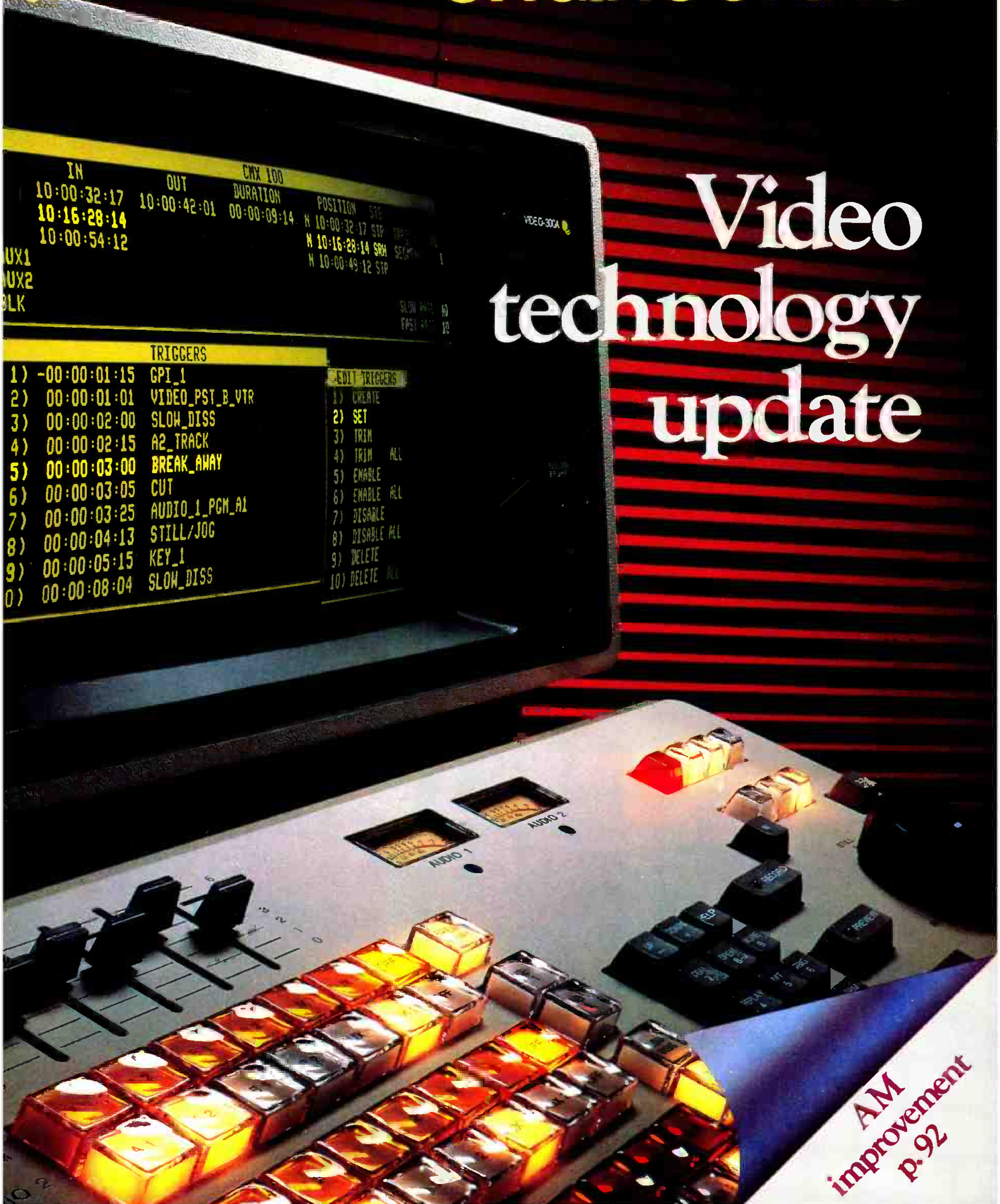
BROADCAST engineering®

AN INTERTEC PUBLICATION

August 1987/$3



Video technology update

AM improvement p. 92

CHANGE CONSOLE SETUPS IN SECONDS!

The New ADM Computer Controlled BCS-PC

Once again, ADM has achieved a quantum leap in audio console technology. By adding a computer to our most successful stereo broadcast console, setups can now be changed in seconds, not just once, but as often as needed. More important, this is not merely an adaptation of a recording or post production console which lacks essential broadcast features. The BCS-PC is solely designed for broadcast console automation.

With the BCS-PC console it is possible to store and recall many of the most important console operations and make a setup in seconds. You can automate input pre-selection, module on/off status, input group muting and output bus assignment. The BCS-PC can address your house router and save its source and console destination selections along with the console presets.

Easy to use? You bet! Set up the console as you normally would and a couple of key strokes saves that setup for future use.

Editing can be acomplished by using either the integ keyboard or by resetting the console switches manua

Console status is displayed on the monitor as well as the console LED indicators associated with each pus button.

Computer failure? No problem! ADM has engineered BCS-PC to totally ignore a computer failure. The con continues to operate manually, as it always has.

With the addition of automation to the BCS, ADM has not forgotten its primary goal of providing a fully func tional stereo console. The BCS-PC still has such features as: input pre-selection and bussing, VCA co trol of all main program paths for superior noise free tracking, four band VCA controlled stereo equalizer, stereo auxilliary busses, 4 independent stereo monit operation and muting for up to three studios - plus mo

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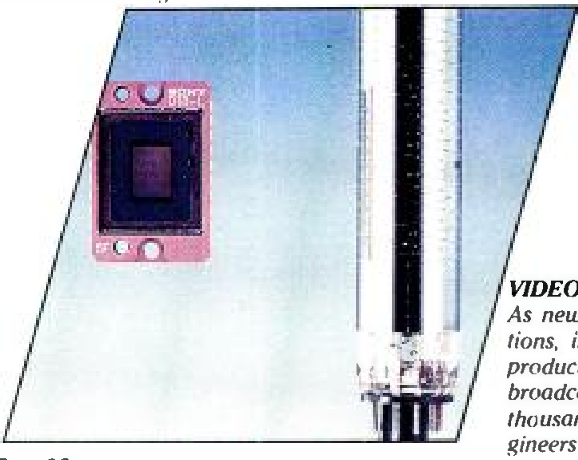

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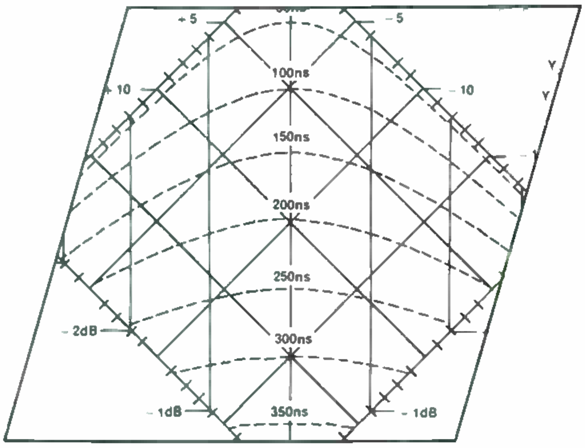
BROADCAST engineering

VIDEO TECHNOLOGY UPDATE:
As new video technology continues to accelerate in all directions, it is integrated into almost every new broadcast video product. Assessing new technology and its applications in a broadcast environment is a full-time job for hundreds, if not thousands, of people. It also is a part of many broadcast engineers' responsibilities at a facility. Our video technology section focuses on several areas where broadcast technology is moving the fastest.



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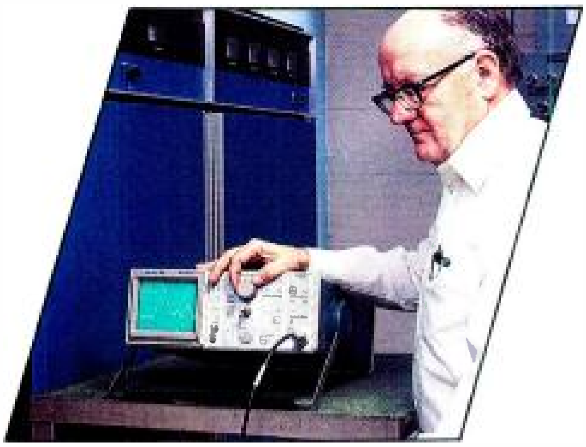

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ON THE COVER
Computer technology has revolutionized broadcast operations from videotape production to camera setup. Many systems that used to occupy several equipment racks can now easily be placed on a desktop. The CMX 100, shown on the cover, is one example of this trend. (Photo courtesy of CMX. Photograph by Joseph Uhlan, UhlanWright.)

DEPARTMENTS

SK-110D
AUTO SETUP
TRANSFER
MEMORY
FILE SELECT

Standards needed for HDTV development

The National Association of Broadcasters' HDTV task force has issued a statement defining HDTV terrestrial broadcast system criteria and endorsed a testing program that began this summer. HDTV is the next generation of television that will provide wide-screen pictures with sharper resolution than those on present TV receivers and with compact disc-quality stereo sound.

Daniel E. Gold, task force chairman, (president, Knight-Ridder Broadcasting, Miami, FL), said, "It is imperative that station management and TV receiver manufacturers work together to develop a viable HDTV system. The technology exists to bring this new technical development into American homes and by working together it can be achieved."

The critical issue is still the availability of spectrum space. The industry has found that a portion of the UHF-TV spectrum is necessary for transmission of HDTV. The NAB and others have petitioned the FCC to delay proposed reallocations of UHF spectrum to land mobile.

The task force, which is composed of network, group and local station engineers and managers, will evaluate the technical development of HDTV. It will make recommendations to the NAB on how to ensure that terrestrial broadcasters remain technically competitive as the new medium develops. The statement says, in part: "For broadcasters to remain technically competitive with other video services, it is necessary to develop a new standard of broadcast quality for delivering significantly improved pictures for the home viewer."

The task force members called on developers of HDTV systems to work with broadcasters to remain on the cutting edge of video technology. They also endorsed the test program being developed by the Advanced Television Systems Committee for HDTV standards.

McKinney assumes White House position

President Reagan has announced the appointment of James C. McKinney to deputy assistant to the president and director of the White House Military Office. He succeeds Richard P. Riley.

Since 1983, McKinney has served as chief, Mass Media Bureau of the Federal Communications Commission. From 1981 to 1983, he was chief, Private Radio Bureau, and prior to 1981, he served as chief, Field Operations Bureau. He is an engineer by training and an instrument-rated pilot.

In 1985, he was selected to receive the Presidential Rank Award for distinguished executive service. In 1987, he was awarded the Federal Communication Commission's Gold Medal for Distinguished Service.

BROADCAST ENGINEERING

Editorial and advertising correspondence should be addressed to: P.O. Box 12901, Overland Park, KS 66212-9981 (a suburb of Kansas City, MO): (913) 888-4664. Telex: 42-4156 Intertec OLPK. Circulation correspondence should be sent to the above address, under P.O. Box 12937. RAPIDFAX: 913-888-7243.

SUBSCRIPTIONS: BROADCAST ENGINEERING is mailed free to qualified persons within the United States and Canada in occupations described here. Non-qualified persons may subscribe at the following rates: United States and Canada: one year, $25.00. Qualified and non-qualified persons in all other countries: one year, $30.00 (surface mail); $108.00 (air mail). Back issue rates, $5, except for the Buyers' Guide/Spec. Book, which is $20. Rates include postage. Adjustments necessitated by subscription termination at single copy rate. Allow 6-8 weeks for new subscriptions or for change of address. Second class postage paid at Shawnee Mission, KS.

BROADCAST ENGINEERING Volume 29, No. 8 (USPS 338-130) is published monthly (except in the fall, when two issues are published) by Intertec Publishing Corporation, 9221 Quivira Road, P.O. Box 12901, Overland Park, KS 66212. Second class postage paid at Shawnee Mission, KS, and additional mailing offices. POSTMASTER: Send address changes to BROADCAST ENGINEERING, P.O. Box 12983, Overland Park, KS 66212.

Advertising offices listed on page 126.

INTERTEC PUBLISHING CORPORATION

Recipe for change

Take one consumer VCR (VHS or Beta, your choice), and separate the chroma from the luminance. Add a Y/C dub cable (introduced to ¾-inch editing VCRs a decade ago), and modify a high-resolution color TV monitor to accept Y/C direct. Now, add some metal particle (MP) tape (developed for the 8mm consumer format—the basis of M-II and Betacam SP), and stir in a generous helping of circuit magic. *Voila:* A new high-resolution consumer-tape format and a new foot in broadcasting's door.

At the 1987 Summer Consumer Electronics Show, a number of major VHS manufacturers introduced Super VHS (aka: S-VHS), a new VHS-based Y/C-MP VCR format that resolves more than 400TVL (even at slow speeds), with a 45dB signal-to-noise ratio. Prerecorded video on Y/C monitors looked similar to a low-band quad. Deliveries will begin soon. Industrial and duplicator models have already been announced.

Then there was Sony's 500TVL, 50dB Y/C-MP spin-off from consumer Beta, ED-Beta (extended definition). An A/B comparison of recorded video to a live broadcast camera source on Y/C monitors as part of the ongoing demonstration, looked more like high-band quad. Sony wouldn't commit to an introduction date in the United States, but it did commit approximately one-fourth of its booth space to ED-Beta.

At least one new S-VHS camcorder featured built-in digital effects—digital freeze frames that may be wiped, dissolved, sized, positioned and keyed over live camera video and recorded on tape. Stand-alone consumer SEGs, PC-based multifont title generators and digital freeze frames also were shown. The power of a broadcast studio in the hands of consumers is now a reality.

A consumer VCR system that surpasses the resolution that TV stations can legally transmit is a milestone in TV history, and a challenge to our technical leadership and adaptability. It opens the doors to potential producers with an affordable format and plenty of gimmicks that look like broadcast video, even after editing.

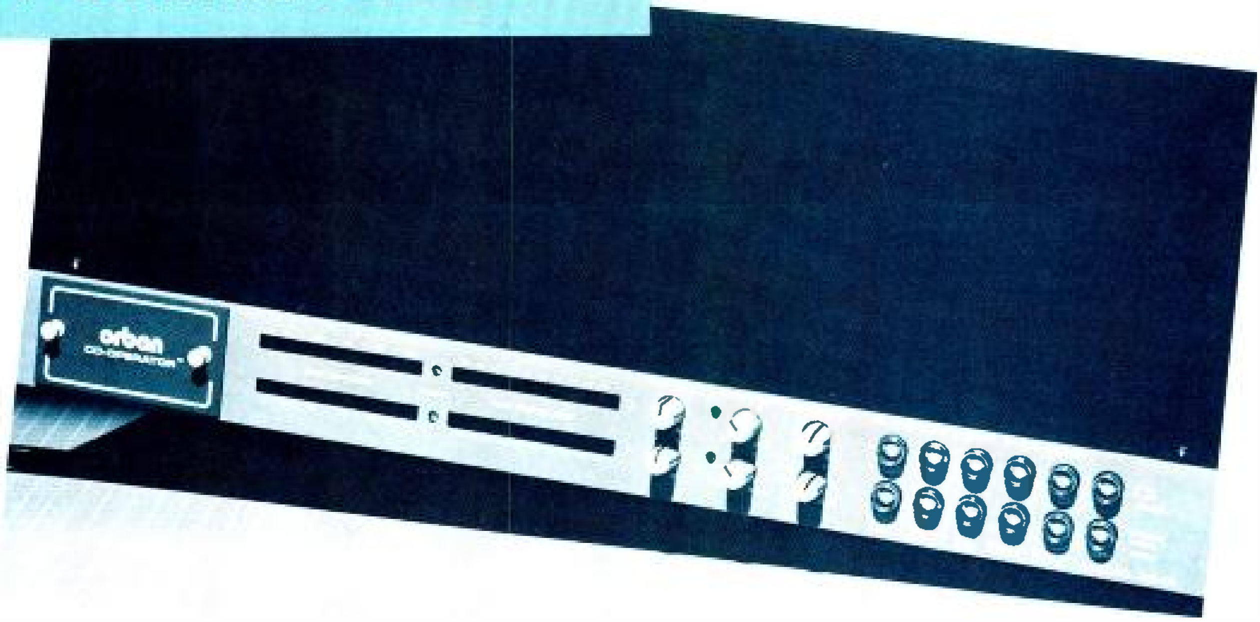
Until now, second-generation (edited) consumer-format tapes rarely were airable. Affordable consumer systems with high-resolution recording and multigeneration electronic editing capabilities can generate programs and spot material shot and edited at home, outside the high-dollar broadcast domain. Amateurs, teachers or just plain video nuts can now produce and edit programs that fulfill technical broadcast requirements at relatively low cost.

The new consumer formats may not be equal to the best broadcast formats, but they are substantially better than the ¾-inch format that has been used for many broadcast programs and news gathering for years, and they're not constrained by the 4.5MHz bandwidth.

The broadcast and entertainment industries will face new opportunities and dilemmas ranging from consumer-produced programming to less detectable copyright violations. It's one more slice in the TV household pie, and another precursor of a major fork in the road ahead for broadcasters—HDTV.

To see the higher resolution from either format requires a special TV monitor with Y/C input terminals. That should test the willingness of consumers to pay for better TV pictures. HDTV would require the purchase of a new TV *and* VCR—just like S-VHS and ED-Beta. If the new formats are accepted by consumers, will the potato chip theory ("betcha can't eat just one") work with video too? Potato chips are sure a lot cheaper!

QUALITY CONTROLLER.



THE NEW ORBAN CO-OPERATOR™ AGC SYSTEM

Introducing the *Co-Operator:* an integrated, easy-to-use Gated Stereo Leveler/ Compressor/HF Limiter/Peak Clipper in a powerful and economical dual-channel package. The Co-Operator automatically rides gain, controls excessive high frequency levels, and limits peaks while protecting audio and video tape recorders, broadcast cart machines, mic channels, STL microwave links, and SCA's.

Its simplified controls ensure top results—even from non-technical operators. Yet there is sufficient versatility so that you are never locked into a single "sound".

The Co-Operator rides gain subtly and intelligently—the way *you* would—to preserve the dynamic "feel" of the program material while effectively controlling levels. Or, if gain-riding is not desired, use it as a transparent, no-compromise safety limiter. Either way, it's always alert to safeguard audio quality. It contains a:

- Smooth leveler for transparent gain riding—*without* long-term distortion-producing overshoots
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- "Silence Gate" and compressor/leveler crosscoupling team up to prevent pumping and noise breathing
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Circle (6) on Reply Card

Daytimer preference is affirmed

By Harry C. Martin

On June 24, the U.S. Court of Appeals in New York affirmed the FCC's decision to make AM daytimers eligible for special enhancement credit in comparative hearings for new FM stations in their communities. The enhancement credit, which originally was adopted in connection with commission deliberations in Docket 80-90, is equal to the credit awarded in a hearing for either local residence or minority ownership.

The preference was attacked in court by the National Black Media Coalition, which claimed the commission failed to demonstrate how the preference would benefit the public or to take into account the diminished opportunities for minorities resulting from the preference policy.

In affirming the preference, the court said the commission had struck a correct balance between the importance of improving the lot of daytimers and its policy of encouraging minority ownership. The court placed particular significance on the commission's careful shaping of the conditions daytimers must satisfy in order to receive the enhancement benefit. According to the court, the most significant of these is the requirement that a daytimer divest ownership of its daytime-only station.

Other criteria governing the award of a daytimer preference are that:

• The preference is available only to a licensee applying for an FM channel in the same community of license as the AM facility.

• The applicant must have operated the daytime-only station for three continuous years prior to filing the FM application.

• The same legal entity that operates the daytimer must be the applicant for the FM channel.

• The daytimer's owners must have "participated substantially" in the management of the daytime-only facility. Substantial participation means that persons with cognizable ownership interests must have spent more than 20 hours per week (individually or in the aggregate) in the management of the daytimer.

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

FCC revisits presunrise question

The commission is proposing to revise its rules governing presunrise operations by daytimers in April each year. The new rules would permit operations with a minimum power of 10W provided there is no interference to the groundwave (primary) contours of Class I clear-channel stations. This proposal embodies comments filed by the Clear-Channel Broadcasting Service, a trade association representing the Class I clear-channel stations.

In January, the commission proposed allowing daytimers to operate between the first Sunday and the last day of April, each year, from 6 a.m. local time until local sunrise, with a minimum power of 50W. However, after reviewing the record, the agency determined that some daytimers operating presunrise with 50W, or even 25W, would cause significant co-channel interference to domestic Class I clear-channel stations. As a result, in March, the commission adopted interim measures permitting presunrise operations with a minimum power of 10W during April 1987. The current proposal is to make the 10W minimum permanent. Higher powered operations during April would be permitted regardless of their impact on skywave (secondary) service, provided no interference to groundwave service is caused.

License modification rules amended

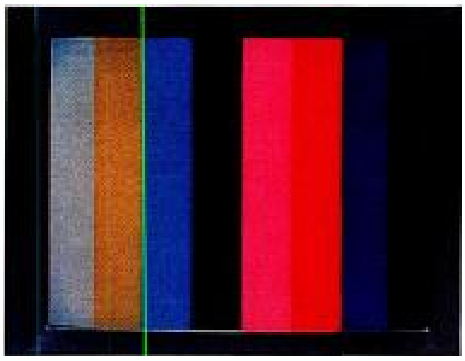
Effective July 20, the commission amended its rules dealing with modifications to the licenses of existing stations when such modifications are necessary to accommodate changes in the FM or TV tables of allotments. Under the rule change, the commission no longer will afford affected stations an automatic right to a hearing on a proposed license modification.

Under the old procedure, when a petition seeking a new or changed channel allocation in community A required a channel substitution in community B, the licensee of the affected community B station had an automatic right to a hearing to show why the substitution should not be approved. When licensees requested such hearings, the commission, in practice, did not actually conduct them. Instead, the agency went ahead with the modification, but did not make it effective until the expiration of the affected station's license term. At that time, the licensee would have to specify the new channel in the renewal application.

In 1983, Congress removed the automatic hearing right from Section 316 of the Communications Act. The commission has taken this opportunity to conform its rules to the changed law because its previous procedure created unacceptable delays due to the extension of license terms for FM stations to seven years and five years for television.

Under the new procedure, the commission will continue to issue an "Order to Show Cause" along with its rulemaking proposal for a particular set of channel changes. Existing licensees who are affected by the proposal will be informed of the reasons for the modification and offered an opportunity to protest. But, unlike the old procedure, the protester must raise a substantial and material question of fact before a hearing will be designated. It is unlikely that many licensees will be able to make such a showing. And, if they do, the commission will have the option of heeding the complaint and denying the original proposal.

With respect to the costs involved in channel substitutions, the commission affirmed its previous rulings that the ultimate permittee of the new channel is responsible for reimbursement of the reasonable cost (both technical and promotional) incurred by a station having to change frequencies. Furthermore, the agency said that affected stations would be afforded a significant lead time before the actual change in channel will be required. An affected station that prefers to retain its existing channel—so it can relocate its transmitter to a site that can be accommodated only on its present channel, or upgrade on its co-channel or an adjacent channel—is free to submit a counterproposal to this effect.



Format war ends, marketing war begins

By Jerry Whitaker, editorial director

CBS has logged the greatest amount of experience with a ½-inch videotape format (Betacam) of any of the three big networks. The CBS Betacam investment currently is placed at about 400 videocassette recorders, plus cameras and Betacart spot playback decks. The CBS commitment to Betacam dates back to 1984.

Most of the Betacam hardware in use at CBS has been concentrated at in-house studio facilities, with the largest current installation at the CBS hard news center in New York. The announcement in May, by Joseph Flaherty (CBS engineering chief), that the network would begin to place Betacam products in the field with news crews marked the first major step away from U-matic decks for outside activities. Flaherty's announcement also included word that CBS would purchase CCD cameras for the news department.

Flaherty said the purchase of CCD units was indicative of CBS's belief that solid-state camera technology had matured to the point that it met newsgathering requirements. Advantages include: low lag, permanent picture geometry and registration and low-power consumption.

Other players

The International TV Symposium at Montreux, Switzerland, brought good news for both Betacam and M-II proponents. Thames Television, the largest independent TV station in the United Kingdom, announced that it will adopt M-II as its standard ½-inch recording format. The decision was made after what was described as "months of careful and considered investigation into the technical and operational aspects of the available formats."

Not to be outdone, just two days after the Thames/Panasonic announcement, Ampex reported that it had won a major Betacam order from Viewplan, a broadcast hire company in the United Kingdom. The Viewplan order was reported to be worth more than $600,000.

The Thames Television deal for M-II hardware was estimated to total $8 million to $10 million over 10 years, with deliveries beginning in the fall.

Manufacturers tool up

With large volumes of Betacam and M-II products moving virtually as fast as the companies can make them, all of the players involved in the two camps are being kept busy. Betacam equipment could be seen at NAB and Montreux in the Ampex, BTS, Thomson and, of course, Sony booths. M-II equipment was being displayed by Panasonic Broadcast and JVC. Virtually all companies had something new to show at one or both of the conventions.

The tool-up procedure also is moving ahead for the Betacam partners. Ampex, for one, plans to be completely independent of Sony manufacturing support by the middle of next year. According to Don Bogue, Ampex AVSD general manager, his company will add its own enhancements and options to the basic Sony format. Compatibility will remain, but features will vary. He characterized the arrangement with Sony as "a relationship that works well for both sides."

The "other" formats

With implementation of ½-inch hardware running full speed ahead, it is easy to overlook the bread and butter of the industry—those formats that are keeping more than a thousand TV stations on the air today. To underscore the belief that ¾-inch will be around for a long time to come, several new U-matic products were introduced at the NAB convention (three from Sony and one from JVC). New U-matic tapes also were displayed at several booths (3M, Sony, Fuji and Maxell).

Not to be left out, 1-inch hardware also was on display on the NAB show floor. Sony introduced a new machine and Ampex unveiled enhancements for one of its existing decks.

Formats galore

The bottom line in all of this, as the **BE** editorial staff sees it anyway, is that the format wars are over, and everybody has won. Both of the ½-inch formats and their older brothers, the ¾-inch and 1-inch systems, each have their place in today's TV industry. None of them will go away any time soon. Look at 2-inch quad. It's been around for 31 years in more-or-less the same form and it's still being used daily for one purpose or another at almost every TV station in the United States.

The days have gone when the choice of product was restricted to price and company reputation. A third factor—*format*—has now entered the picture and will likely stay there for as long as any of us are still in the business. A station's technical manager can choose any of the competing formats displayed on the floor of the 1987 NAB and make it work. There will be personal preferences of various users, considerations of tape type and size, long-term operating expense analysis and interface questions. But, nobody's going to get fired for picking the "wrong format."

This makes the selection process both easier and more complicated. On one hand, you have many more products from a large list of players to consider. But, on the other hand, any decision that is difficult to make implies that the choices are closely matched. Therefore, either choice should be a fairly good one.

The decision on how stations should move on the format question will now advance into the realm of marketing by the individual manufacturers and performance evaluation by potential users. That's the way all other broadcast products are selected. It works with them and it will work with recording formats. In the final analysis, we have sacrificed easy decisions for greater selection and improved performance. That's a pretty good deal.

The mic mixer you would have designed yourself–The Shure M267.

In the space of just two years, the Shure M267 has become one of the most well-known and widely used mixers in the broadcast industry. One look at it will tell you why.

The M267 gives you the improvements you've told us were most important. Every channel has a mic line level switch for maximum flexibility. There's also a built-in limiter to keep the M267 from overloading at critical moments. The unit contains a built-in battery pack that utilizes three standard 9-volt batteries. Simplex (phantom) power and a peak LED are standard, too.

The M267 oscillator provides a clean 1 kHz tone, and is located on the front of the unit for simple access. The headphone output is also on the front and includes a level control. IC design, along with active gain controls, provides greater headroom and quieter operation.

For location work or even studio post-production, the M267 carries on Shure's reputation for reliability and ruggedness.

For more information on Shure's complete line of mixers, call or write Shure Brothers, Inc., 222 Hartrey Avenue, Evanston, IL 60202, (312) 866-2553.

SHURE®

BREAKING SOUND BARRIERS

Circle (8) on Reply Card

Building a multitower grounding system

By John Battison, P.E.

Last month's column outlined the basics regarding ground systems. To continue on this topic, we will see how a multitower grounding system should be constructed.

It is essential that all of the elements in the array be joined electrically by low-reactance and low-resistance metallic connections. Too many operating stations rely solely on the copper shielding of the coax lines for element interconnection. Even though these cables may have a large diameter, there is still some reactance present.

Construction details

Figure 1 shows a typical plot plan for a 3-tower array. Notice that the intersections of the adjacent tower radials are not crossed, but rather, are bonded to a wide copper strap. The strap is located at right angles to another strap, which joins the towers. Note especially that this tower-joining strap is an essential part of the overall station ground system.

The copper strap running between the tower system and the transmitter building parallels the transmission line. The total dc resistance of a system such as this should not exceed 1Ω, if all of the connections have been properly brazed.

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

As in any other circuit, there are I^2R losses. Consider this scenario: If the antenna-base operating resistance is 30Ω and the nominal power is 1kW, then the antenna current should be 5.77A. If there is, say, 5Ω of ground resistance, there is a loss approaching 20%—actually 167W. A ground-system loss of this magnitude is not unusual in older installations and is a frequent source of a lost signal.

Preventive maintenance

For general antenna efficiency and maintenance for the upcoming winter months, let's take a look at a typical 2-tower array with a view to performing some prewinter maintenance.

We'll assume that the towers are properly painted and that the guys have been checked for rust (both in the air and at the anchors). Guy-wire greasing is well worth the while for taller towers. Look for insulators that have been cracked, either from rifle fire or from ice formation. Replace any cracked insulators before further damage can result. Remember, under good conditions, a shorted insulator at the top of the tower can add electrical length to the radiator. Under normal conditions, shorted insulators can produce arcs and other electrical noise.

If the system is a non-DA array, the extra antenna length sometimes can be beneficial if it increases the operating resistance and the same base current is maintained. Then, power will increase, but probably at the cost of some electrical noise from arcs. However, this is not a recommended method of improving signal strength.

Clean house

Once you're sure the tower structure and guys are in good condition, look inside the ATU cabinets. Remove dirt, grass clippings, dead insects (even live ones), nests and any bits of corroded metal that may have fallen off various components.

Check all connections for tightness. Even those connections that look tight may not be. Also, check those clips that sometimes fall off coils whose taps have not been marked with nail polish. Clean the base meter shorting-switch contacts. If the tower lighting passes through the copper RF pipe connection to the tower base, check to ensure that the ac wiring has not shorted to the tower. Check all screwed and bolted connections. If any are corroded, scrape clean, apply silicone grease and tighten (but don't overtighten).

Check the RF connections between the ATU output and the tower base.

Be sure the weep holes in the base insulator are clear. It is a lot easier to do this than to jack up a tower to replace a cracked insulator. Sometimes birds like to build nests on top of base insulators inside the tower. These nests can be left in place during the spring, but remove them before winter. Otherwise, snow and ice may clog weep holes and cause cracks.

If you have monitoring loops on the tower, be sure their transmission lines are secure and that the loops are well grounded, if the design calls for it.

Finally, remove any vegetation from around the tower base, anchor points or dog houses.

Next month, we'll continue our look at antenna-system maintenance by making some important measurements.

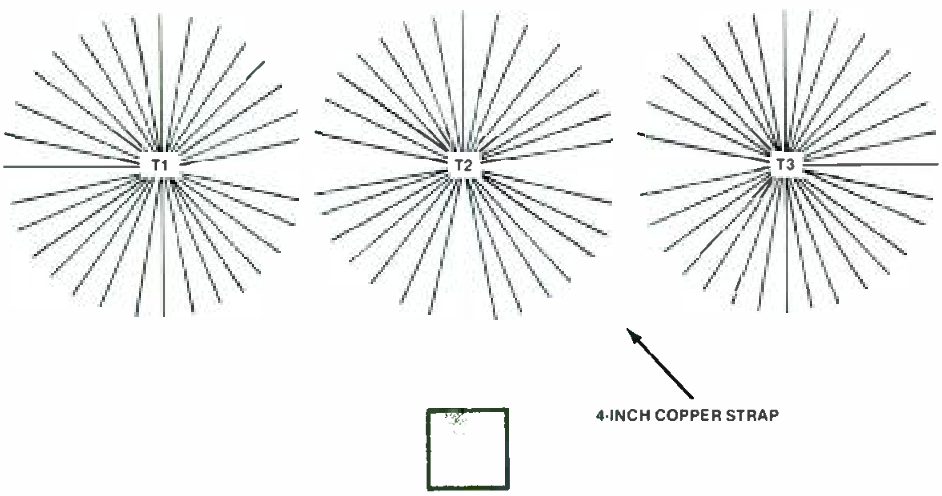
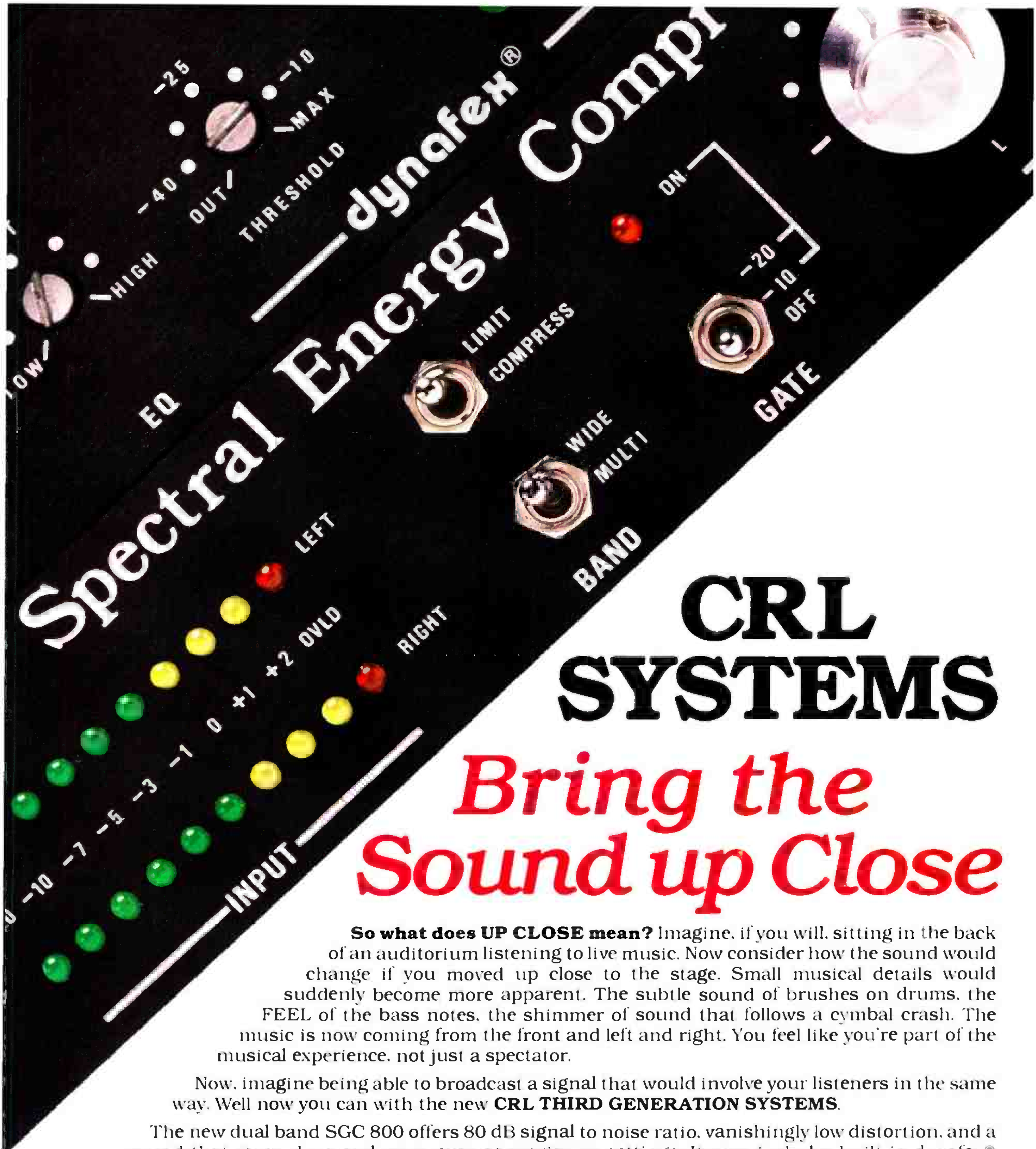


Figure 1. Radials from a multitower array must not cross. Instead, use a large copper strap that runs perpendicular to the main tower-grounding strap as a common connection point.



CRL SYSTEMS

Bring the Sound up Close

So what does UP CLOSE mean? Imagine, if you will, sitting in the back of an auditorium listening to live music. Now consider how the sound would change if you moved up close to the stage. Small musical details would suddenly become more apparent. The subtle sound of brushes on drums, the FEEL of the bass notes, the shimmer of sound that follows a cymbal crash. The music is now coming from the front and left and right. You feel like you're part of the musical experience, not just a spectator.

Now, imagine being able to broadcast a signal that would involve your listeners in the same way. Well now you can with the new **CRL THIRD GENERATION SYSTEMS**.

The new dual band SGC 800 offers 80 dB signal to noise ratio, vanishingly low distortion, and a sound that stays clean and open, even at maximum settings. It even includes built in dynafex® noise reduction circuits. The all new **STEREO MODULATION PROCESSOR, SMP 850**, with our new transfer function limiting circuit and soundfield enhance will let you broadcast a signal superior to anything else on the dial. It provides that UP CLOSE sound that will make you the winner in the button pushing contest.

If you think this sounds too good to be true call now for complete information. Be sure to ask about our FREE trial plan. If you don't, your competition will.

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Circle (9) on Reply Card

MMICs are the trend

By Elmer Smalling III

Last month we discussed the relatively new technology of microstrip circuitry, which allows inexpensive fabrication of microwave circuit boards and occupies less space than older, discrete component circuits. Microstrip boards may contain discrete, surface-mounted components such as capacitors, resistors and transistors. These are called surface-mount devices, because they mount to the metal circuit traces (as shown in Figure 1) rather than mount in holes or to pads.

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

MMICs

The microwave-circuit design trend is toward monolithic microwave-integrated circuits, or MMICs. These are complete circuits that have been fabricated on a substrate and mount on a microstrip circuit board as easily as discrete transistors. (See Figure 2.)

If the monolithic circuits include resonant elements such as tank circuits or transmission line, they are naturally larger than those MMICs that include only wideband amplifiers. Monolithic amplifiers may be used with external bias resistors to amplify a signal from milliwatts to tens of watts, and those circuits that include resonant elements may be used as entire pre-amplifiers, front-ends, IF stages and mixers. It is common for these complete circuit MMICs to be manufactured in a flat pack housing, which directly attaches to a microstrip board.

When MMIC substrates with high dielectric constants (seven to 10) are used, the effective wavelength may be reduced by two-thirds, greatly decreasing the area that the circuit requires on the substrate.

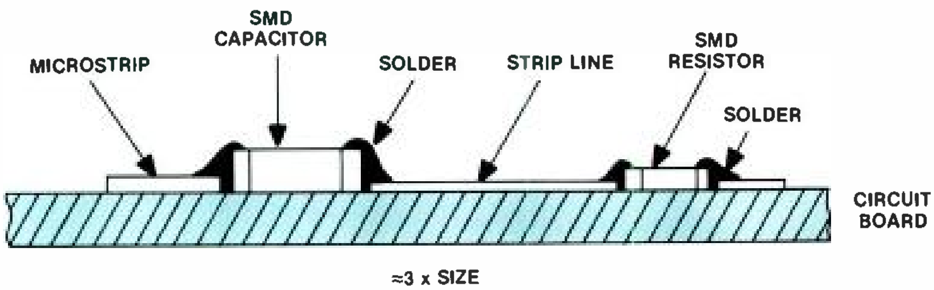

Figure 1. Surface-mount devices are soldered to the metal circuit traces rather than mounted in holes or to pads.

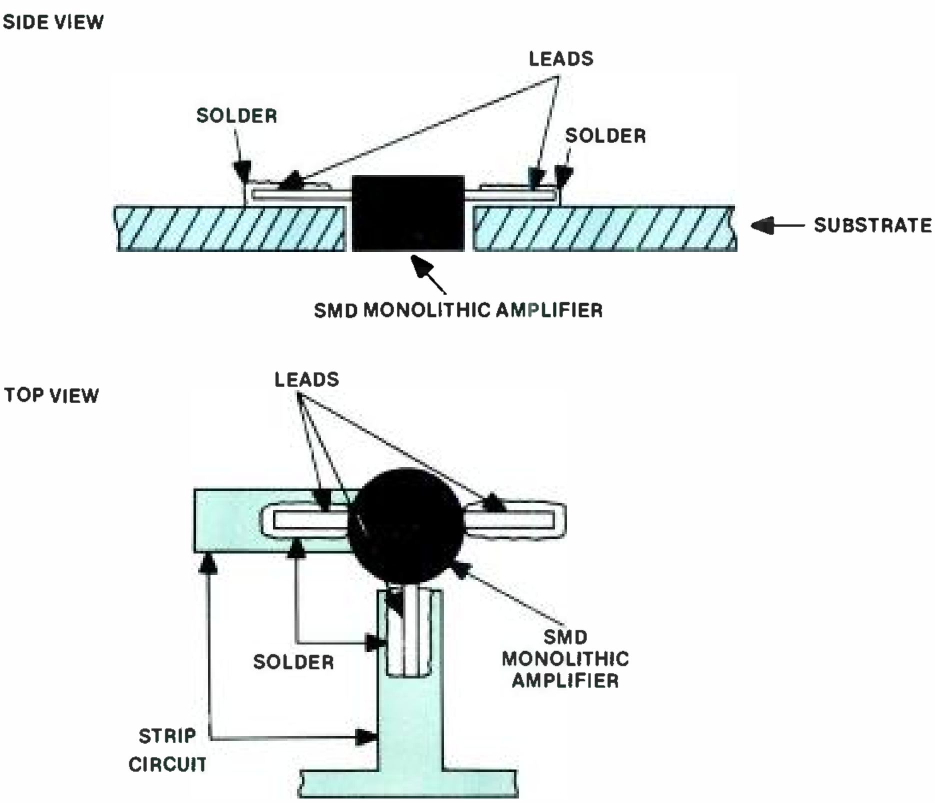

Figure 2. Monolithic microwave-integrated circuits (MMICs) are complete circuits that have been fabricated on a substrate.

Reducing manufacturing time

Circuit-manufacturing time can be shortened by using MMICs in two important ways. First, microstrip circuitry is easy to print on circuit-board material, which reduces wiring time and circuit interaction problems when wires are run in close proximity to each other. Second, pick-and-place machines can pick components from a bin and set them at precise locations on the microstrip boards for soldering. This saves several hours of manual labor and reduces costly placement and positioning errors.

Microstrip circuitry and monolithic ICs have played a large part in the effort to make TVROs, MSN vans and earth stations affordable to broadcasters. This is due to reduced prices for receivers, transmitters and LNAs by as much as 85% from the 1980 prices.

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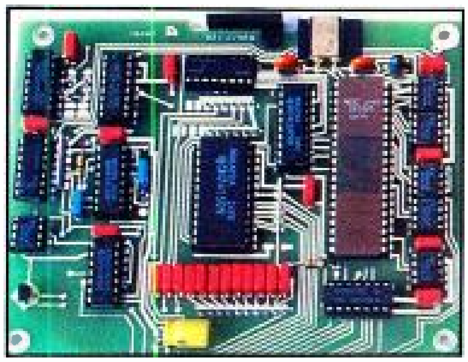
Part II

Circuits



Inside digital technology

By Gerry Kaufhold II

So far in this series, all signals have been parallel. The address-select signals are synchronized with the control signals, and the data signals move eight bits of information as discrete bytes along a parallel databus.

The primary advantage of parallel signal paths is a high rate of throughput. By moving whole bytes in parallel, many bytes can be transferred quickly. In a computer system, throughput rates are measured in millions of bytes per second, or megabytes per second. For example, a typical personal computer transfers data from memory at 250kbytes per second.

The main disadvantage of parallel data paths is cost. The number of circuits for controlling the data transfer, and the circuits for receiving and transmitting the data, equal the number of parallel signals that must be handled. For 16 address signals, an 8-bit databus and 10 control lines, each memory card must provide 34 circuits. The wiring backplane of such a system requires connectors with 34 pins, and the power-supply runs to each circuit must be decoupled to prevent crosstalk between adjacent lines.

Kaufhold is an independent consultant located in Tempe, AZ.

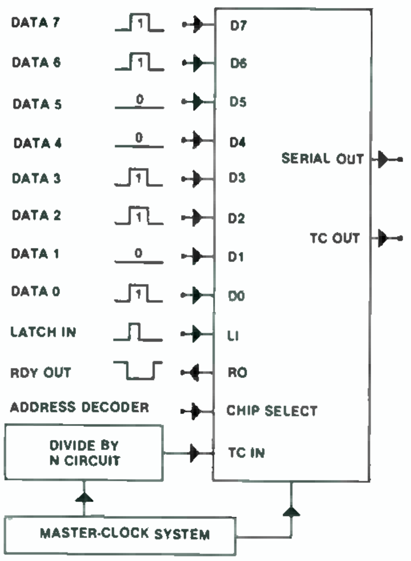


Figure 1. Parallel-to-serial conversion provides single-wire interface between data systems.

Due to the randomness of capacitive loading of the many lines of the parallel bus, parallel signals can be kept in sync over only very short lengths of cabling. For this reason, parallel data paths are usually used only inside the chassis of most digital systems.

Serial data paths

If data is transmitted in a sequence along a single wire, the costs for interconnection are quite low. In addition, because all the signals ride on the same single wire, the length of the wire can be substantially longer without problems due to random capacitive loading between lines.

The speed of serial transmission is much, much slower than the speed of parallel transmission, and the circuitry required to capture serial data and convert it back to parallel data can be very complicated. In spite of these problems, though, most interconnections between digital circuits and remotely located equipment are accomplished using serial data transfer.

Some concepts for serial data transmission require only one wire for transmitted data, one wire for received data and a ground wire for reference. No synchronizing clock is required. Many video display terminals connect to their host computers through such a serial data path. The circuitry required for asynchronous data communications will be covered in a future column.

The most straightforward type of serial transmission is synchronized serial transmission.

Synchronized serial data transmission

Notice in Figure 1 that the left side shows the parallel signals coming into the parallel-to-serial converter. First, the address lines cause the chip-select signal to occur, which enables the parallel portion of the integrated circuit.

Although the chip is selected by the address lines, data is set up and held on the data lines. When the latch input toggles, the eight bits of data are stored. The ready output tells the computer not to send any more data until the data just stored is shifted out to the serial output.

The byte of data stored in the input latches must be converted into a stream of sequential bits. This conversion is performed by shifting one bit at a time from the input latch onto the serial output port.

The transmit clock signal controls this parallel-to-serial conversion process. The transmit clock in Figure 1 is derived by dividing down the master-system clock. However, in some conversion schemes, the transmit clock might be provided by the circuit that is going to receive the serial datastream or by a unique serial clock circuit.

The circuit at the receiving end of the transmission receives two signals. The transmit clock out signal synchronizes the receiver. Note that there is one full cycle of the transmit clock between each serial bit of data. The serial data is shifted out with the least significant bit first.

Notice that transmitting the transmit clock between each databit cuts the effective throughput of information in half, because half of the transmit time is consumed by the clock pulses.

Many schemes have been devised to improve throughput. One idea eliminates the transmit clock cycle between each databit, but inserts a *start* bit to alert the receiver that data is on the way. This scheme also uses a *stop* bit, which lets the receiver know that the current 8-bit databyte is completed. Although this method eliminates the transmit clock pulses inside the datastream, it adds two more bits of data to the serial datastream. All protocols for serial data communications involve trade-offs.

Because the transmit clock is much slower than the master-system clock, the parallel-to-serial converter must tell the computer when the latches are empty and ready to receive fresh data. The ready output signal goes HI immediately after parallel data is latched, and goes LO only after the final bit has been shifted out of the serial port. When ready output is LO, the computer sends the next byte of parallel data to be converted, and latches this byte with the latch-in signal.

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Today, after hundreds of hours of discussion and study, the standard finally exists that will allow receiver manufacturers to increase and flatten their frequency response without risk of increased interference. But for them to do this, broadcasters must implement the standard: a "modified 75μs" pre-emphasis specification brightens up the sound on older radios while minimizing interference to adjacent stations, while a sharp-cutoff 10kHz low-pass filter specification protects the second adjacencies by limiting occupied bandwidth.

Receiver manufacturers have stated their willingness to replace their current AM receiver designs (with their telephone-quality fidelity) with AM receivers having full 10kHz frequency response—but *only* if and when the NRSC standard is fully adopted by broadcasters. For the NRSC standards to be successful, broadcasters must change over *quickly*. If the new high-fidelity receivers generate complaints of interference caused by stations not complying with the new standard, the receiver manufacturers will revert back to the present low fidelity 3kHz designs! *Everyone* will lose.

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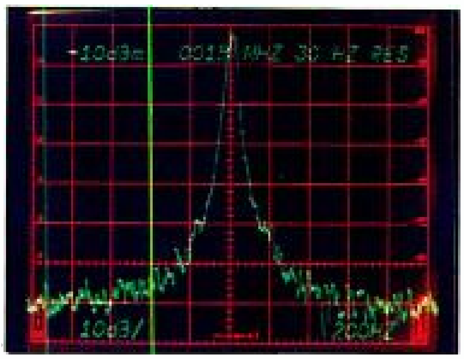

Servicing switching-voltage regulators

By Gerry Kaufhold II

Switching-voltage regulators are characterized by their capability to operate the regulating element as a switch. If the regulating element is a transistor, it will be operated in one of two modes. Either it is turned all the way *on* (saturated) or it is turned all the way *off* (cutoff).

The switching components

A switching-voltage regulator has an oscillator and a pulse-width modulator. The oscillator provides the basic operating frequency that drives the switched-transistor regulating element. Choosing this operating frequency is a critical part of the design. Lower frequencies (below 30kHz) can be more efficient than higher frequencies. However, lower-frequency switchers use larger, more expensive parts, and can produce objectionable noise within the audible range of human hearing.

Higher frequencies use smaller, less expensive parts—but have problems with electromagnetic radiation. The layout of the printed circuit board must be carefully done. Switching pulses of several amps at frequencies above 50kHz require the use of transmission-line techniques for interconnecting components. Printed circuit runs must be wide enough and short enough to adequately carry the peak-current demands of the switching elements.

The pulse-width modulator determines the ratio between the on times and the off times for the regulating element. A rule of thumb for pulse width is this: The percent of on time compared to *total* time (on + off) is approximately equal to the percent of *input* voltage that appears at the *output*.

For example, if the average dc voltage on the power-supply capacitors is 20V, and the desired regulated output voltage is 10V, then the pulse-width duty cycle should be approximately 50% under normal load. (Time on = time off.)

Energy-storing components

The output of the switched-regulating element feeds an inductor. This inductor has been chosen to provide maximum transfer of energy at the frequency of operation under the desired load current and with the normal duty cycle.

When the regulating element is switched on, current begins to flow through the inductor and onto the output-filter capacitor. A magnetic field develops around the inductor, and voltage will lead current.

When the regulating element is switched off, the magnetic field collapses, the diode conducts, and current is smoothly delivered to the load.

A minimum current must be drawn at all times through the inductor. This minimum current is called the preload current.

If excessive loads are drawn, two problems will occur:

The pulse-width modulator has a protection circuit that will limit the amount of on time to approximately 85% duty cycle. If the load attempts to draw too much current, this duty cycle limit will cause the output voltage to drop out of regulation. However, the switching transistor still will try to provide all the current it can during the times that it is switched on. Voltage goes down, but current can go up dramatically.

Next, the inductor heats up, increasing its internal resistance. Then, the inductance changes as the core saturates. Inductors might change value by up to 40% while under severe overload, which means that a switching regulator that works just fine on the bench under normal load may behave quite erratically when installed back into a faulty load.

Other considerations

The filter capacitor on the regulated side of the switching regulator must have a very low *effective series resistance*. ESR values measure the capability of the capacitor to charge and discharge quickly. Tantalum capacitors and some polystyrene types have favorable ESR values. Most aluminum electrolytics have relatively high ESR, so they are not often used in switching regulators. However, because of its low cost, some switching power-supply designers will use an over-value electrolyte capacitor that works quite well until it ages. Then ESR elevates, and a supply that used to work well gets flaky. The capacitor will test out using a capacitance checker, but the important value for switching-power supplies is ESR, not necessarily capacitance.

One other important consideration is the switching diode. This device might appear to be in perfect working order on the DVM diode tester. However, it is chosen for its capability to handle large currents and for high speed at recovering from the on condition to the off condition. Neither of these conditions can be tested using a DVM.

The switching diode must go into heavy forward conduction when the switching transistor is off. As soon as the switching transistor is turned on, voltage goes up on the top of the diode and the diode must turn off.

If the diode remains partially on due to a slow reverse recovery time, current may be shunted through the diode, pulling excessive currents through the switching transistor, bleeding current from the filter capacitors, and even drawing enough surge to blow the rectifier diodes.

Unfortunately, the voltage at the top of the diode may not change at all, because the switching transistor, filter capacitors and collapsing magnetic field of the inductor can supply lots of current for a short time. Even an oscilloscope trace may not show the current pulse at the switching diode, unless the scope is ac coupled, sensitivity is very high, and the horizontal sweep is synced to the oscillator.

One good way of discovering a switching diode that has lost its reverse recovery capability is to connect a current meter in-line with the ac-voltage input. If the current is excessive, check the switching diode.

One other clue to a bad switching diode is excessive noise being coupled back through the rectifiers and transformer into the ac power line, because of the intermittent large current spikes.

Kaufhold is an independent consultant located in Tempe, AZ.

Part 2

Management for engineers

Managing upward

By Brad Dick, radio technical editor

The conflicts that can develop between an employee and a supervisor are often based as much on personality as on work quality. Whether this should be the case is immaterial—it still happens. Personality conflicts can cause more problems within the workplace than quality of work.

Chart your course

Last month's column contained a simplified chart, which you can use to help identify some of your own and your manager's personal characteristics. Using the chart also can help you accomplish two important tasks.

The first task is to identify your own characteristics, which is hard to do. This can force you to come to grips with your personal prejudices and idiosyncrasies. By acknowledging these factors, you may help control your responses to pressure situations.

The second task in using such a chart is to pinpoint your supervisor's characteristics. You don't have to be an expert to know if a person operates better in the morning or in the afternoon. You don't have to have a degree in psychology to see if a person is well groomed and well dressed. The important element is taking time to identify these traits.

Using the chart, write down your answers to the listed categories. The chart is not inclusive and may be expanded as much as you feel necessary. Focus on general characteristics rather than on small details. Don't spend a lot of time considering each category. Your first response to a listed factor is often correct. Now, let's see how identifying your own and your boss's personal characteristics may help improve your working relationship.

Sources of conflict

Suppose you are Polish. Your boss is not and likes to tell Polish jokes, which offend you. This can be a major irritation. In this case, it may be difficult to tell your supervisor that these jokes offend you. Although you may not be able to change your supervisor's behavior, clearly identifying this source of irritation may help you deal with the problem.

Are you a morning or an afternoon person? If you are energetic and raring to go early in the morning, but your boss doesn't perk up until the late afternoon, watch out. Descending upon your boss with questions and reports early in the day may invite negative responses. Be aware of your supervisor's best time of the day, and use it to your advantage.

Another often mentioned source of conflict centers on dress style. Engineers are often perceived, with some truth, as being poorly dressed. If you report to a person who just stepped from the pages of a fashion magazine, then your jeans-and-tennis-shoes image could create a barrier to effective communication.

One area that is overlooked centers on the pressures and responsibilities of your supervisor. You cannot manage your boss if you don't understand your boss's job. You don't have to be able to do the job. However, you need to have a good idea of what is expected of your supervisor.

Analyze the results

After you've completed your analysis, allow several days or weeks to pass before developing a formal action plan. This time will allow you to re-examine your observations as well as to reaffirm the characteristics that you listed. The goal is to identify both your own and your supervisor's important professional and personal characteristics.

After you have identified potential sources of conflict—what then? First, ask yourself if you want the relationship to work. People sometimes unconsciously let, or even help, relationships falter because they want out of a particular situation. Be honest with yourself. If you don't want to remain in the company or in your current position, admit it. It's foolish to spend time trying to make a relationship work when you really want out.

Second, ask yourself if you can make the relationship work. If you want the work relationship to succeed, there is the chance for success. Even if your boss is less than cooperative in the beginning, your positive outlook may help change your boss's mind. Are you willing to spend the emotional energy to seek solutions to the conflicts? If you aren't, admit it now.

Take action

If you decide to approach your supervisor about changes, first develop a plan of action. Don't rush into the office with a laundry list of changes you want to make. Your manager may find such an approach threatening. Instead, you might try the following suggestions:

- *Listen* for clues on what your boss expects from you. Don't assume anything. Ask questions to be sure you thoroughly understand. Many supervisor/subordinate conflicts can be resolved by a 2-way exchange of information. After you think you understand what is expected, restate the task in your own words. Ask your supervisor if what you said is really what was meant. Taking a few minutes to thoroughly understand assignments may save hours of work and irritation later.
- *Compromise* when necessary. Try to adjust to the other person's needs whenever possible. If your boss likes early morning meetings, then you should make an effort to be on time. You can then reward yourself with a long lunch or leave early in the day. An approach such as this is beneficial to both parties.

Adapting to another's needs doesn't mean you have to sell yourself down the river. Stand by your principles and don't try to become something you aren't. Even so, it may be easier to modify the way you deal with a situation than it is to get your supervisor to change.

- *Negotiate* when necessary. You may feel strongly enough about a procedure or a situation to negotiate a change. Depending upon your supervisor, this approach may be risky. Any attempt on your part to discuss your supervisor's tactics may meet with resistance. When negotiating such matters, try to address these issues as *work methods* rather than as management style. By now you should know your boss's style. Adapt your approach to that style. Your chances for success are much greater.

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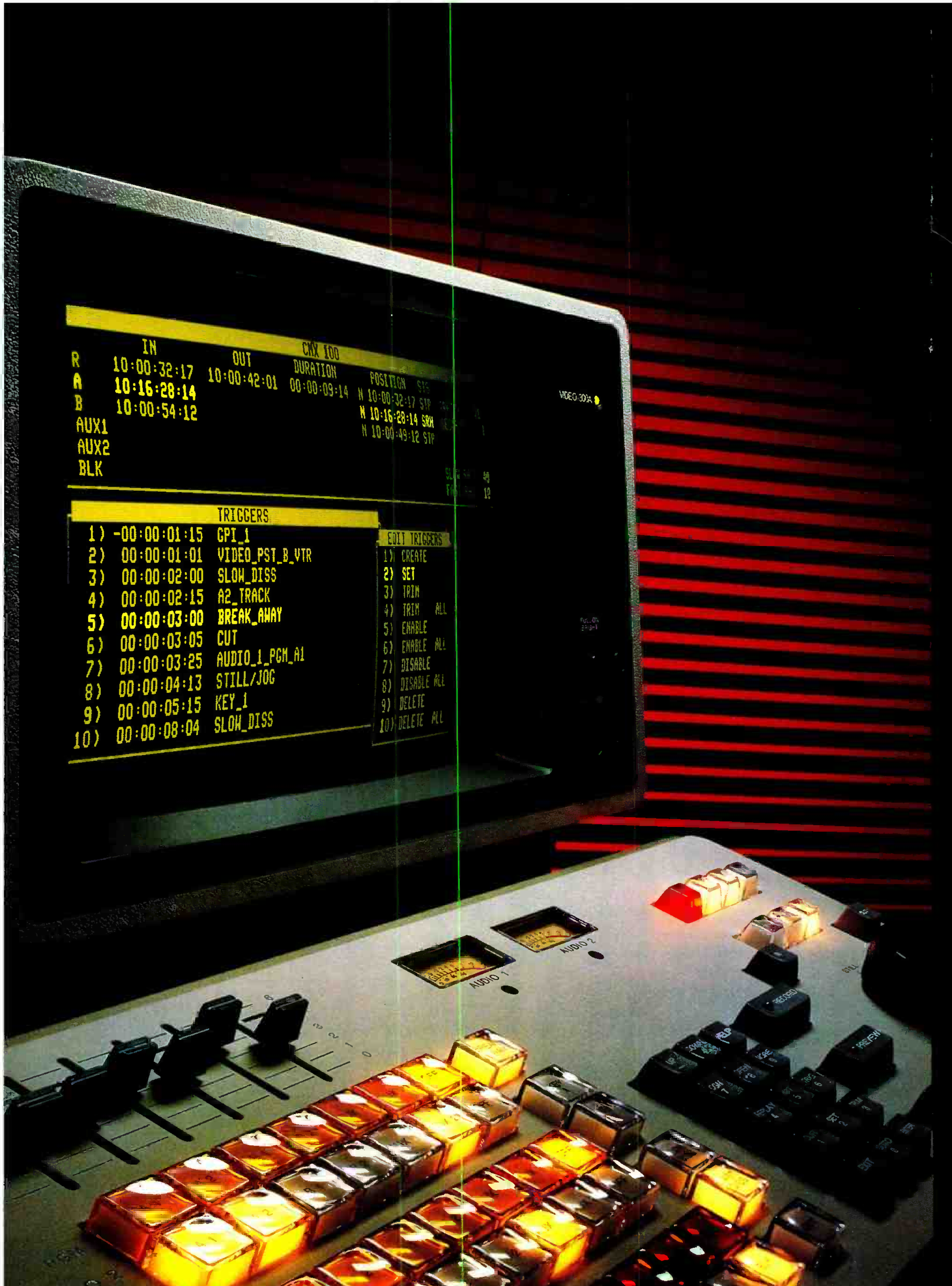
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4) 00:00:02:15 A2_TRACK
5) 00:00:03:00 BREAK_AWAY
6) 00:00:03:05 CUT
7) 00:00:03:25 AUDIO_1_PGM_A1
8) 00:00:04:13 STILL/JOG
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10) 00:00:08:04 SLOW_DISS
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VIDEO 300A
AUDIO 1
AUDIO 2
RECORD
PREVIEW

Video technology update

It used to be a lonely world for broadcast equipment manufacturers. Their market was limited to on-the-air TV stations, and the leading edge of technology usually wasn't that far ahead of the status quo. Payback of research and development costs hinged on mass acceptance of new ideas by a relatively small group of broadcasters at a time when viewers were thrilled just to see pictures.

A decade ago this summer, Ampex and Sony reached an agreement, in principle, to standardize on a single 1-inch helical-scan format, which was later called *type C*. Consumer video products (sharing the same basic technology) were catching on, and a mushrooming non-broadcast and industrial market was hungry for higher-quality video at affordable prices. It was then that the economy of scale began to have a positive effect on broadcast technology.

The potential for huge new markets prompted many manufacturers to develop and market new video technologies. Most of the products generated by these efforts were not intended for use by broadcasters, but videocassettes, helical-scan techniques and portable color cameras were tantalizing. A new industry came into being: the adaptation of this industrial/consumer video technology for broadcast use.

The influence of computers, HDTV research and consumer electronics can be found in almost every piece of broadcast gear. The future of broadcasting will abound with new technology and difficult decisions.

Progress is both a blessing and a challenge. In days gone by, if you needed a new VTR, you simply chose a blue one or a gray one. Regardless of the color of the unit you purchased, everyone was generally pleased.

