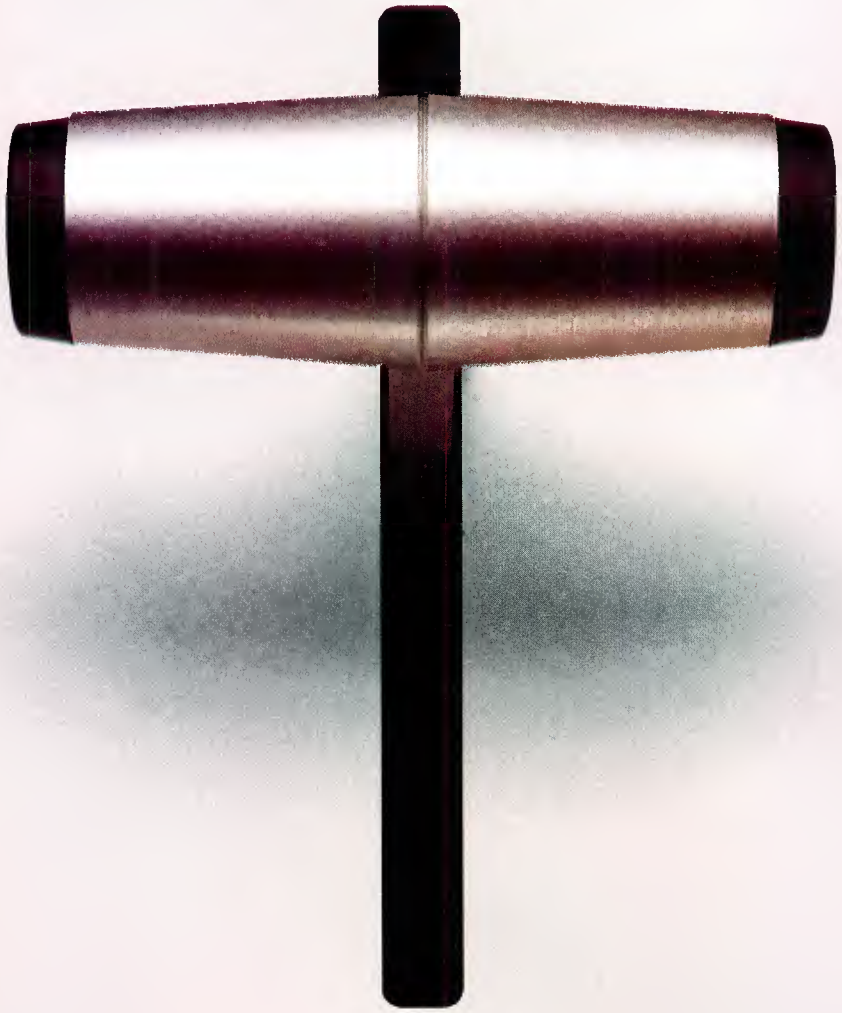
Sikes' third initiative is to promote and encourage broadcast excellence. Pointing to how years of "regulatory neglect" contributed to the deterioration of AM, he said the commission should do its best to afford both radio and TV broadcasters the opportunity to capitalize on the better video and audio quality that supportive commission regulations can foster, particularly in the AM and HDTV areas. With regard to AM, Sikes intimated that new audio-processing standards, requirements for improved receiver capability and standards for AM stereo may be in the offing.

Sikes emphasized the need to maintain an industry consensus that the marketplace serve as a more effective regulatory tool than government-imposed constraints. Of particular concern to him is the need for a voluntary industry code dealing with violence and indecency in programming. Sikes indicated the commission's reluctance to enter into these areas, which, he said, would be more appropriately handled through industry self-regulation.

AM Radio	*4,977*
FM Radio	*4,273*
FM Educational	*1,424*
TOTAL	*10,674*
UHF Commercial TV	*550*
VHF Commercial TV	*549*
UHF Educational TV	*224*
VHF Educational TV	*123*
TOTAL	*1,446*
FM Translators and boosters	*1,815*
UHF Translators	*2,205*
VHF Translators	*2,722*
TOTAL	*6,742*
UHF Low-Power TV	*490*
VHF Low-Power TV	*159*
TOTAL	*649*

Table 1. *The commission has announced the following totals for broadcast stations licensed as of Feb. 28, 1990.*

Comfort.



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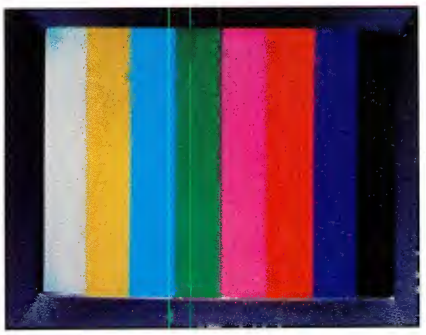


Hawaiian pattern is for the birds

By Rick Lehtinen,
TV technical editor

King Broadcasting operates seven full-service TV stations. The newest one is KOGG Channel 15 in Mailuku, Maui, a satellite station for KHNL, Honolulu. KOGG went on-air one year ago and serves 83,000 viewers in its transmission area, which covers portions of the islands of Hawaii, Maui, Molokai, Lanai and Oahu.

The antenna site is located near the top of the 10,000-foot Mount Haleakala on the island of Maui. It was the natural choice because it is the highest point on the island, but the location presented challenges.

The state of Hawaii identified one site as being too close to the nesting area of the nocturnal dark-rumped petrel, a protected bird species. The state told KOGG that it could not interfere with the flight patterns of the birds.

When an approved site was found, it was located one mile from an astronomical observatory complex, known as "Science City," operated by the University of Hawaii. The observatory also is used by the University of Wisconsin and the U.S. Air Force.

Astronomical observatories can be sensitive to RF frequencies, which means the station had to be careful with its antenna pattern. Approval of the selected site was on the basis that KOGG would not cause interference to operations at the observatory.

Another concern was severe and unpredictable weather conditions at the 10,000-foot site. The weather can change from warm sunshine to driving wind and rain within a few moments. Storm winds can reach 150 mph.

Conquering Mount Haleakala

The transmitter shelter building for KOGG is a 12′ × 24′ precast concrete preassembled structure. The $48,000 structure was built in Texas and trucked on a special flatbed trailer to Oakland, CA, where it was loaded into a freighter bound for Honolulu. It then was barged to Wailuku, Maui and trucked over the winding Haleakala highway from sea level to the 10,000-foot summit. A crane lifted the building onto an elevated concrete support, which is a foundation specially designed for the site's soft volcanic soil.

KOGG's antenna is a horizontally polarized, 16-bay, dipole array, twin-lobe design, with a package designed to make it impervious to the hazardous environment. The antenna provides a modified peanut-shaped pattern, with a beam tilt of −2° provided to serve populated areas near sea level.

The KOGG transmitter operates at 15kW, with an effective radiated power of 759kW. To reduce the signal in the direction of the observatory, the antenna contains a choke, a metal shield that suppresses signal radiation toward the observatory by 43dB-45dB. Repeated testing and actual operation have demonstrated no interference.

The hazardous environment package includes a support pipe of hot-dipped galvanized steel, a stainless steel and copper power distribution system and feedlines that are pressure-tight up to the gas barrier near the radiating points. The hardware is stainless steel.

According to Ken Hermanson, vice president and chief engineer of King Broadcasting, the antenna has satisfied the demands of the state of Hawaii, the observatory, the mountain and the shape of the Hawaiian Islands, as well as those of the dark-rumped petrel.

Acknowledgment: We wish to thank Ken Hermanson, King Broadcasting, Seattle, and Martin Wank, Wank Associates, Greenvale, NY, for assistance in the preparation of this article.

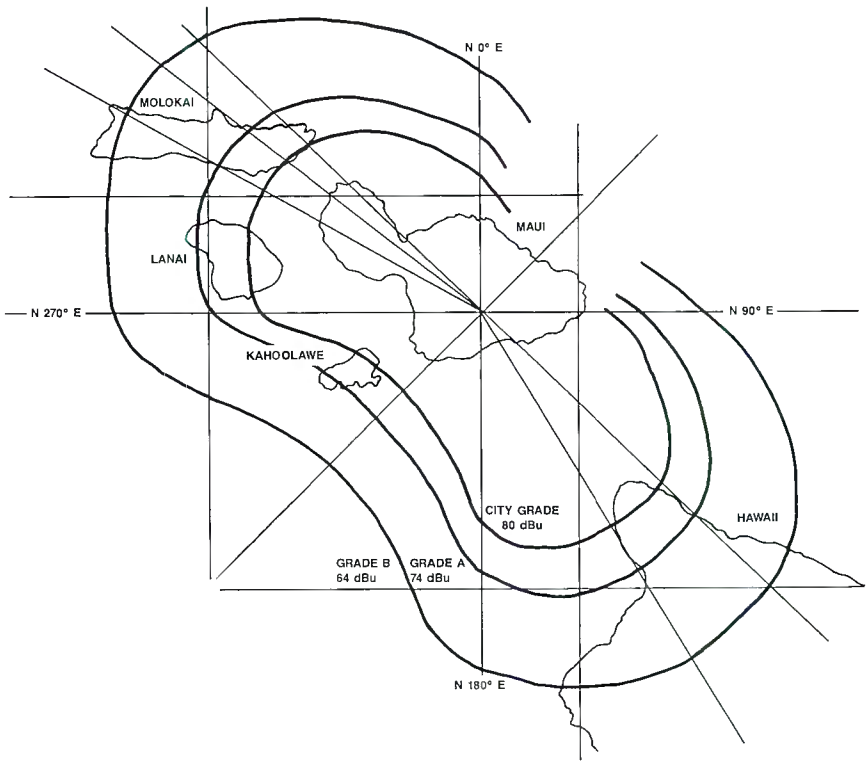
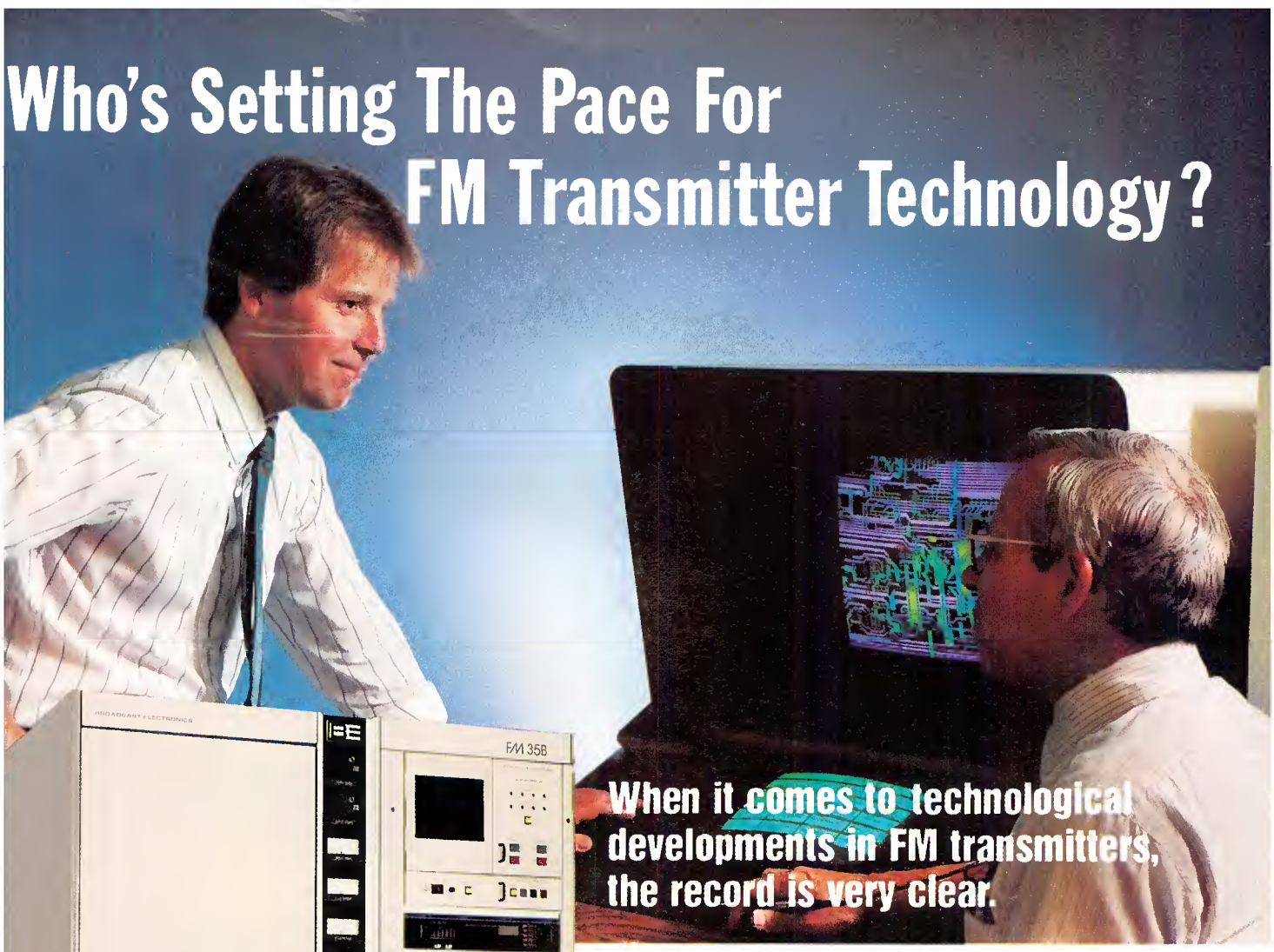


Figure 1. Contour map of KOGG-TV, Channel 15, Hawaii. The station had to site its transmitter so as to protect a nearby observatory and the nesting ground of the dark-rumped petrel, a protected species of bird.

Who's Setting The Pace For FM Transmitter Technology?



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- Folded Half-wave Output Cavity, patented 1982.
  Internal Second Harmonic Suppressor, patented 1982.
- Broadband Input Impedance Matching Circuit, patented 1985.

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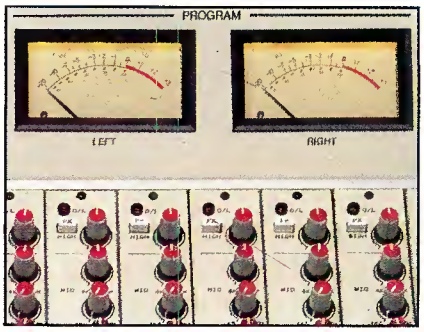


Install your NRSC-1 now

By John Battison, P.E.

By the time you read this, NRSC-1 will be a *fait accompli*. If your station is not using it, you could be headed for trouble. You must install an NRSC-1-compliant processor by June 30 of this year, because you need a device that will limit the occupied bandwidth to 20kHz. It is possible to construct one that meets the requirements of the average radio station, but time is a major factor. Your best bet is to purchase a modification kit, if your station's processing equipment manufacturer makes one.

NAB has an information packet with the FCC's NRSC-1 requirements and a list of manufacturers who sell retrofit kits to bring some audio processors up to date. At least one company offers a series of inexpensive modules that can be installed in your audio chain to bring your station into NRSC-1 compliance.

The NRSC-1 filters provide a 75μs preemphasis prior to any processing. The signal then is passed through a sharp 10kHz low-pass filter. The filter is inserted before the modulator stage.

Improved signals

Approximately 1,200 AM stations already have installed NRSC-1 processors. The results have been quite surprising in many cases. Despite some engineers' doubts about limiting the high-frequency output of the transmitter, listeners seem to like the added crispness. Stations have reported an increase in apparent loudness and reception in areas previously not covered. This probably is due to decreased adjacent-channel interference.

Nevertheless, those AM stations that have prided themselves on wide bandwidth signals will have to cut back. Some stations have taken advantage of the previously allowed 30kHz bandwidth. Without nearby first-adjacent channel stations, these broadcasters have provided hi-fi service far past these new limits. Some stations with adjacent stations only 40kHz away who used to splatter over will have to watch themselves carefully.

Use of NRSC-1 will not require much change in the method of operation. Transmitters should be properly maintained and not overmodulated. Of course, if additional transmitter clipping is used to obtain additional loudness, the benefits of NRSC-1 will be lost.

If NRSC-1 is installed and operated properly, stations will be assumed to be operating in compliance with the new, more stringent Rule 73.44. Unless FCC inspectors uncover out-of-tolerance operation, or competitors complain, a properly installed and operating NRSC-1 system will be assumed to ensure that the station is complying with the rules. However, it still will be necessary to make a harmonic check every year to ensure that out-of-band harmonics are not being produced.

Big Brother and 1994

Beginning June 30, 1994, all AM stations must be able to prove compliance with the rules. No other changes are anticipated in the bandwidth or transmission standards. The rules for NRSC-2 will spell out exactly what has to be measured and how to do it. This means that most stations either will have to purchase instrumentation capable of demonstrating compliance or have such measurements made on a regular basis.

Until June 1994, the commission will accept the premise that installation and proper operation of NRSC-1 satisfy Rule 73.44. If out-of-tolerance operation is suspected, the spectrum analyzer will have the deciding vote. The splatter monitor that currently is available should satisfy most monitoring requirements. In case of dispute, the spectrum analyzer has the last word. The NRSC-2 standards set the requirements for measuring the RF mask and transmitter RF performance, including occupied bandwidth *under program conditions*, pulsed noise and stereo conditions.

If events follow their usual pattern, most stations will not want to spend money on something that does not contribute directly to increased coverage or improved signal loudness. Demand should be good for contract engineers who possess either splatter monitors or spectrum analyzers. By the time the rule becomes effective, lower-priced portable spectrum analyzers should be on the market to meet the demand.

More thoughts on NRSC-1

The objective of NRSC-1 is to alleviate the adjacent-channel interference that is present with the now-specified 30kHz bandwidth. Although the average radio receiver cannot pass the higher audio frequencies, its presence creates the "monkey chatter" and harmonics that still can be heard in the narrow passband of the poor-quality receivers.

Remember, NRSC-1 alone will not remove the interference problems in the AM band. Program directors still will demand the loudest signal and will crank up the compression when the CE is not around. Also, the clever engineer can easily modify NRSC-1 equipment to bypass the bandwidth limits and the degree of limiting.

FCC monitoring is expected to become stricter after June 30. With the expanded range of FCC fines, a few stations may be hit with an unexpectedly heavy assessment for NRSC-1 violations. No station wants to be fined; however, if the stations that continually abuse FCC rules become examples, the rest of us may be encouraged to follow the rules. If the ringleaders in overmodulation and compressions continue to get away with it, then NRSC-1 may not be AM's salvation. It could signal the finish for AM.

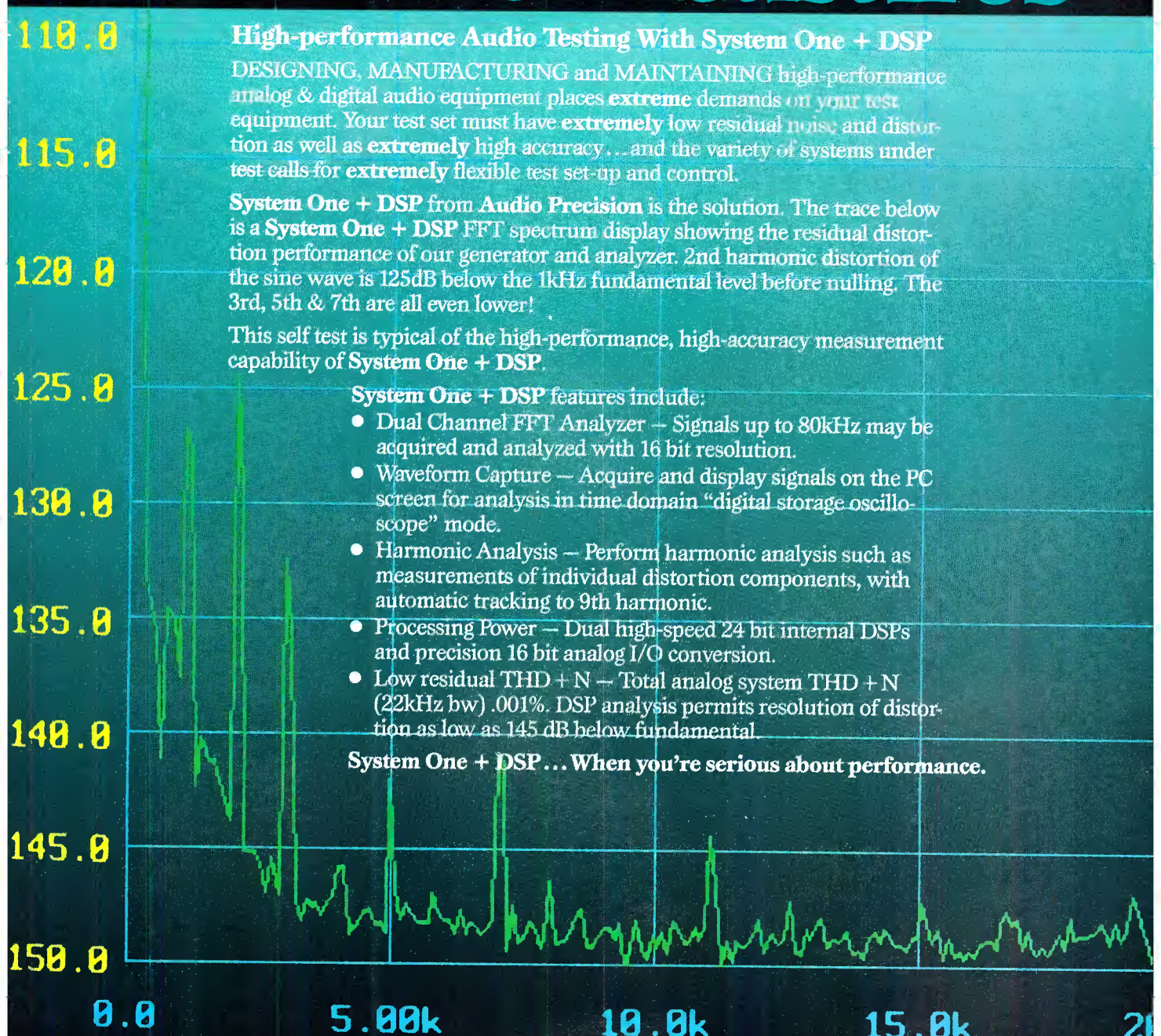
Engineers must make sure their stations follow the rules, or we might see the FCC putting the blame on the engineer for technical violations. The commission has the power to do this, and warnings have been given many times. If we do not educate station owners, Big Brother's foot may come down where it hurts.

Where are the receivers?

Now that broadcasters have taken positive steps to improve transmission, radio receiver manufacturers should do their part to follow through on NAB's development of a radio that makes the best of our new signals. The next step should be continuous tuning for all radio receivers so no sharp discontinuity occurs when going from AM to FM, or FM to AM.

Battison, BE's consultant on antennas and radiation, owns John H. Battison and Associates, a consulting engineering company in Loudonville, near Columbus, OH.

Extreme Measures



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Uncommon engineers

Lew Wetzel

By Elmer Smalling III

As a schoolboy, Lew Wetzel was fascinated with radio. He listened regularly to everything from standard broadcast through short wave. "I would follow the United Airlines flights from Chicago to Newark, night after night," he said. "Their route took them right over our home in central Pennsylvania. I would listen to them report in over Bellefont, wait five minutes, then go out the front door to watch them pass over, go back in and one minute later, hear them report in over Sunbury, PA." This early interest in all types of radio listening whetted his appetite for a career in engineering.

Wetzel was born in Beaver Springs, PA, in 1924. He attended Lehigh University and earned a degree in electrical engineering in 1947. He went to work as a power engineer for the Pennsylvania Power and Light Sunbury plant, not far from his home.

In the late '40s, his cousin introduced him to ham radio. Because it was during the height of the sunspot cycle, they could keep in touch with friends in various parts of the world. Every weekend, weather permitting, they built or modified antennas for 10 and 20 meters. Antenna design became Wetzel's first engineering love.

With the Korean War beginning, Wetzel went to work for the military at Picatinny Arsenal in New Jersey. There, he designed electronic fusing for ammunition. In 1951, he returned to Lehigh University to augment his electrical engineering education.

New directions, new technology

In 1953, Wetzel began what would become a long and distinguished career in broadcasting when he joined RCA in Camden, NJ. His first assignment put him just where he wanted to be — in the UHF antenna design group. It was here that Wetzel met Ed Shively, who was to become a lifelong friend. The group worked on early UHF antennas, especially the UHF slot antenna, which Shively had invented. Wetzel, who had no fear of heights, was assigned to the final assembly, impedance matching and pattern shaping for the antennas. He and Shively formed a special team with Woody Darling (a VHF antenna designer and the father of the traveling-wave antenna). This team would design and develop the RCA antenna test facility at Gibbsboro, NJ. From 1954 to 1957, Wetzel supervised the production of the first 120 UHF slot antennas sold by RCA.

Profile

- *Member of RCA's UHF antenna-design team*
- *Revitalized FM broadcasting through circular polarization*
- *U.S. state department representative to CCIR*
- *SBE national president, vice president*
- *NAB senior vice president for engineering*

Wetzel married in 1954. Too much travel led him to leave RCA and join the consulting firm of Kear and Kennedy in Washington, DC, as general radio and TV consultant. His most interesting assignment there was experimenting with on-channel TV boosters. Most of Wetzel's Kear and Kennedy work, however, was for the Triangle Publications Television Group, located in Philadelphia at its flagship station, WFIL-TV. He was hired as assistant director of engineering for Triangle in 1960.

Wetzel often traveled to Washington, DC, for Triangle meetings at the FCC. On these trips, he and his lifelong friend Harold Kassens frequently discussed their mutual fear that broadcasters might lose the FM frequencies to another service. Almost every FM station was merely simulcasting its AM programming, and poor profits were causing many to turn back their licenses. "We felt that the key to the situation was to get FM used in the automobile, but with horizontally polarized broadcast antennas, this was impossible," he said.

One day, Kassens gave him a copy of a paper written in 1948 by consultant Carl Smith. It dealt with the circular polarization of FM transmissions. Smith had had the answer almost 15 years before! Wetzel agreed with Kassens that circular polarization was the ticket to the revitalization of FM broadcasting. He proceeded to equip the Triangle station in New Haven, CT, with an experimental circularly polarized antenna.

After 15 months and countless tests and readings, the station was issued a license for circular polarization in 1964. Modern FM broadcasting was born. Wetzel presented a paper about this new technology to a standing-room-only crowd at the 1965 NAB convention. It was an exciting time for radio.

Other contributions

As a U.S. state department representative to the CCIR, Wetzel traveled often to Geneva and other European locations from 1965 to 1975 to represent American broadcast engineers. Meanwhile, in 1966, while still with WFIL-TV, he began experimenting with aural power levels. At that time, aural transmitter power was required to be 50% of the visual transmitter power. On most transmitters, this meant 25kW. His tests proved that a received audio signal comparable to the received video signal could be transmitted using only 6% of the visual power. As a result of these and similar tests run by Crosley Broadcasting at WLW, the FCC decided that 10% was a safe limit and changed the 20-year-old rules. For the first time, TV stations could reduce power usage by millions of kilowatt-hours per year.

From 1966 to 1967 he served as national vice president for the Society of Broadcast Engineers, and in 1968, was elected president. When the Triangle Group stations were sold to Capital Cities, he joined Shively Labs in Raymond, ME, owned by his old friend from RCA. He helped Shively triple sales by expanding into the newly opened Canadian market. His next stop was just down the street in Raymond, to Dielectric Products, a manufacturer of strobe lighting for TV and radio towers. In 1975, he joined Bird Electronics (famous for the ubiquitous Bird Watt-meter).

Wetzel was appointed NAB senior vice president for engineering in 1980. He upgraded the engineering laboratory and hired additional engineers to prepare the NAB for the many high-technology issues that erupted during the 1980s.

Today, Wetzel is sales and marketing manager at Flash Technology in Nashua, NH. |:-)))

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

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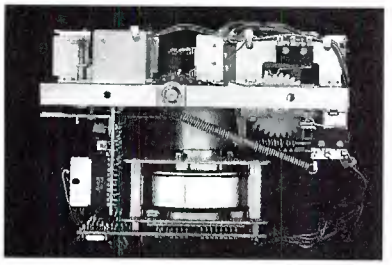

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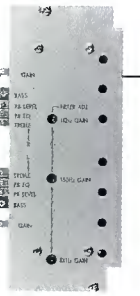

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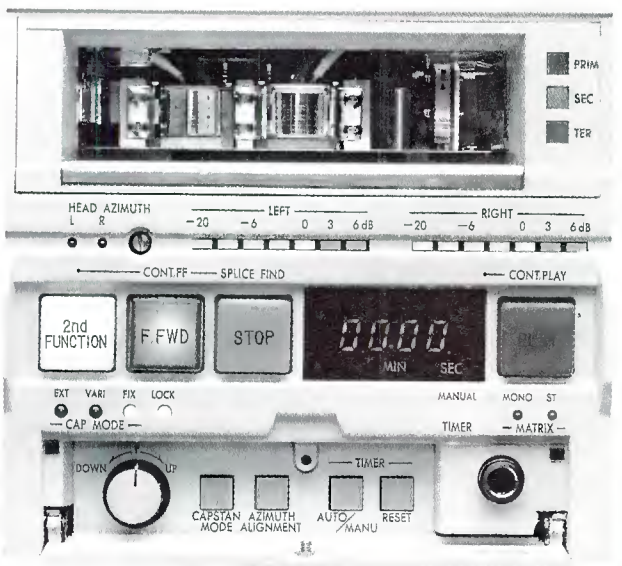

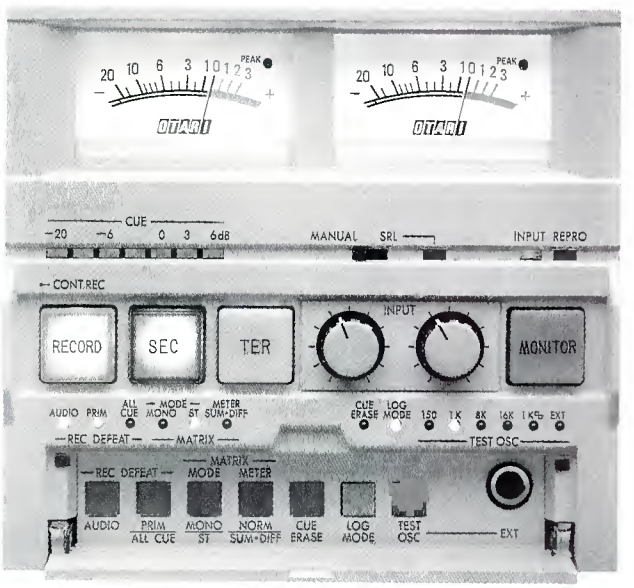

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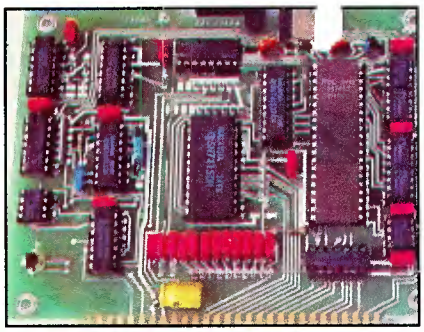

Matching impedances with Smith charts

By Gerry Kaufhold II

You can accomplish a variety of filter functions with a properly designed impedance-match network. For example, these networks can provide low-pass, high-pass, bandpass or notch filtering. Each part of each problem can be solved using Smith charts, taking advantage of the graphical nature of the charts to obtain several different solutions quickly. Because power components for RF work come in limited sizes and value ranges, impedance-matching problems often must be reworked to obtain final component values that can be realized with off-the-shelf parts. We now will work out an impedance-matching problem in detail.

Smith charts step-by-step

Any time you use Smith charts, the following steps must be performed in sequence:

1. Write down all the pertinent actual resistance and reactance values.
2. Choose a convenient denominator that brings the normalized resistance of the characteristic impedance close to 1.0. Normalize all other values by dividing by this number. Note which values are impedances for series circuits and which are admittances for shunt circuits.
3. Plot the normalized values onto the Smith chart.
4. Resolve the problem by applying the rules of Smith charts.
5. De-normalize circuit values by multiplying.
6. Solve the reactance equations at the frequency of interest to obtain correct final component values for the circuit.

Working a practical problem

Suppose a transmission line exhibits R = 50Ω, XR = $-j$5.0Ω (capacitive) at a center frequency of 50MHz. You wish to match an antenna with impedance of R = 72Ω, XR = $+j$15.0Ω (inductive) at the operating frequency.

First, normalize the actual circuit values to get R = 1.0. K = 50 is a convenient constant for normalizing the elements of this problem. The normalized transmission-line output values are R = 50/50 = 1.0, XR = $-j(5/50) = -j0.1$. The normalized antenna input values are R = 72/50 = 1.44, XR = $+j(15/50) = +j0.3$.

Recall that to create an ideal impedance match, you want to cancel out the reactive components so that the source "sees" a pure resistance. The problem to be solved requires the creation of an impedance-matching network that makes the antenna input impedance appear to be the complex conjugate of the transmission-line output impedance. In addition, the impedance-matching elements form a low-pass filter.

In this case, the source has a normalized impedance of 1.0—j0.1. To cancel out the capacitive reactance, the impedance-matching network must have a normalized impedance that is the complex conjugate of the given source impedance. The normalized complex conjugate of 1.0—j0.1 is 1.0 +j0.1. This is used as the desired source impedance.

Plot the antenna input impedance first, labeled "L" for load as shown in Figure 1. The coordinates of the antenna input impedance are 1.44 +j0.3. Plot the complex conjugate of the normalized transmission-line output impedance and label it "S" for source. The coordinates of the normalized complex conjugate of the transmission-line output impedance are 1.0 +j0.1. This point is just above prime center on the R = 1.0 circle.

Next month, we will work backward from point "L" to get to point "S," solving for an impedance match that places a capacitor as the shunt element.

Kaufhold is a market development engineer for SGS-Thomson Microelectronics, Phoenix.

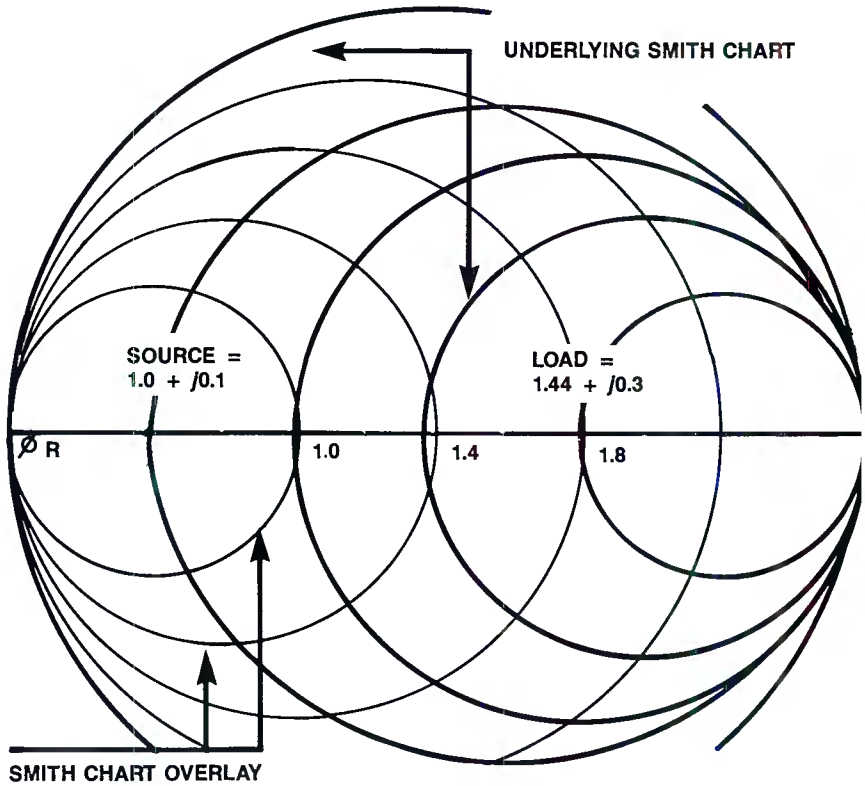

Figure 1. The setup of an impedance-matching problem using the Smith chart with overlay.

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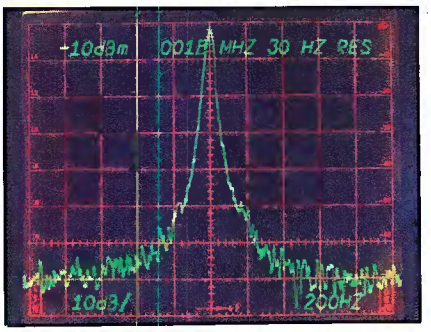

Tracking those pesky culprits

By Brad Dick, editor

Repeated calls to repair the same device irritate not only the user, but also the maintenance engineer. Such problems can be a huge source of tension among employees and departments. The operator thinks the engineer either doesn't care or doesn't know how to fix the problem. The engineer often perceives an intermittent problem as an operator error, not an equipment failure.

Don't give up

The easiest type of problem to fix is that of a dead device. It's much easier to locate the cause of a completely failed device than it is to diagnose intermittent failure. Today's digital equipment, however, is likely to fail only when a certain combination of events occur. Those events may include time-related or operator-generated sequences or steps. In these cases, it's almost impossible for a repair technician to duplicate the conditions that result in failure.

Locating the intermittent type of problem can be time-consuming and frustrating. Maybe the problem simply doesn't occur in the technician's presence. But don't let your staff members shrug off the problem with an "if-it-ain't-broke-I-can't-fix-it" attitude. That approach invariably leads to a repeat complaint. It's easier to fix a hard failure, but if that's not the case, the technician cannot simply ignore the operator's problem.

Where to start

Repairing something that isn't broken at the moment is more art than science. Through experience, the successful engineer develops a knack for locating problems. But what if you don't have years of experience or the equipment is new?

Use a systematic approach. If you don't understand how the equipment is supposed to work, ask the operator. You may pick up valuable information simply by listening to the operator explain what was happening when the device failed. An explanation such as, "I accidentally bumped the machine with my chair while I was updating my slide," could prove extremely useful in helping you identify the problem area. In this case, you might immediately suspect a write error with the disk drive.

Listen to the operators. You may know how the device is supposed to work, but you probably don't know how they actually use the device. There is a big difference.

After you've discussed the problem with the operator, make a thorough visual inspection of the system. Observe the environment. Are factors present that might affect the device's operation?

Detective work

A common culprit is heat. A new device often will be installed in a rack that contains little other equipment. Over time, other equipment is installed, and no one thinks about the resulting heat build-up.

Also consider outside factors. Has new equipment been installed that could affect the device's operation? An arc welder recently installed in the maintenance shop could account for the glitches in digital equipment operation. An air conditioner or other large motor device can disturb power lines enough to cause problems. The maintenance engineer must be mindful that the cause for failure may be external to the equipment itself.

Sometimes even static electricity can cause intermittent problems. Take the situation of an equipment problem being encountered by only one operator; the other operators didn't have the problem. It turned out that when the problem-plagued operator wore certain clothes, sufficiently large amounts of static electricity were generated to affect the equipment. It's easy to see how tempers could flare in such a situation.

Recreate the problem

When you've identified the cause, make the appropriate repairs. Retest the equipment under as many conditions as possible. Place the defective card or component back into the system and observe whether the same problem occurs. If it does, there is a good chance you've actually identified the glitch.

What if the failure doesn't recur? Then you're back to ground zero. It may be that moving the component or cable was all that was needed to solve the problem.

On the other hand, maybe the card or component wasn't the problem after all. You know you've found the problem when you can control what happens by what you do to the system. If the system seems to behave independently of your actions, then you have yet to identify correctly what is occurring.

Ask for help

When tracking intermittents, ask the operator to keep a log of problems. Operators usually aren't trained to identify the cause-effect relationship in failures. They often view problems as random occurrences. A time-vs.-failure log will help both you and the operator identify the trigger that causes the problem.

Teach the operators how to keep the logs. Tell them what actions and settings would be important in helping you identify the problem. Convince them that the failure probably isn't random at all and that their help is important in finding the cause.

Know when to pitch

Some stations are so pennywise that they cost themselves a fortune. There's a time to fix something and a time to pitch it. Don't be afraid to tell the boss that it's time to replace the entire board or device, especially when you're having problems with computer gear.

Don't spend time trying to repair most PC-based equipment. If you can't solve the problem in an hour or so, either send it outside to be repaired (if it's an expensive device) or get yourself some spare boards. There isn't much in a PC that can't be replaced for about $500. Trying to repair a video board or even a motherboard usually is a foolish proposition.

The same logic applies to the inexpensive audio equipment used in many radio stations. Consultants are quick to recognize the financial futility of trying to repair a $500 CD player, but some chief engineers find it hard to admit that a device isn't worth repairing. Save yourself the grief. When it comes to much of the consumer-type equipment, replacement makes a lot more sense than repair.

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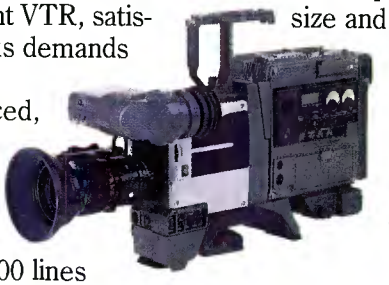

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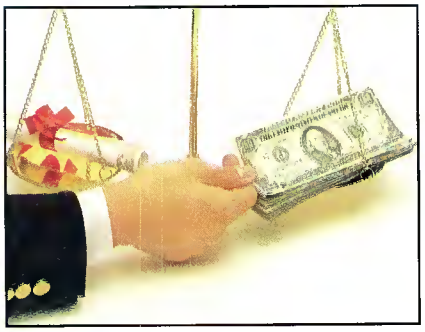

Finances and today's engineer

By Brad Dick, editor

How does your station spell success? Probably not r-a-t-i-n-g-s.

Market share is only one measure of a station's success. The primary test of a commercial station's success is financial performance. Today, because many stations operate as part of a group, about the only thing that counts is the amount of money the operation brings in. This increased emphasis on financial performance means that engineers must reexamine ways they can contribute to the numbers on the bottom line.

Your effectiveness in helping the station to be financially successful requires that you employ more than your engineering skills. You also must understand the basics of your station's financial operation. You don't have to be an accountant, but you do have to comprehend how money flows within the system and how your department's expenses and income affect the results. The more you know about the station's finances, the better you'll be able to contribute to its success and, ultimately, your own.

