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May 1988/$3

Transmission systems special report

Safety in the workplace p. 26

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the SOURCE

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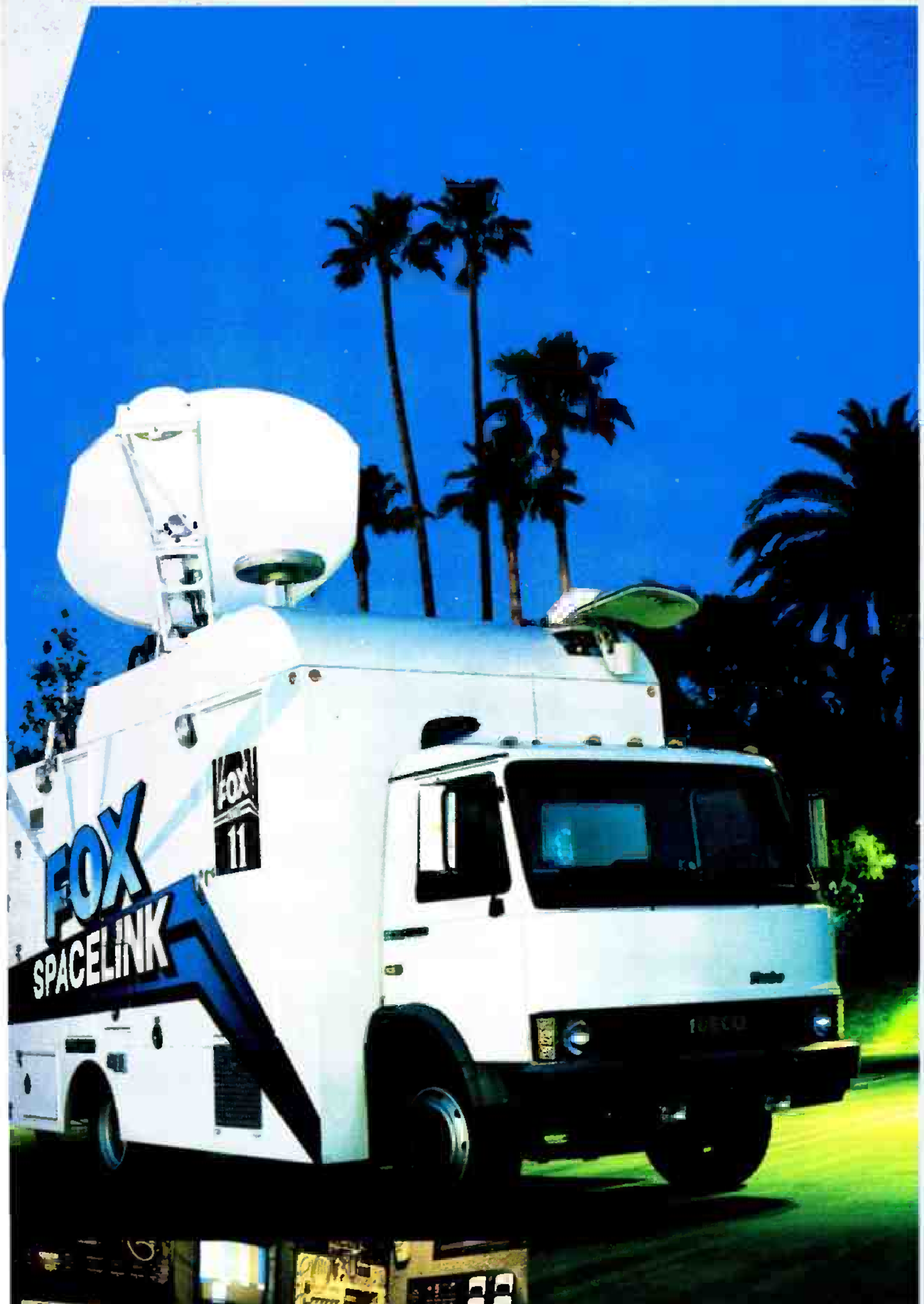

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KTTV VP/Director of Broadcast Operations, Steven H. Steinberg, sums it all up with this comment:
"This is the second S-23 that I have purchased from Midwest. It is not often I can say this, but in both cases, there were no problems."

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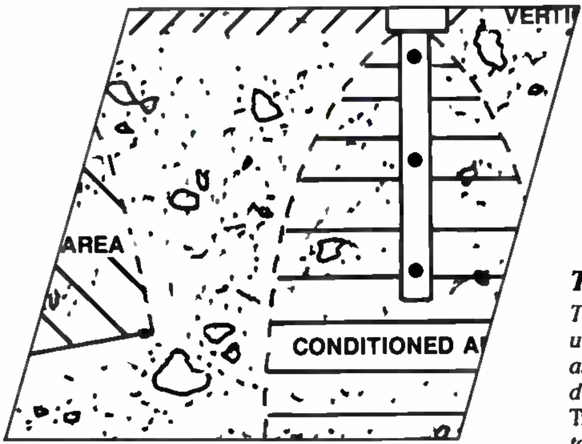

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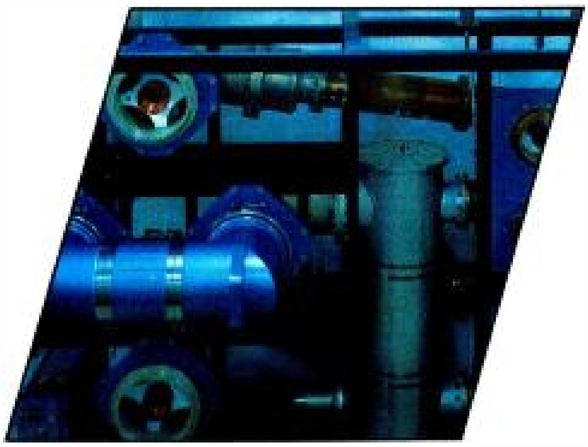

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BROADCAST
engineering

TRANSMISSION SYSTEMS SPECIAL REPORT

The transmission plant of a radio or TV station often is forgotte until a problem occurs. Because the transmitter, antenna an associated hardware are the core of a broadcast facility, prope design and maintenance is paramount. Our Third Annua Transmission Systems Special Report *examines the followin topics:*

ON THE COVER

Advancements in RF technology have given radio and TV broadcasters new ways of putting a signal on the air. One of the major changes in transmission system design to emerge within the past 10 years is the concept of a shared transmitting antenna at a community broadcast site. A major component of such a system is the combiner, or multiplexer. Our cover this month shows a posterized high-power FM combiner. (Courtesy of Dielectric Communications.)

DEPARTMENTS

NRSC proposes AM reception standard

The National Radio Systems Committee (NRSC) has proposed a second voluntary national standard (NRSC-2) for AM radio transmission. The standard will enable AM broadcasters to further control interference to their signals for better audience reception, and complements the first NRSC standard, which was introduced in 1987.

NRSC-2 is known as "RF Mask." Parallel with this is the development of a new technology to monitor AM splatter. This monitor permits economical and accurate measurements of undesired AM interference and can be used in conjunction with the RF Mask.

On Jan. 10, 1987, the NRSC authorized the NAB and the EIA to publish a voluntary national standard to control the extent of audio pre-emphasis and bandwidth of AM stations. At the end of March 1988, more than 700 AM stations in the U.S. and Canada had notified the NAB of their conversion to the NRSC standard. The NAB has petitioned the FCC to make the transmission portions of the standard mandatory. AM stations would have until Jan. 1, 1990 to convert to the standard.

The first NRSC standard is intended to specify the audio signals present at the input to a station's AM transmitter. On Sept. 9, 1987, the NRSC released a voluntary national standard for AM RF limitations. This second standard is intended to characterize the RF emissions of AM stations that use the first standard. It specifies the RF signals that leave a station's transmitter and antenna system. To allow for accommodation of all parties' views, the NRSC established a 6-month public comment period, which expired March 11, with no opposing comments filed.

On April 7, 1988, the NRSC authorized the NAB and the EIA to publish the RF Mask as standard No. NRSC-2. These revisions were incorporated into the standard and published in late May. The RF Mask consists of: limit on out-of-band AM emissions and accompanying measurement procedures.

Steinberg assumes management position

Charles A. Steinberg has been named executive vice president, Sony Corporation of America. He is responsible for non-consumer products. He also is responsible for the existing Sony Communications Products Company, which markets broadcast, professional video and audio products; and the Sony Information Systems Company, marketing dictation systems, satellite communications products, JumboTRON video display screens, Mavica still-image systems, intelligent video systems and high-speed video and audio duplication systems.

In addition, Steinberg is responsible for non-consumer business in Mexico, Central America and South America and other worldwide markets.

Continued on page 13(

BROADCAST ENGINEERING

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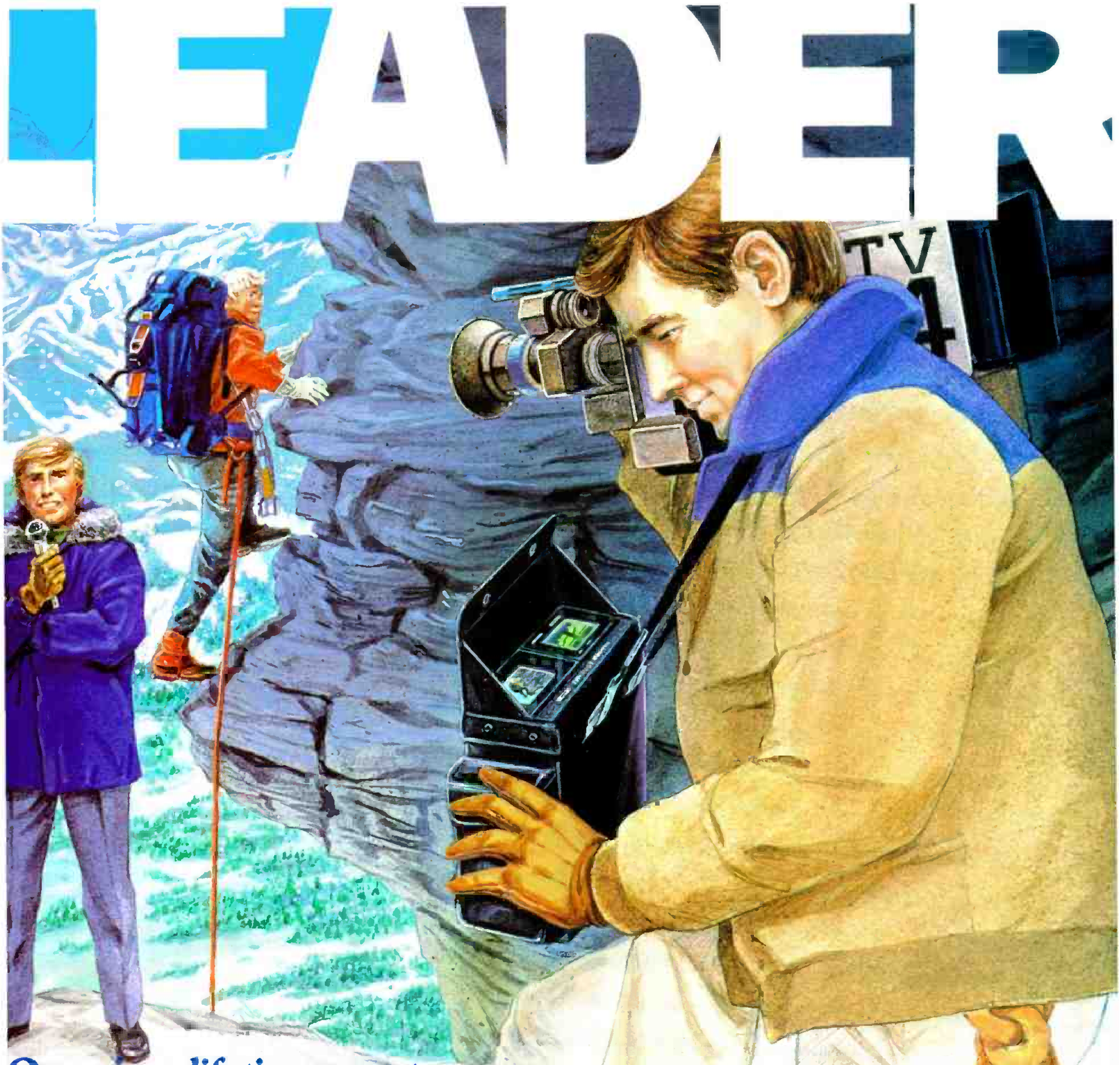

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Editorial

Graphics steps up to bat

A new player has joined the video production team. For news, this new kid on the block can whip up crisp animations that show *what* happened, what *could* happen, or *how* it happened. For production, this person can put together eye-catching backgrounds and sizzling logos as well as perform impossible video manipulations. Quietly, this individual has suited up and crawled onto the bench next to such giants as the editor, the technical director, the writer/producer and the audio engineer. Our new teammate? The computer graphic artist.

Watch television. Does an hour go by in which there is not some computer-generated image? If not a million-dollar combination of live action and flying tetrahedrons, what about a simple gleam behind a logo, or a sparkle that is just out of reach for conventional equipment. Even if the current "glass and marble" trends fade out, the computer artists will not. They can perform many functions more cheaply than the existing technology can and do too many things that the previous technology just couldn't. We might as well shake the computer artists' hands. They will be players for a long time.

So what does this mean for the video engineer?

In the first place, we have to readjust our thinking caps. Broadcasters and computer graphics people came up from different leagues. While broadcasters were refining first color, then ENG, then satellites, the computer people were working out their own separate evolution. As a result, the two factions approach differently. Broadcast engineers are wondering why the computer whizzes have such a hard time with concepts such as video system timing. The computer types are laughing at our seemingly backward, analog, low-resolution way of making pictures.

For now, our hands are at the top of the bat; if the computer pictures go to air, they pass through our systems. Period. Tomorrow, when digital comes to the plate, it may be a different ball game. Both camps must be quick studies, learning all they can about each other in order to use this technology well.

Second, we must become good communicators. Not only is computer art equipment new in the field, but its users may be rookies too. In coming up from the back room and the drawing board, into the production suite and the control room, artists have had to adjust not only to new tools (styli instead of brushes, disk drives instead of scrap files), but have had to quickly master the production process. Going from pasting up camera cards to building major chunks of program may feel a little like moving from bat-boy to star-hitter in a single season. It is our responsibility as engineers to help computer graphics fit in, both technically and as the new player on the team.

Why take such good care of these bit-nosed newcomers? The main reason is that it will help us with our job. If we fix their gear, we have to know how it works, or at least how to have an intelligent conversation with its users. As more and more of this gear arrives, our value to our employers will increase in direct proportion to our mastery of it.

Also, as art departments increase in power, because of a greater need for their services, it is better to be rostered as their fans than as their opponents. Finally, computer-generated images are a glimpse of the future. We can either embrace and foster this technology, cheer it on and become its experts, or we can stand by as those who understand it get called onto the field. And there's nothing worse than sitting in the dugout, just watching the game.

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FM short-spacing to be studied

By Harry C. Martin

In an effort to reduce the distance separations between adjacent- and co-channel FM stations, the FCC is proposing to allow the use of directional antenna systems or lowered power and/or antenna height. Under the proposal, a licensee wishing to change to a more favorable, but short-spaced, site by using a directional antenna or by reducing power and/or antenna height would be permitted to do so if its contours would not overlap the protected contours of neighboring stations or allotments.

In the rulemaking notice, the commission makes it clear that strict minimum distance separations will not be relaxed in the allotment of new FM channels. The proposal contemplates short-spacing only by existing stations on existing channel allotments.