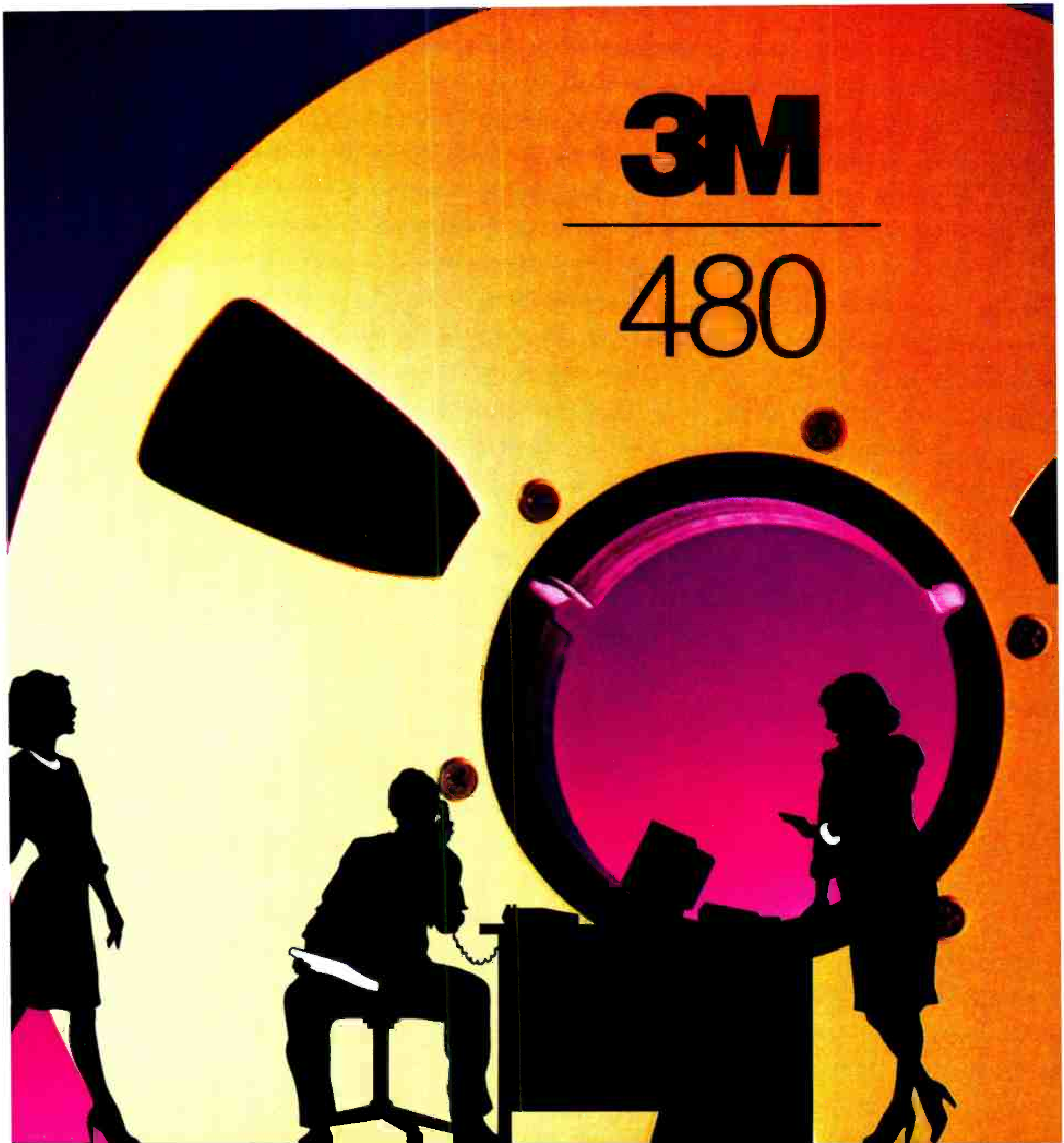
Today, the list of decisions is almost endless, and the pressure to make the *right* decision is intense.

Most broadcasters are asking themselves the same basic questions: *Should we integrate new technology and live with the commensurate interface and maintenance learning curve?* and *How long can we remain competitive without it?*

How to take advantage of changing video technology, and where that technology is headed, is discussed by several industry experts in the following series of articles:

Ned Soseman

Ned Soseman,
issue editor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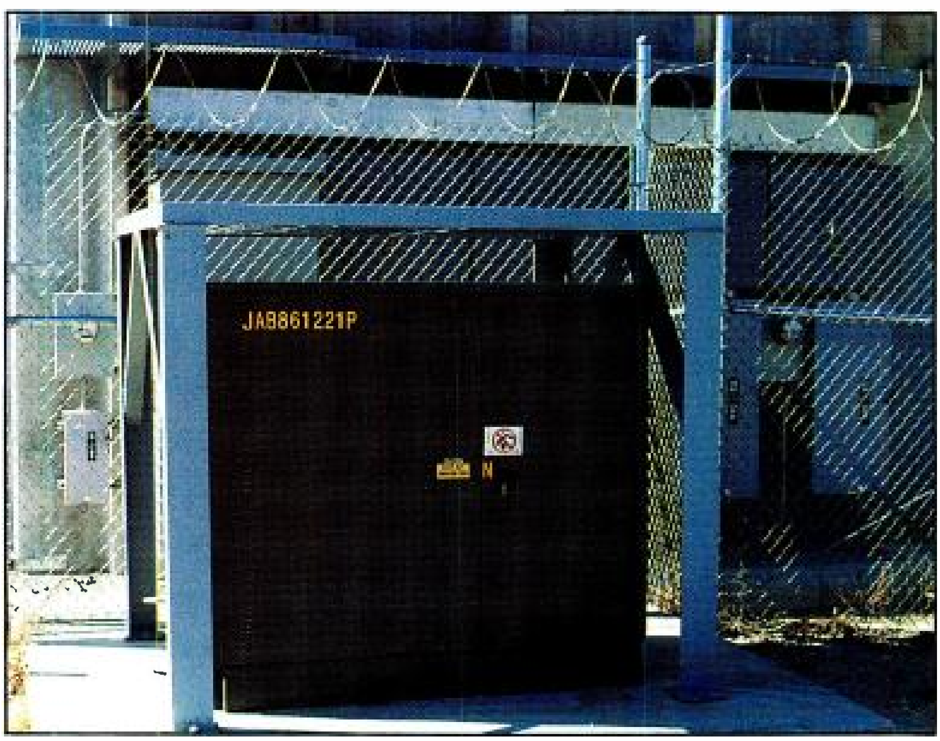
Facility-protection methods

Effective transient control requires attention to all elements in the broadcast plant.

Proper grounding of equipment and structures at a broadcast facility is basic to protection against ac line disturbances. This applies whether the source of the disturbance is lightning, power-system switching activity or a fault in the distribution network. Regardless of the protection approach, all protective devices and systems require a solid, low-impedance earth ground to operate properly. Grounding is important at both the studio and the transmitter plant. Probably the greatest challenge to proper grounding is a mountain-top transmitter.

Typical installation

The grounding arrangement for a remotely located grounded-tower (FM or TV) transmitter plant generally follows the guidelines shown in Figure 5. The tower and guy wires are grounded using 10-foot-long, copper-clad ground rods. The antenna is bonded to the tower, and the transmission line is bonded to the tower at the point where it leaves the structure and begins the horizontal run into the transmitter building. Before entering the structure, the line is bonded to



Most of the transient disturbances in a plant will come from the utility-company ac power line. Take precautions to stop these disturbances from entering your facility.

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a ground rod through a connecting cable. The transmitter itself is grounded to the ac power-distribution-system ground, which, in turn, is bonded to a ground rod where the utility feed enters the building.

The design goal of this arrangement is to strip all incoming lines of damaging overvoltages before they enter the facility. One or more lightning rods are mounted at the top of the tower structure. The rods extend at least 10 feet above the highest part of the antenna assembly.

The grounding configuration shown in Figure 5, although commonly found at many installations, has built-in problems that can make it impossible to provide adequate transient protection to equipment at the site. Look again at the Figure 5 example. To equipment inside the transmitter building, two grounds actually exist: the utility-company ground and the antenna ground. One ground will have a lower resistance to earth, and one will have a lower inductance in the connecting cables or copper strap from the equipment to the ground system. Assume that a transient overvoltage enters the utility-company meter panel from the ac service lines. The overvoltage is clamped by a protection device at the meter panel, and the current surge is directed to ground. But *which ground*, the utility ground or the antenna ground?

The utility ground surely will have a lower inductance to the current surge than will the antenna ground, but the antenna probably will exhibit a lower resistance to ground than the utility side of the circuit. Therefore, the surge current will be divided between the two grounds, placing the transmission equipment *in series* with the surge suppressor and the antenna ground system. A transient of sufficient potential will damage the transmission equipment.

Transients generated on the antenna side because of a lightning discharge are no less troublesome. The tower is a conductor, and any conductor is also an inductor. A typical 150-foot self-supporting tower may exhibit as much as 40μH inductance. During a fast rise-time lightning strike, an instantaneous voltage drop of 360kV between the top of the tower and the base is not unlikely. If the coax shield is bonded to the tower 15 feet above the earth (as shown in Figure 5), 10% of the tower voltage drop (36kV) will exist at that point during a strike. The only way to ensure that damaging voltages are stripped off all incoming cables (coax, ac power and telephone lines) is to use a *bulkhead entrance panel*.

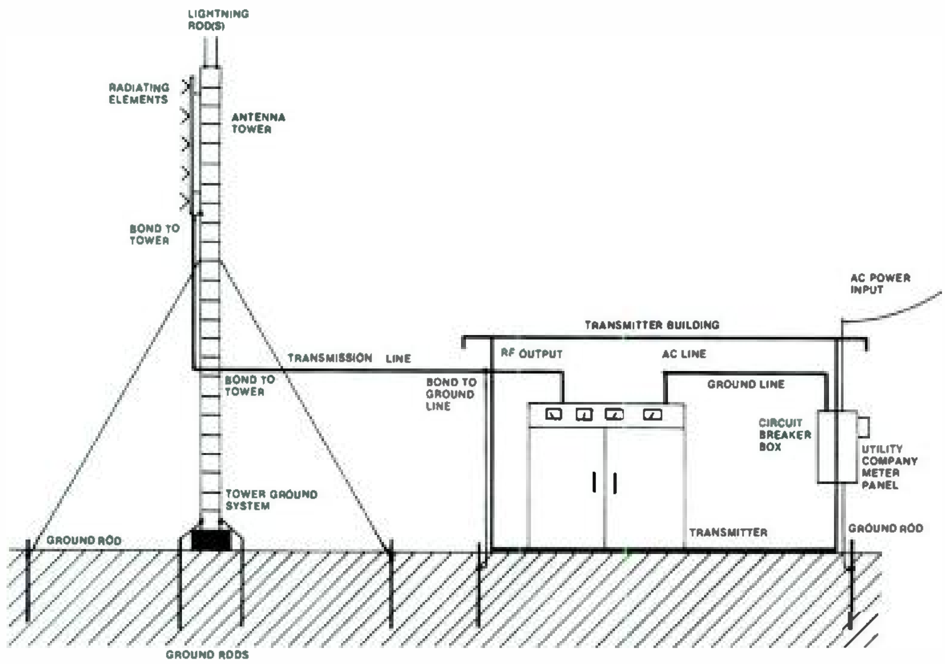

Figure 5. *The typical, but not ideal, grounding arrangement for a transmission facility using a grounded tower. A better configuration involves the use of a bulkhead panel through which all cables pass into and out of the equipment building.*

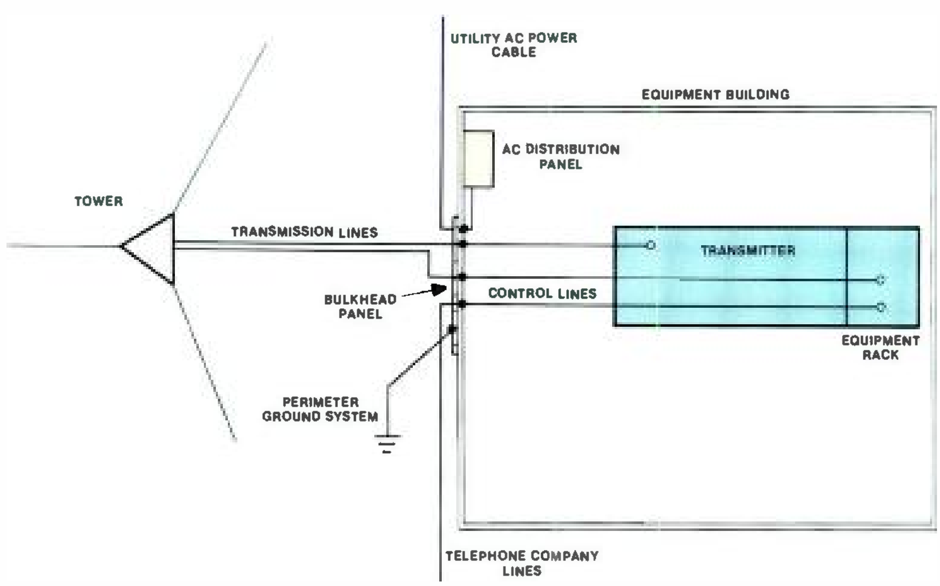

Figure 6. *The basic design of a bulkhead panel for a transmission facility. (Reference 2.)*

Bulkhead panel

The concept of the bulkhead is simple: Establish one reference point to which all cables entering the equipment building are grounded and to which all transient-suppression devices are mounted. Figure 6 shows the basic approach.

The bulkhead panel size depends on the spacing, number and size of the coaxial lines entering the building through the plate. The panel should be made of copper or brass. Do not use steel, unless it is stainless steel (18-8 type or the equivalent). To provide a weatherproof point for mounting transient-suppression devices, you can modify the bulkhead so that you have a subpanel, as shown in Figure 7. The subpanel, attached so that it protrudes through an opening in the wall, creates a secondary plate on which suppressors are mounted and grounded. To handle the currents that may be experienced during a lightning strike, the


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bottom-most subpanel flange (which joins the subpanel to the main bulkhead) must have a total surface-contact area of at least 0.75 square inches per transient suppressor.

Because the bulkhead panel will carry significant current during a lightning strike or ac line disturbance, it must be constructed of heavy material. The recommended material is ⅛-inch C110 (solid copper) ½ hard. This type of copper stock weighs nearly 5½ pounds per square foot and sells for about $2.25 per pound. Installing a bulkhead is an expensive job, but one that will pay dividends for the life of the facility. Use 18-8 stainless-steel mounting hardware to secure the subpanel to the bulkhead.

Because the bulkhead establishes the central grounding point for all equipment in the building, it must be tied to a low-resistance (and low-inductance) perimeter ground system. Ideally, the bulkhead panel will extend down the side of the building and tie into the perimeter ground below grade level. This will result in the lowest resistance and inductance to earth ground.

Checklist for proper grounding

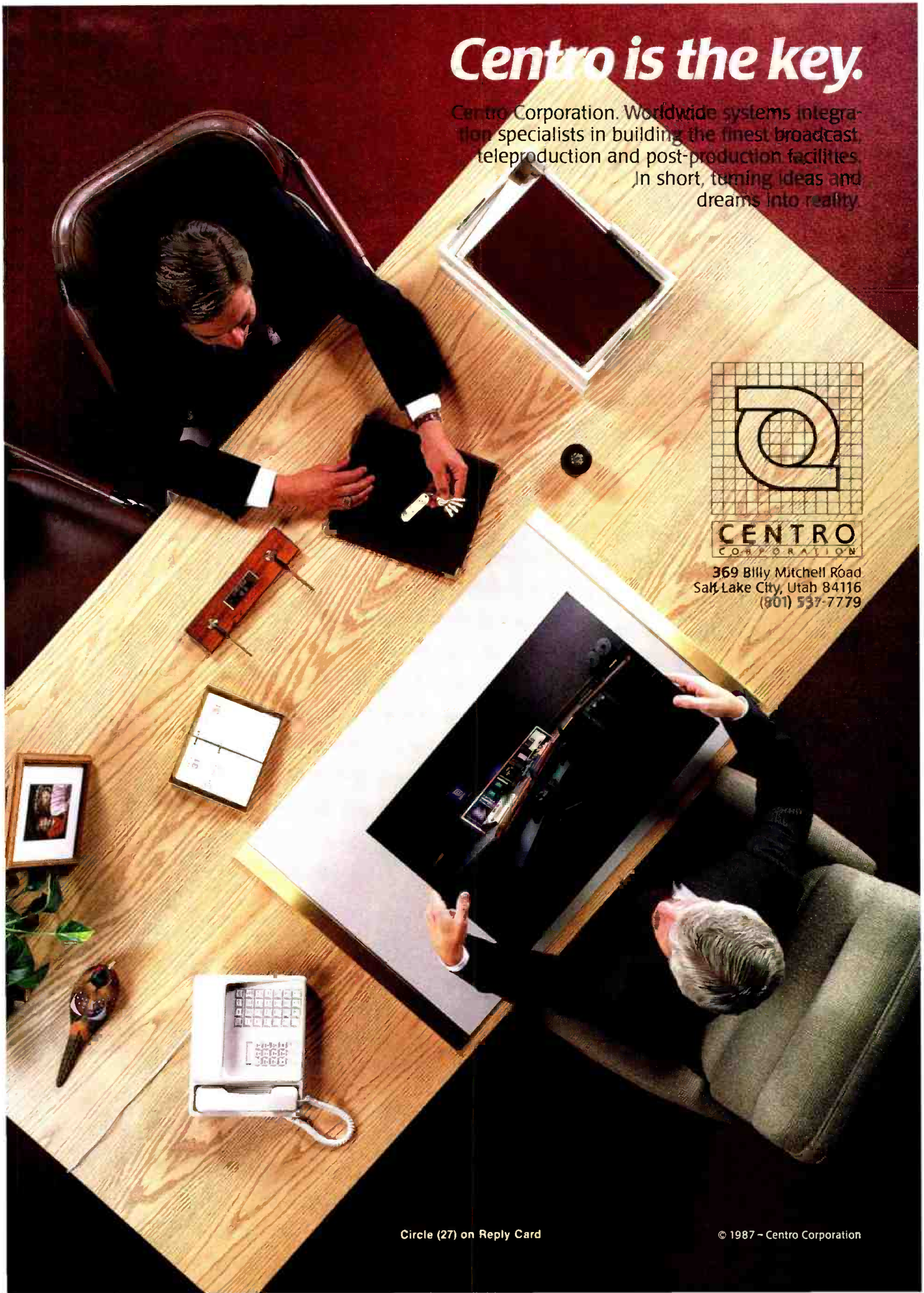
Follow a logical series of steps to ensure that the needed protection can be achieved at the broadcast plant:

1. Install a bulkhead panel to provide mechanical support, electrical grounding and lightning protection for coaxial cables entering the equipment building.
2. Install an internal ground bus using No. 2 or larger solid-copper wire. (At transmission facilities, use copper strap that is at least three inches wide.) Form a "star" grounding system. At larger installations, form a "star-of-stars" configuration. Do not allow ground loops to exist in the internal ground bus. Connect the following items to the building internal ground bus: chassis racks and cabinets of all equipment and all auxiliary equipment (chargers, switchboards, conduits, metal raceway and cable trays).
3. Install a tower earth-ground array by driving ground rods and laying radials as required to achieve a low earth-ground impedance at the site.
4. Connect outside metal structures to the earth-ground array (towers, metal fences, metal buildings and guy anchor points).
5. Connect the power-line ground to the array. Follow local electrical code.
6. Connect the bulkhead to the ground array through a low-inductance and low-resistance bond.

Do not use soldered-only connections outside the equipment building. Crimped, brazed and *exothermic* (Cadwelded) connections are preferable. For a proper bond, all metal surfaces must be clean, any finish must be removed to bare metal and surface preparation compound must be applied (where necessary). Protect all connections from moisture by appropriate means (sealing compound and heat-sink tubing).

The ac wiring system

Most transient disturbances a facility will experience enter the plant through the utility-company ac power line. Effective transient suppression, therefore, begins with proper installation of the ac power-system wiring. Arrange with the local utility to have a separate transformer feed your facility. This may cost more initially, but it will reduce the chance for transient disturbances from nearby operations to affect your equipment. Do not allow the placement of noisy loads on the broadcast facility power line. Devices such as arc-welders, heavy electrical motors, elevators and other large loads can create an electrical environment that



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is prone to equipment malfunctions.

It should be noted, however, that because transient disturbances, by definition, are high frequency, they will capacitively couple from the primary to the secondary of a typical utility-company transformer. Simply installing a dedicated transformer that is not equipped with a special Faraday shield (utility transformers generally do not have such shields) will provide little protection from equipment damage. Installation of a dedicated utility-company transformer, however, will permit you to establish your own facility ground system independent of other users.

Insist that all ac wiring within the broadcast facility be performed by an experienced electrical contractor, and *always fully within the local electrical code*. Figure 8 shows a typical service-entrance panel, with the neutral line from the utility company tied to ground and to the ground rod at the meter panel. Where permitted by the local code, this should be the only point at which neutral is tied to ground in the ac distribution system.

Figure 9 shows a 3-phase power-distribution panel. Note that the neutral and ground connections are kept separate. Most ac distribution panels give the electrical contractor the ability to lift the neutral from ground by removing a shorting screw in the breaker-panel chassis. Insulate the neutral lines from the cabinet. Bond the ground wires to the cabinet for safety. Always run a separate, insulated green wire for ground. Never rely on conduit or other mechanical structures to provide ac system ground to electrical panels or equipment.

A single-phase power-distribution panel is shown in Figure 10. Note that neutral is insulated from ground and that the insulated green ground wires are bonded to the panel chassis.

Conduit runs often are a source of noise. Corrosion of the steel-to-steel junctions can act as an RF detector. Conduit-feeding sensitive equipment usually will contact other conduit runs powering noisy devices, such as elevators or air-conditioners. Where possible, eliminate this problem by using PVC pipe, Romex or jacketed cable.

However, if you are stuck with metal pipe, send the noise to the power ground rods instead of your equipment by isolating the green ground wire from the conduit with a ground-isolating (orange) receptacle. In a new installation, isolate the conduit from building metal structures or other conduit runs. Consult your local electrical code or an experienced electrical contractor before installing or changing any ac power system wiring.

The installation and wiring of equipment racks also must be carefully planned. Bond adjacent racks together with bolts, and clean the contacting surfaces by sanding down to bare metal. Install an ac receptacle box at each rack. Isolate the conduit from the rack. Isolate the power ground from the receptacle box. (One alternative to the isolated-ground receptacle is the use of an insulated bushing between the conduit and the receptacle box.) Mount a vertical power strip inside the rack to power the equipment. (The power strip doesn't need to be insulated from the rack). Additionally, bond the rack to the bulkhead ground or the green ground wire in the receptable box.

Mount equipment in the rack using normal metal mounting screws. If your facility is located in a high-RF field, clean the rack rails and equipment-panel connection points to ensure a good electrical bond. Power the equipment from the vertical power strip using standard 3-prong grounding ac plugs. *Do not defeat the safety ground connection.* Equipment manufacturers use this ground to drain transients.

Before implementing any type of ac

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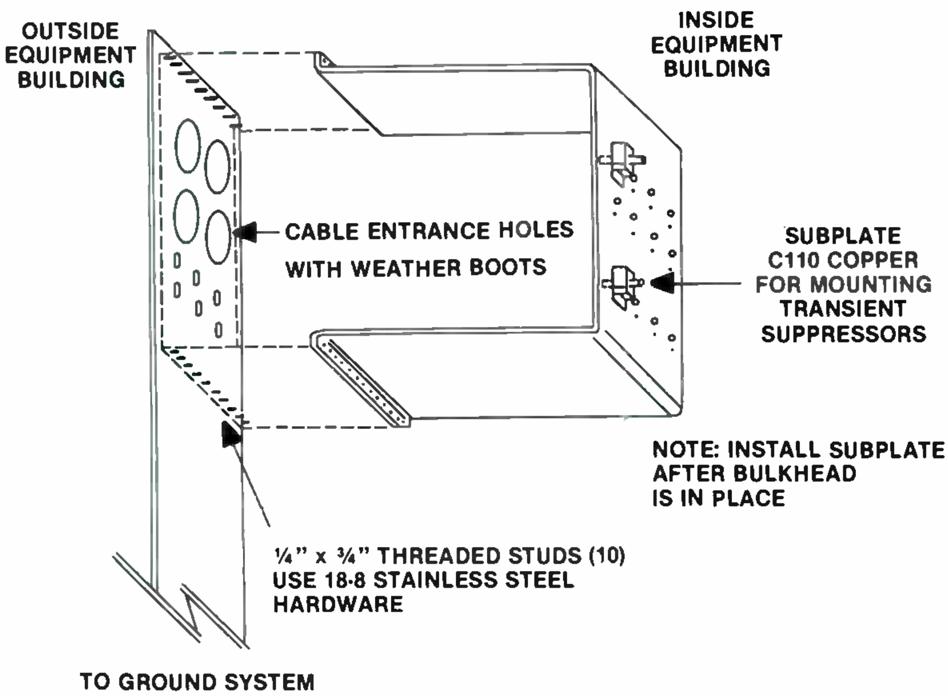

Figure 7. *The addition of a subpanel to a bulkhead as a means of providing a mounting surface for transient-suppression components that is not exposed to outside elements. (Reference 2.)*

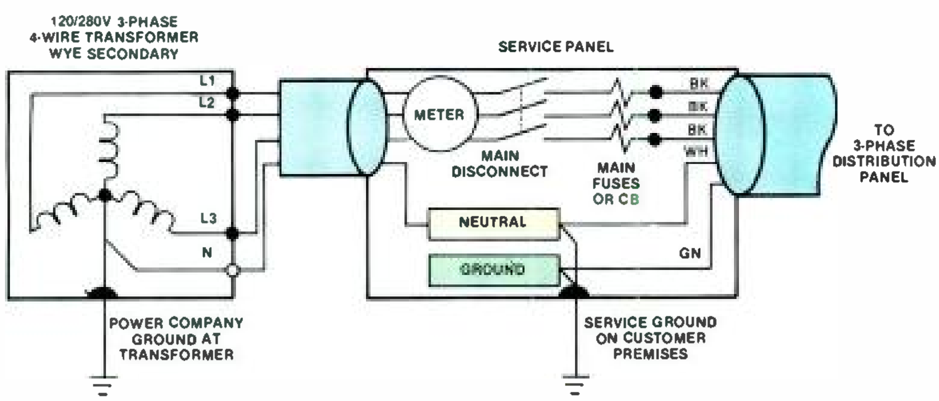

Figure 8. *The recommended connection method for a 3-phase utility-company service panel. (Reference 3.)*

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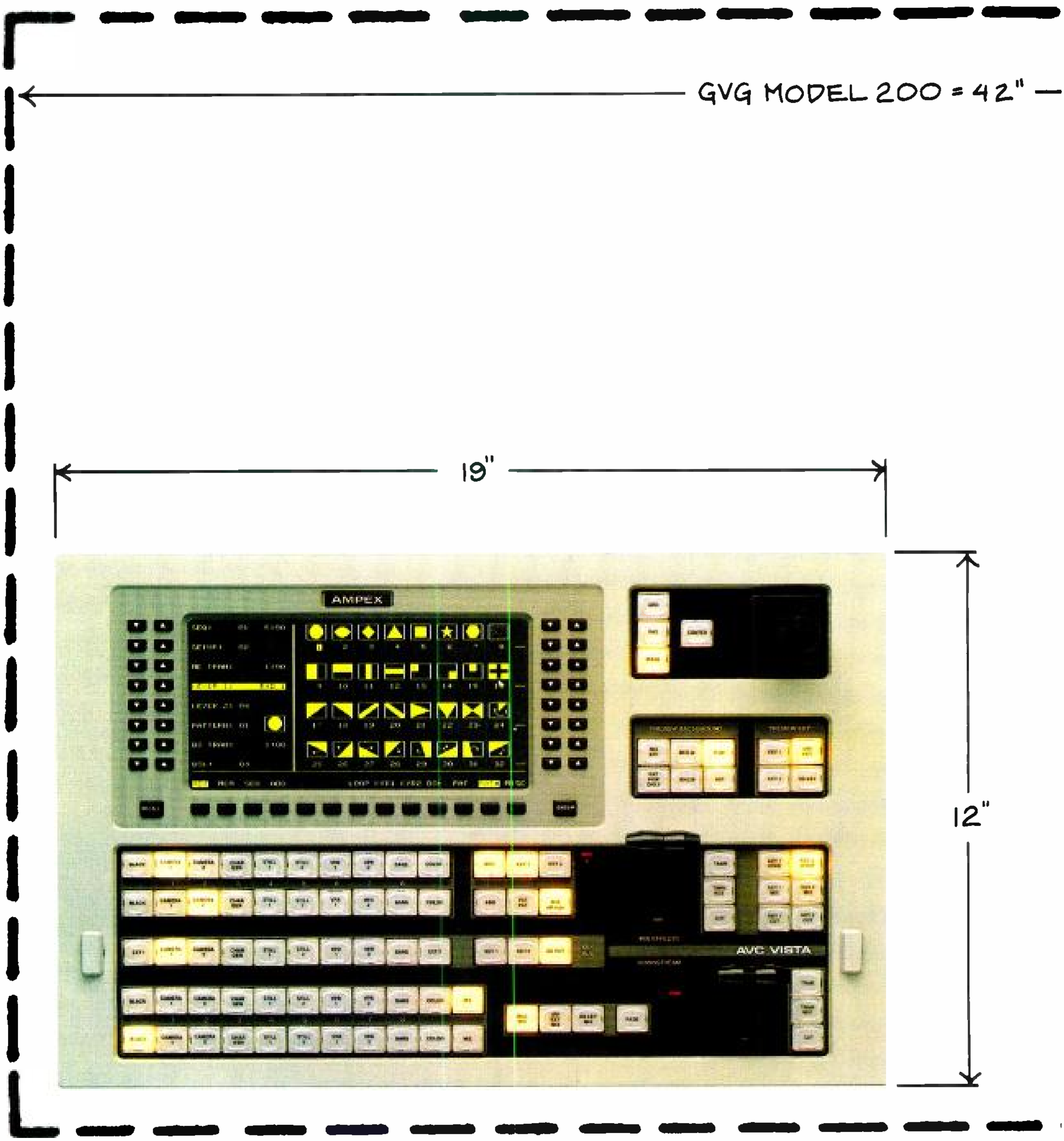

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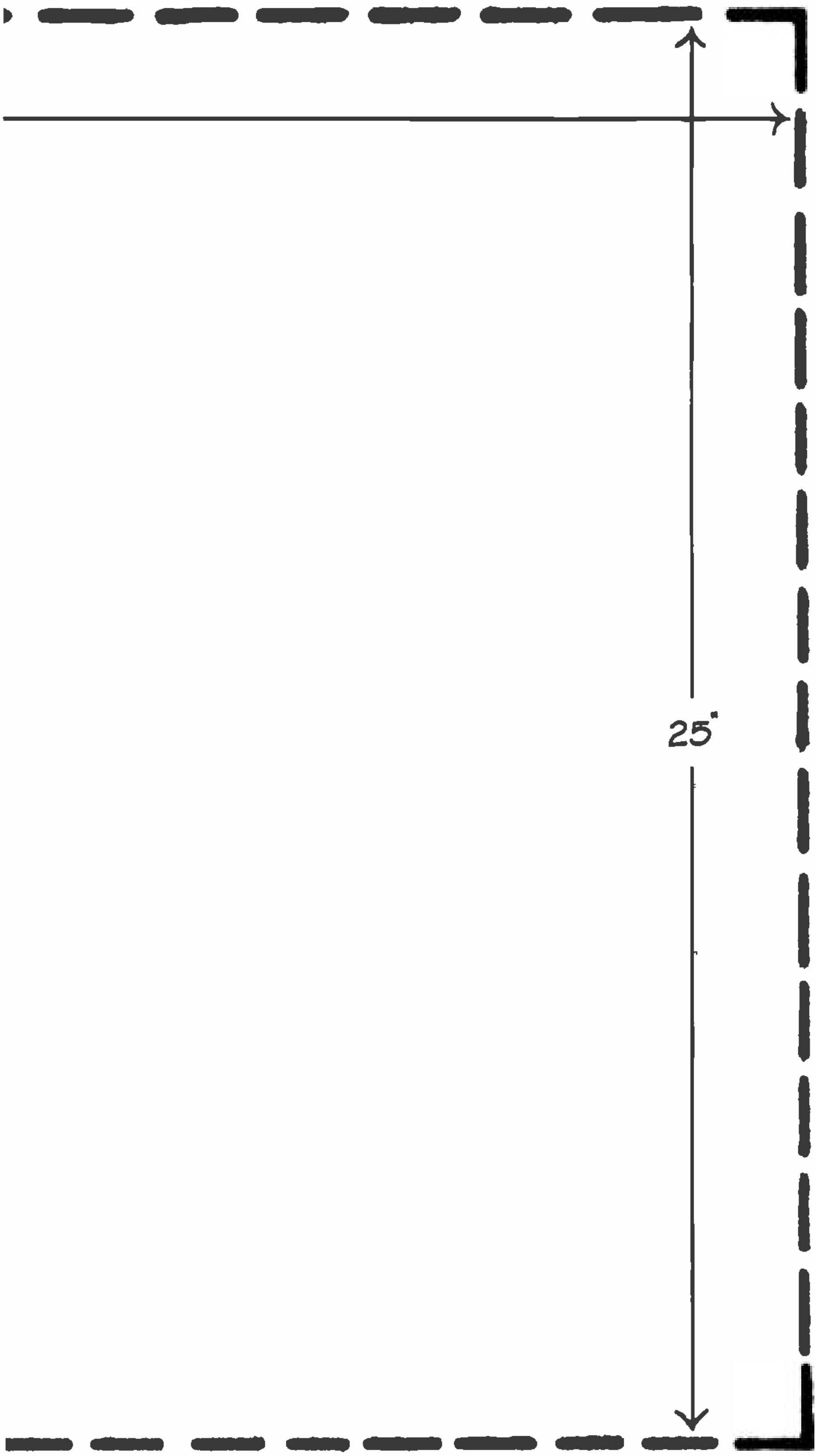

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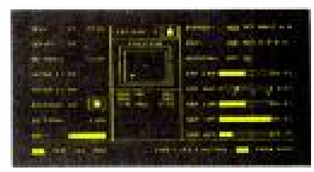

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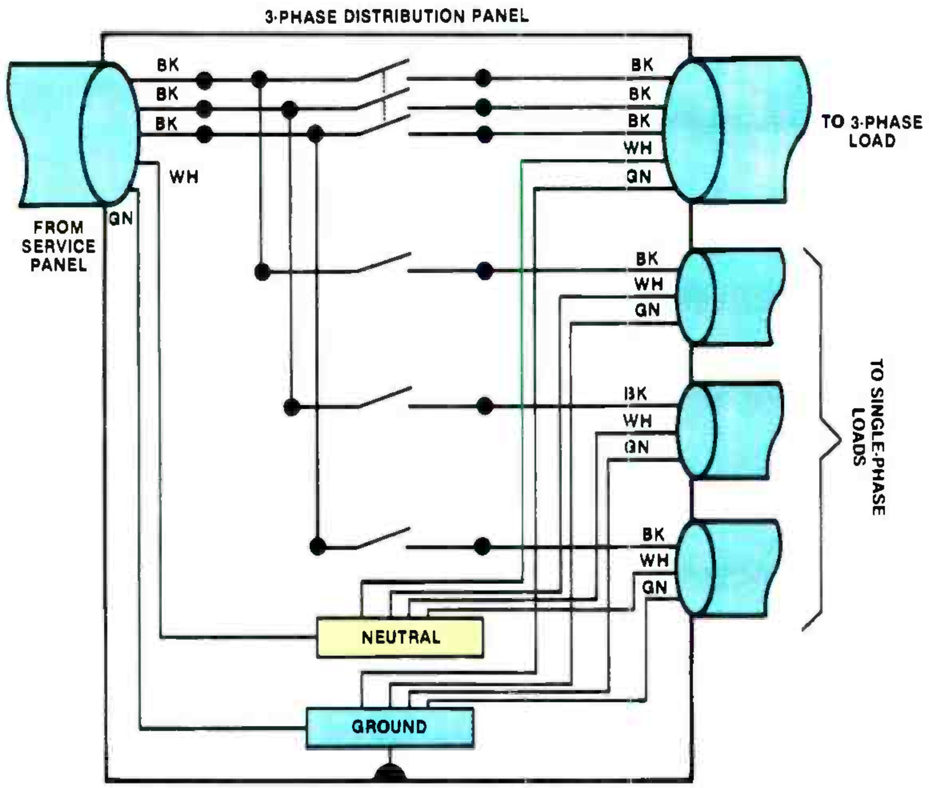

Figure 9. *Arrangement of the neutral and green-wire ground system for a 3-phase ac distribution panel. (Reference 3.)*

Continued from page 48

power-system changes, review the entire project with a qualified electrical contractor.

Discrete device protection

A broadcast facility can be protected from transient disturbances in two basic ways: the *systems* approach or the *discrete device* approach. Table 2 (see page 34) outlines the major alternatives available for the systems approach to transient suppression:

- UPS (uninterruptible power supply) system and standby generator.
- UPS stand-alone system.
- Secondary ac spot network.
- Secondary selective ac network.
- Motor-generator unit.
- Shielded isolation transformer.
- Solid-state line-voltage regulator/filter.

The systems approach offers the advantages of protection engineered to a particular application and need, and (usually) high-level factory support during system design and installation. However, it costs more. Many facilities cannot justify spending $5,000 or more for a sophisticated protection system. For such in-

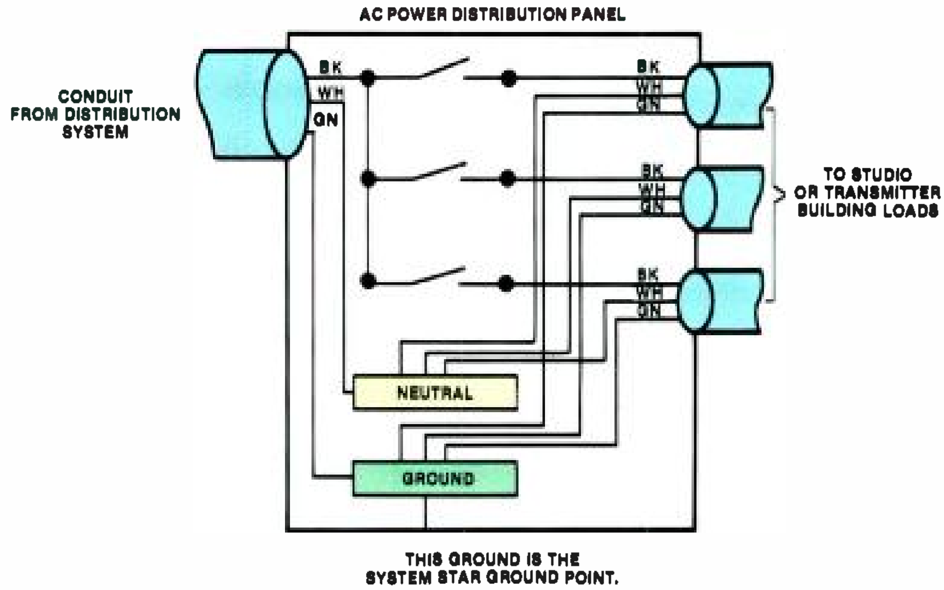

***Figure 10.** Arrangement of the neutral and green-wire ground system for a single-phase ac distribution panel. (Reference 3.)*

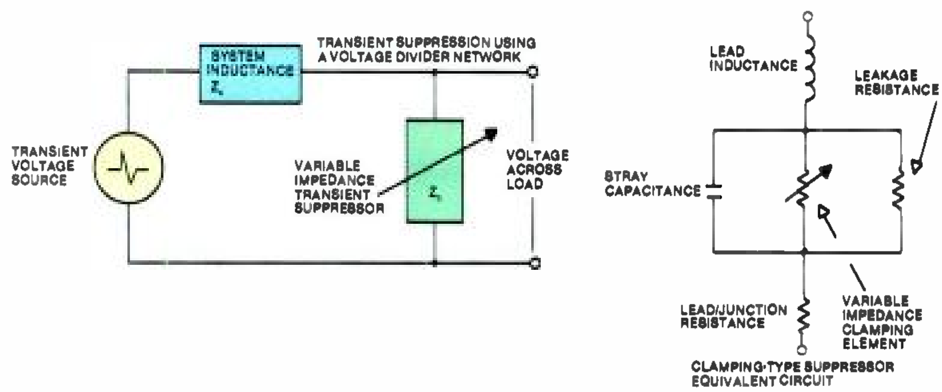

***Figure 11.** The mechanics of transient suppression using a voltage-clamping device.*

stallations, the only alternative is to apply discrete protection devices at critical points in the ac power system.

In the business of transient protection, you get what you pay for. Discrete devices are less expensive and usually provide less protection compared with a sophisticated systems approach. It is unrealistic for a user to expect a group of discrete transient suppressors to do the job of a much more expensive systems design. However, properly applied discrete devices can prevent equipment damage from all but the most serious transient disturbances. The key to achieving this level of performance lies in understanding and properly applying discrete protection devices.

The performance of the discrete transient-suppression components available

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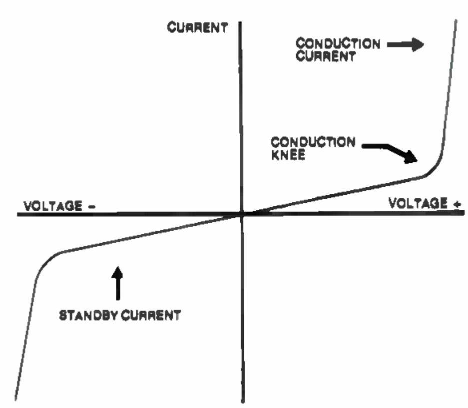

***Figure 12.** The voltage-vs.-current curve for a typical bipolar voltage-clamping device. The component is designed to be essentially invisible in the circuit until the applied positive or negative potential reaches or exceeds the conduction knee of the device.*

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Continued from page 54
to the broadcast engineer has greatly improved in the past 10 years.

The variety of reasonably priced devices now available makes it possible to exercise tight control over unwanted voltage excursions and allows the complicated electronic equipment being manufactured today to work as intended. Much of the credit for transient-suppression work goes to the computer industry, which has been dealing with the problem for more than two decades.

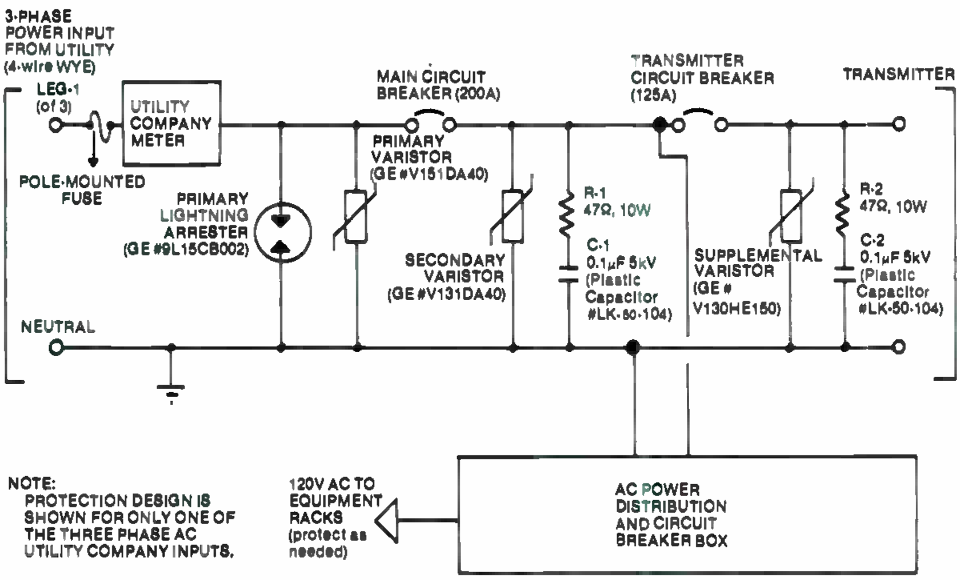

Figure 13. *The application of transient-suppression components to a systemwide protection plan. Install such hardware with extreme care, and only after consultation with the local utility company and an electrical contractor.*

Types of devices

Transient-suppression hardware can be divided into three categories: *ac filters*, *crowbar devices* and *voltage-clamping components*.

The simplest type of ac power-line filter is a capacitor placed across the voltage source. The impedance of the capacitor forms a voltage divider with the impedance of the source, resulting in the attenuation of high-frequency transients. This simple approach has definite limitations in spike-suppression capability and may introduce unwanted resonances with inductive components in the ac power-distribution system.

The addition of a series resistance will reduce the undesirable resonant effects, but it also will reduce the capacitor's effectiveness in attenuating a transient disturbance.

Crowbar devices include gas tubes (also known as spark-gaps or *gas-gaps*) and semiconductor-based *active crowbar* protection circuits. Although these devices and circuits can shunt a substantial amount of transient energy, they are subject to *power-follow* problems.

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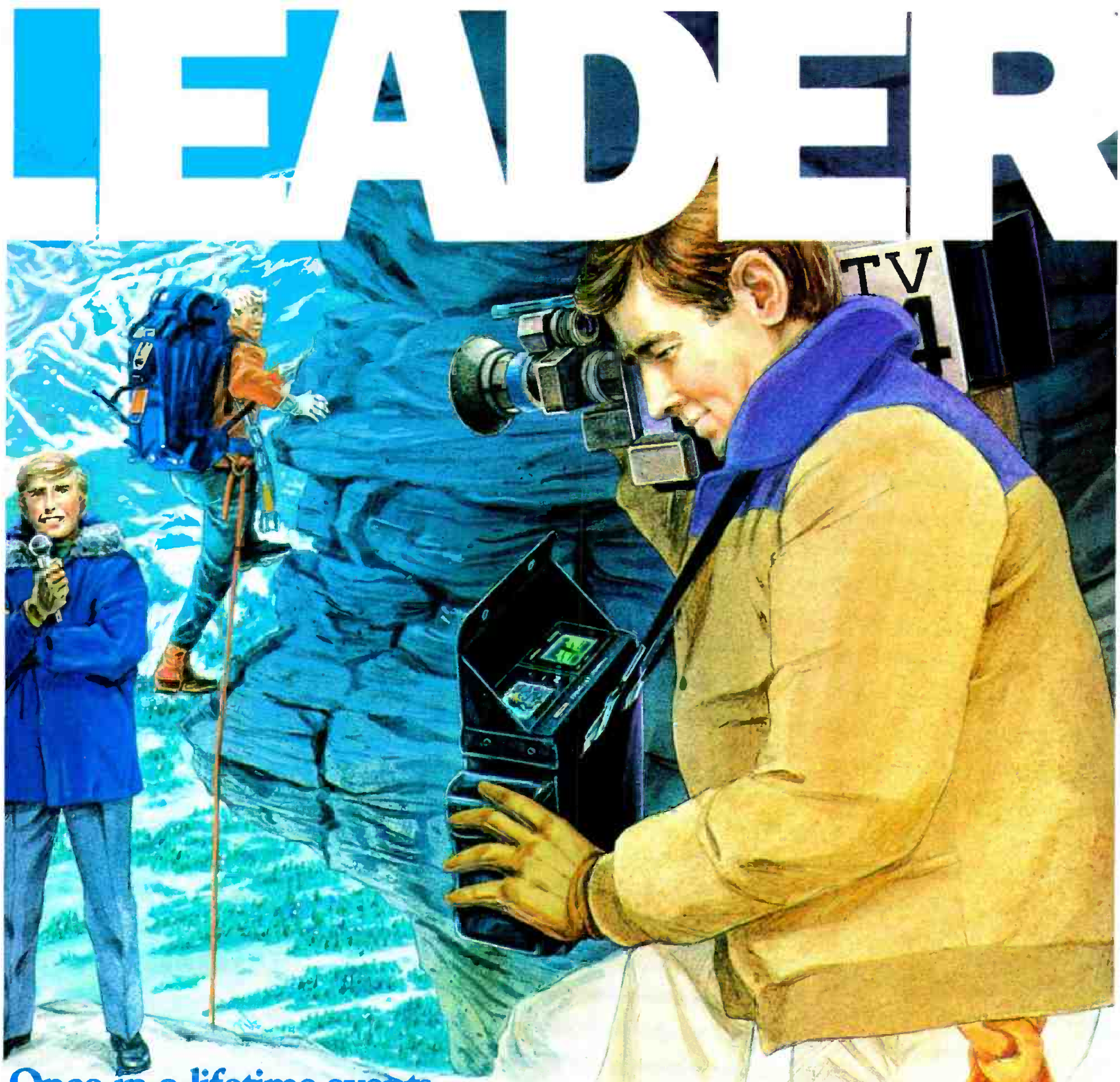

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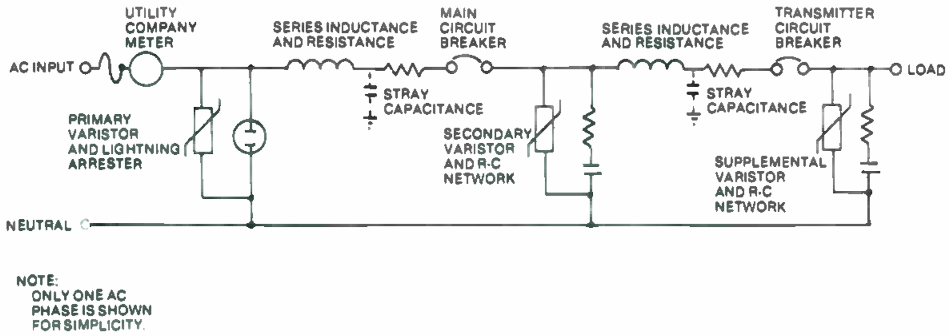

Figure 14. The use of ac system series inductance and resistance to aid transient suppressors in controlling line disturbances. This technique is known as staging.

tection circuit has fired, the normal line voltage and the transient voltage are shunted to ground. This power-follow current may open protective fuses or circuit breakers if a method of extinguishing the crowbar clamp is not provided.

Voltage-clamping devices are not subject to the power-follow problems common in crowbar systems. Clamping devices include selenium cells, zener diodes and varistors of various types.

Zener diodes, using improved silicon rectifier technology, provide an effective voltage clamp for the protection of sensitive electronic circuitry from transient disturbances. On the other hand, power dissipation for zener units is usually somewhat limited (compared with other suppression methods).

Selenium cells and varistors are differ-

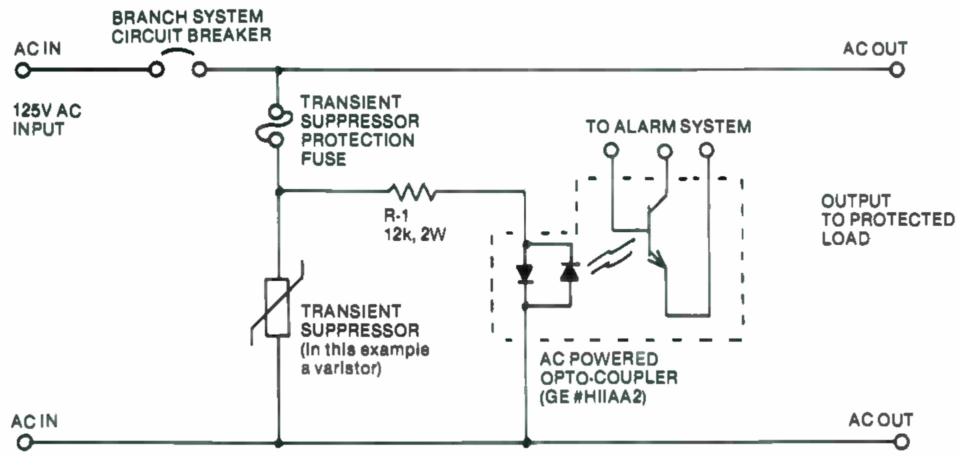

Figure 15. An open-fuse alarm circuit for a fused transient suppressor.

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ent in construction, but act similarly on a circuit exposed to a transient overvoltage. Figure 11 illustrates the variable non-linear impedance exhibited by a voltage-clamping device. It also shows how these components can reduce transient overvoltages in a particular circuit.

The voltage-divider network established by the source impedance (Z_s) and the clamping device impedance (Z_c) attenuates voltage excursions at the load. It should be understood that the transient suppressor depends upon the source impedance to aid the clamping effect. A protection device cannot be fully effective in a circuit that exhibits a low source impedance because the voltage-divider ratio is reduced proportionately.

A typical voltage-vs.-current curve for a voltage-clamping device is shown in Figure 12. When the device is exposed to a high-voltage transient, the impedance of the component changes from a high-standby value to a low-conduction value, clamping the voltage at a specified level.

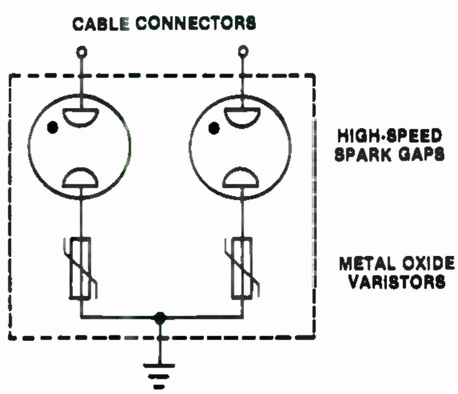

Figure 16. A hybrid voltage-protection device incorporating a gas tube spark gap and varistor in each suppression element. The design goal is to extend the life of the varistor. (Reference 4.)

Selecting a protection device

Selecting a transient-suppression device for a particular application is a complicated procedure that must take into account the following factors:

- The steady-state working voltage, including normal tolerances.
- The transient energy to which the device is likely to be exposed.
- The voltage-clamping characteristics required in the application.
- Circuit-protection devices (such as fuses or circuit breakers) present in the system.
- The consequences of protection-device failure in a short-circuit mode.
- The sensitivity of the load equipment to transient disturbances.

Most transient-suppression equipment manufacturers offer detailed application handbooks. *Consult such reference data whenever you plan to use a protection device.* The specifications and ratings of suppression components are not necessarily interchangeable from one manufacturer to another.

Carefully weigh the addition of transient-suppression devices to a piece of equipment or ac power-distribution system. Make allowances for operation of the circuit under all conditions.

Power protection

Transient-protection methods for a broadcast facility vary considerably depending on the size and complexity of

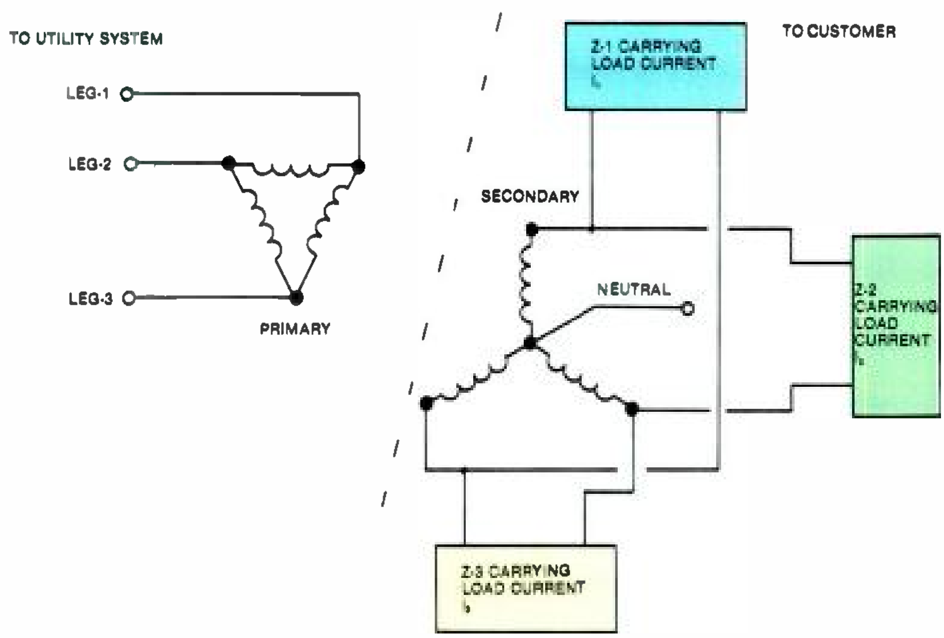

Figure 17. The Delta-Wye transformer configuration for utility-company power distribution.

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the plant, the sensitivity of equipment at the facility and the extent of transient activity on the primary power lines.

Figure 13 shows one possible approach to transient suppression for a broadcast facility. Lightning arresters are built into the 12kV to 208V 3-phase pole-mounted transformer. The service drop comes into the meter panel and is connected to a *primary lightning arrester* (General Electric Company No. 9L15CB002) and a *primary varistor* (GE No. V151DA40).

The circuit shown in Figure 13 is duplicated three times for a 3-wire Wye (208V phase-to-phase, 120V phase-to-neutral) power system.

The primary arrester and varistor are placed at the service drop input point to protect the main circuit breaker and power-system wiring from high-voltage transients that are not clipped by the lightning arrester at the pole or by the varistors later in the circuit path.

The primary varistor has a higher maximum clamp voltage than the varistors located after the main breaker, causing the devices downstream to carry most of the clamp-mode current when a transient occurs (assuming low system inductance). If the main circuit breaker opens during a transient disturbance, the varistor at the service drop entrance will keep the spike voltage below a point at which it could damage the breaker or system wiring.

Placing overvoltage protection before the main service breaker may be considered *only* when the pole-mounted transformer feeds a single load and when the transformer has transient protection of its own, including lightning arresters and primary-side fuses. *Consult the local power company before you place any spike-suppression devices ahead of the main breaker.*

Transient protection immediately after the main breaker consists of a *secondary varistor* (GE No. V131DA40) and a capacitor (0.1µF at 5kV) between each leg and neutral. A 47Ω 10W series resistor protects the circuit if the capacitor fails. It also reduces the resonant effects of the capacitor and ac distribution-system inductance.

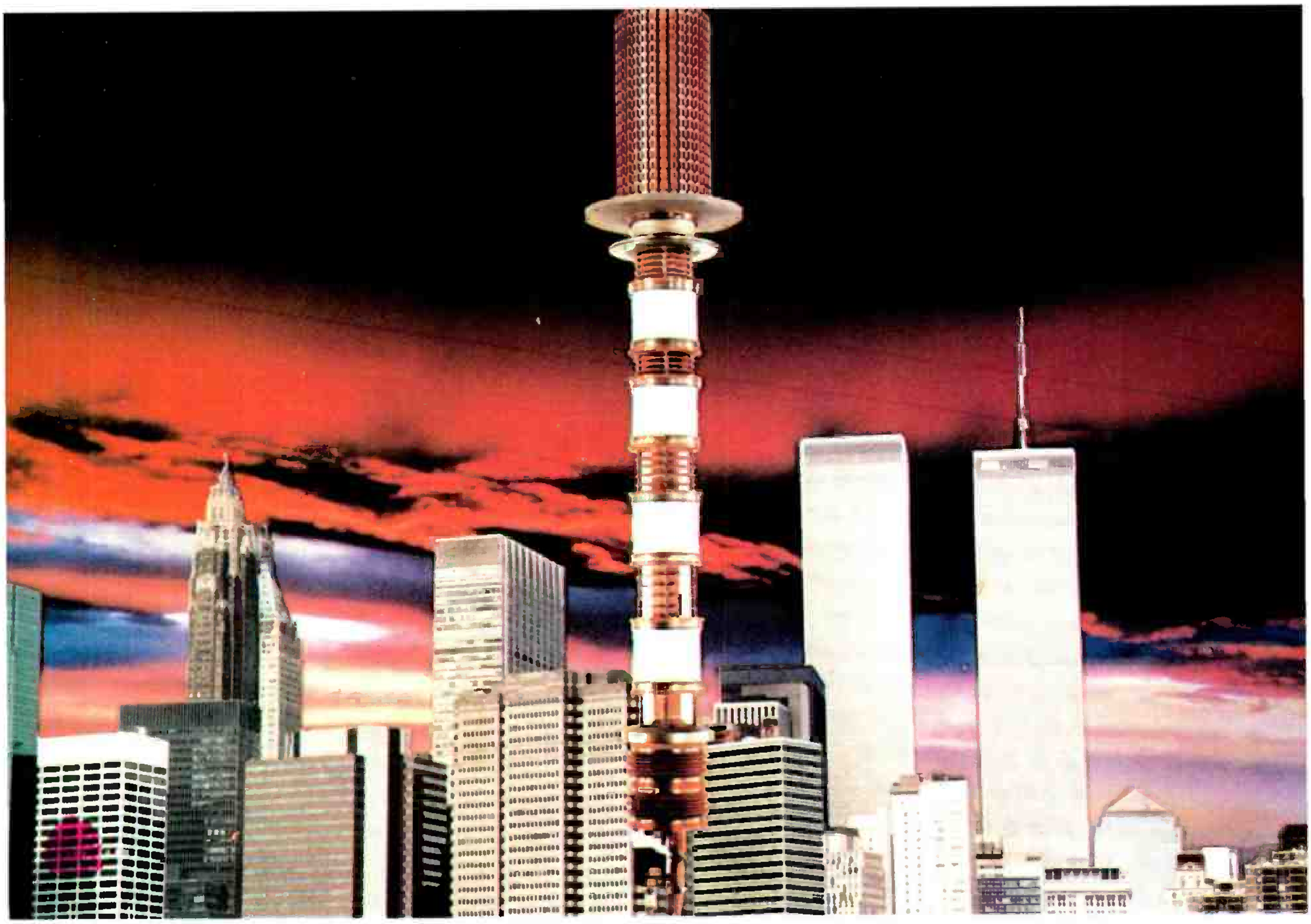
The varistor clips overvoltages as previously described, and the resistor-capacitor network helps eliminate high-frequency transients on the line. The capacitor also places higher capacitive loading on the secondary of the utility-company step-down transformer, reducing the effects of turn-on spikes caused by capacitive coupling between the primary and the secondary of the pole- or surface-mounted transformer.

As an extra measure of protection, a *supplemental varistor* (GE No. V130-HE150) and RC snubber are placed at the primary power input to the transmitter. Transient suppressors are placed as needed at the ac power distribution and circuit-breaker box.

Staging

The transient-suppression system shown in Figure 13 uses a technique known as *staging* of protection components. An equivalent circuit of the basic system is shown in Figure 14. The staging approach takes advantage of the series resistance and impedance of the ac wiring system of a facility to aid in transient suppression.

When appreciable inductance or resistance exists in an ac distribution system, the protection components located at the utility-company service-drop entrance (the primary suppressors) will carry most of the suppressed-surge current in the event of a lightning strike or major transient disturbance. The varistors and RC networks downstream (the secondary and supplemental suppressors) are rated for clamp voltages lower than the primary protection devices. With the assistance of the ac circuit series resistance



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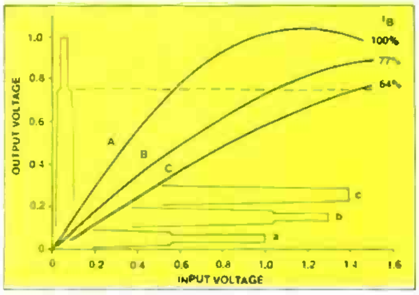

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and impedance, they exercise tight control over voltage excursions.

Staged suppression design also protects the system from exposure caused by a transient-suppression device that becomes ineffective. The performance of an individual suppression component is more critical in a system that is protected at only one point than it is in a system protected at several points. The use of staged suppression also helps prevent transients generated by load equipment from being transmitted to other sections of a facility, because suppressors can be located near offending loads.

Do not place transient suppressors of the same type in parallel to gain additional power-handling capability. Even suppressors that are identical in part number have specified tolerances, so devices placed in parallel will not share the suppressed-spike current equally.

Design cautions

Install transient suppressors at the utility service entrance with extreme care and only after consulting an experienced electrical contractor and the local utility company's engineering department.