This series can help you develop a basic understanding about station finances and accounting. By the time you are finished, you'll understand how to read a balance sheet and income statement. You also will know how budgets set the stage for your department's objectives and, therefore, how you will be evaluated.

You'll even learn some tricks that will help you earn budget increases. As you'll see, getting your share of the monetary pie requires two things: a knowledge of how the system works and a bit of salesmanship. Let's begin by learning how the financial system works.

Accounting 101

The proper financial operation of a station requires that certain practices be implemented carefully. Budgeting is the one engineers are most familiar with. It's the set of records called ledgers and journals, however, that best describes a station's operation.

The basic financial controls and policies often are administered by the business department. This staff also may be responsible for banking, billings to and collections from advertisers and agencies. Additional duties may include purchases and payment for services used by the station.

Payroll, which also is handled by this staff in most stations, often includes the processing of insurance claims and tax payments. A large station or corporation may have a separate payroll department.

The key to effective accounting is establishing and maintaining accurate financial records. These records form a system that protects the station's assets and provides financial information for decision-making by the management and department staff.

Types of accounts

Most accounting systems consist of various journals and ledgers that record and summarize all financial activity. The basic distribution process is symbolized in Figure 1.

The *general ledger* is the main accounts book. It contains two sections and records the transactions posted from the other journals. One section records assets, liabilities and capital. The other section lists the income and expense accounts information. The general ledger information is used to prepare the station's two major financial records, the *balance sheet* and the *income statement*.

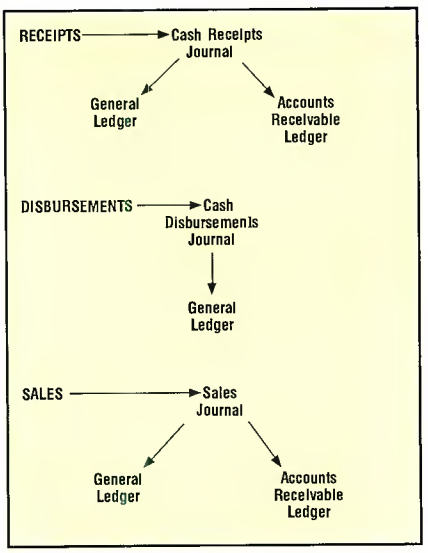

Figure 1. *The basic record-keeping process within a station. All financial transactions are recorded in these journals and ledgers and form the basis for tracking a station's financial well-being.*

The *cash receipts journal* lists all income. Each entry contains a revenue account number and identifying payer. This record of advertising receipts includes the gross amount, discounts, agency commission and net amount received. Journal entries are kept for a specific period of time, then are posted or transferred to the general ledger.

All client payments are credited to the proper account in the *accounts receivable ledger*.

Although station managers prefer to collect money, it's also necessary to pay some of it out to cover expenses. That's where the *cash disbursements journal* comes in. This journal records all monies disbursed by the station. The entries are broken down into several types of expense categories: engineering, sales, direct, program, general and administrative. Each entry includes the check number, date of payment, amount and company or person paid. Totals are posted later to the general ledger.

The *sales journal* records sales by client, invoice number, date and amount. It also lists the name of the salesperson. The journal ensures that each salesperson receives proper credit for commission purposes. Trade-outs are listed here along with other revenue-producing activities.

At the appropriate time, these entries are totaled and posted to the general ledger. The gross billing figure is entered on the client's page in the accounts receivable ledger.

The *general journal* includes non-cash transactions and adjustments. This may incorporate depreciation and amortization and accrued bills not yet paid. The *accounts receivable journal* records the money owed to the station. Entries are tracked by account. This information is used to prepare an *aging sheet*, which shows which accounts are current and which are delinquent. An *accounts payable ledger* records the money owed by the station. Each entry lists the creditor, invoice date, amount and to what account the bill will be charged.

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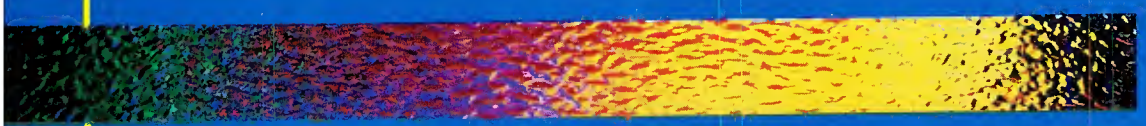
RF transmissions systems special issue



Do you remember your first transmitter experience and the nightly care it took to keep it up? With today's transmitter systems, daily maintenance is a thing of the past.

Try to recall your first AM, FM or TV transmitter encounter. Unless you're too young to drive, the transmitters were probably tube-based systems that required considerable attention.

I remember the first two rigs I worked on. Both were old, but they were still in use. The GE FM transmitter consisted of a 1kW exciter coupled to a 10kW amplifier. I crossed my fingers every morning at sign-on time.

The AM transmitter was so old it made the GE look like new equipment. The AM transmitter was a Western Electric 405 B-1, installed in 1939. We used it for backup, and it always worked. I remember the station chief engineer relating when a lightning storm occurred, he would turn off the relatively new 1960 vintage RCA transmitter because the old Western Electric took the lightning hits better. "It seems to turn those hits around and shove them back up the tower," he said. He sounded convincing.

Those of us who cut our teeth on those vintage devices may remember them fondly. The fact is they required constant attention. Regular maintenance at night was a fact-of-life. Letting one of those old systems operate without daily checks was unthinkable.

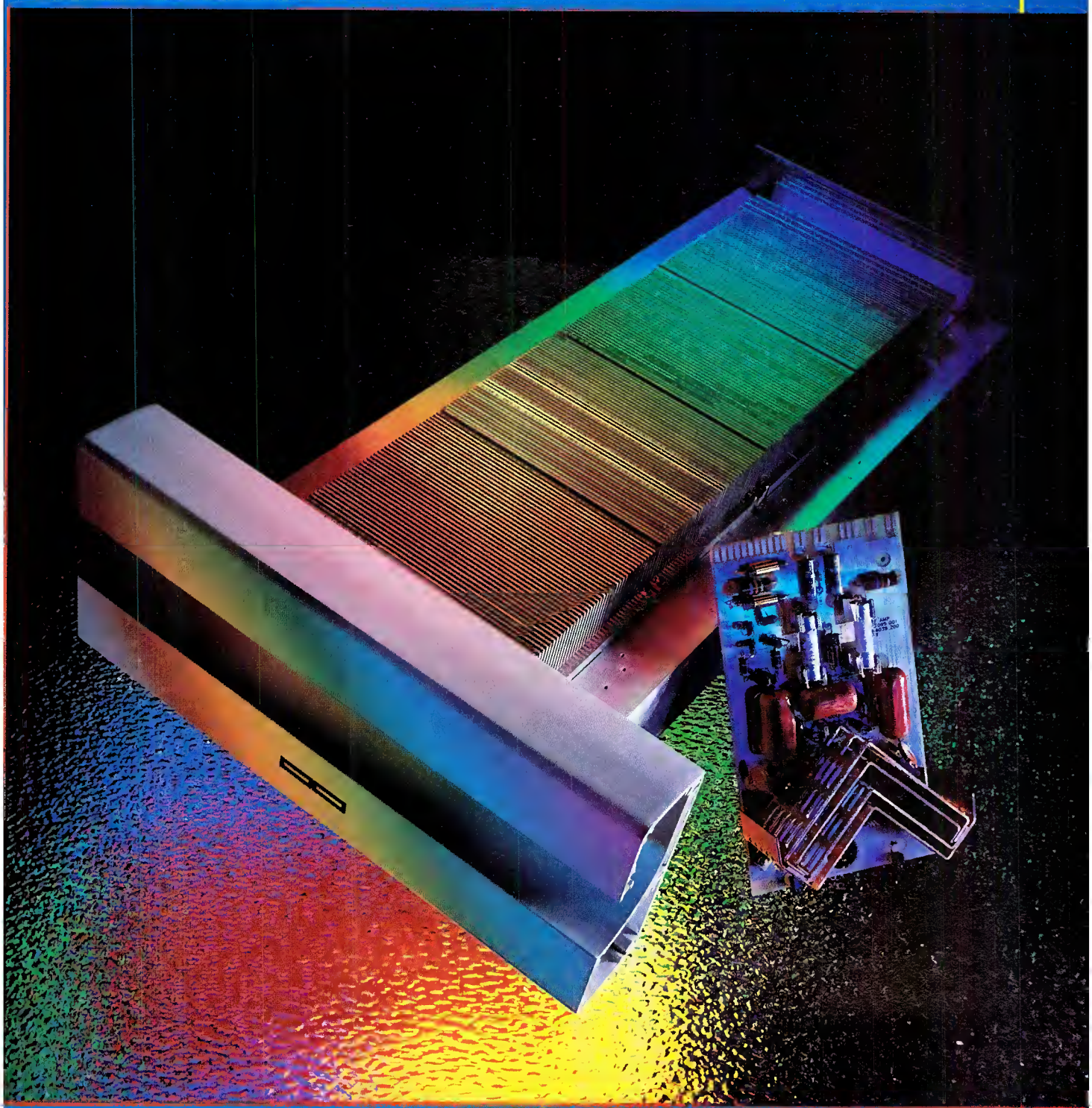
Fortunately, today's RF systems are far more reliable. I know of stations today where the transmitters aren't maintained weekly, let alone daily. Even so, these systems continue to provide reliable and high-quality service. One key to the superior operation of modern transmission systems lies in the devices used to generate and amplify the RF signal.

This month's special issue looks inside the RF section of the broadcast chain. Without this important link, all of those CDs with digital audio and high-quality video signals you generate in the studio would never reach the audience.

This month, **BE** takes a detailed look inside the RF equipment that makes transmission of radio and TV programs possible. Articles this month include:

Brad Dick

Brad Dick, editor



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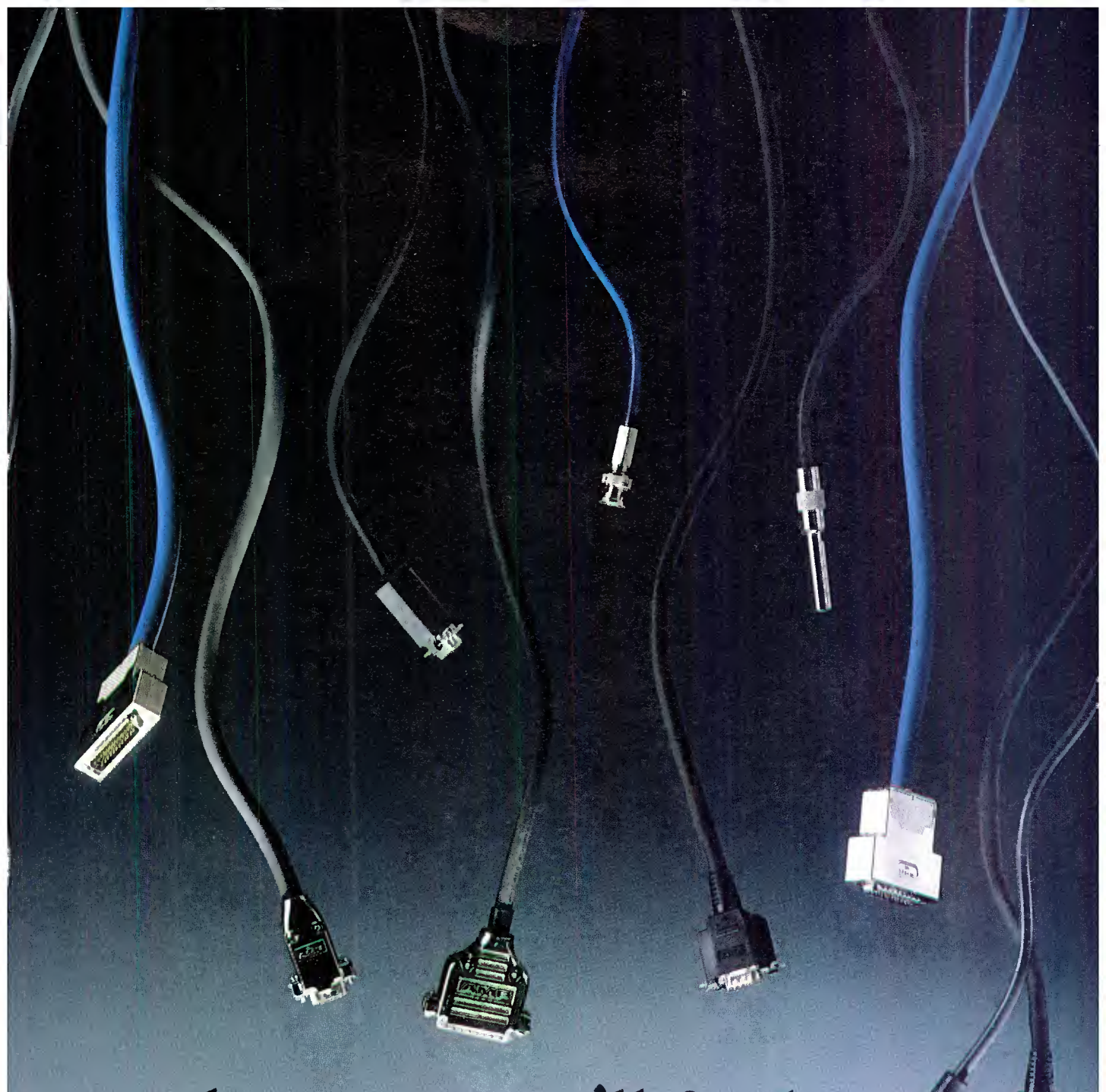

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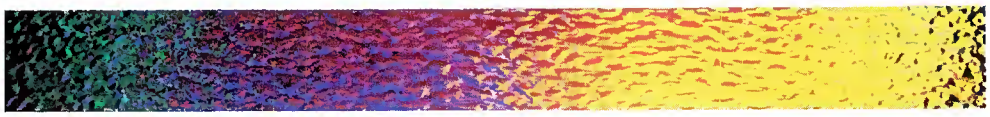
By Jerry Whitaker, associate publisher

RF technology: setting new standards



New devices are pushing radio and TV transmitters to higher levels of performance, efficiency and reliability.

New solid-state devices and advanced microwave power tubes are changing the way broadcasters put their signals on the air. Semiconductors, in particular, play an increasingly important role in the generation of RF energy. Designs based on semiconductors offer a number of advantages over conventional vacuum tubes, including:

- reduced size and weight.
- lower operating voltages.
- no warm-up period required.
- fault-tolerant designs practical.
- simplified cooling.
- improved operating efficiency (depending on the frequency, power level and type of modulation).
- reduced susceptibility to mechanical shock and vibration.

Solid-state devices are routinely used at power levels of 250W (CW). As designers find ways to improve operating efficiency and remove heat generated during use, the maximum operating power will rise. However, it is unlikely that semiconductors will be able to operate cost-effectively in a CW mode in excess of 500W anytime soon. In order to achieve greater output levels, devices — indeed entire amplifiers — must be operated in parallel. Figure 1 illustrates an RF amplifier using both parallel devices and parallel amplifiers. The input signal is split to drive each amplifier, and the outputs are combined to feed the load.

Parallel amplification is attractive from several standpoints. First, redundancy is a part of the basic design. If one device or one amplifier fails, the remainder of the system will continue to operate. Second, lower-cost devices can be used. It is often less expensive to put two 100W transistors into a circuit than it is to put one 200W device. Third, troubleshooting the system is simplified because an entire RF module can be substituted to return the system to operation. The defective part can be replaced at a later time by the technician or returned to the factory for repairs.

Solid-state systems have their drawbacks. A high-power transmitter using vacuum tubes is much simpler in design than a comparable solid-state system. The parts count in a semiconductor-based transmitter may be an order of magnitude higher than a tube design. Higher parts counts usually translate to higher overall failure rates.

However, it is only fair to point out that failures in a parallel, fault-tolerant design usually will not cause the entire system to fail. Instead, some parameter, typically peak output power, will drop when one or more amplifier modules is out of commission.

This discussion assumes that the design

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of a solid-state system is truly fault-tolerant. For a system to provide the benefits of parallel design, power supplies, RF divider and combiner networks and supervisory/control systems must also be capable of independent operation.

Operating efficiency

The efficiency of a solid-state transmitter may or may not be better than a tube transmitter of the same operating power and frequency. Much depends on the type of modulation used and the frequency of operation. For example, new solid-state designs have led to significant improvements in the operating efficiency of high-power (50kW) AM broadcast transmitters. This improvement has come from both improved devices and new modulation schemes. High-power (30kW to 60kW) solid-state TV transmitters, on the other hand, operate with about the same overall efficiency as their vacuum tube counterparts.

Choosing between a solid-state or vacuum tube design is not as simple as it might appear on the surface. Many items must be considered, and trade-offs accepted.

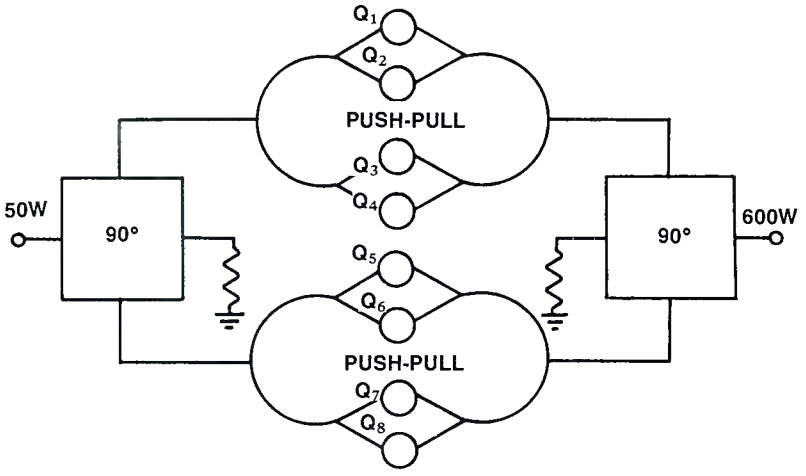

Figure 1. Schematic diagram of a 600W VHF amplifier using eight FETs in a parallel device/parallel module configuration.

Power-handling capability

The primary factor in determining the amount of power a given device can handle is the size of the active junctions on the chip. The same power output from a device may be achieved through the use of several smaller chips in parallel. This approach, however, can result in unequal currents and uneven distribution of heat. At high power levels, heat management becomes a significant factor in chip design.

Specialized layout geometries have been developed to ensure even current distribution throughout the device. One approach involves the use of a matrix of emitter resistances constructed so that the overall distribution of power among the parallel emitter elements results in even

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thermal dissipation. Figure 2 illustrates the *interdigited* geometry technique.

With improvements in semiconductor fabrication processes, output device SOA is primarily a function of the size of the silicon slab inside the package. Package type determines the ultimate dissipation because of thermal saturation with temperature rise. A good TO-3 or a 2-screw-mounted plastic package will dissipate approximately 350W-375W if properly mounted. Figure 3 demonstrates the relationships between case size and power dissipation for a TO-3 package.

Power devices

Today, both bipolar and field-effect transistor (FET) semiconductors are used in broadcast transmitters. FET, particularly metal-oxide silicon FET (MOSFET), devices are common. Silicon RF power FETs are generally N-channel MOS enhancement mode devices. Most are *vertical structures*, meaning that current flow is primarily vertical through the chip with the bottom forming the drain contact. Vertical construction has the advantage of providing greater current density, which translates to more watts per unit area of silicon.

The design of an FET RF power amplifier has much in common with a bipolar amplifier. Both must include circuitry to supply bias voltages and matching networks to perform the necessary input/output impedance transformations over the operating frequency band. Most FET amplifiers produced today use the same basic collector voltages as bipolar systems (12.5V, 28V and 50V). Higher-voltage FET devices also are available.

There is no FET parallel to the common zero base bias bipolar RF amplifier. FET amplifiers require forward gate bias for optimum power output and gain. The bias network may consist of a simple resistive divider.

MOSFET devices can usually be operated in parallel for higher output power at frequencies up to 150MHz-200MHz. Circuit instabilities can sometimes arise at higher frequencies, however, unless careful attention is given to amplifier design and component layout.

Operating limits

Power MOSFETs have found numerous applications in RF transmission equipment because of their unique performance attributes. MOSFETs do not suffer from secondary breakdown as do bipolar transistors. A variety of specifications can be used to indicate the maximum operating voltages a specific device can withstand. The most common specifications include:

- gate-to-source breakdown voltage.
- drain-to-gate breakdown voltage.
- drain-to-source breakdown voltage.

These limits mark the maximum voltage excursions possible with a given device before failure. Excessive voltages cause carriers within the depletion region

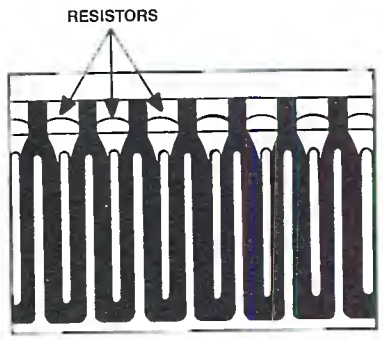

Figure 2. Interdigited geometry of emitter resistors used to balance currents throughout a power device chip.

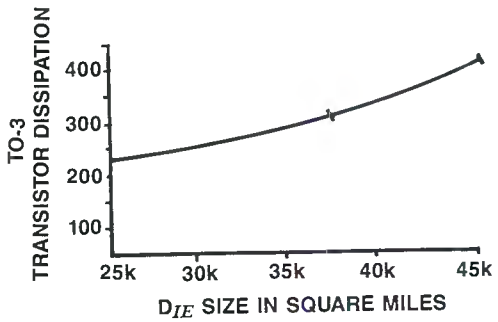

Figure 3. Relationship between case (die) size and transistor dissipation.

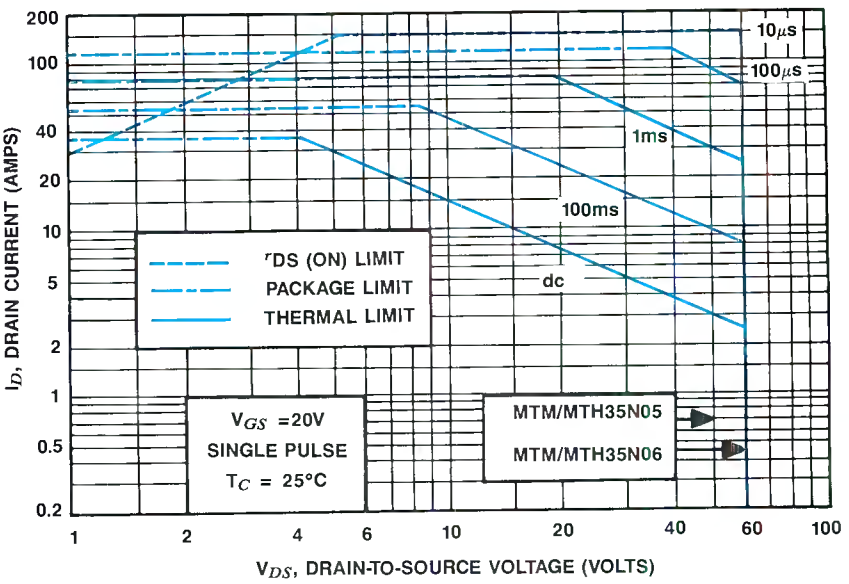

Figure 4. Safe operating area (SOA) curve for a power FET device.

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of the reverse-biased PN junction to acquire sufficient kinetic energy to cause ionization. Voltage breakdown also can occur when a *critical electric field* is reached. The magnitude of this voltage is determined primarily by the characteristics of the die itself.

Safe operating area

The safe dc operating area of a MOSFET is determined by the rated power dissipation of the device over the entire drain-to-source voltage range (up to the rated maximum voltage). The maximum drain-source voltage is a critical parameter. If exceeded even momentarily, the device can be damaged permanently.

Figure 4 shows a representative SOA curve for a MOSFET. Limits are plotted for several parameters, including drain-source voltage, thermal dissipation (a time-dependent function), package capability and drain-source on-resistance. The capability of the package to withstand high voltages is determined by the construction of the die itself, including bonding wire diameter, size of the bonding pad and internal thermal resistances. The drain-source on-resistance limit is simply a manifestation of Ohm's Law; with a given on-resistance, current is limited by the applied voltage.

To a large extent, the thermal limitations described in the SOA chart determine the boundaries for MOSFET use in linear applications. The maximum permissible junction temperature also affects the pulsed-current rating when the device is used as a switch. MOSFETs are, in fact, more like rectifiers than bipolar transistors with respect to current ratings; their peak current ratings are not gain limited, but thermally limited.

In switching applications, total power dissipation is composed of both switching losses and on-state losses. At low frequencies, switching losses are small. As the operating frequency increases, however, switching losses become a significant factor in circuit design.

Applying RF semiconductors

The primary criteria for constructing a solid-state amplifier for RF applications include:

- output power.
- operating frequency.
- required bandwidth.
- noise performance.
- efficiency desired.
- power supply voltages available.
- cost.

Achieving all of the design objectives is a difficult task. Trade-offs are usually required to produce a practical system.

The most basic design variable is the type of power device used. For solid-state RF applications the primary choices are bipolar transistors and FETs. Table 1 lists some of the principal comparison parameters.

Solid-state RF amplifiers

Solid-state transmitters make use of various schemes employing pulse-type modulation and high-efficiency linear techniques. In order to achieve the needed RF output level, several semiconductor devices are usually assembled in a single module. These 50Ω building blocks are then combined to provide whatever power level is needed.

Because of the unpredictable conditions that some transmission equipment will experience over its operating lifetime, protection circuits are required. Each module must be protected against voltage transients on the V+ input line and RF output port, thermal overloads and severe load VSWR. Some designs also incorporate a soft-start feature. With this approach, when the system is turned on, the modules do not simultaneously draw current from the power supply. Rather, each module switches on at a different time, thereby reducing the initial surge applied to the supply. The delay times may range from a few milliseconds to a few seconds.

Each module in a typical high-power system is combined through a combining network. In addition to coupling the modules to obtain higher power levels, the network also protects the modules from the load and from each other. In a properly designed combiner, the failure of one module will have no effect on the other operating modules.

PARAMETER	BIPOLAR	FET
Current carrier	minority	majority
Input impedance	medium	high
Switching speed	medium	high
Ruggedness	good	excellent
Gain medium	low	high
Paralleling capability	difficult	easy
Thermal-handling capability	excellent	fair

Table 1. Comparison of bipolar and FET operating parameters.

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Device requirements

High-power RF applications demand a high degree of performance from transistors and FETs. Operation at high frequencies requires a device geometry and package that offers the lowest possible stray inductance and capacitance. Operation at high power levels requires a device that can tolerate high temperatures and a package that offers low thermal resistance to its accompanying heat sink. Figure 5 shows some of the more common RF transistor packages. A variety of approaches have been taken to solving the problems of generating high powers at high frequencies.

The BLV37 transistor (Philips) is a representative device. Rated for 250W dissipation, the package is a 5-lead rectangular flange envelope with a ceramic cap. All leads are isolated from the flange to facilitate a good thermal bond with the external heat sink. The transistor package (designated SOT-179) measures 13.2mm× 28mm. It includes a thin base layer of beryllium oxide between the transistor junction die and the package, which incorporates an *Alkonite* flange. Alkonite is a strong heat-conductive substance that can be machined flat for optimum contact with the heat sink. Internal input matching provides for wideband operation and high power gain.

Key specifications for the BLV37 transistor include:

- maximum power dissipation, 250W.
- typical operating frequency, 108MHz.
- nominal collector voltage, 28V.
- minimum gain, 11dB.
- typical operating class, Class B.
- typical operating efficiency, 65%.

This device is intended for use in FM broadcast transmitters and commercial/military mobile radios.

The BLV37 package contains two transistors in a push-pull configuration. Each device has 1,400 emitters on an area of just 2.5mm×4.8mm. This arrangement provides for even current distribution on the die, thereby eliminating hot spots. Emitter ballasting resistors, more than 700 per device, further improve heat distribution.

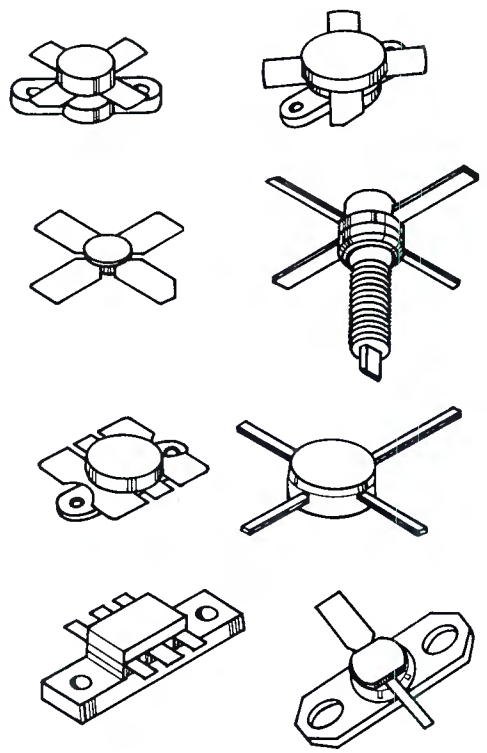


Figure 5. Common RF transistor packages.

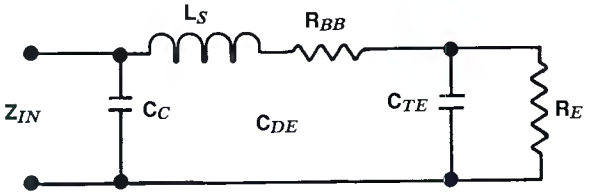
Stage coupling

The typical gain of a single RF amplifier stage ranges from 5dB to 12dB, depending on the operating frequency and bandwidth. To obtain higher gain, stages are combined in series. Usually the input and output of each stage is designed to interface using a common impedance (typically 50Ω resistive) to facilitate stage-to-stage compatibility and isolation. Band-limiting is usually a useful by-product of interstage coupling.

Coupling networks are needed to provide for the best possible energy transfer from stage to stage. The input impedance of an RF power transistor is low, decreasing as the power increases or as the chip size becomes larger. Impedance transformations ratios of 10-20 are not uncommon. Coupling circuits must deal with a number of parameters, not the least of which is operating bandwidth.

Figure 6 shows the equivalent circuit for the input of a power transistor. Most VHF highband transistors will have the series resonant frequency within their operating range. That is, the input will be purely resistive at one single frequency. The parallel resonant frequency will typically be outside the operating range of the device.

The output impedance of an RF power



WHERE:
R_E = EMITTER DIFFUSION RESISTANCE
C_{DE} • C_{TE} = DIFFUSION AND TRANSITION CAPACITANCES OF THE EMITTER JUNCTION
R_{BB} = BASE SPREADING RESISTANCE
C_C = PACKAGE CAPACITANCE
L_S = BASE LEAD INDUCTANCE

Figure 6. Equivalent circuit for the input impedance of an RF power transistor. (Courtesy of Motorola.)

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transistor consists principally of a capacitance that varies as a function of operating frequency. (See Figure 7.) The internal resistance of the device is generally much higher than the load, and is typically neglected.

Impedance matching is accomplished only at the input of the device. Interstage and load matching are basically impedance *transformations* of the device input impedance and of the load into a value determined by the power demanded from the output device and the supply voltage.

Two techniques are commonly used to accomplish the required coupling: transformers and transmission-line techniques, including *stripline*. For frequencies below about 100MHz, matching is usually accomplished with ferrite transformers. Above 100MHz, transformers are too inefficient to compete with simpler transmission-line devices. Transmission-line networks are only practical at VHF frequencies and above. Lower frequencies translate to longer wavelengths, and the length of coax or stripline required to yield a 1/2- or 1/4-wave section can be prohibitive.

Output networks

The design of a network to resonate and couple the output of an RF transistor or FET to its load is a complicated exercise, which involves balancing a number of parameters. Amplifiers that operate Class C rely on a tank circuit to resonate the stage.

Consider an amplifier designed to deliver 50W into a 50Ω load, working with a 12V power supply. A pair of L networks is used for impedance coupling. The basic equation E = PR shows that to deliver 50W into a 50Ω load, 50V rms must be supplied. In order to get 50V rms from a 12V supply, the output network must act as a step-up transformer. Stated from a different perspective, the output network must transform the load so the transistor sees a lower impedance.

Suitable circuits include transformers, Pi networks, T networks and L networks. The approach chosen depends on the operating frequency, preference of the designer and the power level. If the network has reasonable Q, the waveform of Figure 8 will be observed at the transistor collector when the amplifier is driven to full output. The output will swing down from the supply voltage to a minimum point (E_{sat}), limited by the transistor, and will swing above the supply voltage by approximately the same amount. This increased voltage is a result of the *flywheel effect* of a resonant circuit. In order to achieve the

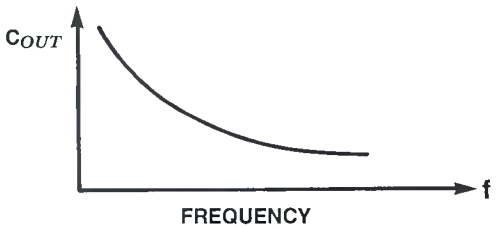

Figure 7. Transistor output capacitance as a function of frequency. (Courtesy of Motorola.)

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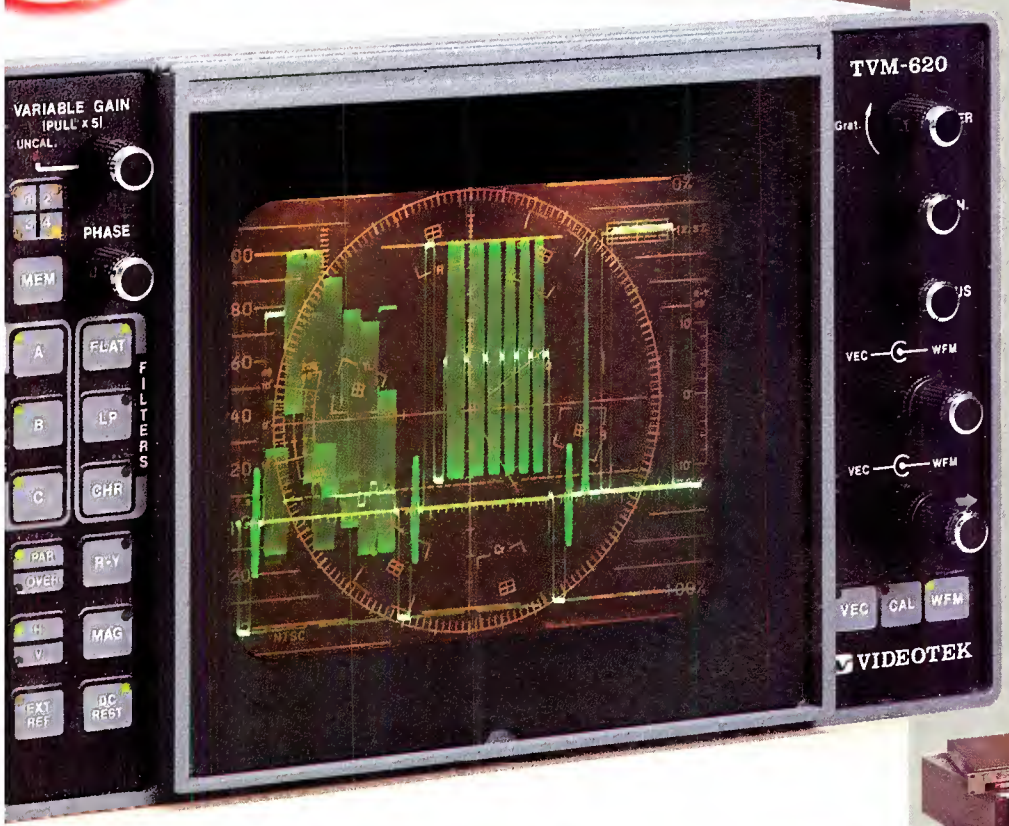

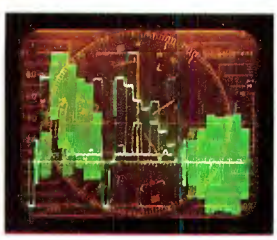

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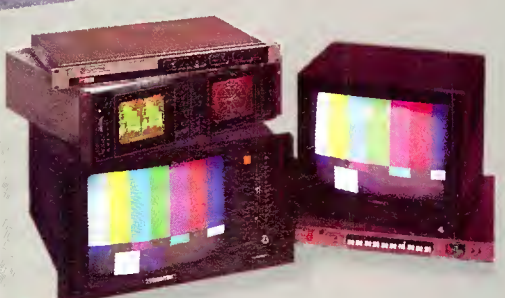

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desired 50W output, the coupling network must transform the 50Ω load to present 1Ω to the transistor.

This greatly simplified example brings up an important point in output coupling circuit design: Seldom are output networks designed to *match* the output impedance of the transistor to the external load. The "equivalent circuits" concept states, in part, that *maximum power transfer* occurs when the load is *matched* to source. (See Figure 9.) The key point is that maximum power is not always wanted. Output networks are designed and adjusted to the impedance that will result in the desired power output and bandwidth. There can be a big difference between maximum power output from a stage and the operating power that will provide the required parameters and not destroy the output device.

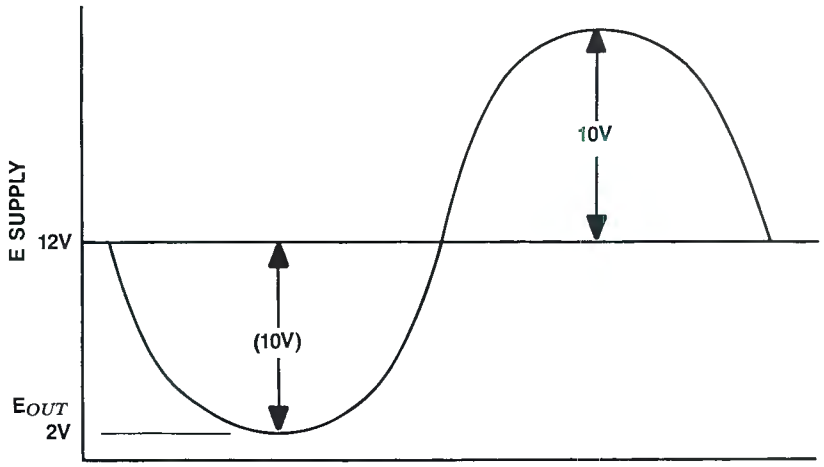

Figure 8. *Collector waveform exhibited by a tuned RF amplifier. (Source Mobile Radio Technology, an Intertec publication.)*

It should be obvious that just because the output impedance of the transistor is not matched, neither is it ignored. Choosing a device for a given application involves the following criteria:

- available supply voltage.
- gain required at the operating frequency.
- output current required.
- thermal dissipation at the operating power level.

The device also may have some reactance that can be used to advantage in the coupling network.

Fixed-frequency circuits

One of the often-mentioned attributes

Continued on page 42

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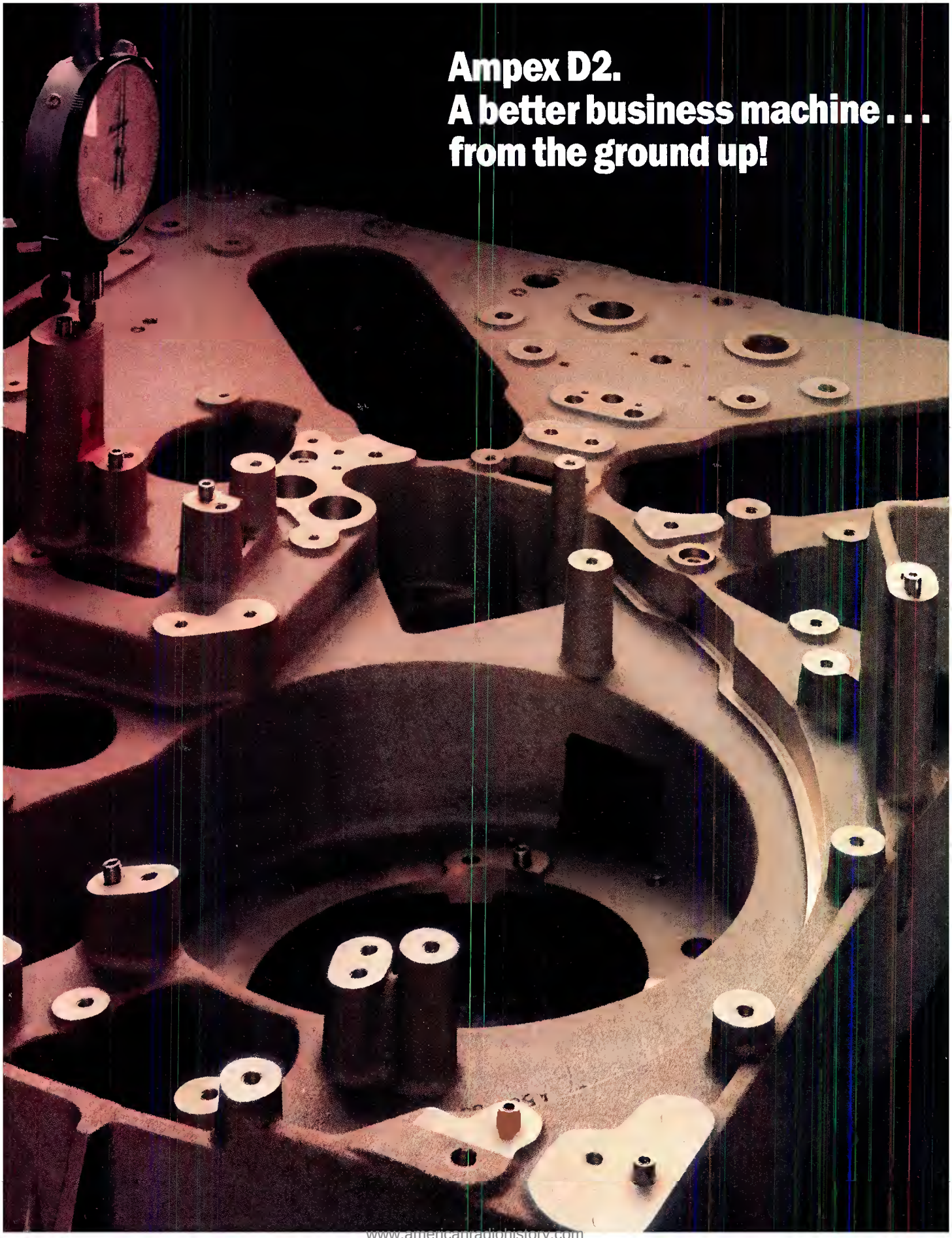

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Continued from page 38

of a solid-state amplifier is its wide operating bandwidth. However, broadband operation for solid-state systems is not really cleverness at all. Using semiconductor devices means working at much lower voltages than vacuum tubes. Low voltage means low impedance, and low impedance translates to high-value capacitors and low-value inductors in coupling networks. With these design criteria, it often becomes impractical to make components variable. As a result, fixed networks are used.