Current rules permit the use of directional antennas to ameliorate short-spacing among "grandfathered" FM commercial stations (those whose short-spacing predated the inception of the Table of FM Allotments in 1964). Noncommercial educational FM stations also are permitted to use directional antennas to avoid interference with co-channel and adjacent-channel stations.

In the same proceeding, the commission asked for comments concerning the accuracy of specifications relating to FM directional antenna characteristics and questioned whether categories should be established to determine the stations to which these rule changes would apply.

IF distance separations examined

The commission is proposing to adjust the domestic intermediate frequency (IF) distance separation requirements for FM stations to provide a uniform level of protection from IF interference. The adjustments are intended to provide increased flexibility in antenna-site selection for most classes of FM stations.

IF is the center frequency in a small range of frequencies used within FM receivers for amplification and filtering. IF interference occurs when a susceptible receiver encounters two relatively strong IF-related signals. Current rules provide minimum distance separations to protect against IF interference. Stations operating on frequencies 10.6MHz or 10.8MHz above or below that of the specified station are subject to these separations.

Under the proposal, the distances between IF-related stations would be calculated to prevent overlap of their predicted 36mV/m contours, regardless of station class. This level of protection is equal to that provided by the least stringent of current IF mileage separation requirements. Therefore, the proposed distances are either the same or less than those presently required.

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

FM "downgrading" procedures to be streamlined

Another proposal under consideration by the commission is whether FM licensees should be permitted to downgrade their allotments to a lower class by filing an application rather than submitting a petition for rulemaking, as currently required. Under the proposed 1-step process, the Table of Allotments would be amended to specify a lower class facility once an application for a facility within the lower class is granted. This procedure would apply to both vacant channels and those occupied by existing stations.

Vacant channel downgrading could be accomplished only if no acceptable application for the class specified in the Table of Allotments is received during the filing window period. After the filing window period, the commission would accept applications for a lower class on a first-come/first-served basis.

TV technical rules to be streamlined

The commission is proposing to eliminate the following technical and operational requirements for TV stations:

- Time restrictions for operation of separate TV aural and visual program material.

- Periodic 6-month power meter-calibration requirements.

- Requirement that the color burst signal must be omitted during the transmission of black-and-white programming.

- Maximum-to-minimum radiation limitations for directional antennas.

- Specifications that pertain to equipment installation and safety requirements.

- Reference table of minutes and seconds converted to decimal parts of a degree.

These rules are slated for elimination because they are considered unduly burdensome, outdated or unnecessary.

Public file retention period change

The period of time that broadcast stations must keep various applications and reports in their public files has been reduced to one license term or until grant of the first renewal applications, whichever is later.

Under previous rules, licensees were required to retain applications for seven years from the date of the application, or until final FCC action on the second renewal application, whichever was later. When this provision was adopted, the license terms for TV and radio stations were three years, instead of the current five years for television and seven years for radio. Therefore, when the license terms were increased, the required retention periods were inadvertently extended to 10 years for television and 14 years for radio. The commission said its rule change would reduce the paperwork burden on licensees while still providing the public with sufficient information to evaluate licensee performance.

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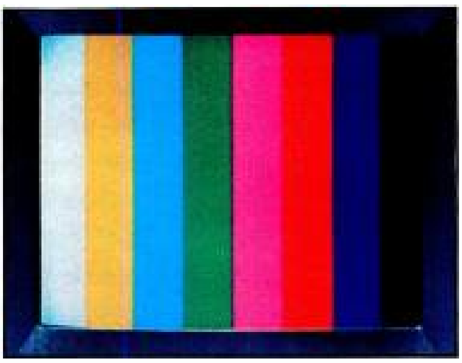


Inside NTSC encoders

By Joseph Roizen

The NTSC encoding process that was introduced in 1953, with the FCC ratification of that system for public broadcasting, remained virtually unchanged until just a few years ago. The original vacuum-tube encoders, which suffered from drift due to thermal effects and needed frequent readjustment because of tube wear, have all disappeared. They have been replaced by stable, reliable solid-state units that require a minimum of "tweaking" to remain operational.

Nevertheless, even modern NTSC encoders have some inherent deficiencies that, until recently, were considered fundamental to the NTSC encoding process. These are generally known as cross-color, cross-luminance and poor detail rendition, especially at low-amplitude transitions.

Needed: better filtering

Extensive research (conducted by Faroudja Laboratories) into the structure of the NTSC composite signal format revealed that the encoding process itself could be improved considerably if certain precautions were taken in the luminance and chrominance paths. By minimizing or eliminating subsequent intermodulation of these two signals in their composite additions, the encoding process could be improved.

The major change in NTSC encoder design derived from this research was that bidimensional (2H) comb filtering of the luminance and chrominance paths, prior to quadrature modulation of the matrixed color-difference signals and addition of the Y signal, virtually eliminated the two most noticeable deficiencies: cross-color and cross-luminance. In addition, a serendipitous bonus appeared in the form of a better chroma signal-to-noise ratio, because the filtering kept luminance noise from polluting the chroma signal.

An encoder built on these principles demonstrably improved the NTSC signal output, and it remains fully compatible with existing non-filtered NTSC encoders. This new encoding process was especially beneficial in computer graphics, chroma-keying and digital VTRs because all of these need or generate RGB baseband signals with significantly faster rise times than do color cameras or telecines. Traditional NTSC encoders without prefiltering do not handle fast rise times well. The result is a visible edge activity in the NTSC output signal. With proper bidimensional filtering and complementary decoding, the NTSC output from any video image source can be virtually indistinguishable from the RGB input.

Detail processing for improved resolution

With cross-color and cross-luminance out of the way, other deficiencies in the encoding process became more apparent. One of these was the way encoders handled small details in the image. By providing detail processing in the luminance path, before mixing and before being put into NTSC form, the resolution or sharpness can be improved considerably. This is because the basic luminance signal is not yet affected by the chroma overlay and can be handled on a wideband basis in its purest form.

To optimize performance of the new encoder, the degree of detail processing is a function of the signal source. This processing is accomplished without creating spurious edges to transitions. The result is a "filmlike," natural look of the video image, which is preserved all the way to the home receiver. Because only graphic or digital sources have hard edges, a provision is made to switch off the detail processing when such inputs are used.

Another NTSC encoder deficiency, which is under greater scrutiny these days, is the problem of proper gamma correction. Up to now, NTSC composite signals have not adhered to the constant-luminance principle for highly saturated colors, mainly because matrixing was done with gamma-corrected signals rather than with non-gamma-corrected ones. To solve this problem, an approximation in the luminance path is made, and the result is an increase in luminance resolution that also is seen by the home viewer.

The chrominance path through an NTSC encoder also must be modified to optimize performance for certain applications. One example is the matting process, which takes its keying signal from the blue channel. Traditionally, this is the narrowest bandwidth color-difference signal (I=1.3MHz, Q=0.6MHz), and it can be increased to match the I channel to render better matting performance.

New NTSC encoder techniques

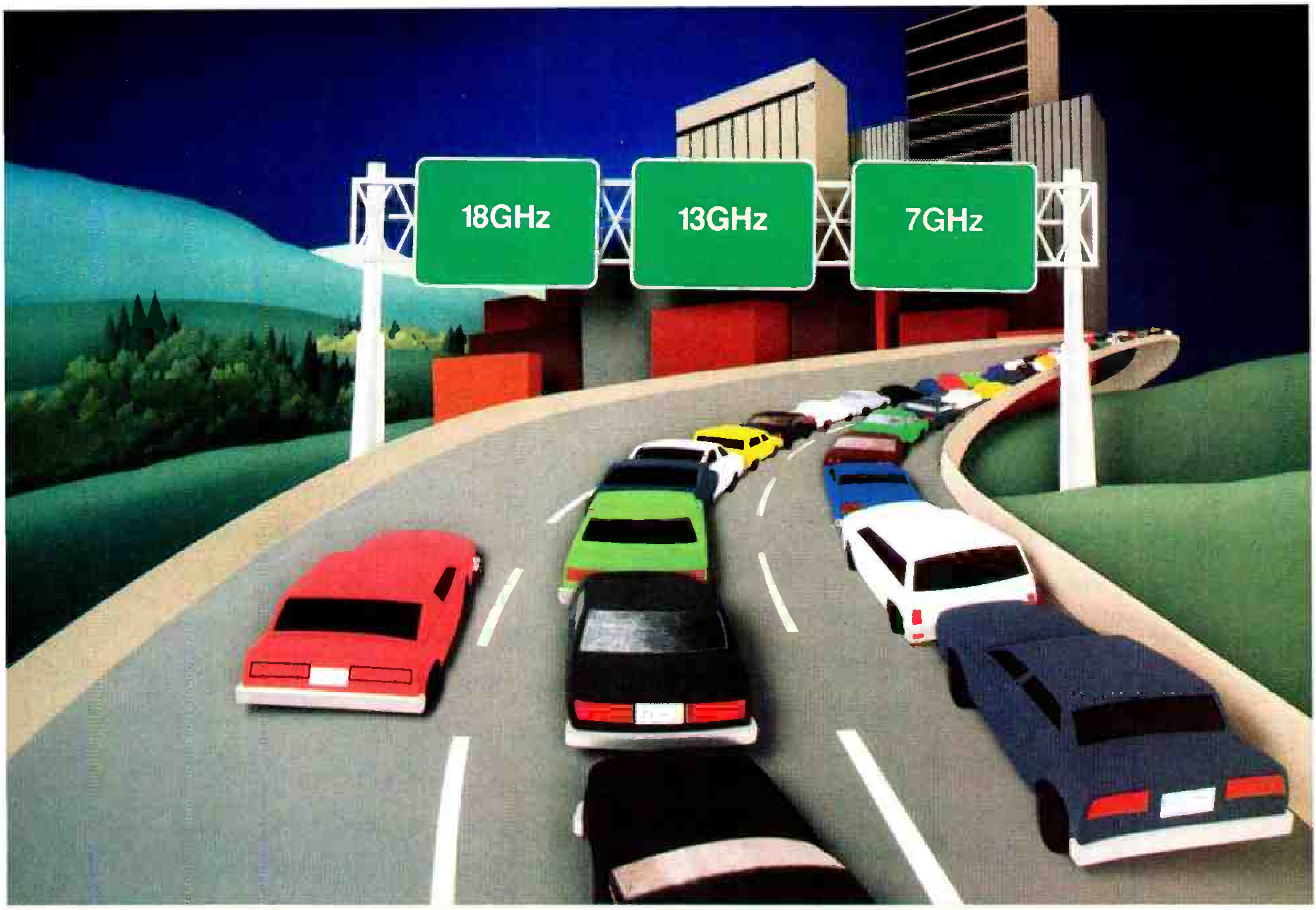
In summary, an NTSC encoder that performs optimally incorporates four new techniques:

- Bidimensional comb filtering of the luminance and chrominance signal path prior to mixing.
- Adaptive detail processing in the luminance path based on the input signal characteristics.
- Correction of luminance bandwidth problems due to gamma processing.
- Chroma path bandwidth expansion that accommodates special applications for which the encoder may be used.

Of course, good fabrication standards must be exercised in building NTSC encoders. Thermal effects should not cause solid-state circuit components to drift. This can be prevented by conservative design and adequate ventilation. Adjustments should be kept to a minimum; however, switchable options should be provided so the encoder can be tailored to the various applications encountered in a TV studio or production house.

The improvement of the encoder is the most cost-effective way of delivering better NTSC signals to the audience.

Roizen is president of Telegen, Palo Alto, CA.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DA's origin is in parasitic radiators

By John Battison, P.E.

For as long as most of us can remember, the term "directional antenna" has referred to a medium-frequency DA with driven elements. However, the origins of antenna directivity lie in parasitic radiators. The early radio researchers discovered that introducing another metallic object—generally a rod or wire—into the RF field of a radiator distorted the normal omnidirectional radiation around a single radiator.

Horizontal antennas

For many years radio propagation and transmission researchers used flat-top horizontal antennas. In fact, in his early spark transmitter experiments, Hertz used a flat metal plate as a transmitting antenna. As radio knowledge increased and propagation and polarization effects were studied, the widely differing characteristics of horizontal and vertical polarization were discovered. However, in the earliest days of radio transmission, these differences were not known.

Horizontally polarized antennas suffer from much higher groundwave attenuation than vertical antennas. Latitude and transmission direction have a pronounced effect on ionospheric propagation, and low antenna heights tend to radiate considerable energy at high vertical angles. These factors may have contributed to the early success of transatlantic radio. To the best of my knowledge, there are no longer any horizontal broadcast antennas in use in the United States.

Vertical antennas

A vertical antenna requires far less ground space and produces stronger groundwave signals with more desirable radiation characteristics. Another good reason for the use of these antennas is the concomitant use of vertical antennas on so many radio receivers in cars and portable receivers. Matching antenna polarization greatly improves the reception characteristics.

As the flat-top antennas dropped out of use in the early 1930s, the vertical antenna developed. The flat-top antenna, with its vertical wire and flat (horizontal) toploading, gave way to the single vertical radiator. I can recall how, in 1923, my father carefully stretched two parallel wires—spaced about three feet apart and insulated at each end—the length of the garden. He then hoisted the contraption up to about 40 feet. The two wires were joined together with a "Y" connection to the "lead-in," carefully insulated, and run through the window. I wonder how reception would have been with a vertical whip!

The pioneer radio engineers were amateur engineers, and a great deal of our early knowledge stems from their amateur experimentation as well as from their "office work."

The need for directional antennas began to develop in the early '30s. A great deal of work was done by people such as Glen Gillette and the late, great George Brown of RCA Labs. Brown's treatise on directional antennas, published in the January 1937 issue of the "Proceedings of the IRE" (Institute of Radio Engineers), laid the foundation for the later popularity and complexity of directional-antenna design.

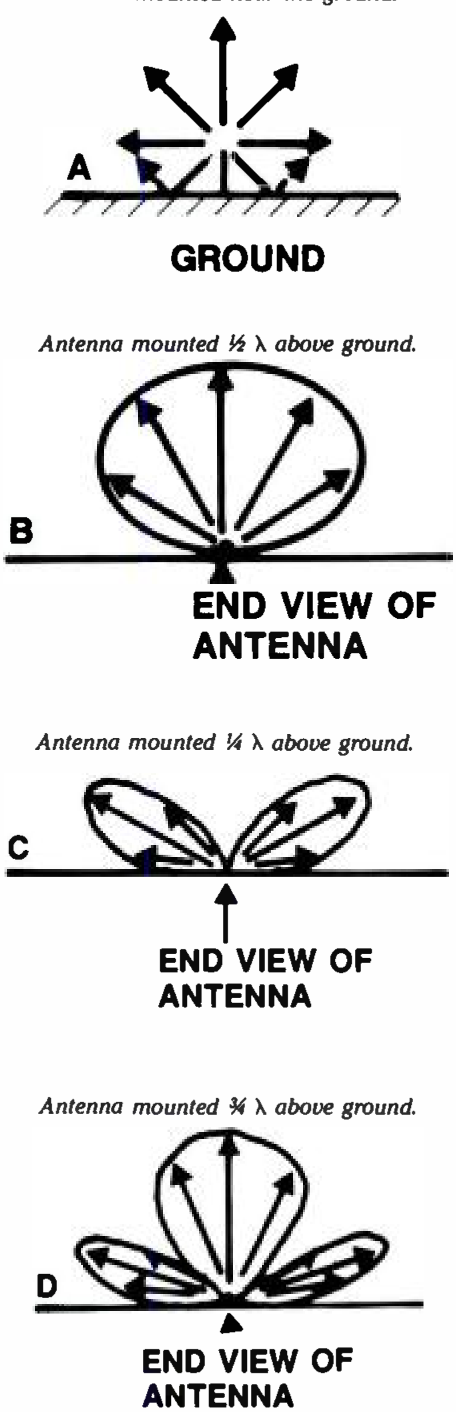

Figure 1. Antenna drawings (a) through (d) show how much the vertical radiation characteristics of a half-wave horizontal antenna depend on the antenna's height above ground.