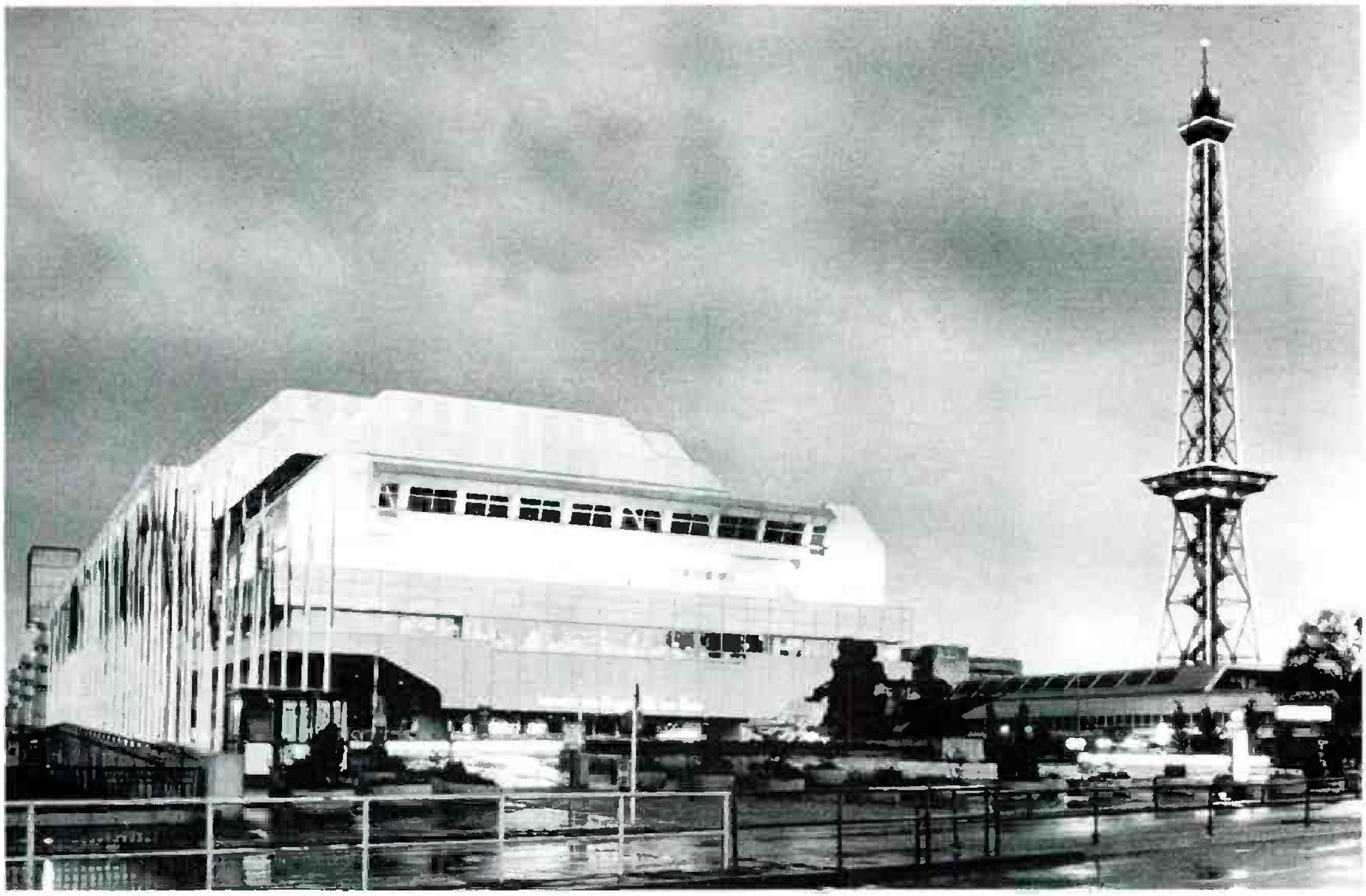
Although the addition of transient protection to an ac feed is vital to the long-term survival of the equipment downstream, the action of surge-suppression devices can cause one or more of the fuses at the service-drop transformer to open, creating a *single-phasing* condition. Positive protection against continued operation under such a condition is necessary if transient-protection devices are installed at the service entrance of a facility.

Protection-device failure is rare, but it can occur, causing damage to the system unless the consequences of the failure are taken into account. Before installing a surge-limiting device, examine what would happen if the device failed in a short circuit (which is generally the case).

Check for proper fusing on the protected lines, and locate transient-limiting devices in sealed enclosures to prevent damage to other equipment or injury to people if a device failure occurs.

In the failure mode, current through the protection device is limited only by the source impedance. High currents can cause the internal elements of the device to melt and to result eventually in an open circuit. However, the high currents often cause the component package to rupture, expelling package material in both solid and gaseous forms.

A transient suppressor must be fused if the line on which it is operating has a circuit breaker (or fuse) rating beyond the point that would provide protection against package rupture of the suppressor. Selecting the fuse is a complicated



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procedure involving an analysis of the transient energy that must be suppressed, the rupture current rating of the suppressor and the time delay of the fuse. Transient-suppressor manufacturers can provide guidance on fuse selection.

The monitoring circuit shown in Figure 15 can be used to alert maintenance personnel to an open fuse. This provision is important for continued safe operation of sensitive load equipment.

Lead length is another important factor to consider when installing surge-suppression components. Use heavy, solid wire (such as No. 12 of minimum length) to connect protection devices to the ac lines. Avoid sharp bends. If possible, maintain a minimum bending radius of eight inches for interconnecting wires. Long leads act as inductors in the presence of high-frequency transients and as resistors when high-current surges are being clamped.

Give careful attention to proper heat-sink design when installing transient-suppression devices. Some suppressors require an external heat-sink to meet their published specifications. Failure to provide an adequate heat-sink can result in premature device failure.

Spike-suppression components fail when subjected to transients beyond their peak current/energy ratings. They also can fail when operated at steady-state voltages beyond their recommended values.

Examine the manufacturer's product literature for each discrete protection device that you are considering. Many companies have applications engineering departments that can assist in matching their product lines to your needs.

Consider using hybrid protection devices that provide increased product lifetime. For example, a varistor normally exhibits some leakage current. This leakage can lead to device heating and eventual failure. Hybrid devices are available that combine a varistor with a gas-filled spark-gap device to hold the leakage current to zero during standby operation, extending the expected product lifetime. During a transient, the spark gap fires and the varistor clamps the pulse in the normal way. (See Figure 16.)

Utility-company interfacing

Most utility-company connections in the United States are the standard *Delta-Wye* type, as shown in Figure 17. This transformer arrangement usually is connected with the Delta side facing the high voltage and the Wye side facing the load. This arrangement provides good isolation of the load from the utility and retards the transmission of transients from the primary to the secondary. The individual 3-phase loads are denoted by Z1, Z2 and Z3. They carry load currents as shown.

When using a Wye-connected system, it is important that the building's neutral lead be connected to the midpoint of the transformer windings. The neutral line provides a path for the removal of harmonic currents that may be generated in the system because of rectification of the secondary voltages.

Some utility connections, however, use the *Open-Delta* arrangement shown in Figure 18. Customers often encounter problems when operating a sensitive 3-phase load from such a connection because of the system's poor voltage-regulation characteristics during varying load conditions. The Open-Delta configuration also is subject to high third-harmonic content and transient propagation. The three loads and their respective load currents are shown in the diagram.

Other primary power connection arrangements are possible, such as *Wye-to-Wye* or *Delta-to-Delta.* Like the Delta-to-Wye configuration, these systems are not susceptible to the problems that can be experienced with the Open-Delta (or V-V) service.

The Open-Delta system can develop a considerable imbalance between the individual phases in either voltage or phase, or both. Such an occurrence can introduce a strong 120Hz ripple frequency in 3-phase power supplies, which are designed to filter out a 360Hz ripple. The possible effects of this 120Hz ripple include increased noise in the supply and possible damage to protection devices across power-supply chokes.

Depending on the loading of an Open-Delta transformer arrangement, high third-harmonic energy can be transferred to the load, producing transients of up to 300% of the normal voltage. These transients can severely strain rectifiers, capacitors and inductors in the power supply as well as add to the supply's output noise.

Phase-to-phase balance

The phase-to-phase voltage balance of a utility company line is important to a broadcast facility, not only because of the increased power-supply ripple an imbalance may cause, but also because of the heating effects that may result. Even simple 3-phase devices such as motors must be operated from a power line that is well-balanced (preferably within 1%).

Studies have shown that a line imbalance of only 3.5% can produce a 25% increase in the heat generated by a 3-phase motor. A 5% imbalance can cause a 50% increase, which is potentially destructive. Similar heating also can occur in the windings of 3-phase power transformers used in broadcast equipment.

Phase-to-phase voltage balance can be measured accurately over several days with a slow-speed chart recorder. The causes of unbalanced operation usually are large single-phase power users on the 12kV distribution line. Uneven currents through the utility-company power-distribution system will result in uneven line-to-line voltages at the customer's service-drop entrance.

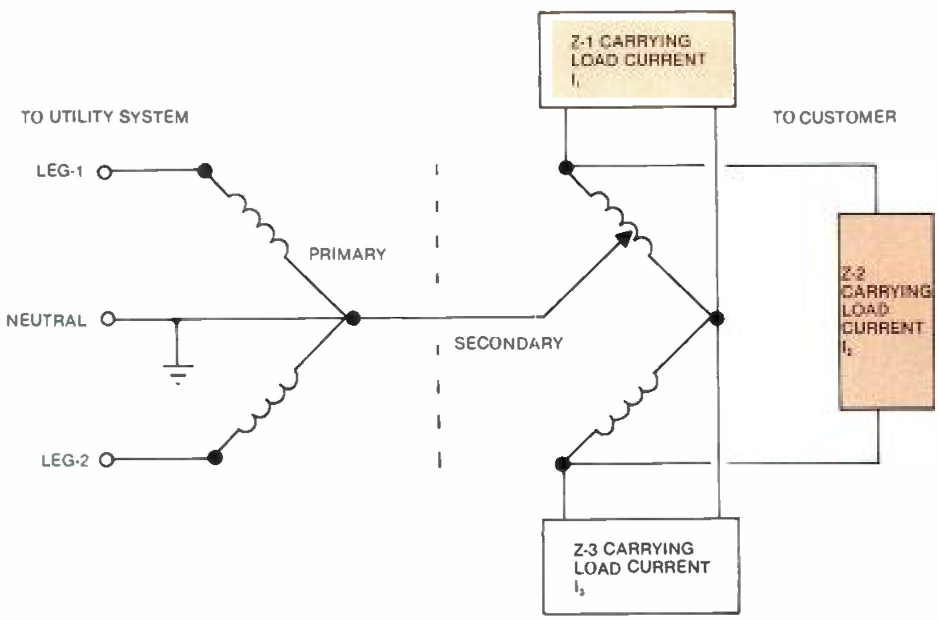

Figure 18. The Open-Delta (or V-V) utility-company service connection. Use of this configuration is not recommended because of the system's poor voltage regulation, high third-harmonic content and transient disturbance propagation characteristics.

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Circuit-level applications

Equipment reliability can be increased by building transient protection into broadcast hardware.

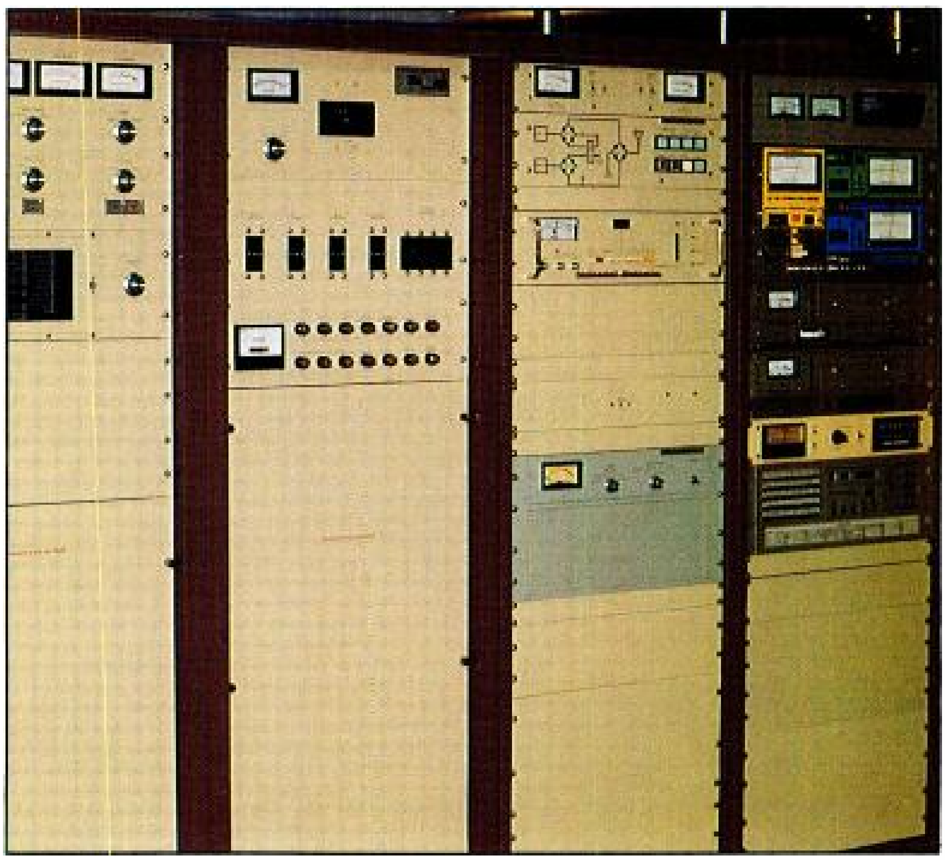
The design of any piece of electronic equipment is a complicated process that is the domain of design engineers, *not users in the field*. Many manufacturers are now building transient protection into their products. This work is welcomed because effective transient suppression is a *systems problem* that extends from the utility-company ac input to the circuit boards in each piece of equipment. Although progress has been made, more work needs to be accomplished on circuit-level transient suppression.

Case histories

Some low-voltage power supplies used in broadcast equipment are, at best, only adequate. All too often, power to an expensive piece of equipment is derived from a circuit that has virtually no transient overvoltage protection. This type of supply certainly will work, but it falls short of the "state of the art," and is less than the industry should expect from professional equipment.

Figure 19 shows the recommended transient protection for a typical low-voltage series-regulated power supply. MOV1, 2 and 3 clip spikes on the incom-

Acknowledgment: The author wishes to thank Roger Block, president of PolyPhaser Corporation, Gardnerville, NV, and Howard Mullinack of Orban Associates, San Francisco, for their help in preparing this report.



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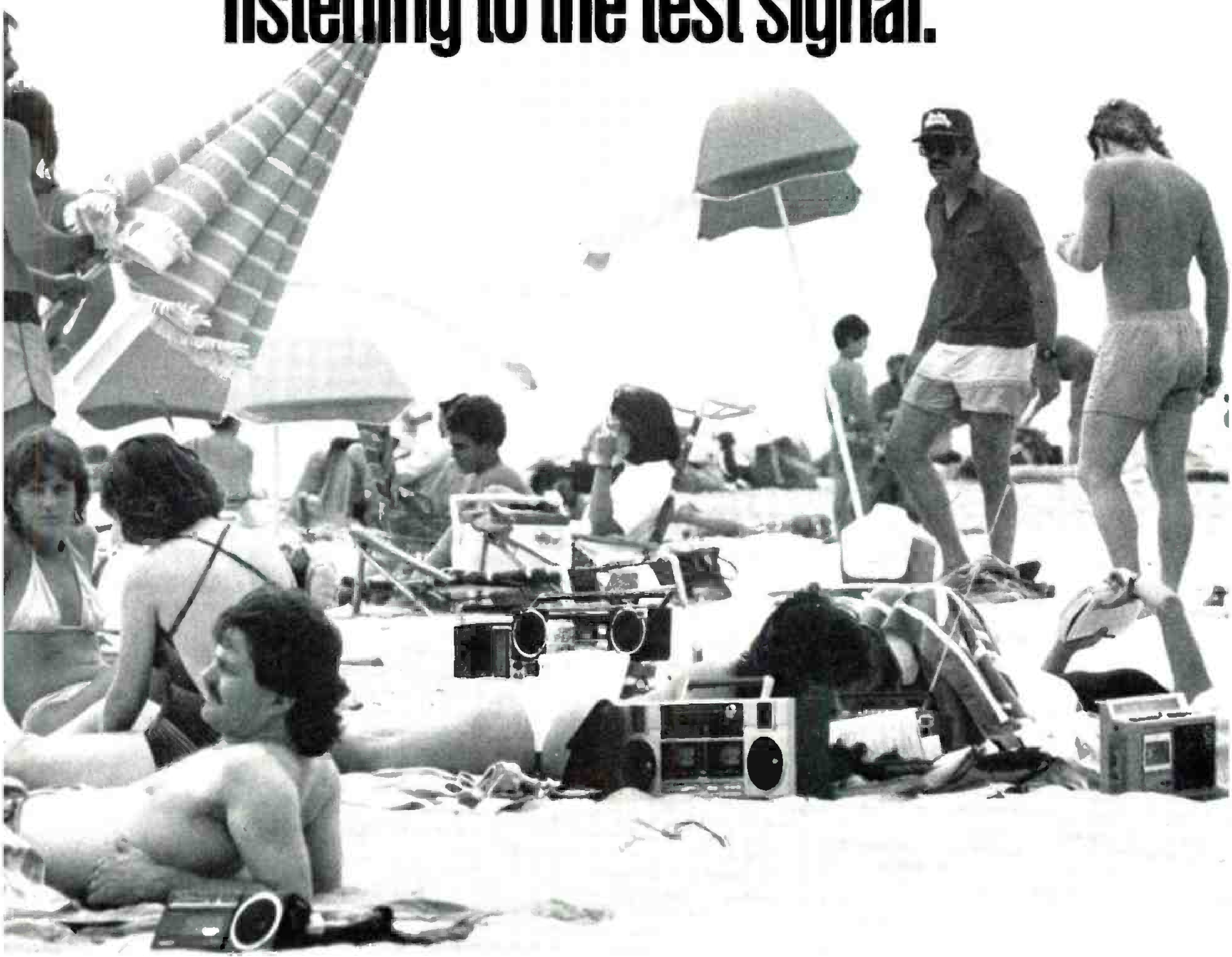

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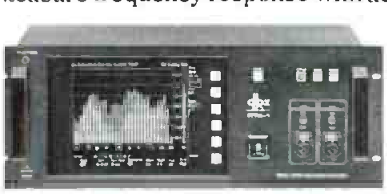

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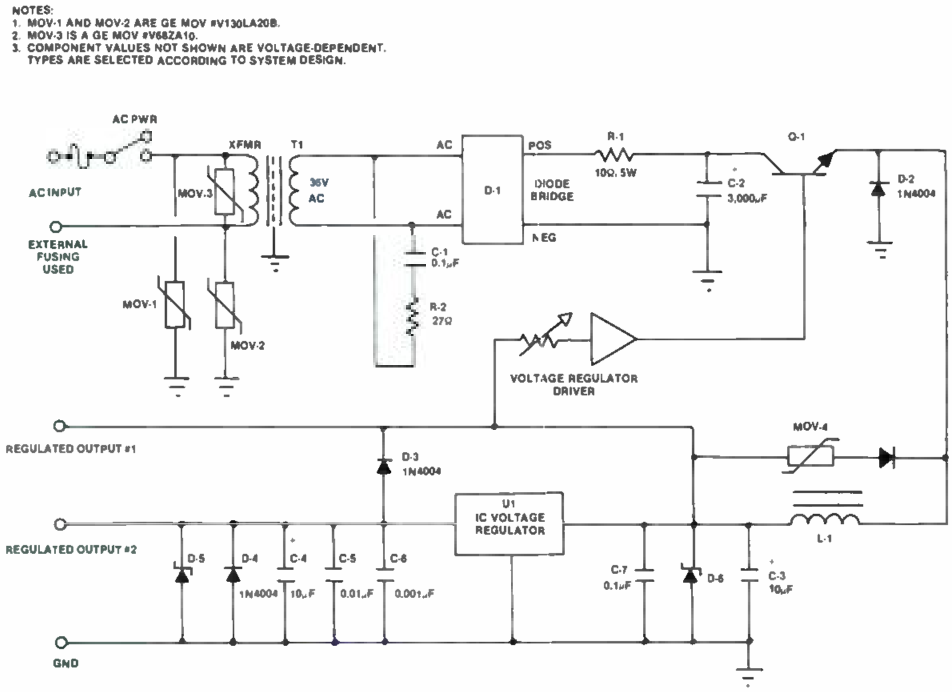

Figure 19. The recommended transient overvoltage protection for a low-voltage power supply. A circuit such as this will survive well in the field despite frequent transient disturbances.

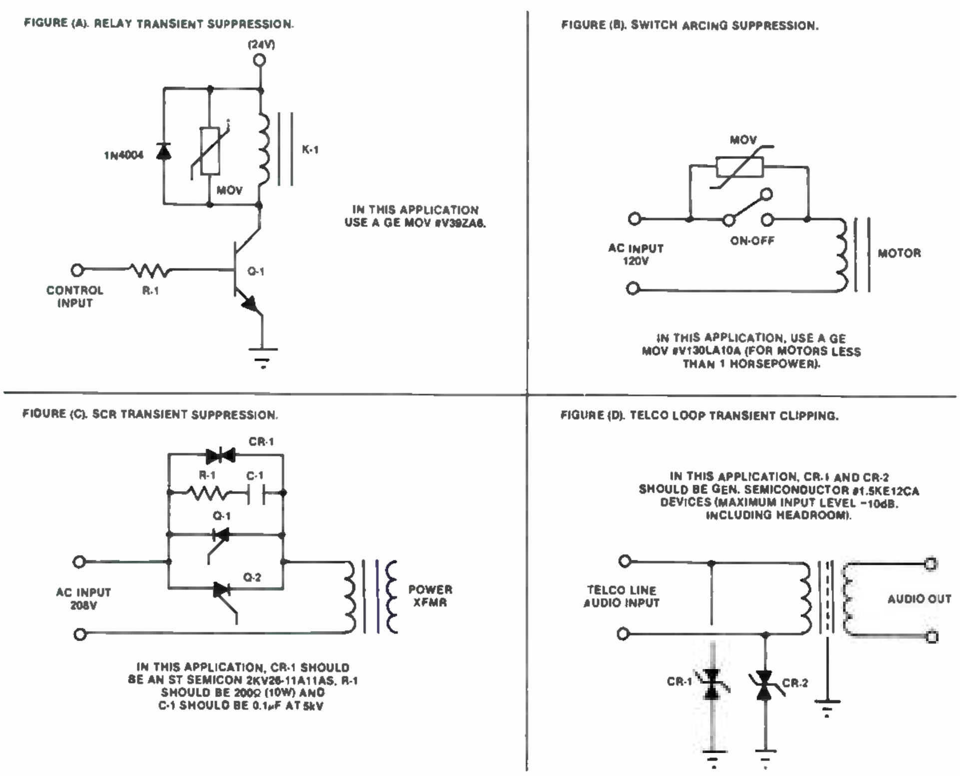

Figure 20. Transient-suppressor applications for several common circuit configurations.

ing ac line, and C1 aids in shunting turn-on, turn-off and fault spikes on the secondary of T1. Resistor R1 protects diode bridge D1 by limiting the amount of current through D1 during turn-on, when capacitor C2 (the main filter) is fully discharged. MOV4 protects series regulator Q1 and the load from damage because of transients generated by fault conditions and load switching. The varistor is chosen so that it will conduct current when the voltage across L1 is greater than would be encountered during normal operation. Diode D2 protects Q1 from back-EMF kicks from L1.

Three-terminal integrated-circuit voltage-regulator U1 is protected from excessive back-current because of a short circuit on its input side by diode D3. Capacitors C3, 4, 5, 6 and 7 provide filtering and protect against RF pickup on the supply lines. Diode D4 protects U1 from back-EMF kicks from an inductive load, and zener diode D5 protects the load from excessive voltage in case U1 fails (possibly impressing the full input voltage onto the load). D5 also protects U1 from overvoltages caused by spikes generated through inductive load-switching or fault conditions. D6 performs a similar function for the input side of U1.

Figure 20 shows additional circuit-level applications for transient suppressors. Any transistor that switches an inductive load must be provided with transient protection, as shown in Figure 20(a). Protection also is required for switches that control an appreciable amount of power, as illustrated in Figure 20(b). The use of a spike suppressor across switch or relay contacts will greatly extend the life of the switching elements.

SCR control of the power input to a large transformer is common in transmitter equipment today, and some form of protection is vital to long-term reliability. The surge protector shown in Figure 20(c) will clip spikes generated by the transformer during retarded-phase operation.

Transient suppression often is desirable on telephone company audio or data loops. The spike-clipping devices shown in Figure 20(d) are selected based on the typical audio voltage levels (including headroom) used on the line.

For maximum protection of microcomputer equipment, transient suppression must be designed into individual circuit boards. Figures 21(a) and (b) illustrate typical applications of on-the-board spike suppression. The devices used are General Semiconductor DQA/DQB series DIP *TranZorbs*. Four individual TranZorb devices are included in each DIP package, making it possible to conveniently place them on crowded printed circuit boards. Figure 21(c) shows an application of transient suppression in a voltage-follower circuit, common in many analog data-acquisition systems. Note the use of suppression devices at the power-supply pins of the circuits shown in Figures 21(a) through (c).

Figure 21(d) illustrates an alternative to the transient-protection arrangement shown in Figure 20(d). The Figure 21 cir-

Continued on page 78

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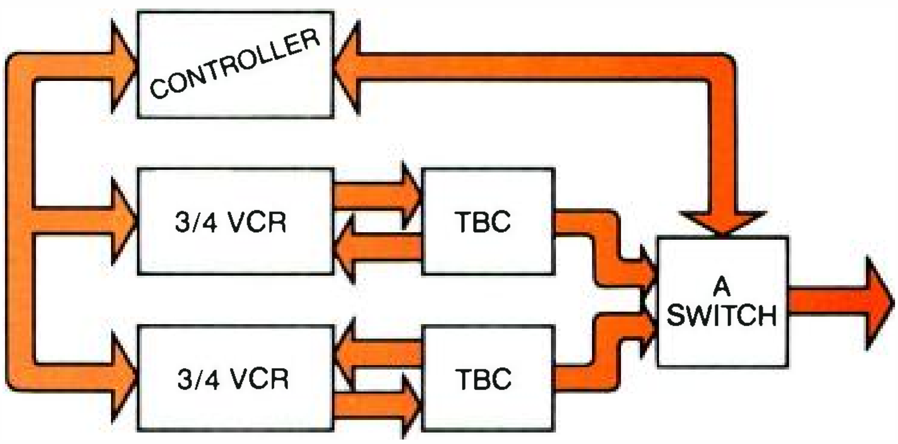

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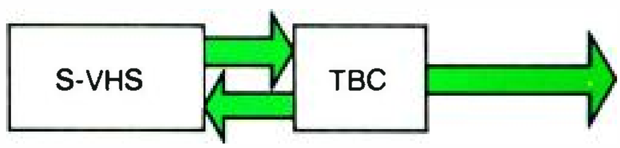

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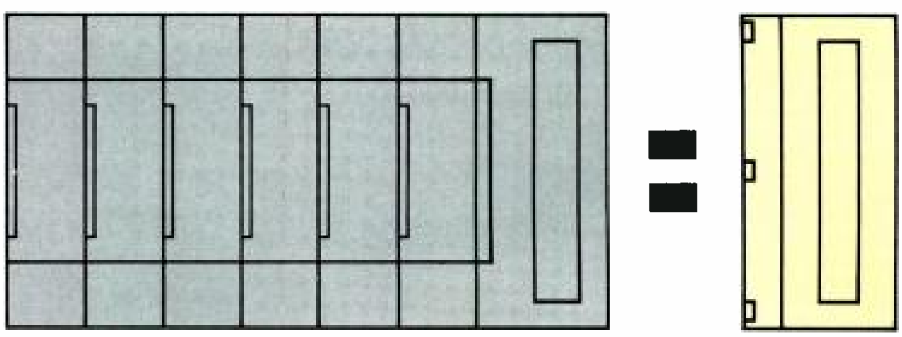

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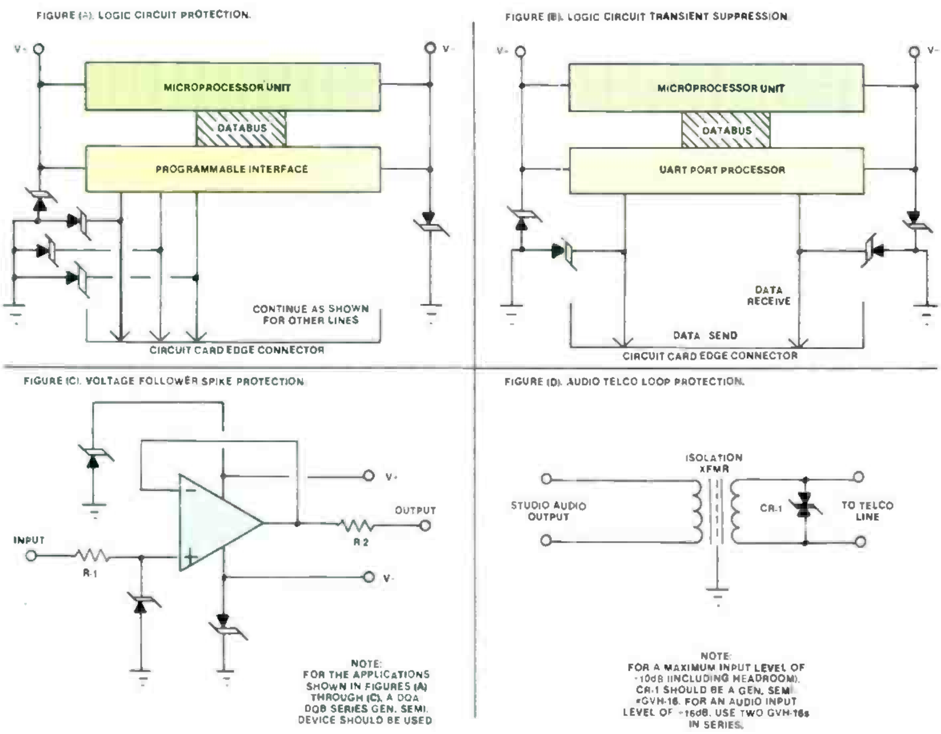

Figure 21. *Application of transient-suppression devices to microcomputer, analog voltage sampling and audio circuits.*

Continued from page 74

cuit prevents the introduction of noise into high-quality audio program lines because of common-mode imbalances that may result from transient suppressors being tied to ground. The use of a low-capacitance suppressor (as specified) ensures minimum capacitive loading on the telco circuit.

The traditional protection element used for telephone company lines is the *gas tube*, which has been used for many years to replace the older carbon buttons that became noisy with time. The gas tube (and its carbon predecessor) protects central office personnel if a high-voltage power line comes in contact with a telephone cable. Protection of customer equipment is of secondary importance.

For balanced telco lines, critical transient considerations include both the above-ground voltage of the two conductors (the *common-mode voltage*) and the voltage between the two conductors (the *differential-mode voltage*). When individual clamping devices are used on each conductor, as shown in Figure 20(d), one device will inevitably clamp before the other. This action can create a significant

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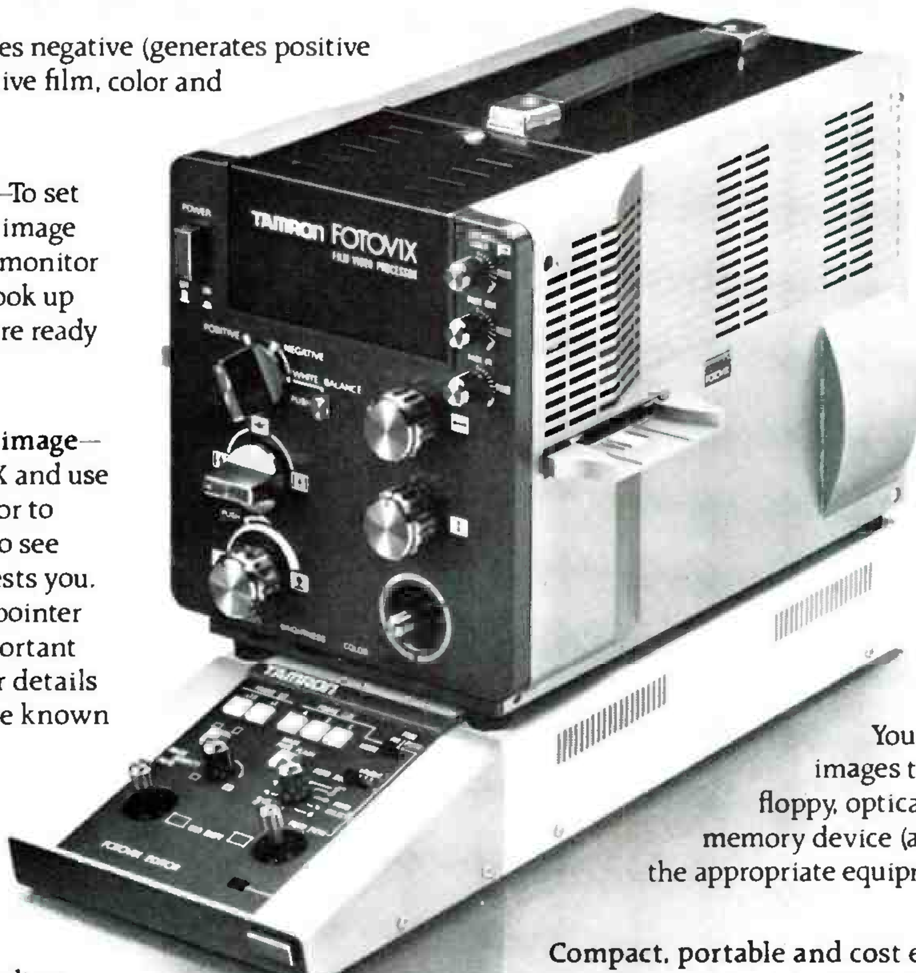

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differential voltage that can damage sensitive equipment on the telco line.

The best solution is to install a 3-element gas tube. The device has a common gas chamber with two gaps, one on each side of the grounded electrode. When one side of the line reaches the ionization potential, both sides fire simultaneously to ground.

Figure 22 illustrates the application of device staging to a broadcast transmitter high-voltage power supply. As detailed previously for line-voltage ac distribution systems, the staging approach uses the series resistance and inductance of interconnecting wiring to assist in suppressing transient disturbances. The Figure 22 circuit includes two sets of varistors, primary and secondary units. The secondary set is rated for a lower clamp voltage, and, together the varistor groups exercise tight control over disturbances entering the transmitter from the ac utility company input.

Additional transient-suppression devices (CR1 through CR3) and three sets of RC snubbers (R1/C1 through R3/C3) clip transients generated by the power transformer during retarded-phase operation. On the transformer secondary, three groups of RC snubbers (R4/C4a-b through R6/C6a-b) provide additional protection to the load from turn-on/turn-off spikes and transient disturbances on the utility line.

The transient-suppression applications presented here are intended only as examples of ways to build protection into equipment to increase reliability. *Do not attempt to modify existing equipment to provide increased transient-suppression capabilities.* Such work is the domain of the equipment manufacturer. Transient suppression must be engineered into products during design and construction, not added on later in the field.

Device application problems

Building transient-suppression capability into a product is not as easy or straightforward as it might appear. Misapplication of a suppressor can *reduce* equipment reliability, not increase it.

For example, Figure 23 shows two transient-suppression arrangements that should be avoided. In 23(a) the relay contacts of K1 are protected by three spike suppressors. Although this is an acceptable application of the devices, the possibility of suppressor failure always must be considered. The usual failure mode is a short circuit. This being the case, a failure of any two of the three devices shown will cause a single-phasing condition, probably damaging the motor.

A better arrangement is shown in Figure 23(b). Device failure in this configuration will open the circuit breaker, shutting down the system but not destroying the motor. Figure 23(c) shows what appears to be a safe application of a surge suppressor, but when power is applied, the filament transformer-Variac combination can generate turn-on spikes that appear "amplified" at the primary of the Variac because of the step-up action from the secondary to the primary. With the filtering resistors and inductors in the line, the primary will ring at point "A" from the spikes generated in the secondary. Depending on the component values involved, CR1 could be destroyed by these normally occurring transients. An appropriate location for CR1 is shown in Figure 23(d).

Another example of an inappropriate transient-suppression application is shown in Figure 24. Diagram 24(a) shows a protection device placed across the high-voltage-on button of a broadcast

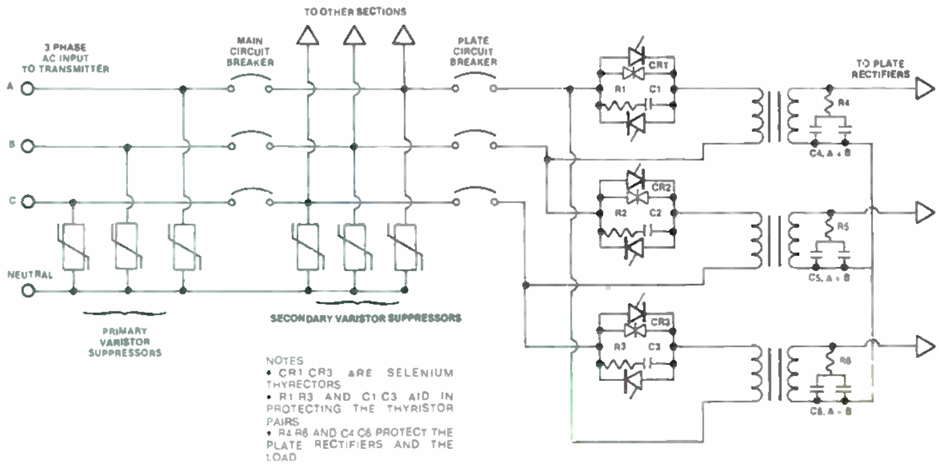
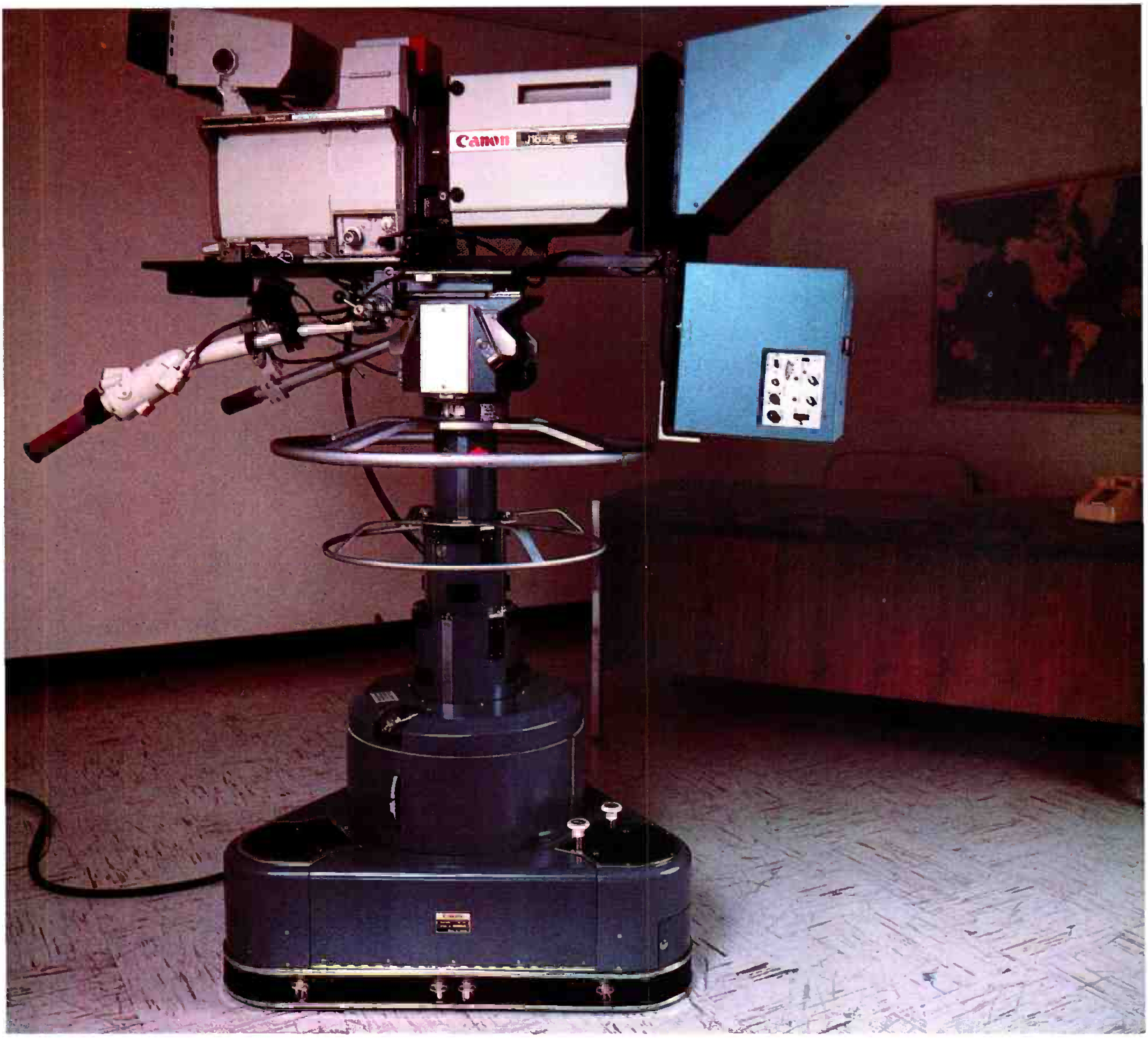


Figure 22. The use of ac system series inductance and resistance to aid transient suppressors in controlling line disturbances in a broadcast transmitter high-voltage power supply.

transmitter. Although this arrangement will extend the life of the switch contacts (especially if the button is switching 120Vac or 208Vac), failure of the device could prevent the transmitter high-voltage supply from being turned off in the event of an overload. Serious equipment damage could result. Figure 24(b) shows a preferable transient-suppression arrangement, in which the protection device is placed across the relay coil. Failure of the device in this configuration would shut down the transmitter and prevent any further damage.

It is important to choose the correct application of a transient-suppression device and to select one capable of carrying the transient energy that will be present in the circuit as well. This point is illustrated by the application shown in Figure 20(d) for telco audio or data loops. In the circuit, two General Semiconductor No. 1.5E12CA protection devices are tied between ground and the telco loop. The devices used will clip at about +20dBm, more than the maximum audio level expected on the line.

In an actual application of several pairs of these devices, however, it was found that, after several months of service, some of the suppressors began to fail. Those failures surfaced because of continual overstressing of the components caused by telephone company fault conditions. Voltages normally used in the dial-up telco network typically run about −48V and could destroy the specified protection devices, depending on where the crossed lines occurred. The symptom noticed on the telco loops was increased noise, a result of the unbalanced condition created by the failure (in a short-circuit mode) of one of the transient suppres-



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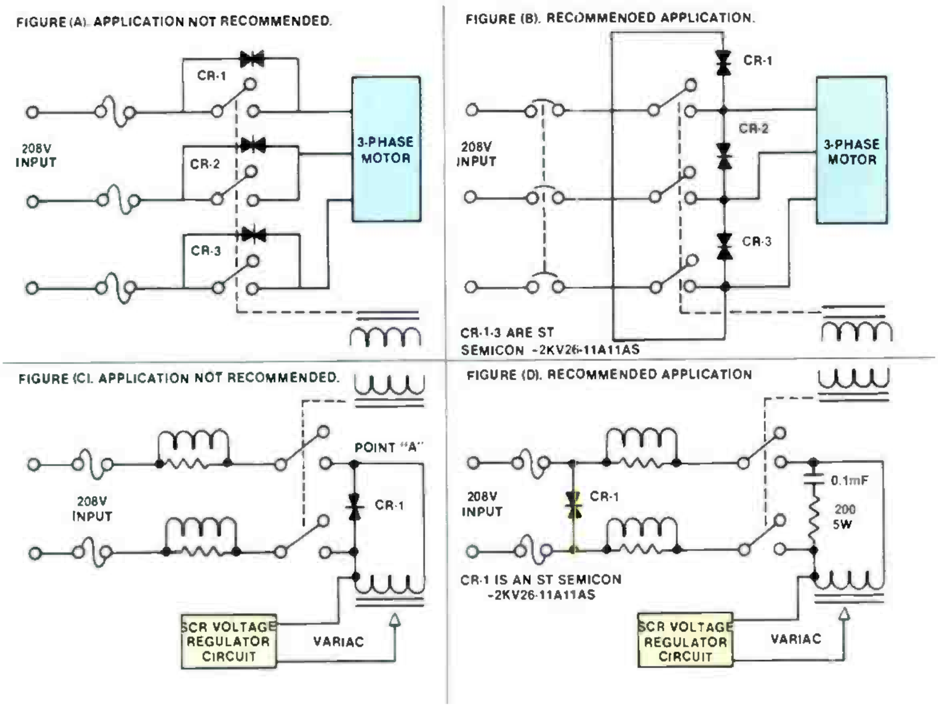

Figure 23. *Transient-suppression circuit arrangements that should be avoided (a) and (c), and the alternate configurations that provide fail-safe operation (b) and (d). The application of any transient-suppression component must be considered carefully, keeping in mind the various modes of operation and the possibility of protection-device failure.*

sors between a given line and ground.

The problem in this application was not with the protection device, but with the telephone company, which repeatedly crossed dial-up network voltages onto audio loops. In light of this situation, the dissipation rating of the protection device must be increased to deal with the failure modes that were observed to occur at the facility.

Plan ahead

Transient disturbances are a fact of life. The power quality in the United States is not improving. With increased loading and diminished reserves in some areas, it is becoming worse. Broadcasters will have to pay the bill for transient disturbances one way or the other—either for protection hardware or for equipment maintenance after the fact.

There is nothing magical about effective transient suppression. Disturbances on the ac line can be suppressed if the protection method applied has been designed carefully and installed properly. Whether the protection method your station chooses involves a systems approach or discrete devices at key points

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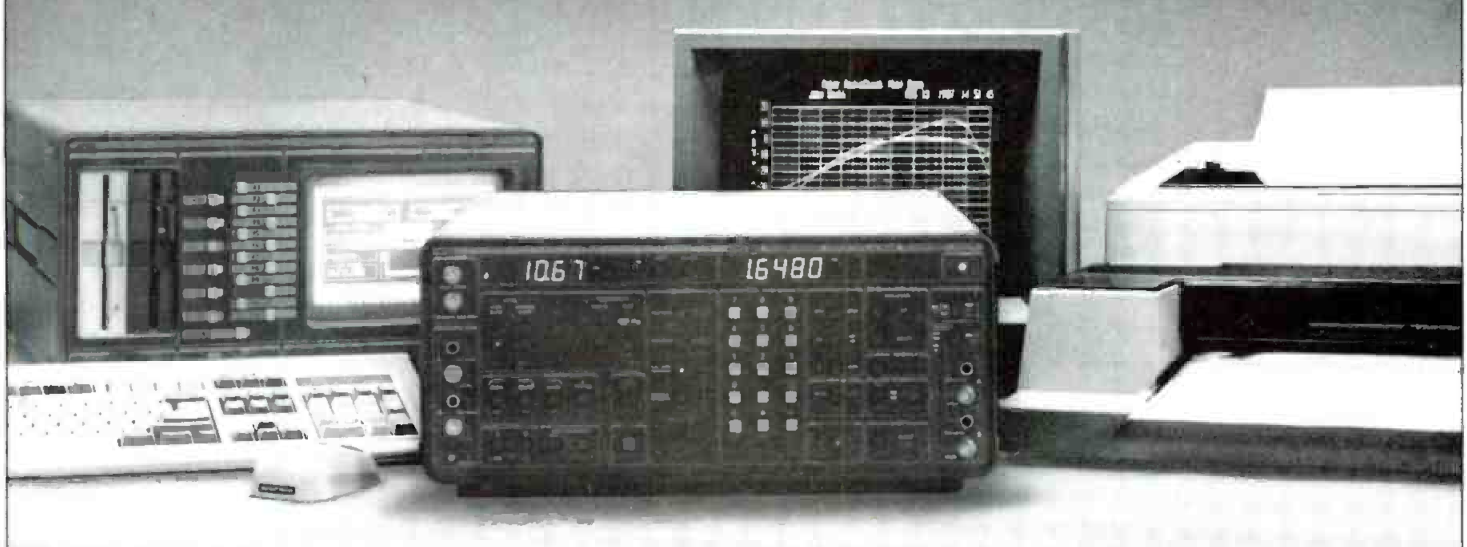

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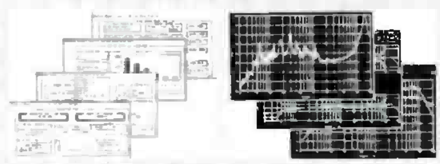
DEMO DISK AVAILABLE An AudioCheck™ demonstration disk and manual with all features except GPIB commands are available for your evaluation. System requirements: MS-DOS computer with 640k RAM and CGA monitor card. Send $10 for your copy.



XY graphs and messages can be intermixed. Hard copy reports on dot matrix printers or multi-color pen plotters can incorporate all of these attributes. Linear and log sweeps with easy selection of range and parameters, even sophisticated asynchronous, reciprocal and adaptive sweeps with complex settling alogrithms are just a few keystrokes.

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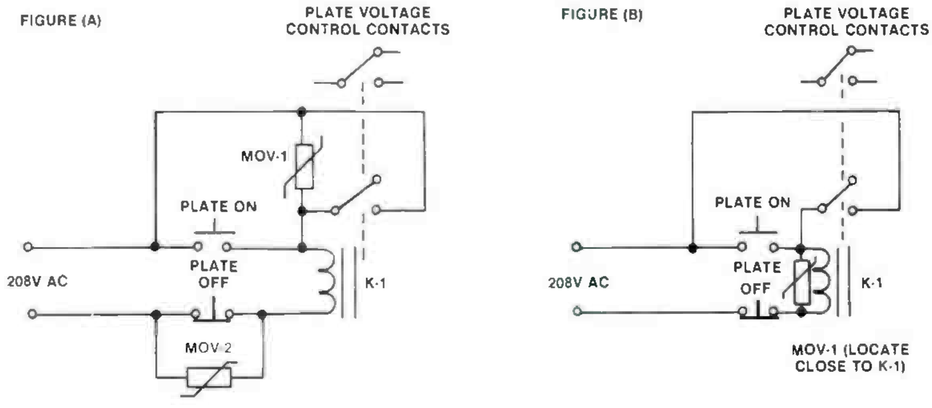

Figure 24. *A transient-suppressor application that should be avoided (a), and the proper method (b) of suppressing switch contact arcing in a transmitter control system. In any application, the consequences of protection-device failure (generally in a short circuit) must be considered.*

in the broadcast plant, the time and money spent incorporating protection into your facility will yield a good return on investment.

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2

The commission is watching

By Brad Dick, radio technical editor

Fewer regulations may mean tougher enforcement.

"Hi, I'm from the FCC and I'm here to help you."

FCC engineers probably don't greet station engineers and managers quite this way, but in this era of relaxed restrictions, it doesn't seem as far-fetched as it once might have. With deregulation, unregulation or reregulation (whatever you want to call it), the commission has assumed a quieter role. Of course there are rules to be followed, but far fewer than before. The number of field inspections also has been greatly reduced. However, some stations have found out the hard way that inspections still take place, and violations still bring fines.

Out with the old

The relaxation of regulations, which means fewer logging and inspection requirements, has caught some stations off guard. Many smaller stations no longer have full-time engineers. Consequently, a potentially troublesome technical matter might go unnoticed and eventually wind up as a problem that results in a violation notice. Even larger stations are not immune to the long arm of the commission.

The reduction of logging and inspection requirements is generally welcomed by the industry. Logs, for the most part, are a thing of the past. The required technical inspection is another task that engineers aren't sorry to see eliminated. Many of the deregulatory changes are simply reflections of modern technology. When was the last time your FM transmitter drifted in frequency by more than 100Hz? How about the transmitter power level? Is it automatically controlled? Today's equipment is just more stable and reliable than when many of the old rules were implemented.

Even so, stations must continue to meet the remaining applicable FCC requirements. One drawback to fewer regulations seems to be that the commission is now strongly enforcing the remaining ones. The emphasis is on compliance. It is more important than ever to know the rules and to follow them carefully.

TABLE 1. SAFETY VIOLATIONS

1. All tower lights out, FAA not notified within 30 minutes as required. *17.56, 17.48, 73.1213* ($2,000)
2. Majority of tower lights out and/or loss of top flashing beacon, FAA not notified within 30 minutes. *17.56, 17.48, 73.1213* ($1,000)
3. Tower lights not observed at least once each 24 hours. *17.47, 73.1213* ($500)
4. Temporary warning lights not present/operational during construction. *17.45, 73.1213* ($1,000)
5. Tower not properly painted, e.g. not the required color bands. *17.50, 73.1213* ($750)
6. High RF voltage at antenna base, hot base at antenna towers not enclosed, damaged fence allowing entry. *73.49* ($1,000)
7. High-voltage equipment not protected so as to prevent injury to operating personnel, damaged interlock, exposed wiring. *73.49, 73.317(b)* ($750)
8. Failure to conduct EBS tests. *73.961* ($300)
9. EBS monitor receiver and/or tone generator not operational or not installed. *73.932* ($1,000)

A matter of policy

To stress the importance of following the rules still in effect, the commission issued a memorandum in December 1985 that outlines a basic policy for field offices in the issuance of violation notices. The policy also suggests specific fines for certain violations.

The memorandum outlines a tiered enforcement program for rule violation of Parts 73 and 74. Under the policy, a *notice of radio station conditions* (FCC form 790) is issued for minor technical matters. This first-level notification concerns infractions that are not as serious as rule violations, but are likely to become violations or cause problems if left uncorrected. A notice also can be issued for minor technical rule violations that have little potential for adverse effects on others or on signal quality. No licensee response is required for this notification.

The second, and more serious, level is the *official notice of violation* (FCC form 793). This notification requires a response from the licensee. It may be issued when the technical violations are more serious than those for which a form 790 would be issued, but are not specifically designated in the policy statement and do not fall under the general categories of safety, interference-harm actual/potential or service quality violations. A notice of violation also can be issued for other specific technical rule violations designated by the mass media bureau.

The third, and most serious, notification level is the *notice of apparent liability* (NAL). This notice is issued for the willful or repeated violation of:

- Specific technical rules detailed in the memorandum.
- Technical rule violations more serious than would be appropriate for issuance of form 790 and which fall into the general categories of safety, interference-harm actual/potential, or service quality violations.
- The specific administrative and non-technical rule violations described in the policy statement.

Pay up

The process of fining a station can be

Continued on page 92

TABLE 2. INTERFERENCE-HARM ACTUAL/POTENTIAL

1. Overpower operation, frequency tolerance, excessive modulation resulting in interference, spurious and/or harmonic emission. *74.636, 74.661, 73.1560, 73.1545, 73.1570, 73.44, 73.317, 73.687* ($1,000 to $2,000)
• Examples:
Output power grossly exceeding the authorized power. ($1,000)
Where numerous complaints occur or where deliberate or malicious interference occurs or where significant harm is caused. ($1,500 to $2,000)

2. Failure to cease operation by remote control when a malfunction occurs in the remote-control system. *73.1410* ($300)

3. Failure to ensure correct calibration of remote antenna base, common point and extension meters, e.g. meter readings are grossly out of tolerance from licensed parameters. *73.57, 73.1550* ($300)

4. AM directional antenna systems tolerance, e.g. base and sample currents are grossly out of tolerance from licensed parameters. *73.62* ($600 to $1,500)
• Examples:
Discrepancy in AM directional parameters (as evidenced by more than 5% deviation of actual base and antenna monitor currents from licensed values) resulting from significant misreading of meters, e.g. wrong scale. ($600)
AM directional parameters grossly exceeding licensed values due to improper equipment installation. ($1,500)

5. Failure to make field strength measurements quarterly at the monitoring point locations for stations not having an approved sampling system. *73.61* ($600)

6. Terms of authorization, e.g. operating non-directional when directional is required, failure to change power at sunset and sunrise, for an extended period of time. *73.1745* ($1,000)

7. Station operating under post-sunset authority. *Docket No. 82-538*
• Examples:
Operating 50% over power. ($1,000)
Operating one-half hour or longer after the station was required to sign off under the post-sunset authority. ($1,000)

TABLE 3. ADMINISTRATIVE AND NON-TECHNICAL

1. Failure to maintain or have a complete public inspection file. *73.3526* ($300)

2. Failure to have a licensed operator on duty. *73.1860* ($200)

3. Willfully or repeatedly incorrect on entries, e.g. readings repetitively logged when the meter is defective. *73.1800* ($1,000)

4. The commission has reduced or eliminated the logging requirements detailed in a Report and Order dated August 12, 1983, Docket No. 82-537. However, it has maintained some logging requirements, and forfeitures will be imposed for failure to log the following:
• Tower lighting operation. *17.49, 73.1213* ($300)
• Experimental Broadcast Stations in Part 74. *74.181* ($300)
• AM broadcast stations operating without commission-approved antenna systems. *73.1820* ($600)
• Situations involving interference or deficient technical operation. FCC may require special technical records to be maintained, as necessary, to resolve special problems. *73.1835, 74.19* ($600)
• Tests of the emergency broadcast system. *73.1820* ($300)

5. Repeated failure to reply with assurance of correction/repair for violations listed on *notice of apparent liability. Section 308(b) of the Communications Act of 1934, as amended* ($1,000)

6. Failure to identify the station in the manner and at the times specified. *73.1201* ($500)

7. Minor technical, administrative and operation rules where the forfeiture penalty will result for repeated violation subsequent to initial violation where Form 790 notification occurred.
• Examples:
Failure to have available the EBS checklist. *73.908* ($300)
Failure to have available the EBS authenticator word list. *73.910* ($300)
Defective meters, improper scale/range, all powers. *73.1215* ($300)
Failure to have available a copy of the most recent antenna resistance or common point impedance. *73.1225* ($500)
Station and/or operator(s) license(s) not posted. *73.1230* ($200)
Failure to designate a chief operator (agreement not available or posted with operator license or in station records). *73.1870* ($500)

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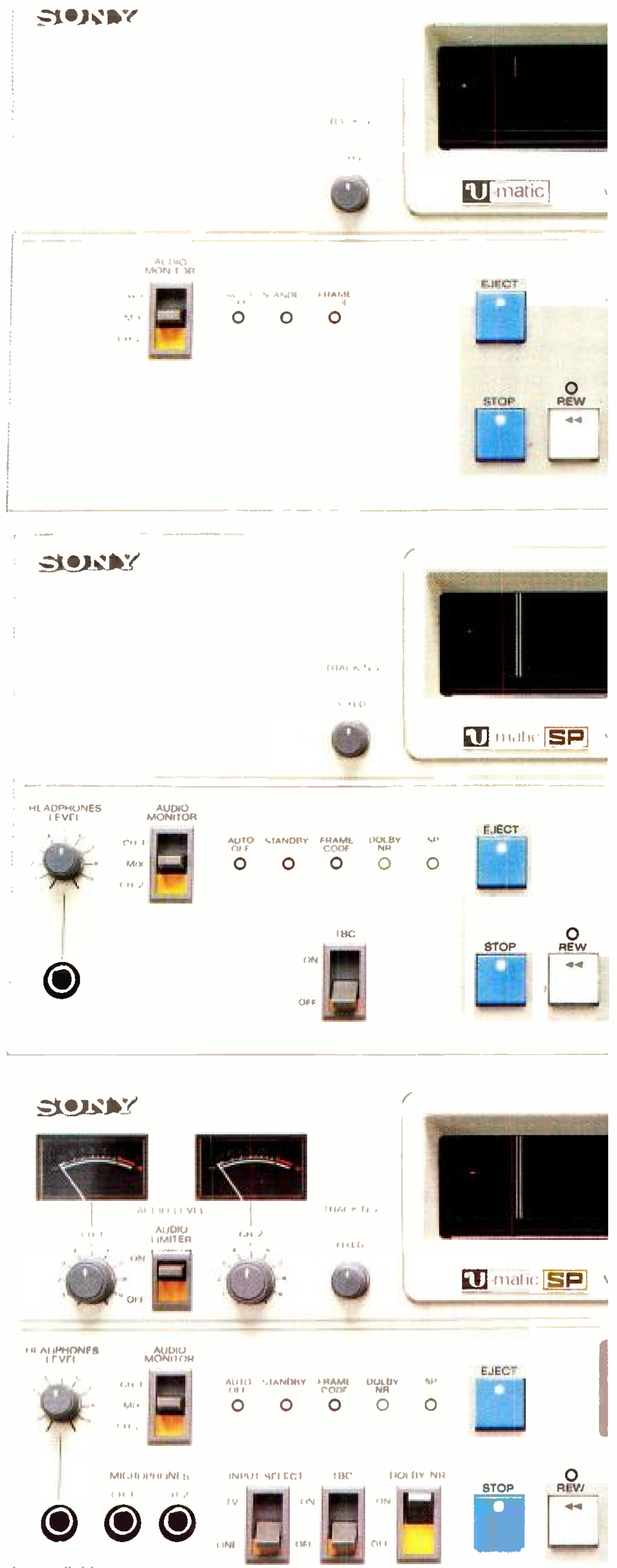

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SONY

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TABLE 4. SERVICE QUALITY

1. TV pulse and reference levels. ($500)
2. FM stereo parameters. ($500)
3. SCA parameters. ($500)
4. AM audio performance requirements. ($500)
5. Excessive AM or FM modulation. ($500)

Continued from page 88

quite lengthy. If, upon inspection, the engineer in charge issues a NAL, the station has 30 days to respond to the notice. The NAL specifies the fine that could be levied for the cited violation.

The station can request a review of the NAL prior to the issuance of a *notice of forfeiture* (NOF). The field supervisor will review the NAL and inform the station of the determination. A higher-level review can be requested if a NOF is issued. At this point, the fine can be reduced or even canceled.

If a NOF is issued, the station has several options. The station can appeal the decision to the field engineer or chief of the field operations bureau. At this stage, if the NOF is judged to be correct, the station is ordered to pay the fine. If the station decides to pursue the matter, the commission may file a civil suit for collection of the fine. The process then passes to the courts. Both the FCC and the station present their cases before a U.S. District Court judge, who then issues a ruling. If the court rules against the station, an order for civil collection of the fine is issued.

Monetary fines are not always levied. Other administrative sanctions may be applied as deemed appropriate.

What's the cost?

Specific fines to be levied are listed in the FCC memorandum. Only in those cases involving mitigating circumstances may fines be adjusted by the field offices. However, the engineer in charge may increase or decrease the fine, with justification. The amount doubles for a second offense.

The listed violations are broken down into four categories: safety (see Table 1), interference-harm actual/potential (Table 2), administrative and non-technical areas (Table 3) and service quality (Table 4).

Each table lists specific rule violations, the applicable FCC regulation number for each and the fine to be levied. Some are further broken down with examples and appropriate fines. This material was taken from the December 1985 memorandum issued by the chief of the mass media bureau.