The result is amplifiers that do not have to be tuned or that cannot be tuned. Solid-state amplifiers also are typically more sensitive to changes in load impedance. This fact must be taken into account in the design of transmission line, filter and antenna systems.

Vacuum tubes

The phrase "high technology" is perhaps one of the more overused descriptions in our technical vocabulary. It is generally reserved for discussion of integrated circuits, fiber optics and satellite systems. Few people would associate high technology with vacuum tubes. The notion that vacuum-tube construction is more *art* than *science* may have been true 10 or 20 years ago, but today it's a different story.

The demand on the part of broadcasters for tubes capable of higher operating power and frequency, and the economic necessity for tubes that provide greater effi-

A 120kW Klystrode transmitter installed at WCLP-TV Channel 18 in Chatsworth, GA. (Courtesy of Comark.)

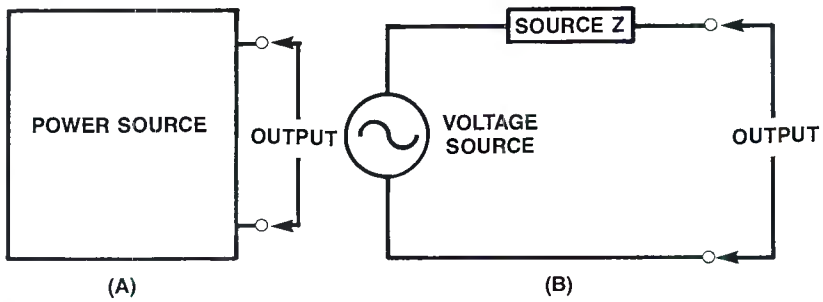

Figure 9. *The "equivalent circuits" concept: a power source (a), no matter how complex, can be represented by a simple equivalent circuit (b) consisting of a voltage source with a series impedance. (Source: Mobile Radio Technology, an Intertec publication.)*

Put Dolby SR before the cart

There's no doubt that compact discs and other digital audio sources have helped to raise broadcast audio quality to new heights. And to some degree, almost all broadcasters have embraced this new technology.

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Circle (26) on Reply Card

ciency and reliability, have moved power tube manufacturers into the high-tech arena.

Power grid vacuum tubes have been the mainstay of transmitters since the beginning of radio. The need for new power tubes is being met today with new processes and materials. Users are asking for systems that incorporate solid-state components in low- and medium-power stages and vacuum tubes in high-power stages. Each technology has its place, and each has its strengths and weaknesses.

Device design

Vacuum tube technology is advancing just as fast as developments in solid-state technology, although accompanied by less fanfare. Today, power tubes are designed with an eye toward high operating efficiency and high gain/bandwidth properties. Above all, a tube must be reliable and provide long operating life. The design of a power tube is a lengthy process that involves computer-aided calculations and modeling. The design engineers must examine a laundry list of items, including:

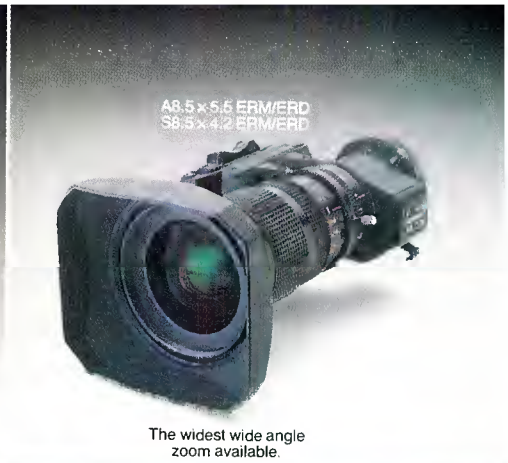
• *Cooling.* How the tube will dissipate the heat generated during normal operation. A high-performance tube is of little value if it will not provide long life in typical applications. Design questions include whether the tube will be air-cooled or water-cooled, the number of fins the device will have, and the thickness and spacing of the fins.

• *Electro-optics.* How the internal elements line up to achieve the desired performance. A careful analysis must be made of what happens to the electrons in their paths from the cathode to the anode, including the expected power gain of the tube.

• *Operational parameters.* What the typical interelectrode capacitances will be, and the manufacturing tolerances that can be expected. This analysis includes: spacing variations between elements within the tube, the types of materials used in construction, the long-term stability of the internal elements and the effects of thermal cycling.

High-power tetrode

Tetrodes have been used in AM, FM and VHF TV transmitters for years. Until recently, however, tetrodes were not used in high-power UHF transmitters because of device limitations. Advancements in vacuum tube technology have now permitted the construction of high-power UHF transmitters based on tetrodes. Such devices are attractive because they inherently operate in an efficient Class A-B mode. At least two 25kW tetrode-based



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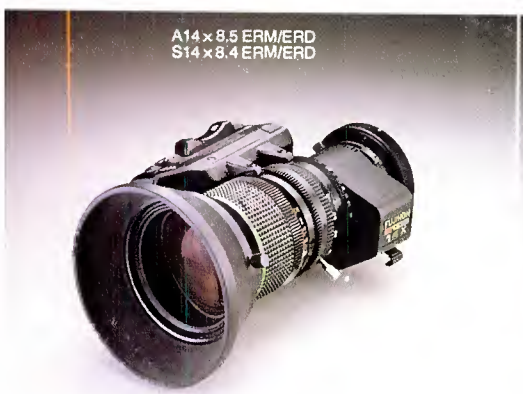
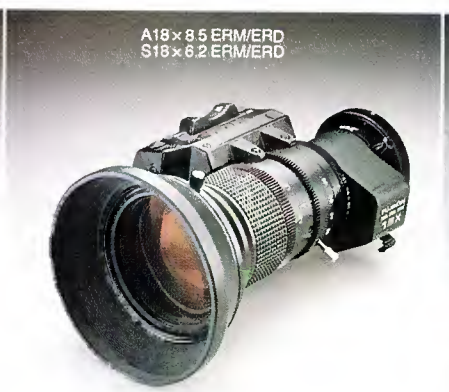
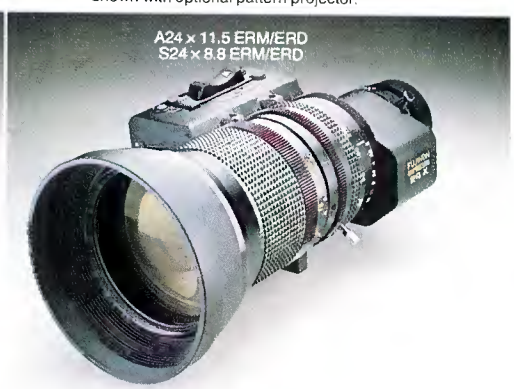


Wide angle, medium telephoto for news/production.



Wide angle, long focal length for news/sports coverage.



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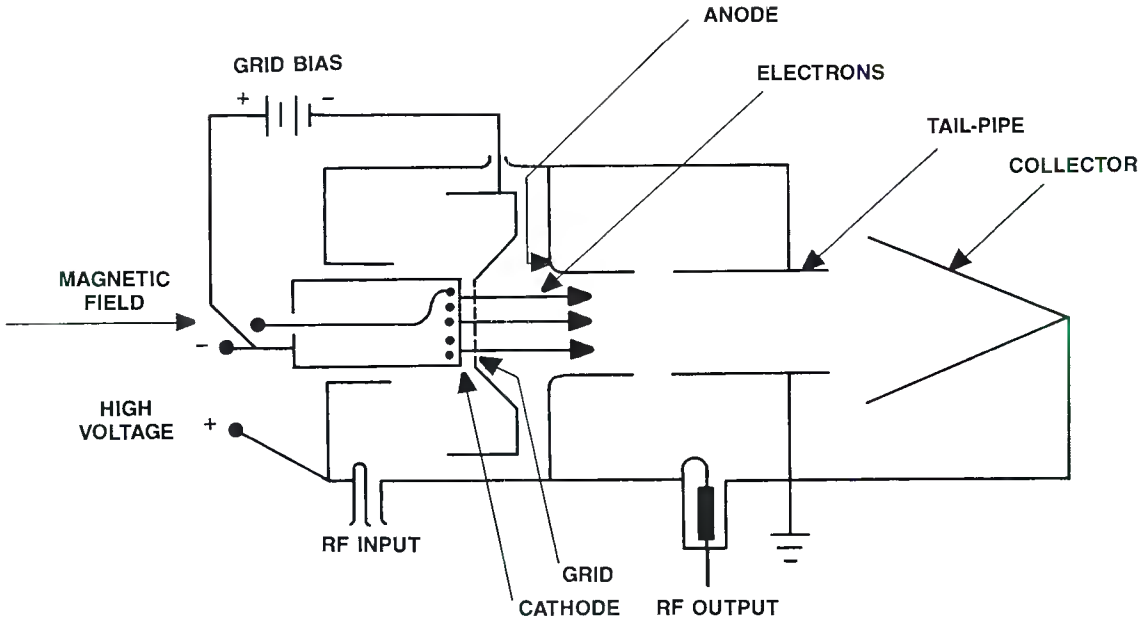
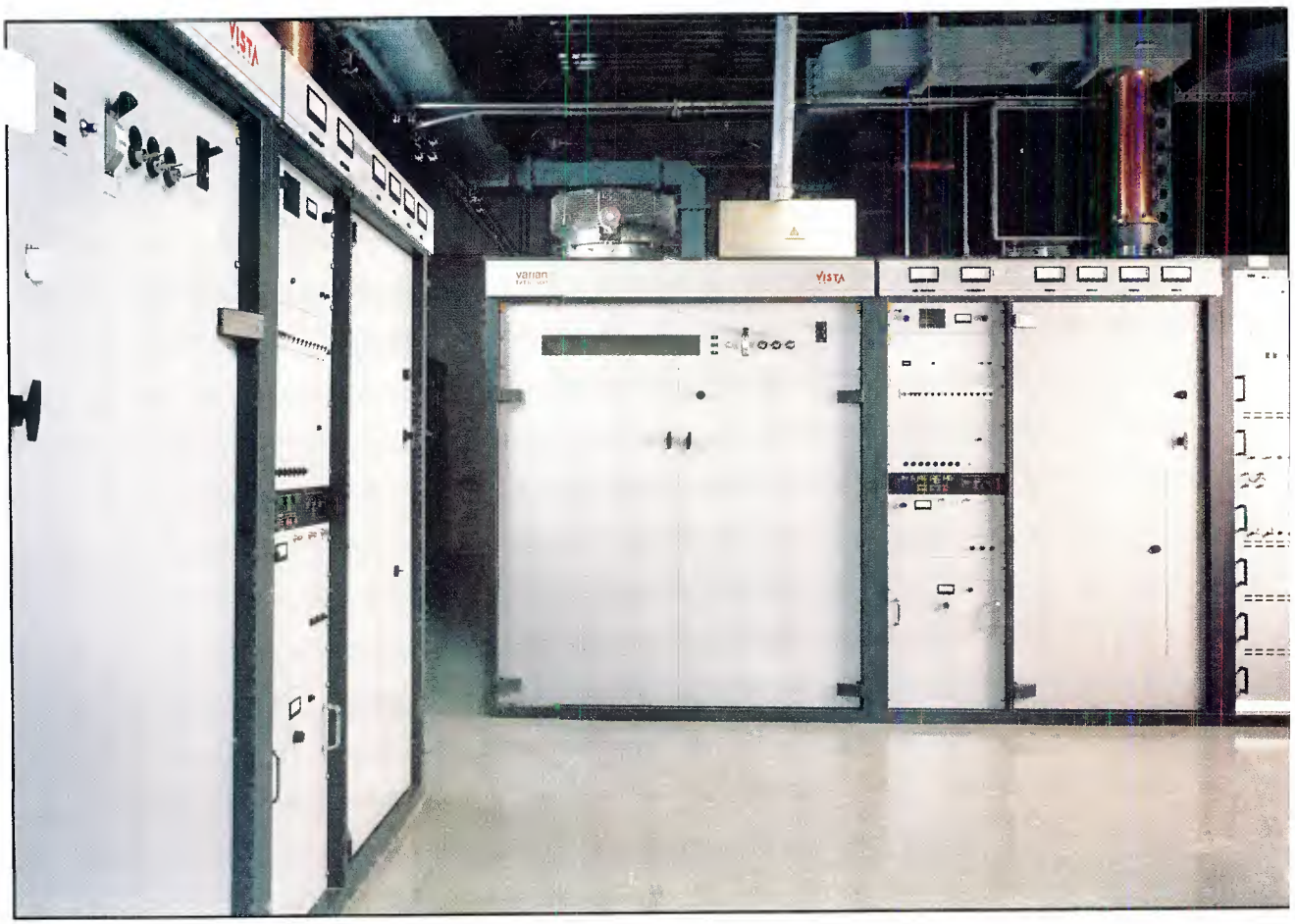


Figure 10. *Simplified schematic diagram of the Klystrode tube.*



A 120kW MSDC-equipped transmitter installed at KVDA Channel 60 in San Antonio. (Courtesy of Varian TVT)

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TV transmitters are now on the air in common amplification service. The TH563 tube (Thomson) is capable of 35kW peak-of-sync power output in split (separate aural/visual) operation.

UHF tetrodes operating at high-power levels provide essentially the same specifications, gain and efficiency as tubes operating at lower powers. The anode power supply is much lower in voltage than the collector potential of a klystron- or Klystrode tube-based system (8kV is common). The tetrode also does not require focusing magnets.

Efficient removal of heat is the key to making a tetrode practical at high power levels. The TH563 uses water-cooling. Air-cooling at such levels is impractical because of the fin size that would be required. Also, the blower for the tube would have to be quite large, reducing the overall transmitter ac-to-RF efficiency.

The expected lifetime of a tetrode in UHF service is shorter than a klystron of the same power level. Typical lifetimes of 8,000 to 15,000 hours have been reported. It must be noted, however, that the replacement cost of a tetrode is much less than a klystron or Klystrode tube.

Work is under way on methods to extend the operating limits of the tetrode, while still retaining the benefits of its inherent Class A-B operation. Tetrodes designed for 50kW peak-of-sync power have been considered by at least one tube manufacturer.

Microwave power tubes

The klystron is the mainstay of UHF broadcasting. The klystron is a *linear-beam* device that overcomes the transit-time limitations of a grid-controlled tube by accelerating an electron stream to a high velocity before it is modulated. Modulation is accomplished by varying the velocity of the beam, which causes the drifting of electrons into *bunches* to produce RF *space current*. One or more cavities reinforce this action at the operating frequency. The output cavity acts as a transformer to couple the high-impedance beam to a low-impedance transmission line. The frequency response of a klystron is limited by the impedance-bandwidth product of the cavities, which may be extended by stagger tuning or by the use of multiple-resonance filter-type cavities.

For decades, the klystron has been the primary means of generating high power at UHF frequencies. Output powers for multicavity devices range from a few thousand watts to 60kW. The klystron provides high gain and requires little external support circuitry. Mechanically the klystron is relatively simple. It offers long life and requires minimum routine maintenance.

The operating efficiency of a high-power transmitter is important to every end-user. The penalties for low-efficiency include high operating costs, shortened tube life and increased complexity of the cooling system. Much progress has been made within the last few years to dramatically improve the efficiency of power tubes used in UHF-TV broadcasting.

Comparing efficiency

Comparing the efficiency figures of TV transmitters is complicated by the many variables involved. Any examination of efficiency must be tempered with an under-

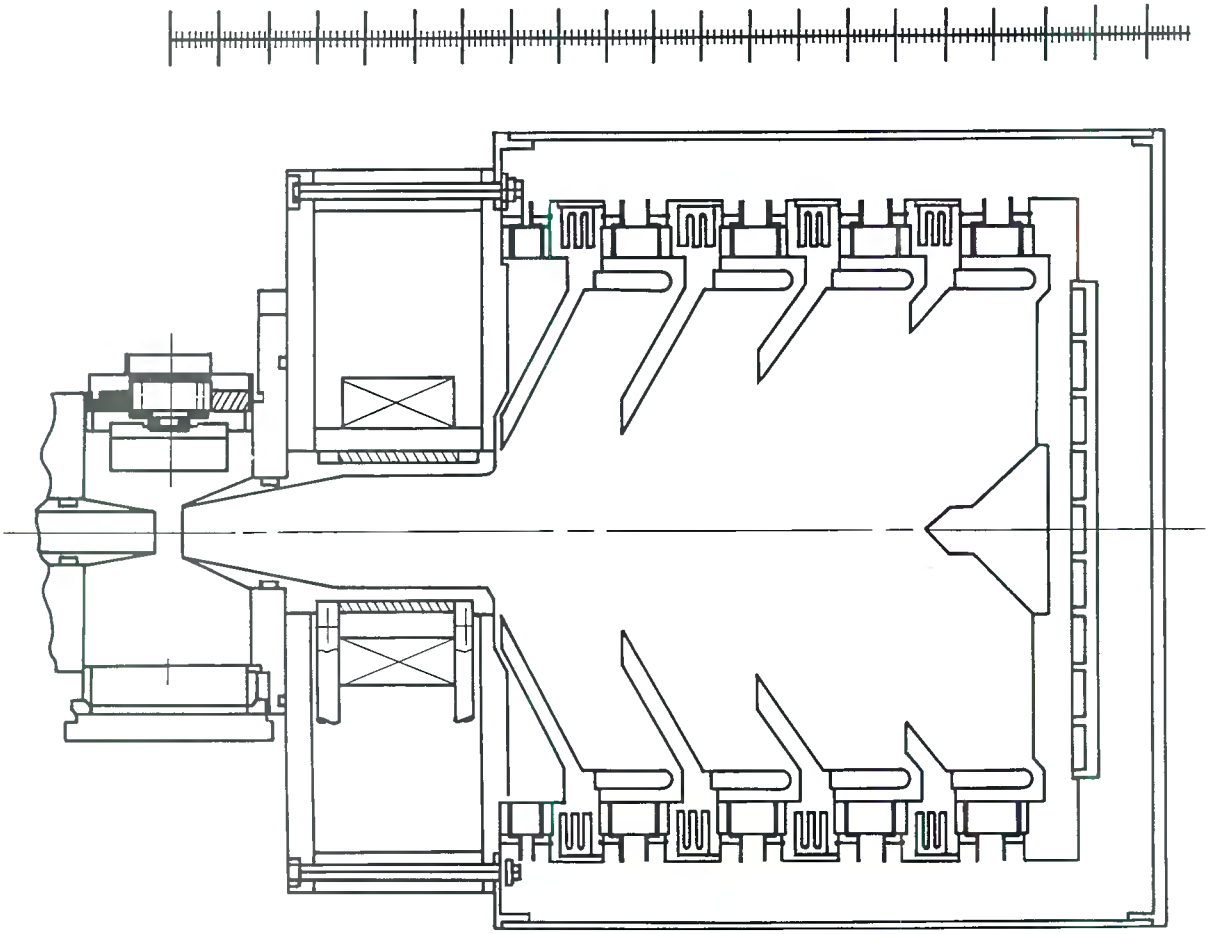


Figure 11. Mechanical design of the multistage depressed collector assembly. Note the "V" shape of the 4-element system.

Panasonic Broadcast News

NAB REVIEW

Panasonic Digital Is Olympic Choice For Barcelona

ATLANTA, GA (March 30, 1990) – Panasonic Broadcast Systems Company released information today that its parent company, Matsushita Electric Industrial Co., Ltd. (MEI), Osaka, Japan, has announced that its 1/2-inch composite digital video systems have been designated the official broadcast equipment for the 1992 Barcelona Olympic Games by the Comite Organizador Olimpico Barcelona '92 (COOB).

According to the official supplier contract, Matsushita, the manufacturer of Panasonic, Technics and Quasar products, will supply its new 1/2-inch digital video systems to the broadcast organization for the Olympic Games, the Radio Television Olympica '92 (RTO). All equipment will be passed through PESA Electronica S.A., an authorized prime contractor for the supply of Olympic broadcast equipment.

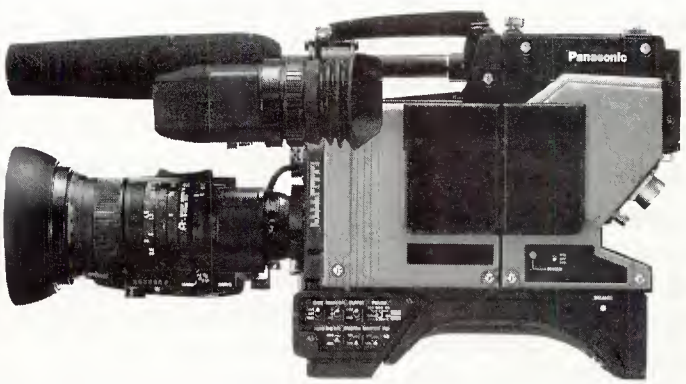
Matsushita's 1/2-inch composite digital video systems were jointly developed with NHK, the Japanese national broadcasting corporation, and will be available in both studio VCR's and camcorders. The camcorder model will be the world's first one-piece unit to incorporate a fully digitalized camera and the new 1/2-inch digital VCR unit.

Some 400 systems will be supplied by Matsushita to the RTO and installed at the International Broadcasting Center. The RTO will provide history's first Olympic coverage employing digital video systems. Through this arrangement, stations from other countries will be supplied with footage of the finest picture quality available.

The new 1/2-inch composite digital format features not only compact and lightweight configuration, but also multigeneration digital editing free from deterioration of picture quality. Available with such equipment as camcorders, portable VCRs and studio VCRs, the Matsushita 1/2-inch digital system will allow the integration of all processes from field shooting and post production to studio transmission with the same format.

Matsushita will supply ENG/EFP-use digital cameras and professional audio systems to theRTO.

AQ-11 Latest in All-digital Processing Cameras



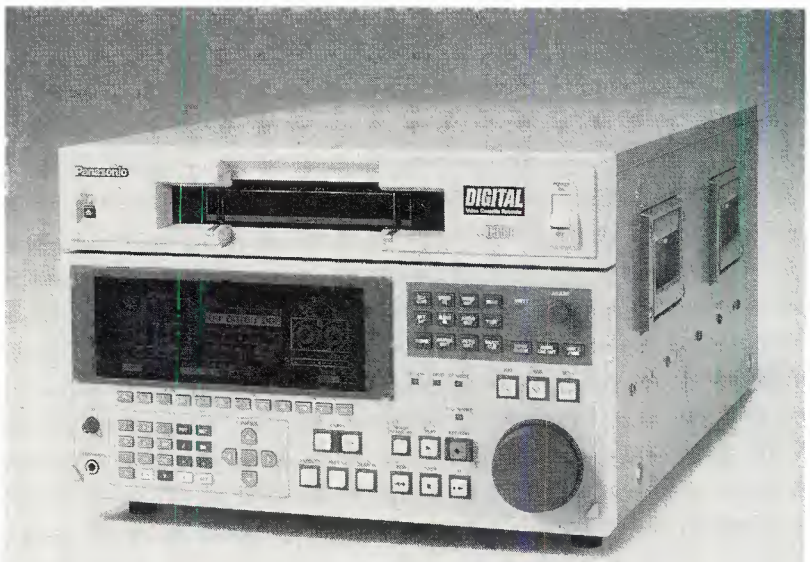
Model AQ-11 Digital Signal Processing Camera With 3-CCD IT Chip

ATLANTA, GA (March 30, 1990) – For a new dimension in ENG operation, Panasonic Broadcast Systems Company (PBSC) introduced the AQ-11 3-CCD digital processing camera here at NAB. The unit can be directly attached to the any compact broadcast 1/2-inch VTR without an adaptor to form a highly sophisticated portable Camcorder system.

The Panasonic Broadcast AQ-11, with its slim profile, weighs about seven pounds and warms up in less than three seconds. It incorporates three densely packed 400,000-pixel (754H x 487V) 2/3" Interline Transfer CCDs to provide the unit with a horizontal resolution of 700 lines. The camera has a signal-to-noise ratio greater than

Continued on page 8.

Panasonic Broadcast Ushers in ½-inch Composite Digital Recording Era



Model AJ-D350 1/2" Digital Composite VTR With Auto Tracking

ATLANTA, GA (March 30, 1990) – Panasonic Broadcast Systems Company ushered in a new era of television recording with the introduction of its AJ-D350 1/2-inch composite digital videotape recorder at the 68th Annual Convention of the National Association of Broadcasters here. The AJ-D350 is the first example of the new 1/2-inch Composite Digital Videotape Recording format that Panasonic expects to see widely adopted by the broadcast and related production and post production industries in the immediate future.

"The new 1/2-inch digital machines will cost substantially less to purchase and to operate than their D2 predecessors," said Stanley E. Basara, President and COO of Panasonic Broadcast Systems Company. "More importantly, we've accomplished those objectives while greatly improving the performance of composite digital recording for both professional broadcast and teleproduction environments."

The AJ-D350 1/2-inch Composite Digital Studio VTR is just the first in a series of new 1/2-inch digital VTRs that will include a broad line of products from a field portable recorder, a camera/recorder, to a Digital M.A.R.C. system. Models of these units were on display at the company's exhibit on the NAB convention floor.

The AJ-D350, as well as other VTRs use half-inch Metal Particle videotape cassettes offering more than 2-hours of running time. Not only are the cassettes themselves much smaller than the 19mm (3/4-inch) videotape cassettes required by D2 recorders, but they are also less expensive to purchase and to store. Cassettes for the 1/2inch digital video systems will come in two different sizes with four different play-durations (64 and 125 minutes and 50 and 95 minutes).

Many new technical advances were forged during the development of the new composite digital recording format. A new 8-14 channel coding system, for instance, led to a packing density 2.5 times greater than that achieved in D2 recording systems. A new error correction format is four times more powerful than the approach used in D2 systems. A new audio recording format utilizing double error correction, field shuffling audio sector allocation and guardband editing insures audio interchange and robust and reliable editing. Other original audio recording techniques provide for scratch protection and head clog protection.

The AJ-D350, an editing VTR, is enhanced markedly by the development of an entirely new editing technique which first erases the original data and then generates a guardband at the IN and OUT points. Even with tracking error, an edit does not result in any unerased original with the same azimuth as the new data. Wide playback heads read only the new data with the correct azimuth. With the error rate minimized, maximum interchange reliability is assured.

A new amorphous head design has increased sensitivity dramatically. Search speeds up to 100X normal are practical.

The Panasonic 1/2-inch composite digital videotape systems was developed jointly with NHK to meet the standards they have proposed to all manufacturers. "We are hopeful that in the next few weeks or months, other manufacturers will announce their intentions to developed machines to meet this standard," said Mr. Basara.

Shown at NAB: Models of a one-piece camera/recorder (top) and a field portable recorder soon to be added to the digital line.

NBC Adds $2 Million Worth of MII Equipment for News Bureaus

ATLANTA, GA (March 30, 1990) – Panasonic Broadcast Systems made public the NBC decision to add two million dollars in new MII field and studio recorders over the next few months to all its domestic and foreign news bureaus. "We are delighted," said Stanley E. Basara, President of Panasonic Broadcast Systems Company, "to meet the ENG requirements for NBC Network News."

Michael J. Sherlock, President, Operations and Technical Services, NBC said, "This latest round of MII purchases is merely a reflection of NBC's continued commitment to the MII format. A major portion of the new MII gear will be used to upgrade those foreign news bureaus still using 3/4-inch U-Matic equipment. The remainder of the MII equipment will be distributed among the domestic news bureaus." Mr. Sherlock continued, "In point of fact NBC has taken delivery of over 2000 MII machines to date. We are extremely satisfied with the performance, reliability, and the resulting operational cost savings the format has provided."

"I would like also to add that Panasonic Broadcast Systems has been very responsive to our needs in terms of training, service and parts. We look forward to continued business with Panasonic," Mr. Sherlock said.

New Dockable Recorders in the Cost-effective MII VTR Line

ATLANTA, GA (March 30, 1990) – Panasonic Broadcast Systems Company (PBSC) introduced the economically priced MII AU-410 and AU-410S high performance dockable recorders designed for ENG and EFP applications here at the NAB Show.

The AU-410 and -410S provide one-inch quality on a compact cassette which can be used in any MII VTR or player without an adaptor. The 410S features somewhat higher video and audio signal performance in order to meet the more stringent demands of broadcast use. Recording time is more than twenty minutes.

The new units weigh about eight pounds and have a signal-to-noise ratio of better than 48 dB for the 410 and better than 54 dB for the 410S. Both recorders are equipped with video confidence heads for both luminance and chrominance channels. The luminance channel playback is available through the viewfinder or conventional monitor while the chrominance signal is monitored by an indicator.

The AU-410 and AU-410S features two longitudinal tracks with Dolby™ C noise reduction, and two high quality FM tracks (CH3/CH4) that are simultaneously recorded on the chrominance track. The units also have a built-in speaker for audio monitoring.

Model AU-410 Series Dockable VTR

The Panasonic Broadcast MII units have a SMPTE LTC and VITC time code generator with an eight digit LCD display; a connector is provided for external input. Also featured is automatic backspace editing capability accurate within plus 3 or minus 2 frames. Playback can be monitored with the camera viewfinder or a black and white monitor by means of the video output connector.

The AU-410 will be available in August at a suggested retail price of $8500. At the same time, a high performance version of the unit, the AU-410S, will be available at a suggested retail price of $9,500.

Low-cost AU-63 Designed For High Quality Automatic Tracking

Model AU-63 MII Player Only
With Auto Tracking

ALTANTA, GA (March 30, 1990) – Panasonic Broadcast Systems Company introduced here at the 68th Annual Convention of the National Association of Broadcasters the AU-63–a new low-cost MII half-inch format studio playback VTR. The AU-63, priced at $13,000, is designed as a high quality automatic tracking playback unit for broadcasting or for source use in editing and dubbing.

Many of the unit's features have been specially designed for its principle role as a source or playback machine in editing and dubbing applications. A Tape Speed Override adjustment compensates for differences in playback speed in a second VTR in ranges from +/- 6.25 percent to +/-12.25 percent. An 8-digit LCD displays time code, CTL and all other data necessary to check the operation of the AU-63. Extensive front panel LED indication is provided for reference SCH, color framing, Dolby® NR, and other data.

The AU-63's analog component and advanced CTCM system, incorporating an amorphous head, assures superb playback quality from metal-particle cassettes that permit more than 90 minutes of playback. A small 20-minute cassette can be used without an adaptor; footage can be edited and broadcast directly from ENG tapes without dubbing.

An internal component digital time base corrector (TBC) provides 32 line correction for the baseband video signal. Complete synchronization with other equipment can be controlled by the internal TBC and external TBC reference input.

By plugging in the optional AU-F65 time Code Generator/ Reader, the AU-63 reads SMPTE time code from recorded tapes, switching between vertical interval and longitudinal data according to tape speed. User bit data can be retrieved independently for either VITC and LTC (time code).

The AU-63 provides high-speed picture search, up to 32 times normal speed, in forward and reverse; the jog mode's quick response permits accurate, convenient picture search. Slow motion speed can be set to 1/2, 1/8, 1/16, or 1/32 times normal speed prior to normal playback for smooth transfer using the VAR key with no disruption in the picture.

Also, the unit allows up to four cue points to be registered and the independent Cue Up button provides speedy access to desired cue points. A tape speed override permits manual adjustment of playback speed differences between the AU-63 and a second VTR in ranges of plus or minus 6.25 or plus or minus 12.25.

The S-Video (4-pin) connector of the new Panasonic Broadcast Studio Player provides separate output of luminance (Y) and chrominance (C) signals for editing and dubbing – it assures that high picture quality is maintained during transfer to S-VHS and VHS format videotapes. When playing back tapes with color framing ID, the unit will control color framing in a 4-field sequence to prevent H-shift at edit points and produce a clear picture.

In addition, the AU-63 features four channel audio – two FM channels supplement the two longitudinal channels, providing stereo as well as bilingual reproduction. Dolby® C noise reduction circuitry provides superior audio signal-to-noise performance on longitudinal tracks.

With the Studio Player's on-screen mode setting, more than 40 fine user adjustments, that once required DIP switch changes, can now be made quickly and easily on-screen. There is less likelihood of error since all settings can be verified on the monitor. A digital hour meter self-stores accumulated running time that can be displayed on the monitor to keep track of maintenance cycles.

The AU-63 is equipped with the RS-422A, a serial (9P) remote interface, that is compatible with existing broadcast serial control equipment. It also accepts 50-pin parallel input by means of an optional interface board. An 8-digit LCD displays time code, CTL and other data necessary to check the operation of the AU-63.

50th M.A.R.C. Cart System Delivered

ATLANTA, GA (March 30, 1990) – Panasonic Broadcast Systems Company announced the delivery of the 50th M.A.R.C. automated recording/playback cassette system at the National Association of Broadcasters (NAB) show. Panasonic Broadcast has sold more than 55 M.A.R.C. cart systems to date.

Panasonic Broadcast will deliver M.A.R.C. Sytems to KTRV in Nampa, Idaho, and to KGSW in Albuquerque, New Mexico, immediately after NAB show, where both systems will be displayed.

Since the stations' agreement for display at NAB caused deliveries to be almost simultaneous, Panasonic will award both 50th delivery honors.

Panasonic Broadcast's "cart machines" have been purchased by ABC, CBS, and Fox network affiliates and independent stations throughout the U.S. as well as the NBC network and O & O stations.

NBC has taken delivery of these systems for use at network facilities in New York and Burbank, as well as stations in Chicago, Washington, Cleveland, and Denver. The M.A.R.C. system plays on-air commercials, as well as programming, not only for these diverse stations but for the Family Channel, a major cable program supplier, as well.

PBSC Posts Strong 4 Quarter Finish: M.A.R.C. Leads The Way

SECAUCUS, NJ (January, 1990) – Panasonic Broadcast Systems Company put a strong finish on its 1989 season with sales in the closing weeks of the calendar year topping $3-million.

Especially gratifying to the company was the sale, in just the past few weeks, of four M.A.R.C. systems, the company's automated video cassette system. The new M.A.R.C. buyers were KTRV, a Fox Television Network affiliate station in Boise, Idaho and the News Press & Gazette, headquartered in Jackson, Mississippi which has purchased a 100-cassette M.A.R.C. system for use at its Wilmington, North Carolina station, WECT. The Providence Journal Broadcast Group purchased two M.A.R.C. II-400 systems for use at its KGSW-TV, station in Albuquerque, New Mexico and at its Tucson, Arizona station, KMSB-TV; both of which are Fox Television Network affiliates.

The strong fourth-quarter performance for Panasonic Broadcast has not been limited to the M.A.R.C. system. In the same period, nearly $2-million worth of recorders and cameras were sold to broadcasters as well as business and institutional television producers. Especially strong was the new low-cost AU-60 Editing VTR, more than 35 of these systems were sold in the span of just a few weeks.

"We're looking at this strong 4th quarter finish as a harbinger of the New Year," said Stanley Basara, president and CEO of Panasonic Broadcast ."We've got an extremely strong hand to play in 1990 in both digital and analog video systems and I think this past quarter is just the beginning of what might well be the Panasonic decade."

WBRE Goes With M.A.R.C. For Automation

SECAUCUS, NJ (March, 1990) – WBRE-TV, Channel 28 in Wilkes-Barre, Pennsylvania, has ordered the M.A.R.C. II-100 MII automated recording/playback cassette system and six AU-60 VTRs, from Panasonic Broadcast Systems Company.

The M.A.R.C. II-100, scheduled for delivery this summer, replaces two quad cart machines for spot play and other VTRs for program playback at the NBC affiliate, according to chief engineer, David Swartz. "We investigated all the systems currently available, including some sequencers," said

Continued on page 6

WBRE Goes With M.A.R.C. For Automation.

Continued from page 5

Swartz. "We were looking for the best quality picture, cost-effectiveness for operations; tape-longevity and size, and versatility of system."

"Panasonic's M.A.R.C.II-100 promises to be WBRE-TV's first step in station automation. "Because the M.A.R.C. is controlled by a Compaq PC we can tie it to our engineering department computer for daily database back-up and link it to our traffic system," said Swartz.

"We expect the M.A.R.C. to get us through at least three hours of spots and programming during local access," he added. "It will also enable us to be more creative with fast-paced promos since the M.A.R.C. can easily handle four or five, five-second IDs back-to-back."

Five of the station's new AU-60 VTRs will be dedicated to the M.A.R.C. with one used externally. "We've been using three AU-650 recorders for more than a year to create break tapes," said Swartz. "They've been utilized heavily with few problems and the quality of the tapes coming off the VTRs has been as good as the originals."

High Performance Studio VTR With Auto Tracking Debuts

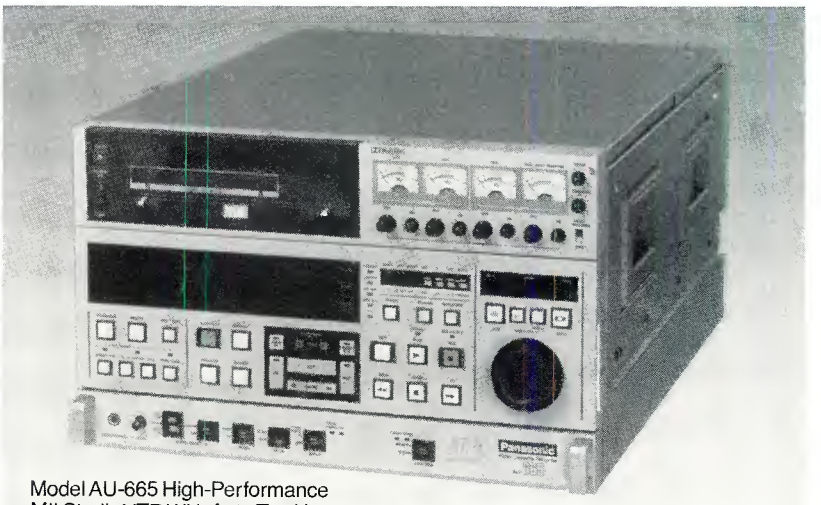
ATLANTA, GA (March 30, 1990)–An advanced, high performance MII Studio VTR with noiseless auto tracking and 90-minute playback – the AU 665 – was introduced by the Panasonic Broadcast Systems Company (PBSC) here at the NAB show.

The new AU-665 VTR incorporates a 9-bit digital Time Base Corrector with 32 Hp-p correction capability to reduce quantizing noise and provide signal-to- noise ratio of better than 50 dB. It incorporates one event editing function recall and has an optional CCIR 601 output to provide a digital signal feed to a D-VTR.

The new studio VTR combines advanced video/audio quality and features confidence playback during editing, S-VHS in/out terminal and input switch, XLR TC in/out terminals, field DOC, digital timer and on-screen display.

Color framing is controlled in a 4-field sequence to eliminate the H-shift at editing points and assures optimal picture quality in editing. Like other MII-format VTRs the unit features 90 minutes of recording/playback though the new AU-665 can run a 20-minute cassette without an adaptor.

An important feature of the AU-665 is a standard adaptive edge comb filtering that delivers outstanding horizontal resolution in slow motion and still playback in the auto tracking mode.



Model AU-665 High-Performance MII Studio VTR With Auto Tracking

Amorphous video heads improve high frequency characteristics to match the performance of metal tape. The VTR's shuttle mode allows high speed access at a maximum of 32 times normal speed in forward and reverse directions. Its jog mode capability allows noiseless playback form -1x to +2x times normal speeds (in 56 steps), plus noiseless still playback.

The AU-665 is equipped with dual video and audio (CH1/CH2) heads that allow real time monitoring of picture and sound during recording. Two FM audio tracks (CH3/CH4) enable audio recording and playback on four separate channels.

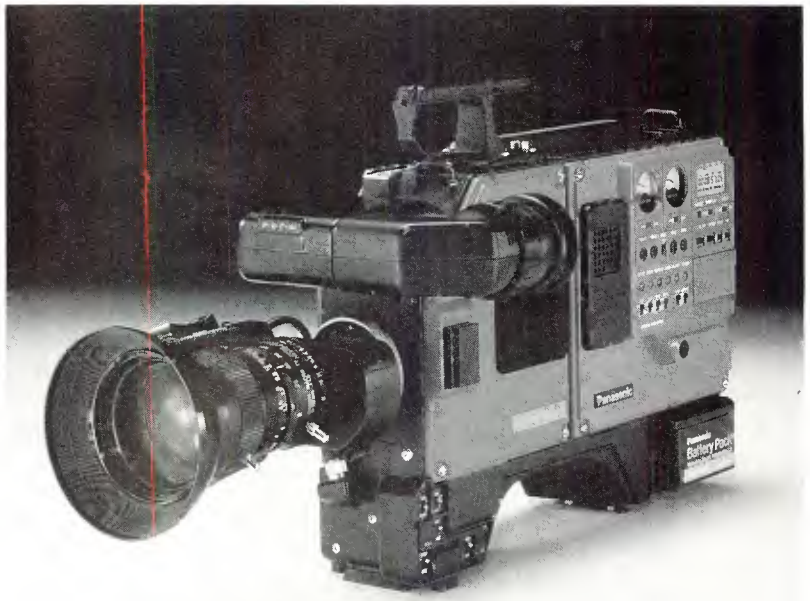
Besides insert/assemble editing, the AU-665 offers Audio Split, Variable Memory, On-The-Fly in the AT mode, Preview, Review, Trim, Go To, Auto Tags, Retry and Discontinuous Time Code. It is equipped with parallel (50-pin) and serial (9-pin) remote interfaces. The AU-665 will be available in November at a suggested retail price of $35,500.

KPNX-TV Finds Place In The Sun For MII

SECAUCUS, NJ (March, 1990) – KPNX-TV, Channel 12, in Phoenix, Arizona has completed its conversion to Panasonic Broadcast Systems' MII recording format this past October with the addition of three AK-400 cameras, reports chief engineer Chuck Deen. KPNX began the conversion to MII with the purchase of a large number of field and studio MII VTRs more than two years ago.

The versatile three-CCD color video cameras are used in a variety of applications from rough-and-ready EFP and ENG to shooting station promos, commercials and sporting events for KPNX-TV's production wing.

Known for capturing the lion's share of area Emmys and other awards for its news coverage, KPNX airs three hours of local news weekdays.