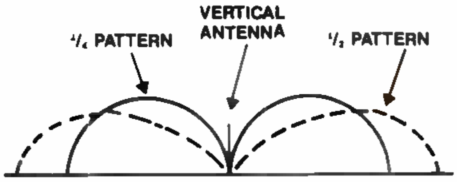

Figure 2. Compared with the horizontal antenna, the vertical antenna requires less ground space and produces less vertical (wasted) radiation.

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

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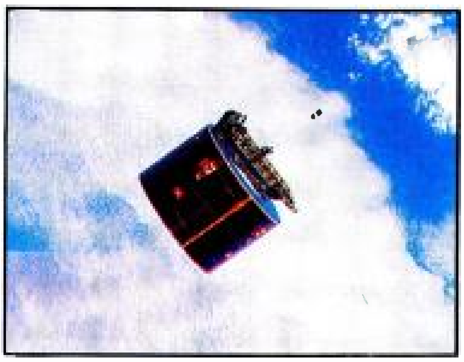

Scrambling methods change with cable

By Elmer Smalling III

In the early days of cable TV and master antenna distribution systems, operators introduced premium channels to augment their regular programming. This premium programming, typically movies, allowed cable systems to offer several tiers of service and to increase revenues. At first, the programming for these new tiers consisted of videotapes, bicycled from one cable operation to another. The individual cable operators provided scrambling systems to keep the customers on lower tiers from receiving the premium programming that brought higher rates.

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

Later, when premium programming began distribution via satellite, the distributors began scrambling to protect their material from unauthorized use by home dish owners, which numbered more than one million in 1986. Today, most TV network services also are scrambling their programming and news feeds.

The earliest type of TV signal scrambling was simple polarity inversion. Because most American-made televisions did not have a provision for inverting video, this crude system worked.

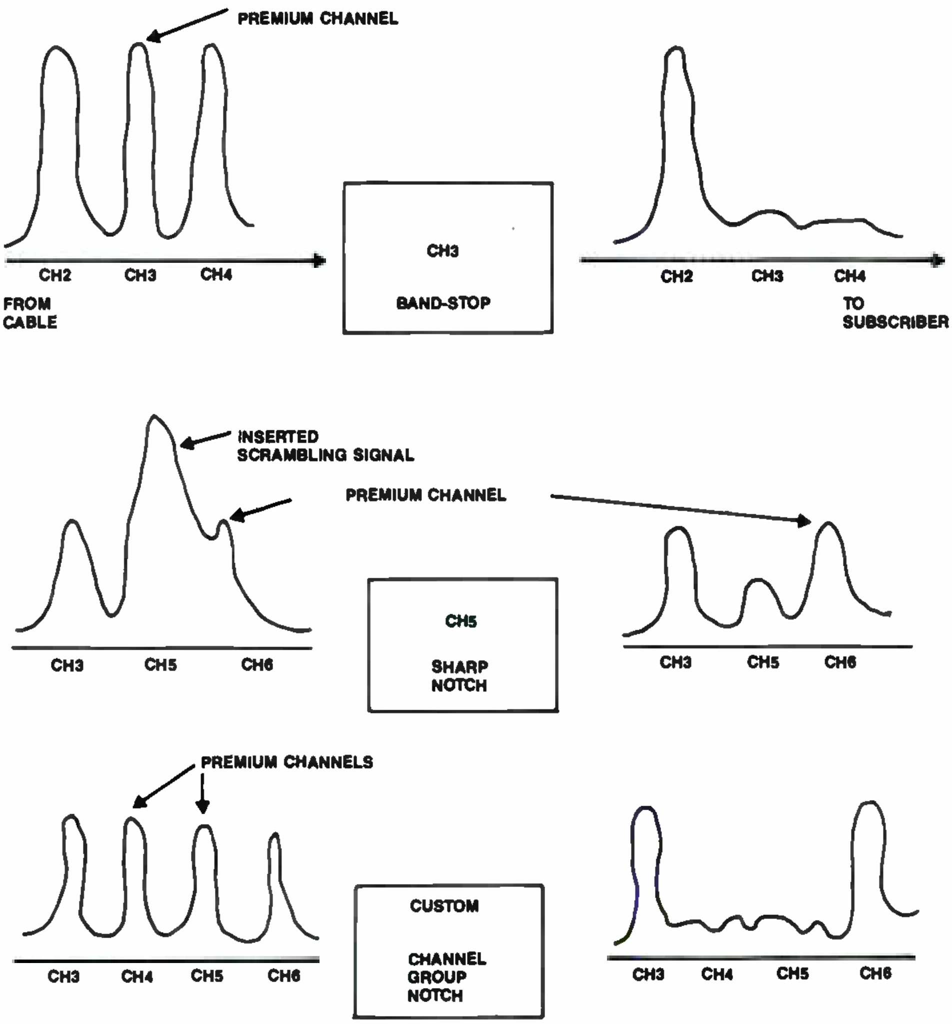

***Figure 1.** Filter-based scrambling systems insert a narrowband filter into the subscriber's feedline. Bandstop filters blocked out whole channels. Sharp notch filters attenuated scrambling signals located on adjacent channels to the premium services. Group notch filters eliminated whole blocks of premium channels, leaving lower tiers of programming intact.*

The next level of scrambling used narrowband filters. In some cases these were bandpass filters, placed in the line to the subscriber to enable passage of a premium channel. Some schemes introduced an interfering, adjacent-channel signal, which obliterated the premium channel. A sharp filter was installed at the subscriber's location to eliminate the jamming signal. All filter-based scrambling systems were flawed in that they required the cable system to maintain a huge inventory of expensive filters, and it required a service call to install or remove them.

A popular scrambling system used today is the digital encoder/decoder system. This system strips away the horizontal and vertical sync pulses, inverts the video, moves the color reference and digitizes the audio. The signal is encrypted at the uplink. Descrambling is accomplished with a digital signal that is transmitted along with the encrypted video and audio. This signal can be changed frequently to reduce the possibility of unauthorized descrambling. This system offers the advantage of programmability. The descrambler has an address that is installed at the factory into firmware. If a customer has not paid the bill, the cable system may shut down the subscriber's descrambler by simply entering a digital code.

Another popular form of scrambling uses time compression. Instead of simultaneous transmission of luminance and chrominance, these elements are time-compressed to two-thirds and one-third their normal interval. Control signals and secondary data (including teletext and multiple-channel audio) are transmitted during the vertical interval. This system allows a higher signal-to-noise ratio for the video portion of the signal.

When assessing a scrambling system, consider the amount of noise introduced by the system. Each time analog video is processed (amplified, frequency-altered, etc.) noise will be introduced into the signal. The sooner an analog signal is converted to digital form in any scrambling process, the less noise will be introduced. When the changeover from analog to digital television is complete, scrambling will be accomplished inexpensively and with no additional noise.

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An integral autolocator; a voice editing mode that allows 2X speed playback at normal pitch; a built-in cue speaker; GSPIPO (gapless, seamless, punch-in, punch-out),* and because you told us you wanted it, *all* adjustments are available through the front panel! These, and many more improvements will help make your job easier, and the results more creative.

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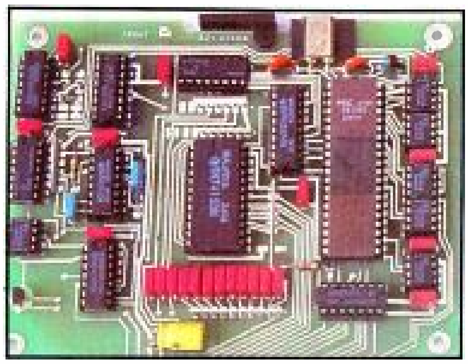
Part 20

Circuits



Inside digital Technology

By Gerry Kaufhold II

Let's look at how signals from the real analog world are converted into the "synthesized" world of digital electronics.

Electrical signals exhibit the property of continuity. Mathematically, the concept of continuity is difficult to explain, but every broadcast engineer works with continuous signals in the form of audio, video and radio frequencies.

Digital circuits differ from analog circuits in that digital circuits handle only *dis*continuous signals. Digital circuit inputs and outputs can be only *true* or *false*. Before a digital circuit can deal with a continuous analog signal, a digital-to-analog (D/A) conversion must be performed.

Analog circuit designers must consider several factors, such as the bandwidths and amplitude ranges of input signals, circuit gains, slew rates, transient response times and impedance matching.

When analog signals are represented by digital circuits, designers are forced to compromise with regard to the number of bits allowed. The greater the number of bits, the greater the cost and the greater the complexity of the design. Usually, some loss of accuracy must be tolerated.

Kaufhold is an independent consultant based in Tempe, AZ.

A simple 8-bit A/D converter

The instruction booklet for a digital multimeter will demonstrate some capabilities of A/D converters. The DMM might provide automatic range adjustment as well as overload indications.

The input analog signal must be buffered to protect the rest of the circuitry. See Figure 1(a). A low-pass filter blocks audio and radio-frequency signals. An adjustable attenuator provides the auto-ranging functions. The output of the attenuator might pass through a diode and charge a capacitor so that the voltage remains constant during the measurement sequence. A single-chip microprocessor controls the attenuator in conjunction with the readings taken from the analog measurement circuit shown in Figure 1(b).

The analog measurement circuit consists of a comparator that has two inputs. Input A sees the signal to be measured from the output of the attenuator. Input B sees the output of an R-2R ladder network. As long as the voltage at input A is greater than the voltage at input B, the output of the comparator is low.

The microprocessor starts measuring with the attenuator adjusted for minimum attenuation and the R-2R ladder set for minimum voltage output. The microprocessor then switches the outputs of the ladder according to a programmed sequence. The voltage on input B moves up until it finally exceeds the voltage at input A. At that point, the output of the comparator goes high, signaling to the microprocessor that match has occurred.

If the microprocessor counts all the way through the R-2R ladder, and the output of the comparator does not go high, the attenuator is adjusted to lower the voltage at input A, and the process is repeated. The microprocessor must keep track of the adjustments made to the attenuator, as well as the current pattern of closed switches on the R-2R ladder.

There are many variations of this simple circuit and many permutations of the control sequence. One way to speed up the measurement is the "binary search." The first measurement is taken by adjusting both the attenuator and the R-2R ladder for midrange voltages. If the comparator output is low, the attenuator and the R-2R ladder are adjusted for ¼ range. If the output goes high, then the binary counting sequence is begun, and it continues until the microprocessor has "zeroed in" on the voltage being measured.

If all possibilities are tried without a match, the overload or under-range indicator is used, depending upon the status of the attenuators and the R-2R ladder. Once the microprocessor has discovered a match condition on the comparator, the information about the attenuator and the R-2R ladder settings must be manipulated to arrive at the numbers displayed on the meter.

Figure 1(a). The input circuit to a typical digital multimeter provides filtering to eliminate audio and RF, and a microprocessor-controlled variable attenuator, which is used to "zero in" on the value of the voltage being measured.

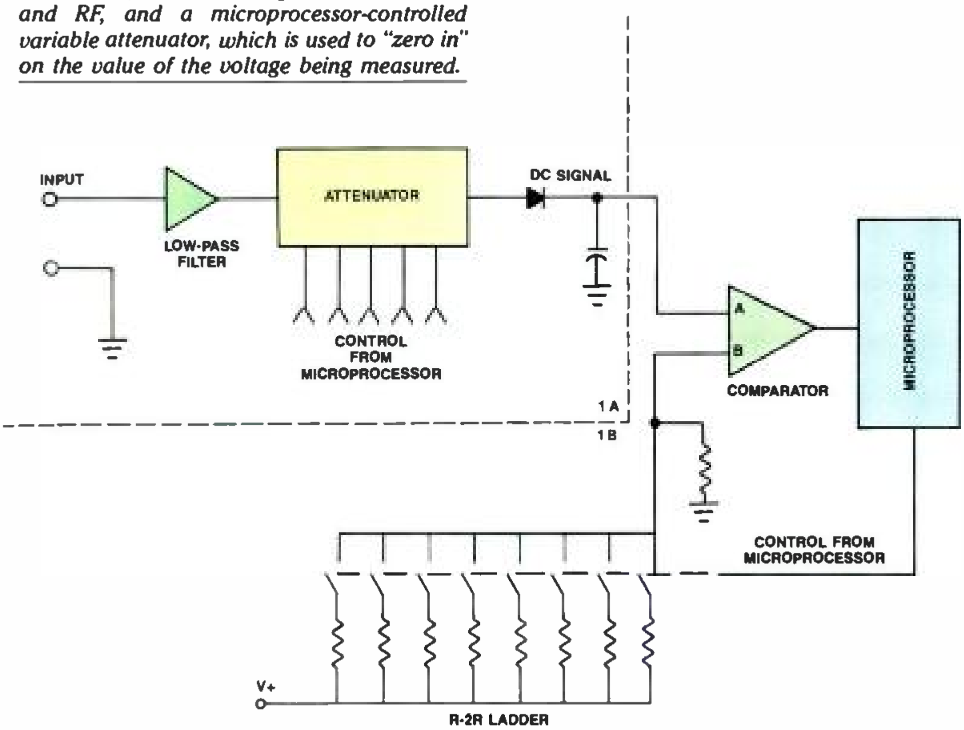


Figure 1(b). The measurement circuit of a typical digital multimeter. A computer-controlled ladder circuit feeds one input of a comparator, and the other input connects to the voltage to be measured, through an attenuator.

THE NEW OPTIMOD®-AM 9100B

Audio processing for AM improvement.

In the several years ince its introduction,)PTIMOD-AM Model ›100A has become one ›f the most-often used ools for improving \M audio.

Now there is a new opportunity for AM improve- ıent. Over a year ago, the National Radio Systems :ommittee brought broadcasters, equipment manufac- ırers, and receiver manufacturers together to talk about voluntary national transmission standard that would ıake wideband high-fidelity AM radios practical.

Today, after hundreds of hours of discussion and tudy, the standard finally exists that will allow receiver ıanufacturers to increase and flatten their frequency esponse without risk of increased interference. But for ıem to do this, broadcasters must implement the tandard: a "modified 75μs" pre-emphasis specification rightens up the sound on older radios while minimizing ıterference to adjacent stations, while a sharp-cutoff 0kHz low-pass filter specification protects the second djacencies by limiting occupied bandwidth.

Receiver manufacturers have stated their willingness › replace their current AM receiver designs (with their ›lephone-quality fidelity) with AM receivers having full 0kHz frequency response—but *only* if and when the IRSC standard is fully adopted by broadcasters. For the IRSC standards to be successful, broadcasters must hange over *quickly*. If the new high-fidelity receivers enerate complaints of interference caused by stations ot complying with the new standard, the receiver ıanufacturers will revert back to the present low fidelity kHz designs! *Everyone* will lose.

Orban was the first to propose and implement AM re-emphasis and low-pass filtering, and we were heavily ıvolved in the Committee work and research. We trongly endorse the new NRSC standard. It's good ngineering *and* good business, and we are making it asy for all OPTIMOD-AM owners to comply.