CONRAC
DEGAUSS POWER
PHASE
CHROMA
BRIGHTNESS
CONTRAST
SYNC
INPUT

3

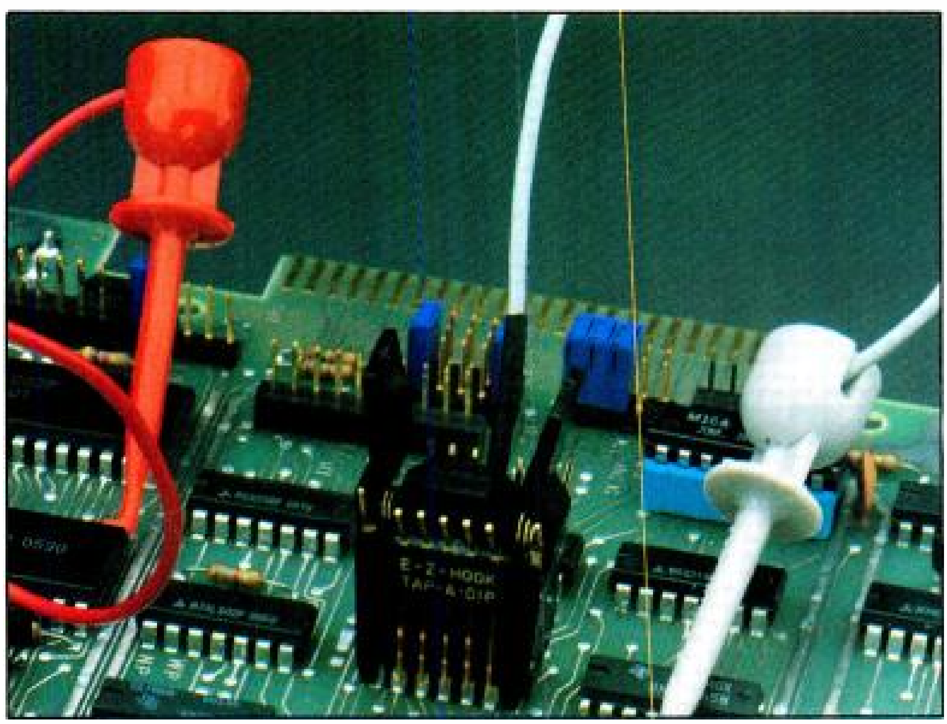
Using digital oscilloscopes

By Ed Caryl

Today's digital scopes can be powerful tools for the broadcast technician.

Maintaining the video and non-video circuits in a broadcast station today presents a wide range of technical challenges. Only a variety of test and measurement instruments can solve the problems a technician will face. Special needs require special instruments. Recent advancements in digital technology have made the digital oscilloscope a viable competitor with traditional analog scopes. Both types, however, have their strong points and weak points. The selection and use of a digital scope requires a full understanding of its operation and specifications.

Caryl is a technical communications manager with Tektronix, Beaverton, OR.



In a typical TV plant, maintenance work requires the following test and measurement equipment:

- A waveform monitor for making quick and easy video-signal level and timing measurements.
- A vectorscope for displaying, in familiar polar coordinates, video-signal phasing.
- An analog oscilloscope for displaying high-repetition-rate signals—video and non-video—in real time, in the studio or in a mobile unit.
- A digital scope for storing waveforms in local memory or sending them to another unit for analysis or comparison.

You probably are familiar with the many advantages of waveform monitors, vectorscopes and analog oscilloscopes. You may be less familiar with the advantages and unique features of new digital scopes for special video and non-video signal measurements. Figure 1 summarizes the advantages and capabilities of these four major waveform test and measurement tools for television.

All these tools are evolving. For exam-

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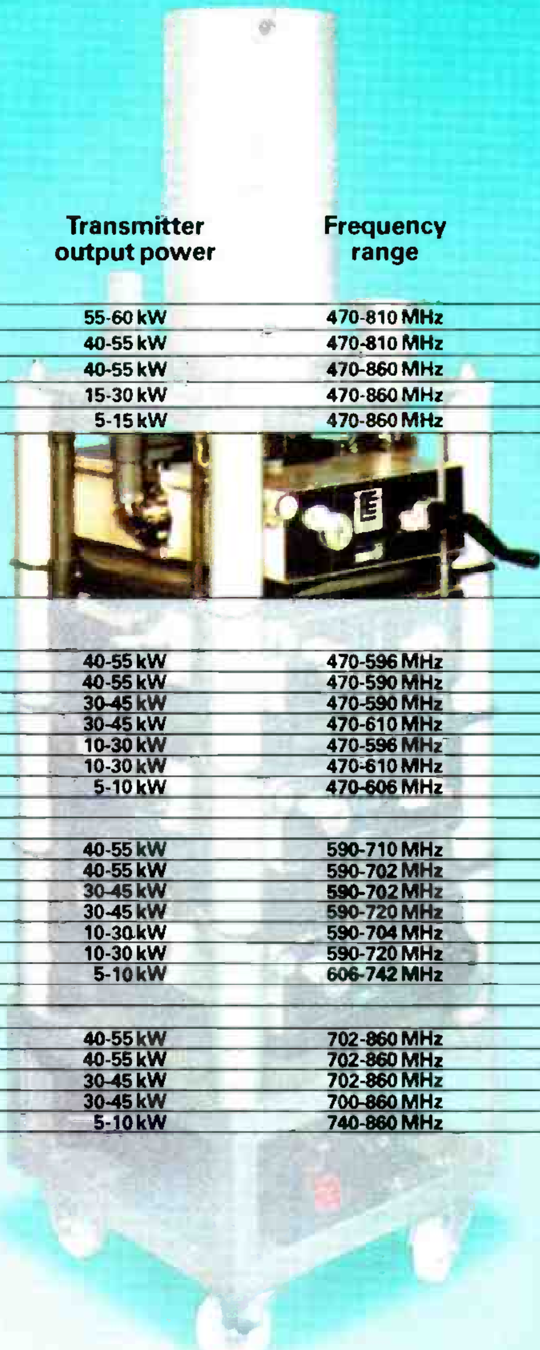

	Transmitter output power	Frequency range	Typical Sync efficiency
WIDEBAND SERIES			
K3672BCD	55-60 kW	470-810 MHz	44% to 48%
K3572BCD	40-55 kW	470-810 MHz	43% to 46%
K3272WBCD	40-55 kW	470-860 MHz	42% to 45%
K3271BCD	15-30 kW	470-860 MHz	42% to 47%
K3270BCD	5-15 kW	470-860 MHz	42% to 47%
STANDARD SERIES			
Low Band			
K3276HBCD	40-55 kW	470-596 MHz	38% to 43%
K3382BCD	40-55 kW	470-590 MHz	38% to 42%
K3217HBCD	30-45 kW	470-590 MHz	40% to 42%
K3282BCD	30-45 kW	470-610 MHz	30% to 40%
K3230BCD	10-30 kW	470-596 MHz	40% to 42%
K376L	10-30 kW	470-610 MHz	34% to 40%
K370/W series	5-10 kW	470-606 MHz	29% to 35%
Mid Band			
K3277HBCD	40-55 kW	590-710 MHz	38% to 43%
K3383BCD	40-55 kW	590-702 MHz	38% to 42%
K3218HBCD	30-45 kW	590-702 MHz	40% to 42%
K3283BCD	30-45 kW	590-720 MHz	30% to 40%
K3231BCD	10-30 kW	590-704 MHz	40% to 42%
K377L	10-30 kW	590-720 MHz	38% to 45%
K371/W series	5-10 kW	606-742 MHz	32% to 35%
High Band			
K3278HBCD	40-55 kW	702-860 MHz	38% to 43%
K3384BCD	40-55 kW	702-860 MHz	38% to 42%
K3219HBCD	30-45 kW	702-860 MHz	40% to 42%
K3284BCD	30-45 kW	700-860 MHz	30% to 40%
K372/W series	5-10 kW	740-860 MHz	32% to 35%

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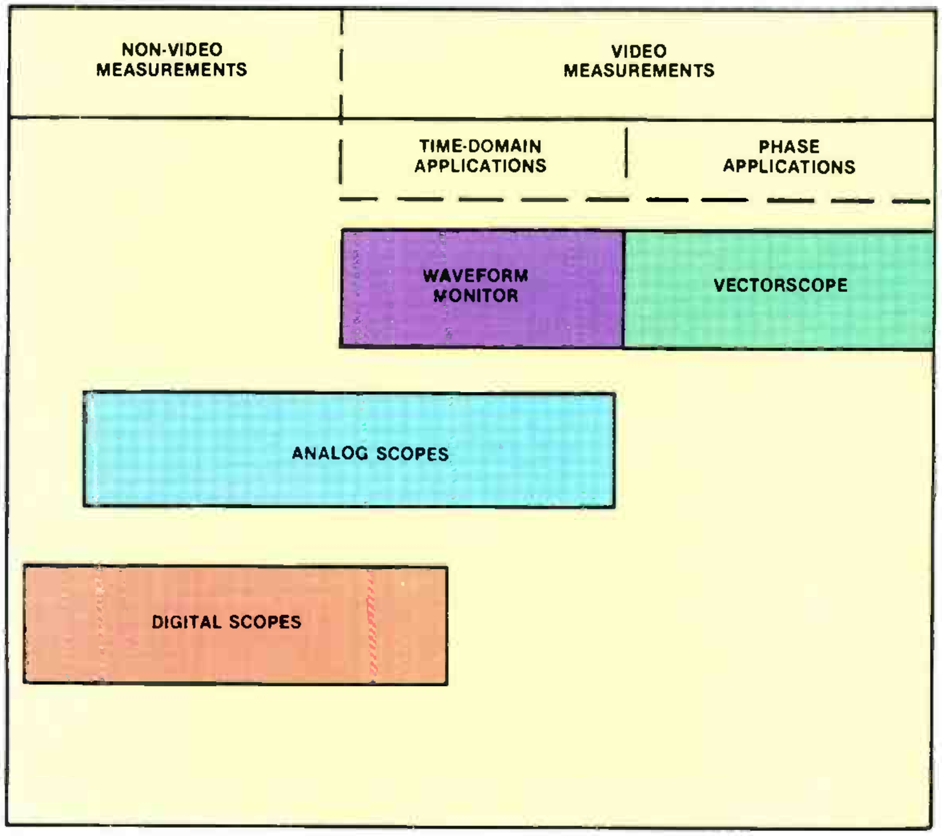
Figure 1. A quick comparison of TV studio test and measurement equipment (a), and a detailed look at the advantages and features of four major types of TV measurement equipment (b).



ple, vectorscopes and waveform monitors now are available in portable, even battery-powered, packages. Combined waveform monitors and vectorscopes also are available. Analog scopes are adding capabilities formerly found only in digital scopes, such as automatic amplitude and time measurement.

Digital scopes for special needs

New digital scopes offer advanced features that allow maintenance engineers to handle special problems that were difficult, or even impossible, to solve in the past. In the engineer's tool kit, digital scopes can be a welcome addition to the proven value of waveform monitors, vectorscopes and analog scopes. Figures 2 and 3 illustrate the major scope technologies.

After a digital scope has digitized a test signal, it can store the waveform in memory or send the waveform to another device. Local (in-scope) storage allows you to save a known-good waveform at one test site, acquire a possibly faulty waveform at another site and compare the two on-screen for a quick pass/fail test. With battery-backed memory, portable digital scopes can store a complete set of comparison waveforms for months. (See Figure 4.)

Digital scopes can make some special measurements that analog scopes cannot make unless they use *microchannel plate* (MCP) display technology. MCP is an electron-multiplier device located behind the screen phosphor. The MCP amplifies cathode ray tube (CRT) beam current, producing a high CRT writing rate.

A digital scope allows you to display—at full brightness—the waveform of a low-repetition-rate signal, such as single lines or parts of lines at the color field rate.

Video maintenance today typically includes checking many digital signals, such as digital effects, computer-generated video and digital video switching pulses. These operations use complex signals and single pulses that may occur only once per frame or once per color field. Pulses such as VCR servo control signals, which are a few nanoseconds wide and occur 15 to 30 times per second, are difficult to see on almost

TEST AND MEASUREMENT TOOL	MAJOR ADVANTAGES	EXAMPLE UNIQUE CAPABILITIES
WAVEFORM MONITOR	Allows quick, easy visual checks of video signals; dedicated to video measurements.	Front-panel and display graticule are optimized for specific TV measurements.
VECTORSCOPE	Provides a high-resolution vector display of chrominance phase and amplitude.	Demodulates color video, and displays phase and amplitude of chroma components.
ANALOG SCOPE	Measurement versatility provides a video and non-video general-purpose tool.	High display rate allows user to see infrequent changes in high-repetition-rate signals.
DIGITAL SCOPE	Can apply signal averaging to reduce signal noise for more exact measurements. Can display low-repetition-rate signals at normal brightness.	Captures, stores, and transfers waveforms. Envelope mode allows measuring peak-to-peak noise and chroma levels.

any analog scope. They can be viewed easily, however, on a digital scope.

Vertical interval test signal (VITS) and vertical interval reference signal (VIRS) waveforms occur at the frame rate. These signals are difficult to see on most analog scopes. (MCP analog scopes are the exception to this rule.) Triggering on individual lines in a field is another barrier for most scopes in video applications. However, an analog or digital scope with advanced TV triggering capabilities can use VITS and VIRS to troubleshoot or adjust video equipment using the broadcast video signal. Figure 5 shows an example waveform.

Some analog and digital scopes can trigger on a specific line in a specific field. The readouts at the top of the digital scope display of Figure 5 show that the scope is triggering on the horizontal sync pulse negative edge of line 70 in field 2.

A digital framing pulse occurs 29μs into line 70, field 2, so the user has delayed time base B by 29.3μs into line 70 to display the pulse for detailed examination. The upper trace (channel 1) shows a digital framing pulse. The user has set the cursors to measure the pulse width (73.500ns). Because of its low repetition rate, this narrow TTL pulse would not be visible on analog scopes that don't use MCP technology.

Digital scopes can end another headache—the need to continuously watch a display for an intermittent error or failure. You may need to watch a waveform for interference hits in the transmission system. You also may need to look for arcs within various stages of the transmitter, high-power filters, transmission line or broadcast antenna.

Consider the following example. You are using a scope that has a "baby-sitting" feature. First you display the normal waveform, then you build an envelope of limits around the target waveform. A spike on the test waveform or drift beyond the specified limits causes the scope to store the data in memory or to document it on a printer or plotter.

While the scope baby-sits the signal, you can attend to more challenging tasks or simply finish your work at a reasonable hour. Figure 6 shows a baby-sitting example. The screen display illustrates the horizontal sync pulse and the rising edge of the VITS on line 17, field 2. (To simplify the display, this example shows a black-and-white signal.) The envelope around the signal sets acceptable amplitude limits above and below the expected values. If the test signal exceeds the envelope, the scope captures the waveform, stores it and outputs it to a printer.

You have another choice, too. You can send a waveform from the scope to com-

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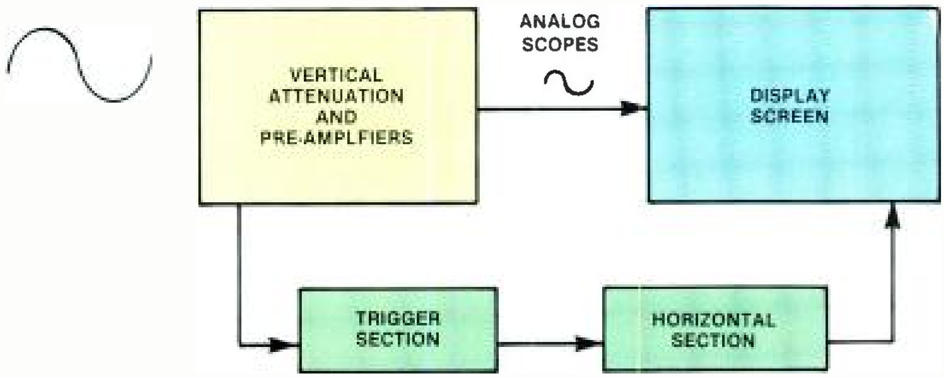

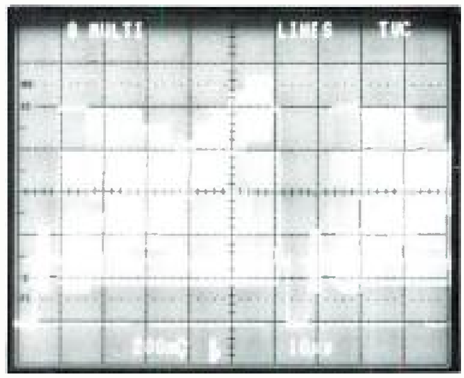

Figure 2. Simplified block diagram of an analog oscilloscope (a). The display shown in (b) is from an analog scope triggered on all TV lines. It illustrates three waveforms: color burst, a staircase and red bar. The photo demonstrates the analog scope's capability to display a waveform from any point in a TV system. (At the top of the screen, the readouts reveal that the front-panel setup for this display was saved in the eighth setup, the setup was named MULTI, the scope is triggering on all TV lines and the TV clamp is on.)

puter memory or to another peripheral device. At your leisure, you can recall the waveform for re-examination, comparison to other waveforms or identification of long-term performance trends.

Automating test procedures

Programmable signal generators and digital scopes can be integrated into computer-controlled systems that automate and speed maintenance procedures. For example, a controller, scope and companion test-generator program allow maintenance engineers to generate—without writing any code—a test procedure for a wide variety of broadcast hardware, such as the servo section of a video recorder.

Such automated test procedures combine two sources of troubleshooting knowledge: the manufacturer's recommendations contained in the service manual and your own experience working with the equipment. With the proper test procedure stored on a PC (the controller), an engineer who is less experienced with a given piece of equipment can follow the troubleshooting routine step by step, attach the scope probes to the proper test points, and let the program make the pass/fail and branch decisions.

Still another dimension that digital scopes can add to automated test systems is the capability to transfer captured waveforms to the PC for display or analysis.

The most advanced digital (and analog) scopes allow you to create test sequences on the scope front panel. You don't need a controller, and you can store a large

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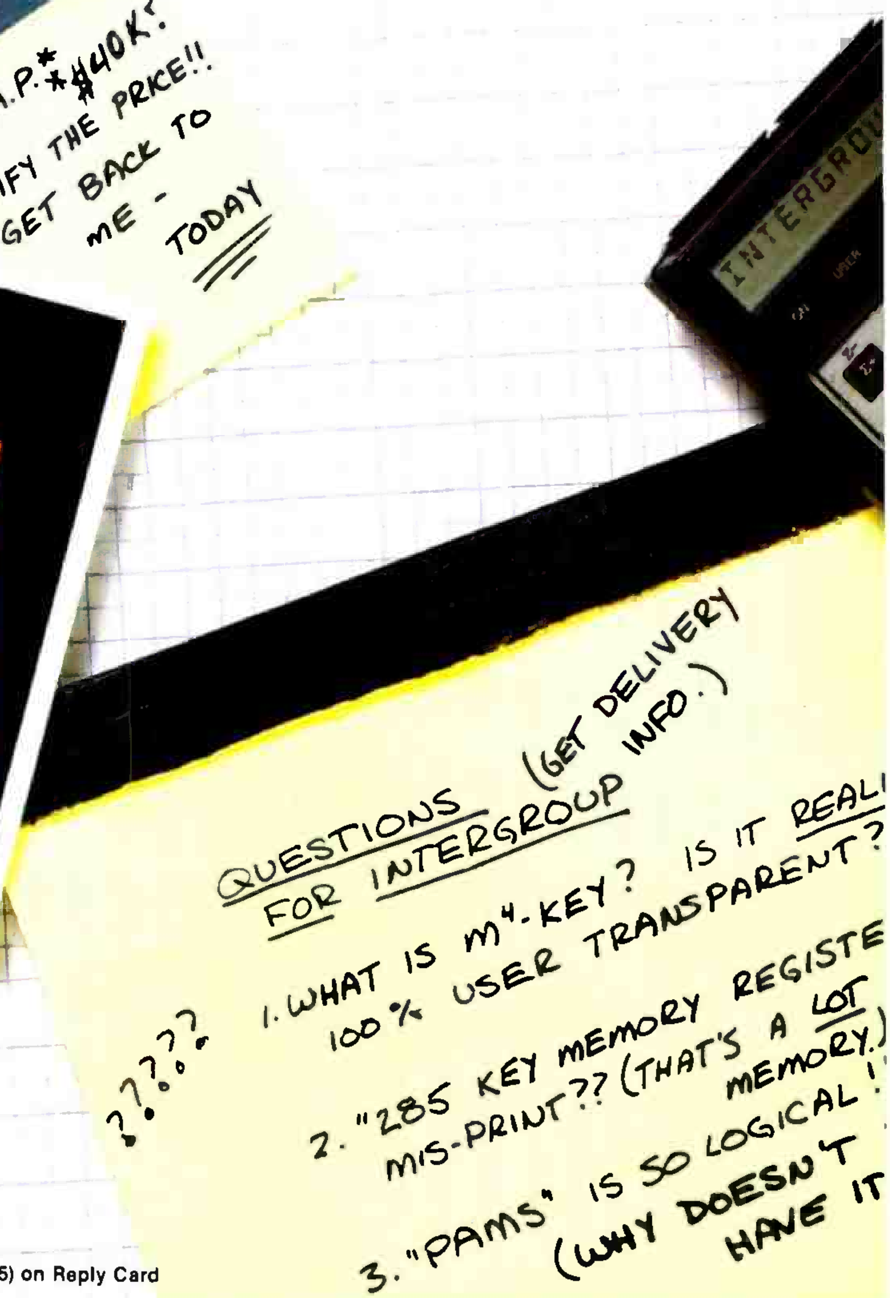

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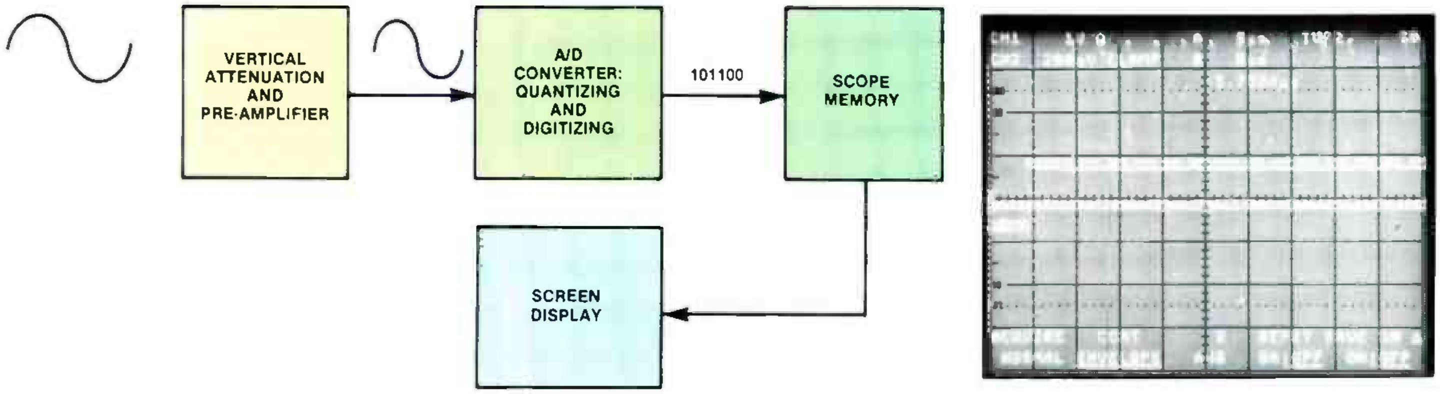

__Figure 3.__ Simplified block diagram of a digital oscilloscope (a). The display shown in (b) is from a digital scope set to measure part of line 70, field 2. The upper trace (channel 2) shows the video component of the signal. The lower trace (channel 1) reveals, in the scope's envelope mode, a digital framing pulse peak (lower center). A unique feature of digital scopes, this mode shows waveform maximum and minimum points (peaks).

number of steps (up to 200 is not uncommon). Each step consists of a front-panel setup or scope action or both. The setup can be complete for a particular measurement, including presetting measurement cursors. The setup may include acquiring a waveform and sending it to a printer or plotter.

This level of automation improves throughput, increases repeatability, reduces drudgery and minimizes the potential for operator error. Figure 7 shows an example system designed using standard programmable video test and measurement instruments. An IEEE standard 488 GPIB (general-purpose interface bus) cable connects the instruments to the PC.

Limitations

In some digital scope applications, aliasing may occur. (See Figure 8.) Aliasing results from undersampling: the scope acquires too few sample points to accurately capture the signal being measured. Chroma bursts often are aliased in digital scope displays of video waveforms.

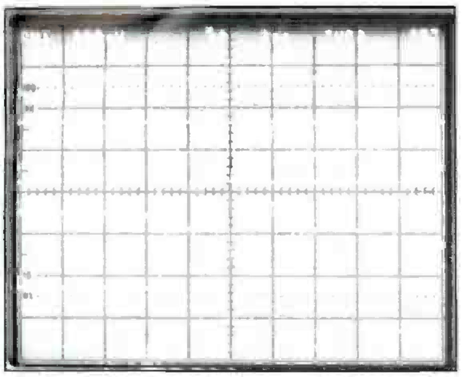

Figure 4. A digital scope has the capability to store and redisplay a waveform. The display shown here compared a stored reference waveform (REF 2) in the lower trace with a real-time sync and burst waveform from line 257, field 2, in the upper trace.

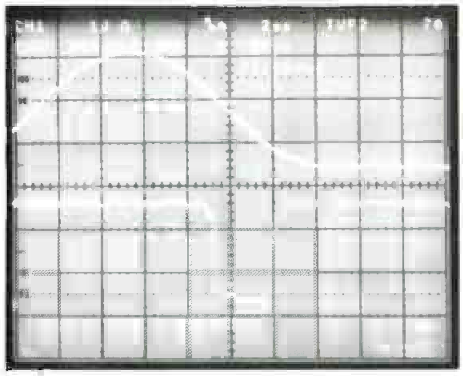

Figure 5. A digital scope display showing the capability of triggering on a specific line in a specific field. Note that the digital scope can display a waveform of low repetition rate at full brightness.

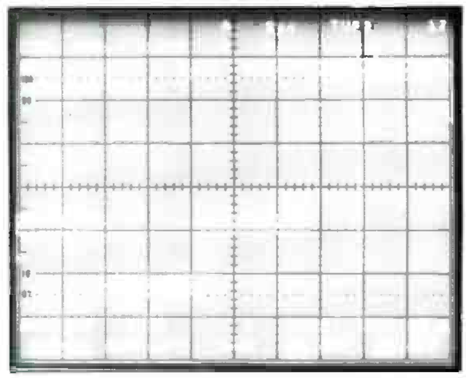

Figure 6. A display showing a user-defined envelope of test limits around a real-time waveform.

In some applications, the problem with aliasing is that the operator is unaware it is occurring. Scopes with advanced features offer an easy way to check for aliasing. In one approach, the *envelope mode* records the minimum and maximum values at each point, providing an outline of the true waveform. This information alerts the operator that aliasing is occurring on the displayed waveform.

Two techniques prevent aliasing. Digital scopes that use *vector* displays interpolate between sample points and connect them with straight lines (vectors). Increasing the scope sweep speed more directly reduces aliasing because more sample points are displayed.

Key digital scope specifications

Many of the key specifications for digital oscilloscopes are similar in nature to those for analog units. However, several of the following specs, unique to digital scopes, are important to consider during the selection process.

- *Bandwidth and sampling rate:*

These two specifications are related,

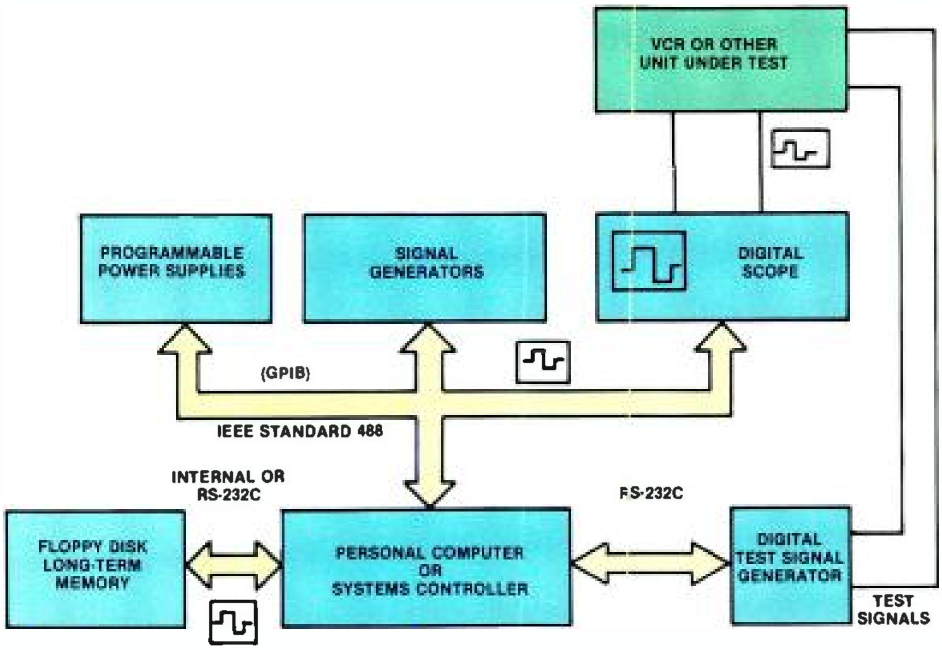

Figure 7. *A simplified block diagram of a PC-based, modular automated test system that uses a digital scope for waveform acquisition, processing and transfer.*

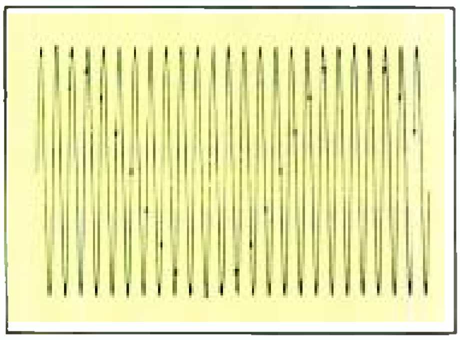

Figure 8. *An illustration of the problem of aliasing in digital oscilloscopes. Aliasing can be thought of as an optical illusion. If the scope takes too few samples to accurately define the applied signal frequency, the user can see a waveform that apparently has a lower frequency.*

but not identical, digital scope parameters. *Bandwidth* is the range of frequencies a scope can acquire and display with less than 3dB attenuation. Digital scope manufacturers specify bandwidths for two conditions, *repetitive* and *single-shot* (single-event) acquisitions.

For repetitive acquisitions, the bandwidth often is called *analog bandwidth* or *equivalent-time bandwidth*. This specification is the bandwidth of the scope's analog signal path.

Single-shot bandwidth is the bandwidth of the scope when it makes only one acquisition, whether the test signal is repetitive or single-event. This specification depends on three factors:

1. The sample rate of the instrument.
2. The type of interpolation used to reconstruct the signal.
3. The number of coefficients used to perform the interpolation.

- *Useful storage bandwidth* (USB):

USB is a valuable way to observe the capability of a digital scope to display sine waves. USB is the maximum digitizing rate divided by the number of samples the scope needs in order to properly display a sine wave.

The digitizing rate is the number of samples that the scope acquires per second (a common number is 100 megasamples/second). The number of samples needed to display a sine wave depends on the type of interpolator the scope uses. (An interpolator adds data words between the sample points.)

- *Averaging and smoothing:*

These two waveform processing techniques make signal viewing easier. Averaging works on multiple acquisitions of samples of the signal under test. This feature numerically averages the vertical (voltage) values for each time point on the waveform over the number of acquisitions chosen by the user. Averaging reduces random noise in repetitive signals and increases effective resolution.

Smoothing reduces noise on single-shot acquisitions of the signal under test. Smoothing firmware examines several points at once on an acquisition, then processes the set of values to reduce noise.

Selecting an oscilloscope

The selection of an oscilloscope—analog or digital—should be made only after all of the pertinent facts have been examined, and the cost vs. benefits of each approach have been studied. When planning such a purchase, consider the following recommendations:

- *Define your application.* Digital scopes are appropriate for many non-video applications in a TV broadcast facility. They also are well-suited for some special video needs.
- *Examine your needs.* What kinds of non-video measurements will you be making? Single-shot or repetitive? At what frequencies? How faithfully do you need to reproduce the signal? What is the required accuracy and resolution?
- *Know whether the scope is user-friendly.* Capitalize on your familiarity with analog scopes. Some digital scopes have front-panel designs similar to popular analog units. Others combine analog (non-storage) and digital (storage) features in one unit. Find a unit that you are comfortable operating. Familiar operation can make your maintenance work more efficient.
- *Study the specs.* Take time to understand the key specifications of the units you are considering. For digital scopes, the terms sample (digitizing) rate and useful storage bandwidth may be new to you.
- *Look for easy-to-use features.* Digital or analog scopes with advanced features cut drudgery, save time and improve results simply because they are easier to use. For example, on some scopes, you can attach probes to a test point for an automatic display of several cycles of an unknown non-video signal. The scope sets itself up at the touch of one button. Another example is the capability to select specific measurements from an on-screen menu. The scope makes the measurements automatically and displays the numerical results alongside the waveform.
- *Consider the video applications.* Look for scopes designed to work with video. Some digital scopes have options that enhance the unit's performance when it displays a video waveform. An effective digital scope for video applications should include:

1. A sync separator capable of triggering the scope on any line in either field.
2. Backporch clamp circuitry.
3. The capability to work with traditional standards (NTSC, PAL and SECAM) and non-traditional video standards (HDTV, PC displays a— other non-standard displays).

The choice of an oscilloscope for maintenance work is one that you—and the other technicians in your facility—will have to live with for a long time. Make the selection carefully. ◼

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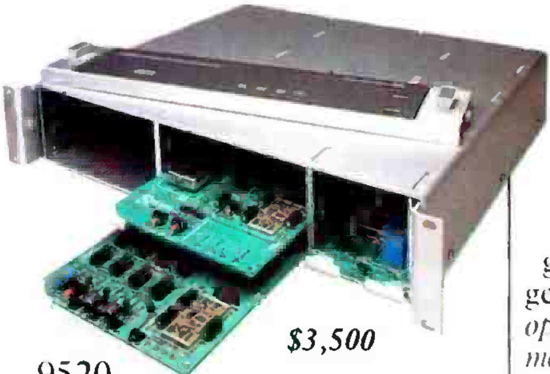

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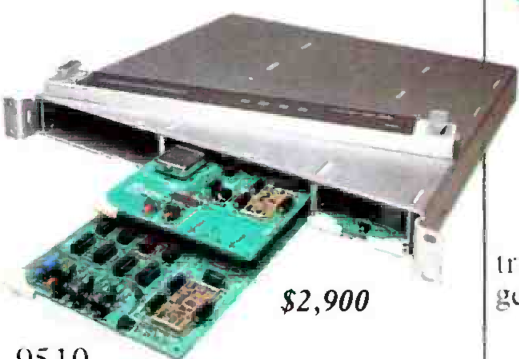

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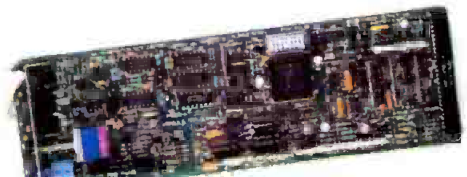

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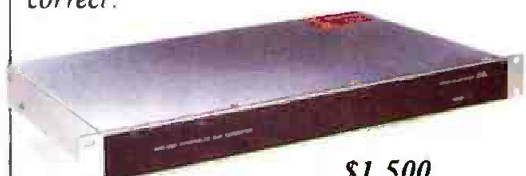

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4

Testing stereo audio for mono compatibility

By Mike Coleman

If you want to broadcast quality stereo TV, you need to know what your audio system is doing.

One of the most misunderstood problems with TV stereo audio is monaural compatibility. Producing a stereo program that is compatible with mono TV sets is critically important, because mono listeners greatly outnumber stereo listeners—and they will for many years to come.

Mono listeners hear the sum of the left and right channels. But a good mono sum results from good left and right audio only if both channels are processed identically. You can't check each channel in isolation and expect an acceptable mono sum to result.

Consider this example: Figures 1(a) and 1(b) show the frequency-response plots of a stereo audio system. Everything looks all right, and you might expect good mono. But look at Figure 1(c). It shows the frequency-response plot of the monaural sum of this system, which has a pronounced high-frequency rolloff. This particular problem is caused by a 30μs delay in the left channel. The frequency-response curve in Figure 1(c) was generated using common broadcast equipment, and it is typical of the problems broadcasters face with processing equipment in the audio chain.

You can observe and measure compatibility problems in two ways. Because the mono listener hears the sum of the left and right channels, you can add them in a test environment and make measurements directly on the resulting signal. This is easy to do and eliminates any guesswork. The other way is to indirectly monitor the mono sum by feeding the same signal to both channels and observing the phase relationship between the channels at the output. Each technique has its place in TV station operation.

The summing amplifier

Making measurements on mono frequency response is simple if you have a summing amplifier. You can either purchase one or use the circuit shown in Figure 2 to make one. The output of the summing amplifier is what the mono listener hears. The plot in Figure 1(c) was made by measuring the output of a summing amplifier while sweeping the frequency of the left and right audio channels.

Coleman is a hardware/software engineer with the TV division of Tektronix, Beaverton, OR.

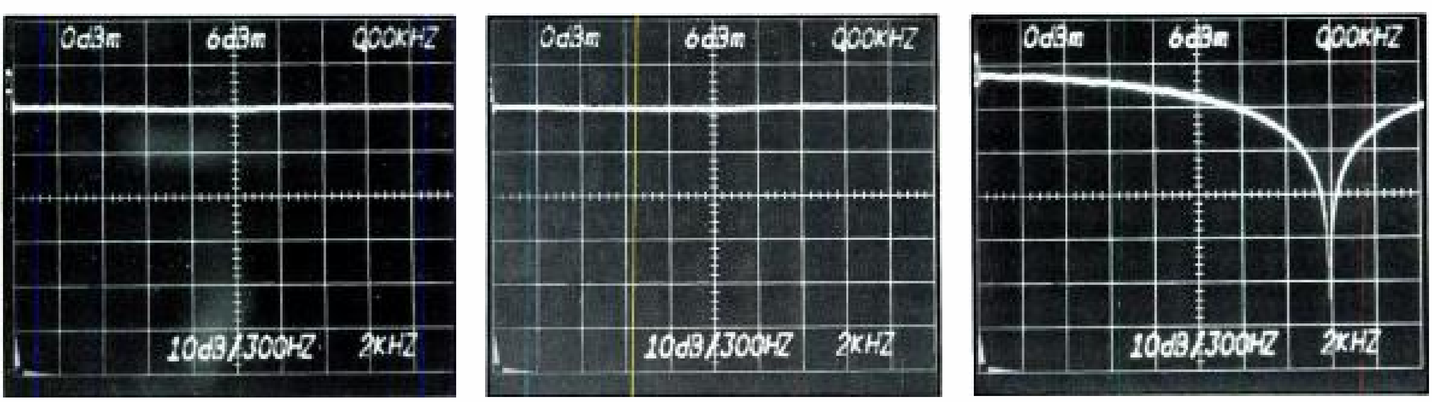

Figure 1. The frequency-response plots of a stereo audio system. Oscilloscope photo (a) shows left-channel amplitude vs. frequency. Photo (b) shows right-channel amplitude vs. frequency. Both plots seem perfect until the signals are summed to mono, shown in scope photo (c). Note the deep notch caused by a phase differential between the right and left channels. (Horizontal scale = 2kHz/div, beginning with 0kHz on the far left side of the display. Vertical scale = 10dB/div.)

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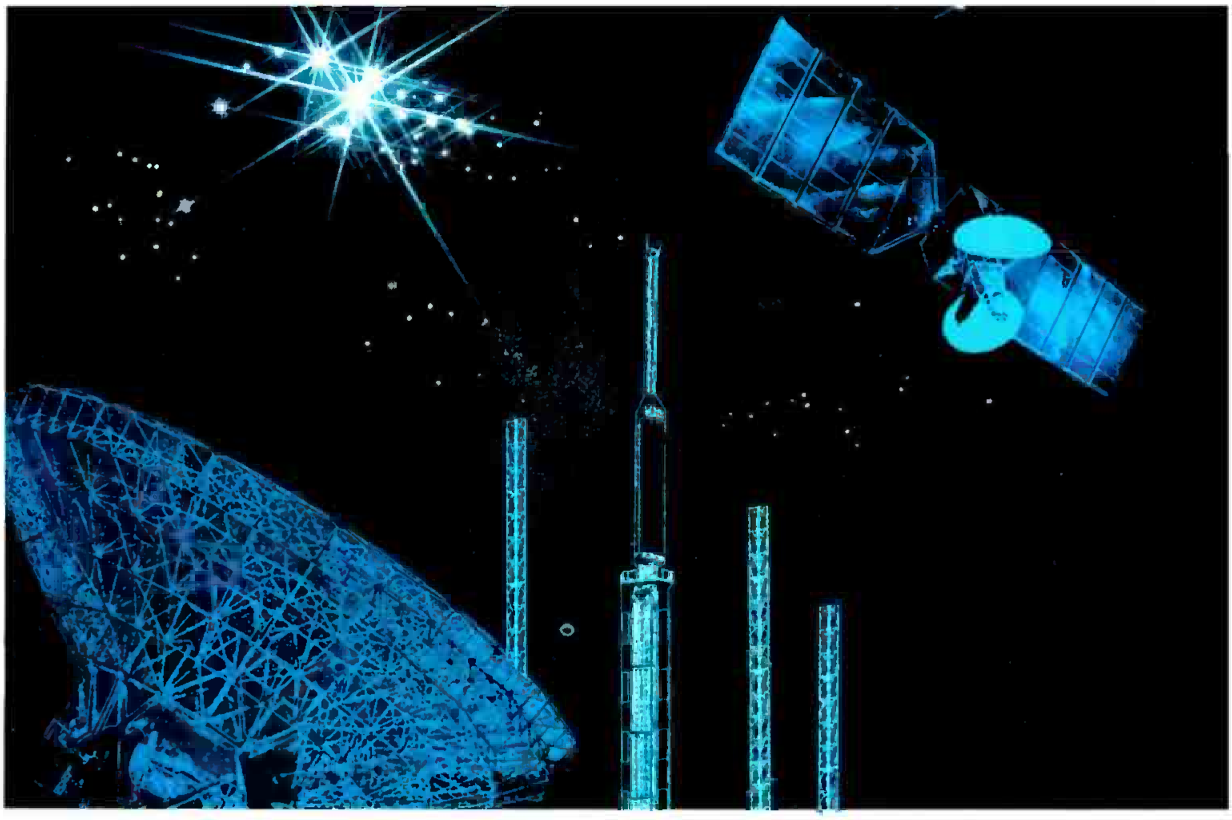

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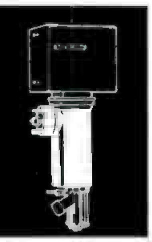

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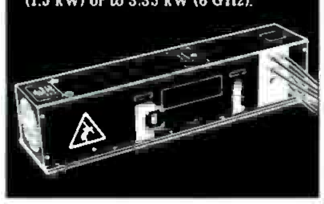

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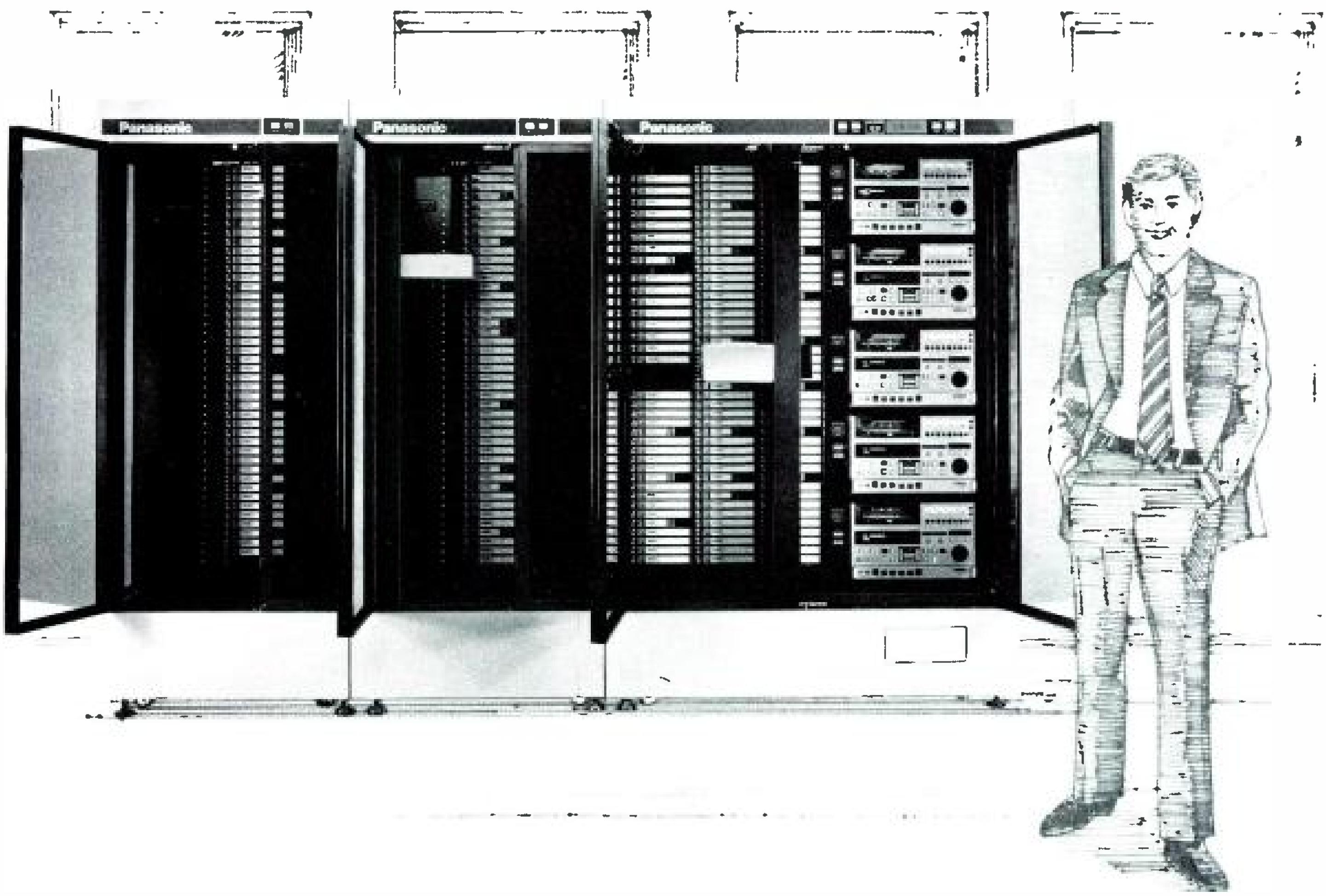

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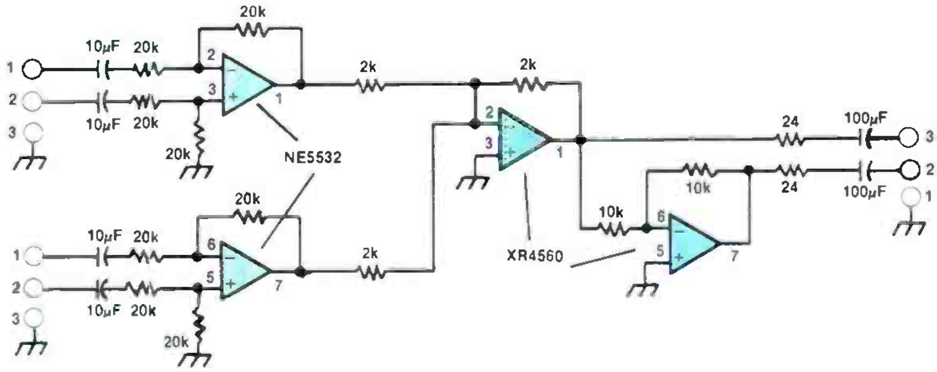


Figure 2. An active summing amplifier circuit used to check the mono compatibility of two audio channels.

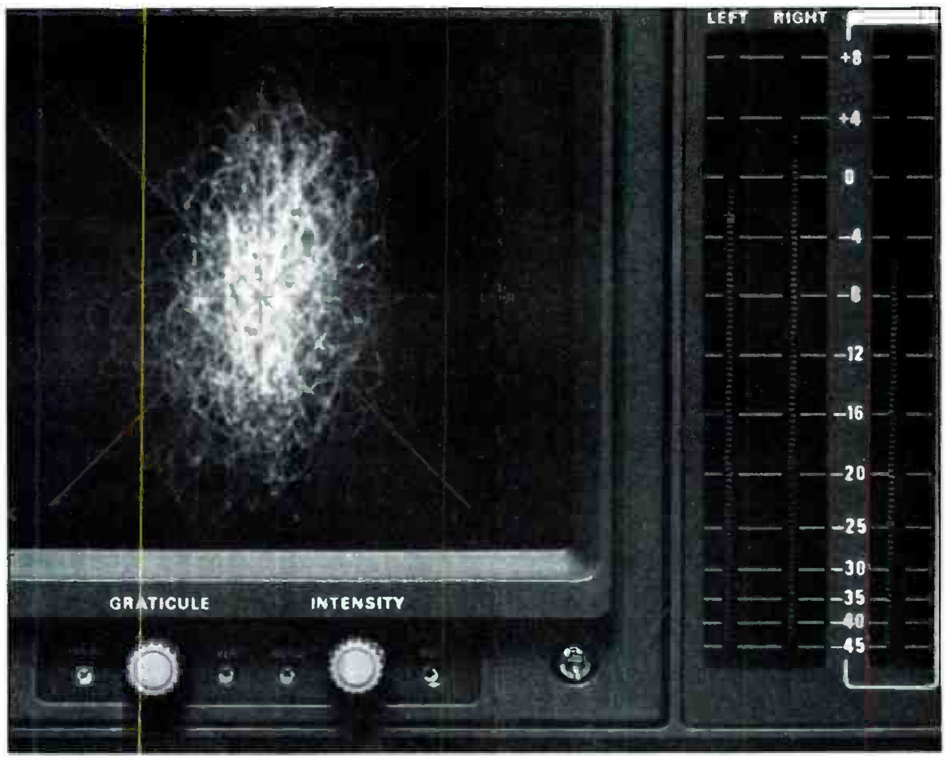


Figure 3. Front-panel controls and display for a stereo audio waveform monitor featuring left, right and sum amplitude readouts.

Continued from page 106

The audio vectorscope

Probably the most important piece of TV stereo test equipment is the audio vectorscope. The display on the instrument is a *Lissajous pattern*. It relates the amplitude and phase of the left and right channels. With experience, you can learn much about audio signals at your plant just by observing the pattern on this instrument.

Some audio vectorscopes also have meters for left, right and sum or difference levels. This combination of metering and pattern display is useful for monitoring and locating compatibility problems quickly. See Figure 3.

Continued on page 114

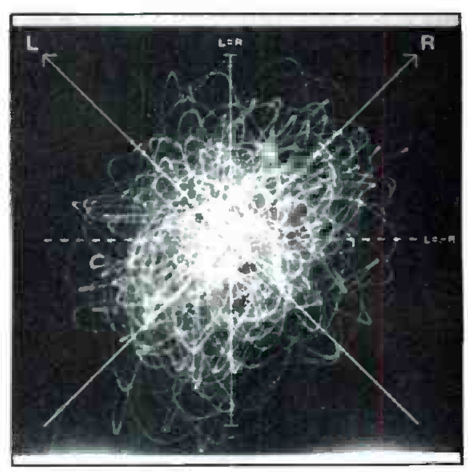


Figure 4. Audio vectorscope display for stereo programming of symphonic music. Note that little correlation exists between left and right audio channels.

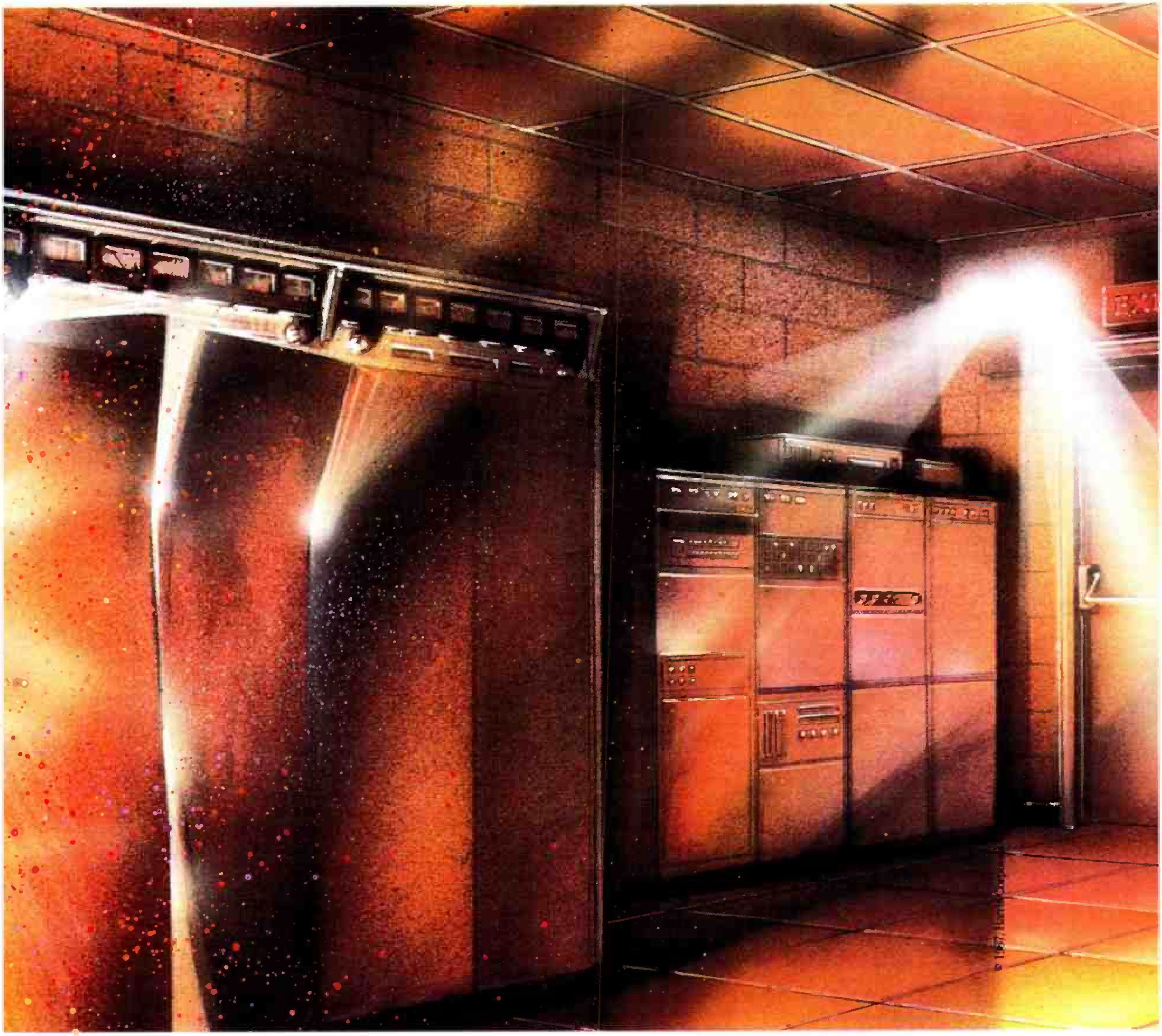
"WHEN OUR TRANSMITTE
STOPPED...EXCEPT TH

Chattanooga. January 26, 19
WTVC's transmitter — from a Ha
competitor — exploded. Doors
blew away. Quarter-inch-thick sh
steel melted. And Channel 9 we
off the air.

Working through the night i
subzero weather, Director of En
neering and Broadcast Operatio
Manager Dennis Brown and his
staff would bring the station to
power in 18 hours. But less pow

3LEW UP, EVERYTHING
:XPENSES"

F. Lewis Robertson
Vice President/General Manager,
WTVC



l meant less revenue. They
eded a replacement fast . . . in
days rather than 30 weeks. Says
›wn with a smile, "We knew if
yone could, Harris could."

The day after the accident, a
rris rep was on site. Assessing
nage. Identifying needs. Rolling
the shirtsleeves to pitch in. And
:e Lewis Robertson gave the go-
ead, a new Harris transmitter
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days after the order. Channel 9 was back on the air at full power . . . with a picture viewers felt was better than ever!

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Continued from page 110

The compatibility question

Now that you have a device for observing stereo audio, you can see more easily why TV stereo presents such a challenge for mono compatibility. Figure 4 shows a pattern typical of symphonic music. The pattern is almost circular, with little correlation between channels.

Figure 5 illustrates a pattern from a typical stereo entertainment program. Note that the stereo signal looks almost like mono. The channels are highly correlated. Most of the dialogue is in the center, and the music and sound effects have limited separation.

TV stereo audio is mixed this way to match the small size of the average TV screen. Your viewers don't want gunshots in the kitchen and car crashes in the bedroom! Because the material in both channels is so similar, any phase or delay errors result in some cancellation of the mono sum.

So the first rule of mono compatibility is this: Highly correlated stereo audio demands identical processing in eac channel in order to sum to acceptabl mono.

Ensuring mono compatibility

The biggest potential problem facin broadcasters who are converting t stereo is wiring polarity error. If th polarity of one channel is reversed witl respect to the other anywhere along th audio chain, most of the correlate (center) audio information will disappea from the mono sum. Because a statio could have hundreds of audio wiring connection points, your plant probabl has some built-in polarity errors. Th penalty for inverted polarity was not to great in the monaural past, but that's no the case today.

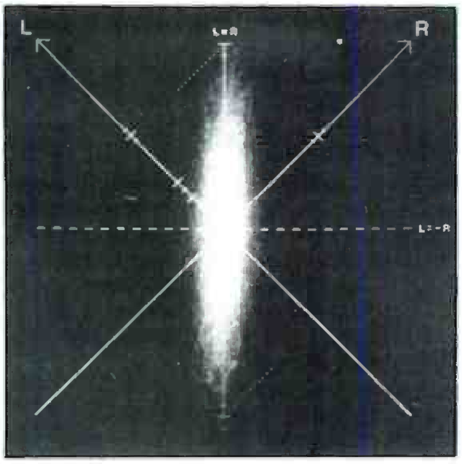


***Figure 5.** Audio vectorscope display configured as in Figure 4, but with programming typical of most stereo dramas or comedy shows. Note the high correlation between left and right audio channels.*

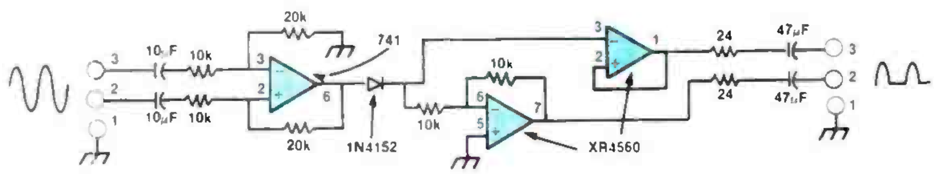
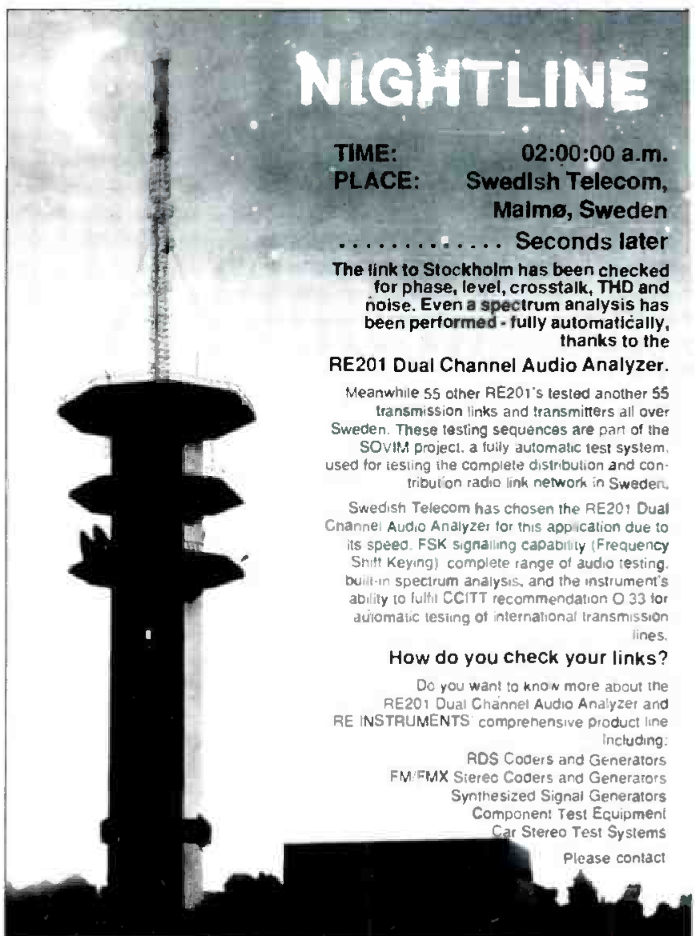


***Figure 6.** A sine-wave clipper circuit used to generate a test signal for checking polarity inver sion in a stereo plant.*



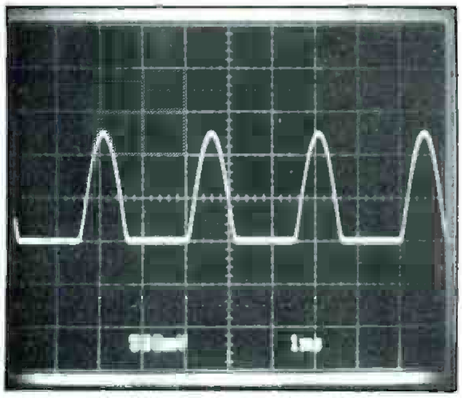


Figure 7. The output waveform of the sine-wave clipper circuit shown in Figure 6. When checking for polarity inversion in a stereo facility, keep in mind that two polarity inversions will yield a waveform that appears to be correct, but is not.

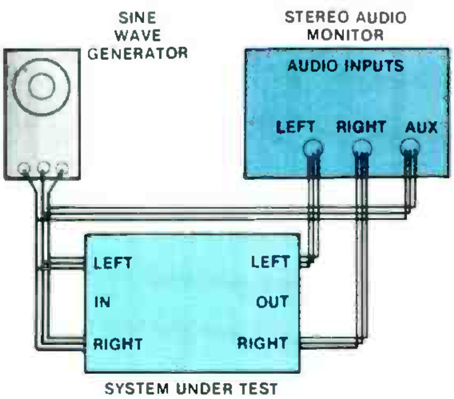


Figure 8. Test setup for checking the relative phase of two audio channels in a unit under test. Check for phase errors in all equipment through which the audio signals will pass.

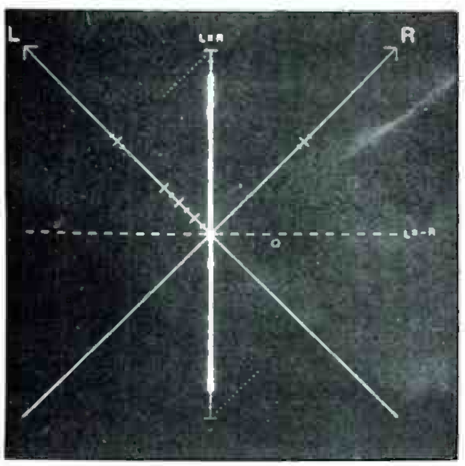


Figure 9. The ideal display from a relative-phase check of two audio channels, configured as described in Figure 8. The display is a vertical line indicating (on this type of monitor) two signals matched in amplitude and phase.