Model AK-400 3-CCD Color Video Camera

For news photographer Howard Shepherd, who began in the industry carrying a 65-pound film camera, the AK-400's mobility and easy handling is crucial to getting the news whenever and wherever it happens. "We do lots of spot news here and since that happens so quickly, if you need to spend an extra 10 seconds getting your camera ready, the story could be gone.," says Shepherd.

"The AK-400 powers up quickly and can white balance instantly," he notes. "This is critical for spot news. As soon as I get in the car I turn on the camera so when we arrive on-site I'm ready to roll tape while other photographers are still waiting to power up and white balance."

Shepherd, who had previously been using tube-type ENG cameras, also appreciates the AK-400's low-light levels. "In deep blacks and shadows you can see lots of detail," he says. "I've used the black stretch feature several times and found it very helpful; that's a feature I haven't seen on other chip cameras."Meeting the rigors of Phoenix's desert climate is also a day-to-day necessity for the AK-400s. "It gets so hot here that many cameras will turn off at 115 degrees," states Shepherd. "But the AK-400 is still operating at 125 degrees."

A recent feature Shepherd lensed on fraud perpetrated against aliens trying to obtain U.S. citizenship under the amnesty program, subjected the camera not only to heat but also the heavy dust of Mexican-border locations. "The dust didn't seem to bother the camera at all," says Shepherd. "All the AK-400's critical areas are capped with spring-loaded doors to keep dust and grime out."

As photographer/editor at KPNX-TV's Gannett Production Services, the production wing of the station, Steve Snow has a different perspective of how the AK-400 performs in a wide range of activities.

"I have to admit the AK-400 was not my first choice," said Snow. "But it's surprised me; I didn't think it would be as good as it is. It's certainly the best buy in the market at the moment."

Snow has used the camera docked to its AU-400 recorder as well as with the AU-500 MII-format portable VTR. He finds the AK-400 very responsive in low-light conditions and likes such design features as the adaptable mic holder, phantom power switch and viewfinder display.

Snow recently packed up his AK-400 and traveled to Yuma and Tuscon, Arizona to tape features on two outstanding volunteers for the "Twelve Who Care" series telecast on all Gannett stations. "We spend time with volunteers, following them around and capturing the activities they're involved in," explains Snow. He admits that he was hard pressed to keep up with the likes of 87 year-old Fan Kane in her work with minority and brain-damaged children and Margaret Smith's fund-raising for kids with Downs syndrome.

"I've used a lot of chip cameras over the past few years, so I think I'm able to make good comparisons," says Snow. "The AK-400 stands up very favorably with other chip cameras and with the Sony 330 tube camera we used to have. My experience with the AK-400 in the field has been just great. I really enjoy using it."

Young Broadcasting Goes With MII For Present And Future

The AU-60 Cost Effective Studio Recorder

SECAUCUS, NJ (March, 1990) – When Young Broadcasting's CBS affiliate WLNS-TV in Lansing, Michigan decided to make a complete switchover to half-inch for its news, on-air playback and multi-cassette operations, it chose Panasonic Broadcast's MII format.

"This is a total revamp for us, replacing our 3/4-inch equipment," explains operations directors Steve Hillman. "We're confident the MII format will not only help us step into the 1990's but also take us through to HDTV.

The image quality of MII is outstanding; it's as close to 1-inch as you can get," said Hillman who selected four AK-400 lightweight, compact, 3-CCD cameras for ENG. "We're the number-one station in the market and we strongly believe the future of local TV is news. The AK-400 is an excellent camera that's going to keep us way ahead of the competition."

WLNS-TV outfitted its four edit suites with a combination of four AU-60 Editing VTRs and four AU-630 studio players with dynamic tracking. Two additional AU-60s are utilized to record network and satellite feeds, one for news and one for sports.

Sister-station WTVO-TV in Rockford, Illinois, which started its conversion to the MII format two years ago, recently ordered six AU-60 VTRs for three news and sports edit suites, an AU-505 portable player for field playback and AK-400/AU-400 ENG camera/recorder systems.

"Young Broadcasting has made a major financial commitment to moving us into the next decade," said WLNS-TV's Steve Hillman. "We're excited to be taking that step with Panasonic technology. Panasonic has shown us its products and service are second to none."

AQ-11 Latest In All-digital Processing Cameras Continued from page 1

60dB and high sensitivity of 2,000 lux at f 5.6.

The new Panasonic Broadcast camera is equipped with a variable speed (1/100, 1/125, 1/250, 1/500, 1/1000, 1/2000) electronic shutter that minimizes lag of moving objects and permits the creation of "stop action" effects. Sampling frequency is 4 fsc (4X subcarrier frequency), allowing direct connection to composite digital VTRs and a wide range of other digital equipment.

The AQ-11 features registration accuracy better than 0.05% and its digital processing technology practically eliminates registration shifts due to time lapses or temperature changes in ambient conditions, making adjustments unnecessary. A large variety of settings can be controlled centrally with the AQ-EC1 Extension Control Unit and setting values are indicated in the viewfinder.

The AQ-11's digital processing circuitry allows selection of peak frequencies within a range of 2.5 MHz to 5.5 MHz; a selection of optimum values according to individual shooting conditions. It also enables precise shading at high speed (within 10 seconds), at a touch of a single button.

The camera provides auto shading correction and set-up memory to compensate for highlight situations and bring out details even from within dark areas. A two-dimensional digital filter supresses cross-color contamination from the mixture of subcarrier and high frequency luminance signals. More than 500 gamma curve points can be designated for a pinnacle of precision never before attainable.

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standing of the measurement parameters. Some manufacturers specify overall transmitter ac-to-RF efficiency, including the cooling system. This number is really what the end-user needs to know. With klystron-based transmitters, the efficiency of the final amplifying stage also is important because that is where most of the energy is expended.

Because the klystron is a Class A device, the average dc input power does not vary significantly with picture content. The *figure-of-merit* (FOM) is defined as:

$$\text{Figure of merit} = \frac{\text{RF peak power output}}{\text{average dc input at 50\% APL}}$$

$$\text{Peak-of-sync efficiency} = \text{FOM} \times 100\%$$

Work over the last two decades to ease the burden faced by UHF stations has been evolutionary. Early klystrons for TV service had an FOM of between 0.30 and 0.40. The introduction of mod-anode pulsing enabled FOM performance of greater than 0.40 to be achieved using these tubes. Improved designs and new methods of tuning, which traded gain for efficiency, brought the basic tube FOM to more than 0.40. External cavity klystrons of this efficiency that were fitted with a pulsed *annular control electrode* (ACE) further improved the FOM to between 0.50 and 0.60. The latest generation of external cavity klystrons have achieved a basic FOM of 0.50, which when pulsed may be raised to between 0.60 and 0.75. Integral cavity ACE tubes are now in service with a potential FOM in excess of 0.80.

The next step up the efficiency ladder is revolutionary, not evolutionary. The Klystrode tube, the first true high-efficiency high-power UHF transmitting device to go into regular service, and the MSDC klystron achieve a dramatic leap in FOM.

Klystrode tube

The basic concept of the Klystrode dates back to the late 1930s, but it was only within the last decade that serious engineering effort was put into the tube to make it a viable product for high-power UHF service.

The fundamental advantage of the Klystrode is its ability to operate Class B. The result is higher efficiency when compared to a conventional klystron. (A simplified schematic diagram of the Klystrode tube is shown in Figure 10.)

Several variations on the basic Klystrode scheme have been developed, including air-cooled klystrons operating at 15kW, 30kW and even 60kW. Air-cooling is practical at these power levels because of the improved efficiency that Class B operation provides.

So far, 10 Klystrode-equipped transmitters have been placed into service (by Comark), and another five are under construction. Power levels ranging from 10kW to 240kW have been delivered and commissioned. Both split and common amplification have been successfully used. A transmitter is currently under construction for WSNS-TV in Chicago that will operate with 120kW in common amplification, air-cooled. FOM performance of Klystrode-equipped transmitters has consistently measured between 1.20 and 1.45.

MSDC klystron

Developmental work on the multistage depressed collector (MSDC) klystron began in the mid 1980s, although experimentation with depressed collector klystrons dates back to at least the early 1960s. Early products offered a moderate improvement in efficiency, but at the price of greater mechanical and electrical complexity. The MSDC design, although mechanically complex, offers a significant gain in efficiency.

MSDC tubes have been built around both integral-cavity and external-cavity klystrons. The devices are essentially identical to a standard klystron, except for the collector assembly. Mathematical models provided researchers with detailed information on the interactions of electrons in the collector region. Computer modeling also provided the basis for optimization of a *beam reconditioning* scheme incorporated into the device. Beam reconditioning is achieved by including a *transition region* between the RF interaction circuit and the collector under the influence of an intermediate magnetic field. It is interesting to note that the mathematical models made for the MSDC project translated well into practice when the actual device was constructed.

From the electrical standpoint, the more stages of a multistage depressed collector klystron, the better. The trade-off, predictably, is increased complexity and, therefore, increased cost for the product. There also is a point of diminishing returns that is reached as additional stages are added to the depressed collector system. A 4-stage device was chosen for production design because of these factors. As additional stages are added above four, the resulting improvement in efficiency is proportionally smaller.

Figure 11 shows the mechanical configuration of the 4-stage MSDC klystron. Note the "V" shape that was found, through computer studies, to provide the best "capture" performance, minimizing electron feedback.

Currently, three MSDC-equipped transmitters are on the air (built by Harris and Varian/TVT). They have been in service about two to three months. Two systems operate at 60kW and the other at 120kW.

Recent developments

This article was going to press as the NAB convention approached. Several developments were expected to be announced at the show, including second sources for both the Klystrode tube and the MSDC klystron. The latest news in this area will be covered in the NAB wrap-up report in the June issue.

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By Dane E. Ericksen, P.E.

Is your STL ready for the 1990s?

You're running out of time to bring your STL into compliance.

Nothing lasts forever. Case in point: The expiration date is just about up on the Federal Communications Commission rules that have exempted grandfathered TV auxiliary microwave stations from meeting minimum antenna standards and minimum path-length standards. Similar minimum antenna standards have been proposed for aural microwave links. This article will review those standards and provide a guide as to whether your studio-transmitter link (STL) will be affected.

Minimum antenna standards

In Docket 21505 (October 1980), the FCC adopted minimum antenna standards for TV STLs and intercity relays (ICRs) in the shared 13GHz band. STL applications submitted after Oct. 1, 1981 had to meet minimum antenna standards. Existing fixed microwave stations and applications on file as of Oct. 1, 1981 were given a 10-year grandfather period. They had until Oct. 1, 1991 to upgrade their transmitting antennas.

FCC General Docket 82-334 subsequently extended minimum antenna standards to the 2GHz, 7GHz, 18GHz and 31GHz TV STL/ICR bands. Any existing fixed links were grandfathered until Oct. 1, 1991.

To promote sharing of the spectrum, the commission adopted two categories of minimum standards. These standards, A and B, define the antenna's beamwidth and off-axis discrimination or radiation pattern envelope (RPE). *Fixed-link microwave stations that have not upgraded their antennas to category A in frequency congested areas and to at least category B in other areas will not have their licenses renewed after 1991.*

The minimum antenna performance standards for the 2GHz, 7GHz, 13GHz and 18GHz TV STL/ICR bands are shown in Figures 1-4. In general, at least an 8-foot dish must be installed for category A performance in the 2GHz and 7GHz bands and at least a 6-foot dish is needed for category B performance. For the 13GHz band, category A generally means at least a 6-foot dish, and category B performance calls for a 4-foot dish.

At 18GHz, high-performance antennas with diameters of two feet or more generally will provide category A performance. Standard-performance antennas with diameters of two feet or more usually will provide category B performance. The only FCC requirements for 31GHz-band antennas are that the antenna half-power beamwidth (HPBW) not exceed ±2° and that the antenna have a gain of at least 38dB. The author has been unable to locate data on 31GHz antennas, and is not aware of any equipment being manufactured commercially for the 31GHz broadcast auxiliary band.

Ericksen is a consulting engineer for Hammett & Edison, San Francisco.

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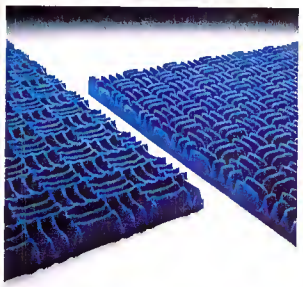

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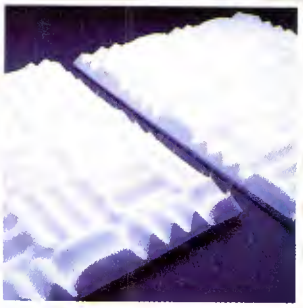

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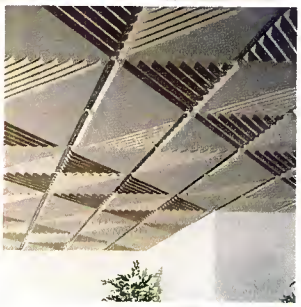

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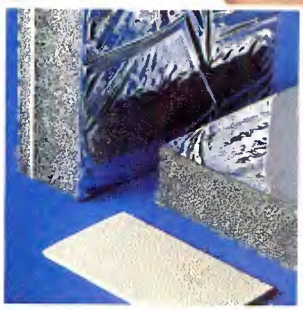

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The minimum antenna standards currently apply only to transmitting antennas. Table 1 summarizes available microwave antenna performance and approximate costs in each band. The table is intended to provide only general guidelines for antenna size vs. performance. Verify the performance specifications and FCC antenna category for the actual make and model of antenna you plan to use.

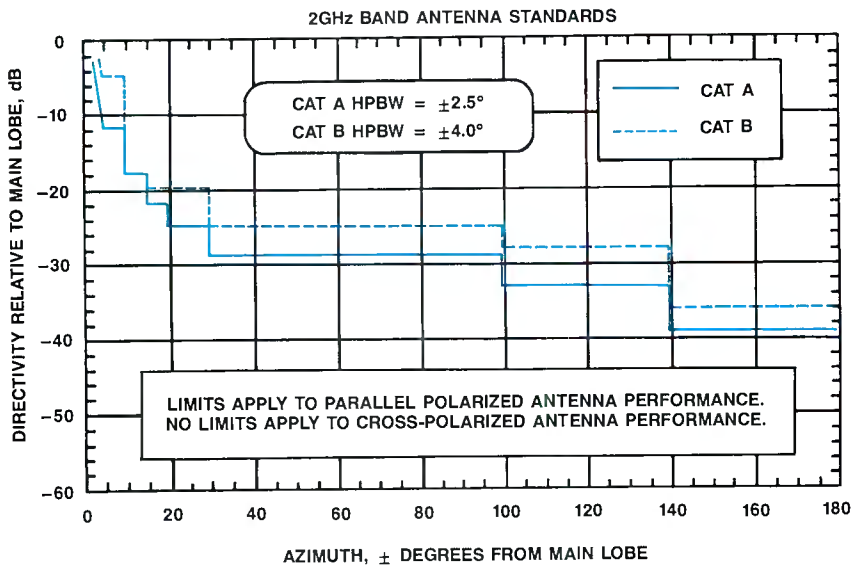


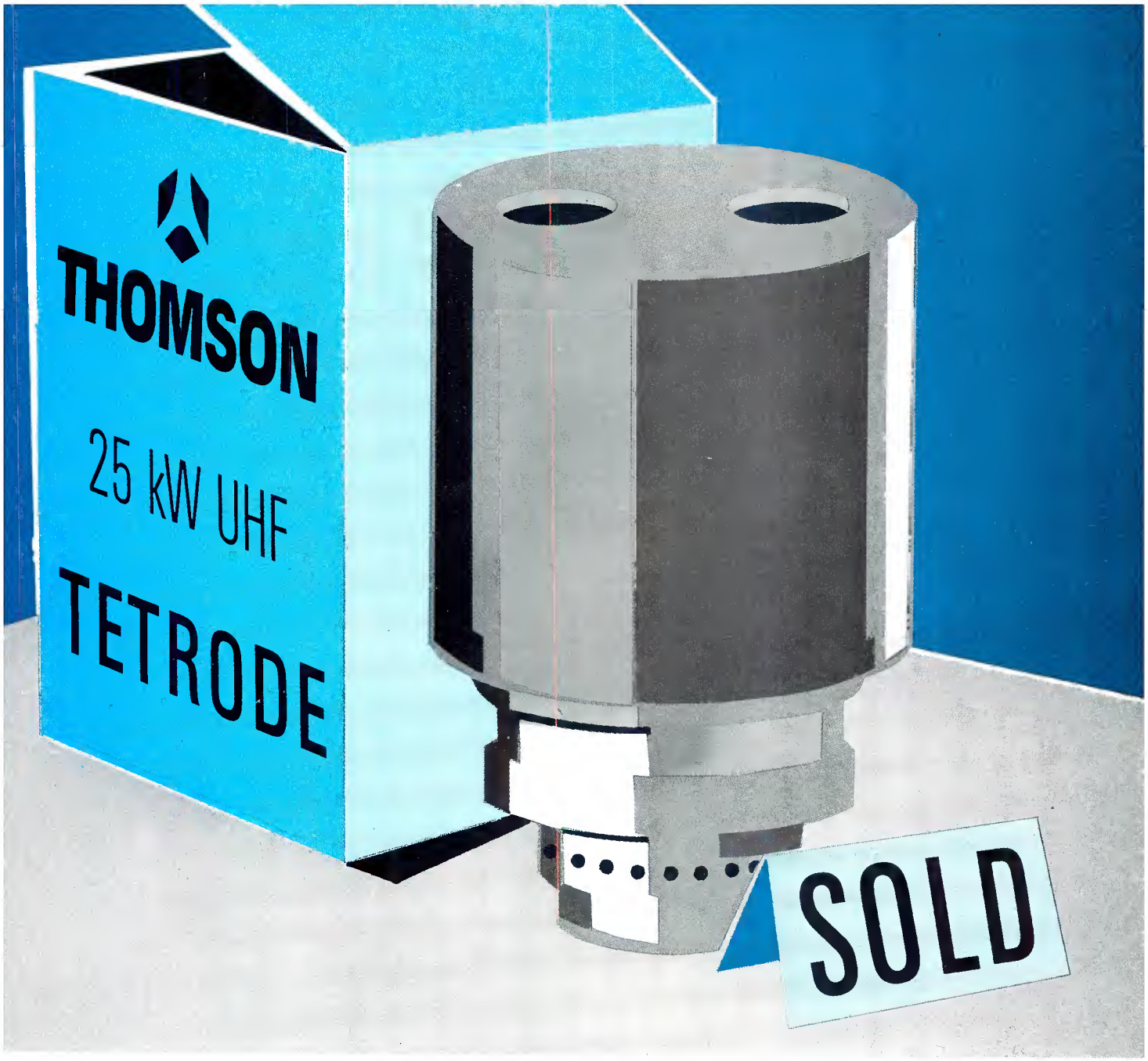
Figure 1. Current FCC minimum antenna standards for the 2GHz band.

What is a frequency-congested area?

Whether a category A antenna must be installed in place of a category B antenna depends on whether your STL/ICR transmitter is located in "an area subject to *frequency congestion*." This term is used in Section 74.641 of the rules. Unfortunately, the commission never got around to defining it. However, if a grandfathered link is located in a major metropolitan area, there is little question that it is located in "an area subject to frequency congestion," and category A antenna standards would apply.

Similarly, if a link is located in a small community with few or no other microwave paths, the station is located in an area not subject to frequency congestion, and category B antenna standards would apply. What is unclear is the status of TV microwave stations located in communities that fall somewhere between these two extremes.

In February 1990, the Society of Broadcast Engineers (SBE) asked the commission to clear up the issue. The SBE filed a rulemaking petition proposing that all standard metropolitan statistical areas (SMSAs) be considered frequency-congested areas. The petition also proposed that the FCC create a list of speci-



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BAND	ANTENNA DIAMETER	TYPICAL HPBW	TYPICAL GAIN	FCC CATEGORY	APPROXIMATE COST
2GHz	6 ft	5.5°	29.4dBi	B	$1,600
2GHz	8 ft	4.1°	32.0dBi	A	$2,400
7GHz	6 ft	1.7°	39.9dBi	B	$1,800
7GHz	8 ft	1.3°	42.4dBi	A	$2,500
13GHz	4 ft	1.4°	41.5dBi	B	$1,500
13GHz	6 ft	0.9°	45.1dBi	A	$1,800
18GHz	2 ft (standard)	1.9°	38.9dBi	B	$700
18GHz	2 ft (high-perf)	1.9°	38.9dBi	A	$1,700

Note: Data based upon composite of performance characteristics for Andrew Corporation, Cablewave Systems and Radiation Systems antennas. Costs are based upon 1989 price lists.

Table 1. Some of the performance characteristics available with today's antennas.

fic sites, outside of SMSAs, which also would be considered "subject to frequency congestion." It was recommended that this list be updated annually, under delegated authority to the Mass Media Bureau chief or the Auxiliary Services Branch chief. Once a site made the list, it would stay on the list because it would be unlikely to become uncongested.

The SBE proposed that a set of geographical coordinates be assigned to each site on the list, and that any microwave station within 3km of those coordinates be considered as located at that site. The SBE anticipates that members of its numerous frequency-coordinating committees and others would help the commission create the initial list and make additions as needed.

The proposal is a departure from previous attempts by the commission and others to define frequency-congested areas based upon burdensome "bean-counting" methods. Those methods required a detailed census of all microwave links within a given area. An advantage of the SBE's SMSA/designated site approach is that it would be easy to implement.

With the exception of the New England states (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont), SMSA boundaries comprise one or more county boundaries. Therefore, congested area status could be determined simply by referring to a list of SMSA counties. In the New England states, SMSAs are comprised of New England Consolidated Metropolitan Areas, or NECMAs. For administrative convenience, the SBE has proposed that county boundaries also be used in the New England states because, for the most part, NECMA boundaries comprise most of their affiliated county boundaries.

Until the commission acts on this peti-

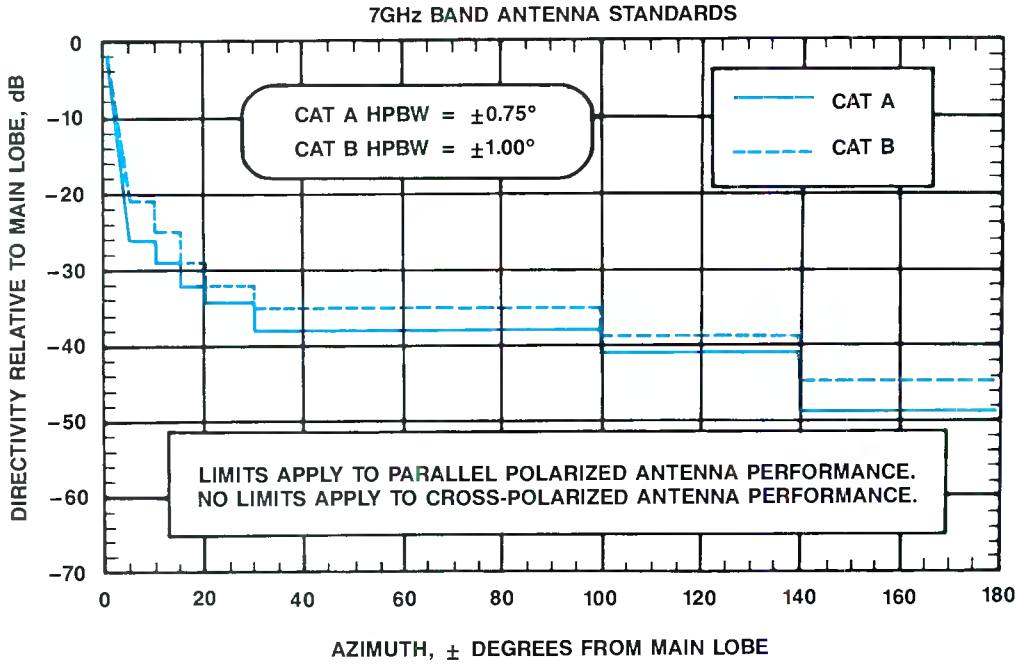

Figure 2. Current FCC minimum antenna standards for the 7GHz band.

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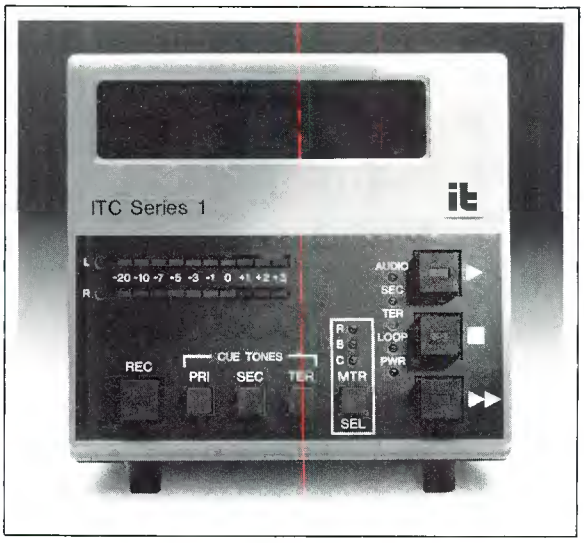

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tion, the congested area question will not be resolved. In the interim, the author suggests that licensees upgrade to category A status any fixed-link transmitting antennas that do not meet even category B criteria. The cost differential is only about $1,200 at 2GHz, $700 at 7GHz and $300 at 13GHz. For grandfathered links, which are already category B, the question is

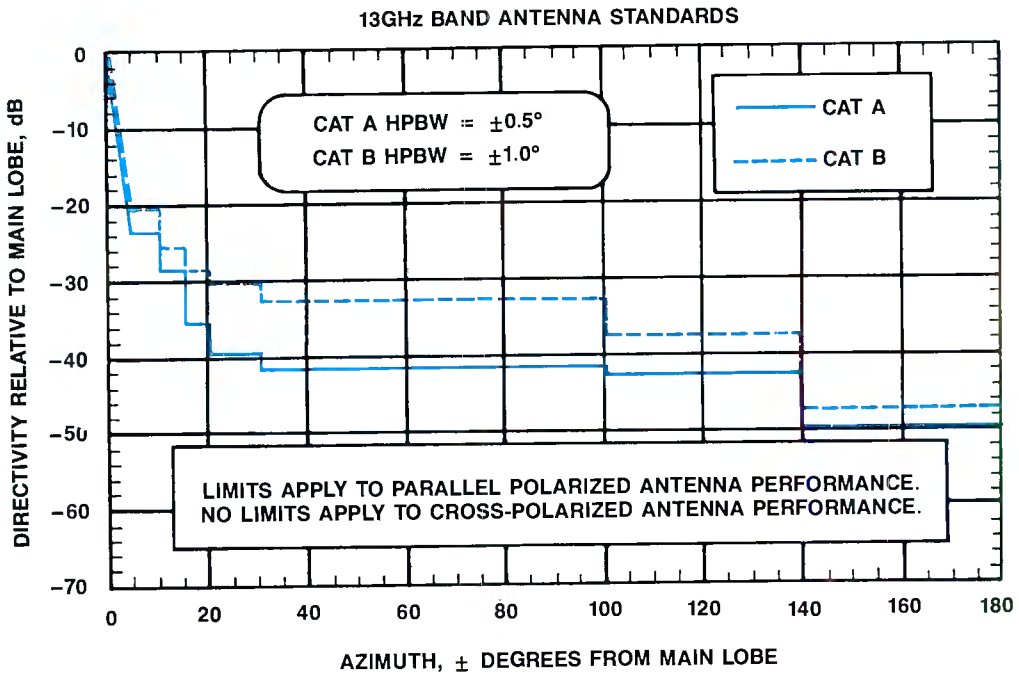

Figure 3. *Current FCC minimum antenna standards for the 13GHz band.*

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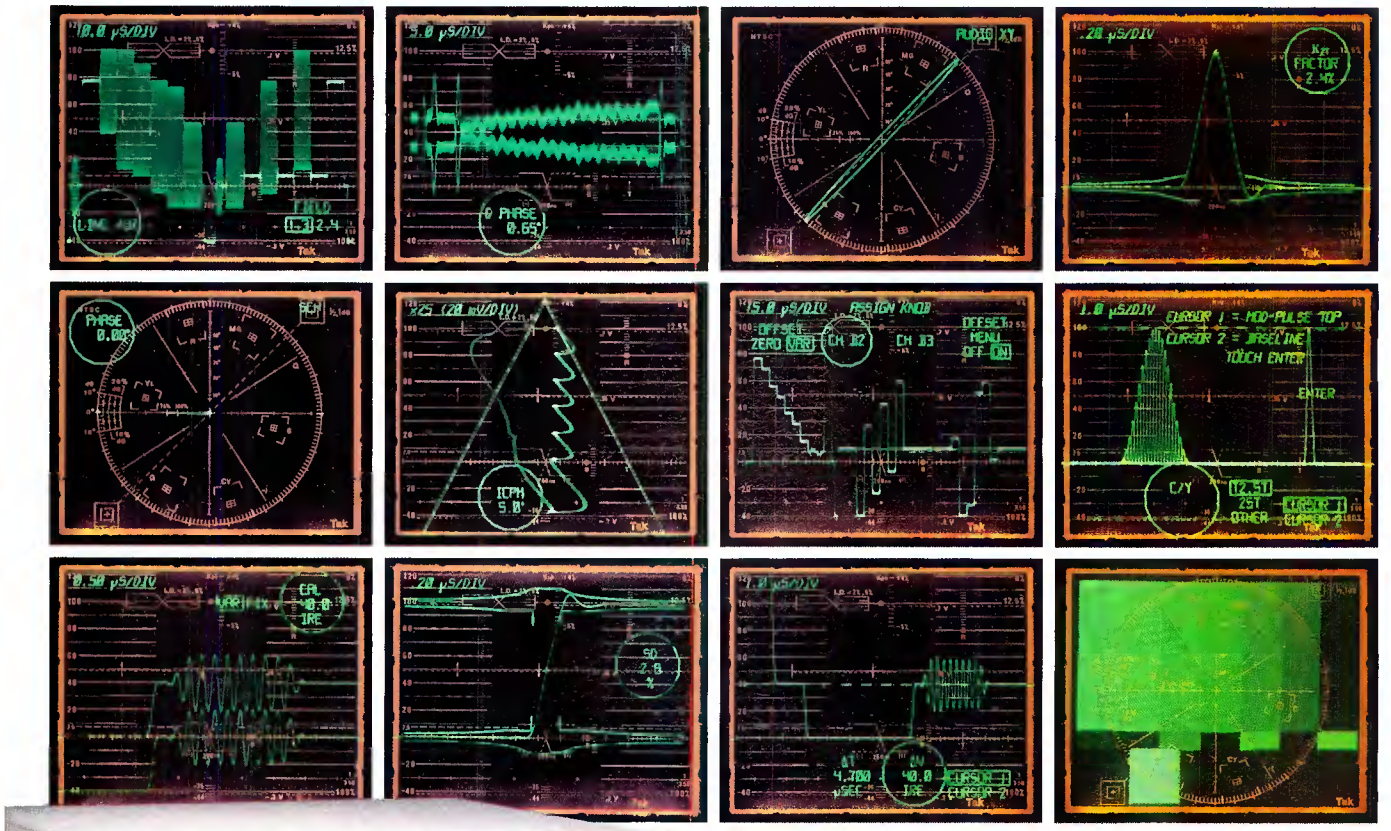

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more troublesome. It is a matter of no change at all vs. upgrading to a category A antenna.

How will the deadline be implemented?

Exactly how the commission may implement the 1991 deadline is not known. The author's informal discussions with FCC staff members have disclosed that at least one possibility is under consideration. It would have the FCC license renewal documents that are issued after Oct. 1, 1991 list exactly which STL and ICR stations are being renewed. This would differ from the current practice of allowing the Part 73 license renewal to serve as a blanket renewal of all associated auxiliary broadcast stations.

It is presumed that the commission will have established its congested area criteria by that time. If so, the agency can use those guidelines to decide which grandfathered links with category B antennas will be subject to renewal.

You may not want to wait until the FCC issues your next renewal document to find out whether your STL or ICRs are going to be renewed. It might be smart to go ahead and upgrade the transmitting antenna to category A if the link is located in an SMSA, on a congested mountaintop or on a tall tower with several TV auxiliary links. Such sites would be obvious candidates for inclusion on the proposed list of additional sites outside of SMSAs that would be subject to frequency-congested status.

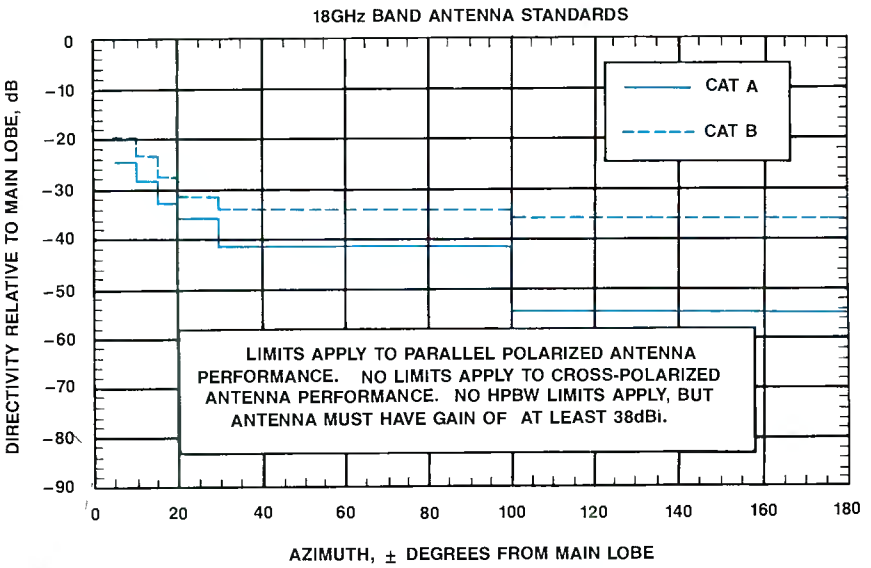
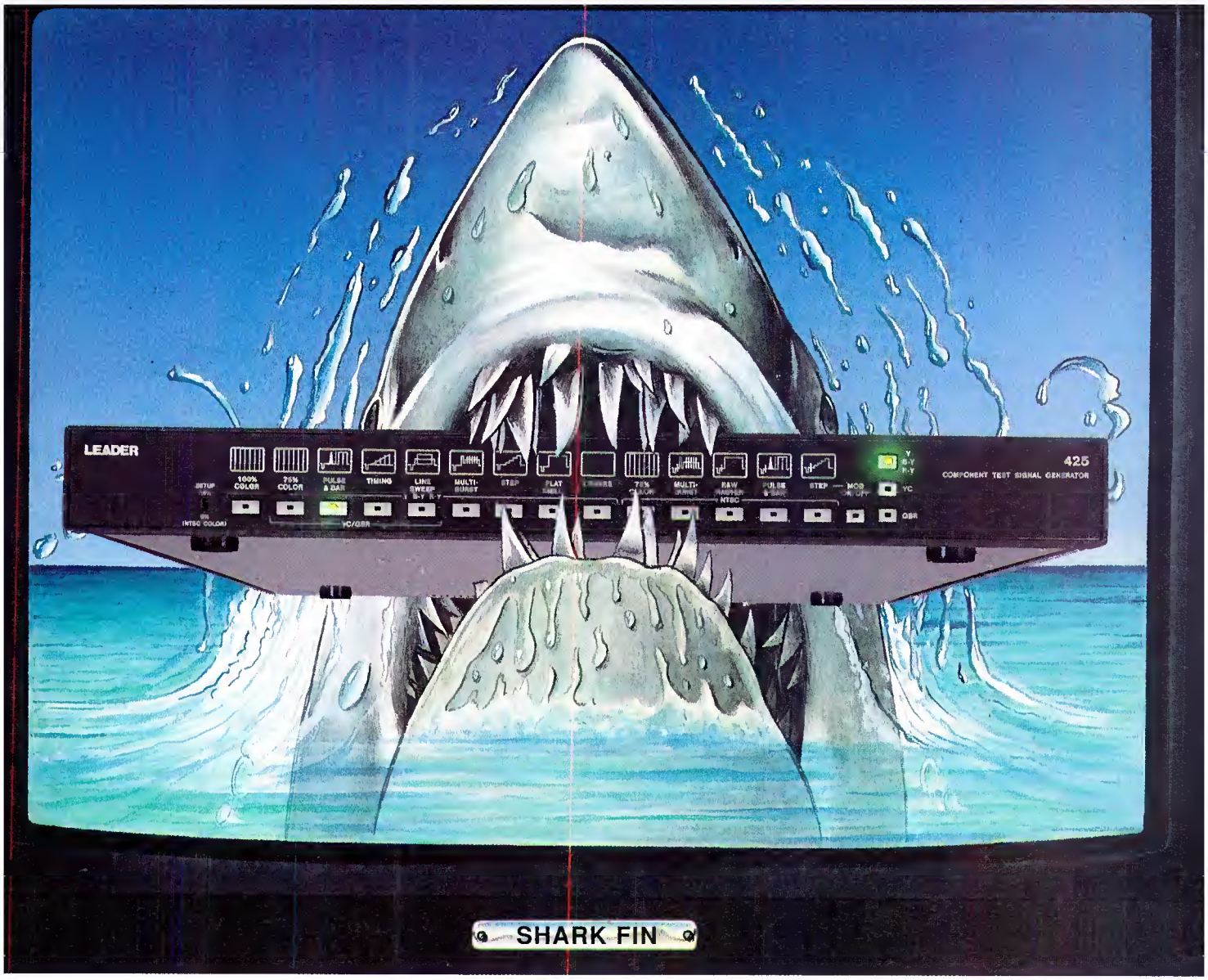


Figure 4. Current FCC minimum antenna standards for the 18GHz band.

Minimum path-length requirements

A second upcoming requirement for grandfathered stations concerns the minimum path length adopted in 1987 by the Third Report and Order to Docket 82-334.



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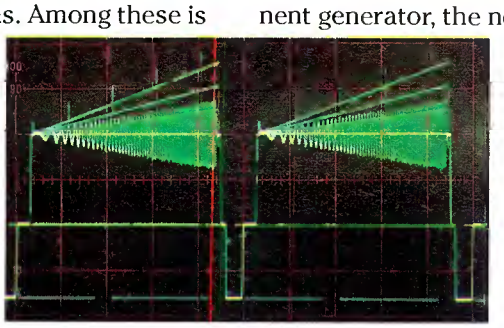

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These requirements are summarized in Figure 5. Minimum path-length requirements do not prohibit short paths at lower microwave frequencies. They do require that the effective isotropic radiated power (EIRP) be reduced according to formulas included in Section 74.644(a) of the FCC rules.

After April 1, 1992, grandfathered links will become subject to the same minimum path-length requirements that new fixed links have had to meet since 1987. These links will be required to reduce their EIRP for paths shorter than 17km (10.6 miles) at 2GHz and 7GHz or shorter than 5km (3.1 miles) at 13GHz if a newcomer station makes a showing that the higher EIRP is preclusive. New microwave links have no such option. They must comply with the minimum path-length EIRP limits in order to be licensed.

950MHz aural STL band

In January, again at the invitation of the FCC, the SBE filed a rulemaking petition proposing to extend minimum antenna standards and minimum path-length requirements to microwave stations in the 950MHz aural STL/ICR band. The same category A and B antenna standards now required for Private Operational Fixed Microwave Service stations in the 952MHz-960MHz band were proposed for aural STL/ICR stations in the 944MHz-951MHz band. These requirements are shown in Figure 6.

A minimum non-EIRP restricted path length of 22km (13.7 miles) was proposed, along with a transmitter output power limit of 10W. The SBE suggested that the frequency tolerance for aural STLs and ICRs be tightened to ±0.0005%. The petition also asked that new aural STLs and ICRs be required to provide at least a 50dB desired-to-undesired ratio to existing co-channel stations and at least a 0dB desired-to-undesired signal ratio to first-adjacent channel stations. In effect, the SBE proposed putting numbers on the longstanding but ambiguous "good engineering practice" requirements of Section 74.503(b), *Frequency Selection*, and Section 74.536(a), *Directional Antenna Required*.

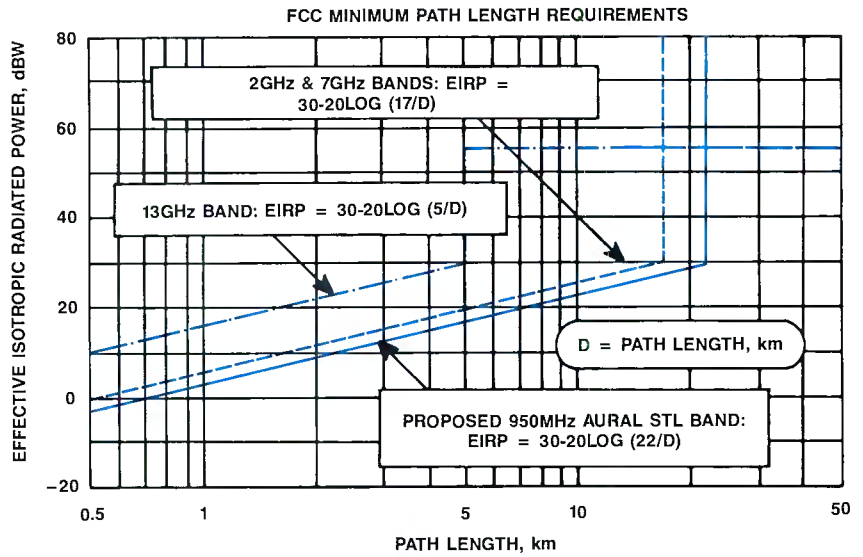

Figure 5. FCC minimum path-length requirements for 2GHz, 7GHz and 13GHz bands. Also shown is the proposed minimum path-length requirement for the 950MHz aural STL band. Note that EIRP cannot exceed 55dBW in the 7GHz and 13GHz bands, but there is no direct limit on EIRP for the 2GHz band. No EIRP limit has been proposed for the 950MHz aural STL band.