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It complies fully with the NRSC standard while retaining the features that have made OPTIMOD-AM Model 9100A the choice of so many stations concerned about competing with FM. The 9100B increases coverage, improves source-to-source consistency, and yields superb quality on both voice and music. And, the new standard allows us to make the new OPTIMOD-AM even louder!

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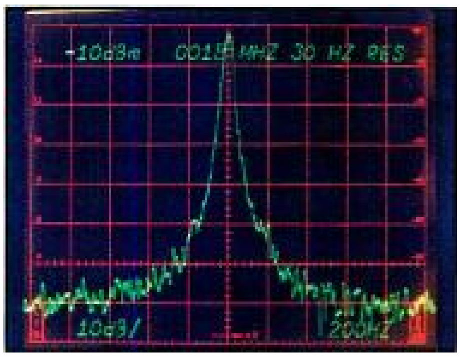
Part 2

Troubleshooting



CD player repair requires skill

By Brad Dick, radio technical editor

Last month we discussed the four servo systems used in a typical CD player. All these servo systems require the proper signal detection from the CD for operation. The key to recovering this signal is a laser beam and optical system.

Laser assembly

Recovering the data from a CD is no easy task because of the extremely small tolerances. The CD signal track width varies from 0.4μm to 0.5μm. The track pitch or spacing between tracks is 1.6μm. The pits in the CD surface vary from 0.833μm to 3.054μm in length. The pits and flats (CD surface), represent the digital information to be recovered by the laser assembly.

Laser pickup assemblies generally are divided into two categories: single-beam and triple-beam systems.

A typical 3-beam laser pickup assembly is shown in Figure 1. The laser beam, generated by a diode, passes through a collimator lens and diffraction-grating lens as it travels toward the CD surface. The collimator lens helps converge the light into a single parallel non-diverging beam. The diffraction-grating lens separates the single beam into three distinct beams of laser light. The main (primary) beam is used to recover the audio signal. The other two (secondary) beams read the same data track but are aligned slightly ahead and behind the main beam. These secondary beams are used to develop the tracking and focus-servo signals.

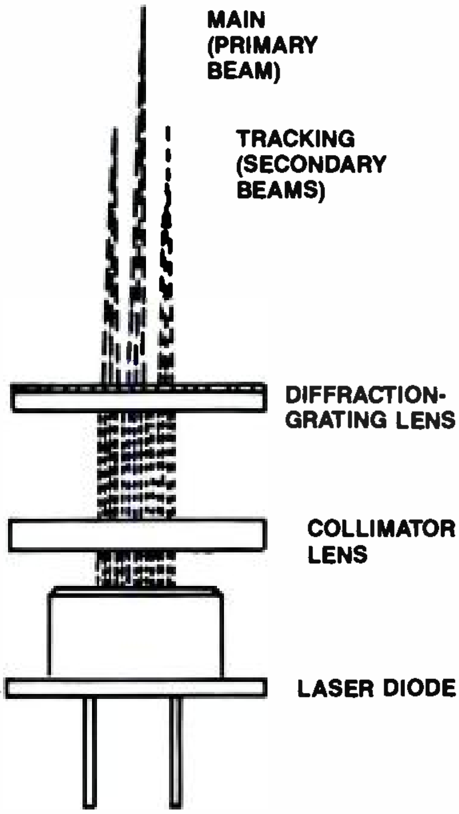


Figure 1. A 3-beam laser system requires a collimator and diffraction-grating lens in order to develop the three separate laser beams.

The three beams then pass through a beam-splitting prism (BSP). The prism's task is to separate the emitted beams from the reflected beams. This process requires that the emitted beams have a different polarization than the reflected beams. A ¼-waveplate, located after the prism, shifts the emitted beam's polarization from planar to circular. After the polarization has been shifted, the beam passes through the focus lens for final precise adjustment.

A perfectly flat CD surface would have no need for a focus lens servo. However, because CDs are not perfectly flat, the focus servo must compensate for the CD warp as the disc turns.

Recovery system

The pit depth of 0.11μm is critical to the recovery process. Because this depth is ¼-wavelength, a 180° phase difference exists between the laser beam reflected by a pit and that reflected by a flat. This causes the laser beam to cancel itself. In an ideal situation, there would be no net signal coming back from the pits. Although the cancellation is not perfect, the reflected signal intensity is reduced greatly. The result is an on-and-off beam intensity, which represents the desired digital datastream.

The reflected primary and secondary beams of light reflect from the CD surface, back through the focus lens and the ¼-waveplate, as shown in Figure 2. The ¼-waveplate again shifts the polarization of the beams, allowing the prism to separate the emitted beams from the reflected ones. The reflected beams then pass through a final cylindrical lens to the photodiodes for recovery.

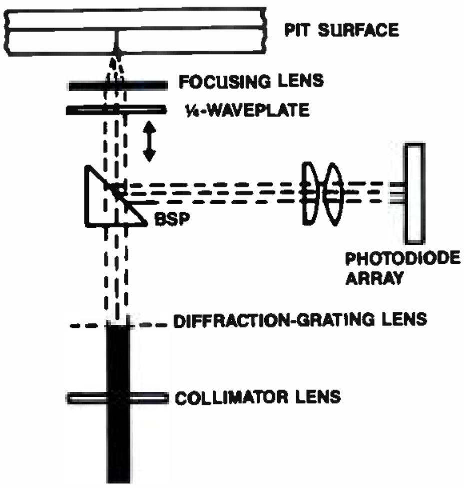


Figure 2. A 3-beam tracking optical path.

Photodetectors

In a 3-beam system, each beam illuminates a different set of four photodiodes. If the laser assembly is tracking the disc properly, the two tracking-beam photodiode arrays will produce equal outputs. If mistracking occurs, the voltage of one of the tracking photodiode arrays will increase, and the other will fall. These output voltages drive a comparator circuit, which develops the actual tracking-error signal. This signal then drives the tracking servo to correct the positioning of the laser pickup assembly. The focus servo derives its correction voltage from the same photodiode arrays. A properly positioned beam will produce equal illumination of all four diodes. If the focus is incorrect, an ellipse is formed, producing unequal illumination on the array. The two sets of opposite diodes are tied together and connected to a comparator. Similar to the tracking servo described, a correction voltage is developed and applied to the focus servo.

Editor's note: Background information on this topic was obtained from "Compact Disc Troubleshooting & Repair," by Neil Heller and Thomas Bentz, Howard W. Sams & Company.

Work scheduling increases efficiency

By David Coles

Even the most organized people cannot escape becoming involved in emergencies. However, if you consistently find yourself hastily performing "last-minute" work, you may need to re-examine your work practices.

The success of any task-management system (work scheduling) depends on your mental outlook. Probably the most common reason for refusing to use a work schedule is that it enslaves. Admittedly, you don't want to see yourself as the lackey for some to-do list. But you must realize that you are the one who decides what goes on that list. If you look at it this way, your feelings of servitude should disappear.

Work scheduling actually liberates you. It allows you to devote your precious few working hours to accomplishing tasks that really matter. Not only does this increase your effectiveness, but it also increases your personal job satisfaction.

Coles is president of Coles & Associates, Houston.

The success of work scheduling is not a result of one system being better than another. The benefits come because a system is used. It doesn't matter whether you choose to employ to-do lists, stick-on notes or calendars. The important thing is to choose a system you like, then mold and adapt it as you go.

Backscheduling

Backscheduling is the most important component of the overall work-scheduling process. Simply stated, backscheduling is a 4-step process:

- Define your objectives.
- Determine the component tasks necessary to accomplish the objectives.
- Estimate the time necessary to perform each task and the best time frame in which to do each.
- Begin working on the tasks early enough to allow adequate time to complete them before the due date.

The details

The advantage of backscheduling is that tasks are scheduled from an objective, or goal, perspective. By scheduling day-to-day tasks with an eye on the desired objective, you can reach your goals more quickly. Furthermore, the backscheduling process helps you redefine your original objectives.

After you determine a particular objective, your next step is to identify the individual component tasks necessary to accomplish that objective. For example, some of the tasks required to prepare an annual budget request might include gathering information, reviewing needs, meeting with your supervisor and compiling the actual request.

The next steps are to determine the estimated length of time to perform each task and to identify the best time frame in which to do it. Breaking down each objective into individual tasks helps you determine the required time to complete the project.

It's also important to remember that much of what you do requires the help of others. Be sure you allow sufficient time for them to complete their portions of the work. For example, preparing an annual budget might involve consultations with other staff members. Although this may take only eight hours to complete, those hours may need to be spread over a week's time.

Finally, list each component task on your calendar (or other work-scheduling device) appropriately backdated from the objective's due date. Now, it's a matter of completing each component task as it appears on your calendar.

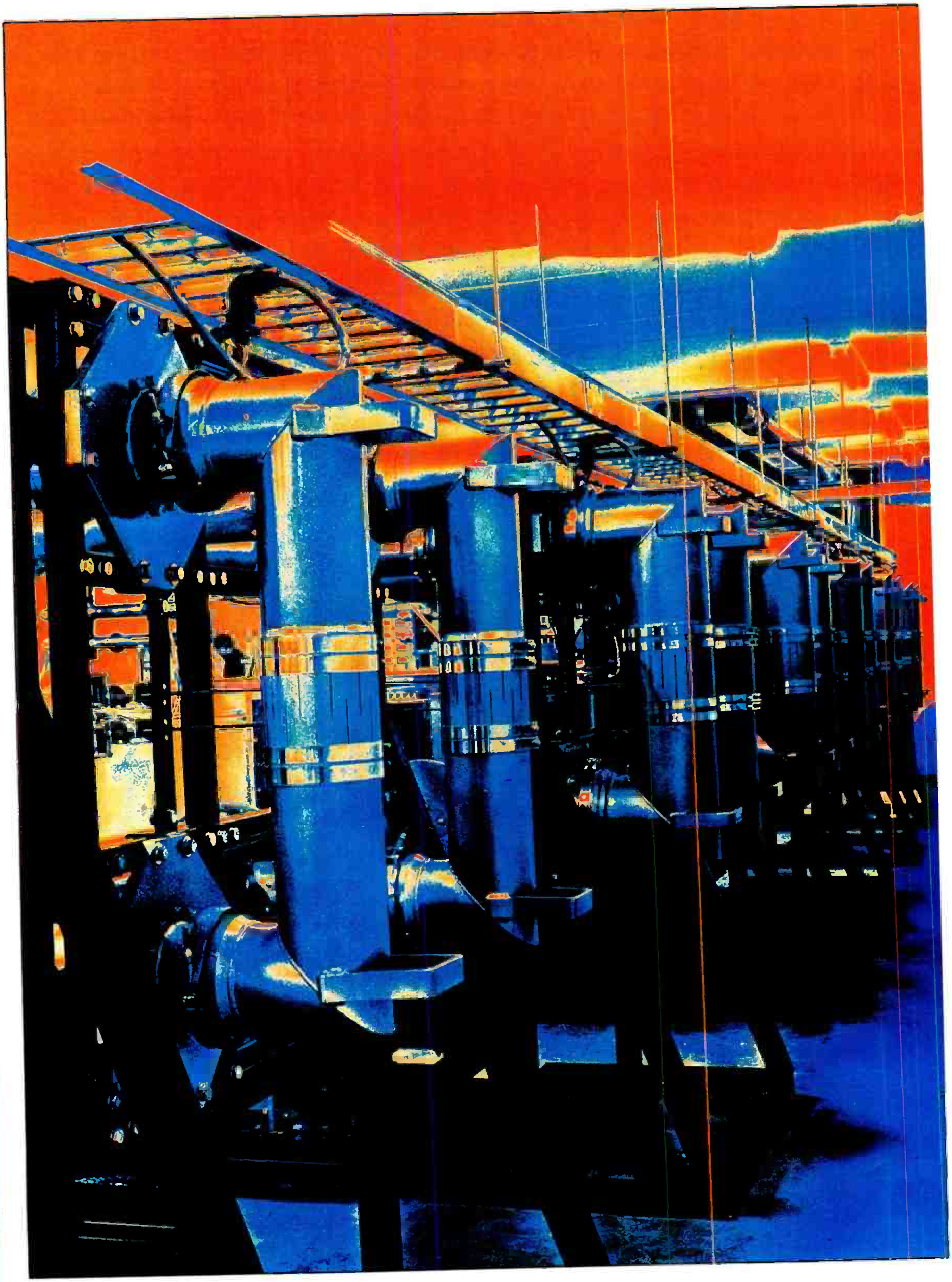
Backscheduling should not be viewed as an objective to be accomplished in itself. It is only a tool to help you attain your goals. Through good work-scheduling habits, you can devote your precious work hours to performing the important tasks. Remember, backscheduling doesn't enslave, it liberates you by increasing your effectiveness and heightening your job satisfaction.

	EXECUTION TIME*	OPPORTUNE DAYS BEFORE EVENT**
GATHER HISTORICAL DATA	2 DAYS	−28
REVIEW EQUIPMENT NEEDS	3 HRS.	−28
REVIEW STAFF NEEDS	3 HRS.	−28
DRAFT BUDGET AND JUSTIFICATION	1 DAY	−21
MEET WITH SUPERVISOR	1 HR.	−21
PREPARE REVISED BUDGET	4 HRS.	−21
MEET WITH SUPERVISOR	30 MIN.	−14
COMPLETE BUDGET FORMS	1 HR.	−7
TURN IN COMPLETED BUDGET		0

* Be sure to include adequate execution time. It's better to allow too much time than not enough.

** These figures should take into account the required lead time as well as the most advantageous date.

Table 1. Backscheduling identifies the component tasks required to meet an objective. Once you list the tasks, it becomes easier for you to estimate the time required to complete each step.



Because the transmission system is the core of a broadcast facility, proper maintenance is paramount.

Transmission systems

Some station managers seem to think that transmitters and antennas should work forever, without failing. But even well-designed and carefully maintained systems can fail. When they do, the only thing that matters is getting the station back on the air.

Although today's transmission systems are more reliable than ever before, they also are more complex. The engineering staff must be able to maintain a system that, in many cases, has no backup. Therefore, unless the station can leave the air for several hours per week, the engineer is faced with performing maintenance on a crisis basis. The bottom line is that broadcast engineers sometimes are less familiar with the RF components than they are with other elements in the broadcast chain.

Knowledge is a powerful tool in the battle against equipment failure. And to help you, this special report addresses RF topics ranging from grounding systems to multiplexing FM antennas to reducing IPM in AM transmitters.

In addition to keeping a constant vigil over the system, the broadcast engineer always must be mindful of the issue of safety. To help you develop a safer workplace and safer work habits, we'll discuss the danger of electrocution within the broadcast station and how to avoid it. If you've ever been "bitten" you know how unpleasant the experience can be. And, unfortunately, because of the high voltages and currents used in broadcast equipment, you may not get the chance to make a "second" mistake. Learning and practicing safe work habits may be the key to staying alive.

By Brad Dick, issue editor

JVC's CHIP CAMERAS LET YOU PLANT A FOOT FIRMLY, IN ALL THREE CONFIGURATIONS... WITHOUT EVER BREAKING STRIDE.

FROM STUDIO TO PORTABLE TO CAMCORDER... JVC's 3-CCD CAMERAS, THE KY-20U AND KY-15U...THE PERFECT FIT!

With all their features, JVC's KY-20U and the KY-15U are steps ahead of the other chip cameras. In fact, they're a hop, skip, and a jump from studio to portable to camcorder configurations.

The easy-to-handle size and weight make them truly mobile one-man operations that walk tall in ENG/EFP environments. But handling is just part of the story. They are designed for rugged, durable use and have solid state pick-up systems that provide high levels of stability.