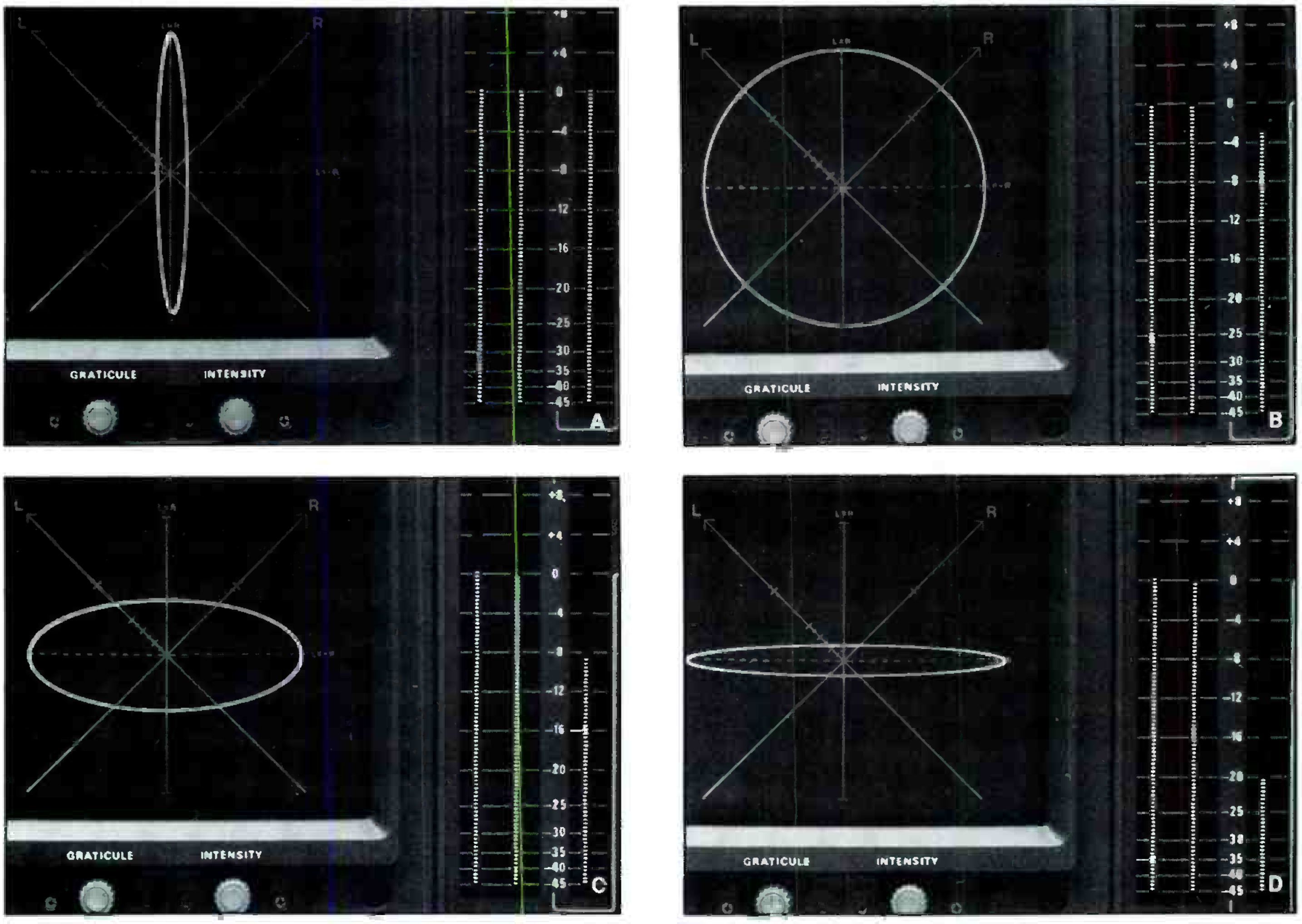

GRATICULE
INTENSITY
A
B
C
D

Figure 10. Audio waveform displays for a stereo channel with varying degrees of relative-phase error. Photo (a) shows a phase differential of approximately 10°. Photo (b) shows a phase differential of approximately 45°, with sum-channel audio response down 3dB. Photo (c) shows a phase differential of approximately 135°, with sum-channel audio response down 9dB. Photo (d) shows a phase differential of approximately 190°, with sum-channel audio response down 21dB. Note that two audio signals perfectly matched in amplitude and 180° out of phase with respect to each other will result in cancellation when summed to mono.

Here's a technique for locating wiring polarity errors. Apply a clipped sine-wave test signal to the input of your system, one channel at a time. The circuit shown in Figure 6 will convert your house sine-wave tone into what you need. Figure 7 shows how the signal should appear on an oscilloscope. Use this signal to probe along both audio signal paths. With the scope connected to the positive phase of the line, the half sine wave should point up. If it points down, the polarity has been inverted.

It is important to check the wiring at any point where a new connection is made. Two polarity errors will cancel each other until a patch is made or until the audio system is modified (for whatever reason). Dual polarity errors compound the difficulty of preserving monophonic compatibility during the rapid pace of a typical broadcast day.

Some stations carry this testing procedure further and check (and rewire as necessary) all audio-processing equipment to eliminate input-to-output polarity inversion. When all polarity errors have been removed from the facility, you can be assured that the audio system will function properly when equipment is removed or replaced.

Phase errors

Now that you have found and corrected your polarity errors, let's turn to the second type of compatibility problem: phase errors. As illustrated in Figure 1, zero relative-phase error (ideally) is needed between the left and right channels in order to accomplish satisfactory mono TV sound.

Phase is simply a way of describing delay in other terms. When one channel has a bit more delay than the other, and the same signal is sent down both channels, the delay can be measured through observation of the relative phase of the audio at the other end.

This point is made so that you will consider all the possibilities for phase (delay) errors that might exist in your plant and

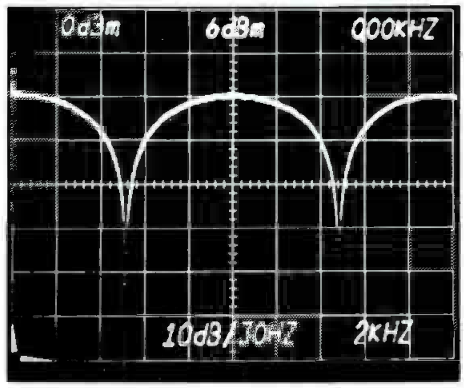


Figure 11. Audio spectrum-analyzer display of amplitude vs. swept frequency in a stereo audio system summed to mono. Note the deep cancellation that occurs at 5kHz and 15kHz. Discrete mono compatibility spot checks that did not include those frequencies could give a false indication that the system under test was operating properly. The notches shown were caused by a delay of approximately 100μs in one of the stereo channels. (Horizontal scale = 2kHz/div, beginning with 0kHz on the far left side of display. Vertical scale = 10dB/div.)

in the distribution system that delivers audio to your facility. Phase errors between stereo channels create errors in the mono frequency response.

Identifying phase errors

Detecting phase errors requires a high-quality audio generator and an audio vectorscope. Figure 8 shows how to connect the output of the audio generator to both channels of the system under test. You can observe the outputs on an audio vectorscope as you vary the frequency of the generator.

Ideally, the response at all frequencies will be similar to the display shown in Figure 9. The display should be a vertical line indicating equal and in-phase left and right signals. Any phase error will show up as an ellipse on the audio vectorscope. If your scope also has metering, you can watch the sum amplitude to make sure it stays constant throughout the audio range. Note that some audio vectorscopes display 0° differential phase by a straight line at a 45° angle relative to vertical. The vectorscope display used in this article has 0° differential phase referenced as shown in Figure 9.

Figures 10(a-d) tie all this together. The mono frequency response of a system is shown along with audio vectorscope photos taken at critical differences in relative phase. These displays clearly illustrate the relationship between phase errors and monaural frequency response. Note that the left and right audio-level bars show good amplitude response in their respective channels, but the sum bar is influenced significantly by the relative phase between channels.

For a quick check of your system or of a remote feed, supply a swept frequency to both channels at one end, and observe the maximum phase excursion at the other end. An even faster check can be accomplished with a pair of discrete frequencies. If you use this test, choose the frequencies with care. Consider the response shown in Figure 11. If your tones were at 400Hz and 7kHz, you would not notice the notches present at 5kHz and 15kHz.

Because these tests are simple, they should help you to quickly locate and observe the common stereo audio problems that affect mono compatibility. These techniques will put you well on your way toward producing good stereo *and* good mono sound.

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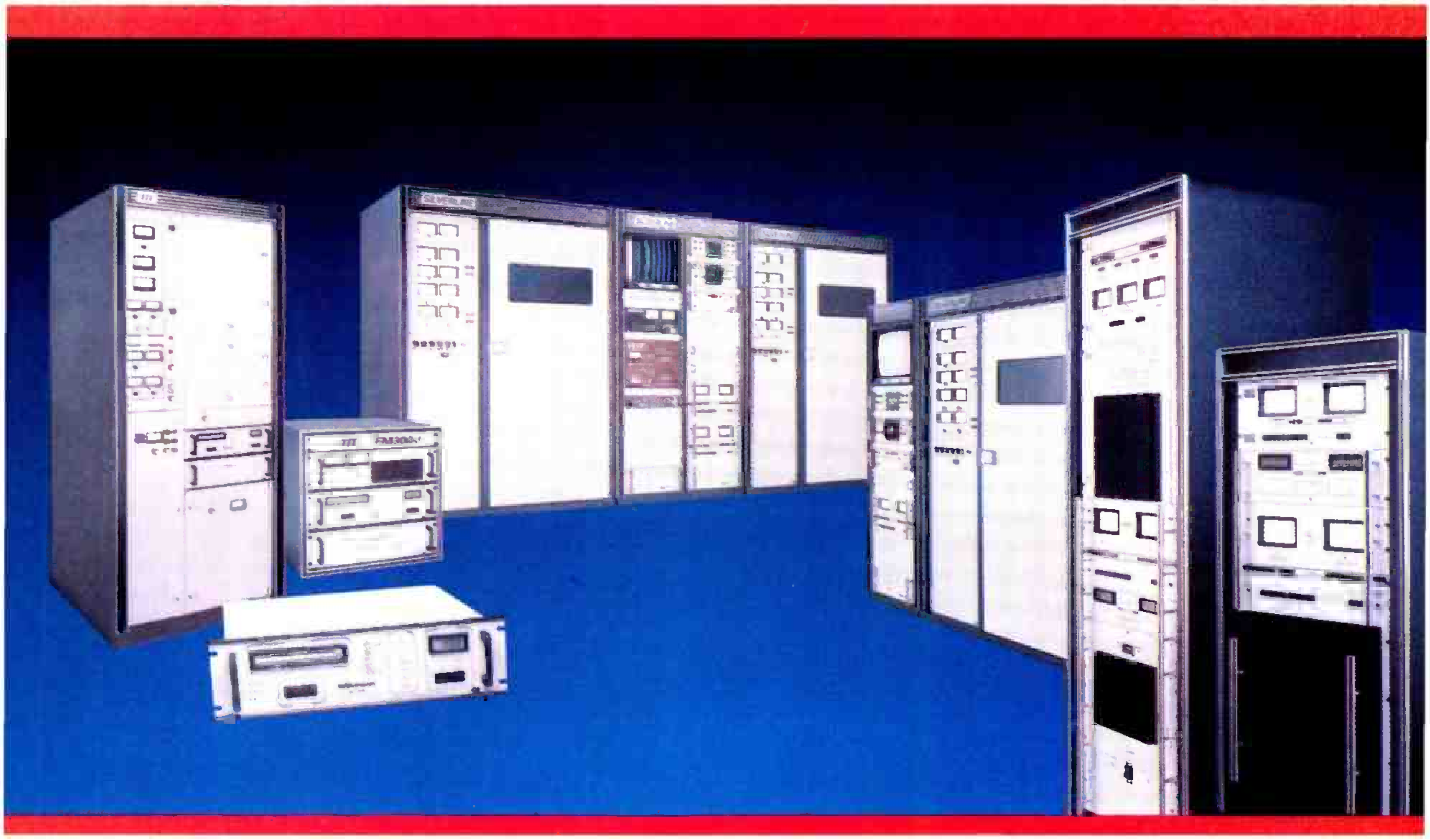

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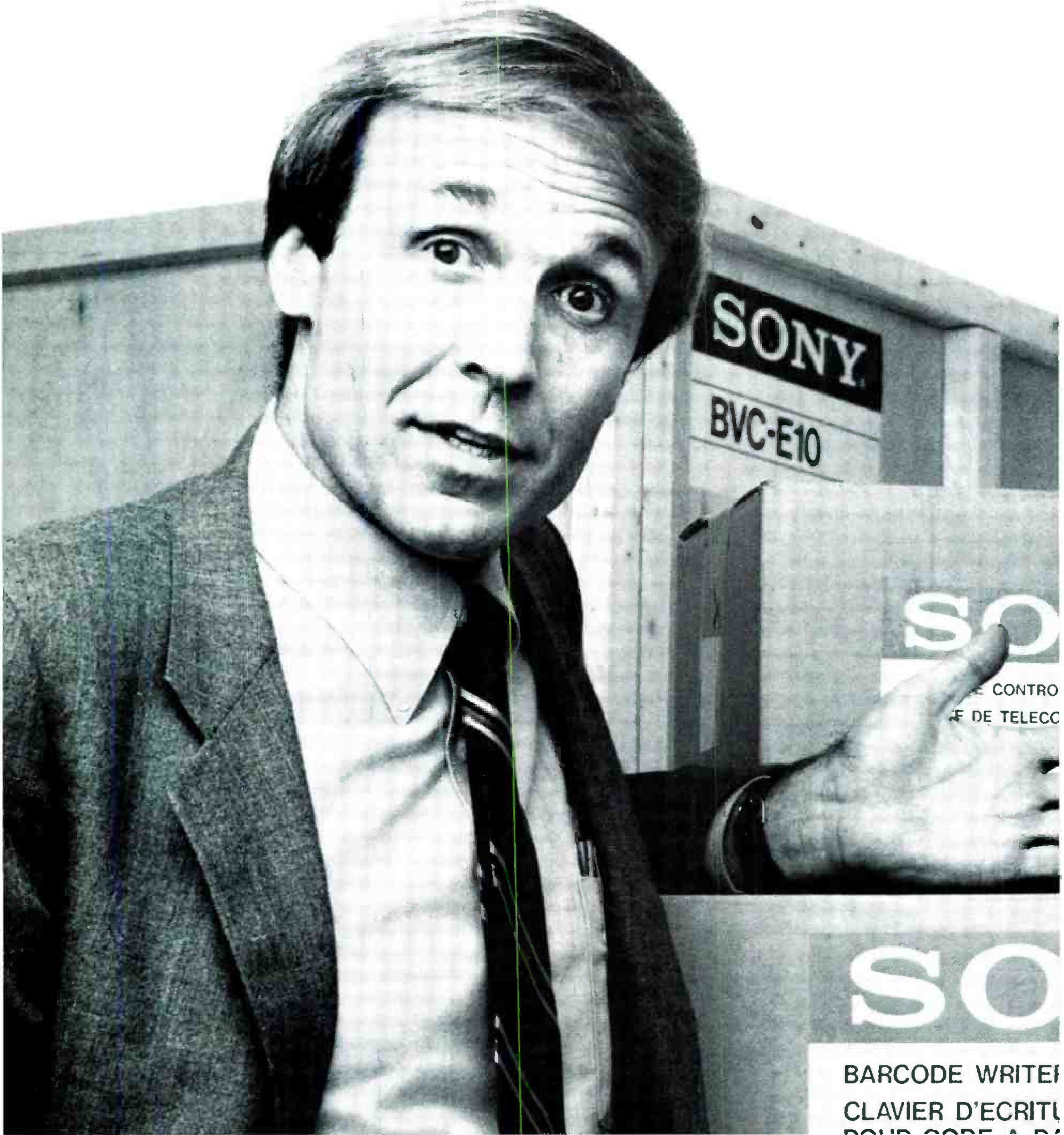

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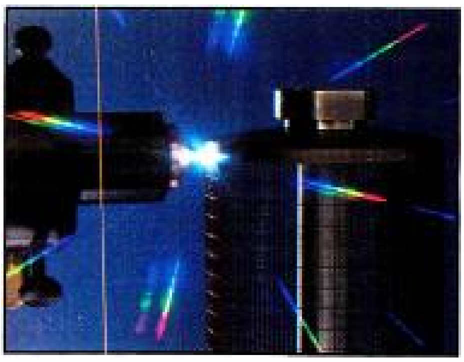
Binaural sound: Expanding on the image



By Claus Wittrock, M.Sc.E.E.

A variety of methods now exist for adding stereo sound transmissions to traditional terrestrial TV broadcasting around the world. These methods are influenced by a lack of bandwidth, by the amount and complexity of information carried in a TV transmission and by their compatibility with existing standards and norms. Consequently, all known stereo systems are compromises between the desire for improving audio performance and the limitations the terrestrial broadcast system imposes.

The key concerns are minimum disturbances of adjacent channels, minimum increases in stress on transmission equipment and no degradation of quality when existing monophonic TV receivers receive the signal. Stereo performance, therefore, has to be achieved either within the traditional sound system or by an additional sound carrier. Sound-in-sync methods, or other ways of carrying stereo information within the video signal, require either extended bandwidth or complex packing, which is based upon digital reduction of the information and is equivalent to a loss of compatibility with existing terrestrial broadcast systems.

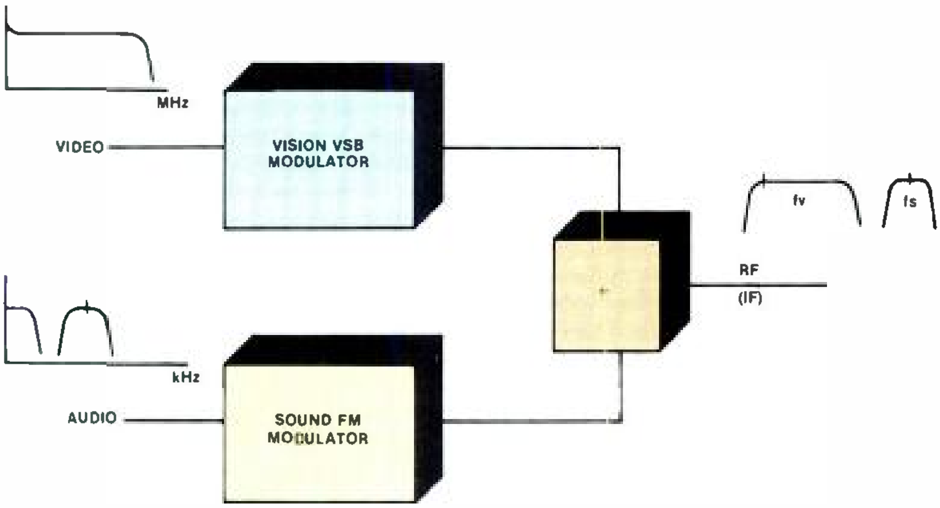


Figure 1. The general plan of single-sound carrier systems.

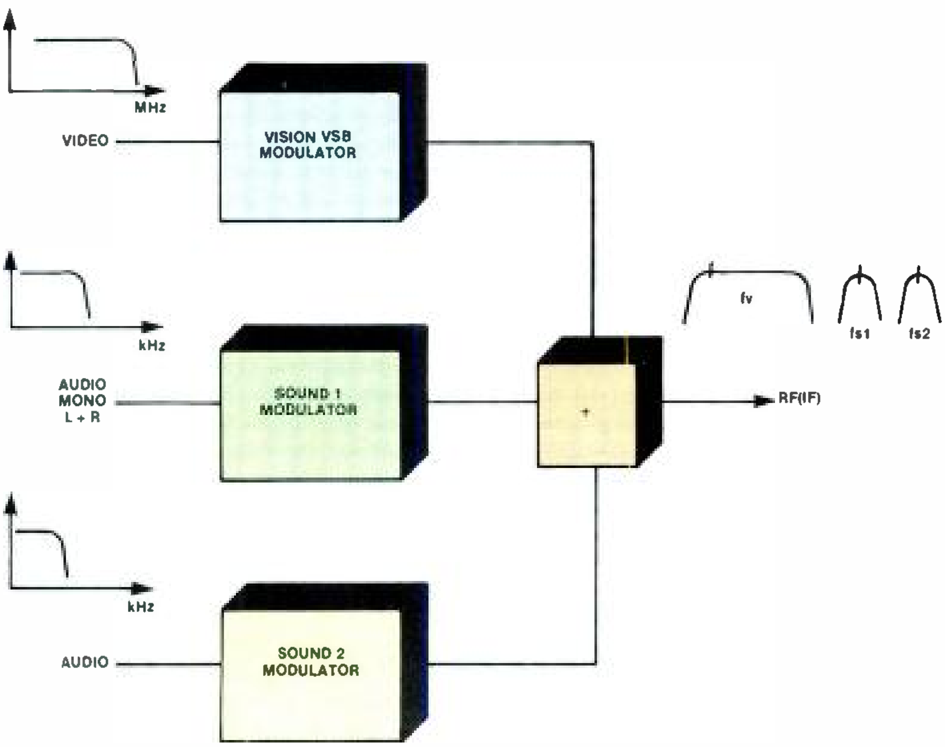


Figure 2. The general plan of dual-sound carrier systems.

Principles for stereo sound

In light of the constraints already noted, stereo quality must be obtained either through modification of the audio signal before transmission or by the addition of another carrier near one of the edges of the channel bandwidth allocated for the transmission. When analyzing the principles that have been described, we can classify them either as single-sound carrier (Figure 1) or dual-sound carrier (Figure 2) systems.

The first single-sound carrier BTSC variation is in operation in the United States and Canada. It features stereo and a second language and data transmission. The audio processing required in the transmitter and receiver is relatively complex (see Figure 3). The spectrum of the encoded audio signal is shown graphically in Figure 4. The BTSC companding scheme (compression during encoding, expansion in the receiver decoder) is based upon the Zenith/dbx processing circuit and makes use of both amplitude and frequency companding. The latter is implemented by using a level-controlled pre-emphasis curve.

Wittrock is development manager, RF TV products, Philips Professional Television, Copenhagen, Denmark.

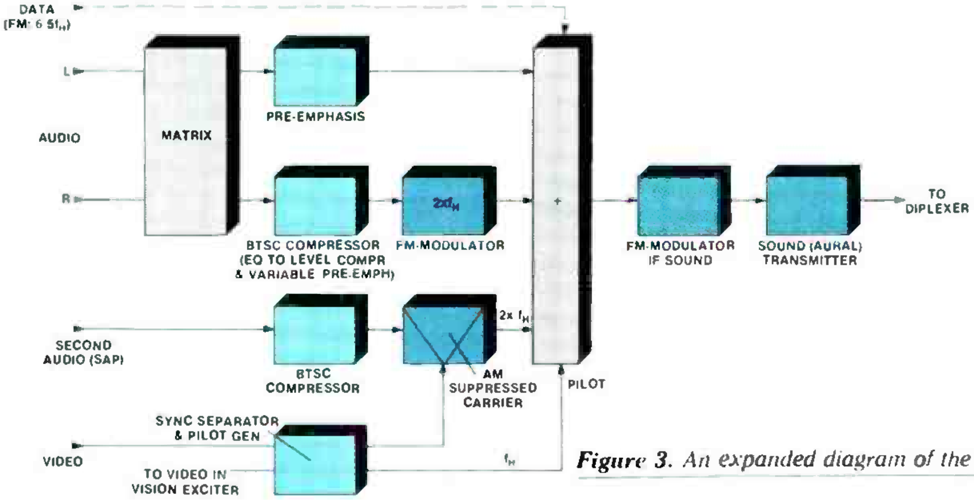


Figure 3. An expanded diagram of the BTSC variation of the single carrier.

A second variation of the single-sound channel approach is in use in Japan. (See Figure 5.) Although the FM-FM design has no direct facility for a second language, a low crosstalk level theoretically allows the left and right channels to carry two different languages.

Two basic principles also are found in the dual-carrier systems. The Institute fur Rundfunktechnik (IRT) developed an analog variation, while the British Broadcasting Corporation (BBC) moved to a digital approach. The IRT system is in use in Germany, Holland and Austria and is being considered for implementation in Australia and Korea. (See Figure 6.) An identification signal at 54kHz is AM-modulated with a low-frequency signal to indicate a mode of mono, stereo or independent 2-channel (language) transmission.

The BBC's system operates with a digitally converted audio signal that is companded, interleaved and quadrature phase-shift modulated on the second carrier. Developed originally for England, the BBC approach has been accepted in Finland, Denmark, Norway and Sweden, although some modifications have been made. (See Figure 7.) The Nordic alteration features VHF (CCIR system B) opertion, using an intercarrier frequency of 5.85MHz instead of 6MHz and other filters in the quadrature phase-shift keying (QPSK) modulator as a compromise between bandwidth and Eye height.

A closer look at QPSK

Of these systems, the BBC approach probably is the most difficult to understand, mainly because it is digital. Initially, the left and right signals are sampled at 32kHz. The resolution of the A/D conversion is 14-bit (maximum) digital word equal to an overload limit placed 12dB above the reference level, which indicates average peak program level. During baseband compression, the 14-bit word is reduced to 10 bits.

In this scheme, a group of 64 samples makes up a frame, while 32 samples comprise a block. Mono samples are placed in odd-numbered frames for language or channel 1, while those for language 2 are encoded into even-numbered frames.

Statement of Ownership, Management and Circulation (Act of August 12, 1970; Section 3685, Title 39, United States Code).

1A. Title of publication: Broadcast Engineering
1B. 338-130
2. Date of filing: Sept. 25, 1987
3. Frequency of issue: Monthly except in the fall, when 2 issues are published.
3A. Number of issues published annually: 13
3B. Annual subscription price: ______
4. Complete mailing address of known office of publication (Street, city, county, state, zip code): 9221 Quivira Road, Overland Park, Johnson County, KS 66215.
5. Location of the headquarters or general business offices of the publisher (not printers): 9221 Quivira Road, Overland Park, Johnson County, KS 66215.
6. Names and complete addresses of publisher, editor, and managing editor. Publisher (Name and Address): Duane N. Hefner, 9221 Quivira Road, Overland Park, KS 66215. Editor (Name and Address): Jerry Whitaker, 9221 Quivira Rd., Overland Park, KS 66215. Managing Editor (Name and Address): Tom Cook, 9221 Quivira Road, Overland Park, KS 66215.
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Frames are numbered in groups of eight with a control bit C_n. (See Figure 8.)

The compression process is implemented by finding the maximum sample value in a block. This value leads to one of five possible degrees of compression. A 3-bit scale factor word (R_2, R_1, R_0) is associated with each block carrying information for the expander in the receiver. Using 2's complement terminology for high-amplitude values, the bits (10 out of the 14) are taken from the most significant positions of the word. If the value is positive, it might be represented as *0, 1, x, x, x, x, x, x, x, x*. Thus, *1, 0, x, x, x, x, x, x, x, x* would indicate a negative value.

For stereo, one block of left samples and one block of right samples are mixed

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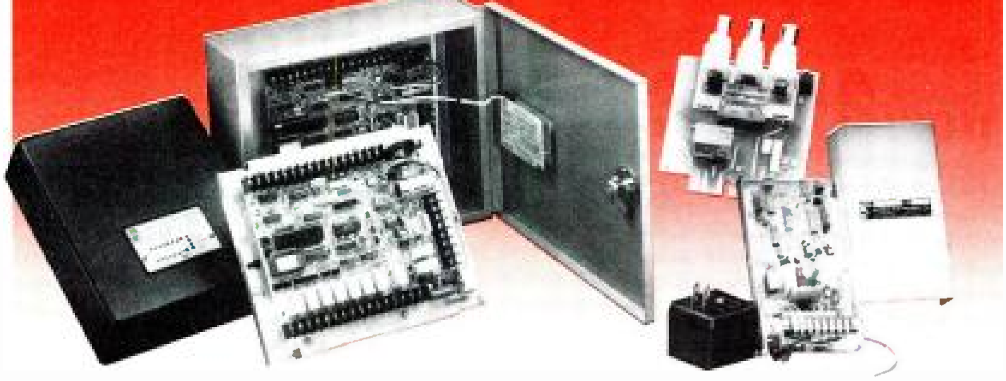
into one frame in such a manner that the samples follow one another successively. Naming the left samples A and the right samples B, we may represent the subgroup of 16 samples as:

$$A_1, B_1, A_2, B_2, \ldots, A_n, B_n, \ldots, A_{15}, B_{15}, A_{16}, B_{16},$$

where A_n (or B_n) consists of a representative group, such as a_{n0}, a_{n1}, a_{n2}, ..., a_{n9}, P_n, where n_0 is the least significant and n_9 is the most significant of the bits in the compressed data. P_n, at the end of the compressed form of the word, is a parity bit in principle, but, it is modified with the scale factor bits, following a specific pattern equal to (for sample number $1(+3n)$): the parity bit modified with scale factor R_2, sample 2 with R_1, and



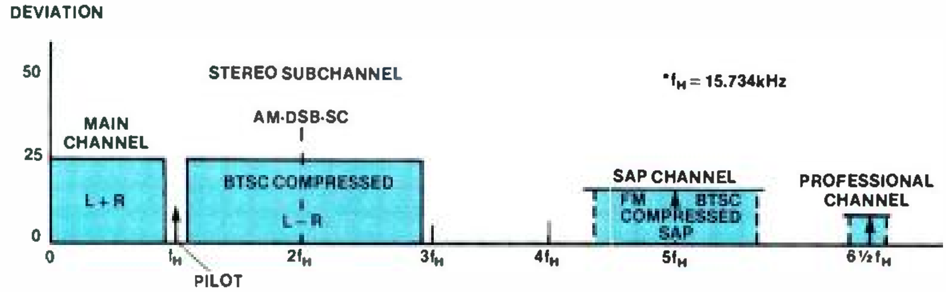


Figure 4. The energy spectrum of the BTSC audio signal.

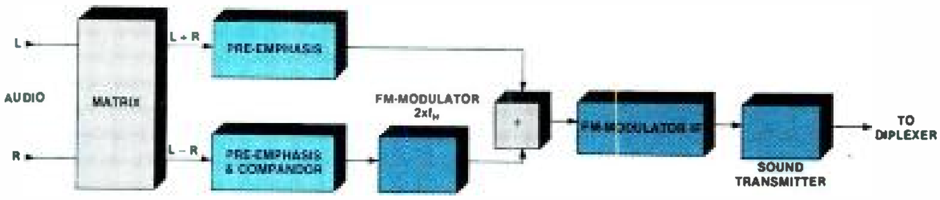


Figure 5. The FM-FM variation of the single-carrier system.

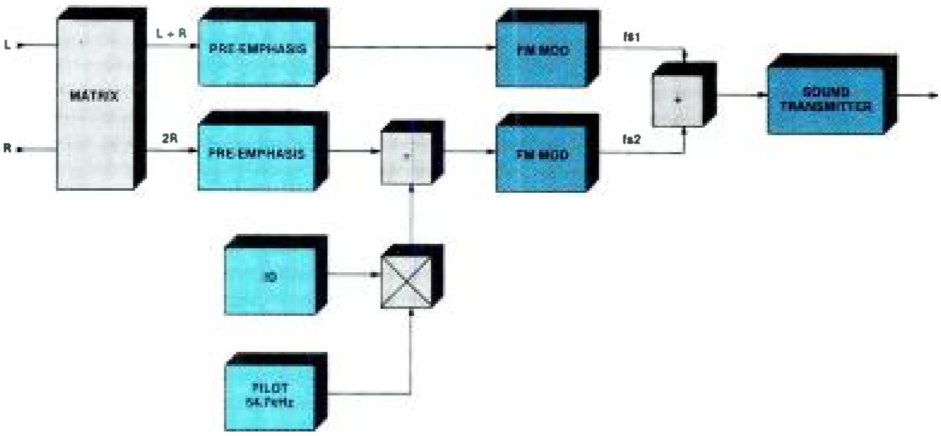


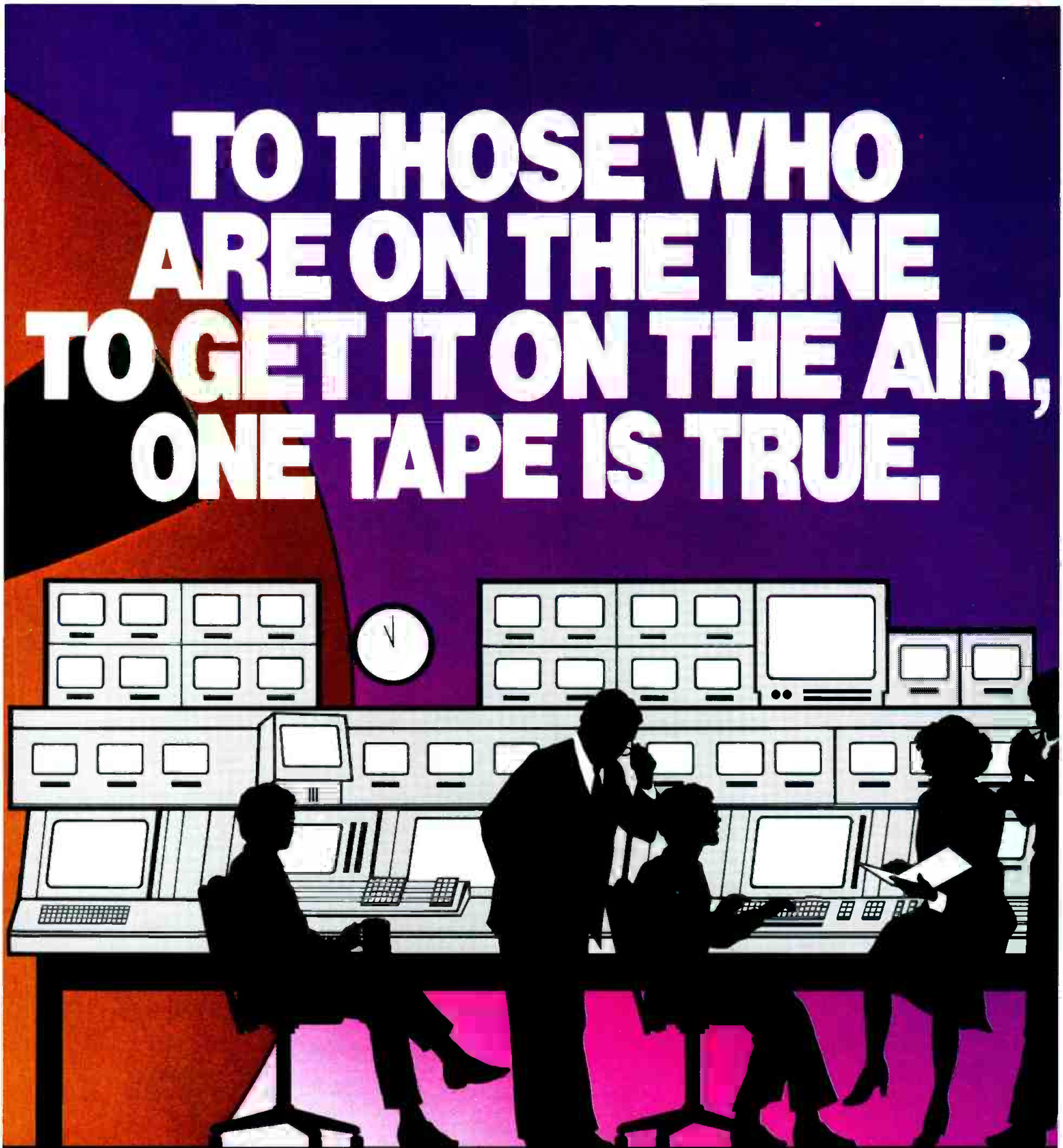
Figure 6. The analog dual-carrier sound system.

sample 3 with R_0, and so on, until sample 55 of the frame. Samples 55 to 64 carry only parity information in the P bit. The interleaving process is performed on every frame. A frame alignment word (FAW) is added plus a number of control bits and data channel information.

When all parts are assembled, the final frame can be represented by Figure 8. Transmission of the matrix begins with the first row, then the second row and so on. The method minimizes the effect of multiple-bit errors on the received signal.

Of the control bits, C_0 is 0 for the first eight frames and 1 for the next eight. The other C bits carry information about the audio mode—mono, stereo, dual

Continued on page 130



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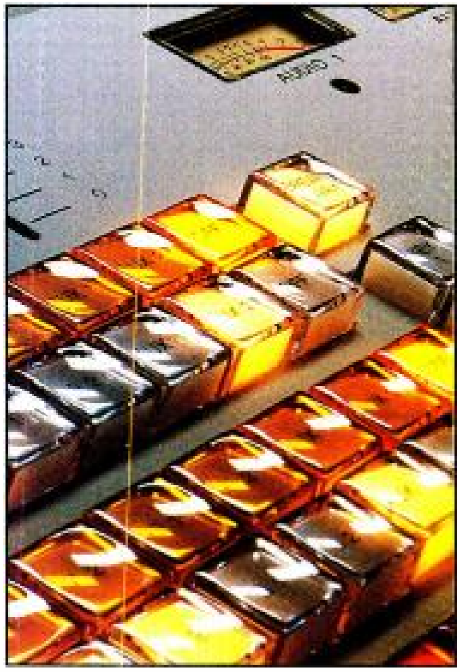
TV camera technology update

By Larry Thorpe



Major advances in imaging technology are improving both tubes and CCDs.

Almost all of the world's major broadcast camera manufacturers showed CCD cameras at the 1987 NAB convention. A variety of solid-state imaging devices jostled for recognition as *the* technological pacesetter. A diverse range of conflicting messages spoke to the promise of an emerging new era in TV imaging. By convention time, more than 600 CCD cameras had been installed within the broadcast environment, but NAB also saw the introduction of high-performance ⅔-inch pickup-tube cameras. There is little doubt that TV camera technology is experiencing significant changes.

CCD advancement will be slow-paced. The outstanding attributes of the CCD will bring important imaging enhancements to our industry, but this first generation of solid-state imagers has definitive limitations. Their performance capabilities are limited by the complex boundaries of present microcircuit design and fabrication. These obstacles will be overcome in time, but only in a progressive, step-by-step manner. Until then, the particular applications of the CCD must be carefully matched to its capabilities as they exist today. This era of CCD evolution will mean measurable improvements in the unusual and grueling world of ENG. The march to full studio production quality will inevitably follow.

The traditional pickup tube will not remain at a standstill either. Spurred by the challenge of the CCD, by clean, high-resolution pictures generated via computer graphics, by demands for ever-higher studio and field camera component video performance for chroma-key (see Figure 1), and finally, by the impending arrival of the super-quality component digital VTR, tube manufacturers are escalating their R & D. High-definition television, with its need for pickup imagers of extraordinary quality,

Thorpe is director of studio product management, Sony Broadcast Products, Teaneck, NJ.

FORMAT SIZE (mm)	SIGNAL CURRENT I, (IN nA)	IMAGE FORMAT AREA (cm²)	LAG AREA/I, (cm²/A)	RELATIVE LAG (PERCENTAGE)
30	400	2.19	5.47x10⁶	100
25	300	1.23	4.1x10⁶	75
18	200	0.58	2.9x10⁶	53

***Table 1.** The lag behavior of pickup tubes is inversely related to their signal-current density.*

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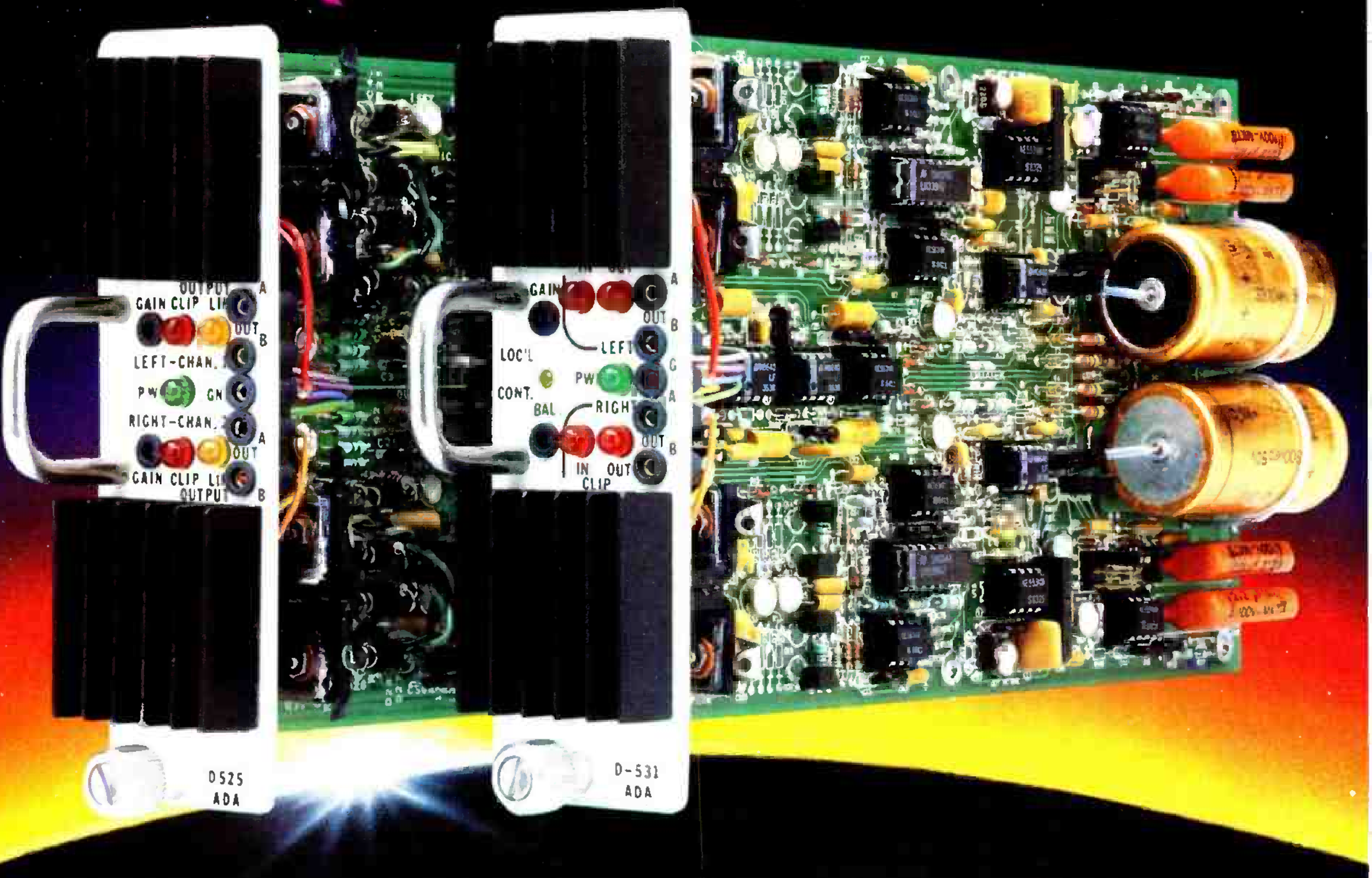

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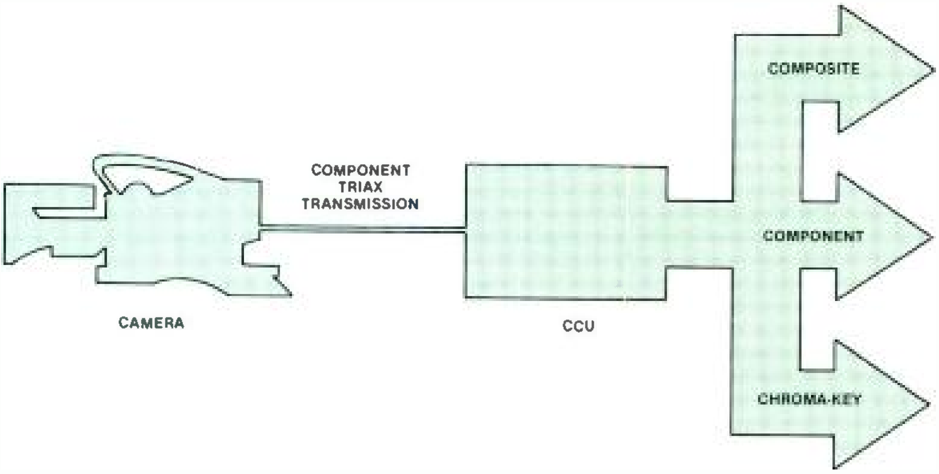

Figure 1. Users are demanding more and more from portable video cameras. Video out and gen-lock are no longer enough.

Magnetic focus-electrostatic deflection is one recent development that has improved many pickup tubes.

has added further impetus to the drive for higher-performance pickup tubes. This effort will inevitably spin off (in fact, it already has) to the 525/625 pickup devices. The pickup tube's accelerated technology will be a moving target for the steadily advancing CCD.

The dynamics of this dual evolution hold high promise for cameras with ever-improving performance. This is a welcome note to an innovative industry that continually seeks more from original picture capture. Better cameras and VTRs will allow more generations of recording and editing, and hence, more creative programming.

Some concerns hover, however, as end-users struggle to assess the true qualities of new pickup-tube designs—and perhaps of greater importance—as they try to gauge the pace of CCD development and its impact on the validity of today's camera-buying decisions.

This article will present an overview of the technological developments now under way and will impart an objective perspective on the real qualities of pickup-tube and solid-state imagers. A key part of the overall discourse is the recognition of the many forms of TV shooting. Many diverse applications and many types of video "looks" place different levels of emphasis on certain attributes contributing to a given picture quality. When making camera choices, end-users must examine carefully the needs of their own particular production environments and satisfy these with the available TV camera technology.

Pickup tube design

Currently, there is a wide selection of pickup-tube technologies. They are available in three image format sizes and in three fundamentally different electron-optical designs. Two types of photoconductive layers are available: Plumbicon and Saticon. Which combination of these represents the truly superior "state of the art"?

The 30mm pickup tube has long dominated high-performance studio cameras. However, the tide has turned in favor of the ⅔-inch image format for *all* TV applications. This remarkable tube format has made enormous performance advances in the past decade. Figure 2 illustrates the pace of development in the performance and application of the ⅔-inch pickup tube.

Most of today's worldwide R & D investment centers on this tube format. All of the major new cameras of the past few years are ⅔-inch. All of the lens manufacturers now offer revolutionary new optical designs, all boasting a range of high-performance ⅔-inch-format field and studio lenses. The f/1.4 optical barrier of the traditional ⅔-inch image block has been removed with the advent of the new f/1.2 prism block. HDTV has created the need for portable HDTV cameras, which is an additional incentive to further enhance this tube.

Unlike the 1¼-inch and 1-inch pickup tubes, which still employ the traditional magnetic deflection-magnetic focus electron optical scheme, the ⅔-inch pickup tube has branched out into three technologies:

- magnetic focus-magnetic deflection (mag-mag or MM),
- magnetic focus-electrostatic deflection (mag-stat or MS) and
- electrostatic focus-magnetic deflection (stat-mag or SM).

All of these technologies can be applied to high-performance tubes, but which would lead to the highest performance? An examination of performance characteristics central to high picture quality will show the thrust of the developments that have taken place. These are:

- resolution,
- registration,
- noise and
- lag and shading.

Pickup tube resolution

The need for a radical breakthrough in pickup-tube capability for HDTV led to a total re-examination of the electronic guns required to produce the requisite fine beam—and of the entire electron-optical system so crucial to the preservation of the precision beam profile all the way to the scanned target. It was this that led one company (Sony) to adopt the magnetic focus-electrostatic deflection (MS) system in the 25mm Saticon tube developed for HDTV. This system offered one major (and inherent) advantage, compared with the others, in maintaining a high resolution over the entire raster.

A brief review of the fundamentals of

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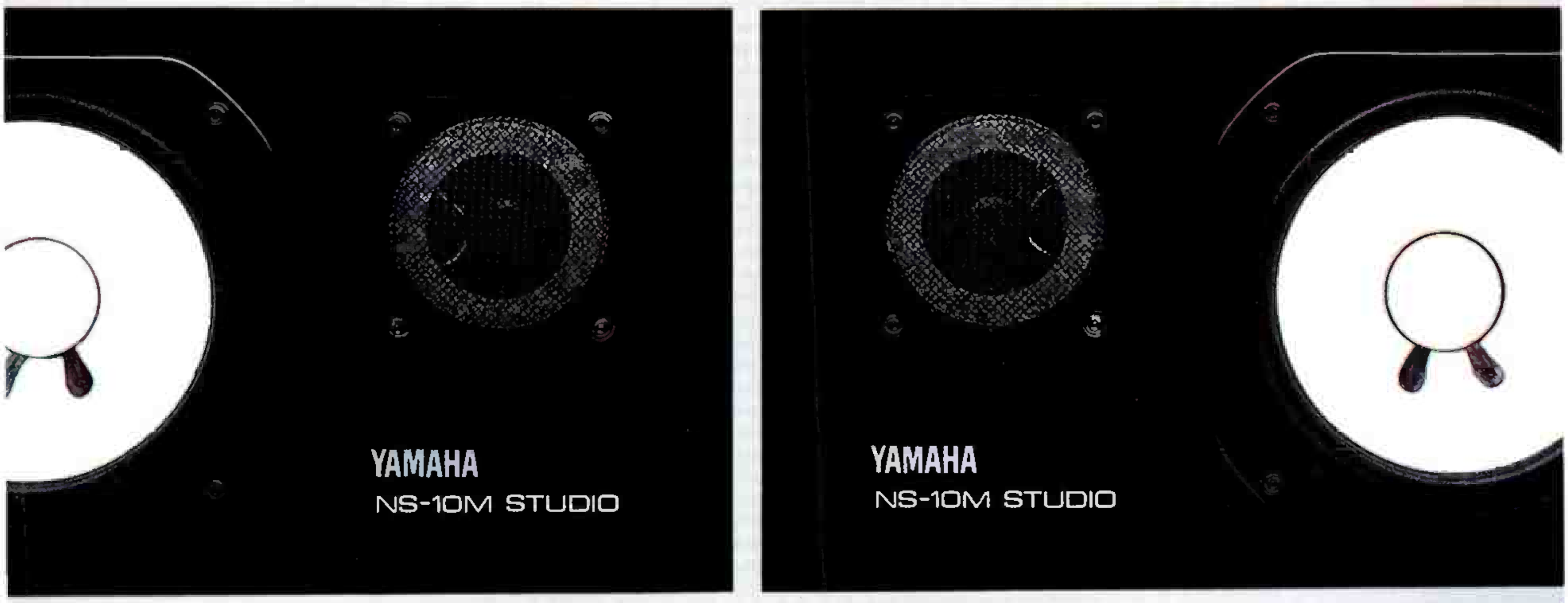

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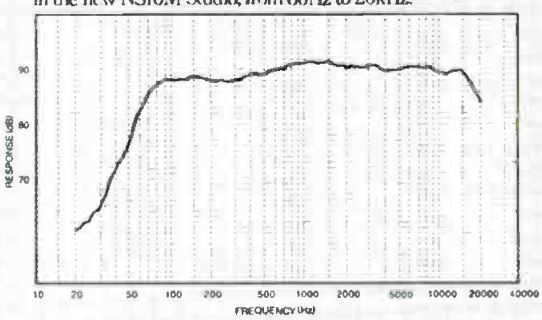

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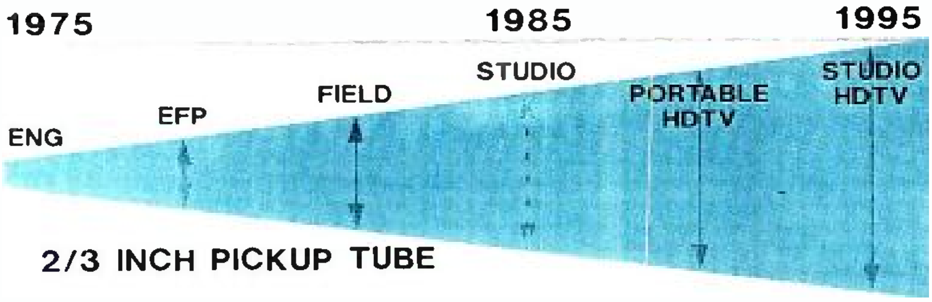

Figure 2. Thanks to HDTV research, the ⅔-inch pickup tube is improving at a remarkable rate.

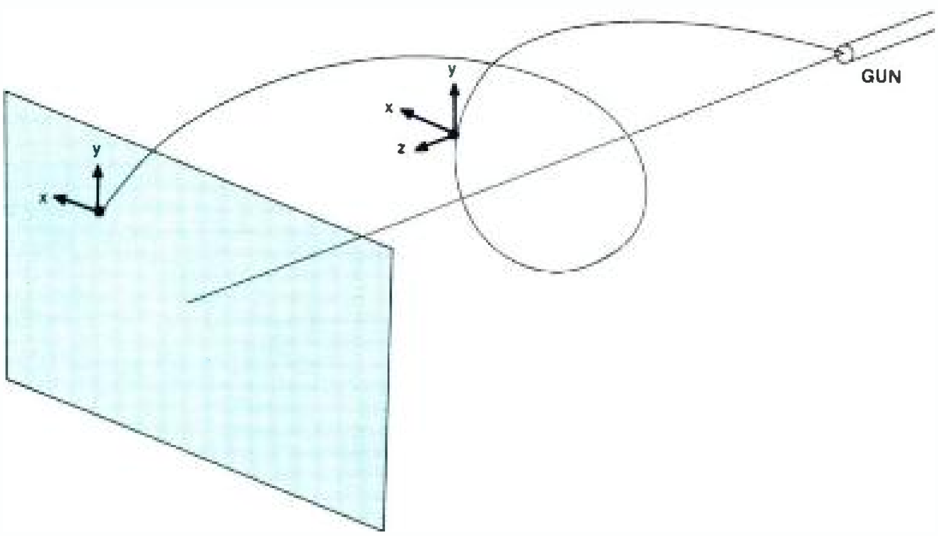

Figure 3. The force executed on the beam by two magnetic fields can be calculated using the mathematical equation F=e V B.

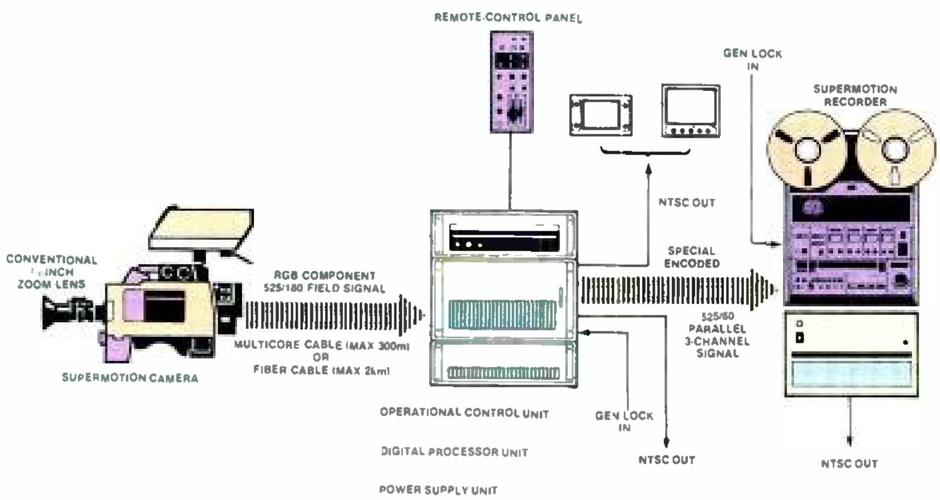

Figure 4. New developments in pickup-device technology have spawned innovations such as the supermotion camera system.

the beam ballistics within each of the three systems described may help you understand this. For the traditional magnetic focus-magnetic deflection system, the force executed on the beam by the two fields (see Figure 3) at any given pnint in space is given by the mathematical expression:

$$F = e V B$$

In mathematical parlance, *e* is a dimensionless quantity (scalar). magnetic field *B* has twn dimensinns—namely *x* and *y*, required for scanning—while the quantity *V* (electron velocity) is a full-vector, 3-D quality with three components (*x*, *y*, *z*), whose amplitudes change instantaneously depending on the location of the beam at a given instance.

It is the authnr's belief that a fundamental problem of magnetic deflection is that the 3-axis component of the velocity vectnr can impart an unwanted "deflection" component in the z-axis direction. The magnitude of this (when the full equation is multiplied out) becnmes a function of the x and y components nf deflection. That is, as the deflection increases, or the beam moves away from the raster center, the beam is increasingly defocused by the action of this 3-axis component. This is why the MM and SM pickup tubes suffer from corner defocusing.

The move to electrostatic deflection was made to overcome this difficulty. Here, the electron ballistics are governed in an entirely different manner:

$$F = e E$$

Again, *e* is the dimensinnless quantity of electronic charge, while *E* reflects the instantaneous value of the deflection field having only an x and a y component. Note that there is no velocity component and, therefore, no mechanism to introduce the defocusing z-axis component. Of the three systems, the electrostatic deflection brings a major technical advance to pickup-tube design. The only real merit of the alternate technology—electrnstatic focus—is a substantial reduction in the power consumption (admittedly attractive for ENG cameras) due to the elimination of the magnetic focus coil. There is, however, no real imprnvement in imaging performance compared with the traditional mag-mag system.

Following the early developmental work on HDTV tubes, this technology was subsequently spun down to a new ⅔-inch tube optimized for the standard 525/625 scanning systems. A new diode gun, and appropriate adjustment of the target layer, produced a resolution in the raster center equivalent to that of the 25mm and 30mm tubes and a corner resnlutinn superior to both, by virtue of the mechanism described here.

Registration

A perennial struggle in pickup-tube cameras has been the attainment of a high degree of geometrical precision and registration accuracy. The traditional problems can be attributed to:

- inaccuracies of, and tolerances among, the three tubes;
- inaccuracies of, and tolerances among, the three deflection coils; and
- "left edge" scanning deformation due


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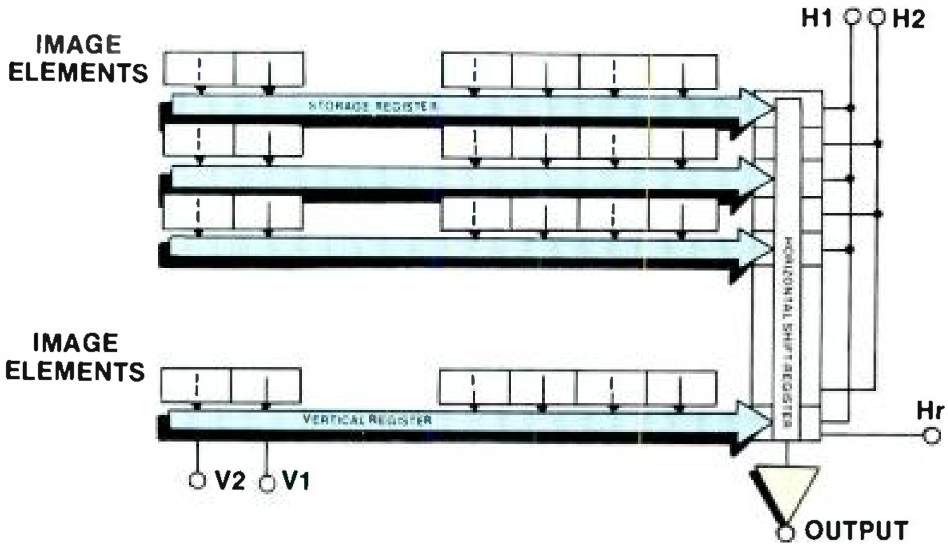


Figure 5. The interline transfer system stores information line by line to memory, reducing vertical smear.

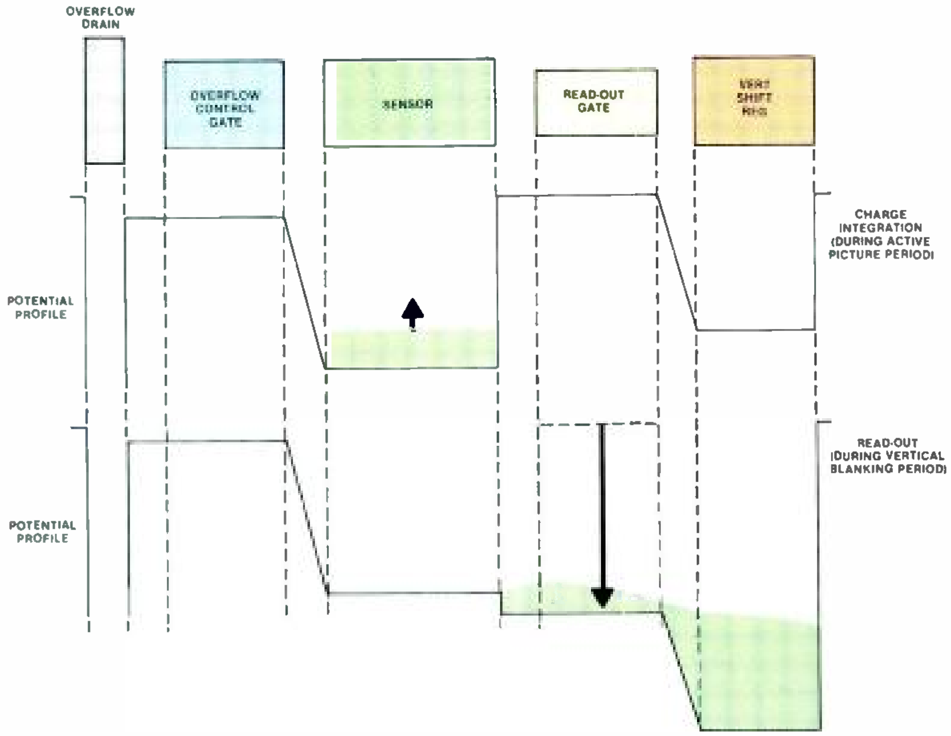


Figure 6. When a "well" is maintained, the greater contrast ratios can be shot.

to deflection coil ringing, which is a result of the large flyback-voltage stimulation.

The electrostatic deflection significantly improves this entire area by eliminating deflection coils. The electrostatic electrodes are deposited on a precision glass envelope and laser-etched to a high degree of accuracy. The geometry is dramatically improved. Coil ringing is eliminated, and overall registration precision is, consequently, enhanced.

Noise

Noise in a pickup-tube camera originates from two sources: front-end pre-amplifier and beam-shot noise. Noise from the front-end pre-amplifier involves the characteristics of the FET used in the first stage, total shunt capacitance at the pre-amp input, the load resistor and the bandwidth and phase characteristics of the closed loop amplifier, according to the expression:

$$\frac{S}{N} = 20 \log_{10} \frac{I_S}{\sqrt{4KTf_o\left(\frac{1}{R_L} + \frac{(2f_oC_t)^2}{3\,G_m}\right)}}$$

Where:

K = 1.38×10^{-23} Joules/degrees Kelvin = (Boltzmann's Constant)

T = Temperature in absolute degrees Kelvin

R_l = Signal electrode load resistor in ohms

G_m = Transconductance of FET in mhos

f_o = Video bandwidth in hertz

I_S = Peak white signal current in amperes

C_t = Total input capacitance in picofarads

Considerable strides have been made in the development of new low-noise FETs, in reducing the total front-end capacitance and in elevating the ohmic value of the load feedback resistor. All these improvements have contributed to the incremental elevation of the signal-to-noise performance. As pickup-tube format size is reduced, capacitance is lowered. This fundamental advantage of the ⅔-inch format is further enhanced by low-capacitance tube innovations. The smaller format size also lowers the signal current and, therefore, the beam current, reducing the noise contribution from the beam.

Recent FET developments are the results of the search for low-noise front ends capable of operation over the far greater bandwidths of HDTV. A new high-transconductance FET with unusually low capacitance has been produced, and is now used in high-end broadcast cameras.

Another kind of noise, of a coherent form that is related to the horizontal scanning, often is quite visible in cameras. Inadequate decoupling of the highly critical G4 electrode and poor shielding, generally in the front end, can cause unwanted picture impairments particularly in high gain. In many new mixed-field tubes, the G4 electrode is not brought out on a rear pin in the conventional manner but, rather, via a metallic ring at the front of the tube in the vicinity of the target. These cameras employ chip capacitors mounted right inside the front end. These innovations contribute to clean pictures.

Lag and shading

Lag is a problem inherent in the Plumbicon or Saticon photoconductive tube. It is a complex function of the target layer itself, of the characteristics of the discharging beam and of the "landing" characteristics of the beam on the target.

The refinement of the target layer is actually an intricate compromising of lag, resolution and sensitivity. The thinning of the layer that is required to raise resolution, unfortunately, also elevates lag. However, the smaller the image format, the less lag.