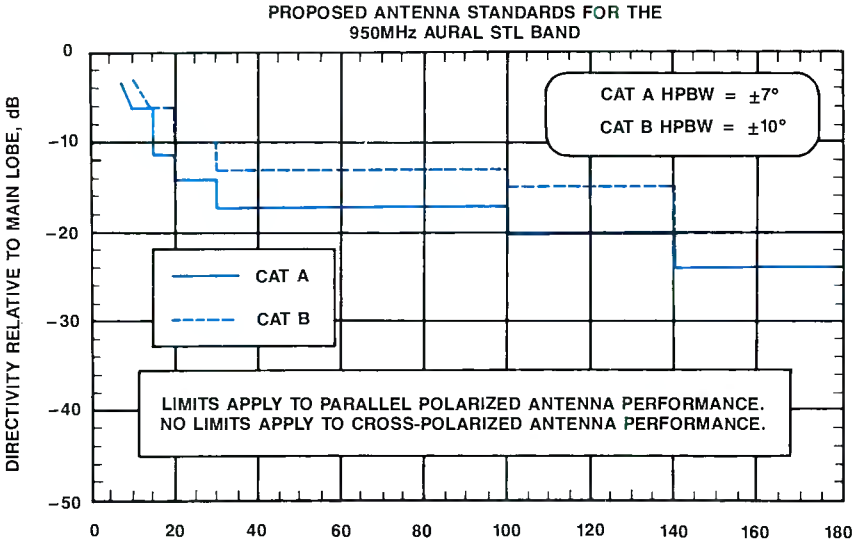

Figure 6. Proposed minimum antenna requirements for 950MHz aural STL transmitting antennas.

Receive antennas

The commission does not, in general, have direct authority over receive antennas. To help assure the use of spectrum-efficient receive antennas, the SBE proposed that calculations of desired-to-undesired ratios be made assuming that the receive antenna meets not only the RPE corresponding to a 6-foot grid-parabolic antenna in frequency-congested areas, but also the RPE corresponding to a 4-foot grid-parabolic antenna in other areas. A licensee with a lower-performance receive antenna who elects not to upgrade would have to accept any interference caused by the antenna.

If an existing link has an antenna that exceeds these RPEs, the actual RPE should be used when performing the desired-to-undesired calculations. A similar approach has been required for many years for Instructional Television Fixed Service (ITFS) stations. Newcomer ITFS stations must show that certain co-channel and adjacent-channel desired-to-undesired ratios are provided to licensed receive locations. These stations are allowed to make the calculations using the RPE shown in Section 74.937(a) of the FCC rules.

Be alert to changes

Whether or not the FCC adopts the SBE petitions, it is clear that grandfathered microwave links in the TV auxiliary bands are facing two important deadlines. All grandfathered TV STL/ICR links must meet the new antenna performance standards by Oct. 1, 1991. Effective April 1, 1992 these links become subject to the new minimum path-length requirements.

Perhaps this article will prevent TV stations being caught by surprise at the expiration of a grandfather period, as recently occurred near the end of a 5-year grandfather period for type acceptance or notification of aural STL/ICR transmitters (see Editor's note). Station engineers should be on the alert for further developments this year.

Editor's note: The SBE petitioned the FCC in November 1989 for a 3-year extension of the July 1, 1990 deadline requiring that aural STL transmitters be type-accepted or notified. The commission granted the request on Jan. 18.

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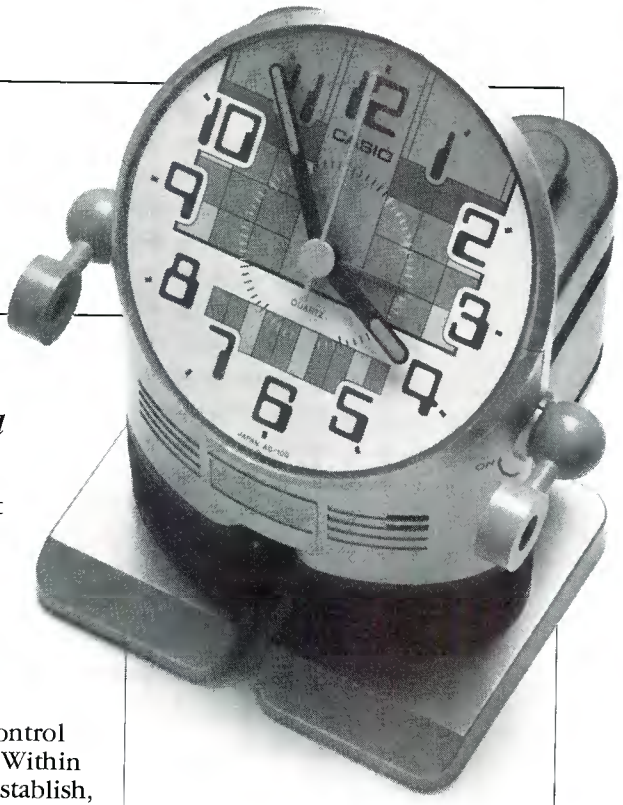

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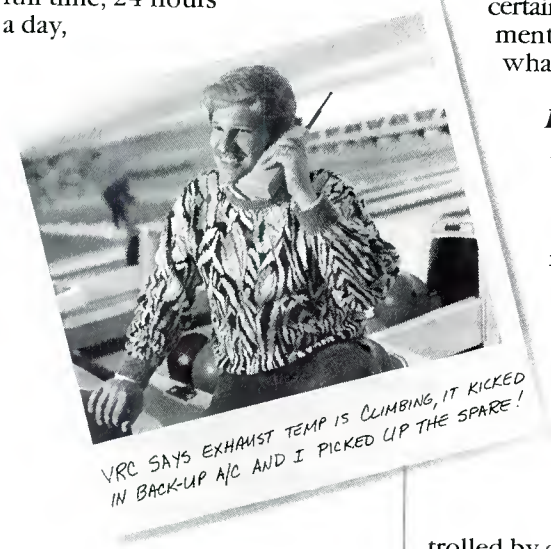

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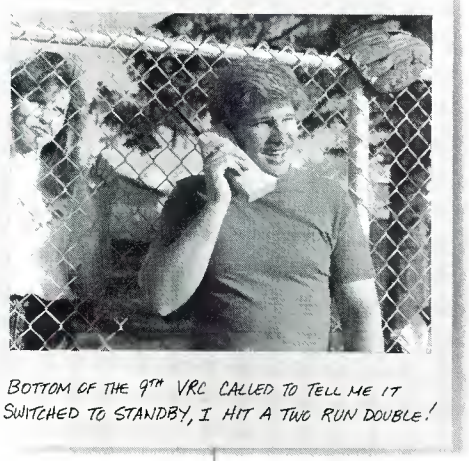

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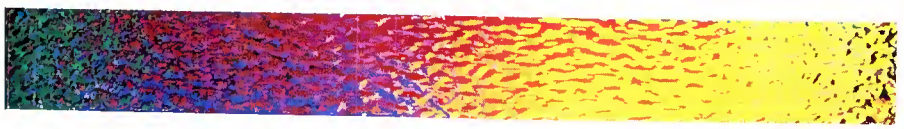
By Rick Lehtinen, TV technical editor

Tower lighting update



Don't take tower marking light-heartedly.

In the midnight hour in the heart of Kentucky, a thin and wiry engineer carries lightbulbs hundreds of feet up an aging TV tower. He scales the antenna itself the last 50 feet or so, something that can only be accomplished by hanging on for dear life with one hand, tensing, and then leaping upward, hoping to catch the opposite peg. Even spry, catlike movements can cause towers to shake at this height.

Near sunset outside of Topeka, KS, an engineer energizes a new set of tower light flashers. At times, the old ones presented an unbalanced load, drawing much more current than was good for the circuitry. The engineer steps back and smiles. By adjusting the flash pattern of the new lights, he gives truckers cause to chatter up and down a lonely stretch of I-70.

In Kansas City, a prominent, self-standing tower has for years been bedecked with external white lights reminiscent of the Plaza area it overshadows. Recently, the lights have been given a new twist; the pattern of the flash indicates whether precipitation is coming and whether tomorrow will be warmer or colder.

Whether your relationship to obstruction lighting is designer, bulb-changer or power-bill payer, you have no doubt sensed some of the romance, and possibly a great deal of the headache, that comes from placing lightbulbs far up spindly structures. There is no doubt that the lights serve a noble purpose. When even the slowest of aircraft travel a hundred miles an hour, RF transmission towers can present a terrifying hazard, especially around airports.

For the past 20 years, white strobes have been allowed in some areas instead of red beacons. Fifteen years ago, white strobes were required in some areas instead of beacons. In some cases, broadcasters have been required to mark their towers with *both* white strobes and red beacons. In short, the industry needs to recognize some of the forces that have shaped the field of tower obstruction lighting.

Red or white?

The good news about strobes is that the need to paint the tower structure is usually relaxed, and that the interval for relamping a strobe is from four to 10 times longer than beacons. A tower equipped with high-intensity strobes typically consumes 50% less power (85% for medium-intensity strobes) than an equivalent beacon-marking system. The bad news is that strobes can be complex electronic devices. Trying to fix them while dangling several hundred feet above the ground is not as simple as screwing in a lightbulb.

The FAA thinks that several areas of the country are "natural flyways," which are areas above convenient geological surface features, such as rivers or major highways. According to the FAA mandates, anything within a few miles to either side of a flyway that sticks up into the "navigable airspace" (above 200 feet) has to be marked. The alternating bands of orange and white

were once considered sufficient, but tall towers (above 1,000 feet) usually are required to use high-intensity strobes. Shorter towers (between 200 and 500 feet) can be painted and use red beacons or medium-intensity strobes can be installed.

Some experts think that the rules are not enforceable by the FAA, but that the rules take the form of recommendations. If broadcasters were not controlled by the FCC, they could shrug off the recommendations, as has allegedly been done by operators of certain high structures such as smoke stacks. (Of course, there would probably be a tremendous liability if a plane hit such an unmarked structure.) In broadcasting, the commission works directly with the FAA and makes proper lighting a condition of obtaining a license.

The commission has sometimes required a station to use red lights for nighttime use, even if the tower already is equipped with strobes. One of the first such instances took place in a western suburb of Baltimore in the early 1980s. Residents, allegedly annoyed by the presence of a 700-foot tower but lacking any other grievances, complained about the tower's strobes to their congressional representatives. Pressure from Capitol Hill is thought to have led the commission to require that the tower be fitted with red beacons at night.

When people in other areas learned of this victory, the traffic from Capitol Hill increased. For a time, the commission apparently started asking for red lights on nearly every tower, even if the tower's height mandated strobes. This left station owners in the position of having to manage two separate tower-marking systems. Currently, approximately 50% of the towers that have high-intensity strobes also have a red light system. However, tower operators who can convince the commission that their tower is not near a community may be able to maintain a reversal.

Courtesy of Wilmer Zehr

One reason for the complaints is that high-intensity strobes can be devastatingly bright. When they were first proposed in 1970, the daytime intensity was 200,000 candela (the metric term for candle power) and the nighttime brightness was 1,000 candela. During the twilight period, roughly 30-minutes before conventional beacons activate, the 1,000 candela intensity was inadequate. In 1974, a more moderate 20,000 level was proposed during times when the North sky intensity was 30-50 foot-candles. When the North sky intensity reaches 3-5 foot-candles, the traditional time to turn on tower lights, a nighttime mode of 4,000 candela was initiated. In 1985, when medium-power strobes were allowed for shorter towers, the nighttime mode was reduced to 2,000 candela, where it remains today.

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Careful design of the strobes could have eliminated most of the problem, however. Internal louvers can baffle most of the light from a high-intensity strobe away from the ground. By the time you get far enough away where the strobes can be seen, they are probably no longer obnoxious. Most medium-intensity strobes use a fresnel lens system that shapes the vertical beam and controls the downward light.

Back to beacons

The good news about red beacons is their simplicity. What could be easier than changing a lightbulb? However, beacons have their quirks, too. Although it is easy to change bulbs, it needs to be done frequently. Secondly, there is a lot of vibration on high towers. This can cause the side lights (the beacons are usually spring loaded) to "back out" of their sockets, lose contact and necessitate a trip back up the tower. Finally, the mechanical flashers that have served for so long are frequently a great sink for preventive maintenance. Some experts think that reliable solid-state versions have come about slowly, although they are available now.

The early mechanical flashing systems lasted for years, but their mechanical operation necessitated frequent preventive maintenance. The fail-safe feature, in which the flashing beacon lamps remain in a steady burning state upon failure of the flasher assembly, is still a prime requisite of today's tower lighting controllers. Controls designed within these parameters are important to the tower constructor or maintenance contractor for a lighted tower in accordance with FCC/FAA regulations.

Modern solid-state devices are now available that can meet these needs, but you have to shop carefully in order to find those that will meet all of the requirements for tower operation and will stand up in use.

Some solid-state tower flashers can greatly increase the life of beacons. This is done by switching the power to the beacon at a zero point on the ac sine wave. When an incandescent lamp is turned on, the cold resistance of the filament is low. Depending on where in the ac sine wave the power is applied, the cold lamp can draw up to 10 times its normal current. This is referred to as the inrush current and it can damage the lamp filaments.

It is not yet clear what today's advanced flashers will mean for tower relamping. The FAA advises that bulbs are to be changed at the half-life point. If the bulb is guaranteed for 6,000 hours, it should be replaced at 3,000. In practice, this is usually done at some convenient time of year, such as the fall. Also, if one bulb fails, you usually change them all.

With red lights, the lamp should be changed every six to nine months. Many manufacturers advertise that strobes can be changed every four years, although many operators have reported nearly twice this usage. If bulb life can be significantly extended through the use of inrush limiting switching devices, the convenience of strobes might be mitigated. However, there is the issue of painting the tower, which is not typically required with strobes. (For further information about painting towers that are fitted with strobes, see "Hardening Broadcast Towers," **BE** March, 1990.)

Acknowledgments: The author wishes to thank Lew Wetzel, Flash Technologies, Gary Krohe, KMCI-TV, and Rick Murphy, Kentucky Educational Television, for help in preparation of this article.

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Lighting system design

By R.M. "Bob" Mosher

Before a tower-lighting control system can be designed and fabricated, certain parameters must be known:

1. The overall structure height must be known, including any length of "bridge" from controller location to the base of the structure. From these given dimensions the FAA classification of A-0, A-1, A-3, etc. can be applied to determine the location (elevations) of mounted lighting fixtures on the structure. These calculations are necessary in order to evaluate wire size and power input to fulfill the FAA requirement of a lamp socket voltage of 120Vac ±3%. In many cases, voltage boost transformers are used rather than oversized conductors to achieve the socket voltage requirement.
2. The style or shape of the tower may be helpful in determining wiring (conduit) runs. On extremely tall towers in the A-3 through the A-6 class, it is important to know whether the structure contains an elevator system and/or bunched conduit runs that might qualify the tower in a solid structure category.
3. At what location will the controller be secured? Indoors or outdoors?
4. What type of lamp failure alarm indicators will be required and in what locations?
5. What type of flasher circuitry will be used? What will be the flash sequence?

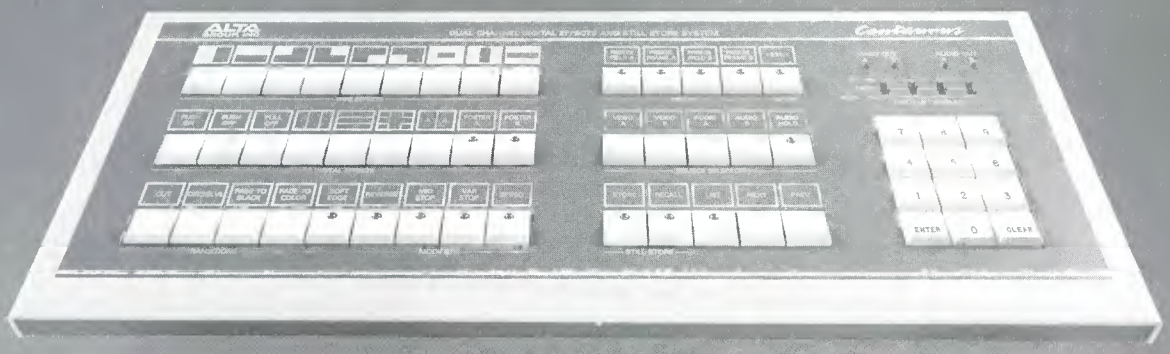
All aspects of the lighting program are well-defined in a series of advisory circulars and standards publications.

The main reference for tower and obstruction lighting is the FAA Advisory Circular, AC 70/7460-1G, titled "Obstruction Marking & Lighting." The circular (suffix 1G) is the latest publication, with indications from reliable sources that a newer revision is imminent. Transport Canada has presented "Air Navigation Systems Requirements," a TCAG publication covering the Standards Obstruction Markings, which is equivalent to the FAA Advisory Circular 70/7460-1G.

In conjunction with the FAA Circular 1G, is the companion Circular AC 150/5345-43D, which covers the Specification of Obstruction Lighting Equipment. The publication redefines the intensities of the flashing red beacons and obstruction (side) lights. The L-810 classification for the steady burning side light has a revised specification divided into two classes. Class 1 is low intensity and Class 2 is high intensity. Furthermore, the red flashing beacon, previously designated as L-866 (red), has been changed to L-864 to minimize confusion with the L-866 (white) strobe flashing beacon. Circular AC 150/5345-43D is currently under FAA scrutiny for significant revision.

An additional Advisory Circular, AC 150/5345-1, titled "Approved Airport Lighting Equipment," lists manufacturers and suppliers of FAA-classified beacons, obstruction lights, connectors, cables, signs, regulators, transformers, switches, taxiway and runway lights.

Mosher is a consulting engineer with Crouse-Hinds Navigation Aids/SEPCO Aviation Lighting Division, Windsor, CT.



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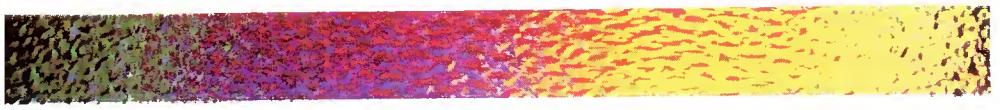
By Gerry Kaufhold

Remote-site security primer



Electronically guarding remote locations.

Remote transmitters and repeater sites must be protected from vandalism, fire and weather-related damage. Station owners must be protected against liability related to remote-site accidents. This makes remote-site security an important part of station operations. Responsibility for specifying security-related equipment often falls to the engineering department.

The security industry is evolving, adding new capabilities and combining with other technologies. New microprocessor-based security equipment, for instance, can perform remote-control functions as well as security tasks, or else security functions can be integrated into a remote-site, remote-control system. What is some of the modern security technology that broadcasters can use to protect their remote sites?

Security at the remote site

Figure 1 shows a typical remote broadcast facility. There is a transmitter building and a storage shed for building-maintenance supplies. An auxiliary generator is housed near the transmitter building and the antenna tower. An open space permits a vehicle to be parked within the fence. A pole-mounted high-efficiency floodlight or streetlight illuminates the entire facility. Let's explore how to protect such a facility.

Kaufhold is a market development engineer for SGS-Thomson Microelectronics, Phoenix. He writes **BE's** monthly "Circuits" column.

Remote-site security can be broken into seven categories:

1. *Perimeter limits* surround the remote-site buildings and are defined by a fence or other enclosure.

2. *Perimeter access* openings can be used to get into or out of any of the remote-site premises. This includes the main gate in the chain link fence and the doors and windows of each of the buildings.

3. *Enclosed protected area* is the entire area within the perimeter limits.

4. *Interior protected areas* comprise the insides of the transmitter building, generator shack and storage shed.

5. *External equipment* at the remote site might be the antenna tower, generator set and public utility access.

6. *Fire sensing and reporting.*

7. *Non-security applications*, such as equipment remote control and monitoring or facility energy management.

Perimeter limits

The perimeter limits provide the first line of defense against unwanted intrusion. Investing in a good perimeter-limits protection scheme might reduce the need for

Continued on page 74

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Continued from page 70

other security measures.

The gate can easily be protected using contact switches that sense when it is opened and closed. The security system can be programmed to provide several minutes' delay to allow station personnel time to unlock the transmitter building, enter and disarm the alarm.

Station management must work out policy on whether personnel will be safe at the remote site if they close and lock the gate after they enter the perimeter limits. An unlocked gate may be an invitation to crime or a liability risk stemming from curious passersby entering the premises. On the other hand, if employees routinely lock themselves in, local law enforcement agencies may request a set of keys to facilitate rescue if an emergency situation develops.

An advantage of providing a set of gate keys to local law officers is that they can occasionally provide help making spot-checks of the premises between visits by station employees or contract engineers. Also, having a good working relationship with the local police may help reports and claims to be filed quickly, if there ever is an incident.

Although the gate is the logical first

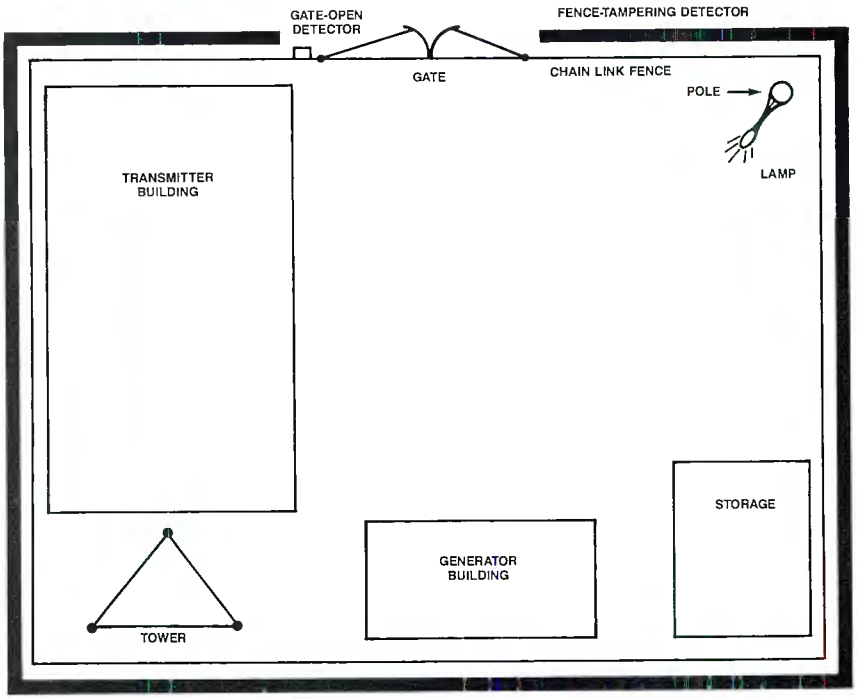
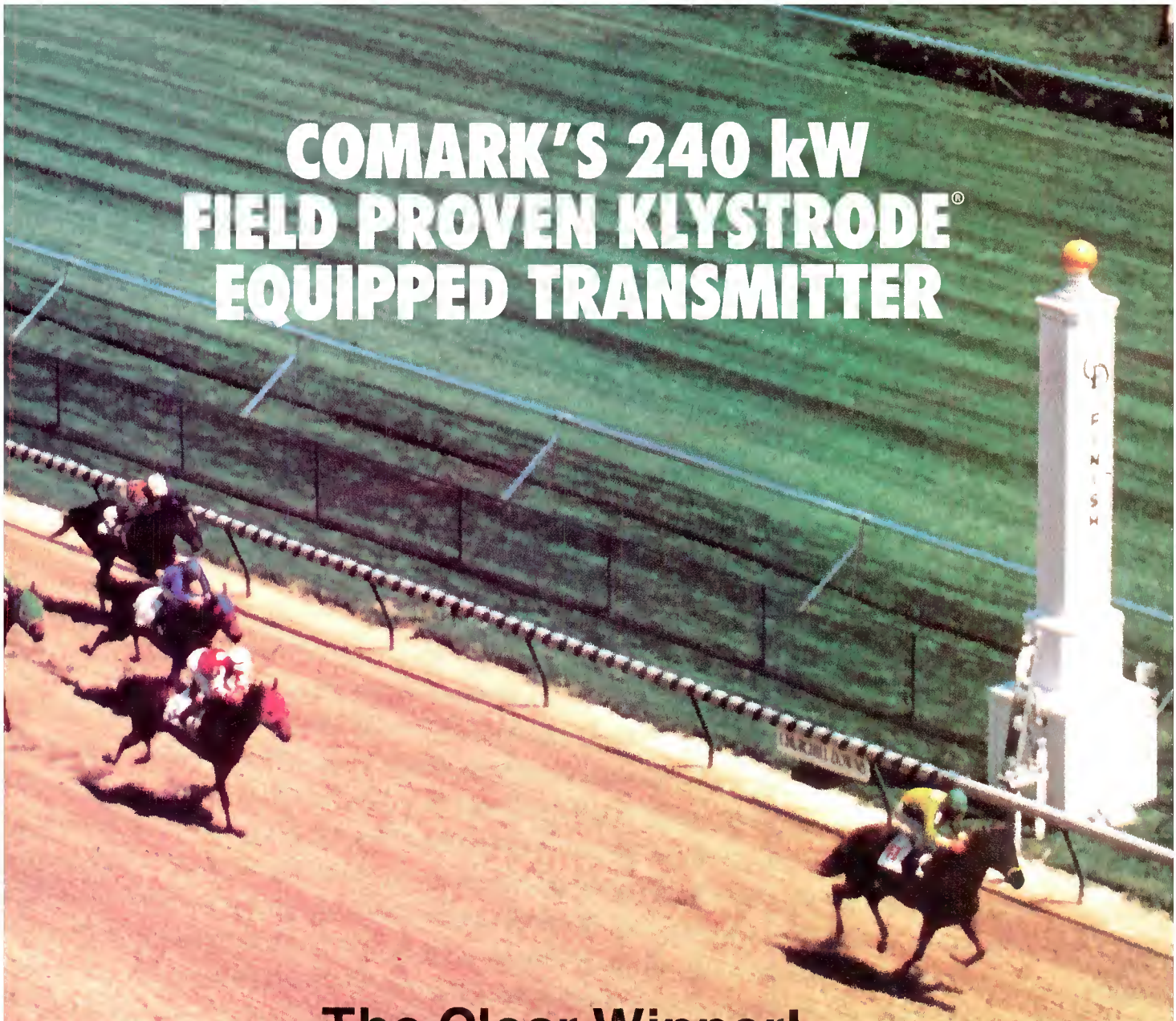


Figure 1. *A security system for a typical remote broadcast facility. The perimeter limits are protected by a chain link fence, with gate-opening and fence-tampering sensors installed. A pole-mounted, high-efficiency floodlight illuminates the entire facility.*



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point of entry, the entire perimeter protected by the fence should be capable of sensing a breach of security. Several technologies have been developed to recognize tampering with the fence. One runs complete loops of wire around the entire perimeter. One strand runs along the top, one or two in the middle and a final strand near the bottom of the fence. A small current is run through the top wire, and leakage currents are detected within the other wires. By using a pulsed current source and time-domain-reflectometry techniques, the approximate location of a fence-climber can be determined. Another system uses buried coax cables. An ultrasonic (sub-RF) signal is pulsed through this cable, and the reflected wave is sampled. If a person or vehicle compresses the coax cable by stepping near it, the reflected wave changes, and an alarm condition is triggered.

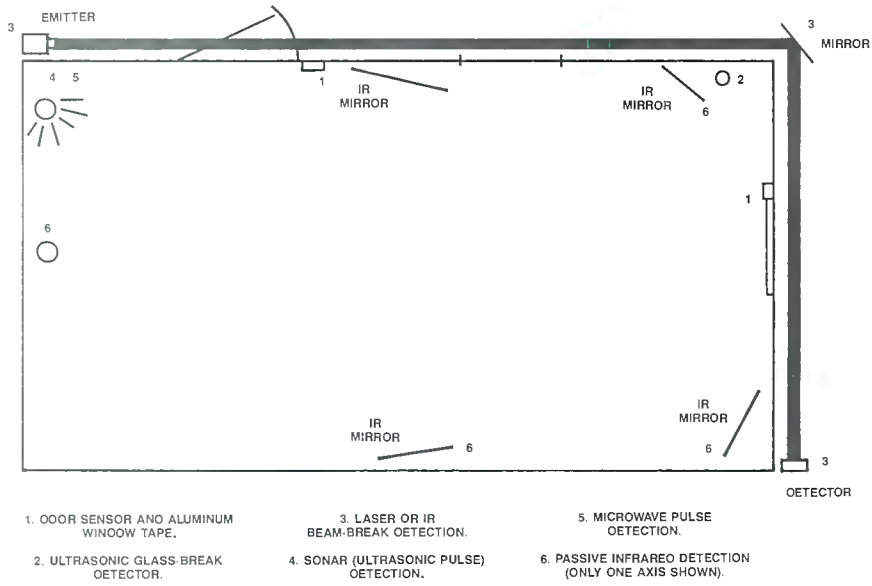

Figure 2. Several options exist to protect individual buildings. Technologies are often combined for greater security.

Enclosed protected area

Adequate lighting will help protect the enclosed area. Studies undertaken by the Security Electronics Industry Association (SEIA) have shown that continuous bright lighting of remote areas significantly reduces instances of reported crime. The increased costs of leaving the lights on all night may be paid back by statistically preventing a crime. In Figure 1, notice that the security floodlight is mounted so it illuminates the entire protected area.

The security floodlight will be a benefit any time a station employee must be at the remote site after dark. A shatterproof housing should surround the light, because vandals in remote areas have been known to use security lights for tar-

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get practice. Keep the security floodlight in good condition and have several spares stored at the site. Train all station personnel to be conscious of the condition of the security floodlight, and make sure it gets replaced immediately whenever it burns out.

If there is expensive equipment at the remote site, it will be worthwhile to install monochrome closed-circuit TV cameras at the remote site. These cameras can feed a stop-frame video recorder similar to those used at banks and convenience stores. If a break-in occurs, the tape may provide clues that help police to recover stolen property and bring the perpetrators to justice. Additionally, the CCTV cameras could easily feed slow-scan video signals down phone lines to a monitoring point back at the main studio or to a local security central alarm station.

Interior protected areas

Figure 2 illustrates several ways to monitor a building's interior protected areas.

Protection of the building interior may once have been considered the most complex and costly portion of a security system. This comes from the days of door-opening sensors and aluminum window tape. Protecting the perimeter openings of a building can now be accomplished with inexpensive sensors that provide double-duty. For example, several companies manufacture glass-break sensors that trigger on the high-frequency sounds of breaking glass. One sensor can protect an entire bank of plate-glass windows, replacing hundreds of feet of aluminum window tape, which saves a lot of cost and labor.

By using several glass-break sensors, adjusted for varying levels of sensitivity, a broad range of situations can be detected. A glass-break detector set for extremely high sensitivity can detect the vibrations in a window caused by someone banging on the glass or a rock being thrown against the glass, which does not actually break. An appropriately tuned set of glass-break sensors can provide an early warning and trigger a local sounding alarm, scaring off a would-be intruder and preventing a crime, rather than simply reporting a break-in after one has occurred. Vibration and shock sensors also can be glued to the surface of a window, which provide similar protection.

Another way to protect the perimeter of a building is to use tightly focused infrared light or lasers to send a beam around the perimeter of a protected area. Anything crossing the path of the beam will be detected and will set off an alarm. Many broadcast transmitter sites already use this method.

Passive infrared detectors

A technology that is gaining popularity for protecting controlled access areas uses a passive infrared (PIR) detector. The sensor is at the focus of a group of mirrors, and detects radiant energy, such as that given off by a human.

PIR detectors trip whenever a person moves side-to-side past the front of the PIR. The detectors tend to be less sensitive for detecting an object that is approaching on a line or receding on a line. For this reason, two PIRs are usually installed in each area to be protected. By aiming the PIRs at right angles to each other, there is a good chance that motion in a room will be detected.

PIRs can sometimes be fooled by reflected sunlight from passing automobiles, the moving blades of overhead ceiling fans and any form of direct sunlight. However, when installed properly in a room with limited windows, PIRs can protect an area of more than 1,000 square feet, up to 50 feet deep and 25 feet wide.

Another popular sensor uses microwave detectors. Low-power pulsers bathe the

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room in microwave energy, and the detectors send out an alarm signal whenever a change in the reflected energy occurs. Microwave sensors might not be usable at a remote broadcast site, because of the high amount of RF energy already present.

A new line of sensors, dual technology sensors, combines passive infrared and microwave.

Ultrasound detectors are similar to microwave detectors. A continuous wave of ultrahigh-frequency energy (similar to a silent dog whistle) is transmitted into the protected space, and a background level is obtained. When a person enters the room, the reflected energy changes, and the sensor reports an alarm situation.

Wireless options

Most of the sensors mentioned can be obtained in two configurations: hard-wired or radio. Hard-wired sensors connect to a standard alarm panel for reporting and power. Radio-based sensors communicate with the alarm control panel on low-power RF links, which are powered with batteries. To avoid security problems from sensor failure, these sensors use a unique method of supervision. Periodically, usually once every hour, each sensor reports the condition of its battery. The control panel keeps track of the sensors, and calls in a trouble report if a sensor fails to check in during its reporting period.

In addition to the passive protection systems, it is a good idea to have several panic buttons available. Panic buttons might be doorbell-type switches hidden under a desktop, or foot-operated floor-switches that must be activated for a period of time to cause an alarm. RF devices also can be issued for employees to carry.

Fire control

Fire-control equipment and smoke detectors used in commercial buildings are covered by local, state and federal regulations, and should be installed by or under the supervision of licensed fire-control equipment contractors.

The field of fire control has become highly specialized. Each municipality has unique fire codes, enforced by the local fire marshal. However, several certification boards test and approve equipment to be used for fire and smoke detection and for sprinkler control. The California Fire Marshal (CFM) certifies components used for fire and smoke detection. Factory Mutual (FM) also tests and certifies fire sensors. Underwriter's Laboratories (UL) performs extensive tests on all components to be used for fire detection and reporting. If a component has received a UL listing, you can be confident that it has been extensively tested. However, a complication exists with UL certification. UL provides different quality levels of approval. You must verify that smoke detectors and fire sensors meet the minimum UL certification level called out by your local fire code.

Non-security accessories

In addition to the security-related functions performed by the security system, a variety of other tasks can be performed. For example, passive infrared detectors can sense when someone is in the studio. When the room is vacant (all clear condition) the security system can send a signal to the air-conditioning equipment and the lighting controller, telling them to turn off. When someone enters, the work lights can be re-energized, allowing employees to enter the studio without having to activate the lighting console.

Anytime the security system senses a change in a room, a response can be triggered. Conceivably, when the PIR detects someone in a room after hours, it could switch the lights on, momentarily disable the door lock to prevent an exit, and switch on a videotape machine and camera to catch the intruder. Voice synthesizers can announce a message to scare off a prowler, or audio listen-in circuits can put the interior sounds out to a remote monitoring station via telephone without the intruder being aware of the eavesdropping.

The additional services provided by the security system might include:

- Thermal sensors to report overheating of key locations.
- Water sensors to detect and report pipe leaks and flooding conditions.
- Auxiliary remote-control functions, such as transmitter reset.

Cost justification

Many broadcasters are surprised to discover that a modern alarm system for a remote site offers improved security and also can perform many ancillary services at a cost substantially less than creating a stand-alone unit. In many instances, installing the correct mix of security equipment also can justify reduced insurance costs, improving the station's bottom line.

Finally, a good alarm system can prevent needless trips to the remote site, which in some regions can be perilous. If a system prevents even one act of theft or vandalism, it will likely prove a sound investment when contrasted with the possibility of lost revenue from missing airtime and equipment replacement costs.

Remote vehicle security

Several patented devices have been introduced into the vehicle security marketplace that deserve the attention of broadcasters.

One system takes an all-in-one approach that works on several different levels. The first level prevents the vehicle from being driven by an unauthorized driver. Within moments of hotwiring the ignition, the system activates, killing the engine, flashing the lights, and blaring a +110dB siren. This technique discourages car theft, yet provides enough evidence for a court to convict the would be car thief of grand theft auto.

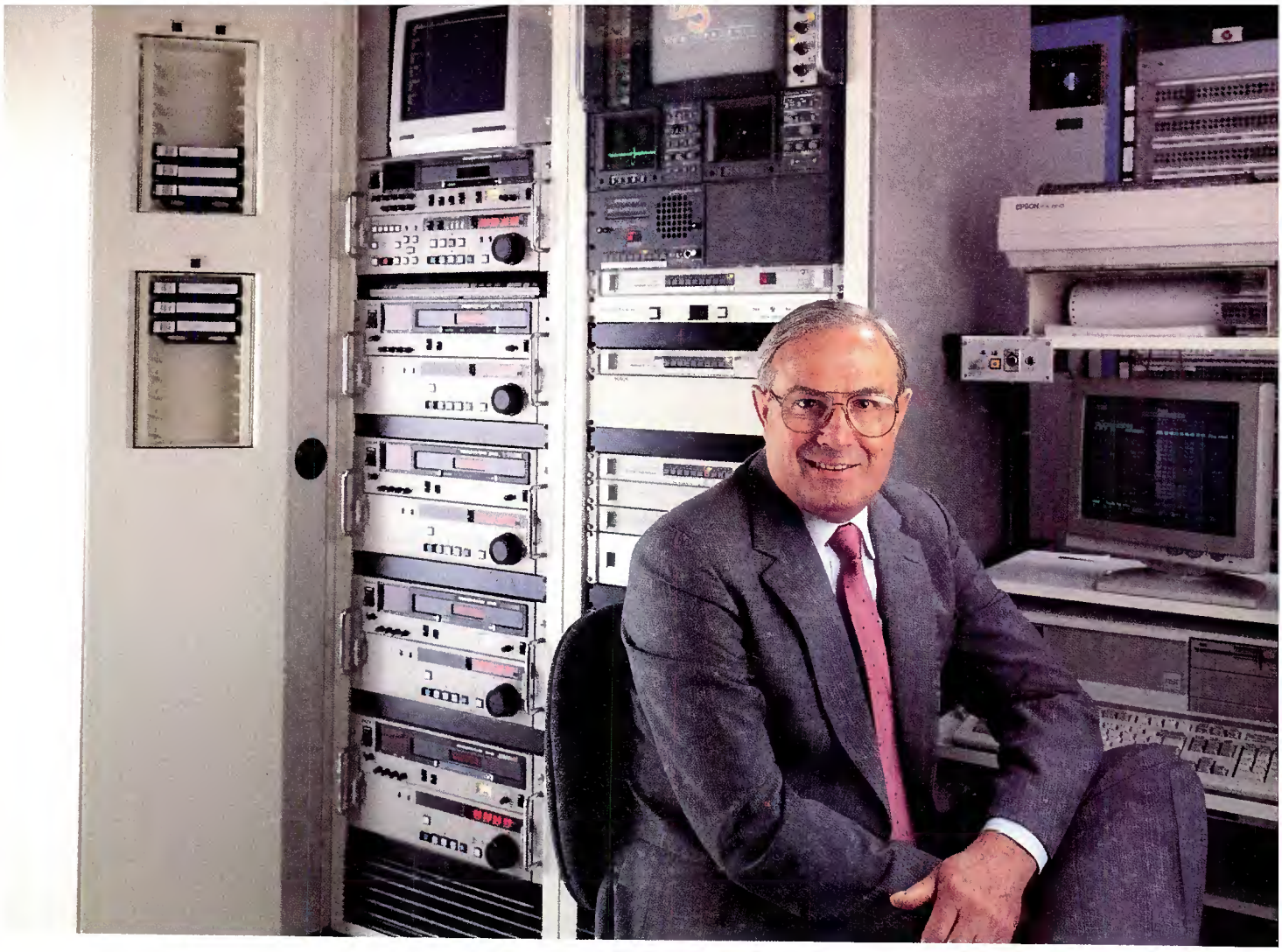
The second level of protection is for equipment within the vehicle. If a window is shattered or even if the truck is rocked back and forth by someone stepping into the operations area, the headlights flash, a loud siren sounds inside the vehicle, and the horn blows outside to alert the crew of the vehicle. A similar system is used by armored car companies, which must protect vehicles while the crew is inside a bank.

The final level of protection is for the vehicle operators. A remote radio transmitter is attached to the keys of the van. As long as the operator is within signaling distance of the vehicle, the alarm can be set off by pressing and holding the transmitter button. If, for example, an operator is being threatened on the street, he can set off the vehicle alarm to summon help. The commotion of the vehicle's siren and flashing headlights alone may be enough to frighten off assailants.

The nature of this specialized remote vehicle equipment is such that it must be installed by factory-trained technicians who work for an authorized dealer. The broadcaster should approach the dealer well in advance, and work out all of the details for fitting the security system equipment around the space requirements of the broadcast gear.

A simpler system uses a single motion detector that triggers the alarm and defeats the ignition anytime the vehicle is moved, even if it is being moved by a tow truck.

With the huge investment in rolling stock that most stations have, a thorough checkup of vehicle security may be in order.



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I didn't know a lot about Odetics before I bought their equipment, so I asked for a factory tour and demonstration. After I saw the large-scale robotics work the company was doing for the space industry as well as the broadcast business, I knew Odetics had the automation expertise I needed. In fact, I would strongly recommend that any chief engineer looking at cart machines take that factory tour. Also, I knew Odetics had already installed about 80 machines at other stations, so I called some of those chief engineers. I didn't talk to anyone who wasn't happy with the Odetics machine.

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Security terminology

As with other industries, the security industry has assigned special meanings to certain words that might not make sense to broadcasters. The security industry originated more than 100 years ago to serve the banking and retail merchant businesses. Much of the terminology is consistent with those original purposes. For example, *day mode* means the store is open for business, so the alarm is disabled. *Night mode* means the system is enabled. A broadcast facility presents a unique set of problems because of its 24-hour operation. The broadcast security system is always active, but at differing levels.

• **Security system.** Usually refers to the intrusion detection and access control parts of a system, *not* including fire control.

• **Local alarm system.** Any security system that uses only local alarms, those that sound on the premises.

• **Monitored system.** Refers to the monitoring service provided for a monthly fee by the security company. Many security companies specialize in monitored systems, and some may not even bid on a job that does not include the monitoring service.

• **Sensor.** Each individual device that is used by the security system to detect a change in the status of an area.

• **Annunciate.** The action taken by the security system in response to a change of status at a sensor. For example, the chime sound you hear when you enter a retail store is a daytime annunciator. The alarm and/or flashing lights are the nighttime annunciators.

• **Report.** In addition to annunciating an alarm, a monitored system will report via telephone to the central monitoring station.

• **Pinpoint system.** A high-end security system that is capable of annunciating the status of each individual sensor.

• **Zone, zone of protection or protected zone.** Refers to a grouping of sensors that activate the alarm as a group. For example, the perimeter zone includes all of the sensors that protect the perimeter. The fire zone includes all of the smoke detectors.

• **Arm.** The action of placing a system into the armed state. When armed, the system will sound an alarm and place a report if any protected zone is violated or any sensor fails.