The KY-20U and KY-15U cameras are laced with features that give you that step in time when you need it. The KY-20U employs a ⅔″ CCD to give you 380,000 pixels for a horizontal resolution of 530 lines while the KY-15U is designed with a ½″ CCD for 360,000 pixels and a horizontal resolution of 500 lines. Both the KY-20U and the KY-15U have a signal-to-noise ratio of 58 dB. Specs which put you a giant step ahead in high quality video. When it comes to true flexibility, mobility and capability these CCD cameras far outpace the rest of the field.

The KY-15U can dock directly with the BR-S410U, S-VHS recorder. The KY-20U can dock with the KR-M260U, MII recorder (with the optional KA-M20U adapter), and in studio or portable configurations will integrate with a variety of formats.

This is only a small part of JVC's Chip Camera story. When your programming calls for a high-mobility camcorder, high-resolution portable and high-performance studio camera, plant your foot firmly in all three configurations with JVC's KY-20U or KY-15U Chip Cameras. You'll feel comfortable with JVC because providing you with your exact needs is a shoe-in.

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Safety is no accident.

Safety: the key to staying alive

By Brad Dick, technical editor

The U.S. Department of Labor records indicate that more than 5,760 broadcasters were injured on the job over a 1-year period, resulting in almost 21,000 lost workdays. Considering that only 240,000 people are employed in this business, this represents a significant financial and personal loss to the industry.

Unfortunately, safety within today's broadcast station often is taken for granted. In all fairness, aside from tower and transmitter work, most stations are reasonably safe. However, today's broadcast staffs often are less experienced, which increases the chance of accidents. And, as inexperienced people take on more technical tasks, the odds of their becoming injured may increase.

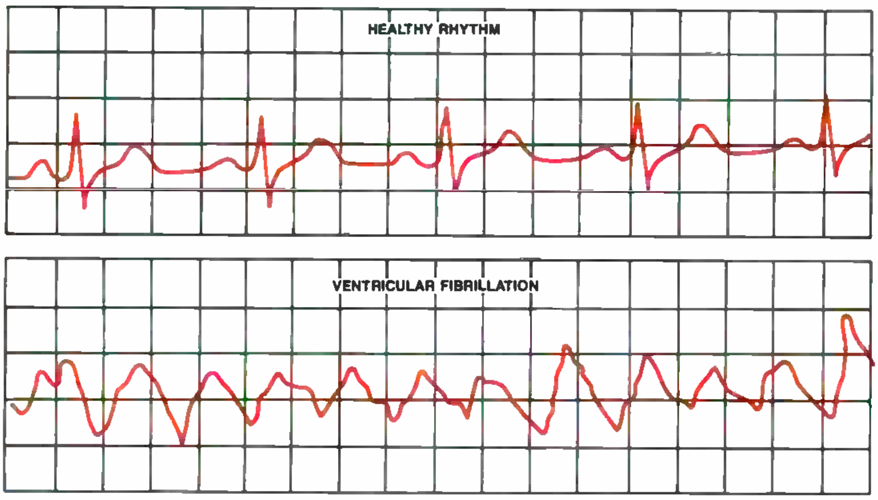

Figure 1. Electrocardiograms showing the difference between a healthy heart rhythm and ventricular fibrillation of the heart.

Electrical safety is something every broadcast engineer thinks about at one time or another. Perhaps the last time you thought about electrical safety was while you were reaching into the driver cabinet of that 20kW FM transmitter or a klystron power supply. Or it may have been when you forgot that the camera power supply was still plugged in, and your finger accidentally contacted the primary voltage.

Broadcast engineers *should* understand the basics of electrical safety. The engineer should know where it is safe to work within a transmitter (and within other equipment) and where special precautions are needed.

Basic electrical safety practice has been well-described in other literature and will not be repeated here. If you need a refresher course, see page 88 of the November 1986 issue. This tutorial, "Safety First," outlines basic safety practices that should be followed by every broadcast engineer.

This article will, instead, examine the hazards of electrical current and discuss

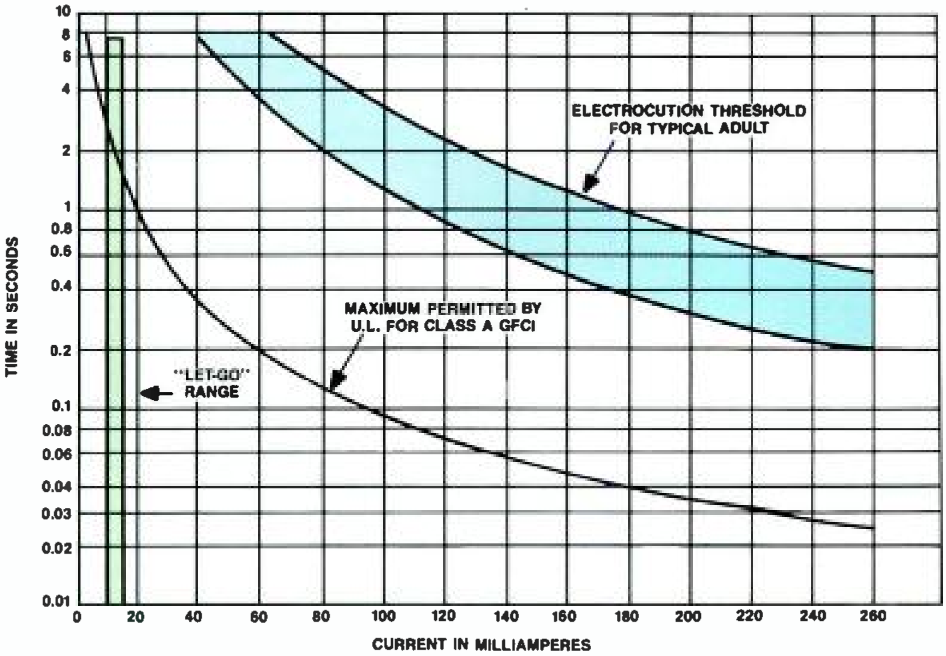

Figure 2. Effects of electrical current and time on the human body. Note the "let-go" range.

safety protection devices and Occupational Safety and Health Administration (OSHA) regulations. These are critical issues for any engineering manager, especially in these days of federal regulations and litigation.

Broadcast engineers should understand the basics of electrical safety...and should know where it's safe to work within a transmitter and where special precautions are needed.

Current facts

At the outset, it may be helpful to review just how little current it takes to injure a person. Studies at Underwriters Laboratories show that the electrical resistance of the human body varies according to the amount of moisture on the skin, the muscular structure of the body and the applied voltage. The typical hand-to-hand resistance ranges from 500Ω to 600,000Ω, depending on the conditions mentioned. Higher voltages have the capability to break down the outer layers of the skin, which can reduce the overall resistance value.

Underwriters Laboratories uses the lower value, 500Ω, as the standard resistance between major extremities, such as from the hand to the foot. This value generally is considered the minimum that would be encountered and, in fact, may not be unusual because wet conditions, a cut or other break in the skin will significantly reduce human body resistance.

Shocking effects

Suppose you are subjected to an electric current. What happens? Table 1 lists some effects that typically result when a person is connected across a current source with a hand-to-hand resistance of 2,400Ω. The table shows that a current of 50mA will flow between the hands if one hand is in contact with a 120Vac source and the other hand is grounded. It also indicates that even the relatively small current of 50mA can produce ventricular fibrillation of the heart and, maybe, lead to death.

Although you may have heard the term before, let's review exactly what ventricular fibrillation is and what happens when it occurs. Medical literature describes ventricular fibrillation as rapid, uncoordinated contractions of the ventricles of the heart, resulting in loss of synchronization between heartbeat and pulse beat. The electrocardiograms shown in Figure 1 compare a healthy heart rhythm to one in ventricular fibrillation. Once ventricular fibrillation begins, it will continue and, unless resuscitation techniques are implemented, death will ensue within a few minutes.

The route taken by the current through the body greatly affects the degree of injury. Even though a current may be small, if it passes from one extremity through the heart to another extremity, it is dangerous and capable of causing severe injury or electrocution. A person can contact extremely high current levels and live to tell about it, but that's probably because the current passed only through a single limb, and not through the entire body. In these cases, the limb often is lost, but the person survives.

Current is not the only factor in electrocution. Figure 2 summarizes the relationship between current and time on the human body. The graph shows that 100mA flowing through a human adult body for a duration of 2s will cause death by electrocution.

An important factor in electrocution, the *let-go range*, also is shown on the graph. This is described as the amount of current that causes "freezing," the inability to let go of the conductor. The left edge of the shaded area, 10mA, represents the current at which 2.5% of the population would be unable to let go of a "live" conductor. The right side of the shaded area, 15mA, represents the point at which 50% would be unable to let go of an energized conductor.

It is apparent from the graph that even a small amount of current can freeze someone to an electrical conductor. The objective for those who must work with electrical equipment is to protect themselves from electrical shock.

Once ventricular fibrillation begins, it will continue and, unless resuscitation techniques are implemented, death will ensue within a few minutes.

Circuit protectors

At this point, you should be convinced that the typical primary-panel or transmitter circuit breaker generally will not protect you from electrocution. The same thing holds for fuses. In the time that a fuse takes to blow, you could be dead. However, the ground-fault interrupter (GFI) and high-voltage rubber gloves are two common methods of helping prevent electrocution.

The GFI works by monitoring the current being applied to the load. The device, shown in Figure 3, uses a differential transformer and looks for an imbalance in the load current. If a current (5mA, ±1mA) begins flowing between the neutral and ground or between the hot

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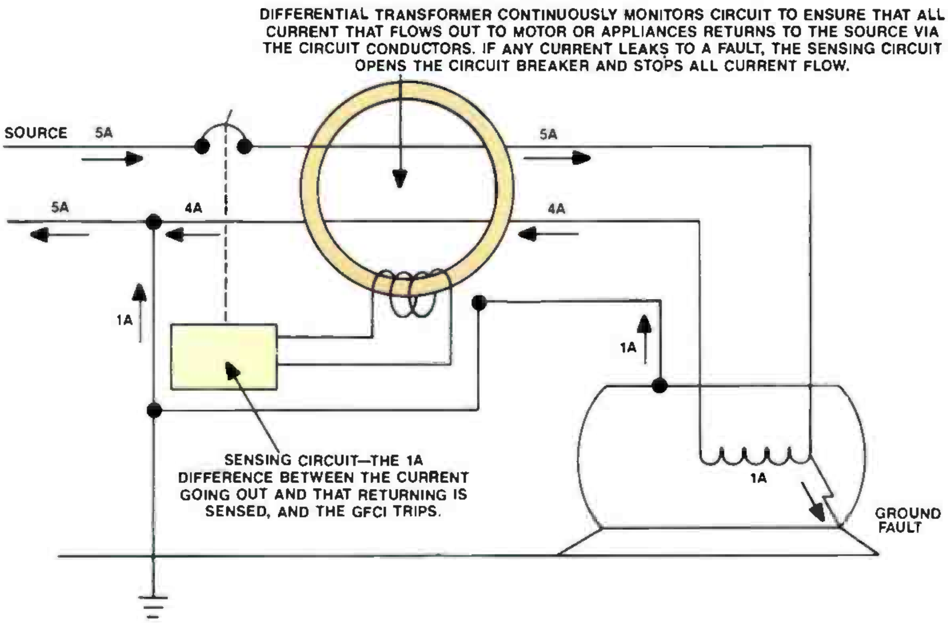

Figure 3. A ground-fault interrupter (GFI) can help prevent electrocution when current flows between the hot and ground or between the neutral and ground conductors.

and ground, the differential transformer detects the leakage and opens up the primary circuit within 2.5ms.

OSHA rules specify that temporary receptacles (those not permanently wired) used on construction sites be equipped with GFI protection. GFI outlets are not needed for receptacles on 2-wire, single-phase portable and vehicle-mounted generators (such as remote and uplink trucks) of not more than 5kW, where the generator circuit conductors are insulated from the generator frame and all other grounded surfaces. In general, this means that remote and uplink trucks are not required to provide GFI outlets.

GFIs will not protect you from every type of electrocution. If you became connected to both the neutral and the hot wire, the GFI would think you were merely a part of the load and would not open the primary circuit. (It is difficult to make a protection device foolproof when fools are so ingenious.)

High-voltage rubber gloves

Broadcast engineers often use high-voltage rubber gloves as protection from hazardous voltages or RF when working on "hot" ac or RF circuits. Although the gloves may provide some protection from these hazards, relying too much on them has potentially dangerous consequences.

For several reasons, gloves should be used only with a great deal of caution and respect. A common mistake made by engineers is to assume that they provide complete protection. However, the gloves found in many stations may be old and untested. Some may even have been "repaired" by the user, perhaps with electrical tape. Few tools could be more hazardous than such a pair of gloves.

Another mistake is not knowing the voltage rating of the gloves. Gloves are rated differently for both ac and dc voltages. For instance, a Class 0 glove has a minimum dc breakdown voltage of 35,000V. Note, however, that the minimum ac breakdown voltage is only 6,000V.

Finally, high-voltage rubber gloves are not tested at RF frequencies, and RF can burn a hole in the best rubber gloves. If you use them for RF protection, you do so at your own risk.

Have you ever known an engineer to have a pair of high-voltage gloves tested? How do you know that your gloves are still safe for use at 20,000V? Have age, wear or microscopic holes reduced the gloves'

The 22kV club

The following story is true. Only the names have been changed. (Actually, they've been left out.) One morning, the UHF-TV engineer responded to a trouble call from the studio. The 55kW transmitter had developed a problem that required immediate attention. Because the transmitter was 100% redundant, the studio had remotely bypassed the failed visual klystron amplifier and had multiplexed the aural and visual signals on the single aural klystron at full power.

When the engineer arrived at the mountain-top location, he found the transmitter to be operating properly. Normally, he would have returned the system to standard operating conditions. Instead, he elected to perform some preventive maintenance on the visual amplifier.

From experience, he knew this model of high-voltage contactor could occasionally stick in the "on" position. With this transmitter design, the stuck contactor could be found only through a visual inspection.

Another club member

Before he began, the engineer followed good safety practices. He shut down all power to the visual transmitter and associated 22kVdc high-voltage power supply. Because he planned to work only on the visual amplifier, he believed no danger existed.

Unfortunately, the visual and aural power supplies are identical in appearance, and he mistakenly opened the aural instead of the visual supply. Then, thinking he was in the visual supply, he noticed the high-voltage contactor stuck in the "on" position. As he reached down to manually free the contactor, he touched the live aural high voltage.

The engineer was thrown five feet across the concrete pad, but remained conscious. The transmitter's overload circuits shut down the high voltage, probably saving his life. He managed to return to the building to answer the phone. It was someone at the studio wondering why the transmitter was off the air.

The paramedics arrived by helicopter almost 25 minutes later. To their amazement, he had been able to get to his vehicle They found him sitting inside, trying to stay warm. Fortunately, he survived and returned to work a few days later. All he had to show for his attempt at maintenance was a burned hole about the size of a half dollar in his foot and a pin hole in his finger.

The moral of this story is to check, double check and triple check power supplies, especially high-voltage supplies. Then use a shorting stick before you touch anything. Also, leave that shorting stick across the potential source while you're working. You never know when something or someone will push the "on" button. Also be sure that all cabinets and components are labeled, shorting bars are present and interlocks are working.

Don't join the 22kV club. The membership dues could kill you.