The lag behavior of a photoconductive tube is inversely related to its signal current density. This is expressed mathematically as:

$$\text{lag} = \frac{K}{\text{signal current density}}$$

Parameters of camera design

The various forms of TV shooting today place stringent requirements on many facets of a camera's design. This is perhaps best exemplified by contrasting the unpredictable conditions of ENG shooting and the meticulous control exercised in high-quality EFP.

Criteria in ENG shooting

Capture best possible picture under uncontrollable scene conditions.

Typical ENG scene

- poor lighting
- no lighting
- high-contrast
- poor shooting angle
- no rehearsal
- crowd environment
- temperature extremes
- no video operator

Key camera requirements

- high sensitivity
- wide dynamic range
- small and lightweight
- reasonable colorimetry
- reasonable resolution
- low lag
- ruggedness
- minimal technical adjustments

Criteria in EFP shooting

Capture highest quality picture under controlled scene conditions.

Typical EFP scene

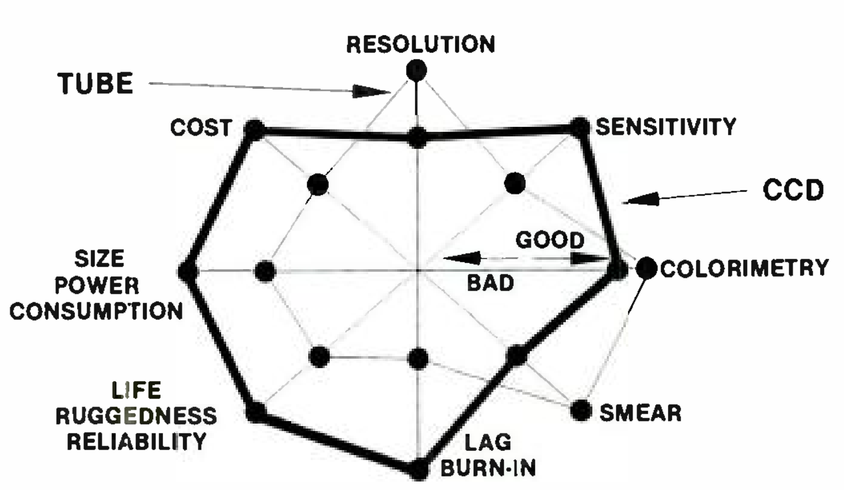
- controlled lighting
- controlled shooting angles
- controlled scene content
- optimized picture composition
- rehearsal
- video operator

Key camera requirements

- highest resolution
- optimum colorimetry
- high S/N

When camera design engineers analyze differences such as the ones listed here, they obviously favor the CCD imager for ENG shooting. The absence of imager setup adjustments, registration adjustments and imager aging all add up to the realization of an ENG camera operator's dream of a "grab and shoot" camera. The absence of lag, blooming and comet-tailing more than compensates for the shortfalls in resolution, colorimetry and signal-to-noise performance.

The parameter comparison between today's CCD and the modern ⅔-inch pickup tube can best be summarized by the "good news/bad news" diagram above. A radial move from the center in any direction is a measure of improved performance of the parameter in question.



A "good news, bad news" chart illustrates the differences between CCDs and tubes. Movement from the center indicates improvement.

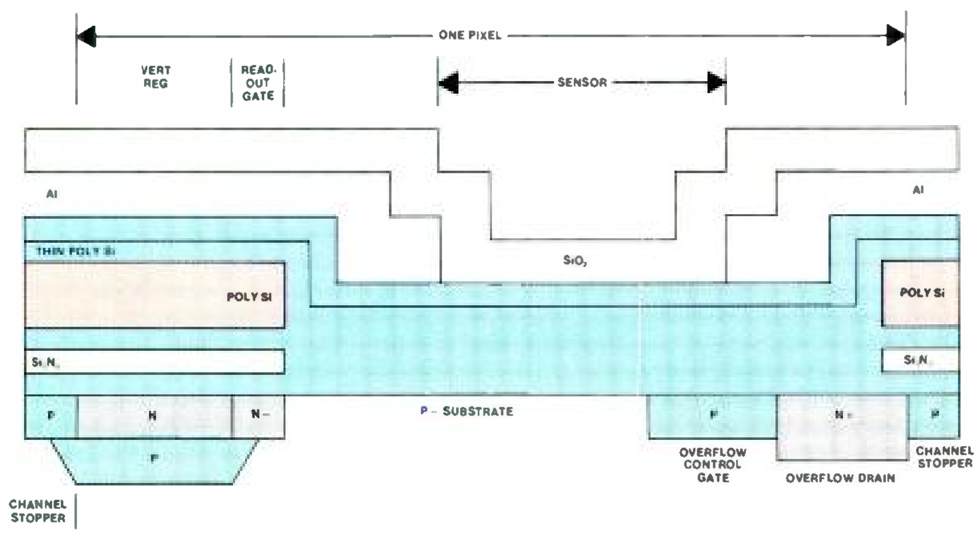


Figure 7. *The thin film layers over the CCD sensor enhance the sensitivity of the device.*

Where

$$K = \text{constant}$$

$$\text{lag} = K\left(\frac{1}{I_s/\text{image area}}\right)$$

$$= K\left(\frac{\text{area}}{I_s}\right)$$

Calculations for three formats would yield the results shown in Table 1. In addition, the new diode guns produce beams with less resistance, offering more freedom in achieving a compromise between high resolution and reasonable lag.

The pickup tube is, by anybody's definition, an imperfect device. It always has been. Every aberration poses another struggle for the tube design teams, but they continue to make improvements. Extraordinarily high-quality pictures can be produced if careful attention is given to operating the tubes in the most optimal manner. The ingenuity of the video circuit designer also has kept pace, and today's camera-processing circuits abound in marvelous schemes that exploit the capabilities of the pickup tubes to their limits.

Future directions

Tube development continues at a fast pace. Recent announcements of new, improved Saticon layers hold high promise. More manufacturers are embracing the electrostatic deflection technology. This mixed-field electron optical system also is spurring innovations in camera imaging. An example of this is the high frame rate supermotion camera as shown in Figure 4.

Electrostatic deflection makes possible the high scanning speeds involved (180Hz field frequency and 47.2kHz horizontal frequency), while maintaining broadcast registration specifications. The advancement of ⅔-inch tubes has taken them to the pinnacle of today's pickup-tube performance.

Broadcasters can expect continuing improvements in sensitivity, resolution, geometry and in reduction of lag and capacitance. HDTV research is stimulating systematic re-examination of all parame-

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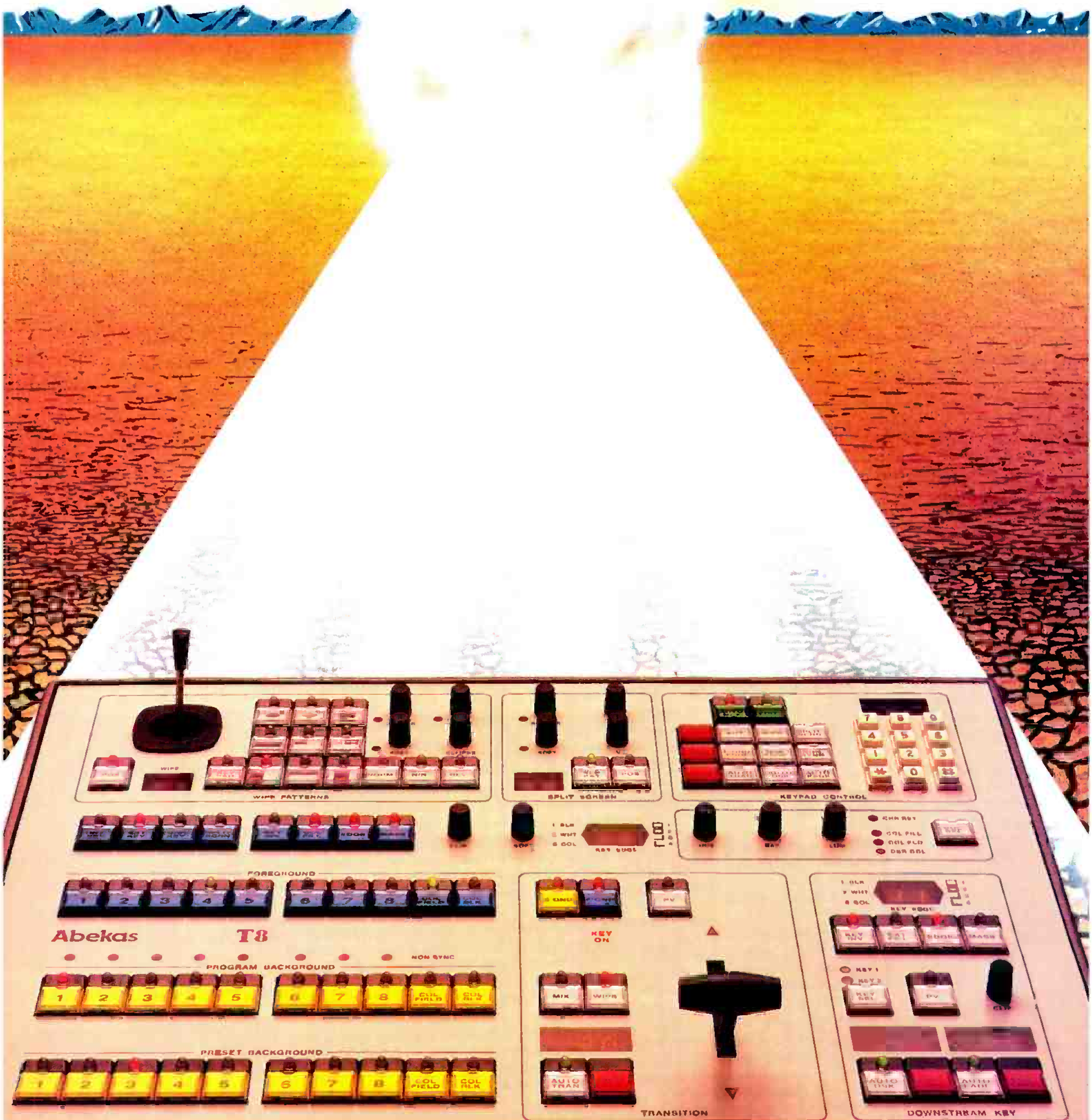

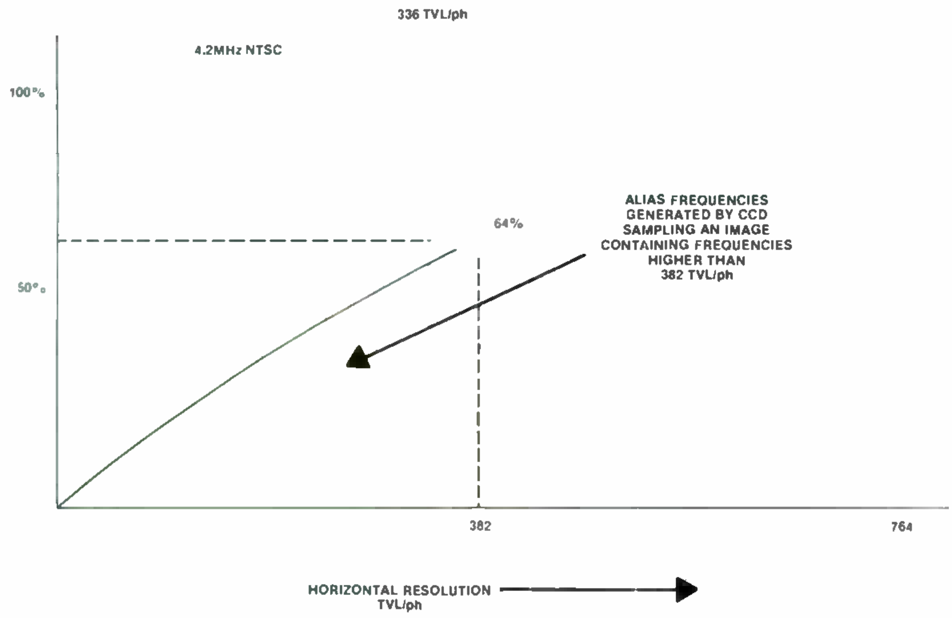

Figure 8. *Aliasing is created when high-frequency detail is introduced to the CCD array.*

ters of tube performance. The ⅔-inch tube is firmly in place as the industry standard for all levels of camera performance, ranging from ENG and EFP to the highest performing field and studio cameras.

CCDs in the marketplace

It's important to put the solid-state sensor in proper perspective regarding its current and future roles in the broadcast and production environments. Fundamental characteristics of these devices endow them with certain performance attributes that are strikingly superior to those of the pickup tube. In addition, the far greater life expectancy and the constant performance to be expected from such a modern microcircuit are major attractions when compared with the thermionic technology inherent in the pickup tube.

It is tempting to seize this new technology—and to expect from it more than it can deliver in these, its early days. There is a tendency to overlook some of the extraordinary qualities of the modern pickup tube. However, fundamental limitations exist in certain key performance characteristics of the current generation of CCD. Those drawbacks must be acknowledged by the camera manufacturer and understood by the end-user.

Bear in mind that the CCD is very much an analog device. Like the pickup tube, the solid-state opto-electronic transducer is a complex device, and like the pickup tube, it is also an imperfect opto-electronic transducer. It has many complex characteristics; some are advantages and some are not.

Each of these parameters has associated specifications that can vary from one manufacturer's technological imple-

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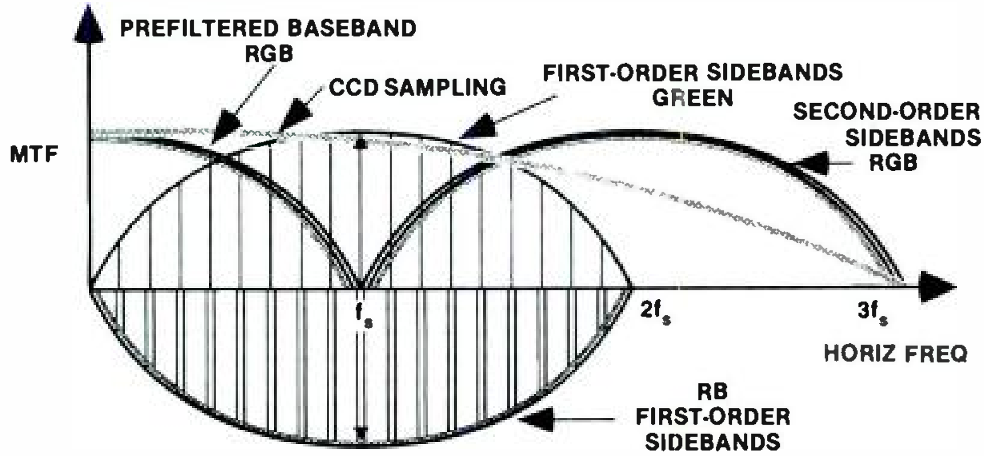

Figure 9. *Red and blue chips, spatially offset, tend to cancel red and blue first-order sidebands.*

mentation to another. In addition, the specs can vary on the device production line, change with temperature, and, more significantly, they can vary from pixel to pixel. Compared with the relatively homogeneous surface of the photoconductive layer in the pickup tube, the solid-state opto-electronic transducer is a whole new ball game.

The most fundamental picture-making capability of the CCD—its resolving power—is directly related to the fact that quantities of pixels can be laid down on a chip. The more pixels, the greater the potential resolution. However, the capability to produce pixel quantity also is a direct measure of contemporary, state-of-the-art microcircuitry. It isn't easy. In fact, it's a major technological struggle, one that will be eased by the continuing miniaturization of this highly complex microcircuit.

Different CCD technologies

Just as the pickup tube splintered into different types of photosensitive layers (each with its own merits) and into different electron-optical methodologies, so, too, has CCD technology developed. Vigorous R & D is under way to perfect the basic sensor. Different approaches are being taken on this sensor, and individual pixels represent an advanced semiconductor design.

The digital technique employed to transfer and assemble the vast array of discrete analog information into an output serial video signal is known as the *transfer mechanism*. A variety of schemes have been employed. Two principal transfer-mechanism methods have emerged. (See "Applied Technology," page 136 in the October 1986 issue of **Broadcast Engineering**.) The Western world tends to prefer a scheme known as *frame transfer* while the major Japanese companies seem to favor the *interline-transfer* mechanism. Figure 5 is a simple depiction of the interline-transfer system.

Both transfer mechanisms have distinct advantages, and both have limitations. The overall quality of a given CCD is a function of many other key attributes of the design; the transfer mechanism is only one aspect of a multifaceted design. More recently, hybrid imagers have emerged. These use both methods of transfer mechanism, combining the merits of the two.

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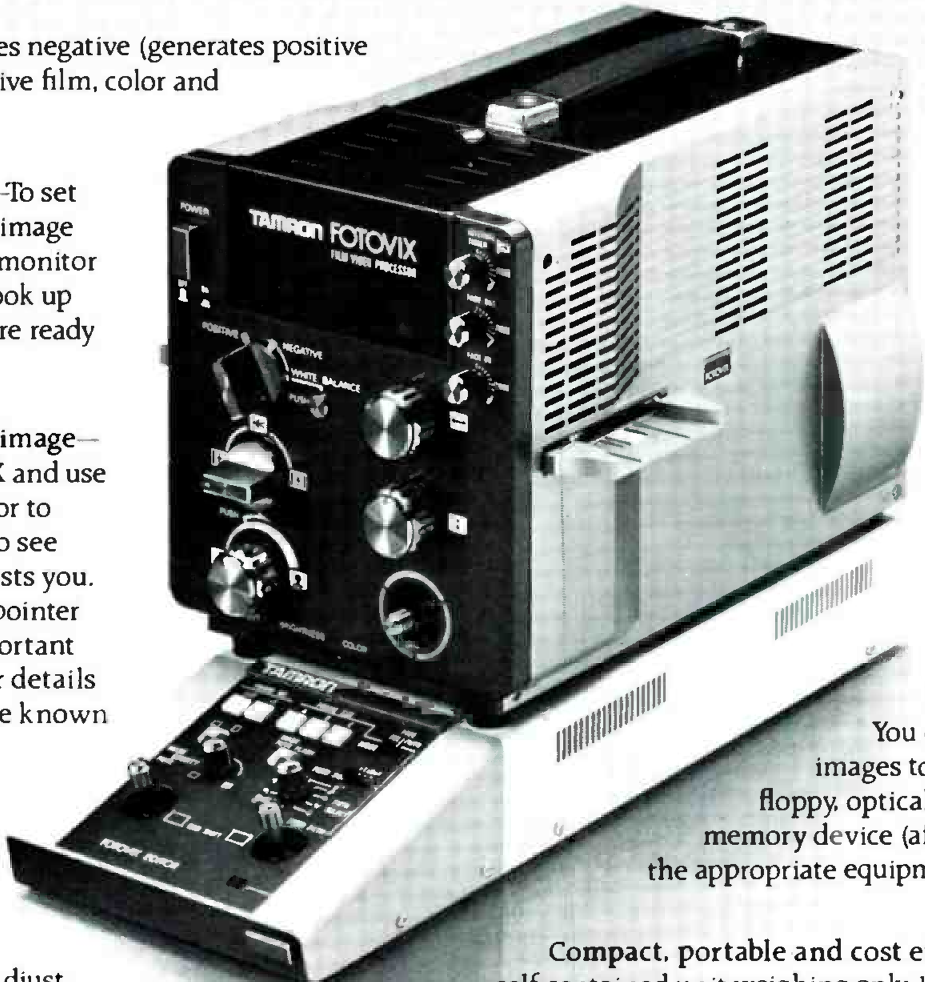

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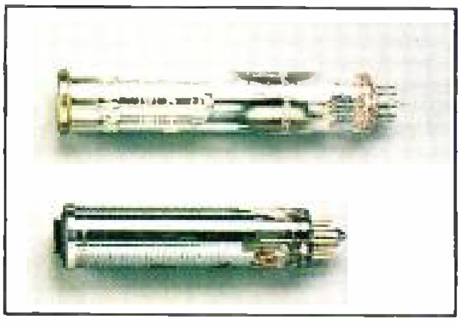


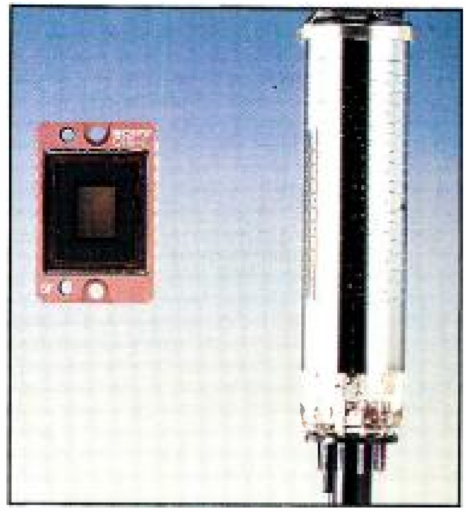
The CCD is an analog device that is still in its early growth stages. Its resolving power is limited to the number of pixels that can be laid down on a chip.

The sensor popular today in many of the broadcast cameras uses a diode photosensor. This technology has been taken a step further with the refinement of a MOS diode sensor, which imparts a much higher efficiency to the rapid transfer of the charge from the individual sensor to its adjacent register. The total emptying of the sensor "well" within each vertical blanking interval is the guarantee of zero lag (see Figure 6). The MOS diode sensor also employs a number of proprietary thin film layers that enhance the sensitivity of the sensor (see Figure 7).

In addition to the inherent sensitivity of the photosensor, the capability of the sensor well to accumulate charge beyond the normal camera exposure level is a measure of its capacity for a wider dynamic range. In the case of some high-end broadcast cameras, the well has a 600% overload capability. That is, it accumulates charge linearly up to a level of 600% above normal camera exposure. When the well is "full," other technologies come into play, such as the proper handling of any further generation of charge if the light level continues to increase, as in the case of a severe highlight. How it is handled directly determines the blooming characteristics of the imager.

Two issues are central to an "advanced" CCD imager: the number of pixels and the "goodness" or "quality" of each pixel. A real imager simply cannot separate the two. The overall quality of that pixel will determine:

- sensitivity
- dynamic range
- signal-to-noise ratio
- lag
- blooming
- temperature-dependence characteristics



The 25mm (⅔-inch) pickup tube has benefited greatly from HDTV research.

All of these qualities, of course, add up to the "goodness" of the camera.

CCD and resolution

It is true that a high number of horizontal pixels inherently offer the potential for more horizontal resolution. However, there is a great deal more to it than that. The final luminance horizontal resolution actually realized is an intricate in-

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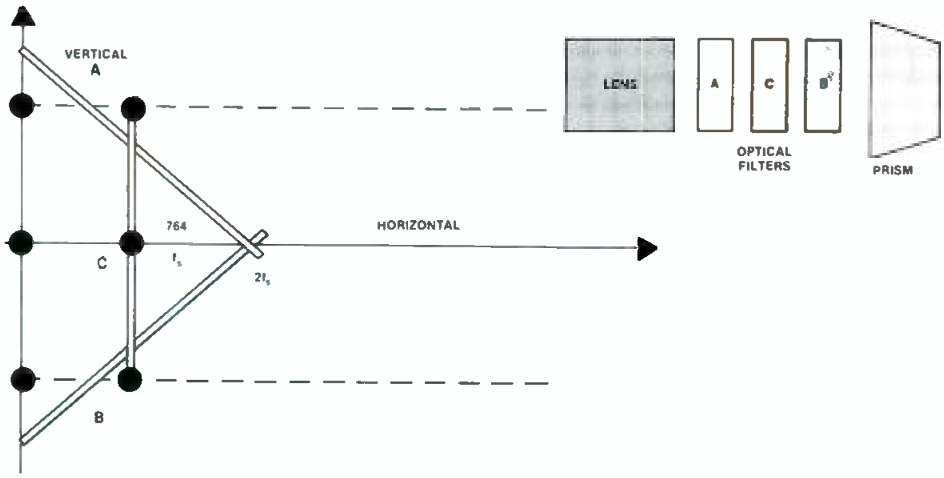

Figure 10. Optical low-pass filters can be used to control aliasing.

terplay of each of the following:

- horizontal pixel count;
- width of individual sensor;
- characteristics of optical low-pass prefilter;
- characteristics of sample-and-hold circuits with associated electrical low-pass filter;
- registration (precision of mounting of chips to prism); and
- employment (or not) of spatial offset and the precision with which this is accomplished.

The CCD inherently introduces interference when looking at high-frequency detail information (see Figure 8). This is fundamental to the discrete sampling nature of the CCD. The phenomenon is called *aliasing*. The trick is how to precisely mount the CCD imagers to the prism block, and how to implement the optimum compromise in the various filters to achieve useful resolution and minimum aliasing. Each technique involved is an exacting science and a highly technological implementation.

In the Sony BVP-5, the red and blue chips are spatially offset in the horizontal direction by ½-pixel. This has the effect of reversing the phase of the first-order sidebands of the red and blue signals relative to that of green (the many sidebands produced are, of course, a result of the sampling nature of the CCD imager). As shown in Figure 9, capitalizing on the cancellation effect of the red and blue first-order sidebands on that of the green allows the prefiltering to be designed in a manner that extends the signals beyond fs/2 (the normal Nyquist limit).

Horizontal resolution is one popular yardstick. Keep in mind that the real pictures you see are exercising resolution in all radial directions. That is why some cameras have three optical low-pass prefilters, to more effectively control the aliasing and symmetrically filter the picture in all dimensions. (See Figure 10.)

Finally, because of the nature of the final luminance frequency response (due to the sampling nature of the CCD), special attention must be paid to the detail correction system.

CCD noise

Compared with the CCD, the pickup tube is relatively simplistic from a noise-generation viewpoint. The photon-related shot noise of the beam is the only

Main story continues on page 46

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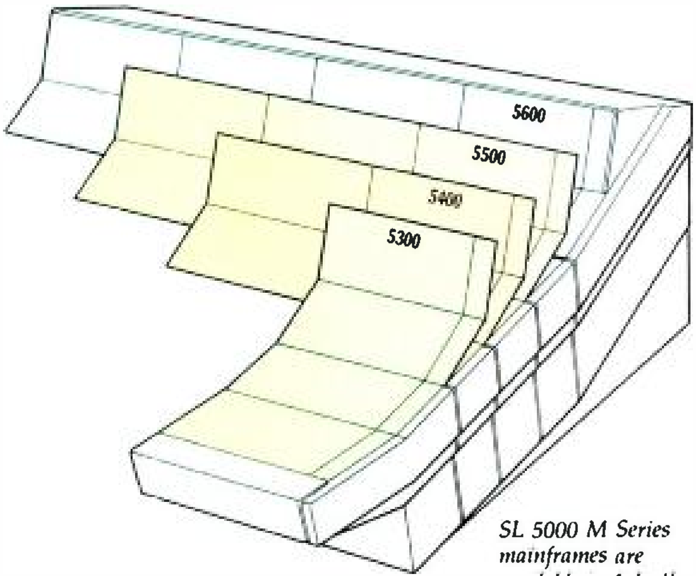

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Specsmanship

Camera brochures, for all camera types and from all manufacturers, can be somewhat deceptive. This is due not so much to what appears in the technical specifications section, as it is to what does not appear. The lack of information stems from the assumption that much of the implicit material is understood (which is not always the case), a desire for brevity, an absence of standards and a recognition of the genuine problems encountered in specifying certain parameters. This state of affairs makes it particularly difficult to assess a CCD camera's true performance capability. The specsmanship employed by most CCD camera manufacturers is the same used for pickup-tube cameras. It ignores the many new parameters of the solid-state imager. Consider three key parameters central to the composition of a high-quality video picture:

- resolution,
- colorimetry and
- signal-to-noise performance.

If you examine the latest brochures for three new CCD cameras, you'll find:

PARAMETER	CAMERA A	CAMERA B	CAMERA C
RESOLUTION TVL	550	40% DEPTH OF MODULATION AT 5MHz	650
COLORIMETRY	---	---	---
SIGNAL TO NOISE (dB)	58	---	58

All these specs portray a tidy, succinct set of numbers which, in fact, tells very little. On colorimetry, all are silent. This is perhaps not so much a deliberate ploy to deceive than it is the perpetuation of a legacy of carelessness and the result of a lack of measurement standardization in the industry.

For an end-user to truly assess the capabilities of each of these CCD cameras, the first evaluation, at brochure level, should be followed by some basic measurements. The following is suggested as a simple, practical measurement procedure that will easily reveal the pertinent qualities of each camera. It is based on a practical yardstick—a side-by-side comparison with your favorite pickup-tube camera and the availability of a couple of popular standard test charts.

- *Resolution:*
  1. Measure luminance depth of modulation at 330 TVL (4.2MHz) using standard burst chart *with detail off.*
  2. Note presence or absence of aliasing in all bursts up to 330 TVL. (This is a measure of cleanliness in useful video band.)
  3. Measure luminance-limiting resolution (highest frequency burst that is resolvable).
  4. Measure aliasing content within bursts greater than 330 TVL. This tells a great deal about the various techniques employed in the camera.
  5. Turn on detail correction. Adjust 300 TVL for 100% depth of modulation. Assess flatness of frequency response up to 300 TVL. Assess aliasing behavior below 300 TVL.
  6. View subjectively a typewritten page at different zoom angles.

Following this procedure with any two of the CCD cameras side by side with a pickup-tube camera will reveal the relative resolution merits of each CCD camera.

- *Colorimetry:*
  1. Using your favorite color chip chart, measure vectors on a vectorscope against your favorite tube camera. Note behavior of vectors (amplitude and angle) when linear matrix is switched on and off.
  2. Compare CCD camera side by side with your favorite pickup-tube camera while viewing a human face and hair. Note behavior over entire gain range.
  3. View a wide range of colors—in clothing, plactic items, flowers and other objects—to assess the "holes" in the color spectrum.

- *Signal to noise:*
  1. Make the traditional measurement, just as you would on a pickup-tube camera (that is, unweighted luminance over a 4.2MHz bandwidth, gamma at unity, detail off, linear matrix off, color trap on). This will check the spec published in the brochure.
  2. With gamma on and detail set to your liking, view a gray-scale chart. Note the subjective noise at each level of the gray scale. While in auto iris, switch to 9dB, then to 18dB gain. Note the form and the subjective amount of noise compared to your pickup-tube camera under similar conditions. This will tell a lot about the CCD noise characteristics.
  3. Point the camera at a low-lit scene (about 1fc or 2fc), and raise gain to 18dB. Pan the camera slowly from side to side. The subjective visibility of a meshlike effect will be valuable in assessing the fixed-pattern noise associated with the pixels and will indicate the quality of the pixels.
  4. Again, viewing a gray-scale chart, examine the picture at 0dB, 9dB and 18dB for fixed dark lines (usually vertical, at regular spacings). If present, they indicate unwanted clock noise or crosstalk associated with the clock-driving circuits of the CCD.

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Continued from page 42

noise source generated by the pickup tube itself.

The CCD device, on the other hand, has associated with it a number of noise sources:

- shot noise associated with photon action;
- fixed-pattern noise associated with the discrete nature of the dark current within each individual sensor;
- reset noise associated with charging and discharging of output capacitance; and
- output amplifier noise, both white noise and 1/f noise.

Again, basic semiconductor design can influence the form and magnitude of each of these contributions. Process control in manufacturing also is important in reducing the individual noise levels and their tolerances. Remarkable strides have been made in reducing CCD final noise.

However, although the standard noise-measurement technique may produce an rms noise reading equivalent to that from a pickup-tube camera, the subjective appearance of the CCD noise is unquestionably more disagreeable. It has a "busier" form. Different CCD designs manifest different forms of visible noise. In some, the 1/f and reset noise may predominate. In others, the fixed-pattern noise may be objectionable.

A particularly imposing challenge to the CCD camera designer is the elimination of crosstalk associated with the digital clock drivers for the CCD. Like the coherent noise described for the pickup tube, this clock noise manifests itself as stationary dark lines within the active picture raster.

One specific area in which some CCD designs are more vulnerable than the pickup-tube devices is the temperature dependence of the individual sensor dark current. This can cause adverse changes to black shading and fixed-pattern noise visibility as the camera encounters different environments. Again, individual CCD design technologies show different types of behavior in this respect. (See the related story, "Specsmanship," page 44.)

CCD vs. tube for ENG and EFP

The essence of camera design is to use an imaging system as efficiently as possible to capture a "slice" of the enormous contrast range of live scenes. Camera video processing is now tasked with somehow passing as much picture capture as possible through the final bottleneck—the approximately 100IRE units between the black and white clippers of the video processing—prior to encoding. All imagers have finite dynamic ranges with upper and lower limits. Furthermore, they all have impairments at both

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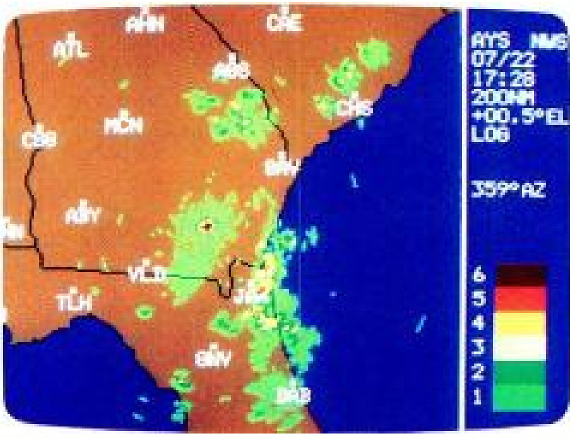
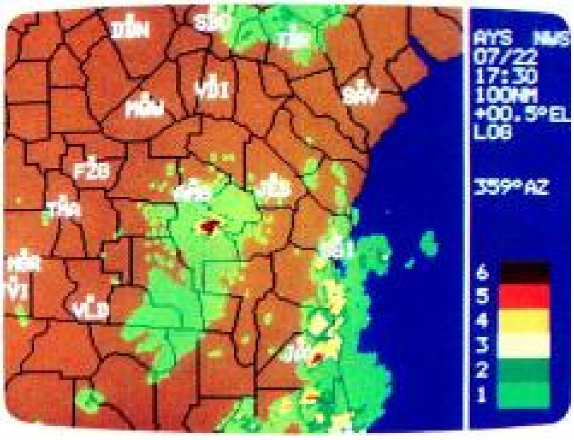
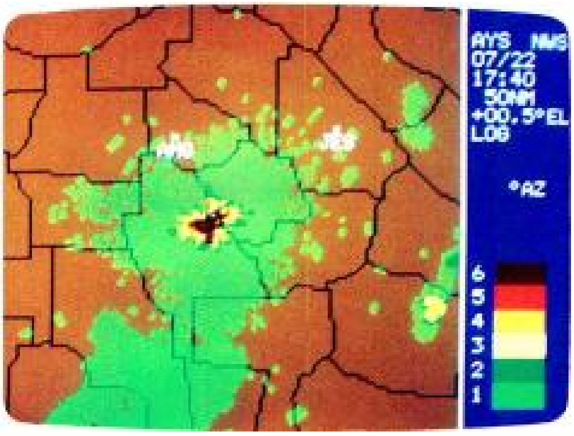


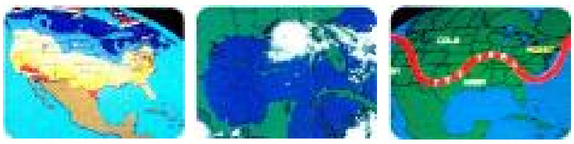
Waycross, GA: 200-nautical mile range.



Same storm, 100-NM range (with county lines).



Close-in, 50-NM range (same storm).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ends of their dynamic range. Some of the more typical are listed below:

Upper end	Lower end
• blooming	• lag
• comet-tailing	• noise
• retentivity	• flare
• permanent burn	• shading

These impairments detract from the useful dynamic range of a given sensor and effectively lower the two boundaries. If you must resort to increased video gain when seeking an adequate video level for low-light scenes, lag and noise can make the picture unusable.

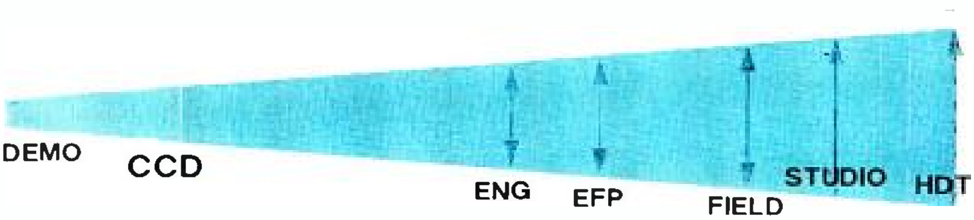

Figure 11. The future of CCDs and tubes is clear; they will both improve greatly.

These impairments must be cast in proper perspective with the basic picture-making qualities of the imager (pickup tube or CCD). Essential qualities such as colorimetry, resolution and signal to noise must be considered. Separating the types of TV production being contemplated can help you decide whether a pickup tube or CCD is the better choice for a given application. For example, the two worlds of ENG and EFP call for quite different consideration (see the related story, "Parameters of Camera Design," page 34).

Those conversant with the technical limitations in pickup-tube cameras try to overcome them by using techniques born of years of experience. Although this often restricts total shooting freedom, most people in the industry are accustomed to working within these limitations when seeking a high-quality video image.

In ENG shooting, however, it may not be possible to implement such control. Here, the superlative ruggedness of the CCD excels. The qualities of today's devices—the higher sensitivity, increased dynamic range and the absence of lag, comet-tailing and blooming—all allow picture capture in the most difficult of ENG scene conditions. The current limitations in CCD resolution, colorimetry and noise yield to the more reliable capture of an important (sometimes fleeting), usable video image.

In high-quality EFP production work, however, in which the production team often stretches every contributing factor to the limit to realize the picture that meets the director's vision, some specific performance parameters emerge as predominant. Resolution and colorimetry are paramount components of a beautiful video image. No compromise is acceptable, and no imager today is quite good enough. The pickup tube, however, indisputably holds the lead in these two critical areas, and is likely to do so for some time. Their continuing, but slow, improvement will pace the equally slow advance of the CCD. It's for sure, however, that the gap will steadily narrow. Figure 11 outlines the milestones in the evolution of the CCD.

It is difficult to predict accurately when the CCD will advance to EFP quality, to studio quality and on to the requirements of HDTV. The day will come, however, when the gap narrows so much that the other striking attributes of the CCD will tip the balance, and the era of the pickup tube will surely wane. [BE]

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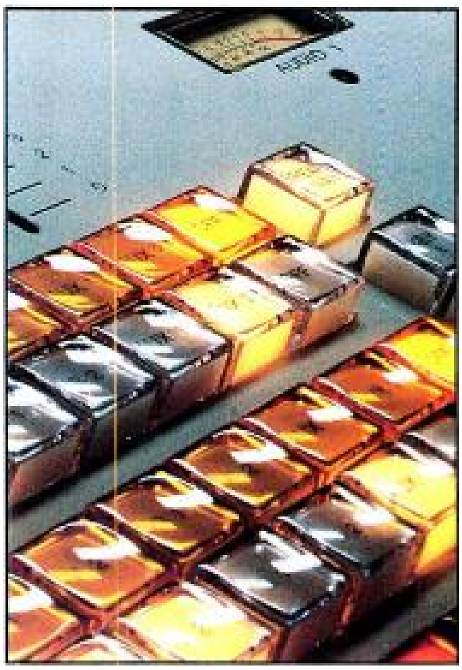
Video in transition

By Victor L. Kong



Integrating component video into a composite system requires special attention.

During the first 40 years of television, facilities throughout the world handled the TV signal exclusively in composite form, even though the basic component signal elements of the red, green and blue of a color picture were available from the camera or an artificial studio source. The TV signal in its baseband form (which will be referred to here as a video signal) had to remain in the composite format so that program material could be archived. Until about five years ago, the problem was that VTRs could record only composite signals.

Component vs. composite

The video composite signal was an ingenious way of carrying all three basic signal components. Luminance, chrominance and synchronization information are encoded in a unique way following a fairly rigid equation. However, in order to fit all the component information into the limited bandwidth and dynamic range of the composite waveform standard, the luminance and chrominance components must be scaled in bandwidth and signal levels.

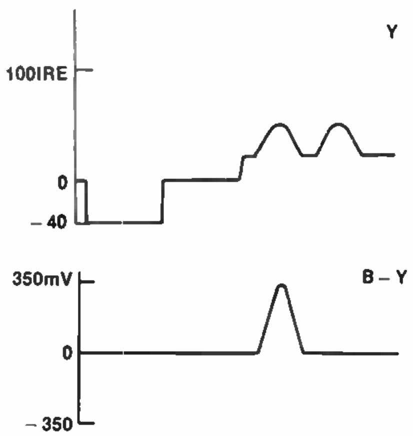


Figure 1. Dual timing pulses are used to monitor component levels and timing at the composite output with a composite waveform monitor.

This process is final and largely irreversible. The decoded component signals from the encoded composite signals lose, to some extent, the fidelity of the original signals. More importantly, undesirable artifacts are introduced unless elaborate and extensive decoding methods are employed. These distortions, however, are relatively unimportant to the viewer if the translation occurs only once.

It should be remembered that even the domestic TV receiver translates composite signals to a component format, driving the picture tube with either R, G and B or the color-difference signals of R–Y, G–Y and B–Y. The distortions introduced into the picture by the decoding process depend entirely upon the quality of the decoder employed. The idea of a component analog transmission system is unlikely; digital technology will come before that type of system becomes a realistic consideration or requirement.

Kong is president of Magni Systems, Beaverton, OR.

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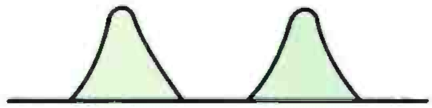

Figure 2. On a composite waveform monitor, Y and color-difference signals matched in amplitude and delay display a flat baseline.

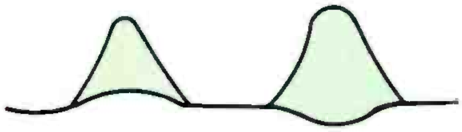

Figure 3. Vertical bowing of the composite baseline indicates amplitude errors. A waveform such as this indicates low B–Y and high R–Y amplitudes.

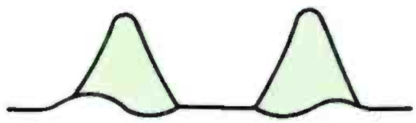

Figure 4. If the composite baseline curves like a sine wave within each pulse, it is because of time delays between Y and color-difference components.

Video signals in component form have proved to be superior to those in composite form when signal processing and manipulation is involved, such as in digital effects and video graphics. The integration of computer and IC technologies into the TV industry brought about this evaluation. When more and more individual pieces of equipment are processing video signals in their component form, yet continue to interface with each other in a composite form, serious signal degradation is imposed if multiple signal encoders/decoders are in the chain.

To minimize the distortion artifacts and signal degradation, signal interfaces between equipment should remain in the component form. This solves one problem and creates several more:

- What about existing equipment such as VTRs, frame synchronizers, switchers and more, most of which cannot be converted readily for component interface?
- What should be done with all the archive materials that are recorded in composite form?
- How does an individual operation handle materials and equipment in both formats?
- Can operations handle component analog formats that also are different?

The result is that the transition from composite to component signal interface is not revolutionary, but evolutionary. The industry will have to live with both signal standards for many years—until the conversion is complete, all the current equipment has been replaced, and the archived program materials become obsolete.

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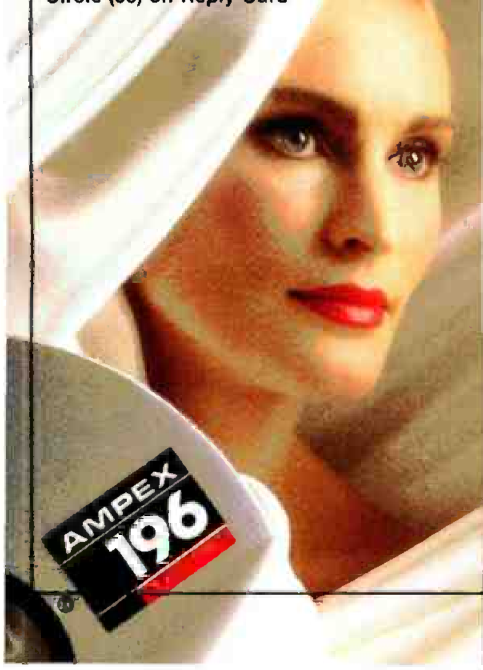

Component descriptors

The labels R, G, B are typically used to describe the single-channel, non-complex component make-up. When compared with the complex signals (the color-difference signal line-up of Y, B−Y, R−Y), however, a break in logic occurs. Y should be more nearly compared to G. Therefore, it has become more conventional to change the single-channel 3-wire descriptors to G, B, R. The full set of descriptors becomes:

NTSC			Composite
G	B	R	Component, 3-channel, non-complex
Y	P_b	P_r	Component, color-difference (SMPTE/EBU)
Y	B−Y	R−Y	Component, color-difference (Betacam or M-II)

In a 2-wire format (frequency or time-division multiplexed signals for component recorders), the designators are:

Y	CTDM	Betacam
Y	CTCM	M-II

Mixed format environment

The composite signal equation is derived from three component signal equations (using one of G, B, R; Y, B−Y, R−Y; or Y, I, Q). They remain in a one-to-one correspondence relationship except for the unwanted artifacts introduced and bandwidth constraints in the system.

The signal-quality measurements of a signal in its composite form also must be made on signals in their component form. You can correlate the results if you can identify the relationship between the signals and understand what you are

Continued on page 58

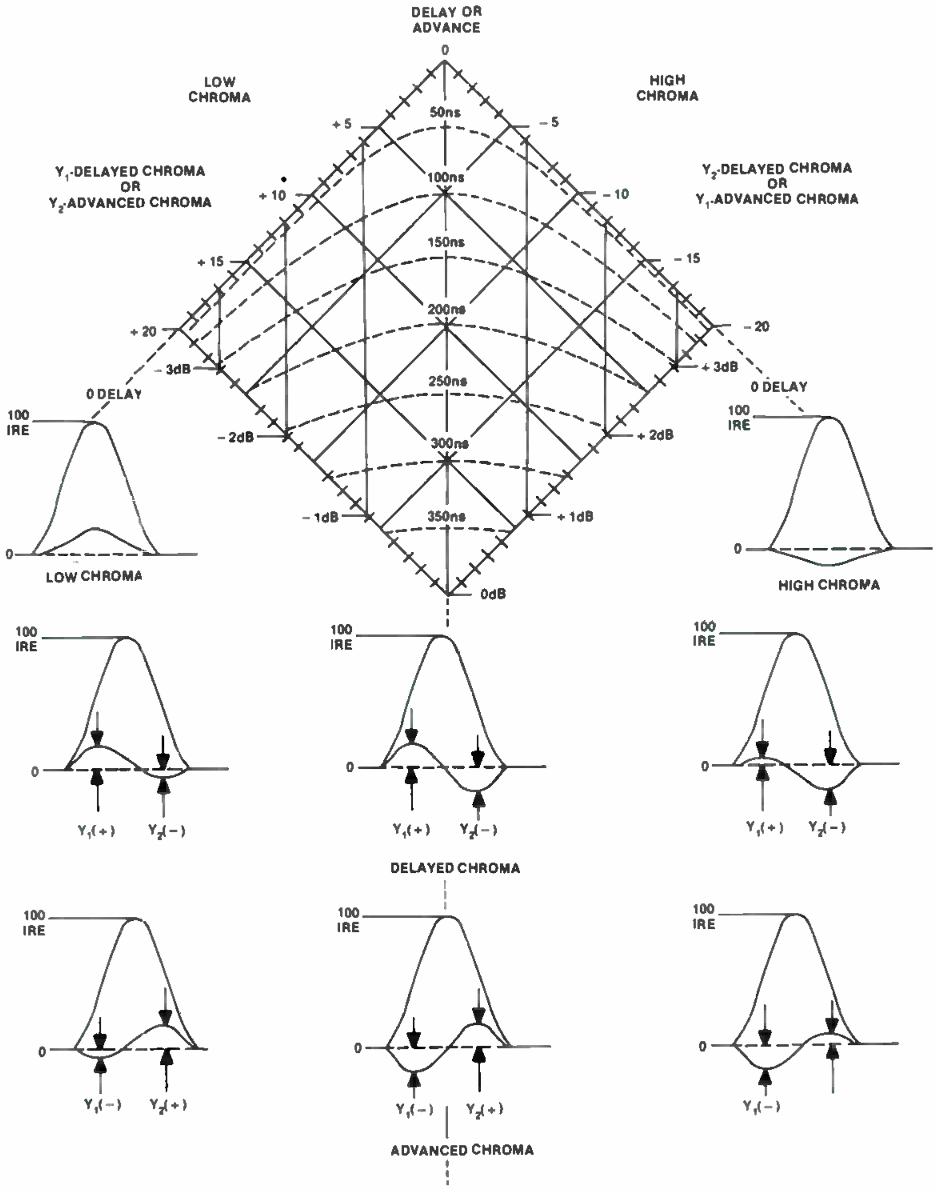

Figure 5. Nomograph for determining Y−C gain and delay errors. The delay is $(Y_1 - Y_2) \times 10$ in nanoseconds if the amplitude is correct. When amplitude is in error, delay and gain errors can be read from the chart.

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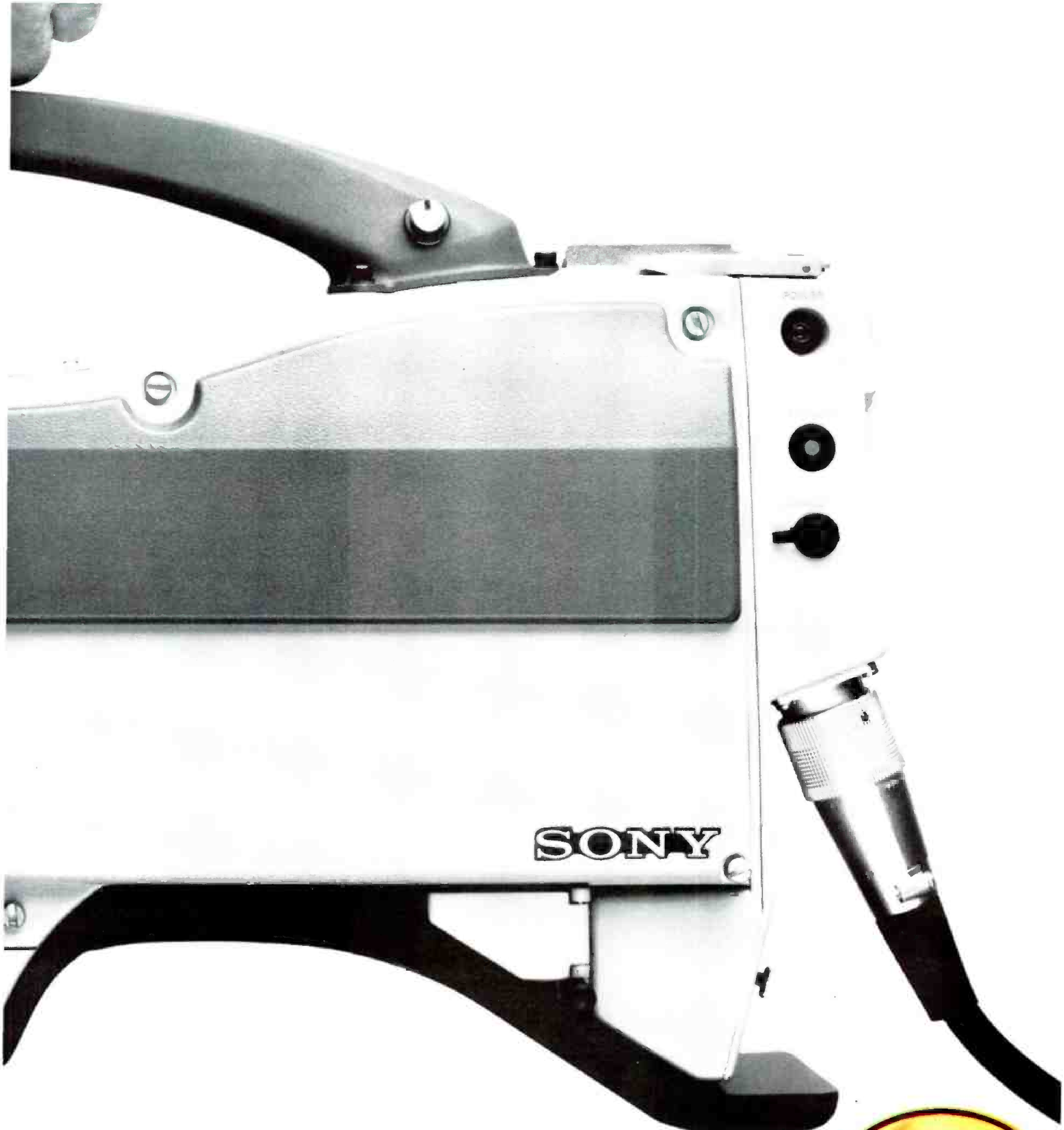

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Continued from page 54
seeking and, in some cases, what you are seeing.

Various figures of merit are used for measuring video quality in the two systems. The common issues for both component and composite signals are channel gain and frequency responses. Unique to composite signals are differential gain and differential phase, chrominance/luminance delay and gain inequalities. With component signals, relative gain and timing among the channels are the most critical adjustments, and in cases in which timing/gain cannot be corrected, the inequalities must be measured.

Differential gain and differential phase measurements are not applicable in the analog component domain; they are purely a function of the system quality of composite equipment. However, it should be noted that the non-existence of the measurement of differential phase and gain in, for example, the Y-channel of a component system does not mean that the causes of those distortions have been removed. Those causes could create other distortions in the final coded, composite signal. In this respect, testing equipment, such as distribution amplifiers with a modulated ramp, might be quite useful even in the totally component studio.

The most critical test for a composite or component signal is its tolerance to delays. This is the timing between chrominance and luminance for the composite signal and the timing between channels for component signals, whether in 2- or 3-wire configurations. Errors result in color misregistration along the horizontal axis, causing a loss of resolution on vertical edges and an apparent color fringing resembling a convergence error. This can be detected easily by observation on a color picture monitor.

Relative gain error (chrominance-luminance gain inequality in the composite form and relative interchannel gain in the component environment) is not as critical as the relative delay error. If all of these measurements could be combined into one simple method, it could ease the pain of having to analyze them separately. Although the methodology invites innovation, it also allows the user to slip comfortably into well-known and tried systems of measurement. The measurement burden, therefore, is not dramatically increased.

It also should be possible to continue full use of the existing installed equipment. A novel, yet standard, interchannel timing and gain measurement and adjustment technique is available using the unique characteristics of the modulated sine-squared pulse.

Modulated sine-squared pulses are capable of measuring the gain and delay errors of two signals. The method has been used extensively in the composite environment since the late 1960s for chrominance-luminance gain and delay inequalities. The measurement results can be interpreted readily with a scaled nomograph.

Dual timing pulses signal

The same technique by which two signal components of the modulated sine-squared pulse are subjected to minimal distortion during the encoding-decoding process can be applied to the three component signals. This has been done through the use of *dual timing pulses* in the component signal forms, which directly correlate to the modulated sine-squared pulse in the composite form. The dual timing pulses technique ensures that all equipment maintains signal integrity during the interfacing between the units, whether in the composite or component form, until the final translation/encoding to composite form for terrestrial transmission.

If the CAV signal is to be encoded to NTSC, the dual timing pulses allow video operators a simple operational method to

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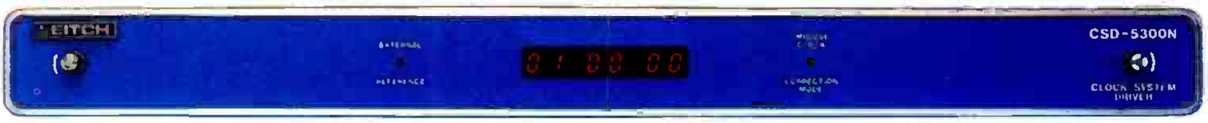

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*Generates SMPTE. EBU Time Code.

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quickly verify amplitude and timing between the luminance and color-difference channels. The signal is monitored on a standard NTSC waveform monitor. In the dual timing pulses signal shown in Figure 1, the luminance channel contains twin 12.5T sine-squared pulses. The leading pulse is time-coincident with a 12.5T sine-squared pulse in the B–Y channel and reveals distortions between Y and B–Y. The second is time-coincident with a 12.5T sine-squared pulse in the R–Y channel and reveals distortions between Y and R–Y. All the pulses have the same half-amplitude duration, and in the encoding process, produce two 12.5T modulated sine-squared pulses with their modulations on the B–Y and R–Y axes, respectively.

Any amplitude or timing errors between the Y and B–Y or Y and R–Y channels will show up as distortion on the baseline of the encoded pulses. A flat baseline indicates no amplitude or timing errors on the output (see Figure 2).

Pulses with baselines that are bowing up or down, as in Figure 3, indicate an amplitude error between the luminance and the corresponding color-difference component. If the luminance amplitude is correct, an upward bow indicates that the color-difference amplitude is too small. Conversely, a downward bow means that the color-difference amplitude is too high. An amplitude error measurement on a 12.5T modulated sine-squared pulse (normalized to a peak amplitude of 100IRE), a 1IRE (or 1%) peak bow corresponds to an approximate 2% color-difference amplitude error.

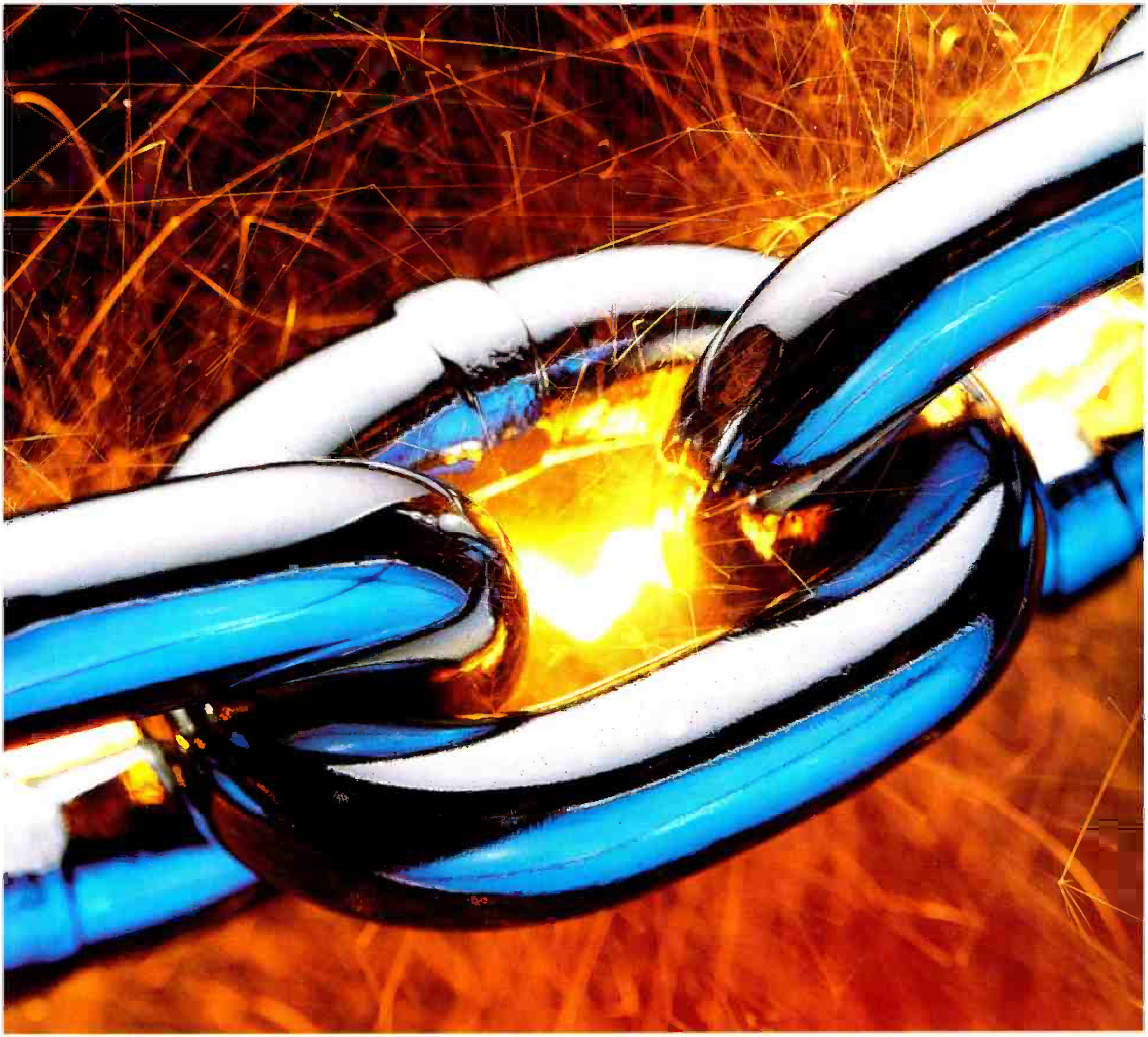
If there is distortion because of time delays between the luminance and color-difference components, the baseline will appear to curve in the shape of a single cycle of a sine wave (see Figure 4). If the first peak of the distortion is positive-going, the color-difference component is delayed relative to the luminance. If the first peak is negative-going, the color-difference component is advanced relative to the luminance. When a timing error is measured on a 12.5T modulated sine-squared pulse (normalized to a peak amplitude of 100IRE), a distortion of 1IRE corresponds to a 10ns timing offset between the luminance and color-difference components.

It is normal for the baseline distortion to be a combination of amplitude and timing errors. Measuring a waveform with both errors present is more complex and requires the use of a nomograph (see Figure 5). Normally, quantitative measurements of delay and amplitude error are not as important as appropriate adjustment of the system in order to make the baselines flat again—in other words, correction of the time and amplitude errors. It is important to note that amplitude and timing errors seen on the encoded dual timing pulses indicate only that something is misadjusted or faulty, and by itself cannot show whether the error was caused by the encoder or existed on the CAV inputs.

The complete test pattern

The dual timing pulses provided for the test signal pattern are part of a split field signal. There are actually two pairs of pulses, as shown in Figure 6. Pulses are placed at the beginning and end of the line to detect any timing skews that may occur over the duration of a line.