• **Disarm, clear or day mode.** The action of disabling the alarm to permit free use of an area during the day.

• **Restoral.** If a device reports an alarm and the alarm condition clears, this is a restoral.

• **Digital communicator.** The circuit that connects directly to the telephone line for a monitored system, and formats the digital message that goes to the central monitoring station.

• **False alarm.** A bugaboo of the entire security industry, and a constant nemesis to security technicians. This is what happens when a sensor triggers by accident or misadjustment, or whenever an alarm system reports a breach of security when nothing really happened.

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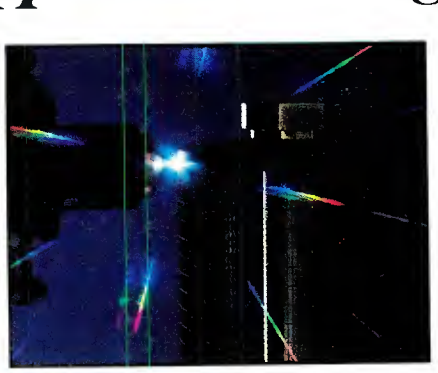


Variable circularly polarized UHF antenna

By John Schadler

Circular polarization is common to most FM and many VHF TV stations but, until recently, UHF stations didn't pay much attention to the technology. The development of a slot-driven parasitic dipole, however, now makes this technology available to UHF channels as well. The first variable circularly polarized UHF antenna was installed in March 1989 at WYHS-TV, channel 69, in Hollywood, FL.

Antenna design

A coupled-slot cut into the wall of a coaxial, rectangular or circular waveguide radiates the RF energy. This signal is polarized in the plane perpendicular to the long dimension of the slot. Arrayed vertically on a cylindrical pylon antenna, these slots radiate horizontally polarized signals. Dipoles placed above these slots couple a controlled amount of energy and radiate it as a vertical signal in phase quadrature with the horizontal signal. (See Figure 1.)

Schadler is an electrical engineer at Dielectric Communications Antennas, Gibbsboro, NJ.

Grounding the vertical radiating elements, or Z poles, to the pole above the slot circularly polarizes the antenna. The ratio between horizontal and vertical power is based on the amount of coupling between the slot and dipole. Coupling, in turn, varies with the slot and dipole.

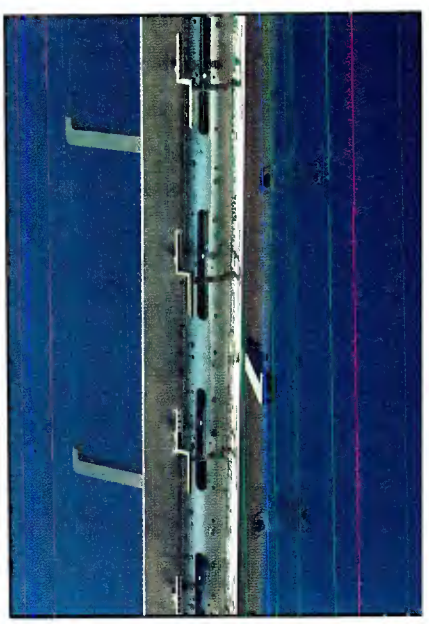
Axial ratio

Axial ratio quantifies the figure of merit of circularly polarized TV antennas. It is expressed as the relationship between minimum and maximum voltage at the output of a receiving dipole rotating perpendicularly to the radiating antenna. In a pure circularly polarized wave, this ratio is one. In a variable circularly polarized wave, it fluctuates with the polarization ratio of the horizontal and vertical components.

If a rotating test dipole indicates a voltage higher than that of the horizontal component or lower than that of the vertical component, the two components are not phased in quadrature. These conditions produce an axial ratio that is higher than the polarization ratio. The result is picture breakup caused by linear or rotational movement of the receiving antenna.

Because the Z dipoles of the transmit antenna have the same phase centers as the slots, phase quadrature and axial ratio remain constant in all directions. Designs using interspersed slot and dipole radiators may be subject to deteriorating axial ratios as the angles of depression increase below the peak of the main beam. This deterioration results from the increase in space phase between adjacent radiating elements. (See Figure 2.)

For a typical spacing of 1/2-wavelength between interspersed radiators, the space phase differential in the first 6° of depression increases by almost 19°. This result is equivalent to a deterioration of 3dB in axial ratio, which is acceptable for most antenna designs. However, as the depression angle continues beyond 6°, the axial ratio deteriorates rapidly. When th



Note the Z dipole elements mounted in front of each antenna slot. These allow the amount of vertical radiation to be adjusted as desired in the manufacturing process.

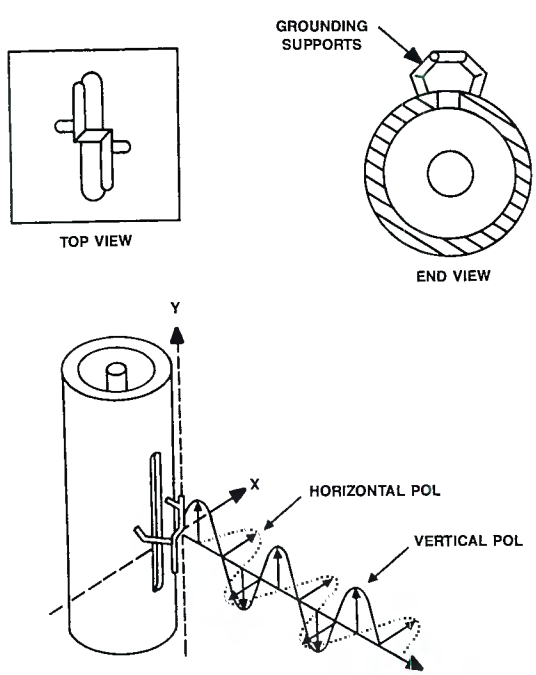


Figure 1. *Circularly polarized pylon antenna. Z dipoles placed above radiating slots couple a controlled amount of energy to the vertical plane in phase quadrature.*

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depression angle reaches 30°, space phase differential is 90°, resulting in an axial ratio of infinity. Beyond 30°, axial ratio begins to decrease, but the sense of rotation of the circularly polarized wave reverses.

As illustrated in Figure 3, this rise/fall axial ratio and polarization reversal occur at each 30° cycle throughout the elevation pattern. The slot-driven Z dipole de-

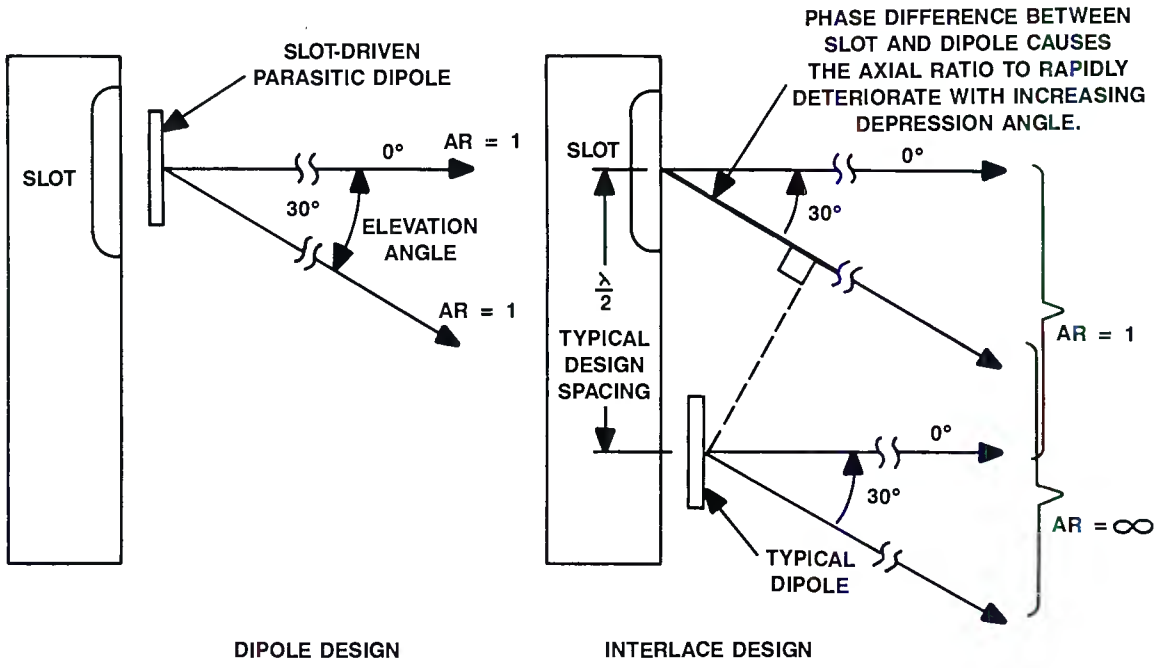

Figure 2. *Dipoles and interlace antenna designs. The spacing between radiating slot and Z dipole in the interlace design creates a phase difference in the horizontal and vertical signals. This can cause the axial ratio to deteriorate with increasing depression angle.*

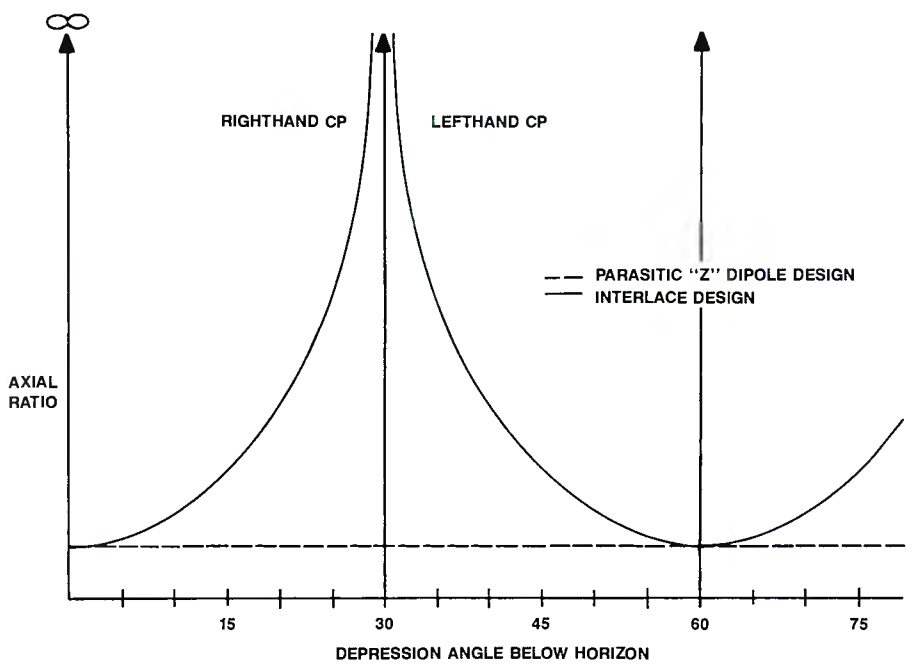

Figure 3. *The rise and fall of the axial ratio and polarization reversal occur at each 30° cycle throughout the elevation pattern in an interlace-type antenna.*

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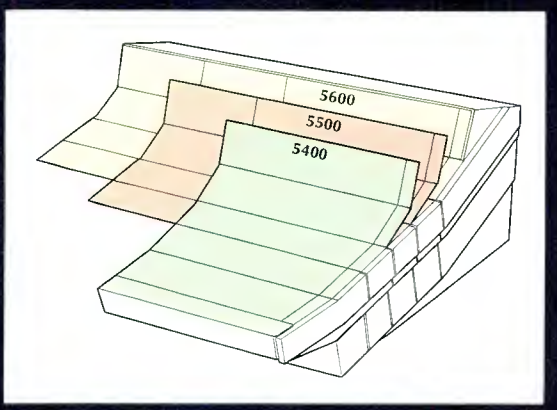

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sign solves this problem by placing both the horizontal and vertical radiators in the same plane. This configuration eliminates phase delay between the elements and maintains constant axial ratio at all depression angles.

Measurement

Figure 4 illustrates four different antenna patterns. Each shows the measured azimuthal patterns for the two linear components, as well as axial ratios for full and variable circular polarization designs. These patterns show that phase quadrature is maintained throughout the azimuth.

If the axial ratio falls significantly below the vertical component (i.e. poor quadrature), orientation of the receiving antenna becomes a critical factor in obtaining good signal strength and picture quality. Because the axial ratio of the dipole over the slot is optimal, the new design eliminates this problem as well.

Z dipole-type variable circular polarization antenna on the test bed in Gibbsboro, N.J.

The new circular polarization design is available in numerous vertical and horizontal pattern combinations to meet a wide range of broadcasting requirements. Factory-adjusted for vertical component, these antennas incorporate the same basic hardware as Dielectric's standard horizontally polarized UHF pylon antennas —slotted outer pipe, internal coupling, feed design and radome considerations.

The result is a simple, sturdy design that provides excellent performance. The antenna is insensitive to lightning and provides a true circularly polarized signal in both azimuthal and elevation planes.

Acknowledgment: The author sends special thanks to Dr. Oded Bendov and the staff at Dielectric Communications Antennas.

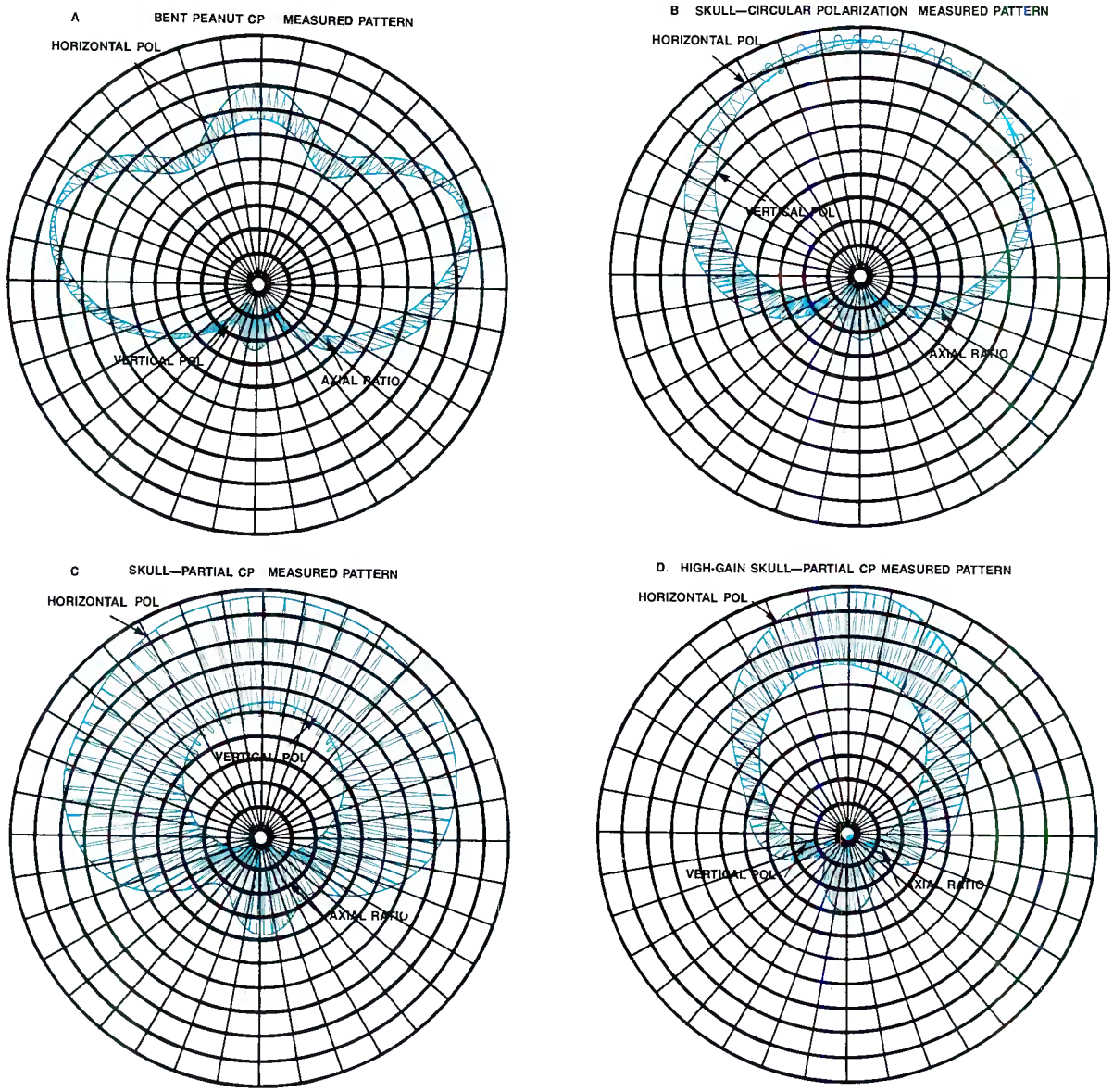

Figure 4. *Measured azimuthal patterns for the two linear components and axial ratios for full and variable circular polarization designs. Note that phase quadrature is maintained throughout the azimuth.*

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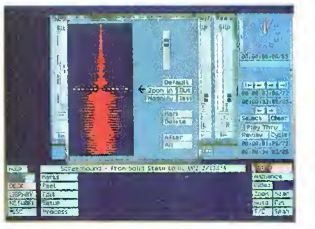

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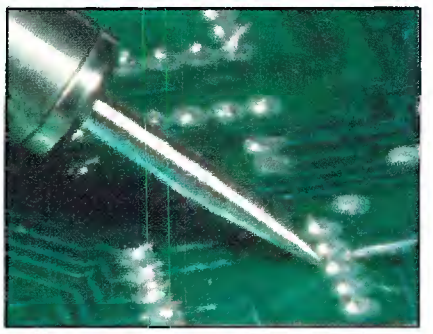


Taking the measure of video processors

By Jack Baird and David Dykstra

Over the past few years, there has been a quiet revolution in the field of video-processing equipment. The result is an increased high-frequency response. The new current-feedback operational amplifiers have made it relatively easy to build a video amplifier with an upper-half power frequency of 50MHz or more.

For some video systems, this increased frequency response may not be necessary. Many video technicians and engineers will agree that whether or not the improved high-frequency performance solves any of their problems, it does in fact create a new problem. How do you measure the frequency response of this new equipment?

The measurement technique used from 0MHz to 10MHz does not seem to work at 60MHz. Let's first discuss the standard measurement technique, look at what goes wrong with this technique between 10MHz and 60MHz, then consider a simple solution that will correct the problems.

Start by measuring the frequency response of a unity gain distribution amplifier. Two pieces of test equipment are required: a signal generator and an oscilloscope. The signal generator should be capable of producing at least a 1V output at a frequency of at least 60MHz. The old HP606A (3V at 65MHz) is satisfactory and not too expensive if purchased surplus. The 50Ω output impedance is acceptable.

The oscilloscope should have dual channels with at least a 60MHz frequency response. A Tektronix 2215 (or equivalent) is sufficient.

The standard technique

The standard measurement technique is illustrated in Figure 1. The output of the signal generator is connected to channel 1 of the oscilloscope through a BNC tee. The same signal also is applied to the input of the distribution amplifier under test. The cable is terminated with a 75Ω load at the amplifier input.

The output of the distribution amplifier is connected to the channel 2 input of the oscilloscope. A second BNC tee is used at the scope input to allow the cable to be terminated by a 75Ω resistor.

The amplitude of the signal-generator output is now set to 1Vp-p as measured on channel 1 of the scope. The gain vs. frequency of the amplifier is recorded by changing the frequency of the signal generator and recording the amplifier output voltage as observed on channel 2 of the scope.

This technique works well at frequencies up to about 10MHz. But, between 10MHz and 100MHz, strange things start to happen. The amplitude of the output of the signal generator seems to change dramatically as the frequency is changed. The output of the distribution amplifier under test also is strangely affected above 10MHz.

The problem

Two things happen at about 10MHz. First, the input impedance of a typical oscilloscope is 1MΩ in parallel with about 30pF of capacitance. (Some higher-priced scopes are as low as 15pF.) At frequencies of 7MHz or below, it is a good approximation to neglect the impedance of the scope input capacitance. It cannot be neglected

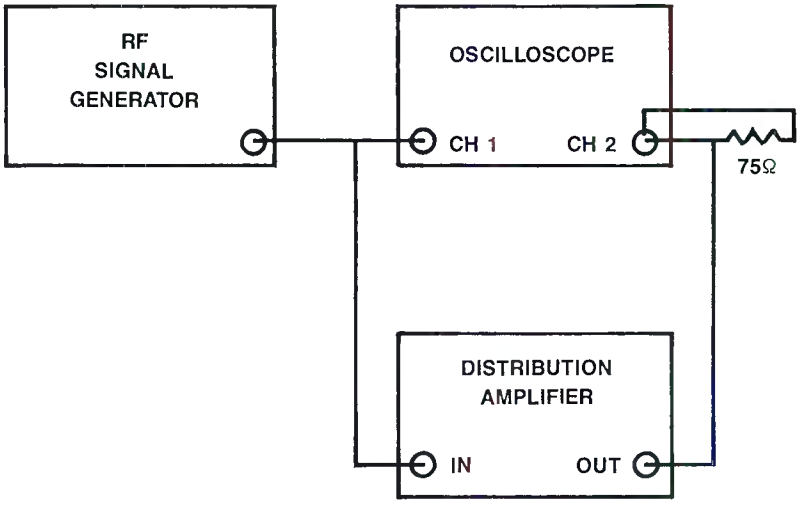


Figure 1. The typical test configuration for measuring frequency response works adequately with signals below 10MHz.

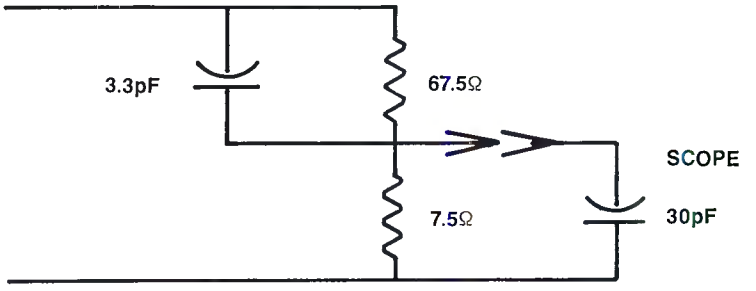
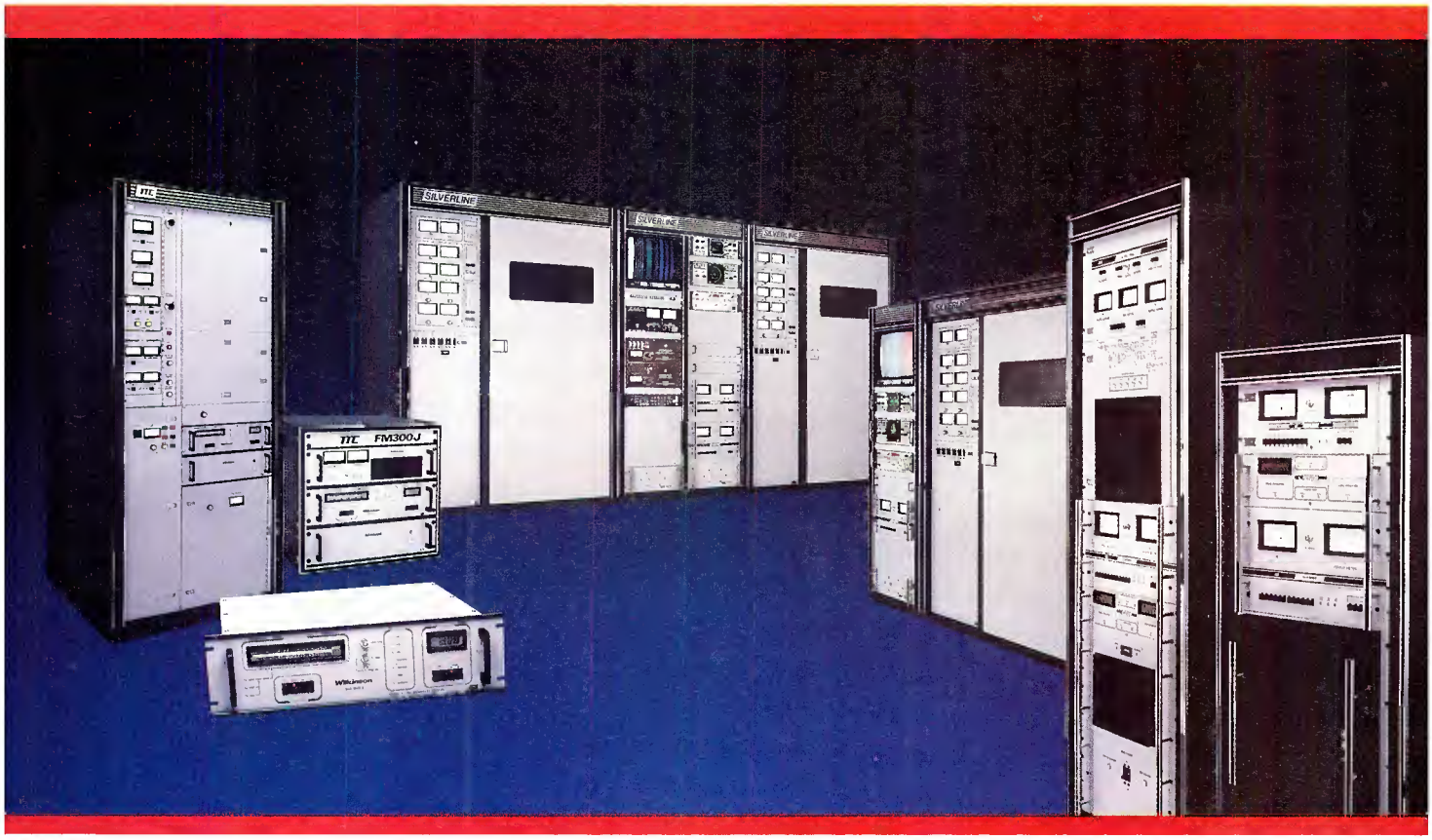


Figure 2. The key to accurate measurement of the higher frequency response is to rely on a 10:1 voltage divider, as shown here.

Baird and Dykstra are engineers with Video Accessory Corporation, Boulder, CO.



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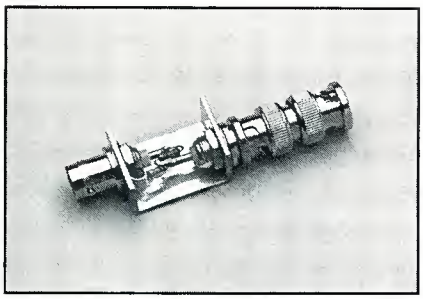

Figure 3. A small piece of aluminum channel makes an effective bracket to hold the BNC connectors and attenuator circuit of Figure 2.

above 7MHz.

The second occurrence at about 10MHz is that a 10-foot coaxial cable starts to lengthen to a significant fraction of a wavelength. This alone would not be a problem if all lines were terminated properly. When an impedance mismatch is present, however, cable length can alter the results of any measurements dramatically.

The simple solution

The video engineer does not need to become an expert in transmission-line techniques. There is only one cardinal rule: Every video line must be terminated by a pure resistance equal to the characteristic impedance of the cable (75Ω). The technique of using a BNC tee and a 75Ω terminator at the input of the scope does not work above 7MHz because of the scope's 30pF input capacitance.

It is possible to borrow a trick from scope probe technology and raise this 7MHz limit to 70MHz, as illustrated in Figure 2. The idea is to build a 10:1 resistive voltage divider with a total resistance of 75Ω. Then parallel this resistive divider with a capacitive voltage divider using the 30pF input capacitance of the scope as one of the capacitors.

The resulting circuit is a 10:1 attenuator with an input impedance of 75Ω resistance in parallel with 3pF (instead of the 30pF that exists with the BNC tee and the 75Ω terminator). The input shunt capacity of this circuit is, of course, the 3.3pF in series with the 30pF of the scope.

It is a relatively simple matter to build this high-frequency terminating attenuator, as illustrated in Figures 3 and 4. It is recommended that 1/4W metal (or carbon) film resistors be used. The series resistor should be 67.5Ω, and the shunt resistor should be 7.5Ω. Unfortunately, neither value is available in 1% tolerance. If 5% tolerance resistors are used, the voltage divider ratio could be off by as much as 10%.

An accuracy of better than 1% can be achieved if the resistors are selected with the use of a good digital ohmmeter. First, check the accuracy of the ohmmeter by measuring several 1% tolerance resistors in the 68Ω to 75Ω region. Now, obtain a large number of 68Ω, 1/4W, 5% resistors, and find one that measures 67.5Ω. Do the same thing with a large number of 7.5Ω resistors.

The 3.3pF capacitor shown in Figure 2

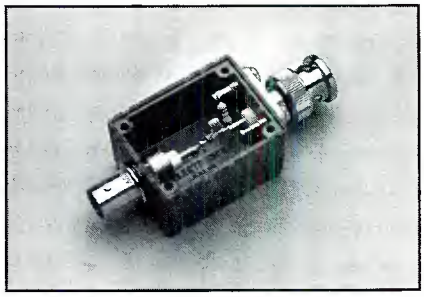

Figure 4. A small metal box such as this provides a convenient and shielded environment for the attenuator circuits.

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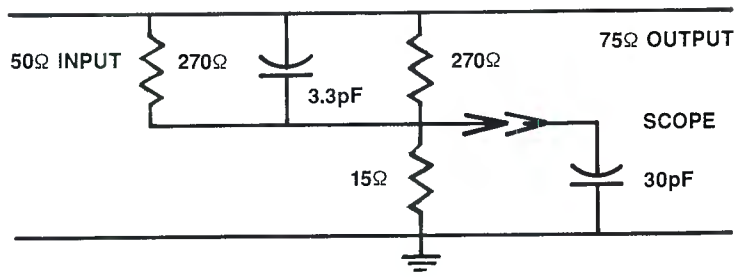

Figure 5. A 50Ω to 75Ω tee may be constructed to minimize the effects of the mismatched impedances.

is actually more than what is needed. A 1/4W metal-film resistor has a shunt capacitance of about 1pF, thus a 2.2pF capacitor is all that needs to be added in parallel with the 67.5Ω resistance. (Use 1pF for scopes with 15pF input capacitance.) Simply placing the 67.5Ω resistor as shown in Figure 3 yields good results.

Figure 3 shows how to build a high-frequency scope terminator using parts that are not too difficult to find. The frame is a 3/4-inch-long piece of 1 1/8"×9/16"x 1/16" aluminum channel, available at most hardware stores. The scope connector needs to be a male BNC connector, but a panel-mount BNC male connector (Pomona model 4979) is hard to find. The unit shown uses two female panel-mount BNC connectors and a male-to-male adapter. Measurements cannot tell the difference between 50Ω connectors and 75Ω connectors until the frequency gets to several hundred megahertz, so use whatever you have on hand.

If you want to build a really nice-looking unit, the Pomona component mounting box (model 3752) shown in Figure 4 is well-suited. The cover has been removed to show the component layout. Either of these units will properly terminate the output of the distribution amplifier up to at least 70MHz.

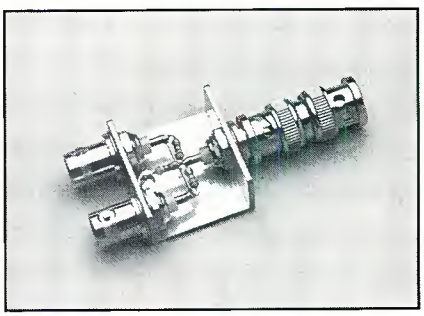

Figure 6. The circuit from Figure 5 mounted on aluminum channel.

The input-matching network

With the standard measurement technique, the output of the RF signal generator is connected to a BNC tee at the channel 1 input of the scope, and the other side of the tee is connected to the input of the distribution amplifier. Again, this is poor transmission-line practice and will lead to standing waves. In this case, the scope input looks like a 30pF capacitor connected across the transmission line at a point somewhere between the signal generator and the input to the distribution amplifier.

It is possible to build a simple circuit to diminish the adverse effects of the scope input capacitance. The recommended circuit is shown in Figure 5. It has one input

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(from the RF signal generator) and two outputs (one to the scope input and a second to the cable leading to the input of the distribution amplifier).

The input impedance of almost any distribution amplifier should be close to 75Ω resistive with, at most, 1pF or 2pF of shunt capacitance. The shunt capacitance at the scope input is caused by the input attenuator (gain control), which is not present on most video equipment. On video equipment, it is more common to find an input impedance with a small amount of series inductance due to the wires from the BNC connector to the actual load on the circuit board.

As shown in Figure 5, the output going to the distribution amplifier looks as if it is 75Ω resistive. This 75Ω is in parallel with the 150Ω of the voltage divider going to the scope. The input impedance to this circuit is then 50Ω, with about 3pF in parallel. If a 50Ω coaxial cable is used between the RF signal generator and the 3-port circuit of Figure 5, then the impedances are matched everywhere. Above 70MHz, a slight mismatch will start to occur between the signal generator and the scope because of the 3pF input capacity of the voltage divider.

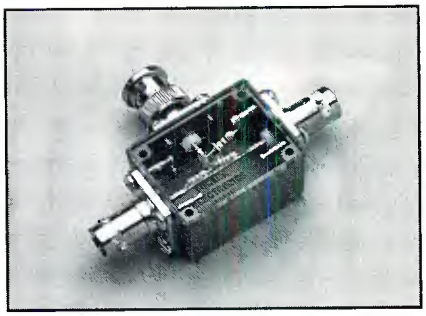

Figure 7. *The 50Ω to 75Ω tee circuit mounted in a small metal enclosure.*

Figure 6 shows a simple way of constructing the circuit shown in Figure 5. Again, the 135Ω resistor needed for the 10:1 voltage divider is not a standard 1% tolerance value. Using a good digital ohmmeter, select two 1/4W, 240Ω resistors and connect them in parallel (135Ω) as shown in Figure 6. The 15Ω resistor may be selected or a 1% tolerance resistor may be used.

A good approximation of the 3.3pF capacitor is achieved by the physical placement of the resistors and shorting wire between the input connector and the output connector. Figure 7 shows the same circuit fabricated in a Pomona box (model 4057). The cover has been removed to show the physical layout of the parts.

To test a homemade scope-terminator/attenuator, use a 10-foot length of RG-59 cable in place of the distribution amplifier. The output signal should be attenuated by no more than 5% at 60MHz. To prove that your efforts were worthwhile, try the same measurement using BNC tees and 75Ω loads.

Continued from page 4

Symposium, Part 2 of the 6th World Telecommunications Forum Oct. 10-15, 1991, in Geneva.

The papers must be unpublished and based on original research, developments and approaches carried out in the period between Telecom '87 and Telecom '91. The papers should deal with technical aspects of telecommunications, technologies, networks and services.

Authors should submit a 1-page abstract of their proposed paper by Oct. 15, 1990 to the Forum 91 secretariat, International Telecommunication Union, Place des Nations, CH-1211 Geneva 20; telephone +41-22-730-56-80; fax +41-22-740-10-13.

Australian regional AES convention features new venue

The Melbourne Audio Engineering Society (AES) convention will be held Aug. 20-22, 1991, at the Moonee Valley Function Centre. It is 6.3km north of Melbourne's business district and offers expanded exhibition space.

If you wish to participate in the event, contact the AES Melbourne Office, P.O. Box 149, Ashburton, Vlc. 3147, Australia; telephone 03-885-5088; fax 03-885-9974.

Microwave Radio purchases M/A-COM MAC division assets

Microwave Radio has agreed with M/A-COM, Burlington, MA, to purchase the business and assets of the M/A-COM MAC division, Chelmsford, MA.

The assets include short-haul and long-haul analog radio communications systems used in the microwave transmission of audio, video and data signals.

News from Europe

By John Blau,
European correspondent

Satellite TV study for EC

British Aerospace (BA) has been commissioned by the EC to study satellite television in Europe, particularly how it can be further developed to meet future broadcasting needs. In its review, BA will focus on technical and legal developments in Europe's turbulent market for satellite television. A major focus will be on the status of HDTV direct-reception, including the possibility of interference with other satellite broadcasts.

Confusion of D2 Mac in Germany

West Germany's two main public-service networks, ARD and ZDF, are debating the future standard for satellite broadcasts in a united Germany. Their discussion has emerged from the need to provide East Germans with West German broadcasts via satellite. East Germany does not have a modern terrestrial broadcasting infrastructure. It will take years and cost billions to modernize East Germany's broadcasting industry.

Distribution via relay to cable systems is not viable in East Germany because of the poor state of cable systems in rural areas.

Satellite television is an obvious solution.

Continued on page 108

Congested area proposal filed

By Bob Van Buhler

In the effort to meet a long-standing federal need, the SBE has filed a petition for rulemaking, which defines the criteria for determining whether a particular broadcast market is designated a *congested area* for frequency coordination purposes.

The FCC has referred to these congested areas, particularly about issues raised in Docket 82-334, but never has defined exactly what was meant by a spectrum-congested area. More than a year ago, the California consulting firm of Hammett and Edison filed a request for a declaratory ruling that would define the term. FCC officials, in discussing the matter, indicated in conversations to the SBE that a filing by the society would be welcomed to resolve the issue.

SBE proposal

Two alternative criteria have been suggested for triggering the congested area status under the SBE proposal. The first criteria is the Census Bureau's designation of an area as a standard metropolitan statistical area (SMSA). There are 309 SMSAs in the United States, recognized in the report on the 1980 census. More probably will be added after the 1990 census.

Mountaintop areas or tall structures with favorable locations also would fall into the category of a congested area if many users operated at the site. The SBE plan would draw a circle with a 3km radius around such sites and specify the nature of auxiliary antennas allowed within the area. Annual updating of these lists is recommended.

Antenna types

The plan proposes two categories of antennas. Category A antennas include those with a half-power beam width of 14° or less. Category B antennas would have a half-power beam width of up to 16°. This would compare roughly to a 6-foot grid parabolic antenna, which meets Category A standards, to a reflector-style antenna that meets the Category B criteria under vertical (but not horizontal) polarization conditions.

According to the SBE filing, there would be a cost difference of about $1,000 for a new installation. With new aural STL installation costs approaching $20,000, this represents a cost differential to the broadcaster of about 5%, which is not unreasonable.

Initially, the criteria proposed by the SBE is recommended only for the aural STL band and the 2GHz and 7GHz TV auxiliary bands, because the matter can be handled exclusively by the Mass Media Bureau. Any rule changes for the 13GHz, 18GHz and 31GHz bands involves other bureaus of the FCC, and cooperation would be necessary.

The best recommendation for extension of the rule to other bands would be a successful track record in the Mass Media Bureau-controlled bands. According to the society, this proposal, if adopted, would provide such an opportunity.

The society's current filing on congested area definition and the previous filing on technical amendments to the 950MHz aural STL broadcast auxiliary band were prepared by SBE director Dane Ericksen, P.E., Hammett and Edison, and SBE Washington attorney Christopher Imlay, of Booth, Freret & Imlay.

SBE examines convention

Current studies indicate that the convention committee and board must consider more carefully the convention's location to assure its success.

Board discussions from the spring of 1989 indicated many directors think that long-range studies and research are necessary to plan the location of future SBE events. The locations should be selected based upon the desires of the broadcast engineer and the exhibitor, rather than whether or not the show is held in a desirable location from a visitor's standpoint.

Many trade shows and conferences are expensive to attend and too broad in their purpose and focus. This makes attendance impractical for broadcast engineers with modest resources and limited company support. The objective of SBE, according to SBE president Brad Dick, is to provide a reasonable-cost, high-quality technical show for the broadcast industry.

To accomplish this, Dick said the show must continue to grow in size and scope. The convention must move to areas that have the greatest number of broadcast engineers, rather than going only to attractive locations. This probably will mean changing the travel orbit to include East and West Coast locations, where there is the largest concentration of broadcast engineers. Research indicates that a successful show follows the highest concentration of local attendees, as well as easy and convenient air travel locations.

Protecting the name

The society holds exclusive rights to the logo and the service mark, "SBE," and has taken action in the past to protect this name from infringement. Anyone wanting to use the logo or service mark "SBE" should contact the SBE office for information regarding their proper use.

The image and reputation of the SBE is important and will be aggressively protected by the officers and directors.

Mark your calendars

The 1990 SBE Convention will be held Oct. 4-7 in St. Louis. This year's convention promises to be bigger than ever. New Ennes workshops include: *Using Computer-Based Design Software*, *AM Stereo Installation and Maintenance*, *Transmitter Maintenance*, *AM and FM Antenna Tuning* and *Management for Engineers*.

New equipment from a wide range of manufacturers will be available for inspection. Don't be left out. Plan now to join us at the 1990 SBE Convention.

Van Buhler is manager of engineering at KNIX-AM/FM, Phoenix.

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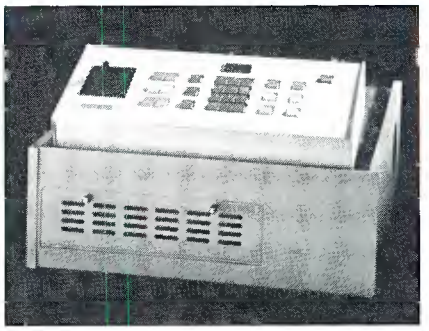


By Mark Fenton

The 11 o'clock news has ended and most of the staff has gone home, leaving only a handful of people on duty. A phone call comes in to the assignment desk about a large fire at an industrial plant. The on-call photographer is contacted after some delay, but by the time he gets there, the blaze is almost out. He picks some shots of the cleanup work and gets an interview with the fire marshal. Although it was a headline fire, the video only rates a page three. However, a local shooter who was on the scene at the height of the fire with a 35mm camera has a whole roll of top-quality slides.

Unfortunately, the station has a policy against using amateur photography in newscasts. The policy has a sound basis; home VHS and Beta equipment usually doesn't produce the kind of quality you want to air. Besides, most stations don't maintain equipment for editing those tape formats.

Still photography is out because of the problems of getting it into the still-store. This is not because it is not of high quality. It is simply that the resolution of film is an order of magnitude greater than even professional video equipment. Because a still camera has no video output and cannot be edited, it is just not used for TV video.

There is a solution: the Video Slide Scanner from Nytone.

Fenton is an engineer with KSL-TV, Salt Lake City.