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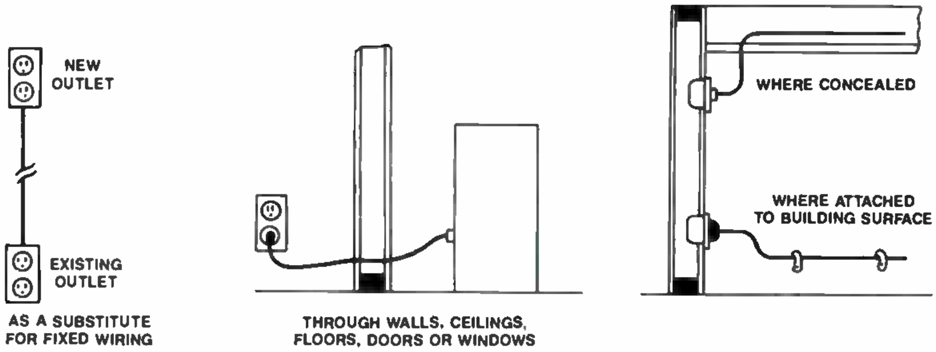

***Figure 4.** Using flexible cord for permanent installations and in concealed locations, as shown here, is prohibited under NEC regulations.*

ability to protect you? A consultant tells of losing a friend (a lineman) who assumed the gloves he was wearing would provide adequate protection. Unfortunately, a small pinhole in the gloves greatly reduced their safety margin, and the lineman was electrocuted when he touched a live conductor.

Always perform a visual inspection before using any pair of gloves. Look for cracks and "roll" test them for leaks. The roll test is accomplished by flipping the glove while holding the cuff to capture air inside. As you roll the cuff toward the fingers, listen for air leaks or pass the glove near your face to feel for air leaks.

If you are not completely sure that your gloves are safe to use, replace them or have them tested. Your local electric utility may be able to provide you with the name of the company it uses for testing of gloves. Don't take the chance of wearing untested gloves.

Proceed with caution

Working on "live" circuits involves much more than simply wearing a pair of gloves. It requires a certain frame of mind—a keen awareness of everything in the area, especially ground points. Be conscious of where you place your feet, arms and legs. Don't lean against a grounded surface or kneel while working. The related story, "The 22kV Club," emphasizes the danger of making even one small error in judgment.

As previously discussed, it is critical that you don't allow the use of gloves to create a false sense of security. That's a good way to develop dangerous working habits. However, sometimes gloves are the only way to prevent disaster. Take the story of the engineer who was working on a high-voltage fuse panel in a field. While he was bent over looking into the cabinet, a stray goat butted him into the equipment. Fortunately, he was wearing high-voltage gloves, so when he instinctively extended his hands to catch himself (inside the fuse panel), he wasn't electrocuted.

It's unlikely that an animal will wander into your transmitter building, but you could slip on a tool or a bolt carelessly left on the floor. If you were to reach out to catch yourself and touched a high-voltage point—well, you get the picture.

Do you recall the axiom that says to keep one hand in your pocket while you're poking around in a device with cur-

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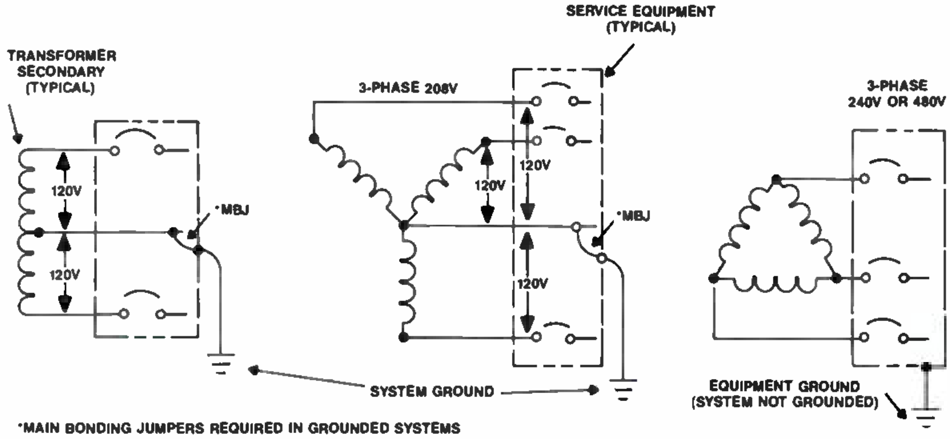

Figure 5. *Although regulations have been in place for many years, OSHA inspectors still find violations in the area of grounding primary electrical service systems. Note that the main bonding jumpers are required in only two of the designs.*

rent flowing? That advice actually is based on simple electricity. It is not the "hot" connection that causes the problem; it's the ground connection that lets the current begin to flow. A study in California showed that more than 90% of fatalities resulting from electrocution occurred when the grounded person contacted a live conductor. Line-to-line electrocution accounted for less than 10% of the deaths.

When working around high voltages, always look for grounded surfaces. Keep your hands, feet and body away from any grounded surface. Even concrete can act as a ground if the voltage is high enough. If you must work in "live" cabinets, then consider using—in addition to rubber gloves—a rubber floor mat, rubber vest and rubber sleeves. This may seem like a lot of trouble, but when you consider the consequences of making a mistake, it's certainly worth it. Of course, the best troubleshooting methodology is to never work on any circuit unless you are positive that no hazardous voltages are present. In addition, any circuits or contactors that normally contain hazardous voltages should be grounded firmly before you begin work.

Working on "live" circuits involves much more than simply wearing a pair of gloves. It requires a certain frame of mind.

Finally, how many of you reading this article work alone on transmitters? Perhaps as many as 90% of the radio engineers and 50% of the TV engineers regularly perform transmitter maintenance by themselves. This is not a safe practice.

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A dangerous practice

Broadcast engineers often rely on rubber gloves to make adjustments on live RF circuits. However, this can be an extremely dangerous practice.

Let's look at a typical antenna-tuning unit, in the configuration shown below, disconnecting the coil from either L2 or L3 places the full transmitter output literally at one's fingertips. Depending on the impedances involved, the voltages can become quite high, even in a circuit that is normally relatively tame.

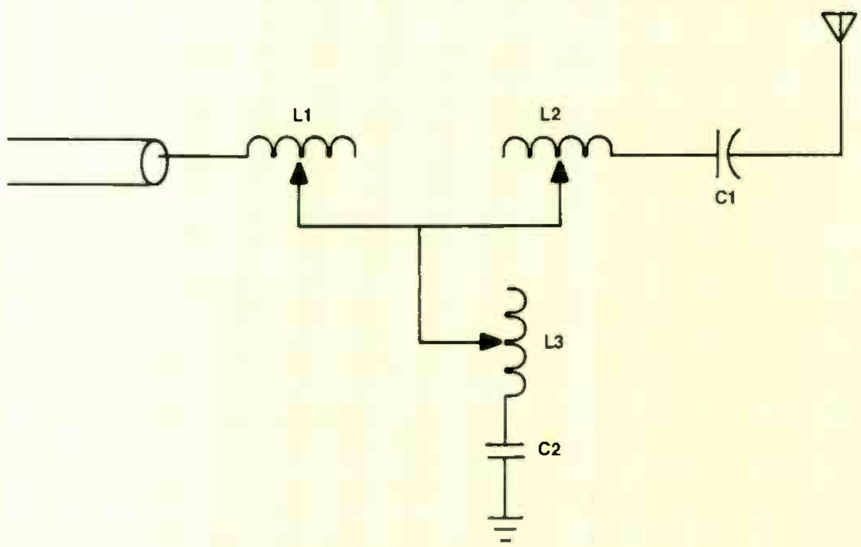
If the station has an antenna of 120 electrical degrees, the base impedance might be approximately 106 +j202Ω. With 1kW feeding into the antenna, the rms voltage at the tower base will be approximately 700V. The peak voltage, which determines insulating requirements, will be close to 1kV—and perhaps more than twice that if the carrier is being modulated.

At the instant the output coil clip is disconnected, the current in the shunt leg will increase rapidly, and the voltage could easily go to more than double. What if the engineer relies on an old, dirty pair of lineman's gloves that happen to have a pin hole?

Many newer transmitters incorporate automatic shutdown circuits for high VSWR conditions (such as when a coil tap is disconnected). However, many older transmitters or high-power units operating at lower power levels might continue to deliver power into this unusual load—even if the load happened to include the station engineer. In addition, some transmitters use dc in the final output network as an arc-detection device. If the blocking capacitor is shorted, leaky or missing, then that voltage is available to help hold the engineer while the RF cooks him.

Of course, the result might be that only a large arc is drawn, and a very lucky engineer could get away with no burn or shock. This may provide some comfort to him while he recovers from the broken arm he got falling off the ladder trying to get away from the arc.

There is simply no substitute for safe work habits. It is important to treat every station as if it were a 50kW facility and to develop the work habits appropriate to such a plant. At 3 a.m., when the brain tends to become foggy, well-developed safety habits can keep you from making a mistake that could be your last.



The voltages present on a typical antenna-tuning unit can become extremely hazardous, especially if a coil tap such as L2 or L3 is disconnected.

Who's going to shut down the transmitter and call for help if you are knocked unconscious? Even if you can't afford to hire a trained assistant, get someone to accompany you when you perform maintenance so that you'll have help in case of an emergency. If no one is around, one mistake may be all you get to make.

OSHA safety violations

You can prevent accidents by simply following the rules. The federal government has taken a number of steps to improve safety within the workplace through OSHA, which helps industries monitor and correct safety, including electrical, practices. Although OSHA may have caught some bad press when it was conceived, the agency has developed practical guidelines that could help you prevent accidents within your station.

OSHA records show that electrical standards are among the most frequently violated of all safety standards. Table 2 lists 16 of the most common electrical violations. Let's review some of the ones most applicable to broadcasters.

Protective covers

A common safety violation concerns the guarding of live conductors. All potentially dangerous electrical conductors should be covered with protective panels. How many transmitter buildings have you seen with a breaker panel or disconnect switch cover removed? Have you ever operated a transmitter beyond a maintenance period with the cover panels removed? If you did, you violated OSHA regulations.

The danger is that someone may come into contact with the exposed, current-carrying conductors. It also is possible for metallic objects such as ladders, cable or even microphone stands to contact a hazardous voltage, creating a life-threatening condition. Open panels present fire hazards too.

Identification and marking

Another common electrical violation centers on the labeling of circuit breakers and switch panels. The breakers and equipment switches in some stations might have been labeled years ago and may no longer reflect the equipment actually in use. The author once worked at a station with a breaker labeled "disk lathe" (transcription disk recorder). The lathe had been gone for 15 years, but the circuit was still in use and powered a number of unknown devices.

There is another important reason to properly label electrical circuits. Although you may know which breaker controls what equipment, other staff members or the fire department may not. If you (or someone else who understands the system) are not available in an emergency, an incorrectly labeled circuit panel can lead to unnecessary damage or casualties.

If a number of devices are connected to a single disconnect switch or breaker, provide a diagram or drawing for clarification. Label it with brief phrases and use clear, permanent and legible markings.

A related area is that of equipment marking. This is not the same thing as equipment identification. Marking equipment means you label the equipment breaker panels and ac disconnect switches according to the devices' ratings. Breaker boxes should contain nameplates showing manufacturer, rating and other pertinent electrical factors. The intent is to prevent devices from being subjected to excessive

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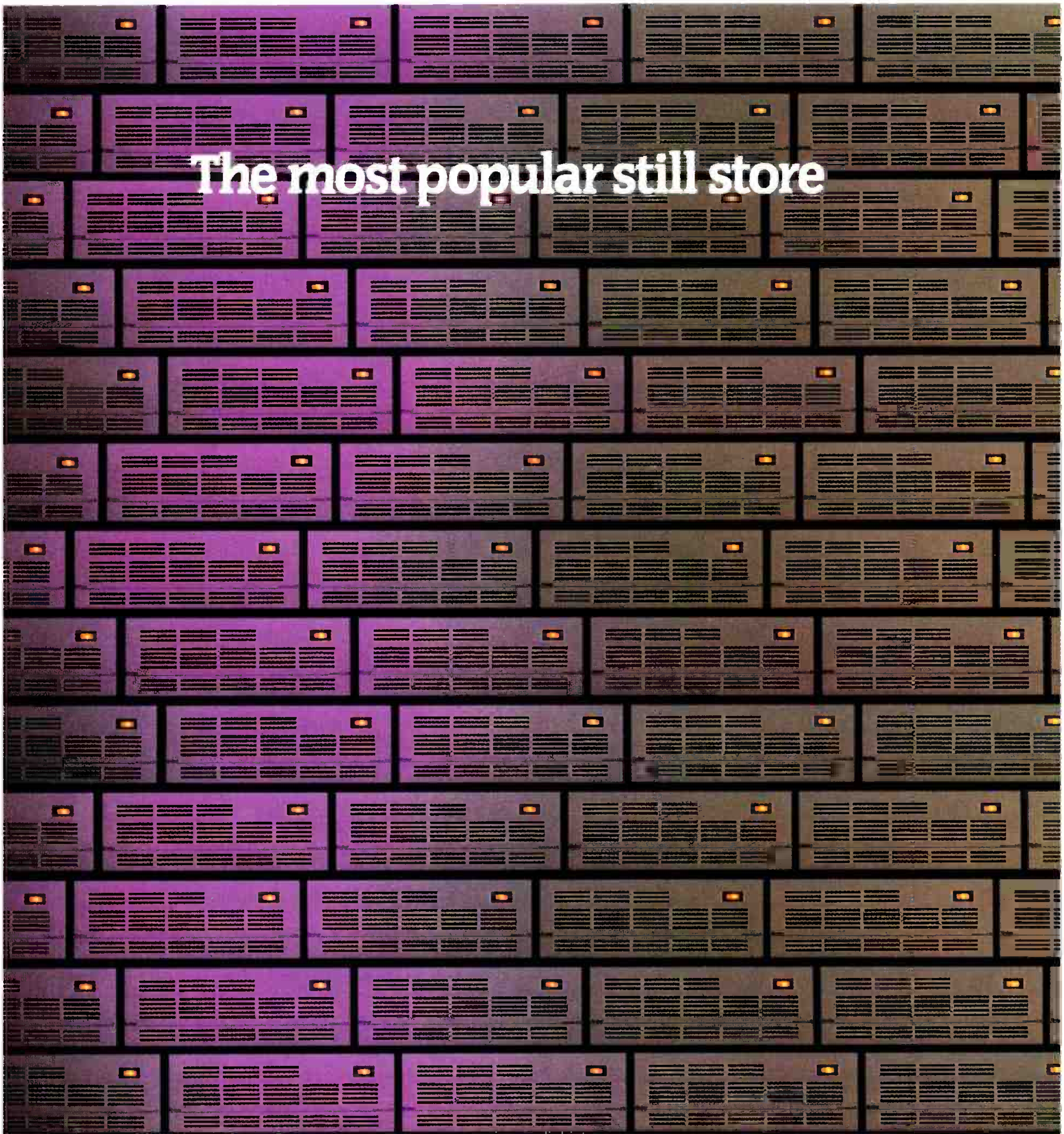


1mA or less	No sensation, not felt.
More than 3mA	Painful shock.
More than 10mA	Local muscle contractions, sufficient to cause "freezing" to the circuit for 2.5% of the population.
More than 15mA	Local muscle contractions, sufficient to cause "freezing" to the circuit for 50% of the population.
More than 30mA	Breathing is difficult, can cause unconsciousness.
50mA to 100mA	Possible ventricular fibrillation of the heart.
100mA to 200mA	Certain ventricular fibrillation of the heart.
More than 200mA	Severe burns and muscular contractions; heart more apt to stop than fibrillate.
More than a few amperes	Irreparable damage to body tissues.