To complete the waveform, amplitude reference flags are included on the luminance channel. It should be noted, however, that the effects of skew or other mechanical problems may not be similarly displayed between today's various recording and multiplexed systems. These flags encode to the same peak amplitude as the modulated pulses, regardless of any setup level that the NTSC encoder may add. The PLUGE in the middle of the line is added for picture monitor black-level adjustments. Color bars also are included in this matrix



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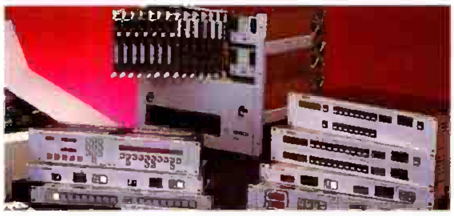

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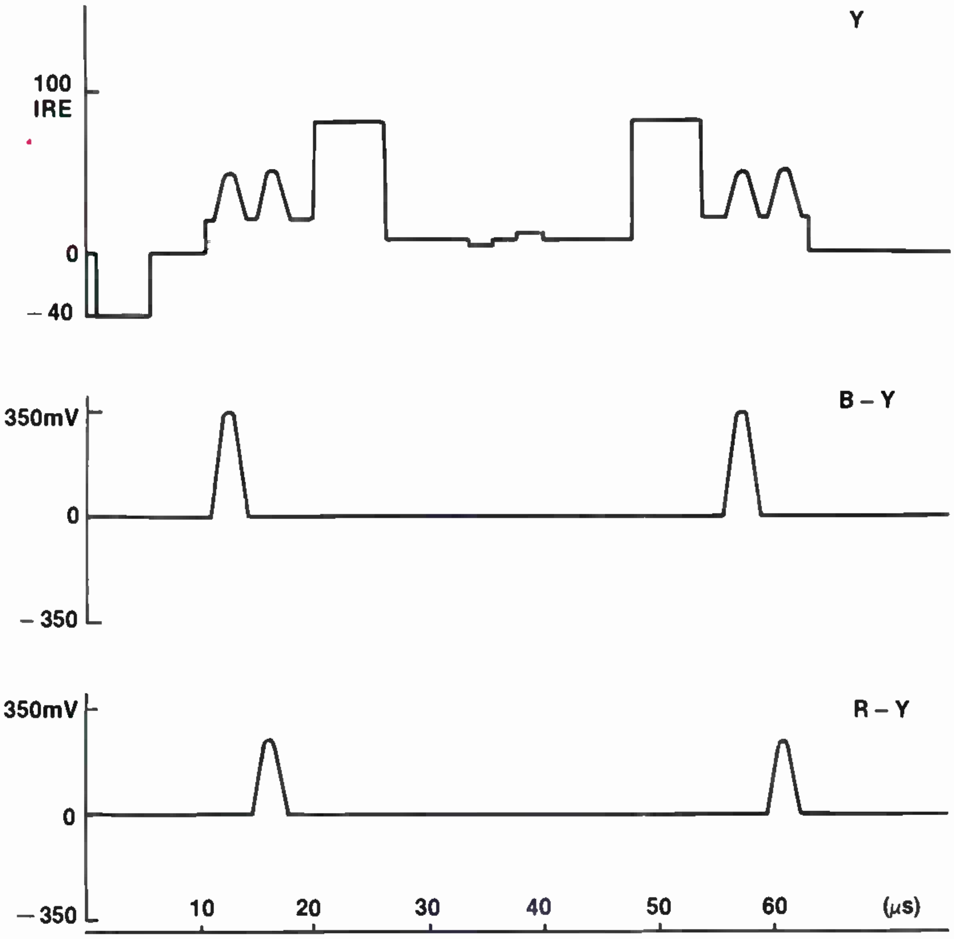


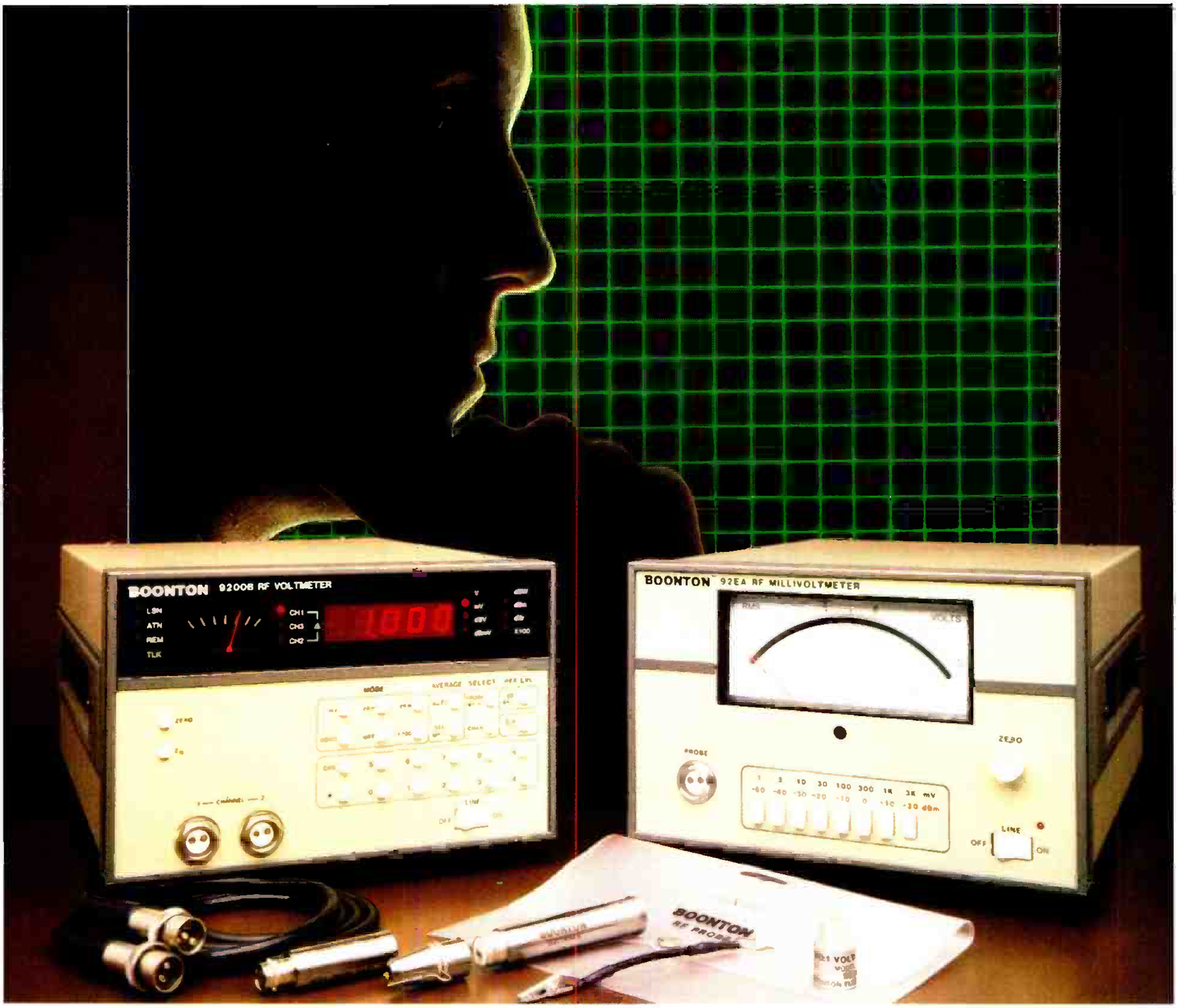
Figure 6. Dual timing pulses use two pairs of pulses, to detect any timing skew that may occur over the duration of the line. Note: three separate signals occur at component output.

signal. This assists in measuring and adjusting video amplitudes and the chrominance phase/gain on the encoded output of the tape machine. The waveforms are shown in Figure 7 (component form) and Figure 8 (composite resultant).

Transposition

The most important aspect of the dual timing pulses signal is its unique ability to be translated (transposed) from one form to another without degradation. When the construction of the signal is examined in its component form, it is evident that the pulse signal in each of the color-difference signals modulates a different 12.5T pulse in the luminance channel. If a timing error exists between one of the color-difference channels and the luminance channel, the composite, modulated waveform will show a phasing error on the baseline, the shape of which depends on the signal that arrives the earliest. If there is a simultaneous gain error between one of the color-difference channels and the luminance channels, the modulation will either overfill or underfill the 12.5T pulse, depending on whether the color-difference amplitude is relatively too large or too small.

The measurement technique is important to many because it allows the con-



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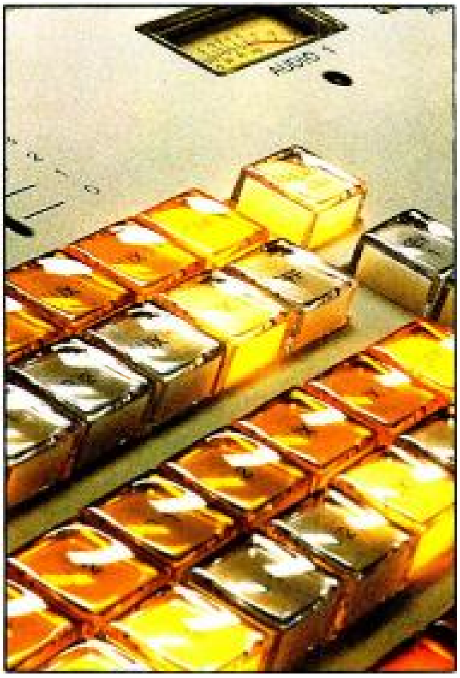
The mysteries of video editing revealed

By Frank Davenport



Smooth editing requires careful attention to technical details.

Editing film is delightfully simple and requires no expensive equipment. You can examine each frame individually, make trial edits with a razor blade and glue, and view the result in real time or at any speed to ensure the desired result. Before videotape recorders, TV programs were either seen live, through the use of electronic cameras, or they were produced through the medium of film.

Early monochrome video recorders were used to allow live shows to be transmitted at similar clock times across the United States. When editing was essential, the framing pulses recorded on tape were revealed with iron filings and a magnifying glass or microscope. Then a steady hand wielding a razor blade performed the edit with special adhesive tape. Pictures could not be viewed in stop- or slow-motion, so the edits were hit or miss, and were done only when absolutely necessary. Because the tape was physically damaged, it could not be reused; this also discouraged editing.

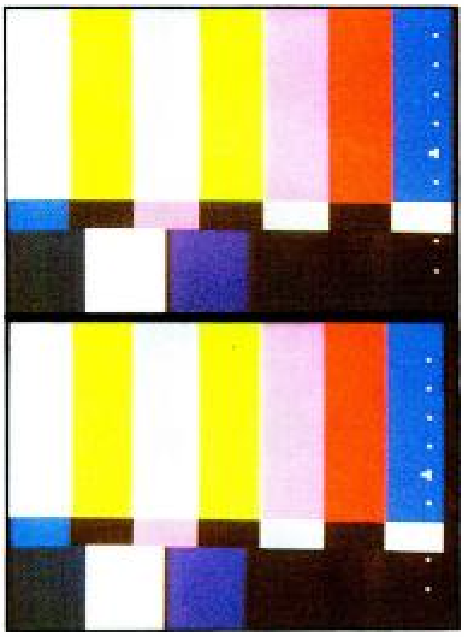
Davenport is manager, technical development laboratory at NBC, New York.

Later, electronic editors and color capability were added to recorders. Editing became more common, but still required great care, quick fingers and plenty of luck for satisfactory results. Sometimes, even unedited tapes suffered random horizontal shifts of the picture content during replay. Worse still, if color framed, the machine might reframe for no apparent reason, often at a different point down the tape.

Hindsight says these problems were caused by the monochrome and color time base correctors fighting to keep the picture stable when either the recorded video or the reference sync-pulse generator experienced poor phase instability of color subcarrier and horizontal sync. As the drift progressed, the color TBC eventually would run out of range.

Color timing

The need for color framing arises from the frequency relationship between color subcarrier and horizontal sync. A feature of the NTSC color system is the concealment of subcarrier dots in the displayed



The Time Code Sync Monitor provides cursors to confirm SC/H phasing and time code. The photo above shows standard time-code framing with zero SC/H error. The photo below shows standard time code with an SC/H error of 20°.

picture through the careful choice of 3,579,545Hz for the color subcarrier frequency. This is 227.5 times the horizontal scanning rate, 59,718.75 times the vertical scanning rate and 119,437.5 times the frame rate. The effect is that visibility of the subcarrier dots is minimized within the picture because they seem to follow a circular path—the so-called busy dots pattern.

The unfortunate by-product of this bit of trickery concerns the odd half-cycle of subcarrier within each frame. Although it works wonders in terms of masking the dots, concealment produces consecutive frames that have color subcarrier phase differing by 180° at otherwise similar points in each frame.

If a VTR is replayed in monochrome lock, there is a 50-50 chance the color-frame sequence of the off-tape video will not match the reference each time play is initiated. The time base corrector can match the horizontal sync (and the picture content) or chroma-phase, but not both. When chroma takes precedence, as is needed to allow the output video to be combined with other sources in a video switcher, then sync and picture are shifted horizontally by 140ns, one-half of the subcarrier period.

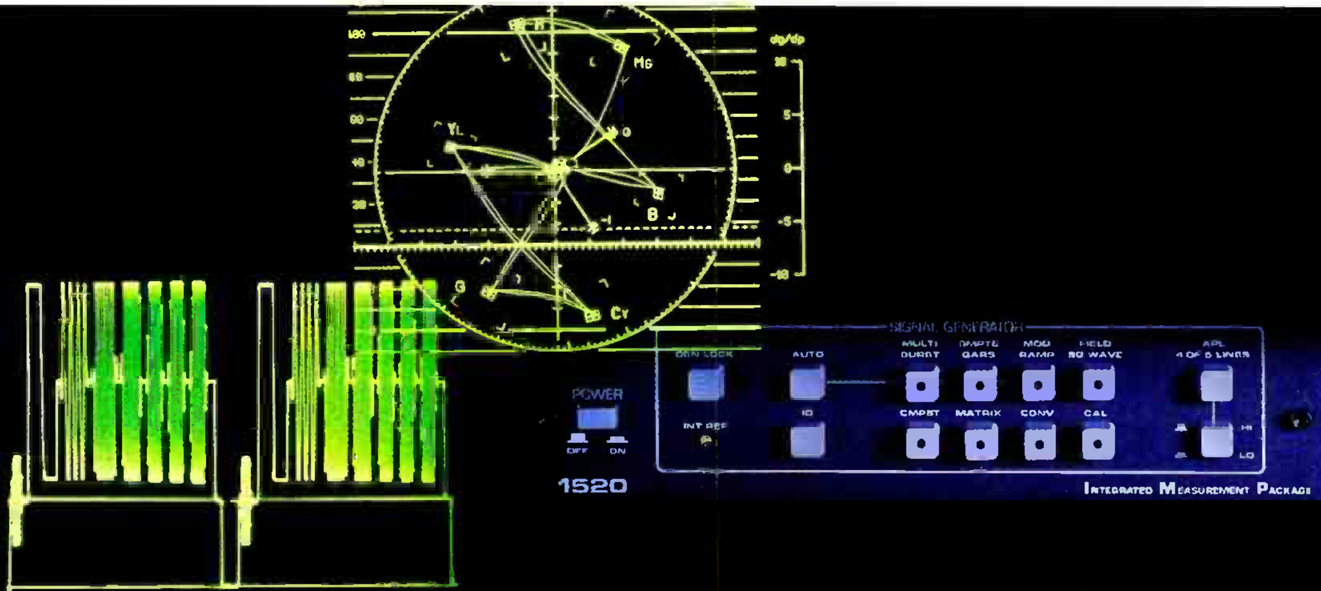
The TBC or video-processing amplifier can reinsert correctly timed sync to produce an apparently satisfactory result. However, the front porch will be lengthened or shortened by 140ns, which might take it beyond allowable limits.

For edits without color framing, another effect appears when the picture content before and after an edit remains at least partly unchanged. This is the so-called invisible edit. For example, if you are doing animation or inserting captions into a background picture with edits to allow setup of each caption, 140ns horizontal shifts will occur on about half of the edits, requiring corrective action.

The arrival of computer-controlled editors using SMPTE time-code signals recorded on spare audio tracks of the VTRs allowed quick location of various takes, total precision and repeatability of edits.

After previewing the in and out points in slow- and stop-motion, the SMPTE frame numbers were fed into the editor and the edit was performed. During run-up, the editing computer steered the machines into approximate sync using the time-code signals. It then returned control of the machines to their own servo systems immediately before the edit to allow full lockup and correct TBC operation in the source machines.

It was soon realized that if the VTRs were in a color-framing mode, then the editing computer must recognize the need to preserve the color-framing se-



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mendation is that each even-numbered time-code frame should coincide with a video-frame type A.

The two frames of the sequence are identified as follows. Each field starts at the beginning of vertical sync. In fields one and three, sync commences at the start of a horizontal line and the first pre-equalizing pulse is, therefore, preceded by a complete line at the end of the previous field. In field one, the half-amplitude point of the leading edge of all even-numbered horizontal sync pulses is coincident with the positive-going zero crossing of reference subcarrier (0°). Frame A consists of fields one and two.

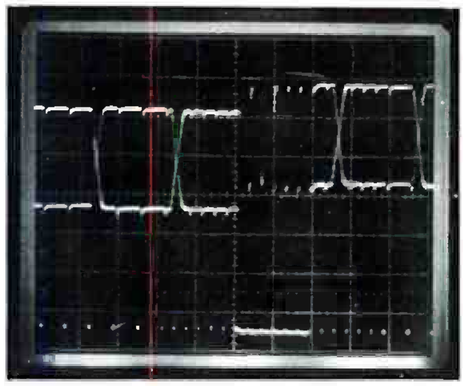
The amplitude and wave shape of the code signals must be adequate for correct decoding. Although the code signals are nominally capable of transmission as audio signals, there are more stringent requirements in terms of phase error, overshoot, distortion and frequency response to ensure reliable decoding.

The real world

If your facility never sees an outside tape, then you can easily set up and control color-framing problems. Most facilities receive an amazing number of outside tapes recorded with technical errors that create problems when editing. Typically, the identification of these problems requires a skilled engineer and some downtime.

An instrument (known as the Time Code Sync Monitor) has been developed in England that should help non-technical editors monitor their edits.

In its simplest form, the unit accepts an NTSC video signal and provides analog displays of SC/H phase and relative color framing of video and code signals. If confirmation of correct color framing of the displayed video signal is required independently of the time-code signal, an input also can be provided for a second NTSC video signal or color-framing reference pulse. The main output of the device comprises the input video signal with cursor displays added for viewing on a picture monitor.

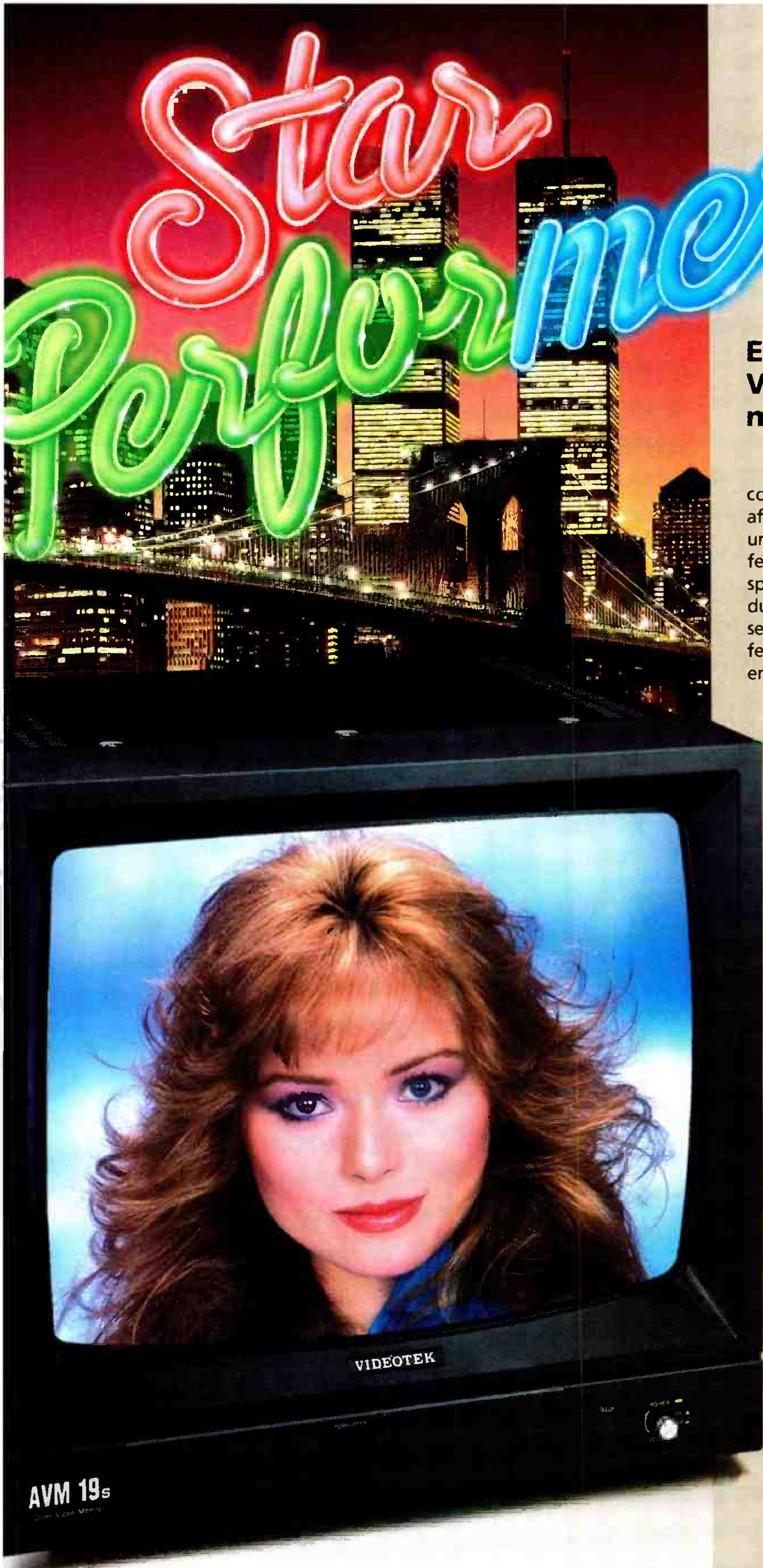


Time-code signals superimposed over field one sync pulses can reveal the sources of editing problems that are otherwise difficult to identify.

Two more outputs are designed to feed a TV waveform monitor. One is composed of the buffered time-code signal superimposed on composite sync pulses with field one of the 4-field video sequence. This allows amplitude and waveform distortion of time-code signals to be assessed at the VTR console or monitor bridge using a normal TV waveform monitor.

The second output comprises SC/H error and mixed sync, again with field one of the video sequence marked. This allows quantitative measurement of SC/H error, sync jitter and phase modulation throughout each TV frame.

Tools that speedily identify source tapes that contain problems save time and headaches. Editing system operators should spend their time editing, not chasing down someone else's problems.



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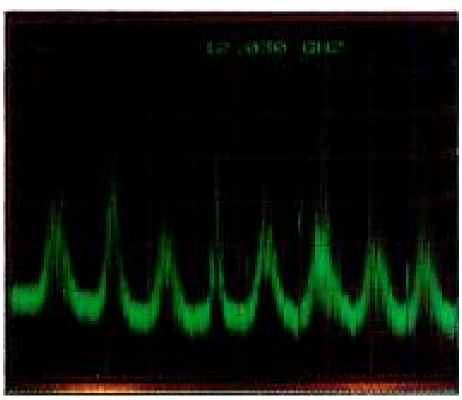
Monitoring satellite system performance

By Guy Lewis

Analyzing the RF spectrum has become increasingly important in the preparations for satellite transmissions.

With the advent of satellite program transmission, spectrum observation has become a routine operational procedure at many TV stations. Modern spectrum evaluation instruments provide a quick, easy and accurate check for RF system performance, whether they are connected into the station's broadcast transmission system or satellite earth station.

Figure 1. Adjusted for a 50MHz/division span, the spectrum monitor displays carriers from a Ku-band satellite. The center-screen frequency is 12.030GHz. (Satellite spectra displays are from a TEK 1705 spectrum monitor.)

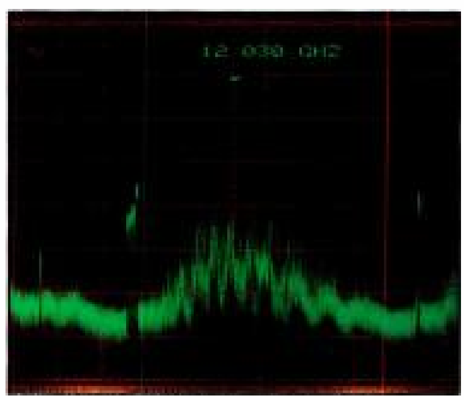


Two types of spectrum evaluation instruments have evolved: the spectrum analyzer and the spectrum monitor. Each has different qualifications and applications. The spectrum analyzer is a measurement tool, designed to accommodate a wide range of input signal levels and frequencies. It is used to assign quantitative values to parameters of the spectrum. Applications include monitoring and measuring carrier power levels, modulating the aural carrier and monitoring the performance of bandpass filtering by the transmitter and associated RF plumbing. A quite different application is the setting of proper carrier frequencies and deviations on the VTRs in the studio. The spectrum analyzer provides a wide range of features for technical operators involved in maintenance and quality control.

While the analyzer is a general-purpose instrument in many ways, the spectrum monitor is designed specifically to view spectrum parameters during

Lewis is product marketing manager, TV waveform displays, Tektronix, Beaverton, OR.

Figure 2. The monitor display, set for Ku-band frequency 12.030GHz, is expanded to 10MHz/division to show one transponder.



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A spectrum analyzer is set to monitor a TV carrier at 196MHz.

signal adjustments. It is intended for continuous, on-line monitoring with a minimum of operator adjustment to the instrument. Both spectrum monitors and analyzers must provide the expected information about the signals being displayed without contributing instrument-generated anomalies.

The trend in both types of spectrum evaluation is toward instruments designed for TV broadcast applications. Units have become smaller, easier to use, more reliable and less costly, with features directly suited to the broadcaster's needs.

With the rapid growth in the number of satellite news vehicles, spectrum monitoring is becoming a familiar task. Unlike satellite antennas that are permanently installed and optimized, news vehicle antennas are relocated frequently, and are quickly put into operation under less-than-ideal conditions. Clearly, there isn't enough time for superfluous knob-turns or cable changes.

A spectrum monitor includes several features that make it appropriate for TV news vans. First, it is designed to work specifically with frequencies that are applicable within the vehicle. These include the L-band (900MHz to 1,450MHz)

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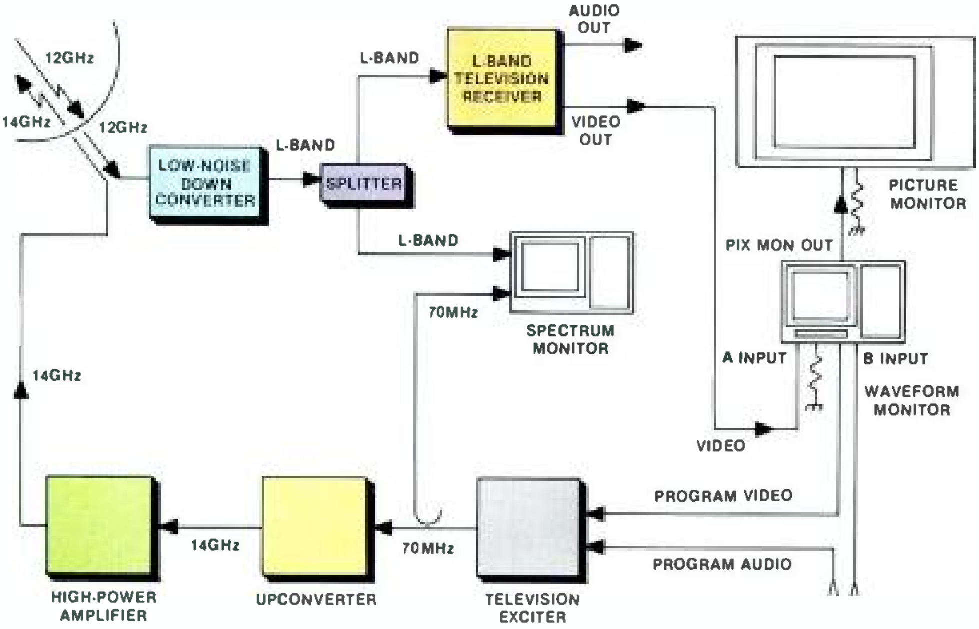

Figure 3. *For measurements and monitoring of a Ku-band up/downlink system, the spectrum monitor connects to L-band (70MHz) signal paths.*

downconverted signal and the 70MHz band (45MHz to 100MHz) signal to the upconverter. L-band and 70MHz are common in today's TV vehicles regardless of whether a Ku-band or C-band satellite is used.

In a given vehicle, signal levels exist in a relatively narrow range. In L-band, the lowest level is established by the noise floor of the antenna downconverter, and the maximum level is determined by the antenna size and the power of the satellite being received. Typically, this range is less than 30dB. The output of the TV exciter is in the 70MHz band and on a different cable with a slightly wider dynamic range. Both bands, however, may be semi-permanently set up in the system to provide inputs that do not require operating adjustment or recabling.

The spectrum monitor makes it easier to find the correct satellite. Its greater sensitivity helps in two ways:

- It indicates the presence of signals before an FM receiver, as the antenna approaches alignment; and
- It gives a useful indication of signals that are weak or scrambled.

The bandwidth of the monitor permits immediate display of all the RF signals from a satellite, which allows identification of the spectral pattern of the signals.

Satellite analysis

In an operational example, a satellite news vehicle is positioned where its antenna can be directed toward the satellite. The uplink antenna azimuth and elevation are calculated or referenced from previous experience. (See "Antenna-Pointing Guide," page 88, for more information.) The antenna is pointed in the approximate direction of the satellite while the uplink amplifier is warming up.

With the antenna set for an initial

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Continued from page 82

To assure correct setup of the spectrum monitor in the satellite news vehicle system, L-band and 70MHz signals may be permanently connected to an RF-input switch, with system levels preset by external fixed pads. The band of interest then may be selected by a single button.

Although the full satellite downlink spectrum can be monitored, an on-screen frequency readout and marker can be used to identify a particular transponder or signal. Because a display of the L-band frequency is of little value, the read-out should be set to indicate actual satellite signal frequency (1-band frequency plus the antenna downconverter offset (see Figure 2). The setting of this frequency indication is an off-line procedure using a satellite beacon for calibration. A read-out accuracy within 10MHz is sufficient because the system downconverter for video operation has low stability.

The spectrum monitor is designed primarily for the news vehicle, but a similar application exists at the other end of the circuit, in a situation just as critical and, often, just as hectic. Many stations operate several satellite-downlink antennas to access the programs available from the networks and program syndicators.

At the satellite-downlink control point, the news vehicle transmission is just one more of many transmissions (see Figure 3). This is a busy operation, critical to the flow of TV programming through the station. In a downlink operation, the purpose of the spectrum monitor is similar to that of the waveform monitor. Both verify the presence of the anticipated signal at the expected level and provide assistance in achieving proper adjustment of the equipment.

Spectrum monitors and spectrum analyzers have distinct applications in a TV station. The spectrum analyzer has much more precise measurement capability, and it is best used for maintenance and troubleshooting rather than being tied up in a permanent application. The spectrum analyzer can be used to measure specific signal parameters and signal by-products as an aid to the maintenance of station RF equipment. A spectrum analyzer provides direct comparison of signal levels to internal calibration signals. It also provides the spectrum width and selects resolution filters to observe the signal harmonics and intermodulation products. In a portable configuration, the spectrum analyzer may be used as a tool for antenna-pattern and field-strength measurements.

Selecting instrumentation

The spectrum monitor is designed for

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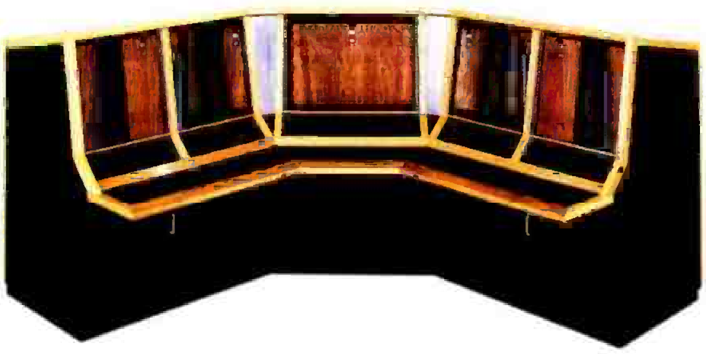

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Antenna-pointing guide

The following program is suggested as a general aid in calculating antenna-pointing information. It can be used with nearly any computer programmable in BASIC. Although some commands are more specific to the MS-DOS BASIC language than other dialects, you should not have to make many changes.

This program is available both as an ASCII text file (BESAT.TXT) and as a BASIC program file (BESAT.BAS) in the Broadcast Professional Forum data library on CompuServe. It may be obtained without charge, beyond access time, by entering GO BPFORUM at any prompt and downloading from data library DL4.

This program allows determination of proper pointing angles for the earth-station antenna in the Northern Hemisphere, given the antenna site location and the satellite location along the geosynchronous arc.

```
10 CLS: PRINT "NORTHERN HEMISPHERE ANTENNA
   POINTING GUIDE": PRINT
20 PRINT "Express all entries in decimal degrees North
   latitude."
30 PRINT "or West longitude, i.e., 12 degrees, 30 seconds
   would"
35 PRINT "be entered as 12.5."
40 R=3963: H=22300: REM earth radius satellite altitude
50 PRINT: PRINT "Enter SATELLITE location."
60 LINE INPUT "Degrees West longitude:"; SL$:
   SL=VAL(SL$)
70 IF SL=0 THEN SL=.001
80 PRINT: PRINT "Enter ANTENNA SITE location."
90 LINE INPUT "Degrees West latitude:"; WL$:
   WL=VAL(WL$)
100 IF WL=0 THEN WL=.001
110 LINE INPUT "Degrees North latitude:"; NL$:
    NL=VAL(NL$)
120 IF NL<0 THEN PRINT "Program valid in Northern
    Hemisphere": PRINT "Modification needed for Southern
    Hemisphere": END
130 IF NL<.02 THEN NL=.02
140 TA=90-NL: A=ABS ((SL-WL)*.01745)
150 IF A>1.35 THEN PRINT "Satellite is at or below
    horizon": END
160 C=TA*.01745: CA=SIN(C)*COS(A): TA=SQR
    (1/(CA*CA)-1)
170 AA=ATN(TA): BS=SIN(A)/SIN(AA)
180 IF BS=1 THEN BS=1.0001
190 TB=1/SQR(1/(BS*BS)-1): BB=ATN(TB)*57.2958
200 IF SL>WL THEN TR=180+BB ELSE TR=180-BB
210 X=SQR(R*R+(R+H)*(R+H)-2*R*(R+H)*COS(AA)):
    SE=(R+H)*SIN(AA)/X
220 TE=1/SQR(1/(SE*SE)-1): EL=90-(ATN(TE)*57.2958)
230 PRINT
235 PRINT "Set azimuth###.# degrees clockwise from TRUE
    NORTH"; TR
240 PRINT
245 PRINT "Expected elevation above horizon is ###.#
    degrees"; EL
250 PRINT: END
```

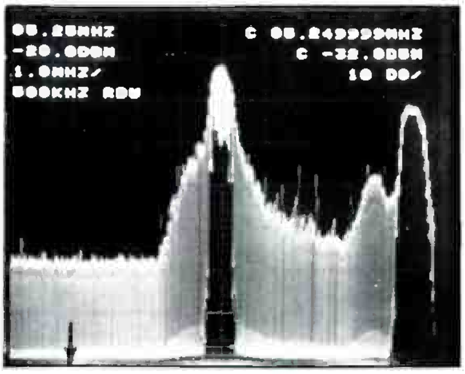


Figure 5. The analyzer display is centered on the video carrier of TV channel 2. The aural carrier is at 59.75MHz, and the subcarrier is at 58.83MHz. To the left of center, the vestigial sideband drops to more than 40dB below the visual carrier. No measurable indication of subcarrier in the lower sideband is visible (see arrow). Alphanumerics on this screen indicate the actual counted visual carrier of 52.249999MHz, an absolute aural carrier level of −32dBm. (Black-and-white spectrum photos are from a TEK 2710 analyzer.

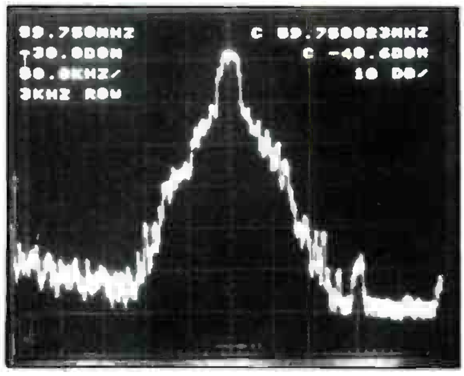


Figure 6. The percentage of FM modulation (deviation) can be estimated by expanding the display of the spectrum around the aural carrier. Carefully observe the amount of horizontal movement at the top of the carrier.

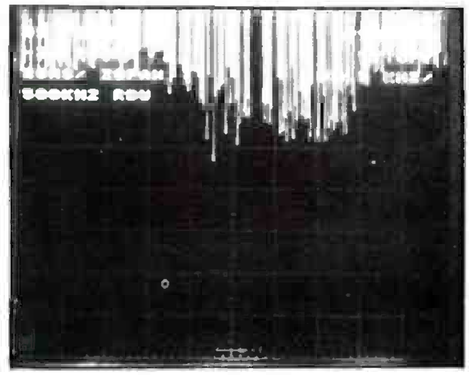


Figure 7. A special mode to directly display aural FM deviation converts the instrument to a time-domain unit, measuring peak deviation (vertically) vs. time (horizontally).

specific applications. It is configured as an indicator to rapidly locate a desired satellite and to facilitate all of the antenna setup functions encountered in a rapid-response TV news system. It is designed to help you avoid errors while your attention is divided among several tasks. Rack-mounting is convenient for a permanently assembled news vehicle, but there are times when a battery-powered portable instrument is convenient. Spectrum monitors may include a low-voltage supply to power the antenna downconverter; analyzers generally do not provide such power.

Several performance elements are important in the selection of a spectrum analysis instrument. The unit should be clean on every band of interest. It must not display any of its own internal signals and products, and must not radiate any signals that might disturb the operating environment. An instrument that generates its own interference is annoying and detrimental. The unit should be small and light enough to conform to the system without compromising the system's design. The display must be large, clear and bright enough for its working environment. It should be compatible

New approaches to AM improvement

Some high-tech solutions are in the works for AM improvement.

By Brad Dick, radio technical editor

During the past 10 years, AM radio has watched its audience shrink to a mere fraction of what it used to be. Today's AM stations attract less than one-third of the total radio audience. According to some experts, however, that trend doesn't have to continue.

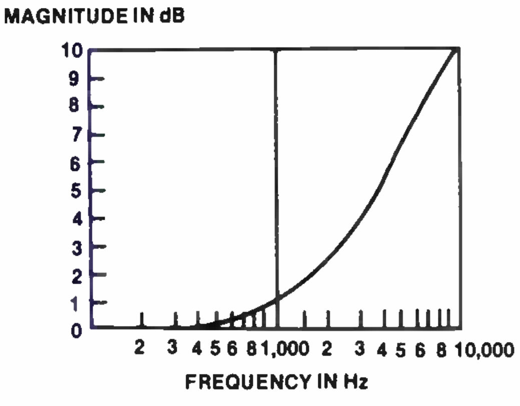


Figure 1. The modified 75μs pre-emphasis curve produces a sound similar to that used by many of today's AM stations. The curve is a key ingredient to the success of the NRSC voluntary standard.

National Radio Systems Committee

Industry leaders, aware of the problems AM broadcasters face, are addressing the issue. Broadcasters, the NAB and broadcast equipment and receiver manufacturers are renewing their commitment to improve the AM service. The key to a successful revitalization of AM is improved technical standards.

The most widely publicized effort has come from the NAB. In the late 1970s, the NAB and Electronics Industries Association (EIA) formed the National Radio Systems Committee (NRSC). Composed of broadcasters and AM receiver and broadcast equipment manufacturer engineers, the committee was formed originally to conduct technical research. However, it was reactivated in 1985 to explore ways to improve AM quality.

Standards proposed

An early responsibility of the reactivated committee was to develop pre-emphasis and de-emphasis standards for use by the broadcast industry and receiver manufacturers. After considerable research, the NRSC proposed that a *voluntary* AM broadcast standard be adopted. The standard consists of a modified 75μs pre-emphasis curve (shown in Figure 1), a matching de-emphasis curve and a 10kHz transmission bandwidth.

In developing the proposed standard, the committee looked at the complex nature of interference on the AM band. A major component of this interference is the relationship between the 10kHz *channel* bandwidth of an AM station as compared with its *occupied* bandwidth of 20kHz to 30kHz.

Note that under the maximum bandwidth conditions shown in Figure 2, the signals from stations A and B overlap. Although today's narrowband receivers ignore the interference, they do so at a penalty of reduced fidelity. A wideband receiver, however, would detect and reproduce the interference caused by the overlapping signals.

The key to reducing the interference lies in decreasing the station's audio bandwidth to 10kHz (see Figure 3). Because an overlap does not occur, the wideband receiver can reproduce the higher-fidelity 10kHz audio signal without interference.

For these band-limiting techniques to be effective, all AM stations must

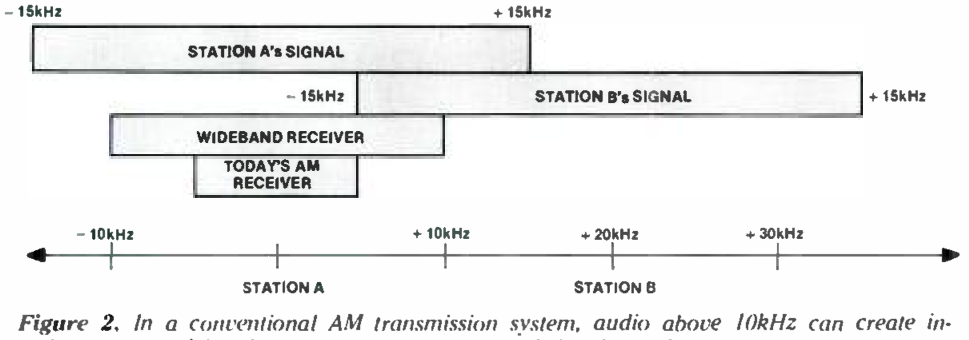


Figure 2. In a conventional AM transmission system, audio above 10kHz can create interference on wideband receivers when two stations' signals overlap.

cooperate. Fortunately, broadcasters seem willing to comply with the NRSC standard. Stations can implement the standard through the purchase of new NRSC-compatible audio processors or modification kits. If your audio processor manufacturer is no longer in business, you can build your own filter and pre-emphasis network to meet the standards.

Additional recommendations

The NAB's AM Improvement Committee authorized a study to examine ways to ensure a clean, full-fidelity AM signal without overmodulation and splatter. The study, released in September 1986 (and conducted by Harrison Klein, Hammett & Edison Consulting Engineers, San Francisco), detailed six recommendations and conclusions:

- The primary cause of splatter interference is the presence of excessive high-frequency audio products in the audio that modulates the transmitter.
- Meeting the FCC bandwidth limits does not necessarily guarantee a "clean" transmitted signal.
- Splatter can be minimized by using low-pass filters on the audio prior to modulation and final protective clippers in audio processors or at the transmitter inputs. (Klein also suggested that it is important to eliminate dc level shift in the transmitter.)
- Modulation percentage often is measured inaccurately in the field and differs from what is commonly measured at the transmitter.
- AM stations should evaluate modulation performance using appropriate analysis techniques, then adjust the transmitter modulation accordingly.
- A high-quality synchronous detector AM demodulator should be developed for accurate analysis of modulation characteristics in the field.

Klein suggested that following these recommendations would do a great deal to improve the quality of AM sound and to reduce objectionable interference. His report, "Modulation, Overmodulation and Occupied Bandwidth: Recommendations for the AM Broadcast Industry," is available from the NAB.

New antenna designs

Resolving the audio problems inherent with today's AM service is only one important step toward improving the quality. Skywave interference continues to plague night reception for many stations. To address the problem, the NAB is sponsoring research into new antenna designs that attempt to reduce skywave radiation.

A station's coverage area is defined primarily by the intensity of the groundwave. This signal travels along the

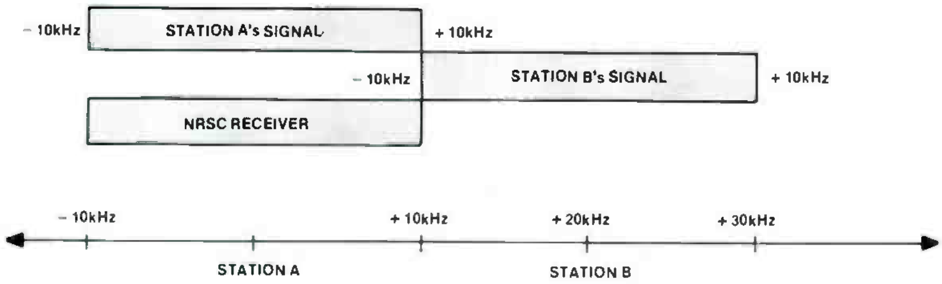


Figure 3. *When stations adopt the NRSC standards, a high-quality audio signal can be produced in compatible receivers.*

earth's surface, and it attenuates fairly rapidly. Signal radiated upward is, for the most part, wasted. It is estimated that approximately 85% of a transmitted signal travels upward instead of along the ground. This leaves only 15% of the original signal (groundwave) available to serve the station's audience.

These characteristics create two problems: Much of the station's power is wasted in skywave radiation, and a station's signal may travel hundreds or even thousands of miles when reflected by the ionosphere. When the signal returns to earth, interference is created in areas far away from the originating location.

In an effort to solve these problems, the NAB is funding the full-scale testing of two radically different AM antenna systems. What makes these projects so exciting is that little research has been conducted on AM antenna designs since the 1930s.

The anti-skywave antenna

One approach to controlling skywave has been proposed by Richard L. Biby, of Communications Engineering Services, P.C., Arlington, VA. Biby's design, shown in Figure 4, relies on a monopole operating over a conventional ground system. Around the tower base are several short vertical radiators approximately 1/30-wavelength in height. Around the entire array of monopole and short radiators is a circular electric screen or fence approximately 1/30-wavelength high and located ¼-wavelength away from the antenna.

The electric screen, in combination with other design elements, acts to decrease the groundwave the short radiators produce, while increasing the skywave the short radiators generate. Appropriate adjustment of the phase and magnitude of the currents flowing in the short radiators causes the short radiators' skyward radiation to nearly cancel the skyward radiation of the taller monopole. Even though the screen greatly affects the capability of the short radiators to generate a surface wave, the screen has little effect on the surface wave characteristics of the taller radiator. The net result is a strengthened groundwave and reduced skywave radiation.

Computer modeling shows that groundwave signal fields (per unit of input power) may be as much as twice those produced by standard antenna designs. One computer-prediction model showed an increase in unattenuated groundwave field strength from 401mV/m to 827mV/m at 1km. The average skywave suppression ranged from 6dB to 20dB at the range of angles corresponding to interference distances of 600km to 1,200km.

Prestholdt VH antenna

Ogden L. Prestholdt, of A.D. Ring & Associates, P.C., Washington, DC, proposes a quite different approach to the skywave radiation problem. His design, shown in Figure 5, relies on a combina-

tion of vertical, horizontal and diagonal antenna elements to obtain significant separate control over groundwave and skywave radiation.

The basic antenna is composed of a base-fed vertical antenna tower and support guy system. At a suitable height, a center-fed horizontal antenna is located. This antenna is oriented parallel to the Y-axis and supported by insulators and an auxiliary set of transparent guy cables. The horizontal element is fed by a balanced network supported and insulated within the tower. A matching and phase-control network feeds the transmission line for the horizontal antenna, and a conventional matching network feeds the vertical antenna. A typical combining network is used to combine the two antennas into a single feedline.

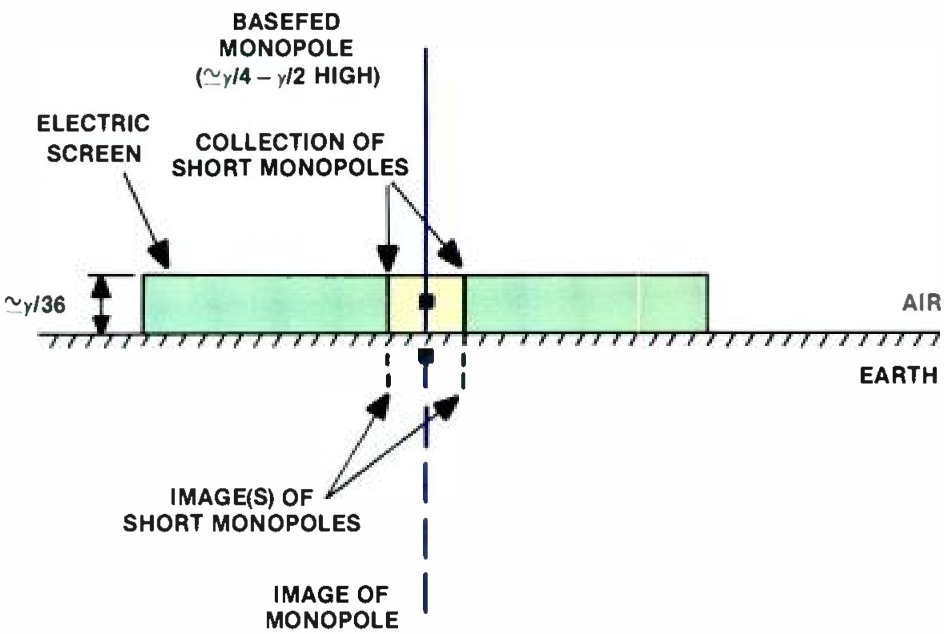


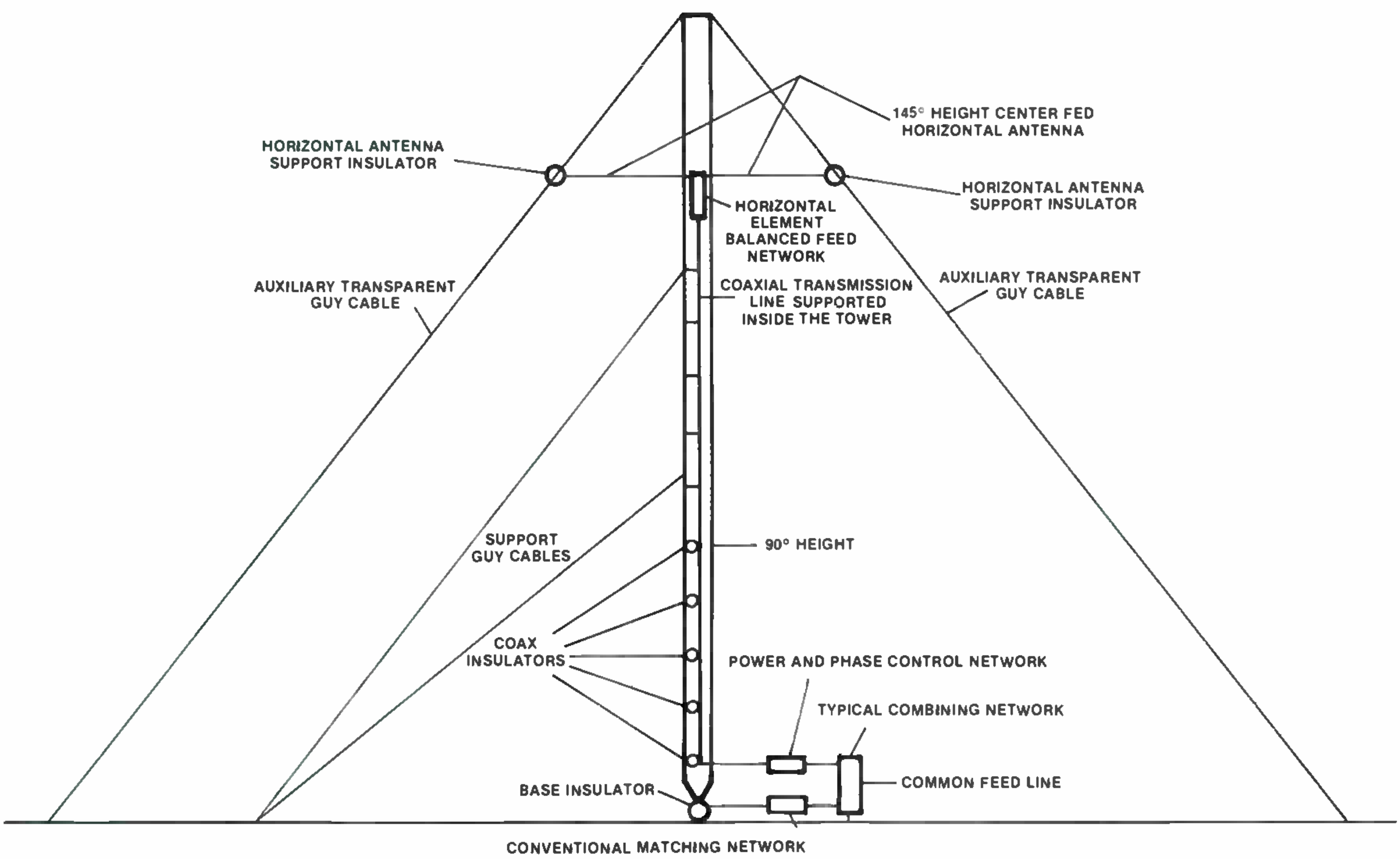
Figure 4. The Biby anti-skywave antenna relies on a combination of short radiators and an electric screen to control skywave.

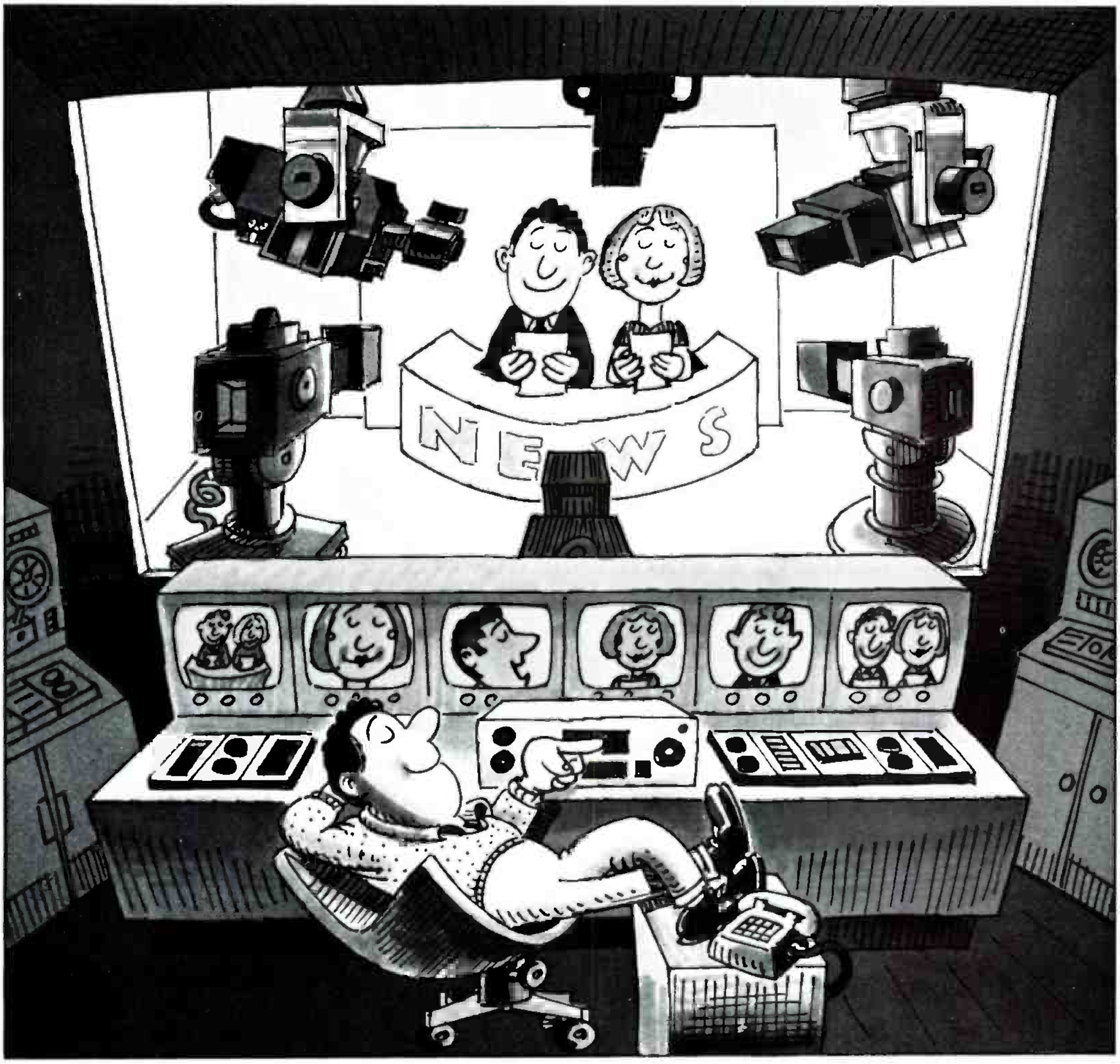
Figure 6 illustrates the improvement possible in signal coverage for a pair of similar stations. One station is protected to the daytime 0.43mV/m groundwave contour. Its 0.5mV/m contour occurs at 60.5 miles. At night, during operation with the same power and antenna configuration, the interference limit extends to approximately the 6.8mV/m contour, which occurs at 17 miles.

With the vertical-horizontal (VH) design, the nighttime limit is reduced to approximately the 1mV/m contour, which occurs at 33 miles. The change in vertical pattern requires a 5:1 ratio of horizontal loop current to vertical antenna current with a phase of −90°. This model assumes the horizontal antenna is parallel to the line joining the stations.

For the same input power to the combined antenna system, the additional horizontal antenna reduces the rms of the groundwave to 65% of its former value. However, even with this reduction in groundwave efficiency, the service radius nearly doubles.

Figure 5. The Prestholdt VH antenna uses a horizontal antenna located at the 145° point on the tower to help control skywave.





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Toaster-sized transmitters

For many stations, the advantages of presunrise or post-sunset operation are outweighed by the costs of modifying and operating the transmitter. It is not always economical or feasible to operate a 5kW transmitter at 10W to 20W. In some cases, stations have had to dissipate hundreds or even thousands of watts of power in resistors to reduce the transmitter output. This is not a cost-effective mode of operation.

It is now possible to provide low-power operation through the use of small, solid-state transmitters. These transmitters are easily installed and, often, quite cost-effective. For some stations, they also provide the assurance of backup operation.

This type of low-power transmitter was first used in carrier-current applications. Typically, the transmitters are coupled into a wire loop or long length of cable, which acts as an antenna. Common applications include sports stadium and hospital communication systems. For churches, low-power (closed-circuit) public address needs often are best met through the use of these transmitters. Instead of headphone cables, which restrict mobility, wireless receivers and earphones can be used effectively.

Another low-power transmitter application includes Travelers' Information Station (TIS) systems. These systems operate under Part 90.242 of the FCC rules, and the stations must be located at least 15km outside the measured 0.5mV/m signal-strength contour of either adjacent channel (540kHz or 1,600kHz). Antenna heights are limited to 15m with a maximum field strength of 2mV/m at 1.5km. Radiating cable systems are limited to a maximum cable length of 3km and transmitter power of 50W.

TIS systems were used at both the 1986 SBE and the 1987 NAB conventions. The NAB installation in Dallas provided interference-free coverage over approximately 1.5 miles. What made that installation unique was that the system operated on the same frequency as the Dallas-Fort Worth Airport information system.

Today's small, solid-state transmitters can provide high-quality, stable operation in a cost-effective package. Installation is usually quick and simple. Because of the low-power design, these transmitters often rely on low-level modulation techniques. A linear RF amplifier is then used to provide the necessary gain. This design can not only provide topnotch audio, but also makes it possible to adjust the total power output from 1W or 2W up to the maximum available.

Best of all, most of your listeners will never know that their favorite station is sometimes operating on a transmitter not much larger than their toasters.

Synchronous transmitters

Some AM broadcasters are looking to synchronous transmitters for improved coverage. In Europe, two transmitters of equal power often are synchronized to cover a large area. In the United States, the technique is not as well developed and usually relies on unequally powered transmitters.

Several U.S. stations are now either operating or planning for synchronous installations. Although synchronous operation may improve a station's signal strength within a certain area, it can be a complex system to install and maintain.

A synchronous installation still requires land for an antenna, equipment and, most importantly, a method to synchronize the two (or more) transmitters. In Europe, highly stabilized and accurate crystal oscillators are used. In the United States, stations typically use one transmitter as the reference frequency for the second site. Through a sometimes complex arrangement, the second transmitter is then frequency- and phase-locked to the master transmitter.

Keeping the two transmitters locked together precisely is important to controlling the zones of interference. These interference zones are areas where the differences in transmitter signal levels combine to create distortion in the receiver. If the transmitters are carefully locked and phased, the interference zones remain fixed. If not, the zones move through the coverage area.