Performance at a glance

- *Flying-spot scanner technology*
- *700 lines resolution*
- *4X magnification*
- *Zoom, pan and horizontal and vertical flip*
- *Image rotation*
- *Horizontal and vertical size changes*
- *Up to 250 user-programmed moves*

System description

The Video Slide Scanner fits in a standard 19-inch rack. It accepts a standard slide carousel on top and outputs an NTSC video signal. The controller is a desktop unit that takes up about as much space as a keyboard.

The scanner provides several operational features: advance, random-access sequencing and programmable sequencing. With optional equipment, it can zoom, pan, flip horizontally or vertically, rotate or change the horizontal or vertical dimensions.

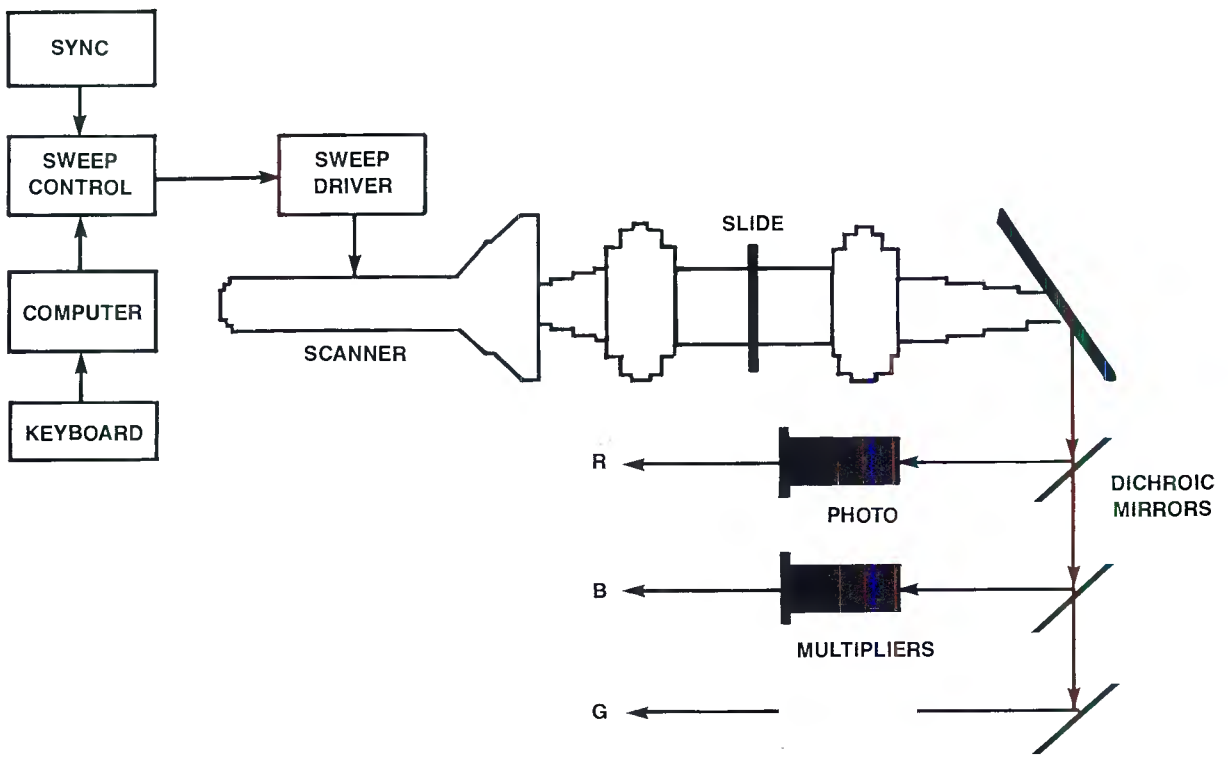


Figure 1. Using flying-spot scanner technology, the image is first separated into RGB components.

The basis of the video translation is a flying-spot scanner. This is basically a cathode ray tube similar to those used in early studio cameras, so the technology is not new. However, the flying spot scanner is still a stable, time-proven idea, and it has the advantage of simplicity. A 3-tube camera requires registration, whereas a scanner does not.

In operation, the unit looks like an elaborate slide projector. However, it is much more sophisticated. The scanner produces an intense, flying-spot light source that scans the film with a raster-type sweep, similar to the sweep used in a television or monitor.

Although the image produced on the other side of the slide is complete, as perceived by the human eye, the internal image at any instant is only a tiny light spot. The light passes through the film and through a collector lens, then is separated into its red, blue and green components by a series of dichroic filters. (See Figure 1.)

After being separated, the light is collected by special color-selected photomultiplier tubes, amplified, gamma-corrected and processed by an internal IQ encoder. The video signals are controlled automatically to give constant output signals in relation to the variable density of the slides.

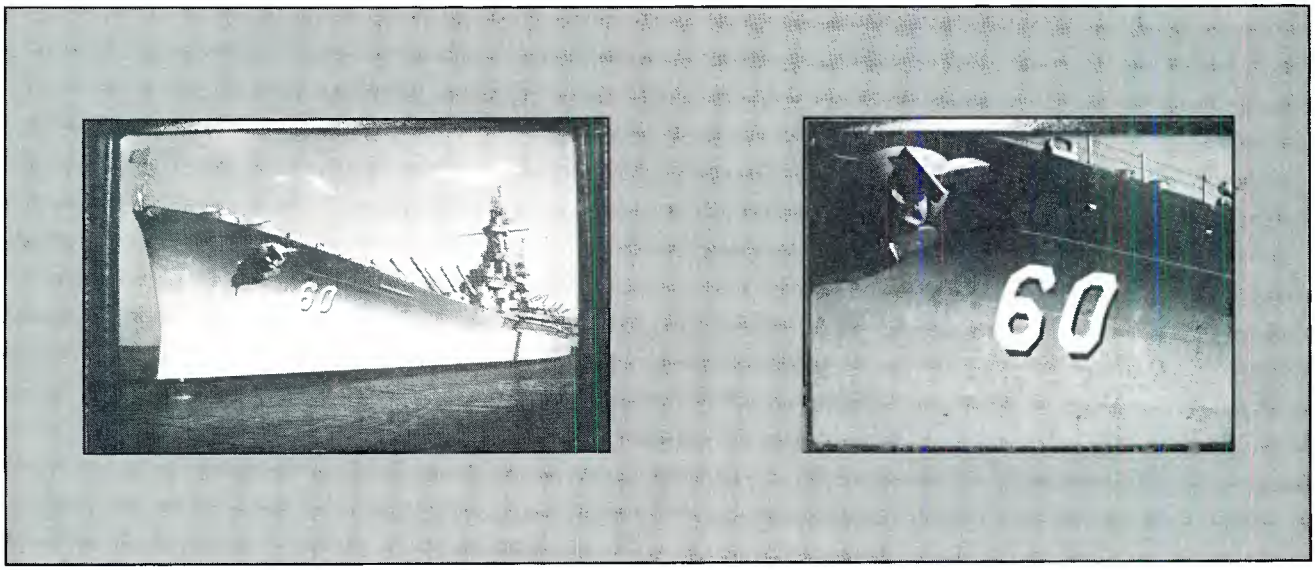
The scanner's CRT is coated with rare earth phosphorus to reduce spot retention and enhance spectral response. A special non-burning faceplate is used to increase tube life. The system also uses high-efficiency optics and photomultiplier tubes that allow the CRT to operate at a relatively low beam current.

Special effects

The scanner provides 700 lines of resolution. Even though NTSC video only uses 525 lines, the higher resolution of the scanner provides some advantages. When a picture is zoomed in on, the detail of the image normally becomes grainy. With a digitally enlarged image, this grain would be apparent. Rather than using digital manipulation, the Video Slide Scanner controls the image with a computer that directs the scanner's sweep.

Magnification is achieved by reducing the scanned area to the portion of the picture desired. This compresses the sweep and squeezes the scan lines closer together. Because the internal image at any instant is only a tiny dot, as seen by the photomultiplier, this means that more emphasis is being applied to fewer pixel elements. With the high information density of film and the relatively high resolution of the flying spot scanner, an image section can be magnified several times without graininess or loss of picture detail.

The company claims the scanner will produce a 4X power magnification, which may be conservative, depending on how you define magnification. If you reduce



The 16× magnification is useful when you want to emphasize only a portion of a photo. Shown first is the original photo of a ship. The second photo shows a 16× magnification of only the bow area.

the scan to one-fourth, as is done in this system, you can say that you have 4X magnification. However, because the scan is reduced to one-fourth of both the vertical and horizontal sweep, you actually are viewing 1/16th of the total picture. A 16X power magnification is impressive.

Operational features

A joystick on the control panel controls both rotation and panning, and a pair of button switches control zooming, with both a fast and a slow zoom. Operation is straightforward.

The scanner can be programmed for a sequence of up to 250 moves. This allows a program to be created and edited before it goes onto videotape, eliminating the need for video post-production. Adding a bit of movement creates a nice effect, too, by reducing the impression that you are looking at a still picture. This effect is used frequently in documentaries.

A printer/processor can be combined with the scanner into a single unit. These units are intended for professional film finishers so that, someday, you will be able to drop off your film at a local store, and for an extra fee, get a videotape copy of your prints. Because televisions and VCRs are replacing more and more slide projectors and screens in homes, offices and classrooms, this is likely to become a common procedure.

Internal controls

The unit was fully adjusted before shipping. Anyone familiar with the setup of cameras should be able to handle the maintenance with the aid of the service manual. The system uses IQ encoding and has the same familiar camera controls of luminance and chroma gain. It also has a sync generator and color-bar generator. Components are card-mounted, and all circuitry is easily accessible. If any circuit fails, the card is removed and either repaired or replaced.

The Video Slide Scanner can be ordered in several configurations, and upgrades to the advanced features can be made later. With both RGB and composite video output, it can be used in virtually any application.

Editor's note: The field report is an exclusive **BE** feature for broadcasters. Each report is prepared by the staff of a broadcast station, production facility or consulting firm.

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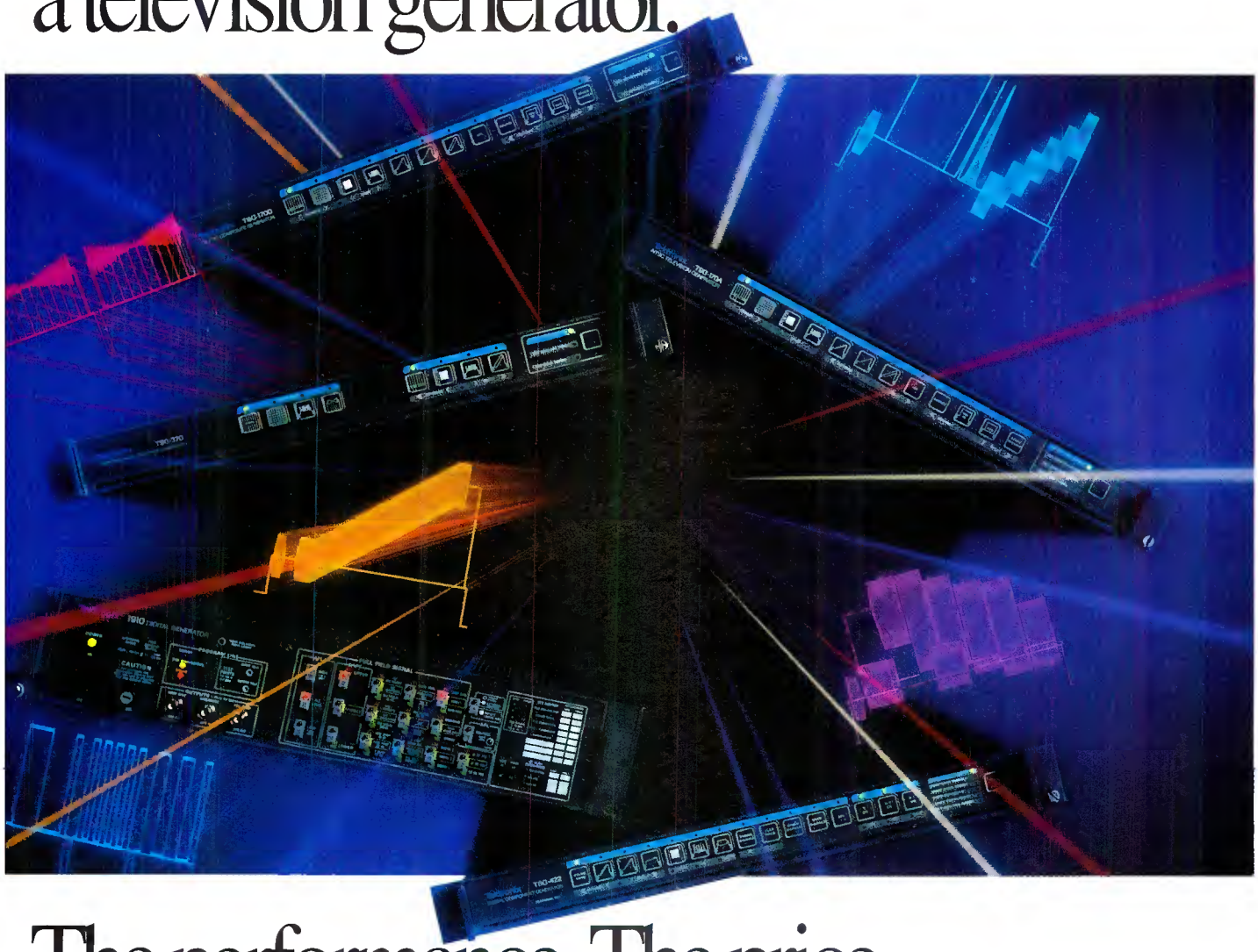

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Circle (76) on Reply Card

MCG surge protectors

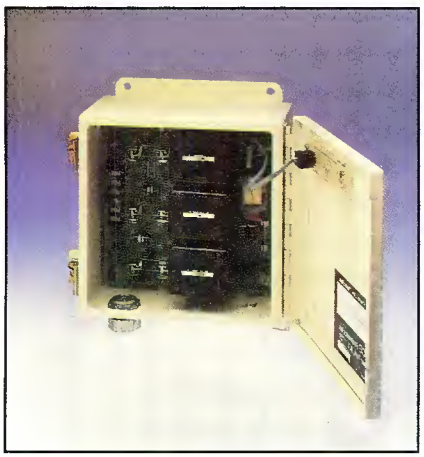
By Robert Andrade

If you've ever had to repair the damage caused by a lightning-induced power surge, you know it can be expensive. Lightning and power-line transients surging along ac power lines can be potentially disastrous to sensitive broadcast equipment. Today's microprocessor-driven recorders, videotape machines and studio computers all demand clean power. Transient or surge suppressors can be effective in reducing or even eliminating the damage caused by lightning and power surges.

Need for protection

Evergreen Broadcasting owns two stations in south central Pennsylvania: WWCP-TV, a Fox-affiliated station in Johnstown, and WATM-TV, an ABC affiliate in Altoona. All programming and available spots for both stations are generated at the Johnstown facility with an IBM System 36 computer. If the computer system goes down, both stations are off the air.

I suspected that we were getting spikes in the primary feed, which was resulting in equipment failure. Our area experiences thunderstorms, which can trigger voltage spikes on the power line. Automobile accidents and heavy icing in the area also knock down poles, which create outages. In addition, internal spikes and transients are generated by elevators, medical equipment and a metallurgy lab located in other parts of the building where the studio is located.



The SPB series of protectors can be repaired with plug-in modules. Each module has redundant circuitry, which reduces the likelihood of being without protection.

Search for a surge suppressor

After reviewing the options, we decided to install surge suppressors at the main and local service panels. This seemed to be the most cost-effective means of protecting both the office and the studio equipment.

After investigating several products, we selected the MCG SP series of surge protectors. Performance and price were the major considerations. The SP series delivered more energy-absorption capability per dollar than other products. The MCG protectors also have status LEDs that show whether the suppressor is operational. The units are UL listed, which made us confident that they would perform safely.

System overview

WWCP is a large facility located in a former high school building. The auditorium was converted into the studio and the upstairs area became offices.

Two power buses feed power to the studio. One supplies the satellite equipment, and the remaining bus handles the office power requirements.

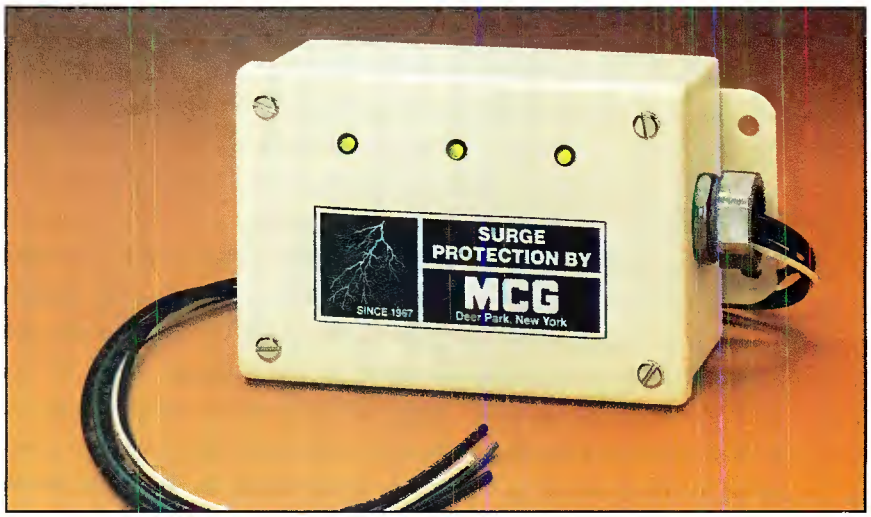
The SP series of protectors works by rapidly intercepting an overvoltage whenever it exceeds the clamp voltage. Once this point is reached, the protector creates a low-resistance path to ground. Most models incorporate redundant protection elements on each phase. This ensures that the unit is never out of service, even in the event of a catastrophic hit. If one protection element is damaged, a fuse operates, taking it off-line. The second element remains on-line to protect the equipment.

Installation documentation was com-

Performance at a glance

SPA series:
- *5ns response time*
- *Heavy-duty MOV protection*
- *Front-panel status monitoring*
- *Available in various power ratings*

SPB series:
In addition to the above features:
- *Redundant protection*
- *Troubleshooting LEDs*
- *Capable of on-site repair*



The SPA-type surge protectors are usually installed near the main power panel.

Andrade is chief engineer, WWCP-TV, Johnstown, PA.

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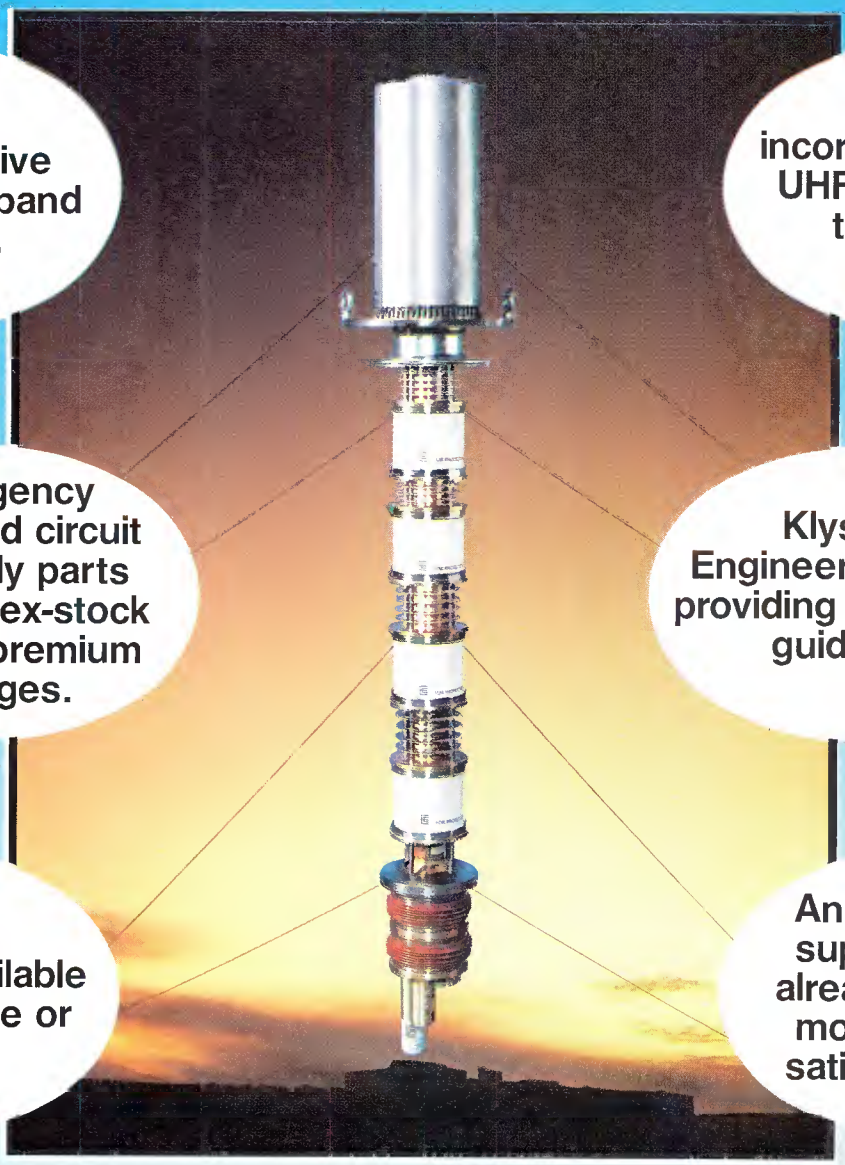

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plete and easy to follow. The surge protectors were mounted close to the service panel, shunted across the ac power line. The protector draws no power and it is completely silent in operation. The only maintenance the unit requires is periodic checks of the indicator lights to see that the green light is illuminated.

Equipment must be repairable on-site whenever possible. Although we haven't had to service the suppressors, there are status indicators on the front panel informing us of any damage. Because this was an important feature, we did not consider competitive units without status lights. We did not want to be uncertain about the protector's working status.

Repair time on the field-repairable SPB series is supposed to be less than five minutes. The units are equipped with troubleshooting LEDs to help pinpoint the problem area. The built-in redundancy on each phase greatly reduces the likelihood that the station would ever be totally without protection.

Our specific needs

The studio's primary wiring plan is shown in Figure 1. Two SPB-120Ys are installed at the main inputs. A 102Vac/208Vac 3-phase, 4-wire plus ground protector was used for the wye systems. The device is capable of handling 800 joules per leg or 2,400 joules total. Clamping begins at 200V peak and will withstand IEEE 587 category B impulses (6kV-3kA).

These units provide ample protection for all of our studio equipment, which includes videotape machines, still-store, routing switcher, video cart machine, four editing bays, satellite receivers and the auxiliary support equipment.

Two more protectors are used near the IBM System 36 and the North Star computers. These protectors operate and are configured similar to the SPBs we have at the main electrical entrance. The joule rating is scaled back for use at the local service panel (380 joules per leg or 1,140 joules total). These units help ensure that program logs, commercials, payroll and all stored data from various departments as well as microprocessors inside the computer are adequately protected.

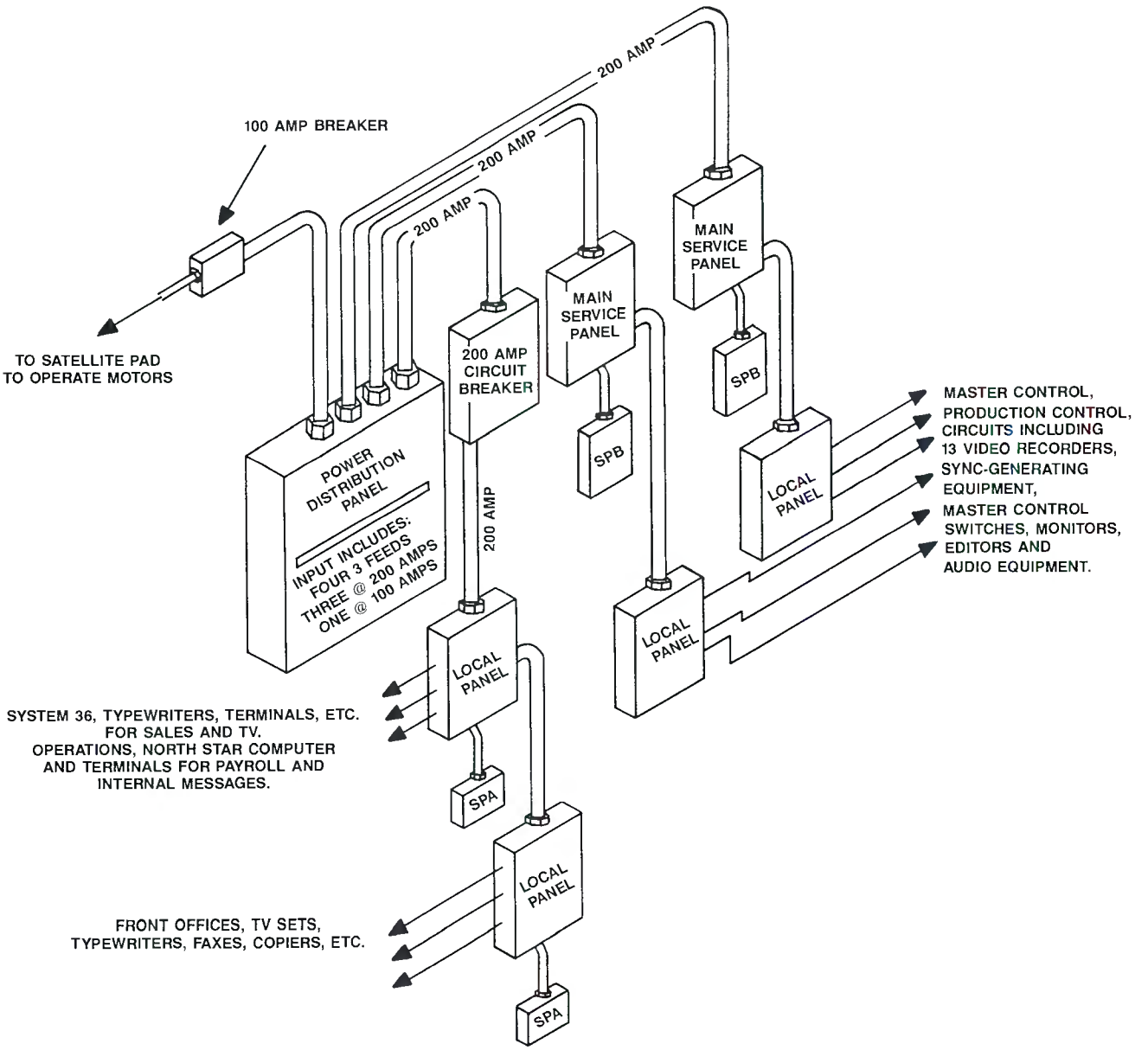

Figure 1. The surge-protection scheme for WWCP-TV relies on the SPA and SPB protectors. Since they were installed, the station has not experienced any damage from power surges.

Downtime costs

Before the SP protectors were installed, we experienced a lot of downtime. Whenever the power failed and then returned, there was always a voltage surge that was damaging studio and office equipment. When there's an equipment failure, our two technicians troubleshoot and try to make repairs within 24 hours. If the routing switcher goes down, we have to find another way to patch the commercials onto the air.

The cost of downtime varies with the time of day. During prime-time, the cost can run as much as $1,000 per hour. At other times, it varies between $400 and $600 per hour. These costs do not include employee overtime or replacement part costs. Nor does it take into account the aggravation of scrambling against the clock to get back on-line.

Errors and damage dropped to zero after the installation of the suppressors. I was correct in assuming that the previous equipment damage was being caused by electrical power surges. Since then, no ICs have been replaced and downtime is nil. The SP protectors just sit there and do their job.

Future installations

The studio in Altoona does not house computers like the Johnstown facility, but it has sensitive recorders, players and other equipment, which also need protection.

When the building was erected, the contractor installed a step-down transformer to convert the incoming 480Vac power to the required 208Vac. The transformer provides some surge suppression with thermistors, but the technology is not fast-acting. High speed, short-duration transients still pass on to the equipment. As a first-step measure, protective devices will be installed on the incoming 480Vac line.

We also are investigating protection for the transmitters and translator sites. For these applications, we'll use the Surge Master series. These units have a substantially higher transient-absorption capability and several additional features, including an audible alarm that sounds in case of failure.

The addition of the MCG SP series has cost-effectively solved our transient-related equipment problems. The additional peace of mind and continued uptime are pleasant additional benefits.

Editor's note: The field report is an exclusive **BE** feature for broadcasters. Each report is prepared by the staff of a broadcast station, production facility or consulting firm.

In essence, these reports are prepared by the industry and for the industry. Manufacturer's support is limited to providing loan equipment and to aiding the author if support is requested in some area.

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Continued from page 97

Currently, West German broadcasters can beam their programs via the Kopernikus telecommunications satellite or the Astra medium-powered direct-broadcast satellite in PAL, requiring no special receiving equipment. They can also use the direct-broadcast satellite TV-Sat 2 in D2 Mac, an intermediary step to HDTV. This technology, however, is not compatible with PAL.

Although East Germany uses SECAM, approximately 90% of the sets in the country are equipped with dual SECAM/PAL systems. Officials in West and East Germany have pushed hard in recent weeks for PAL to be the transmission of choice in the East. Their interest in D2 Mac is waning rapidly.

The West German networks have never warmed up to Mac technology and now have a good reason to avoid it.

Approximately four million satellite dishes are in operation in East Germany. To re-equip these for D2 Mac reception would require manufacturing special chips. East Germany lacks the knowledge and technology to manufacture these components and can't import them because the country is (still) subject to Co-Com regulations.

ARD and ZDF have agreed to broadcast their public channels via satellite in East Germany only if D2 Mac is dropped. However, an EC directive stipulates that Mac must be used for all DBS broadcasts in Europe.

Nevertheless, rumors are circulating that the French are willing to let D2 Mac "die silently" if the Germans agree. Given the East German situation, the French have every reason to do so. Also, experts say the EC is willing to compromise.

For those companies that risked investing in Mac technology, the prospects look gloomy. But for the East German electronics industry, there may be a good chance to start production of PAL equipment and to export cheap satellite receivers to Western markets.

New channels in Turkey

Turkey will receive three new channels this year. The country's national broadcasting station and Magicbox have already started to test transmissions on the Eutelsat satellite.

Magicbox, a commercial operation, has signed a series of program deals, including one with CNN. The channel also has signed a contract with ITT for 200,000 satellite receiving systems. Aimed at the 1.5 million Turkish expatriates in central Europe, Magicbox also is looking at the domestic market where broadcasting remains a state monopoly.

A third venture, German-Turkish TV, is still looking for a transponder but is likely to transmit from three Intelsats.

European media trends in the '90s

The European media landscape will continue to be marked by turmoil and transition during the '90s as its revenues double from 17 billion pounds to 35 billion pounds, according to a study by Booz Allen & Hamilton in London. This growth will be affected by four factors: increased advertising revenues, the arrival of pay-TV, continued high growth of video, and the approximately 127 additional households from the former Eastern bloc.

According to the study, the newly discovered revenue opportunities in Europe are already stimulating increased merger and acquisition activity. Moving rapidly on this front will be larger non-media investors, such as European construction companies and utilities, seeking synergies with their own management systems. Also, the internal telecom giants, with the exception of British Telecom, are interested in the broadcasting business. U.S. phone companies, for instance, are building a strong presence in Europe. The key media investors, including Bertelsmann, Maxwell and Murdoch, who are seeking expansion into the single European market, will vie for a larger piece of the pie.

Booz Allen & Hamilton predict that one-quarter of the deals will represent "upstream" investments into production and facilities. Recent examples include Paramount's investment in Zenith and ABC's 25% share of Hamster.

As for the Japanese, they could bypass the cable operators entirely and use the whole spectrum of direct-delivery systems, such as DBS, VCR and videodiscs, to distribute their own software, doing so from other studios they are likely to acquire — and, of course, in an HDTV format.

Europe, including the former Eastern bloc countries, could soon become a major lower-cost production base, according to the study. The 1990s will be an exciting decade of change, partnerships and new ways of doing business. Additionally, these new partners could provide a useful obstacle to hostile takeovers or the funds for expansion and bids. The new owners also will bring new management, financial and technical expertise into the European broadcasting industry. Initially, a large reverse flow of funds is expected as much of the revenue growth will return to the Hollywood film industry, the study contends.

The bypass of cable by terrestrial pay-TV or by direct-to-home is expected, not only in Europe but also in the United States, where a DBS venture is being planned by Murdoch, NBC, Hughes Communications and Cablevision. Finally, HDTV may be the lever that will give the Japanese the opportunity to overturn the structure of the industry in the '90s.

HDTV project in West German state

The government of North Rhein Westphalia (NRW), West Germany's most populated and industrial state, has established its own HDTV studio. Located in the industrial Ruhr Valley, it is receiving state aid to develop new HDTV applications, to make several productions for the state's large public-service network (WDR), and to experiment with new HDTV video technologies.

Although independent of the Eureka HDTV project, the studio is cooperating closely with officials in Brussels. In fact, Reimut Jochimsen, minister of economics in NRW, hopes that the state-subsidized project will be able to contribute to Eureka's development efforts.

West Germany telecom ministry runs HDTV tests

The Deutsche Bundespost Telekom, the entrepreneurial arm of the West German Ministry for Post and Telecommunications, is currently running tests regarding the new HDTV standard (1,250 lines/50MHz). According to a DBP Telekom official, reception quality is being checked on broadcasts beamed from the Kopernikus telecommunications satellite. The results of the testing have not been disclosed.

Italian media scene rapidly changing

The Italian media scene is being changed rapidly by Silvio Berlusconi, one of Europe's leading commercial TV magnates. Berlusconi has a controlling interest in three commercial TV stations and a stake in several other local channels. With all of these interests combined, he controls almost one-third of Italy's total viewing audience — second only to the country's public-service network.

This month, the Italian senate passed Italy's first law to regulate overlapping ownership of newspapers and TV stations. Last year, Berlusconi took over control of Mondadori, the largest publishing group

in the country.

If the lower house confirms the legislation, Berlusconi could be forced to dispose of either his newspaper interests or one or more of this three commercial networks.

Also, the left-wing faction of the Christian Democratic Party has called for legislation to halt advertising in the middle of movies, operas and other theatrical performances. Berlusconi claims this measure would cost him $300 million a year in lost revenues and would put many smaller stations out of business.

Portugal moves slowly on commercial TV

Portugal's socialist party has criticized the government for dragging its feet on commercial television. It has been pushing hard to change the current state-controlled monopoly on broadcasting. Elections are scheduled for next year and the party aims to make commercial television an issue. The Portuguese government has still to present its long-awaited commercial broadcasting bill.

Japanese sponsor HDTV production

The Bavarian Opera Company will be participating in the world's largest HDTV production. More than 70 hours of an opera written by Richard Wagner have been recorded in this new technology. Approximately 16 hours of the opera will be used. The project is being financed and produced by NHK, the Japanese network. Its premiere is scheduled for September.

West German broadcasters test broadband networks

West Germany's public-service broadcasters have been participating in the country's nationwide fiber-optic preliminary broadband network. The technology has been engineered by Nixdorf Computer and ANT telecommunication, both of West Germany. They are supplying the technology to the Deutsche Bundespost Telekom, West Germany's national telecom carrier.

West German network moves on HDTV

Production will determine the future of HDTV in Europe, according to Gerd Pohle, chairman of the technical commission with West Germany's ARD public-service network. In a recent interview, Pohle said that ARD is discussing the possibility of joining the European Economic Interest Group, an EC project supporting HDTV production equipment.

According to Pohle, the group has received wide support from the European Broadcasting Union, representing the public-service broadcasters throughout Europe.

Philips cooperates with Chrysler

Philips of the Netherlands and Acustar, Chrysler's components subsidiary, have formed a joint venture to develop and produce car audio and video products as well as information and communication systems.

New products

Note of caution

Editor's note:

• **In February issue of BE**, an announcement was published regarding a low-power TV transmitter device. The product was included because of its potential use in closed-circuit applications. However, if such a unit was used to "transmit" from your VCR to various TV receivers around the house or office, it would be considered illegal because of interference caused to standard broadcast services.

Digital multimeters

By American Reliance/ARI

• **AR-3000 series:** 3 3/4-digit DMMs; programmable, autoranging; 40-segment analog bar graph display, automatic data hold feature; min-max memories; relative measurement, dc voltage, current; ac current, dBm; continuity, diode junction, resistance measurements; fast display updates each 50ms.

Circle (351) on Reply Card

RF suppression

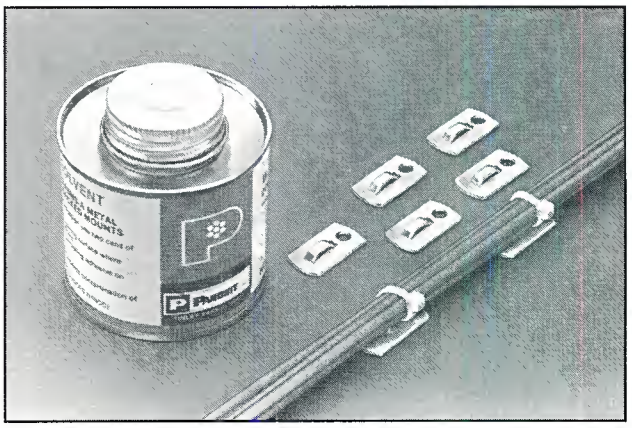
By Renco Electronics

• **RL 1325, RL 1326:** power-line chokes; standard values from 3.9μH to 0.1H; high saturation flux density material with saturation currents from 77mA to 14.7A; axial lead design; restricts RF energy from entering equipment via power line.

Circle (354) on Reply Card

Cable management

By Panduit



• **Tie mounts:** low-profile aluminum, adhesive-backed with 40 lbs pull-off force; thread cable-tie through slot to secure single cable or bundle; adhesive activated by non-flammable solvent; device may also be attached via screws.

Circle (352) on Reply Card

Experimenter packages

By Sintec Company

• **FO designer kit:** all components to construct a datalink via

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FIRST - 20 MHz solid state video switching system (NASA), 1963

FIRST - 360 x 800 20 MHz switching system —worlds largest (JPL), 1964

FIRST - 30 MHz bandwidth switching system (USAF), 1965

FIRST - 30 MHz equalizers for up to 200 feet of coaxial cable, 1967

FIRST - 90 MHz video matrix (Satellite Tracking Center), 1969

FIRST - 42 MHz bandwidth switching system (USAF), 1969

FIRST - Use of laser-trimmed hybrid video circuits, 1978

FIRST - Switching of high res computer generated graphics, 1980

FIRST - 120 MHz switching system, 1987

FIRST - 135 MHz switching system, 1987

FIRST - 150 MHz video DA's, 1988

FIRST - 40 MHz 2 RU V/A router, 1989

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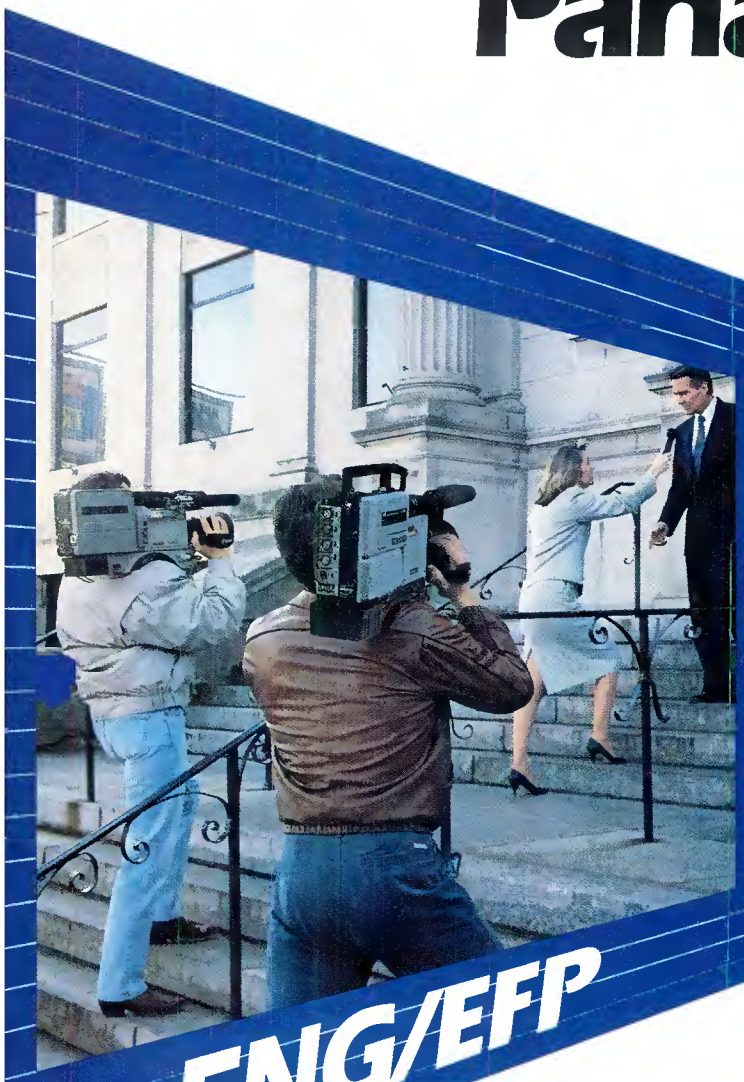
Panasonic Has Down To



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fiber optics; simplex (1-way), duplex (2-way) versions; 10m system with extension kits available; for 5Vdc power supply; interfacing to TTL/CMOS logic.

Circle (355) on Reply Card

Wide enclosures

By Equipto

• **30″ panels:** an addition to the Heavy Duty line of equipment racks in vertical and sloped-front configurations; the extra wide units are available in 32 standard heights and in depths to 36 inches.

Circle (387) on Reply Card

Component TBC

By Prime Image

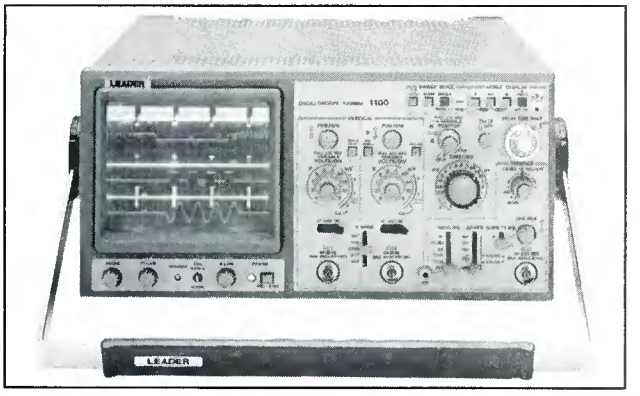
• **Model 50 TBC/Freeze:** full-frame synchronizer with 525-line memory; complete proc amp control of video level, setup, chroma saturation and hue; 7-LED front-panel indicator uses three colors to permit signal adjustments without use of a wave-

form monitor; 8-bit luma, chroma processing.