Table 1. *The effects of current on the human body.*

FACT SHEET NO.	SUBJECT	NEC REFERENCES
1	Guarding of live parts	110-17
2	Identification	110-22
3	Uses allowed for flexible cord	400-7
4	Prohibited uses of flexible cord	400-8
5	Pull at joints and terminals must be prevented	400-10
6-1	Effective grounding, Part 1	250-51
6-2	Effective grounding, Part 2	250-51
7	Grounding of fixed equipment, general	250-42
8	Grounding of fixed equipment, specific	250-43
9	Grounding of equipment connected by cord and plug	250-45
10	Methods of grounding, cord and plug connected equipment	250-59
11	Alternating-current circuits and systems to be grounded	250-5
12	Location of overcurrent devices	240-24
13	Splices in flexible cords	400-9
14	Electrical connections	110-14
15	Marking equipment	110-21
16	Working clearances about electrical equipment	110-16

National Electrical Code, NFPA No. 70®

Table 2. *Sixteen common OSHA violations.*

loads or voltages. If you are using old, unmarked switches or breakers, contact the manufacturer for rating information. Then, label them properly with the approved ratings.

An incorrectly labeled circuit panel can lead to unnecessary damage or casualties.

Extension cords

Extension (flexible) cords often are misused. It's easy to connect a new piece of equipment with a flexible cord, but be careful. The National Electrical Code (NEC) lists only eight approved uses for flexible cords.

Have you ever "installed" an additional ac outlet by using a flexible cord? Don't. It's not permitted. Another violation is the use of a flexible cord that passes through holes in walls, ceilings or floors. Running the cord through doorways, windows or similar openings also is prohibited. Finally, a flexible cord may not be attached to building surfaces or concealed behind building walls or ceilings. These typical violations are summarized in Figure 4.

Another common infraction is the failure to provide adequate strain relief on connectors. Whenever possible, use manufactured cable connections. If you must make your own extension cords or attach power plugs, be sure to install a strain relief.

Grounding

When it comes to grounding, broadcasters should know better. Even so, violations occur. OSHA regulations describe two types of grounding: *system grounding* and *equipment grounding*. System grounding actually connects one of the current-carrying conductors, such as from the terminals of a supply transformer to ground. (See Figure 5.) Equipment grounding connects all of the non-current-carrying metal surfaces together and to ground.

From a grounding standpoint, the only difference between a grounded electrical system and an ungrounded one is that the "main bonding jumper" from the service equipment ground to a current-carrying conductor is omitted in the ungrounded system.

The system ground performs two tasks. It provides the final connection from equipment-grounding conductors to the grounded circuit conductor, completing the ground-fault loop. Also, it solidly ties the electrical system and its enclosures to their surroundings (usually earth, structural steel and plumbing). This prevents voltages from any source from rising to harmfully high voltage-to-ground levels. It should be noted that equipment grounding—bonding all electrical and to ground—is required whether or not the system is grounded. System grounding should be handled by the contractor who installs your power feeds.

Equipment grounding also does two essential things. It bonds all surfaces so that there can be no voltage differences among them. It also provides a ground-fault current path from a fault location back to the electrical source, so that if the fault current develops, it will rise to a level high enough to operate the breaker or fuse.

The NEC is complex and contains numerous requirements concerning electrical safety that are applicable to broadcast stations. If your station's electrical wiring has gone through many changes over the years, it might be wise to have it inspected by a qualified consultant. You can perform many of the checks yourself by using the fact sheets listed in Table 2. They are available from your local OSHA office.

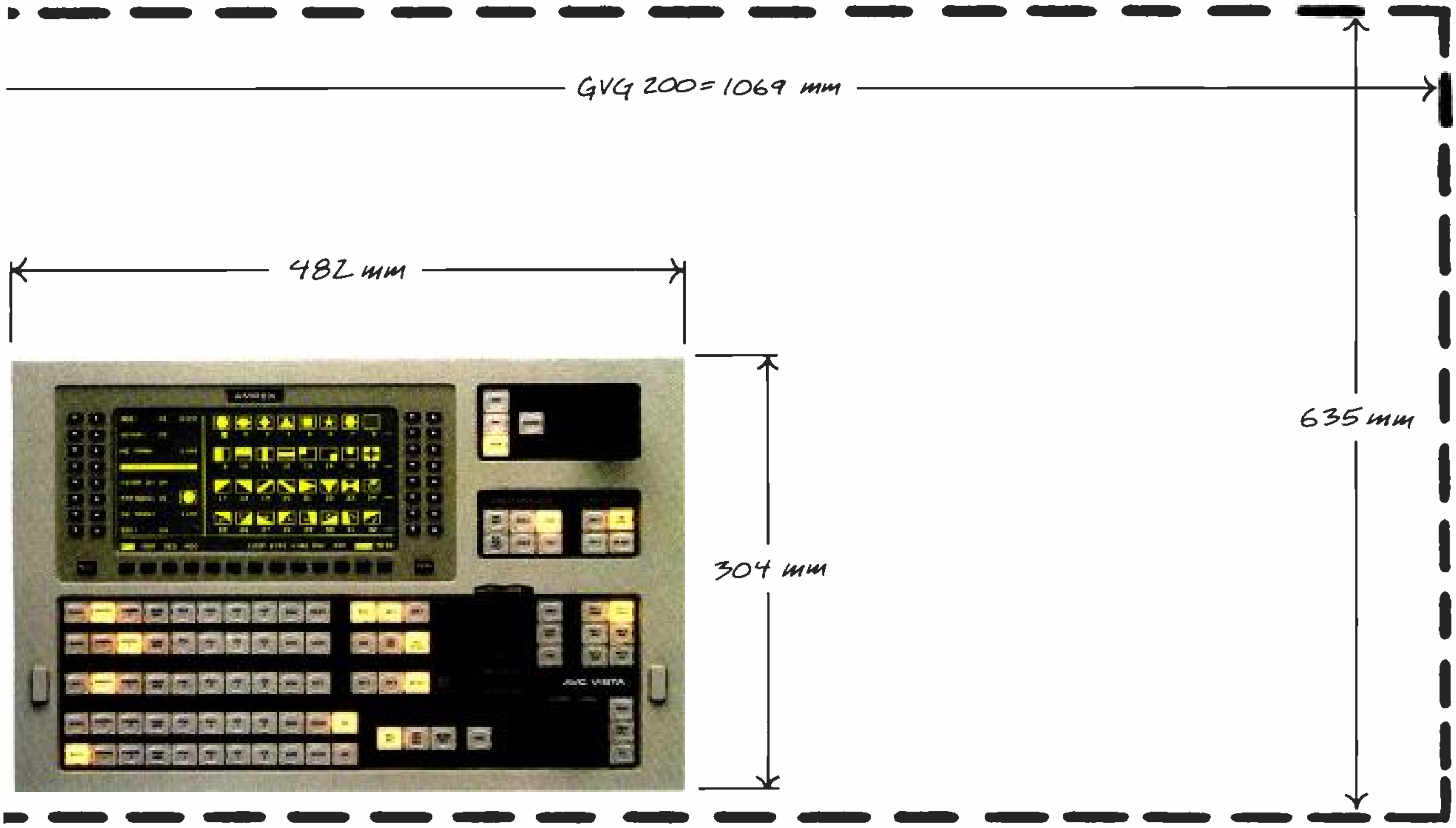
Prepare a plan

The key to operating a safe facility is diligent management. If your station does not have a safety program, now is the time to start one. A carefully thought-out plan will provide your station with a coordinated approach to protecting the staff from injury and potential litigation.

Although the details and overall organization may vary, facilities that have implemented comprehensive accident prevention programs follow seven basic guidelines. These practices are summarized in Table 3. Let's look at the seven steps and see how they apply to the overall program.

Step 1. Demonstrate management

Continued on page 42



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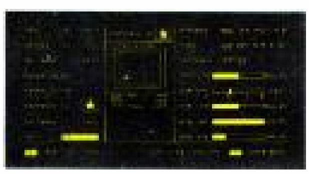

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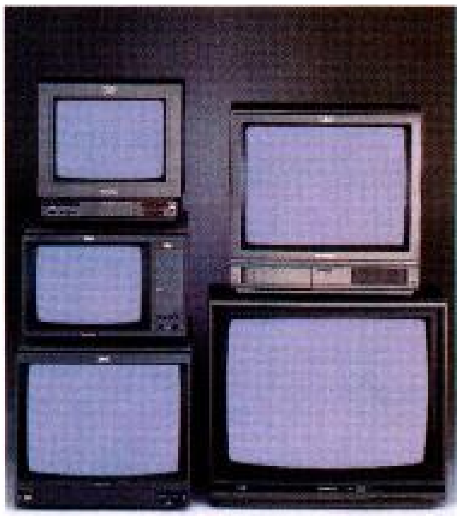

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- Management assumes the leadership role regarding safety policies.
- Responsibility for safety and health-related activities is clearly assigned.
- Hazards are identified, and steps are taken to eliminate them.
- Employees at all levels are trained in proper safety procedures.
- Thorough accident/injury records are maintained.
- Medical attention and first aid is readily available.
- Employee awareness and participation is fostered through incentives and an ongoing, high-profile approach to workplace safety.

Table 3. *These elements are basic to the development of a successful safety program.*

Continued from page 38

leadership:

The manager's position on safety is crucial to the program's success. This person's attitude toward job safety will be reflected in the behavior of the employees. If the manager is not particularly interested in preventing accidents, nobody else on the staff is likely to be. Here are some useful ways in which a manager can develop an effective safety program.

- Post the OSHA workplace poster, "Job Safety and Health Protection," where all employees can see it. This is an OSHA requirement.

- Hold a meeting to discuss job safety with the employees and to talk about mutual responsibilities. If necessary, write a policy statement on safety, and display it near the OSHA poster.

- Review all inspection and accident reports to ensure follow-up when needed. Comment favorably on good practices, and correct unsafe work practices as soon as they are discovered. Finally, be sure you set a good example for others.

Step 2. Assign responsibility:

After a basic policy has been developed, it must be implemented. The key is tc delegate the policy details to those whc normally perform supervisory duties. These people are in the best position tc oversee a safety program. If you are a primary supervisor, then you shoulc assume the task.

Step 3. Identify hazards:

Look for any hazards that exist within the facility. Install the necessary procedures to control or eliminate them as soon as possible. This step may require a careful tour of your station. Sample check lists are available from your local OSHA office.

Step 4. Train the employees:

Provide training for those who will implement the program, and make them aware of the program's goals. Be sure that all employees, especially new or reassigned ones, receive adequate training. If there are areas where special protective equipment is required, be sure that employees know how to use it.

Step 5. Maintain good records:

Don't make the mistake of not keeping proper records. It is far better to have a complete record of all accidents and in-

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Refer regularly to this check list to maintain a safe facility. For the three categories shown, be sure that:

ELECTRICAL SAFETY

- Fuses of the proper size have been installed.
- All ac switches are mounted in clean, tightly closed metal boxes.
- Each electrical switch is marked to show its purpose.
- Motors are clean and free of excessive grease and oil.
- Motors are properly maintained and provided with adequate overcurrent protection.
- Bearings are in good condition.
- Portable lights are equipped with proper guards.
- All portable equipment is double-insulated or properly grounded.
- The station's electrical system is checked periodically by someone competent in the NEC.
- The equipment grounding conductor or separate ground wire has been carried all the way back to the supply conductor.
- All extension cords are in good condition, and the groundingpin is not missing or bent.

EXITS AND ACCESS

- All exits are visible and unobstructed.
- All exits are marked with a readily visible, properly illuminated sign.
- There are sufficient exits to ensure prompt escape in case of an emergency.

FIRE PROTECTION

- Portable fire extinguishers of the appropriate type are provided in adequate number.
- All remote vehicles have proper fire extinguishers.
- Fire extinguishers are inspected monthly for general condition and operability and noted on the inspection tag.
- Fire extinguishers are mounted in readily accessible locations.
- The fire alarm system (if you have one) is tested annually.

Table 4. *Sample check list for safety. Add items that are of special concern for your station.*

juries on the job than to have to claim no knowledge of them.

• Obtain a report for every injury requiring medical treatment (other than first aid). Record each injury on OSHA form No. 200.

The key to operating a safe facility is diligent management.

• For recordable cases of other types of occupational injury or illness, use form No. 101. Worker's compensation insurance forms also may be used for these reports.

• Prepare an annual summary, OSHA form No. 200, and post it no later than Feb. 1. This form must remain posted until March 1, and all these records must be maintained for five years.

Step 6. Provide first aid:

It only makes sense to provide adequate first aid. Maintain sufficient supplies, and be sure someone on your staff knows at least the basic procedures of first aid. This step is not required if your facility is near an infirmary, clinic or hospital.

Step 7. Encourage employee awareness:

If you are concerned about safety, it is likely that your employees also will be interested. Display safety pamphlets, and recruit employee help in identifying hazards. Reward your employees for good safety performance. Often, an incentive program will help maintain safe work practices.

Tailoring your safety program

An abbreviated safety check list is shown in Table 4. Using it as a guide and adding your own areas of concern, inspect your station. Eliminate any hazards identified, and obtain any forms or first aid supplies that may be needed.

The OSHA "Handbook for Small Business" outlines the legal requirements imposed by the Occupational Safety and Health Act of 1970. The publication, available from your local OSHA office, suggests additional ways in which a company can develop an effective safety program.

Free on-site consultations also are available. A consultant will tour your facility and offer practical advice about your station's safety. These consultants do not issue citations, propose penalties or routinely provide information about you or your workplace conditions to the federal inspection staff. Contact the nearest OSHA office for additional information.

The key to a successful program is making safety a part of your regular business activity. If the necessary standards are built into your regular operating practice, the entire program is easier to maintain.

As a broadcast engineer, you owe it to yourself to know safety procedures. Your livelihood, and even your life, may depend on your effectiveness in maintaining a safe work environment. It is a good idea to spend some time reviewing your station's work practices. If you see ways in which your station can become a safer place, work with management to implement them. Remember, safety doesn't cost—it pays.

Bibliography

OSHA "Handbook for Small Business." U.S. Department of Labor.

Hammer, Willie. "Occupational Safety Management and Engineering," Prentice-Hall.

"Occupational Injuries and Illnesses in the United States by Industry," Bulletin 2278, 1985.

"Electrical Standards Reference Manual." U.S. Department of Labor.

OSHA "Electrical Hazard Fact Sheets." Revised January 1987.

SBE newsletter, Los Angeles chapter.