Although significant technological hurdles must be overcome when commencing synchronous operation, the idea does hold promise for some stations. The technique may be effective in recovering an area lost because of natural obstructions that block the signal path. Also, a station sometimes finds that its formerly rural transmitter site has become surrounded by commercial and residential construction. If the conductivity has changed over the years, previously served areas may no longer receive a strong, reliable signal. In these instances, synchronous operation may prove advantageous. The use of synchronous transmitters is complex and requires careful planning. For more information on this technique, see "Return of the Synchronous Amplifier," page 176 in the June 1987 issue of **Broadcast Engineering.**

Long-term solutions

Despite the problems faced by AM broadcasting, there is renewed optimism within the industry. Broadcast manufacturers see the opportunity for the service to regain its health—witness the new products introduced. Also, receiver manufacturers have expressed an interest in producing high-fidelity receivers

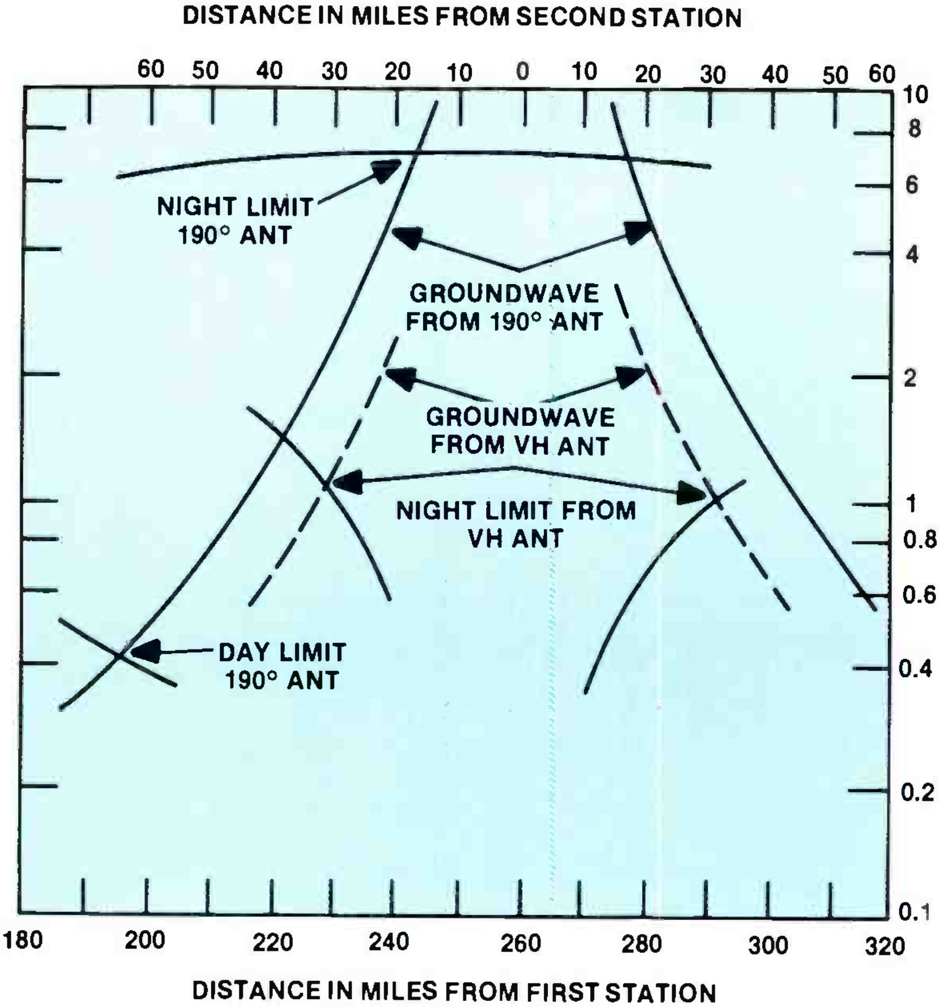
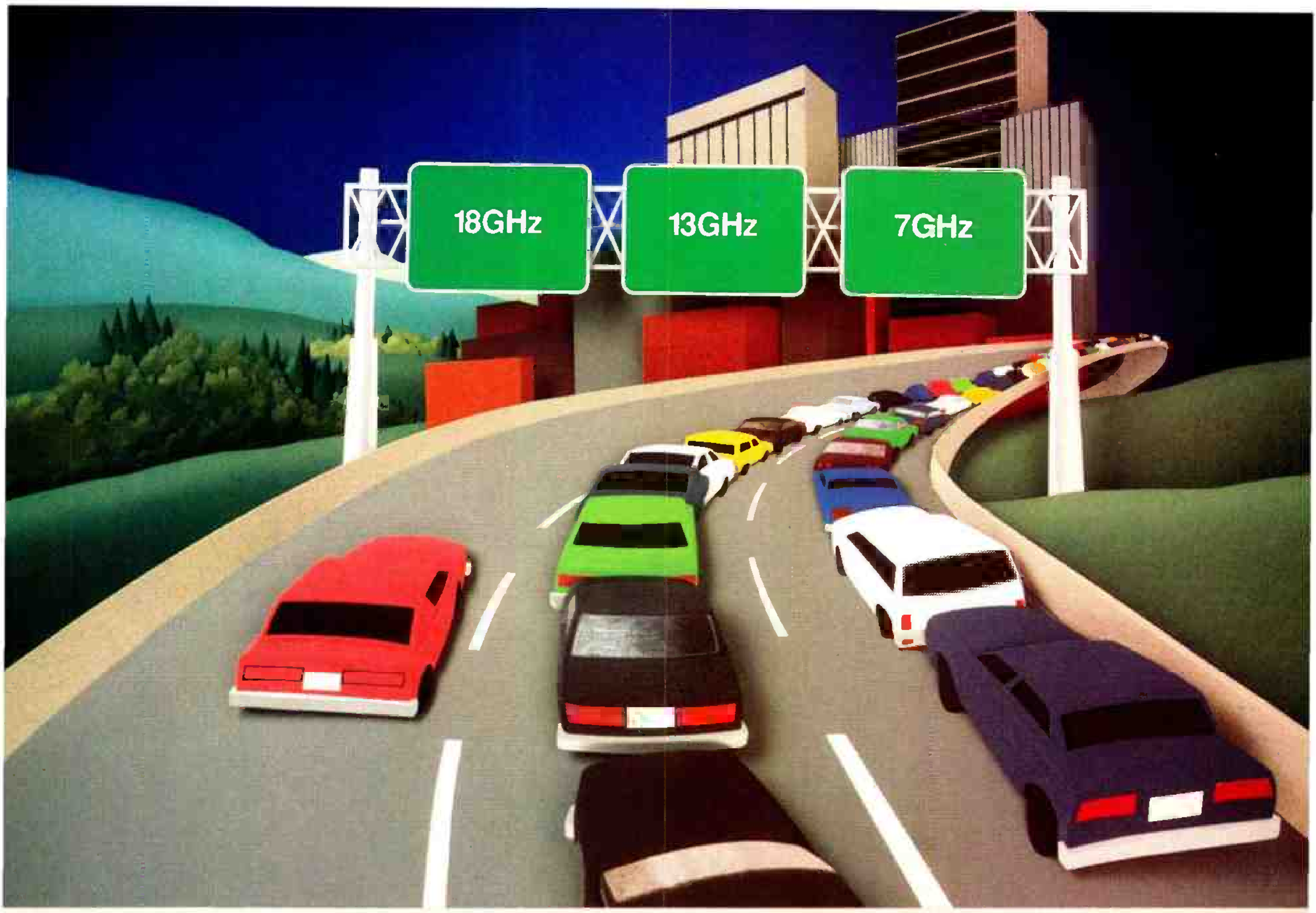


Figure 6. The chart plots groundwave field strength vs. distance for both a standard vertical antenna and the VH antenna. Nighttime interference limits improved from 6.8mV/m at 17 miles to 1mV/m at 33 miles.

for both the home and car. But most importantly, broadcasters now seem willing to reinvest in AM.

Curbing the loss of audience will not be easy for the AM broadcaster. Solving the problem requires monetary investment and a willingness to be a leader and, perhaps, to take chances. Has your station updated its audio processing to conform to the NRSC-recommended standard? What steps have you taken to improve the performance of your transmitter? Have you switched to stereo? Or, are you waiting for someone else to lead the way?

Perhaps never before has a broadcast service been so dependent upon the implementation of new technology for its survival. Who holds the key to its successful implementation? You, the broadcast engineer. What steps can you take now to improve your station's signal?



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For over 20 years M/A-COM MAC has specialized in providing microwave radio equipment to broadcasters. Every unit with our name on it is built in our own factory, so we not only control the quality, but we know how to service it.

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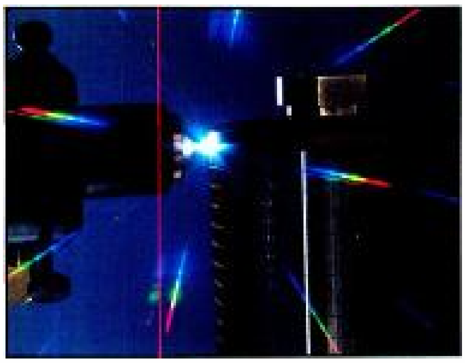
M/A-COM

Circle (82) on Reply Card

Modifying time—system considerations



By Lawrence Rich

Discrepancy report: 9:57 p.m.:
Log indicated 30-second commercial, but material run :35; used 10-second ID as scheduled; late to network by five seconds. If correct time had been known, engineering could have avoided this.

Time-compression/expansion systems offer broadcasters and production facilities the capability to alter program lengths while retaining all of the program material. Such a capability is not a complete panacea to schedule problems, because on-air operators must know ahead of time to set up the equipment. If correct times are known, however, operators can fit material into a schedule without the discrepancies that appear as bad switching.

Rich is broadcast sales manager for Lexicon, Waltham, MA.

The capability to alter time allows for the placement of additional commercials in syndicated shows and the fitting of commercials precisely into allotted, automated time slots, without cutting scenes or adding fillers. Post-production houses can time commercials precisely without reshooting or compromising artistic quality for length. New segments can be timed to fit exactly with less editing. Audio sweetening becomes a faster and easier process.

The capability to compress and expand the time of audio and video material resulted from a series of evolutionary steps in signal processing. Because digital technology played a role in the developments, many people have erroneously concluded that the equipment is a form of digital delay. That is, however, not the case.

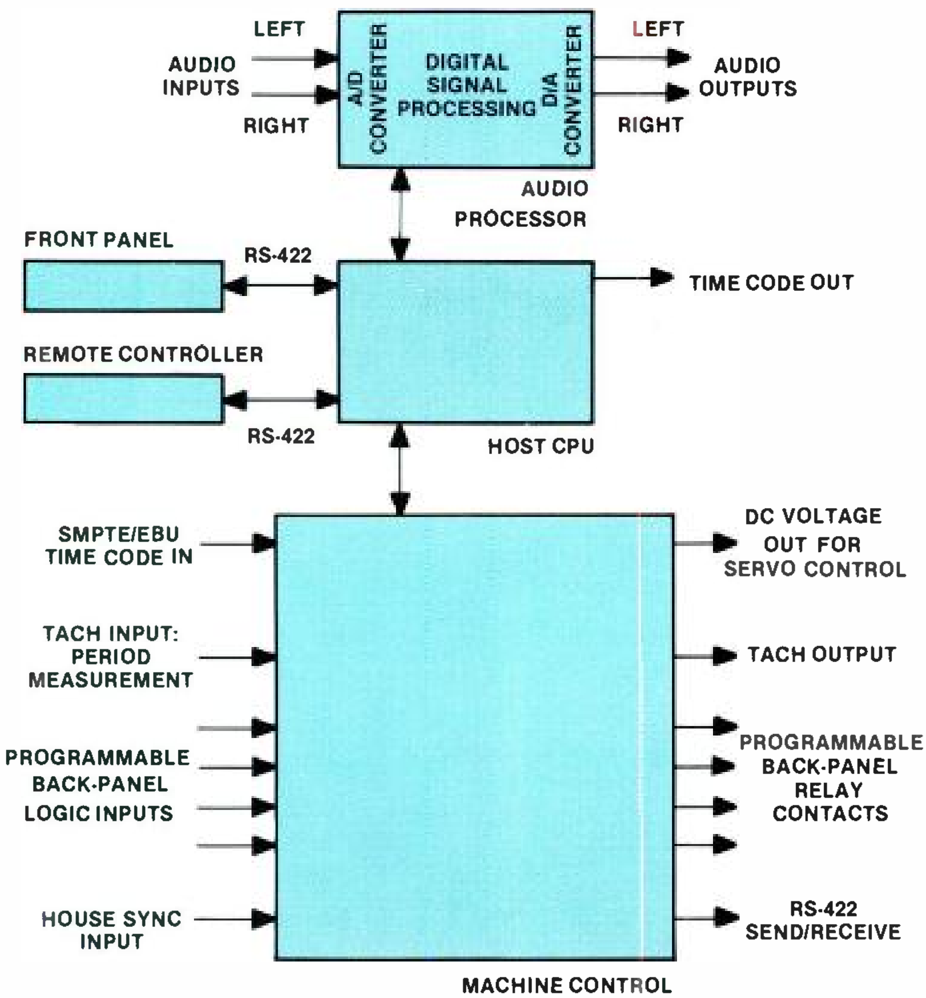


Figure 1. Elements of a time-modification system, such as the Lexicon 2400.

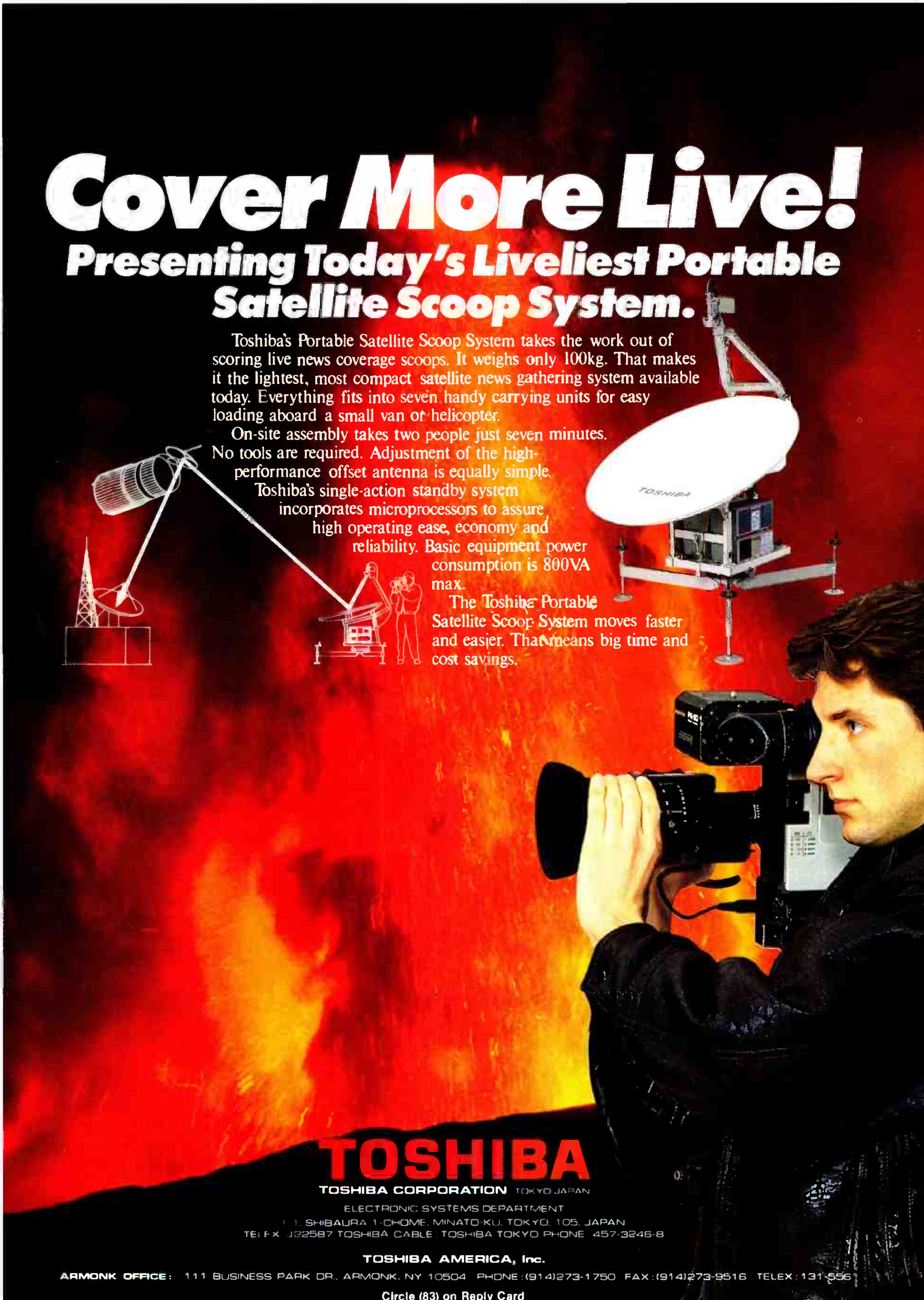
At a minimum

A basic time-compression/expansion system consists of a variable-speed playback machine and the time-compressor/expander unit. The unit does not process video (as is often thought) nor does it require hours of processing to do its job. Instead, the system processes audio in real time to restore correct pitch. The system is interfaced to the playback machine, and it determines and maintains the play speed for the project. (See Figures 1 and 2.) As the controlling element of a system, the time-modification equipment indirectly oversees video playback if the VTR speed is non-standard, and appropriate equipment is used for variable scanning and tracking features.

In its most powerful role, a time-compressor/expander unit controls the playback speed of a reproducing machine, enabling an operator to enter the original play time and the newly desired play time. (See Figure 3.) The unit calculates the required play speed and a corresponding pitch change. As long as the time change is held to less than 10%, the material seems virtually unaltered. For on-air use, remote operation from a master-control switcher ground pulse or closure to ground is possible.

Preserving pitch

The time compressor/expander determines the required amount of pitch correction from the play speed. If a tape is played faster than normal, the audio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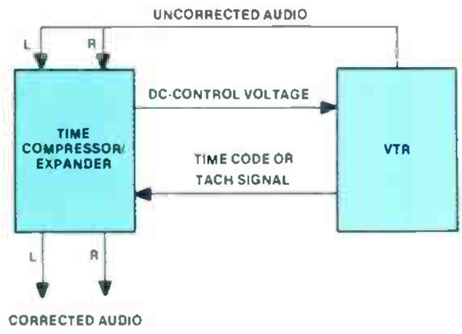


Figure 2. Connections for serial control of a VTR from the time modifier.

pitch is automatically raised. Sounding like Alvin the Chipmunk can pose a problem, so the first task is to restore normal pitch to the taped material. But, how is the pitch corrected?

Think of the program material as a length of recorded tape. First, cut the tape into small pieces, each a few milliseconds in length. Then, discard every tenth piece and splice the rest back together. The result is a tape that is time compressed by 10%. Now that the tape is shorter, play it back at normal speed and the pitch is normal again. A time compressor works on this concept, except the correction is made in real time in the digital-audio domain.

Time-compressor systems accomplish pitch alteration by changing digital sampling rates. First, the audio is sampled with an analog-to-digital converter and the result is stored in a memory in digital form. The A/D conversion sampling rate varies in proportion to the tape speed. If the playback speed is 10% faster, sampling is done 10% more often (and 10% more digital data must be stored in memory per unit of time).

Audio output from the time compressor/expander occurs after D/A conversion. If data were clocked out at the same rate that it went in (10% fast), the pitch would remain 10% high. When the output clock operates at normal speed, pitch is shifted downward by 10%, restoring the audio to normal.

Because audio samples are clocked into the system faster than they are clocked out, the machine must eliminate some of the data. This is where splicing enters the picture. By splicing out some data, the slower outgoing stream keeps up with the faster incoming stream in real time.

In time expansion, the reverse process occurs. Input sampling is slower than the output rate. To maintain the output signal, the compressor/expander copies or duplicates and splices the data into the outgoing data to produce a continuous output.

Pitch shifting is accomplished by altering the input sampling rate with respect to the output clocking rate. In theory, pitch shifting can be applied to any audio source, running at any speed. The final subjective quality of the audio depends on the elegance and sophistication of the splicing function, which occurs many times per second.

Splicing

In monaural use, splice points and the methods of cutting or pasting must be optimized. For true stereo operation, they must be optimized simultaneously on two channels. Recent advancements in stereo-splicing technology have made such control possible. Data manipulations to optimize stereo splicing require computation speeds approximately 100 times faster than the VAX minicomputer, which was used to develop the splicing algorithm.

This technology substantially eliminates the audio artifacts that have been associated with time compression/expansion. *Burbles*, or audio anomalies, resembling dropouts and flutter, historically have been a problem in expansion, particularly when changing the run length of musical material. Where stereo was involved, time compression/expansion forced a trade-off among stereo separation, mono compatibility and an increased audibility of the burbles. Now, compression or expansion in true stereo is possible with virtually no audible artifacts.

System interfacing

The time compressor/expander is only a portion of the system required to perform time-modification functions. Other equipment includes an audio, video or film playback device, and possibly an editing system, chase synchronizer or control switcher.

The simplest interface of the time compressor/expander into a system requires the operator to manually enter the appropriate speed change for the playback machine and a corresponding pitch shift ratio for the time compressor/expander. The pitch shift ratio (the new pitch divided by the old pitch) is the exact inverse of the speed factor ratio (the new speed divided by the old speed). For example, a new play speed 10% faster than normal is equal to a speed factor ratio of 1.1 (1 for normal speed plus 0.1 for the additional 10%); the pitch shift ratio then is 1/1.1 or 0.909. The pitch must be corrected (reduced) by that factor.

Machine interfaces can bring automation to the operation system in varying degrees. These interfaces can be parallel or serial in type, master or slave in function. A parallel link includes timing by tach, time code, dc and pulse-code signals. Type C VTR manufacturers have developed protocols for the SMPTE RS-422 bus. The following discussion outlines some of the possible interfaces, but does not imply availability with every time-modification system.

Videotape recorders

Of the VTRs capable of variable-speed operation, some have sufficient speed resolution for long-term time accuracy under their own control. These machines can act as a master, using a time-compressor unit as a slave. With tach, time code or RS-422 interfacing, speed information is communicated directly to the time-control unit, which, in turn, corrects pitch based upon knowledge of the normal speed tach, time code or serial protocol, respectively. (Applicable models include Sony BVH-2000 series, Ampex VPR-3, Hitachi HR-230, RCA TR-800 and the NEC TT-8000.)

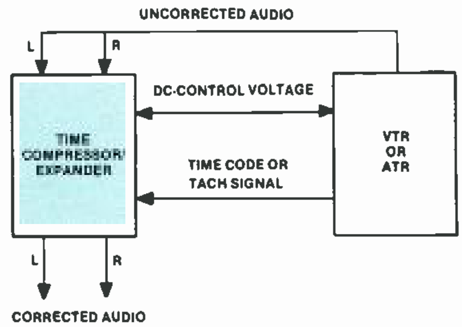


Figure 3. Connections to dc-servo control of ATRs or VTRs.

Controlling a VTR from the time-compression system allows the most flexible interface. The time compressor/expander calculates the playback speed from the original and desired running times, whereas most VTRs (Hitachi HR-230 excepted) will not. Functions such as stop, play and cue can be controlled from the time compressor/expander by using RS-422 protocol or general-purpose relay interfaces. Of course, to interface to a VTR via SMPTE RS-422, the time compressor/expander must be able to receive and interpret that manufacturer's serial data protocol. Not all protocols currently are supported.

Time-compressor/expander control with some VTRs is the only practical interface because of variable-speed limitations of the VTR. The first generation of controllable tracking type C VTRs, such as Ampex VPR-2B, Sony BVH-1100, Hitachi HR200 and NEC TT-7000, fall into this category. Typical control methods include dc servo or tach-reference parallel interfaces. Time-code feedback, which is provided in some new generation time-compression systems such as Lexicon 2400, will ensure long-term time accuracy. Some of these interfaces require external or internal switching or other modifications of the VTR.

Some VTRs, such as Ampex VPR-6 and VPR-80, are capable of serial or parallel interfacing in master or slave modes, but their speed resolution is insufficient for long-term time accuracy. As slaves to the time compressor/expander, the speed steps may become noticeable as corrections are made to compensate for time inaccuracies.

Smaller format VTRs also are capable of producing pictures that can be broadcast while operating off-speed. A portion of the ¾-inch VCRs, such as Sony BVU-820 and BVU-870, allow compression and expansion through serial or parallel interfacing. The two ½-inch formats currently vying for the marketplace—Sony Betacam and Panasonic M-II—do not generally include a range of playback speeds and are not suited to time compression and expansion.

Telecines

Although they provide the best quality video time compression and expansion, variable-speed telecines tend to have fixed frame rates and are not readily controlled. Post-production telecines (Rank Cintel Mark IIIC, Bosch FDL 60, Dwight Cavendish Copymaster, Marconi B3410 or a broadcast system Rank Cintel ADS 1), therefore, interface to a time compressor/expander as the master. The interface consists of a tach pulse, usually at 10 times the frame rate, which is one side of the signal sent to the magnetic tape follower. (See Figure 4.)

Audiotape recorders

A number of audiotape recorders can control or be controlled during variable-speed playback. Common applications include audio post-production and sweetening, TV announcements, radio and recording. Many ATRs (from Ampex, Fostex, MCI, Otari, Scully, Sony, Studer, Tascam and others) accept tach-control parallel interfaces.

Some audiotape recorders, such as Nagra's T-Audio-TC, include the function to follow external time code. To the extent that they can lock to off-speed time code, ATRs can be controlled by a variable-rate time-code output from the time-control system. In a similar way, a recorder that can resolve to a pilot tone in principle could be controlled by varying the frequency. Also, any variable-speed audiotape deck can be a master with an output to the time compressor/expander of tach, time code or pilot-tone frequency, although it may not be time accurate.

Other interfacing possibilities

Because time compressor/expanders can now provide variable-rate time code or tach, they can serve as a reference for machine synchronizers, such as Adams-Smith or the TimeLine LYNX. As long as the synchronizer can lock to the variable-rate time code or tach signal from the time compressor/expander, the playback speed of several machines can be controlled at once. This setup is particularly useful if the synchronizer can control a transport that cannot interface directly with the time compressor/expander.

Although machine synchronizers usually are found in audio-for-video facilities, many video-editing systems also can control machines at variable speeds; some offer time-fit functions as well. In such cases, it is possible to interface a time compressor/expander directly to the editing system. This enables a new dimension in time compression/expansion, making the function a tool in the editing process, rather than a post-editing alteration. (See Figure 5.)

Although time compression can offer a considerable economic incentive to a broadcaster by providing additional commercial inventory without cutting programming, there is still a question of how to accomplish it economically. In general, it is possible to time compress/expand directly on air without dubbing the program first. One method uses dual type C VTRs, each with a time-compressor unit, directly nn air—one plays while the other is prepared with the next segment. Another method uses circuitry in the time compressor to allow a master-control switcher pulse to start a type C machine in slow-motion. In that type of installation, while the compressor is in bypass, the VTR operates in normal play mode.

Another application uses ¾-inch equipment direct to air using a master-control switcher to initiate forward variable speed on a parallel remote. Time compressing or expanding directly on air may save the expense of dubbing, avoid the degradation of another video generation and enable programs to meet different timing requirements each time they are aired.

Video quality

With the exception of film-to-tape transfers, video artifacts are a frequent by-product of time compression/expansion on videotape. A better understanding of what happens to video during the process helps to minimize or avoid the problems.

Film-to-tape transfer is the best place to do time compression/expansion. Because it is essentially the same process both off speed and on speed—each frame of film is copied to two or three fields of video at usual frame rates—there is virtually no degradation resulting from the transfer.

Videotape presents a different story. Increasing the speed of a VTR requires dropping of frames (relatively few are capable of this) or fields with a variable-tracking head. When a frame is dropped, there is a conceivable problem of motion jerk or *judder*. When a field is dropped, there might be motion judder with an added problem of vertical *jitter*.

One line vertical jitter results from dropping (or adding) one field, momentarily forcing a pair of even or odd fields to make up the frame. When a field is dropped, the whole picture moves up or down one line, as interlace forces one like field to be in the unlike field's position. The rate at which this happens varies as more fields are dropped or added with higher or lower tape speeds. At 400 lines vertical resolution, one line of jitter is only one-quarter of 1%, but still a problem.

Sony's solution to this problem is to interpolate or average two adjacent lines whenever fields are mismatched. This eliminates a noticeable vertical shift at the expense of lowering resolution. The acceptability of this method depends upon the material. It would be better to avoid time compression when vertical jitter would be obvious. Because the jitter is most noticeable on titles, it is best not to process segments with titles. Perhaps titles can be inserted after time compressing the main program.

Another solution to the jitter problem

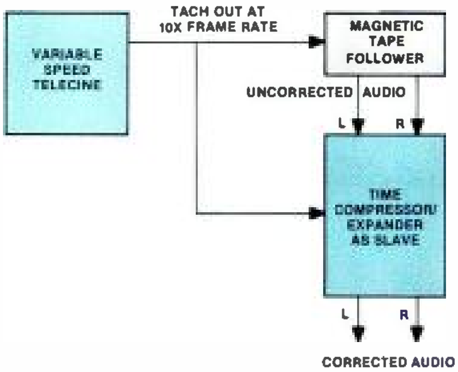
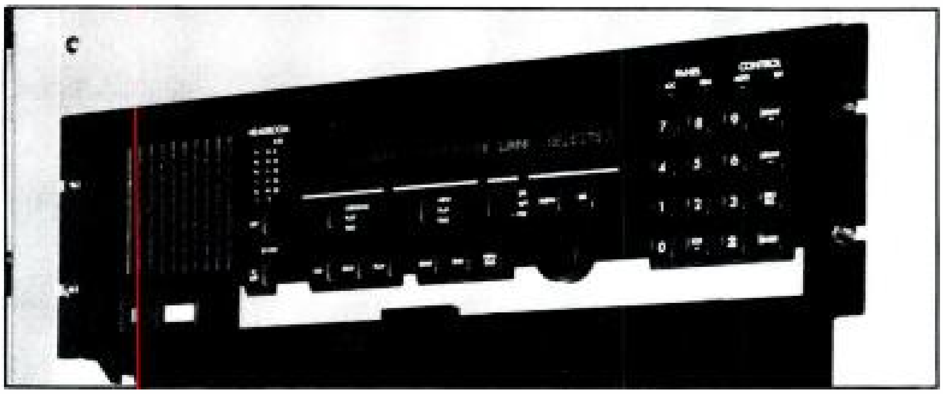


Figure 4. *Connections for film-to-tape transfers from a variable-speed telecine.*



The Lexicon 2400 system installed at KDNL-TV, St. Louis, is located next to type C and ¾-inch VTR equipment.

is found in the newest generation of time base correction or a video-processing device, such as Ampex Zeus and Sony BKH-3050. In the drop-field mode, such a device performs an interpolation between lines to maintain the correct vertical position without lowering the apparent resolution.

Judder, a term borrowed from standards conversion, is motion jerk. In time compression, it results from the loss of a unique moment in time because a field is dropped. It is noticeable on original videotape productions, but it can be reduced by avoiding pan and zoom shots. Neither judder nor jitter may be noticeable when cameras are hand-held, such as at electronic news-gathering or sporting events.

Judder is not apparent if the videotape is transferred from film. This fact is explained because each film frame is repeated on two or three video fields (the 3-2 pull-down). When one field is dropped, at least one other similar field exists to back it up. So time compression is more acceptable on videotapes that are transferred from film originals than on those that are video originals. The jitter problem also is less noticeable because film gate jitter partially obscures it. It's still wise to avoid compressing titles.

On VTRs that make it possible to remove a whole frame, such as Sony BVH-2000, Ampex VPR-3 and VPR-6, vertical jitter is eliminated effectively. For film-to-tape transfers, although not recommended for video original productions, drop frame is more acceptable. Usually, dropping a full video frame eliminates only two of the three video fields originating from a single film frame www.americanradiohistory.com

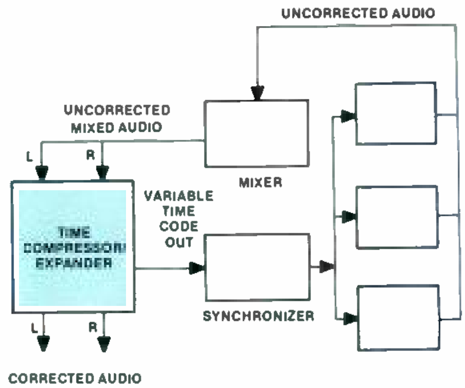


Figure 5. *Variable time-code control of a synchronizer with time-modification system.*

or eliminates one video field in each of two film frames. Only a fraction of dropped video frames will eliminate an entire film frame and produce judder. Thus, drop frame is often the method of choice when time compressing videotapes transferred from film.

Solutions to these video problems technically are within reach. TBCs that correct vertical jitter now exist and will be available from various manufacturers. Motion judder can be approached with existing motion interpolation techniques adapted from videographics and standards conversions. Solutions also may be improved from original production with shuttered frame-rate video cameras (as opposed to conventional field rate), which would be more filmlike. Judder can be avoided by using film in the first place.

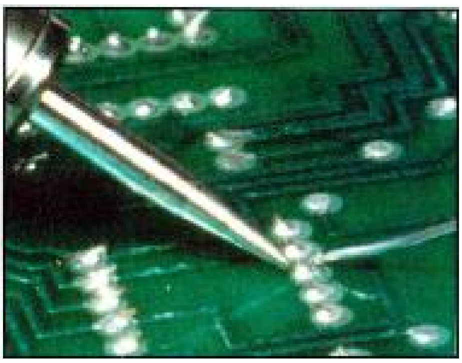
Time compression and expansion is a useful editing technique, allowing time slots to be fit without noticeable alterations of the program material. Such time modification can be used in a broadcast system with variable speed VTRs or telecines and its use automated via the master-control switcher for on-air work. It represents a powerful tool that not only aids in programming and scheduling, but also contributes to profitability by increasing commercial inventory.

In post-production, time compression interfaces with high-quality variable-speed telecines, with VTRs and with video-editing systems, offering timing and pacing manipulation never before available in the editing process. The time-modification unit in audio recording serves notably in audio sweetening, interfaced to ATRs and potentially to machine synchronizers.

The story of time compression and expansion cannot be told without including the means by which audio and video products are able to be operated at nonstandard play speeds. Time base correction must be mentioned, because without it, many VTRs would not be usable on air. The practical applications of digital audio processing, and later video processing, also have played a part in making time fit. But with these steps in existence, the future of time compression/expansion has a different light because stereo-audio pitch processing and video jitter problems have been solved.

Editor's note: BE's editorial policy generally does not include the mention of specific products by name and model number, except in Field Reports or a specific product discussed in Applied Technology. Because certain basic requirements must be met for time-modification systems to operate, applicable products have been noted to more clearly define those requirements. Mention of these products does not imply endorsement. If an applicable item was not mentioned, it was unintentional and indicates the applicability was unknown to the author and to the BE staff.

Station-to-station



Transmitters wired for remote control

By Mike Armatta

With a simple home computer and modem, you can retrieve your daily newspaper, check your bank balance, leave a message for a friend or even book an airline flight. Given this level of sophistication, why shouldn't broadcasters be able to check on transmitters from their homes? Well, today they can.

Station KTRH-AM has served the Houston and Louisiana Gulf Coast areas with a 50kW signal since 1930. In 1980 a new transmitting plant was installed 30 miles north of the old site. Despite the fact that the new site was wired for remote control, the transmitter was fully manned until 1985 when remote-control operations were initiated.

System design

When the engineering staff began to plan for a remote-control system, three important criteria surfaced:

(1) The remote-control system needed to be a standard product with a proven track record.

(2) The remote control needed to have a computer interface with sufficient flexibility to perform all of our logging and control tasks.

(3) The system also had to provide access and control via a dial telephone line and modem.

After looking at the various products available, we learned that the hardware was the least of our problems. Several manufacturers could provide us with high-quality equipment. What was lacking was a system with sufficient software to perform the needed control and logging tasks. This aspect forced us to write our own software.

Hardware installation

After evaluating several systems, we selected a Moseley MRC-1600C. In addition to providing the necessary control functions, the remote control also provided an RS-232 control port. This port was designed to interface with an optional CRT and logging system. However, because the addition of a CRT to this port would not provide automated logging, we use the port for our own purposes.

The studio control unit and modulation monitor are located in the control room within easy reach of the board operator. Control signals are passed to the transmitter via the 950MHz STL system. The telemetry data is returned to the remote control via a leased telephone line. See Figure 1.

Computer selection

We selected an Apple II+ computer for two significant reasons. First, the station was using this model in several other applications, so the staff was already familiar with it. Second, we knew a local programmer who could write the necessary software to interface the computer with the remote control.

The computer is equipped with two RS-232 interface cards, a printer interface, a dot-matrix printer, a single disk drive and a green-screen monitor. One RS-232 line connects the computer to the remote control and the other line is connected to a 1,200 baud auto-answer modem.

Software

Dan Judd, a local broadcast engineer, agreed to write the necessary software to meet our specifications. The main program is divided into three sections. A BASIC program boots the system and initializes the peripheral equipment. A 6502 machine language program

Armatta is chief engineer for KTRH-AM and KLOL-FM, Houston.

01	STL SIGNAL	3.236	MVOLTS	01	INTERLOCK	CLOSED
>02	COM POINT	32.59	AMPS	02	DOOR	CLOSED
03	PLATE E	9.24	KVOLTS	03		
04	PLATE I	6.50	AMPS	04	POWER	HIGH
05	A PLATE E	−0.04	KVOLTS	05		
06	A PLATE I	−0.02	AMPS	06		
07		0.00		07	STL RCVR	606
08	ROOM TEMP	71.2	DG	08	XMTR ON	MW50
09	PHASE MON	117	PERCENT	09	PATTERN	DAY
10		0.00		10	EMG ANT	NORM
11		0.00		11	DC OL	OK
12		0.00		12	VSWR OL	OK
13	TWR No. 1 LIGHTS	15		13	AUX PWR	STOP
14	TWR No. 2 LIGHTS	56		14	AC POWER	GSU
15	TWR No. 3 LIGHTS	20		15	AUDIO	MW
16	TWR No. 4 LIGHTS	12		16	PHONE	ON HOOK
					MAINTENANCE OVERRIDE :	DISABLED
	ESC FOR ATTENTION, HOME TO SWITCH :				CAPTURE OFF :	ON: 00:01:17

Table 1. Standard CRT display during normal operations.

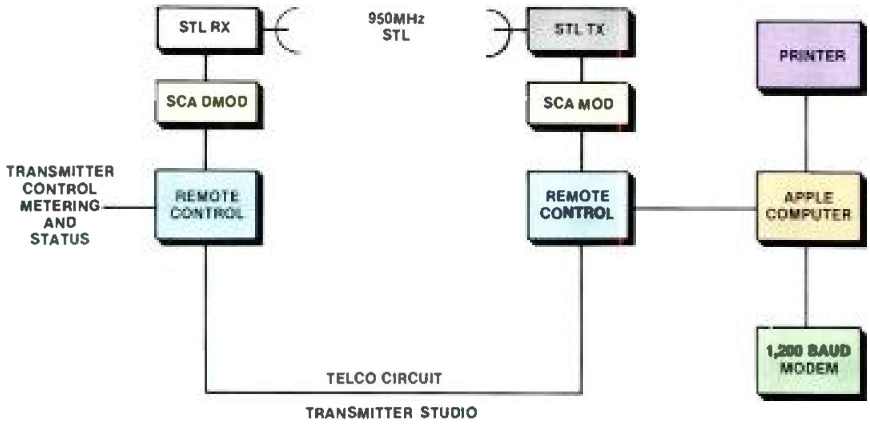


Figure 1. For most operations, the remote control is under the supervision of the computer. Control data is sent to the transmitter via the STL and returned on a telephone line.

handles the data exchange with the remote control, writes the information to the screen, checks for interrupts from the function operations and directs data to and from the modem. An additional program provides dial access to the remote control and data logging features.

Our first problem developed when we tried to use the data from the remote control to feed the computer. The remote control transmits data to the RS-232 port in a format compatible with the ADDS Viewpoint terminal. Because our equipment was different, an emulation program was needed to allow the computer to properly interpret the data.

As originally configured, the MRC-1600C sent data to the port in an 80-column format. However, the Apple screen is only 40 columns wide. Our software allows us to properly display the information in a severely truncated format. The computer CRT displays a small portion of the channel labels, so only the first few characters are visible. As you can imagine, this led to some interesting contractions being displayed on the screen. A new computer and software update now permit displaying the entire 80 columns of data.

The channel labels can be changed by the operator through the computer keyboard. The labels are contained in a non-volatile memory in the remote control. When the system is booted, or when the character O is sent to the remote control, a screen refresh is issued and the entire computer screen is rewritten.

The remote control can be operated from the computer keyboard. The operator simply moves the cursor up or down to the desired function with the return or backspace keys and presses either an R or L to issue a raise or lower command. See Table 1.

Automated control

Providing automated logging was one of our primary goals when we first began the design process. The computer allows programmed functions to take place at selected times. When the program boots, the operator is asked if these parameters need to be changed. If the answer is yes, a spreadsheet-type display appears on the screen. The operator can then set the time for each function to occur, which channel should be accessed and if a raise or lower function should be issued to the remote control.

The daily pattern change is an example of the automatic control. At the appropriate time, the remote control is commanded to switch to channel 9 and issue a raise command to the remote control. The pattern is automatically changed and the printer logs the event. The functions can be changed by the operator at any time by issuing a control S at the keyboard. All automatic functions are recorded on the program disk and automatically load when the program boots.

Modem connection

The auto-answer modem allows an engineer with a computer to dial into the system from any location. Once the connection has been established, all remote-control functions are available. This feature was necessary because our operators are hired for their production talents, not for their engineering skills.

Operators are trained to get the transmitter back on the air in an emergency. However, as many engineers know from experience, talking a board operator through an unusual situation can be frustrating and time-consuming. With our system, an engineer can get KTRH-AM back on the air or correct a problem much faster than might otherwise be possible.

Access to the modem is through a dial-up phone line. After the modem answers the phone, the operator must enter the password. To discourage possible hackers, the system is programmed to immediately dump the caller upon receiving an incorrect password.

To access the system, the engineer must have a computer, a 1,200 baud modem and a communications program, which emulates an ADDS Viewpoint terminal. When the modem is in operation, the studio computer acts as a pass-through device. For this reason, the external communications program must provide its own terminal emulation routines.

The main studio remote control remains in a supervisory mode even when the modem is being used. An indicator light alerts the operator as soon as the modem is accessed. The light monitors the carrier detect line between the modem and the computer. If the operator thinks that problems are being caused by the person connected to the modem, a switch can be opened that terminates the caller's access to the system.

Successful implementation

The system has been in operation for almost two years. During that time there have been few problems. As with most in-house projects, there are several features we would like to add. System expansion and feature enhancements currently are being investigated.

Because this installation has been so successful, our company plans to install a similar system in another city. Once that system is completed our engineers will be able to monitor that station's transmitter from Houston.

Making inroads in frequency coordination

By Bob Van Buhler

The SBE continues to make inroads in the area of frequency coordination. At the NAB convention, plans were reviewed and established to improve the already successful program.

Key projects that are under way include the standardized database software, developed by the SBE for coordinators. The MS-DOS-compatible software functions with the most recent version of Nantucket's Clipper compiler. The compiler works with dBASE III and many other database programs.

Gerry Dalton, SBE national frequency coordinator chairman, assured coordinators that assistance will be available for converting or translating an area's existing database into the new format. According to Dalton, there will be few systems that are not capable of direct or indirect translation.

Another project that is under way is the frequency coordination handbook, which will be compiled by the NFCC and printed by the NAB. The handbook will help ensure a readily available coordination procedure reference for use by local users and coordinators. The handbook also will help develop uniformity in practices at the local and the national levels.

Issues to be covered in the handbook include: the role of database manager, coordinator accessibility, dealing with network personnel and real-time coordination procedures. Suggestions for material have been received from the networks and the SBE. A first draft should be ready this summer.

Example success

The society salutes the ever-progressive Los Angeles TV market, which has adopted an areawide *home channel plan.* The key to the plan was the mutual agreement of all users to the terms and conditions.

In the plan, the seven lower and three upper 2GHz channels are split into half-channels. Each local user has a 2GHz channel with which to conduct normal business. Each user is then assigned two halves or a full channel, depending on the station's activity level.

If a user needs an additional channel for a particular real-time event, coordination by way of community repeater is used to ask another user to surrender an idle channel for the brief time of the desired feed.

Key elements of this real-time coordination process are an accurate list of management people for all systems involved, up-to-date 24-hour telephone numbers and three pages of operating procedures.

The plan took two years of work, and the 1984 Olympics, to bring everything together. Just getting all licensees in a market to agree on anything was a major accomplishment. Richard Rudman, SBE president, and others were instrumental in the plan's original concept and final implementation. According to Rudman, the work has only begun, because the plan needs to change with conditions and remain flexible in order to respond to current conditions.

New Tennessee chapter

About a year ago, representatives from the Tennessee Association of Broadcasters (TAB) approached the society, hoping to encourage the establishment of a local SBE chapter. The TAB thought that the society had much to contribute to broadcasting and hoped that they would help them get things started.

The original work was successful and the SBE is pleased to welcome the newly formed group, Nashville's Chapter 103. For information on meeting times and locations, contact John Dolive (WSMV-TV), chairman, at 615-749-2244.

National service

The society welcomes members who are interested in serving at the national level. Would you be interested? If so, keep the following points in mind.

The board members are not reimbursed for expenses associated with society activities. This means that you or your company must pay for your travel to a minimum of two board meetings a year, plus numerous long-distance telephone calls. Other expenses include occasional postage and time away from your job. An enthusiastic employer also is a valuable asset.

The board members are assigned to activities on multiple committees, usually ones in which the members have shown some expertise or interest. Depending on the areas in which the board member becomes involved, the work can take as little as two hours a week or a lot more. On a practical basis, the work is usually divided between your employer's time and your personal time. Activity on the national level is not an honorary function, but rather, hard work on behalf of the membership.

The preferred credentials for a board member include multiple years of service as a local chapter officer, or service on a national SBE committee. These are not the only two routes to a national office though. If you feel you have something to contribute to the SBE at the national level, consider what is involved well in advance of the nomination procedure. More information can be obtained from the national office. Members wishing to get a feel for the national board's functions are welcome to attend board meetings, which are held during the SBE's national convention and the annual NAB convention.

Frequency coordinator's list

The latest update of the national frequency coordinator's list now is available. Copies can be obtained from the SBE national office or from Bob Van Buhler at WBAL-AM. Updates are available (including recent revisions) from the CompuServe Broadcast Professionals Forum (BPForum). If you have coordinator changes, they can be transmitted via CompuServe Easylink or MCI Mail to Gerald Dalton, who maintains the master listing.

For this fall's *must-attend* event plan now to attend the SBE National Convention and **Broadcast Engineering** Conference in St. Louis, Nov. 10-12.

Van Buhler is chief engineer for WBAL-AM and WIYY-FM, Baltimore.

ABC chooses Fuji videotape for Winter Games

Fuji Photo Film U.S.A., Elmsford, NY, will be the exclusive supplier of videotape for ABC's coverage of the 1988 Winter Games in Calgary, Alberta. ABC holds the exclusive U.S. TV broadcast rights for the games, which will open in Canada, Feb. 13, 1988.

In a related move, Fuji also announced that ABC has selected the same videotape products for use during the network's coverage of the Democratic and Republican National conventions, to be held during the summer of 1988.

Leasametric IRD offers instrument rental credit card

Leasametric Instrument Rental Division, Foster City, CA, has introduced the MetriCard, the first credit card in the test equipment rental industry. The MetriCard provides customers with discounts and special free services, along with easier instrument rental. Those with a MetriCard can rent their equipment intantly, because credit approvals and delivery details are already available in the company's database. Benefits include free inbound/outbound shipping and free calibration certification.

EMCEE transmitters upgrade ITFS system

The archdiocese of New York's instructional TV system is replacing all of its transmitters with equipment from *EMCEE Broadcast Products*, White Haven, PA. With seven transmitter sites in 10 counties in southern New York state, the archdiocesan system carries its ITFS signal throughout the boroughs of Manhattan and the Bronx in New York City.

The ITFS stations in Yonkers, Manhattan, Staten Island and Rhinecliff, NY, have been upgraded with the installation of EMCEE transmitters.

Valley People takes new name

Valley International, Nashville, TN, is the new name for Valley People. The renaming occurred to reflect Valley People's expanding market. Nine new products have been introduced during the last 18 months.

Correction

Page 118 of the June NAB wrapup report contained an incorrect reference to the product *Cypher* in a summary of the new products introduced by Cipher Digital. *Cypher* is a registered trademark of Quantel and should not have been listed in the summary.

New products

Spatial image enlarger

Modulation Sciences has introduced the StereoMaxx, a spatial image enlarger. It uses the concept of spatial image enhancement to create a bigger sound. The unit widens the sound field, adding more depth and a psychoacoustical increase in punch. Ladder LED displays show width and width limiting. Depth and diffusion controls determine the amount of signal that is tapped from a digital delay line for insertion into the main audio path. An automatic width-limiting circuit prevents overenhancement, while centrally located sounds, such as an announcer, remain centered. The system includes active inputs with transformer (or optional transformerless) outputs for adaptability of installation in any radio or stereo TV audio chain.

Circle (345) on Reply Card

Amplifier and bass drivers

McKenzie Acoustics has introduced the following products:

• The Q-MAX 600 amplifier to complement the Q-MAX 7000 system PA loudspeaker enclosures. It is rated at 300W per channel. Suited to both roadwork and permanent installations, the amplifier eliminates fan noise, making it suitable for studio use. Cast aluminum heatsinks ensure adequate heat dissipation. The amp's input circuit has been designed to eliminate hum loops without disconnecting the mains safety earth, while a relay-controlled delay gets rid of power surges and speaker thump during switch-on.

• The C15-500 and C18-500 are two extended bass drivers. Both the 15-inch and 18-inch 500W loudspeakers have a magnet system that bolts together via six 8mm tensile bolts. A flux-gathering ring at the base of the pole piece improves magnetic flow and locks the ferrite core in a permanent position. The 4-inch diameter voice coil is edgewound for greater sensitivity and simultaneously reduces voice coil mass. It is then wound on a ventilated, high-temperature Kapton to handle and dissipate the heat generated. A double-coil suspension system gives improved voice coil stability and control.

Circle (346) on Reply Card

Data storage and time-code systems

Cipher Digital has introduced the following products:

• The Softouch Softpac data storage system is an enhancement to the Softouch audio editor. It allows unit soft key control and loop memory to be extended, preserved, protected and reviewed. Features include an external cartridge capable of storing 500 Softkey instructions; stores Softkeys, loops or machine control parameters; Write protect circuitry; fully compatible with the 4700 Shadow II and the 4800 Shadow II. All the data save and load functions are menu-driven.

• The 4800 Shadow II synchronizer/controller features include: selectable RS-232/422 computer compatability, time-code reader, mute command path, memory locations and variable park tolerances. The unit continually adjusts a transport's capstan speed to keep it synchronized to another transport within 1/100th of a frame.

• The CDI-750 is a time-code reader, generator, character inserter and event controller in one system. It is microprocessor-based and offers a programmable jam sync mode, built-in time-of-day clock, RS-232 computer interface and 16-event controller. Features include: extended sync source selection; instant selection of 24, 25, 30 or drop-frame code; memory retention of set up on power loss; and a fully positionable video inserter.

Circle (347) on Reply Card

Disc-based audio recorder

Integrated Media Systems has introduced Dyaxis, a disc-based audio recorder designed to use the power of the Apple Macintosh Plus or Sun Microsystems Sun 3 computer for control. The system includes: a true 16-bit, linear-phase audio-processing system capable of real-time direct-to-disc data transfer, a mass storage system capable of storing up to two hours of 48kHz sampled stereo audio information and a software package.

The system performs editing, multi-event stereo and mono mixing, panning and special effects. A digital audio processor provides master quality 16-bit audio conversion circuitry featuring three proprietary IMS high-performance innovations: PAL TM, psychoacoustic linearization for low-level signal reproduction, two filter circuits and AIMM, an asynchronous interactive memory management technology.

Circle (348) on Reply Card

Computer-aided broadcast system

DKW Systems has announced the CABS, a multi-user computer-aided broadcast system. It controls a variety of playback equipment and provides the announcer with schedules, current plays, upcoming events and on-air information, together with fingertip control of peripheral audio devices. A history of aired events is maintained; upcoming events and schedules also are available for immediate reference. Information required internally or by external regulatory and royalty agencies is available on-line or in printed reports. The company provides initial support during installation and startup of the computer system, and on-going assistance as needed.

Circle (349) on Reply Card

TVRO terrestrial trap and interference filters

3217 tunable notch filter

Microwave Filter Company has introduced the following products:

- The model 3217LST tunable notch filter removes interference at a receiver's IF caused by microwave terrestrial interference at ±10MHz from the transponder center frequencies. It is available for 60MHz or 80MHz. The notch-filter response is designed to be nonsymmetrical in order to preserve the receiver's 70MHz IF passband. The 3dB points in the direction of the passband can be set by tuning between 0.5MHz and 1.5MHz. The exact notch-center frequency can be adjusted within ±3MHz of the notch-center frequency.
- A line of filters, designed for installation directly into the baseband line, will suppress interference at baseband for TVRO reception. The model 5707-(*) trap for suppressing selected subcarriers is factory set to any subcarrier frequency (4.5MHz to 10MHz) but is tunable ±100kHz minimum. Typical notch is 25dB; 3dB bandwidth is about 500kHz. The model 3634-(*) bandpass filter isolates a desired subcarrier from other subcarriers and is available centered on any subcarrier from 5MHz to 110MHz. Subcarrier loss is 2dB with 3dB relative bandwidth; 400kHz selectivity is about 30dB ±700kHz.

The series 3322 low-pass filters pass video and suppress audio subcarriers. The model 3322-4.2 has a 0MHz to 4.2MHz passband, a 5MHz to 600MHz stopband and 40dB minimum stopband attenuation. The model 3322-4.2/4.5 has a 0MHz to 4.2MHz passband, a 4.5MHz to 1,000MHz stopband and 30dB minimum stopband attenuation.

Circle (380) on Reply Card

Voice response alarm monitor

DINET has introduced the VOCALERT 2.2, a solid-state alarm annunciator that gives a clear voice report of an alarm condition. A switch connected to any of the 14 input channels will trigger a user-programmed description of what happened. Each channel can be programmed with its own distinct alarm message.

The monitor is programmed by speaking into the microphone of the programmer. A dictionary of key phrases spoken into the programmer is used to assemble the alarm messages, which are stored in the permanent memory of the monitor and remain after the programmer is disconnected.

Circle (381) on Reply Card

Filter

Electron Processing has announced the EPI hum notch model HN60-120 filter. It occupies one 1¾-inch-high RETMA 19-inch-wide rack unit and eliminates 60Hz and 120Hz hum in broadcast and recording studios, and can be ordered configured to eliminate other unwanted frequencies in a spectrum of additional applications. The filter provides a pair of deep 50dB notches, while passing all other audio frequencies with negligible attenuation. It operates from 117V 60Hz ac lines and requires little operational current, dissipating a maximum of 4W in the cabinet. Industry-standard 3-pin Cannon XLR connectors are used to route audio in and out of the filter. Users need only connect noise-laden signals to one input and derive clean hum-free signals at the other.

Circle (382) on Reply Card

Post-production mono-stereo converter

Kintek has introduced the KT-904Post mono-to-stereo converter. The width controls are available for remote mounting on the mixing console, giving the mixer immediate and full control over the acoustical image width. The controls allow the operator to adjust the acoustical image widths from very narrow to an 180° spread. These controls can be mounted at any reasonable distance from the converter. There is no audio signal present on these remote circuits. The converter can be bypassed from the console so direct feeds can be made without changing the input patch. Remote status indicators show if the system is in the active or bypass state.

Circle (383) on Reply Card

Crimping tool

CooperTools has introduced the Xcelite MAC-8281 crimping tool, which works on Belden 8281 cable as well as most brands of dual-crimp BNC/TNC coaxial connectors. The tool features small handle spread and dies that may be interchanged with Xcelite MAC-2210 and MAC-NI-8281 tools.

Circle (384) on Reply Card

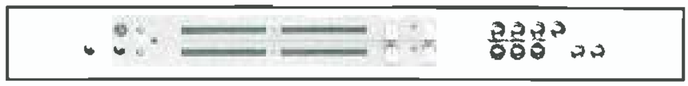
EMP protector

EEV has announced the TPU7P/250 hybrid EMP protector with a 5A mains feedthrough device. The device features a spark gap, VDR, avalanche diode and hybrids in a compact unit.

Circle (352) on Reply Card

Stereo gated leveler/compressor/limiter/clipper

Orban Associates has announced the model 464A Co-Operator, a stereo, gated leveler/compressor/HF limiter/peak clipper. It automatically rides gain, controls excessive high-frequency levels (with selectable pre-emphasis) and limits peaks. It is switchable for stereo-tracking or independent dual-channel operation. Two LED bar graphs in each channel simultaneously display gain reduction and peak output level. Infrequently used controls are concealed behind a security panel. Balanced, floating inputs and outputs are EMI-suppressed. A 25dB gain reduction range is achieved with a low-distortion, Class A VCA.



Circle (353) on Reply Card

Studio and video lights

Osram has introduced the following products:

- The HMI 270 studio light features the HMI 250 W/SE lamp that gives the same spectral distribution as daylight. The lamp comes to full output in less than one minute, and is axially positioned in the reflector for high luminous intensity. The electronic power-supply unit has a square wave design that prevents fluctuation of the luminous intensity, so no flicker is produced during filming.
- The Video 1001 video light is equipped with a 1,000W tungsten-halogen (3,400°K) Superhot lamp. The light features

a built-in blower to maintain a constantly cool operating temperature and a thermostatic cutoff to prevent overheating. The light provides a 90° angle of illumination in the flood setting and 50° in the spot setting for telephoto shots.

- The Video 1002 light is equipped with a luminous 100W tungsten-halogen (3,400°K) Superhot lamp. The light features a quiet blower cooler for continuous operation; variable flood/spot angle of illumination; a diffusor for soft lighting; and a reflector that swivels vertically through 90°. Four barndoors permit more creative lighting effects. The economy switch saves lamp life and reduces heat output.
- The Video 1003 light has a high-powered 1,000W tungsten-halogen Superhot lamp that maintains a constant color temperature of 3,400°K. The light is fitted with a heat-resistant diffusion screen to provide soft lighting and eliminate harsh shadows and glare. A thermostatic cutoff prevents overheating. The light features a built-in blower that maintains a cool operating temperature. The light provides a variable angle of illumination from 90° to 50°.

Video 1001 light

Circle (354) on Reply Card

Uninterruptible power system

Nova Electric has announced the Nova Galaxy 3000 3kVA on-line uninterruptible power system. The module measures 8¾"x17"x22" and weighs 145 pounds. The UPS includes a battery charger, an inverter and a solid-state transfer switch. A single battery module will deliver up to 21 minutes at 3kVA. Standard features include operational status monitors displayed on the front panel, audible alarms and remote alarm contacts.

Circle (355) on Reply Card

Digital audio system

New England Digital has announced the expansion of the Synclavier digital audio system to 200-track capacity and up to 1.5Gbyte of memory. A 512K card enlarges note storage—up to ¼ million notes can now be maintained on-line in the Synclavier. Accessories include a stereo sample-to-memory for direct storage of sound in random access memory at a variable sampling rate of up to 100kHz per channel with 16-bit resolution; a MIDI option for linking MIDI-compatible devices; and a mouse for cut-and-paste digital sound editing.

Circle (356) on Reply Card

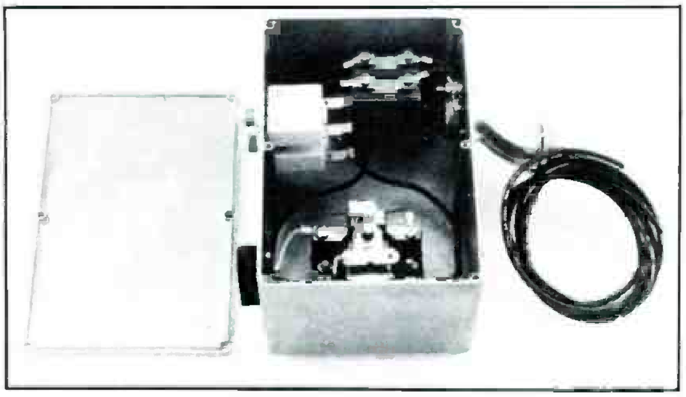
Tape shipping case

Maxell has introduced a flame-retardant, hard-orange plastic casing for transporting professional quality 1-inch tape. The 1-inch line is available in cardboard and plastic shelf boxes as well as the 1-inch shipper. The plastic frame and a locking hub and rotating plate reduce the chances of tape being cinched.

Circle (357) on Reply Card

Lightning protector

PolyPhaser has introduced the IS-PM240 series of power mains shunting-type surge protectors. The protectors are available in single phase and 3-phase models that provide common-mode protection via field-replaceable MOV blocks, and are rated at 30kA per leg. The model IS-PM240-1P has a 60kA rating and 900J of energy dissipation. Surge-type circuit breakers in series with MOV blocks will not open for surges less than 24kA per leg, but will take the MOV off-line at end of life, preventing a building power outage. Internal relay has dry single-pole contacts that can be used for local or remote-status signaling.



Circle (358) on Reply Card

Frequency converters

Powermark has expanded its line of SINE 2 sine wave inverters and frequency converters to include 500VA and 1kVA models. The systems generate 100 energy pulses every 16ms. By constantly modulating the widths of the pulses, these systems maintain a nearly distortion-free output sine wave, even for non-linear loads. Other benefits of the pulse-width modulation technology include 85% energy efficiency, and units that are up to 80% smaller and lighter. An added feature is INSTON instant starting capability, enabling inverters to operate in a standby mode while still providing UPS effectiveness in critical applications.

Circle (359) on Reply Card

Dub-mode time base corrector

Prime Image has announced the DUB•TBC+. The TBC removes time-base error and avoids degradation due to excessive signal processing. Advanced component dub-mode processing makes videotape duplicates for all commonly used dub mode videotape recorders. The TBC also provides transcoding of Y/C688, Y/C629 and R−Y/B−Y-type signals to NTSC composite or from NTSC composite to Y/C688, Y/C629 or R−Y/B−Y, which makes possible editing between the ½-inch and ¾-inch tape formats and the Beta and M formats.

Circle (360) on Reply Card

INTELSAT video receiver

Scientific-Atlanta has announced the series 7514 INTELSAT video receiver. The receiver complies with all INTELSAT standards and provides broadcast-quality reception of TV video and audio from satellite transmissions. The receiver combines the qualities of its 414 INTELSAT receiver and the 7500 series video receivers. The receiver provides audio and video signals, extended tuning range, video threshold extension demodulation and flexibility in options and control. The unit provides extended tuning (3.625GHz to 4.2GHz) over the entire C-band range, necessary for INTELSAT VI satellites. Audio threshold extension demodulation is provided by a synthesized audio demodulator that has the added benefit of frequency agility. Although one audio demodulator is standard in the receiver, up to four audio subcarrier demodulators may be accommodated. This expanded capability can provide stereophonic or separate audio programs.

Circle (361) on Reply Card

VBI data receiver

PBS Enterprises and *EEG Enterprises* have announced the VDR high-performance data receiver. It will function as a high-speed (9,600 bits per second) data receiver, decoder and processor. Through its built-in key pad, the receiver can be tuned to any UHF, VHF, cable or HRC cable channel and can access various data services on each VBI line. The receiver automatically fine-tunes to the requested channel, using TV-tuning circuitry optimized for data reception. It separates the VBI containing the data, from the TV picture, and extracts the data from the VBI. The data is then checked for errors and corrected if necessary.

Circle (362) on Reply Card

10½-inch reel

Polyline has introduced a professional quality 10½-inch reel with 3-inch NAB center for use with ½-inch tape. The reel is manufactured from semitransparent brown plastic, and may be ordered with or without a hinged white box. |:[:-))))]

Circle (363) on Reply Card

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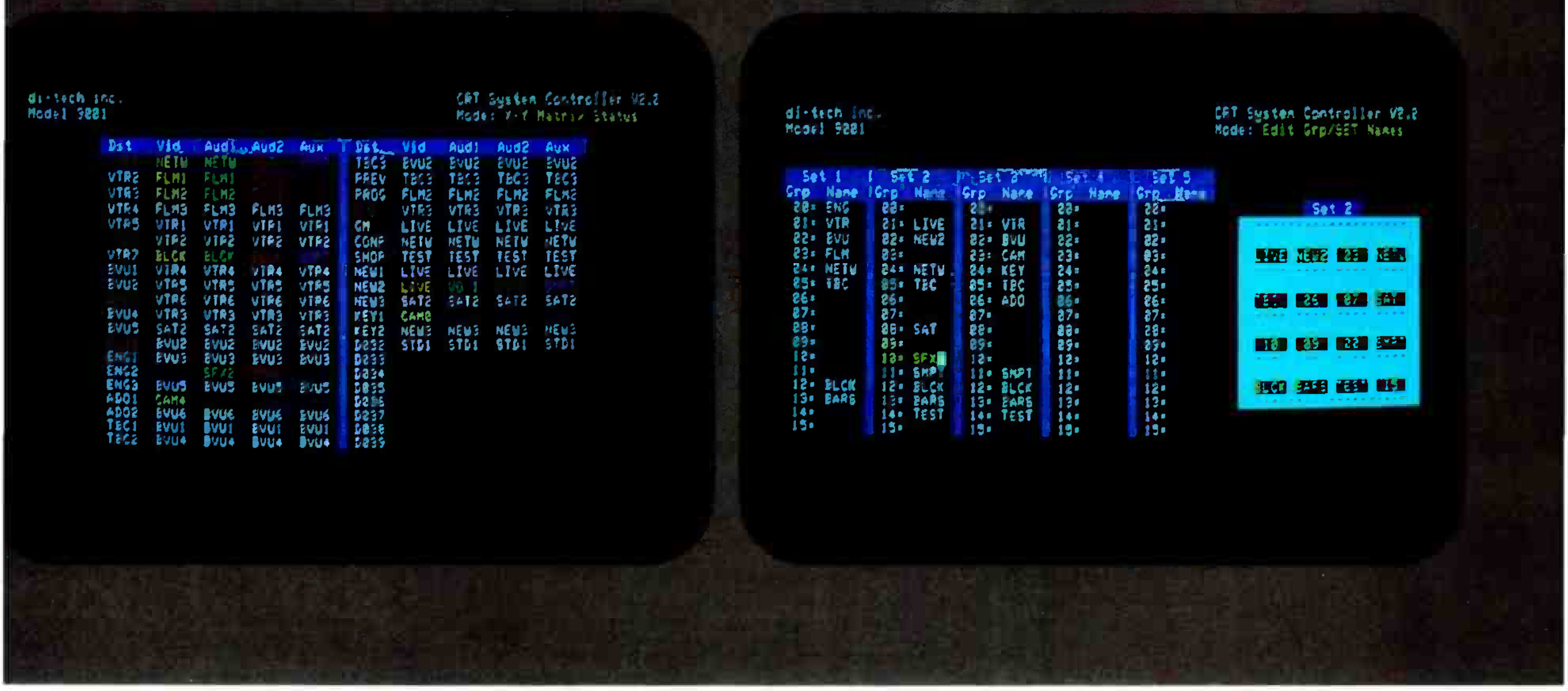

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