Circle (362) on Reply Card

Test instrument

By Leader Instruments



• **Model 1100:** 100MHz oscilloscope; 3-channel system with dual time base; 6-trace capability with 500μV maximum sensitivity; 5ns maximum sweep speed; alternate trigger, alternate time base and variable holdoff for versatility in measuring; two vertical, one horizontal sync separator circuits; permits simultaneous monitoring of horizontal and vertical signals.

Circle (384) on Reply Card

Signal routing

By Eidson

• **TEC E² 2088:** vertical interval router; programmable switcher control from PC or terminal; integral blackburst source with eight outputs for source timing; three audio channels per input, output with audio-follow capability; BNC video, RCA audio connectors; memory protection guards against power failures.

Circle (368) on Reply Card

Power protection

By Lightning Prevention Systems

• **GROUNDGRID:** ground reference point; for 10× greater grounding capacity than standard rod; 12′ ×12′ unit of high-grade copper; all intersections silver soldered; useful in areas where soil composition makes grounding difficult or in limited spaces.

Circle (361) on Reply Card

Cable protection

By Tyton

• **LightGuide System:** protective channel designed for fiber-optic materials or other types of cables; available in three sizes with 90° elbow and "T" sections; attach via adhesive backing or mechanically mounted to equipment racks; snap-on plastic covers.

Circle (356) on Reply Card

Security device

By Midland International

• **Model 72-130:** remote-control switch; keychain transmitter and companion receiver operate on UHF-coded channels, similar to garage door systems; receiving unit can be connected into the power system of any equipment operating on 12Vdc; remote control at distances to 50 feet are possible; reduces unauthorized equipment operation and stymies theft.

Circle (386) on Reply Card

Upgraded receiver

By ISS Engineering

• **GL5020A:** second-generation satellite receiver; for C-/Ku-band operation; front panel can be removed for installation of VideoCipher II Plus descrambling module; switchable narrow bandwidth filter to remove terrestrial interference; proof of performance provided with each receiver shipped; remote control via RS-232, serial communications software provided.

Circle (382) on Reply Card

Power phase conversion

By RotoPhase Systems

• **RPSR, RPSS series:** rotary phase converters; single-phase input, 3-phase output from fully remote-controlled deluxe system; automatic regulation and startup current limiting; easy serviceability; front-panel 3-phase metering; also available in standard versions without remote control; ratings from 48A for 10kW transmitter to 135A for 35kW transmission system.

Circle (377) on Reply Card

Duplication DAs

By Tobin Cinema Systems

• **BVA-12, SVA-12:** video with stereo audio distribution amplifiers; one looping input drives 12 outputs; BVA type with BNC, SVA type with Y/C S-VHS video connectors; audio may be balanced or unbalanced with RCA jacks or solderless terminals; video response flat to 12.5MHz; audio response is ±1dB to 200kHz.

Circle (380) on Reply Card

Multitester

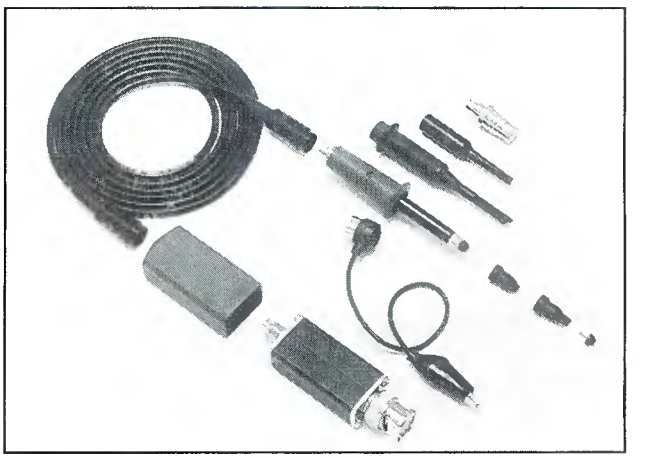
By B&K Precision/Maxtec International

• **Test Bench Jr No. 377:** multifunction instrument includes voltage, current, resistance, capacitance and frequency measurements in addition to logic, transistor, diode and continuity testing; pocket-sized unit is designed with protective circuitry for reverse polarity and overload as well as high-energy fusing.

Circle (385) on Reply Card

Probe replacement

By Test Probes



• **TPI 300:** oscilloscope probes for operation to 300MHz; on-

Continued on page 120

People

Peter Suzuki has been named president of Yamaha Corporation of America, Buena Park, CA.

Kevin J. Breen, William F. Lyons, Christopher Gagliano, Scott G. Nicholson and **Douglas Triblehorn** have been promoted to positions with Hughes Television Network, New York. Breen and Lyons are senior communication services coordinators. Gagliano, Nicholson and Triblehorn are communication coordinators.

Peter Hearne has been appointed president, U.S. operations for GEC-Marconi, Arlington, VA.

Kevin Elliott has transferred from the New York office of JVC Disc America Company to its Los Angeles office.

Michael G. Blankenship has been named Development Fellow by Corning, Corning, NY. The distinction recognizes his contributions to the development of optical fiber products and manufacturing processes.

Carl C. Dorwaldt, Mark Duncan and **Graeme Harrison** have been appointed to positions with Renkus-Heinz, Irvine, CA. Dorwaldt is national sales and marketing manager. He is responsible for planning, promotion and sales activities. Duncan is product manager. He directs new product development programs and engineering assistance. Harrison is European marketing manager. He is responsible for marketing in the United Kingdom and Europe.

Richard A. Cooper has been named national sales manager, robotics, for A.F. Associates, Northvale, NJ.

Dave Powell has been named Eastern regional sales engineer for Solid State Logic, New York. He is responsible for sales of the Screensound digital audio-for-video editing system.

Robert H. Joseph and **Richard J. Parissidi** have been named to positions with Joseph Electronics, Northbrook, IL. Joseph is vice chairman. He is responsible for special projects and assignments. Parissidi is president and CEO. He is responsible for the operation of the business, with all officers reporting directly to him.

Greg Pine has been appointed product marketing manager of Broadcast Television Systems, Salt Lake City. He also will serve as the acting marketing manager for Betacam products.

Daniel J. McCarthy, George I. Hardy, Carl Guastaferro and **Eric P. McCulley** have been appointed to positions with Microwave Radio, Lowell, MA. McCarthy is Northeastern regional sales manager. Hardy is Southeastern regional sales manager. Guastaferro is Western sales manager and McCulley is Midwestern regional sales manager.

Phillip Lachapelle has been appointed Western regional sales manager, large screen display products for BARCO, Smyrna, GA. He is responsible for sales of large screen display monitors and large screen projection systems.

F. Wesley Dixon has been appointed vice president of U.S. operations for CEL Electronics, Saffron Walden, England. CEL U.S. offices will be located in Kansas City, MO.

Michael C. Rau has been named senior vice president, science and technology, for the National Association of Broadcasters, Washington, DC.

Courtney Spencer has been named vice president, professional audio division, for Sony Communications Products Company, Park Ridge, NJ. He oversees all sales and marketing operations and activities of the professional audio division.

Hugh R. Heinsohn and **Elaine Jones** have been appointed to positions with Gentner Electronics, Salt Lake City. Heinsohn is director of marketing. He is responsible for company sales, distribution, marketing coordination and customer support departments. Jones is director of corporate projects. She is responsible for the implementation of corporate level projects.

Jay C. Adrick, Robert D. Johnston and **Brad L. Nogar** have been assigned new management duties with Midwest Communications, Edgewood, KY. Adrick, executive vice president, manages the systems group. Johnston, executive vice president, manages the branch sales group. Nogar, executive vice president, manages the marketing group.

Warren T. Reeves has been named LPTV chief engineer for Video Jukebox, Miami. Reeves is responsible for the installation and maintenance of the owned, operated and affiliated LPTV broadcast stations that carry the Jukebox network programming.

Denise Lund has been appointed resident architect for the Shaffer Communications Group, Houston. She is responsible for new designs for antenna applications on high-rise buildings and tower structures.

George N. Chaltas and **Joseph M. Wallace** have been appointed to positions with Broadcast Data Systems, New York. Chaltas is director, Western region. Wallace is director, Eastern region.

Philip Atkins and **Paul Jones** have been appointed to positions with BAL (UK) Limited. Atkins is export sales manager. Jones is sales engineer.

Katcha Burnett and **Gary Attanasio** have been appointed to positions with Aurora Systems, Melville, NY. Burnett is international sales manager. Attanasio is Northeast regional sales manager.

Joe P. Wellman has been named marketing manager for Microtime, Bloomfield, CT.

Lawrence Weiland has been appointed president of Microtime, Bloomfield, CT.

Scott Smith, Stavros Hilaris, Jordan Scott, Peter Greco, Richard Hanf and **Eric Silverthorn** have been promoted to new positions in the broadcast and systems divisions of IDB Communications Group, Los Angeles. Smith is director of operations at the international facilities teleport on Staten Island. Hilaris is director of engineering at IDB-NY. Scott is audio manager. Greco is audio supervisor. Hanf is video supervisor. Silverthorn has relocated to IDB Systems in Dallas as project manager.

Brent Bullock has been named national sales manager for Quanta, Salt Lake City.

James L. Faust has been appointed corporate vice president international, a new staff position, for Scientific-Atlanta, Atlanta. The company's international subsidiaries will report to Faust. He is responsible for foreign representative relations, and will coordinate between S-A operations and provide leadership in building cable TV business abroad by assuming responsibility for the company's international cable TV operations.

Andrew Duncan has joined Vinten Broadcast, Hauppauge, NY. He is marketing manager of remote-control camera systems.

We sold more of our new Auditronics 900 TV audio consoles at NAB-Atlanta than we forecast.

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Circle (106) on Reply Card

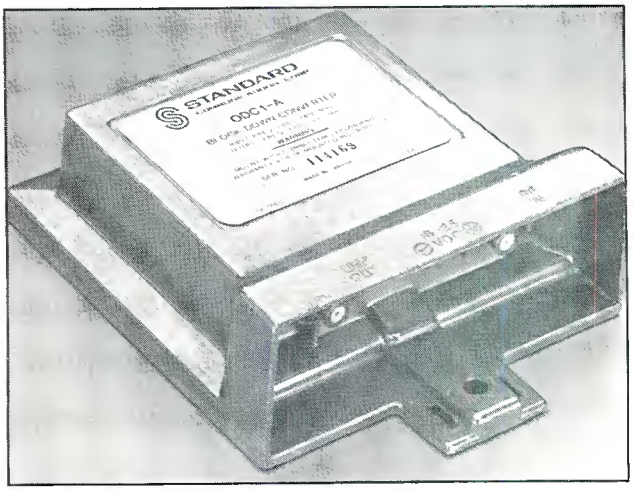
Continued from page 117

site repairable, thin-cable unit matches instruments with 1MΩ input impedance; modules screw together for secure, solderless contacts and quick repair; models have an activator pin to trigger readout and auto scale factoring features of some instruments; compatible with most popular oscilloscope models.

Circle (383) on Reply Card

TVRO downconverter

By Standard Communications

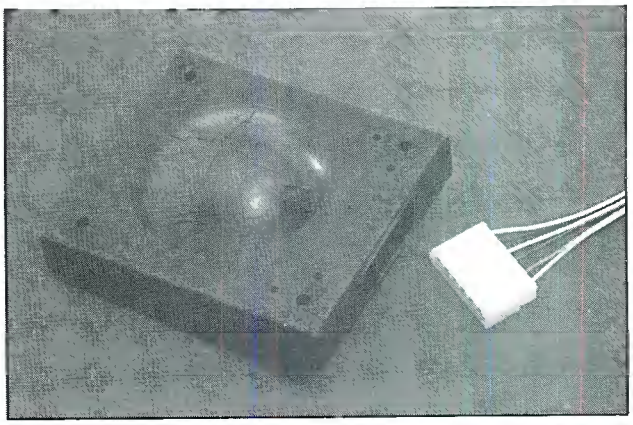


• **ODC1A:** block downconverter; converts 270MHz-700MHz TVRO systems to 950MHz-1,450MHz; permits operation with a lower noise temperature for improved C/N and S/N ratios resulting; enables satellite receiving system to be used with some newer receiver models offering descrambling functions.

Circle (381) on Reply Card

Automatic level sensor

By Lucas Sensing Systems



• **AccuStar II:** measures angular orientation through two clinometers; useful for automatic leveling, motion detection systems; ±20° range in X and Y axes with ±0.2° linearity, repeatable to ±0.1°; output signal is proportional to relative tilt of two axes at right angles to one another.

Circle (374) on Reply Card

If you want to deliver the best, you have to start with the best. And for critical applications like original acquisition, editing, and mastering, you can't do better than Ampex 196 1" master broadcast videotape and Ampex 197 ¾" U-matic and 297 ¾" U-matic SP master broadcast videocassettes. They offer consistent low dropout performance with exceptional high RF output and superior signal-to-noise ratios. So you can depend on every reel, every cassette, every carton to deliver uniformly high performance every time, end to end. All backed by the industry's most acclaimed service and support organization. Surprising? No. It's Ampex.

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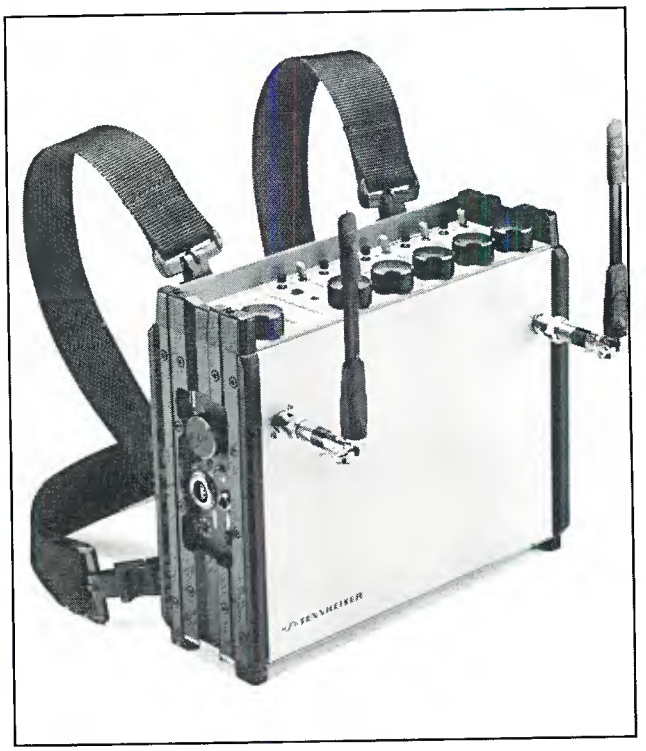
Circle (100) on Reply Card

Portable audio mixer

By Sennheiser



• **WM-1 wireless:** field mixer includes four channels with wireless mic receivers, fifth channel for wired mic or line level audio source; bass, treble EQ controls, 70Hz cut-off filter; LED bargraph monitors audio, RF levels; headphone output; 1kHz tone source; operates from six D cells.

Circle (376) on Reply Card

Production organizer

By Victory International Productions

• **Production Forms Manager:** software package for IBM and compatibles; user completes necessary information for storyboard, time sheets, photo releases, contracts, logs and other applicable forms; tracks petty cash expenses, calculates staff salaries; completed forms may be produced on a wide range of printers; blank forms may be produced for completion at a later date.

Circle (379) on Reply Card

Wiring terminals

By Zierick Manufacturing

• **Torsion-Lok IDC:** insulation displacement contacts for strand or solid wire from No. 24 through No. 30 sizes; creates dependable connections without solder; enables quick disconnection if needed; dual spring design maintains fixed tension on wire, unaffected by vibration, temperature cycling.

Circle (369) on Reply Card

Coaxial cable

By Comm/Scope

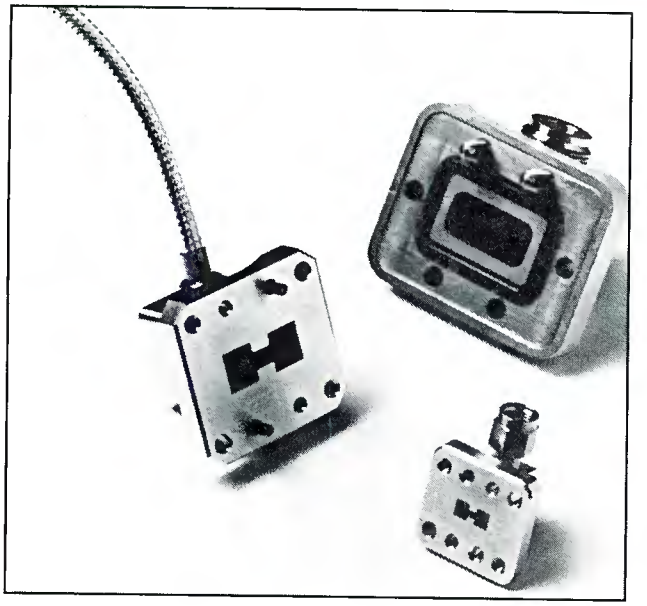
• **PLENUMAX:** plenum rated coaxial cable; designed for CATV or an in-house CCTV system; meets NEC Article 820 smoke and flame propagation standards; RG59, RG6 designations; Ky-

nar jacketing, fluorinated ethylene propylene dielectric.

Circle (372) on Reply Card

Waveguide-to-coaxial

By ITT Sealectro



• **Sealectro adapters:** provides correct matching structure between waveguide and coaxial transmission lines; broadband with low reflection and low loss; available from 2.65GHz-40GHz; rectangular and double-ridged with interfaces for N, K, TNC, SMA and PC7 male and female connectors.

Circle (371) on Reply Card

Cable protection

By Bentley Harris Products

• **Expando oversleeving:** self-fitting protective materials for individual or bundled cables, air lines, fluid hoses; available for temperature range from -70°C to 200°C; open-weave construction from polyester, dual-monofilament, Halar fluoropolymer, polyetherketone, polyphenulene sulfide materials to meet various environmental and fire hazard conditions and restrictions.

Circle (370) on Reply Card

FO material

By Belden Wire & Cable

• **Multifiber material:** six fiber-optic conductors in a single tube; for outdoor FO interconnection applications; may be used in aerial installations; available with 2, 4, 8 and 12 fibers and with various fiber sizes.

Circle (366) on Reply Card

Frequency measurement

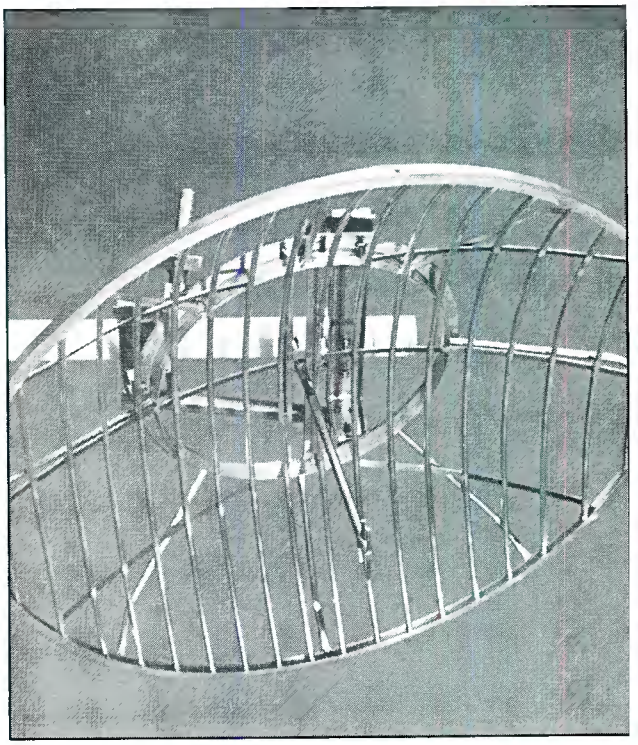
By Optoelectronics

• **Model 2210-A:** frequency finder and counter; easily held in one hand; usable from 10Hz to 2.8GHz in two ranges; 1Hz, 100Hz resolution with ±1ppm accuracy; 10mW input sensitivity; CMOS VLSI counter chip with monolithic microwave ICs.

Circle (373) on Reply Card

Ice-free microwave

By Radiation Systems/Mark Antennas



• **Heated antennas:** for 335-2,700MHz microwave systems heated grid parabolic antennas in diameters from four feet to 16 feet; de-icer activates with temperatures in the 25°F to 35°F range; radiating element heated by lamp or heater strap, depending on antenna size; 110Vac or 220Vac operation.

Circle (367) on Reply Card

Strain relief

By Panduit

• **DISCOGRIP:** molded disconnects; for 22-18 and 16-14 wire sizes; guards against inadvertent disconnections in areas of high vibration or excessive conductor strain; nylon barrel improves wire insulation grip; meets UL, CSA requirements.

Circle (365) on Reply Card

Correction

The telephone number for Intraplex was listed incorrectly in the March issue. The correct phone number is 508-486-0709.

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Contact Renée Hambleton, at (913) 888-4664, for information on frequency and pre-payment discounts. To place your classified ad send your order and materials to Broadcast Engineering, Classified Ad Mgr., P.O. Box 12901, Overland Park, KS 66212.

HELP WANTED

Telecommunications Engineer—Greenville Technical College one of the nation's leading community colleges, located in the northwest corner of South Carolina invites applications for the position of Telecommunications Engineer. Responsibilities include: design, test and maintain equipment and facilities for ITFS reception, distribution and talk back systems. Serve as a technical advisor to educational institution personnel in planning, designing, developing, and building distribution systems. Minimum of five years experience in a telecommunications environment and completion of a two-year electronics degree or related field program required. Prior experience with microwave, ITFS and other RF equipment for use in audio, video and data applications. General FCC Radio/Telephone license required. Excellent oral and written communication skills required. Salary will commensurate with experience. Send cover letter and resume to:

Personnel Services, Greenville Technical College, PO Box 5616 Greenville, SC 29606-5616 EOE M/F/H/V.

BROADCAST ENGINEERS WANTED: 2 broadcast engineers with experience in ¾" tape equipment. Studio and transmitter knowledge helpful. Great benefits, no agencies please. Send resume to Don Roden or Steve King, WHNT-TV, 200 Holmes Ave., Huntsville, AL 35801 or call (205) 533-1919. 04-90-2t

BROADCAST SENIOR ENGINEER. System design, installation, training, and component level maintenance of broadcast electronics. Facilities include: Public FM Radio & UHF TV Stations, TV & audio prod. studios, mobile TV prod. truck, CCTV/CATV, mobile satellite uplink. Min. 3-yr component level video electronics maintenance experience and 2-yr degree in related field required. Previous maintenance experience on 3-tube cameras and 1" C format tape machines a plus. Experience with computer hardware and software, and supervisory experience helpful. Competitive salary with University benefits. Applications including 4 prof. ref. Prev. applicants need not re-apply. Apply to: Keith Turcot, Chief Engineer, Bradley Univ., WCBU-FM/WTVP-TV, Peoria, IL 61625; AA/EOE. 05-90-1t

MAINTENANCE ENGINEER—Premier southern Florida post facility seeking quality person experienced with Ampex 1", Sony Beta, and Grass Valley equipment. Send resume to: Chief Engineer, 2040 Sherman St., Hollywood, FL 33020. 05-90-1t

EASTERN IOWA/WESTERN ILLINOIS STATIONS SEEK A CHIEF ENGINEER. Must have transmitter repair experience. RF knowledge a must. Studio engineering and microwave knowledge required. Excellent pay and benefits. Send resume and salary requirements to: Broadcast Engineering, Dept. 713, P.O. Box 12901, Overland Park, KS 66212. EOE. 05-90-1t

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needed for a national Christian studio post production satellite uplink facility. Three years component level maintenance experience. Ampex, AVC, ADO, VPR-3, Beta, Scientific Atlanta Uplink. Positions available in San Diego and Dallas. Competitive salary and benefits (Paid vacations, holidays, incentive programs, medical & dental insurance) with an exciting organization. Send resume to: Personnel Dept., Word of Faith, P.O. Box 819099, Dallas, TX 75381-9099

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We offer a salary commensurate with experience and a benefits package. Qualified applicants should send resume with reference to:

Personnel Department, OETA, P.O. Box 14190, Oklahoma City, Oklahoma 73113.

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BROADCAST ENGINEER for AM side of dominant AM/FM combo in mid-west. Good interpersonal skills and demonstrated knowledge of audio and studio construction a must. Five years minimum experience as chief or assistant. Send resume and salary history to: Jeff Glass, Nolte Communications, 3901 Brendenwood Road, Rockford, IL 61107. 815-399-2233. Nolte Communications, an Equal Opportunity Employer. 05-90-2t

MAINTENANCE ENGINEER: Five years experience in Broadcasting or related fields required. Repair to component level on cameras, VTR's, switchers and related studio and ENG equipment. FCC license or SBE certification preferred. Reply to Operations Manager, WINK-TV, P.O. Box 1060, Ft. Myers, FL 33902. Tel. 813-334-1131. EEO05-90-1t

TELECINE RESEARCH AND DEVELOPMENT FACILITY, is seeking an experienced rank telecine engineer. Duties will include research and development, light assembly, and customer service. Send resume and expected salary requirements to: Broadcast Engineering, Dept. 714, P.O. Box 12901, Overland Park, KS 66212. 05-90-1t

MAINTENANCE ENGINEER: Christian TV station seeks full time Maintenance Engineer. Experience repairing and maintaining broadcast equipment a must. UHF transmitter experience helpful. Send resume and salary requirements to: Trinity Broadcasting Network, WDLI CH-17, 6600 Atlantic Blvd. N.E., Louisville, Ohio 44641, EOE.05-90-1t

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NEW 24' PRODUCTION TRUCK, production switcher, 16 channel Tascam audio board, Sony monitors, 2 6.5Kw generators, Sigma distribution system 500, RTS comms, and much more. 305-893-6627. 05-90-1t

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NAPA VALLEY COLLEGE offers a 2-year telecommunications program with emphasis in 1-inch "C" format, T.B.C.S., component and digital video. Call or write Gary Vann, 707-253-3258, Napa Valley College, Napa, California. 05-90-3t

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Alta Group Inc.	69	48	408/297-2582
Ampex Corp (AVSD)	115,117	89,95	800/227-8402
Ampex Corp (AVSD)	40-41,65		800/25A-MPEX
Ampex Recording Media	121	100	415/367-2911
Anvil Cases, Inc.	120	98	818/575-8614
Arrakis Systems, Inc.	21	13	303/224-2248
Audio Precision	13	8	800/231-7350
Auditronics, Inc.	119	106	901/362-1350
Behlman, Div. of Fiskars Electronics	38	22	800/456-2006
Belar Electronics Laboratory, Inc.	124	103	215/687-5550
Benchmark Media Systems	76	54	315/452-0400
Bext, Inc.	56	35	619/239-8462
Broadcast Electronics, Inc.	11	7	217/224-9600
Broadcast Video Systems, Ltd.	58,116	39,91	416/764-1584
BTS Broadcast Television Systems	85	51	800/962-4BTS
Cablewave Systems	47	28	203/239-3311
California Broadcasters Assoc.	115,117		916/444-2237
California Tube Laboratory, Inc.	116	90	800/824-3197
Clear-Com Intercom Systems	107	83	415/527-6666
Comark	75	53	215/822-0777
Computer Assisted Technology	76	55	212/360-2591
Conex Electro Systems	92	99	206/734-4323
Continental Electronics, Div. of Varian	52	30	214/381-7161
Cortana Corporation	92	87	505/325-5336
Delta Electronics	36	20	703/354-3350
Di-Tech Inc.	78	93	516/667-6300
Dolby Labs, Inc.	43	26	415/558-0200
Dynair Electronics, Inc.	111	96	619/263-7711
EEV, Inc.	105	82	914/592-6050
ESE	109	85	213/322-2136
For-A Corp of America	95	70	213/402-5391
Fujinon, Inc.	45	27	201/633-5600
Full Compass Systems	78	80	800/356-5844
Geleco Electronics, Ltd.	92	77	416/421-5631
Gentner Electronics Corp.	61	42-43	801/975-7200
Grass Valley Group, Inc.	9	6	916/478-3000
Harris Corp.	29,31	15,16	800/4HA-RRIS
Henry Radio	56	34	800/877-7979
Hitachi Denshi America Ltd.	3		800/645-7510
Hybrid Arts	68	47	213/841-0340
Illbruck	51	31	800/662-0032
International Tapetronics Corporation	55	33	800/447-0414
Intraplex, Inc.	58	38	508/486-3722
ITT Canon/Canada	42	25	416/668-8881
Jampro Antennas, Inc.	32	17	916/383-1177
Jensen Transformers, Inc.	116	92	213/876-0059
JVC Professional Product Co.	19	11	800/582-5825
LDL Communications	99	81	301/498-2200
Leader Instruments Corp.	59	40-41	800/645-5104
Leitch Video Of America, Inc.	IBC	2	804/424-7290
Mark Antennas, Div. of Radiation Systems	122	104	708/298-9420
Markertek Video Supply	93	78	800/522-2025
McCurdy Radio Industries	77	56	416/751-6262
MCL, Inc.	101	75	708/759-9500
Micro Circuits, Co.	44	86	616/469-2744
Midwest Communications Corp.	1	3	606/331-8990
Minolta Corporation	82	63	201/825-4000
Moseley Associates, Inc.	83	62	805/968-9621
Myat	28	14	201/767-5380
Nautel	94	69	902/823-2233
NCA	74	52	716/852-4521
Nikon Corporation	5	4	516/222-0200
Odetics, Inc.	81	61	800/243-2001
Opamp Labs, Inc.	116	94	213/934-3566
Orban, Div. of AKG Acoustics, Inc.	7,17	5,10	800/227-4498
Otari Corp.	15	9	415/592-8311
Panasonic Broadcast Systems Co.	48A-H	29	201/348-7336
Panasonic Pro Industrial Video	72-73,112-113	59,88	800/553-7222
Polyphaser Corp.	38	23	800/325-7170
Pro Audio Asia	122	105	
Queue Systems	56	36	213/656-0258
Rank Cintel, Inc.	67	46	818/765-7265
RTS Systems, Inc.	62	44	818/843-7022
Sachtler Corp. of America	71	49	516/867-4900
Schmid Telecommunications	93	68	201/530-8555
Shure Brothers Inc.	IFC	1	708/866-2553
Solid State Logic LTD.	87,89	65,66	800/343-0101
Sony Communications Prod/ Broadcast Div.	24-25		800/635-SONY
Sony Corporation/ Broadcast Products	35	19	800/635-SONY
Sound Technology	109	84	800/359-5080
SSAC, Inc.	66	45	315/638-1300
Standard Tape Laboratory, Inc.	92	79	415/786-3546
Switchcraft, Inc.	27	12	312/792-2700
Tascam, Div. TEAC Corp. of America	64,123	50,101	213/726-0303
Tektronix, Inc.	57,103	37,76	800/452-1877
Telex Communications, Inc.	96,97	71,72	612-887-5550
Thomson Tubes Electroniques	53	32	201/812-9000
TTC-Television Technology Corporation	91	102	303/665-8000
Utah Scientific, Inc.	39	24	800/453-8782
Videotek, Inc.	37	21	602/997-7523
Ward-Beck Systems, Ltd.	BC		416/438-6550
Winsted Corp.	120	97	800/447-2257

BROADCAST engineering ACTION CARD

☐ New Subscription ☐ Renewal ☐ Address Change ☐ Information Request

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Name _____

Title _____

Company _____

Address _____

City _____

State _____ Zip _____

Phone (_____) _____

FASTER ACTION!

If you have immediate interest in any products in this issue, write in the number(s) below and check all the appropriate boxes.

I am interested in these items

	Immediate Need	Have Sales-person Call	Name Nearest Dealer	Send Literature	For Future Reference
#					
#					
#					
#					

Circle reader service numbers below for more information

1	34	67	100	134	168	202	236	270	304	338	372	406	440	474	508	542	576
2	35	68	101	135	169	203	237	271	305	339	373	407	441	475	509	543	577
3	36	69	102	136	170	204	238	272	306	340	374	408	442	476	510	544	578
4	37	70	103	137	171	205	239	273	307	341	375	409	443	477	511	545	579
5	38	71	104	138	172	206	240	274	308	342	376	410	444	478	512	546	580
6	39	72	105	139	173	207	241	275	309	343	377	411	445	479	513	547	581
7	40	73	106	140	174	208	242	276	310	344	378	412	446	480	514	548	582
8	41	74	107	141	175	209	243	277	311	345	379	413	447	481	515	549	583
9	42	75	108	142	176	210	244	278	312	346	380	414	448	482	516	550	584
10	43	76	109	143	177	211	245	279	313	347	381	415	449	483	517	551	585
11	44	77	110	144	178	212	246	280	314	348	382	416	450	484	518	552	586
12	45	78	111	145	179	213	247	281	315	349	383	417	451	485	519	553	587
13	46	79	112	146	180	214	248	282	316	350	384	418	452	486	520	554	588
14	47	80	113	147	181	215	249	283	317	351	385	419	453	487	521	555	589
15	48	81	114	148	182	216	250	284	318	352	386	420	454	488	522	556	590
16	49	82	115	149	183	217	251	285	319	353	387	421	455	489	523	557	591
17	50	83	116	150	184	218	252	286	320	354	388	422	456	490	524	558	592
18	51	84	117	151	185	219	253	287	321	355	389	423	457	491	525	559	593
19	52	85	118	152	186	220	254	288	322	356	390	424	458	492	526	560	594
20	53	86	119	153	187	221	255	289	323	357	391	425	459	493	527	561	595
21	54	87	120	154	188	222	256	290	324	358	392	426	460	494	528	562	596
22	55	88	121	155	189	223	257	291	325	359	393	427	461	495	529	563	597
23	56	89	122	156	190	224	258	292	326	360	394	428	462	496	530	564	598
24	57	90	123	157	191	225	259	293	327	361	395	429	463	497	531	565	599
25	58	91	124	158	192	226	260	294	328	362	396	430	464	498	532	566	600
26	59	92	125	159	193	227	261	295	329	363	397	431	465	499	533	567	601
27	60	93	126	160	194	228	262	296	330	364	398	432	466	500	534	568	602
28	61	94	127	161	195	229	263	297	331	365	399	433	467	501	535	569	603
29	62	95	128	162	196	230	264	298	332	366	400	434	468	502	536	570	604
30	63	96	129	163	197	231	265	299	333	367	401	435	469	503	537	571	605
31	64	97	130	164	198	232	266	300	334	368	402	436	470	504	538	572	606
32	65	98	131	165	199	233	267	301	335	369	403	437	471	505	539	573	607
33	66	99	132	166	200	234	268	302	336	370	404	438	472	506	540	574	608
R5A			133	167	201	235	269	303	337	371	405	439	473	507	541	575	609

FOR ISSUE OF MAY 1990
USE UNTIL SEPTEMBER 1990

(After this date, please contact supplier directly)

1 **IMPORTANT: Do you wish to receive/continue to receive *Broadcast Engineering* FREE?**

☐ Yes ☐ No

_____

Signature required

Title _____

Date _____

2 **Please check the ONE type of facility or operation that best describes your business classification.**

20 ☐ TV Station
21 ☐ AM Station
22 ☐ FM Station
23 ☐ AM & FM Station
24 ☐ TV & AM Station
25 ☐ TV & FM Station
26 ☐ TV, AM & FM Station
19 ☐ Low-Power TV Station
27 ☐ CATV Facility
28 ☐ Non-Broadcast TV including Closed-Circuit TV (CCTV)
29 ☐ Recording Studio
30 ☐ Teleproduction Facility
31 ☐ Microwave, Relay Station or Satellite Company
32 ☐ Government
33 ☐ Consultant (Engineering or Management)
34 ☐ Dealer, Distributor or Manufacturer
35 ☐ Other _____ (please specify)

3 **Which of the following best describes your title? Write the number in the box (select one number only):**

A ☐ **Company Management**—(1) Chairman of the Board, (2) President, (3) Owner, (4) Partner, (5) Director, (6) Vice President, (7) General Manager (other than in charge of Engineering or Station Operations Mgt.), (8) Other Corp./Financial Officials

B ☐ **Technical Management & Engineering**—(9)Technical Director/Mgr., (10) Chief Engineer, (11)Other Engineering or Technical Titles

C ☐ **Operations & Station Management/Production & Programming**—(12) VP Operations, (13) Operation Mgr./Director, (14) Station Mgr., (15) Production Mgr., (16) Program Mgr., (17) News Director, (18) Other Operations Title

D ☐ **Other:** Specify _____

4 **If you checked 19 through 26 on question No. 2, which of the following best describes your over-the-air station? (check only one):**

A ☐ Commercial
B ☐ Educational
C ☐ Religious
D ☐ Campus Low-Frequency
E ☐ Community
F ☐ Municipally Owned

5 **What is your annual budget for equipment purchases? (check only one):**

A ☐ Less than $25,000
B ☐ $25,000 to $49,999
C ☐ $50,000 to $99,999
D ☐ $100,000 to $250,000
E ☐ Over $250,000

6 **What is the ADI rank of your station?**

A ☐ Top 20
B ☐ 21 to 50
C ☐ 51 to 100
D ☐ Over 100

7 **Which statement best describes your role in the purchase of equipment, components and accessories?**

A ☐ **Make final** decision to buy specific makes, models, services or programs
B ☐ **Specify** or make **recommendations** on makes, models, services or programs
C ☐ Have **no part** in specifying or buying

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ACTION CARD

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Name _____

Title _____

Company _____

Address _____

City _____

State _____ Zip _____

Phone (_____) _____

FASTER ACTION!

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I am interested in these items

	Immediate Need	Have Sales-person Call	Name Nearest Dealer	Send Literature	For Future Reference
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12	45	78	111	145	179	213	247	281	315	349	383	417	451	485	519	553	587
13	46	79	112	146	180	214	248	282	316	350	384	418	452	486	520	554	588
14	47	80	113	147	181	215	249	283	317	351	385	419	453	487	521	555	589
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16	49	82	115	149	183	217	251	285	319	353	387	421	455	489	523	557	591
17	50	83	116	150	184	218	252	286	320	354	388	422	456	490	524	558	592
18	51	84	117	151	185	219	253	287	321	355	389	423	457	491	525	559	593
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26	59	92	125	159	193	227	261	295	329	363	397	431	465	499	533	567	601
27	60	93	126	160	194	228	262	296	330	364	398	432	466	500	534	568	602
28	61	94	127	161	195	229	263	297	331	365	399	433	467	501	535	569	603
29	62	95	128	162	196	230	264	298	332	366	400	434	468	502	536	570	604
30	63	96	129	163	197	231	265	299	333	367	401	435	469	503	537	571	605
31	64	97	130	164	198	232	266	300	334	368	402	436	470	504	538	572	606
32	65	98	131	165	199	233	267	301	335	369	403	437	471	505	539	573	607
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FOR ISSUE OF MAY 1990
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_____

Signature required

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Date _____

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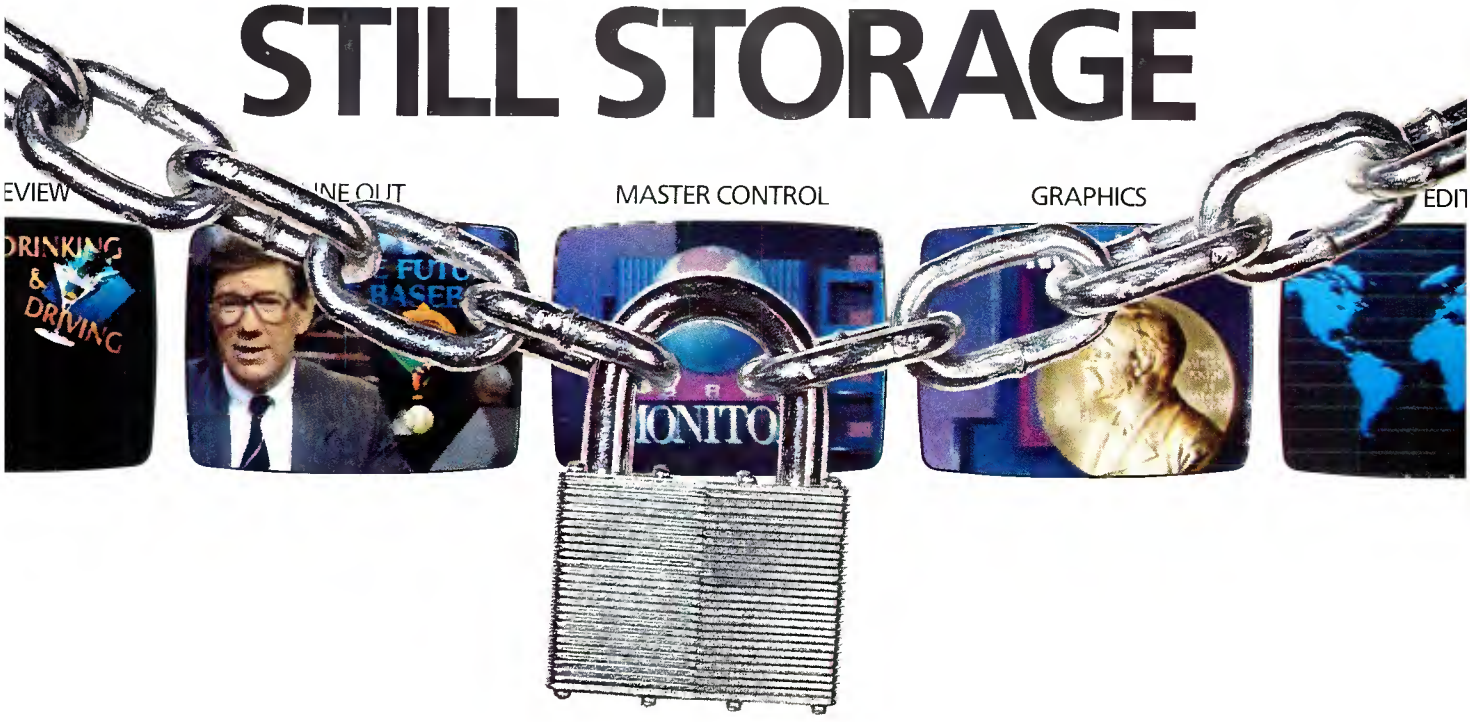

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