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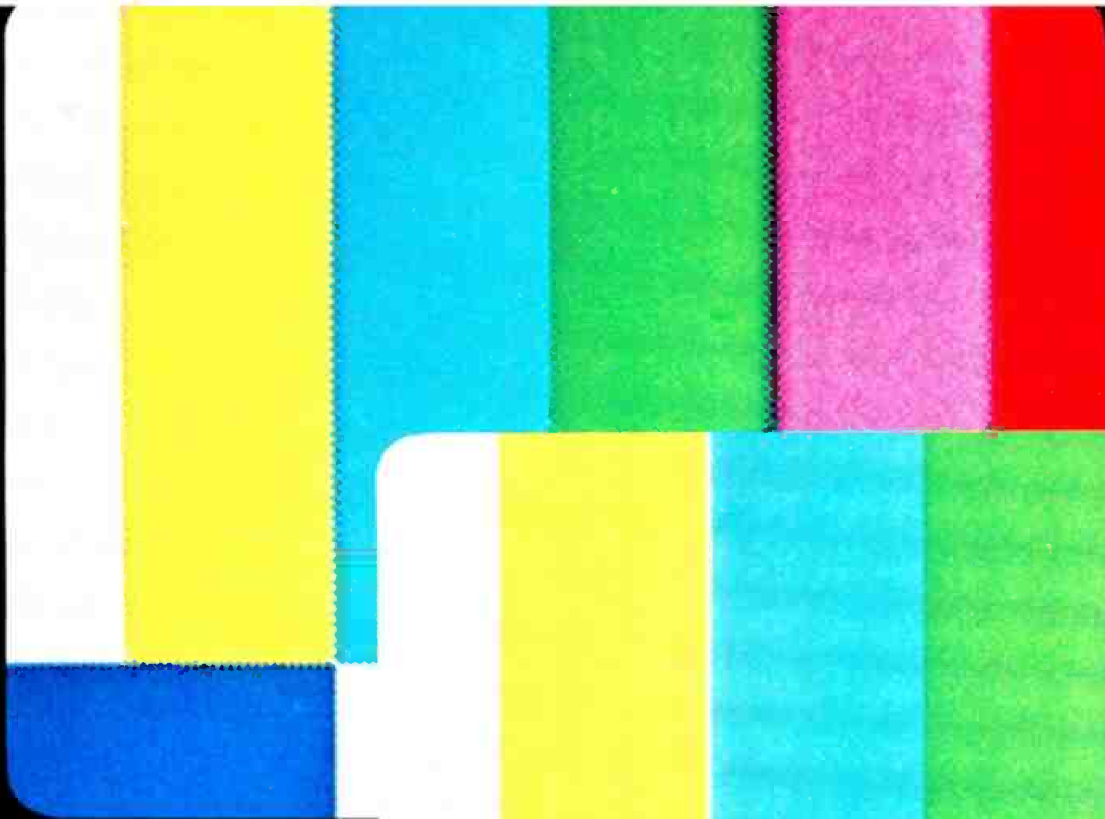

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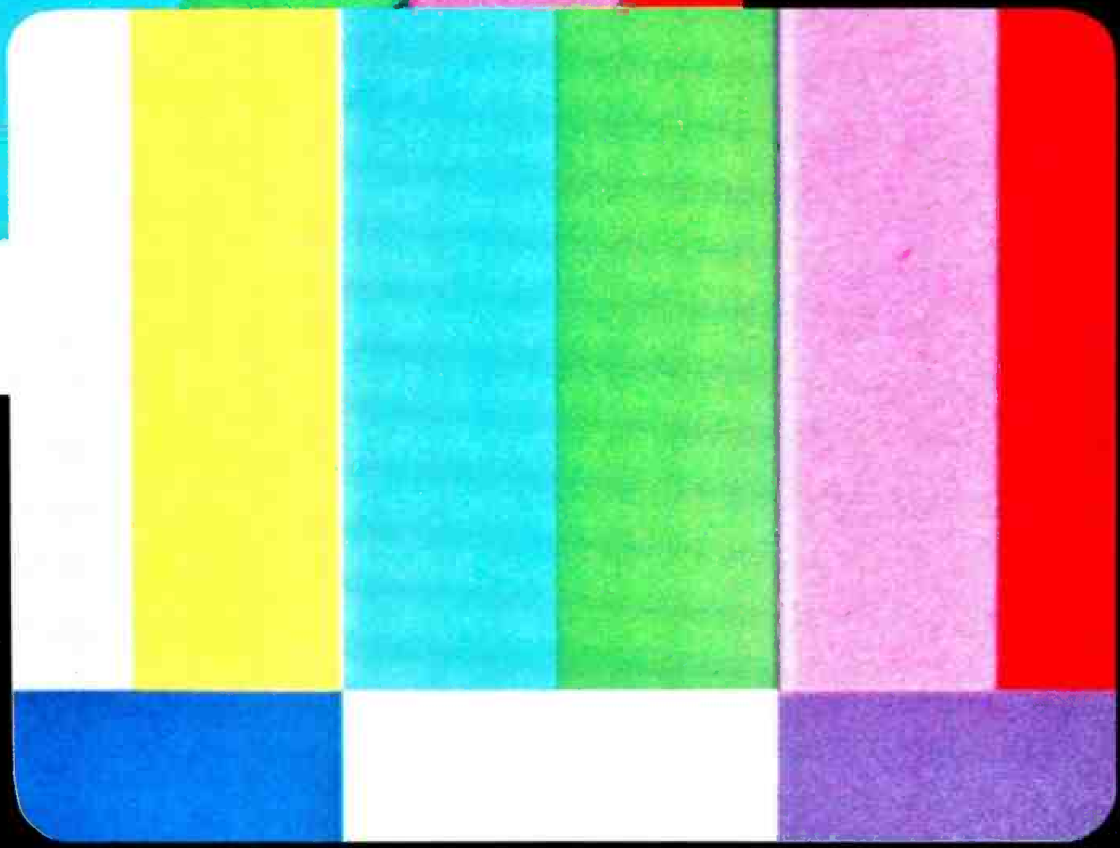

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Planning a ground system for your studio is no small task.

Grounding procedures for broadcast facilities

By Jerry Whitaker, editorial director

The attention given to the design and installation of a studio ground system is a key element in the day-to-day operation of any radio or TV station. A well-designed and installed ground network is invisible to the engineering and operations staffs. But a marginal ground will cause recurring problems for the station, usually when you least need the additional problems.

Grounding schemes range from simple to complex, but any system serves three primary purposes:
1. It provides for operator safety.
2. It protects electronic equipment from damage caused by transient disturbances.
3. It diverts stray radio-frequency energy away from sensitive audio, video and computer equipment.

Most engineers view grounding mainly as a method to protect equipment from damage or malfunction. However, the most important element is operator safety. The 120Vac line current that powers most broadcast equipment can be dangerous—even deadly—if handled improperly. Grounding of equipment and structures provides protection against wiring errors or faults that could endanger human life.

Proper grounding is basic for protection against ac line disturbances. This applies whether the source of the disturbance is lightning, power-system switching activi-

Cadwelding is the preferred method of joining elements of a ground system. This photo sequence illustrates the procedure. Photo (a) shows the powdered copper oxide and aluminum compound being added to the Cadweld mold after the conductors have been mechanically joined. Photo (b) shows final preparation of the bond before igniting. Photo (c) shows the chemical reaction that produces the excellent bond provided by Cadwelding.

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Mounting 6" × 9.5"
Weight 10 lbs.

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SPB-480D	480VAC	3ph 3 wire + gnd	985

Physical Specs: Same as SPC Models

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SPA-277Y	277/480VAC	3ph 4 wire + gnd	435
SPA-480D	480VAC	3ph 3 wire + gnd	455

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Model SPA

*Other configurations are available.

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ty or a fault in the distribution network. The problem of transient-induced equipment failure has become more critical as the complexity of broadcast equipment increases and the ruggedness of individual components decreases.

Proper grounding also is a key element in preventing radio-frequency interference in studio equipment. A facility plagued with a poor ground system may experience RFI problems on a regular basis, especially if the station's studio and transmitter are co-located.

Implementing an effective ground system for a studio facility is not an easy task. It requires thorough planning, quality components and skilled installers. It is not cheap. However, proper grounding is an investment that will bring high dividends for the life of the facility.

Any studio ground system consists of two key elements: the earth-to-grounding electrode interface outside the facility and the ac power and signal wiring systems inside the facility.

Establishing an earth ground

The grounding electrode is the primary element of any ground system. The electrode can take many forms. However, in all cases, its purpose is to interface the electrode (a conductor) with the earth (a semiconductor). Grounding principles

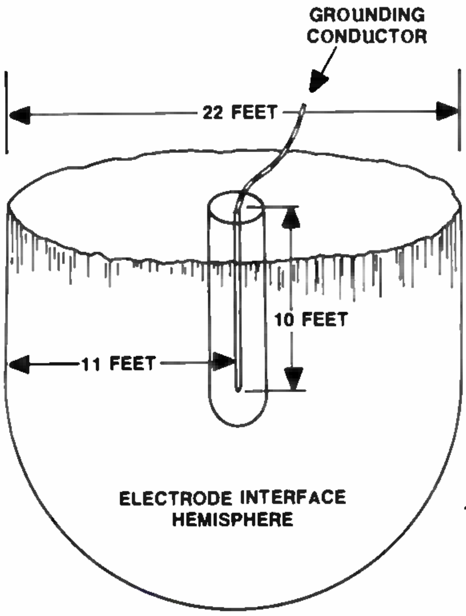

Figure 1. The effective earth interface hemisphere resulting from a single ground rod driven into the earth. The 90% effective area of the rod extends to a radius of approximately 1.1 times the length of the rod. (Reference 5.)

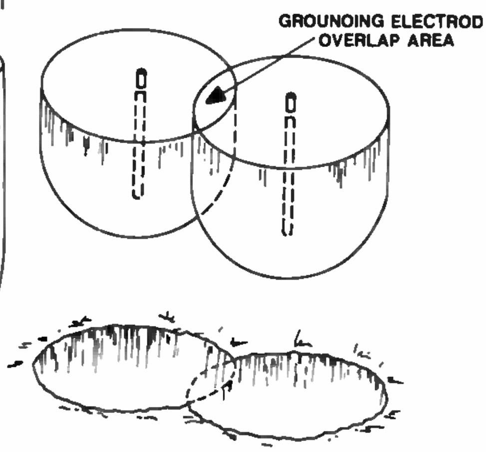

Figure 2. The effect of overlapping earth interface hemispheres by placing two ground rods at a spacing less than 2.2 times the length of either rod. The overlap area represents wasted earth-to-grounding electrode interface capability. (Reference 5.)

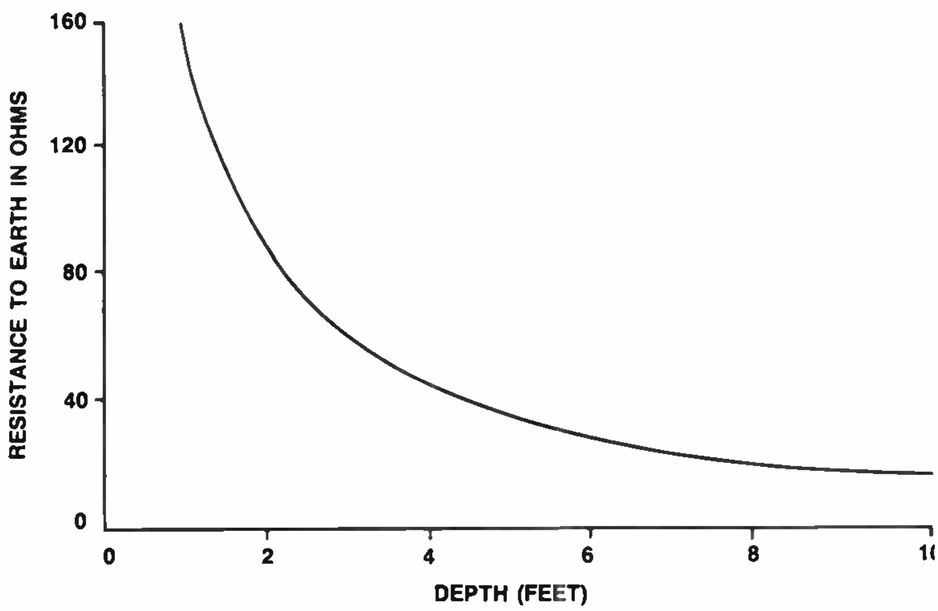

Figure 3. Charted grounding resistance as a function of ground-rod length. It can be seen tha ground-rod length in excess of 10 feet produces diminishing returns. The chart applies to a 1-inch diameter rod. (Reference 5.)

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have been studied in great detail, changing the work of creating an effective ground system from the realm of opinion to science. However, many misconceptions about grounding still exist. An understanding of proper grounding procedures begins with the basic earth-interface mechanism.

The grounding electrode (or ground rod) interacts with the earth to effectively create a hemisphere-shaped volume, as illustrated in Figure 1. The size of this volume is related to the size of the grounding electrode. The length of the electrode has a much greater effect than the diameter.

Studies have demonstrated that the earth-to-electrode resistance from a driven ground rod decreases exponentially with the distance from that rod. At a given point, the change becomes insignificant. It has been found that for maximum effectiveness of the earth-to-electrode interface, each ground rod requires a hemisphere-shaped volume with a diameter that is approximately 2.2 times the rod length.

The constraints of economics and available real estate place practical limitations on the installation of a ground system. It is important, however, to keep the 2.2 rule in mind because it allows you to use the available resources to the best advantage. Figure 2 illustrates the effects of locating ground rods too close to each other (less than 2.2 times the rod length). An overlap area is created that wastes some of the earth-to-electrode capabilities of the two ground rods.

Research has shown, for example, that two 10-foot ground rods driven only one foot apart provide about the same resistivity as a single 10-foot rod.

There are two schools of thought with regard to ground-rod length. The first approach, to which this author subscribes, states that extending ground-rod length beyond about 10 feet is of little value for most types of soil. The reasoning behind this conclusion is given in Figure 3, where ground resistance is plotted as a function of ground-rod length. Note that beyond 10 feet in length, you reach a point of diminishing returns.

A second school of thought concludes that optimum earth-to-electrode interface is achieved with long (40-foot or longer) rods, driven to penetrate the local water table. When planning this type of installation, consider the difficulty you might encounter when attempting to drive long ground rods.

The foregoing discussion assumes that the soil around the grounding electrode is reasonably uniform in composition. Depending upon the location, however, this may not be the case. At least one stud (reference 5) indicates that the use o several shorter rods, spaced at 2.2 time their length, provides a lower effective in terface resistance than a smaller numbe of longer rods. This was true even wher lower soil levels were more conductive than the higher levels.

Ground rods are available in a wide va riety of types, offering various diameters cladding and lengths. Rods often are clad with copper to prevent rust. The coppe is not used to provide better conductivi ty, as you might think. The copper certain ly provides a better conductor interface to earth, but the steel that it covers also is an excellent conductor when compared with ground conductivity. The thickness of the cladding is important only insofar as rust protection is concerned.

Chemical ground rods

An alternative to the conventiona ground rod is the chemically activated ground system. The idea behind chemica ground rods is to increase the earth-to electrode interface by conditioning the soi surrounding the rod.

Experts have known for many years tha the addition of ordinary table salt (NaCl to soil will reduce the resistivity of the earth-to-ground electrode interface. With

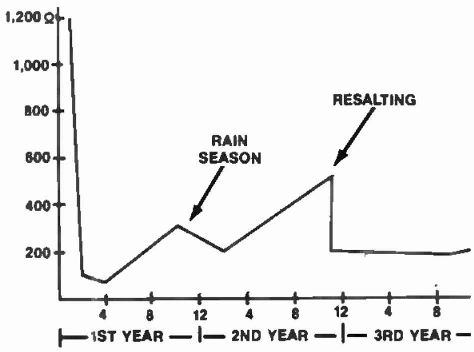

Figure 4. The effect of soil salting on ground rod resistance with time. The expected resalting period, shown here as two years, varies depend ing on local soil conditions and the amount o moisture present. (Reference 5.)

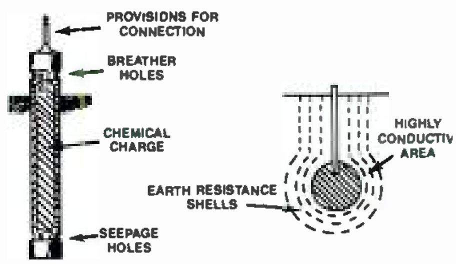

Figure 5. Construction of a typical air breathing, chemically activated ground rod Breather holes at the top of the device allow moisture into the chemical charge section of the device. A salt solution subsequently seeps ou of the bottom of the unit. (Reference 5.)

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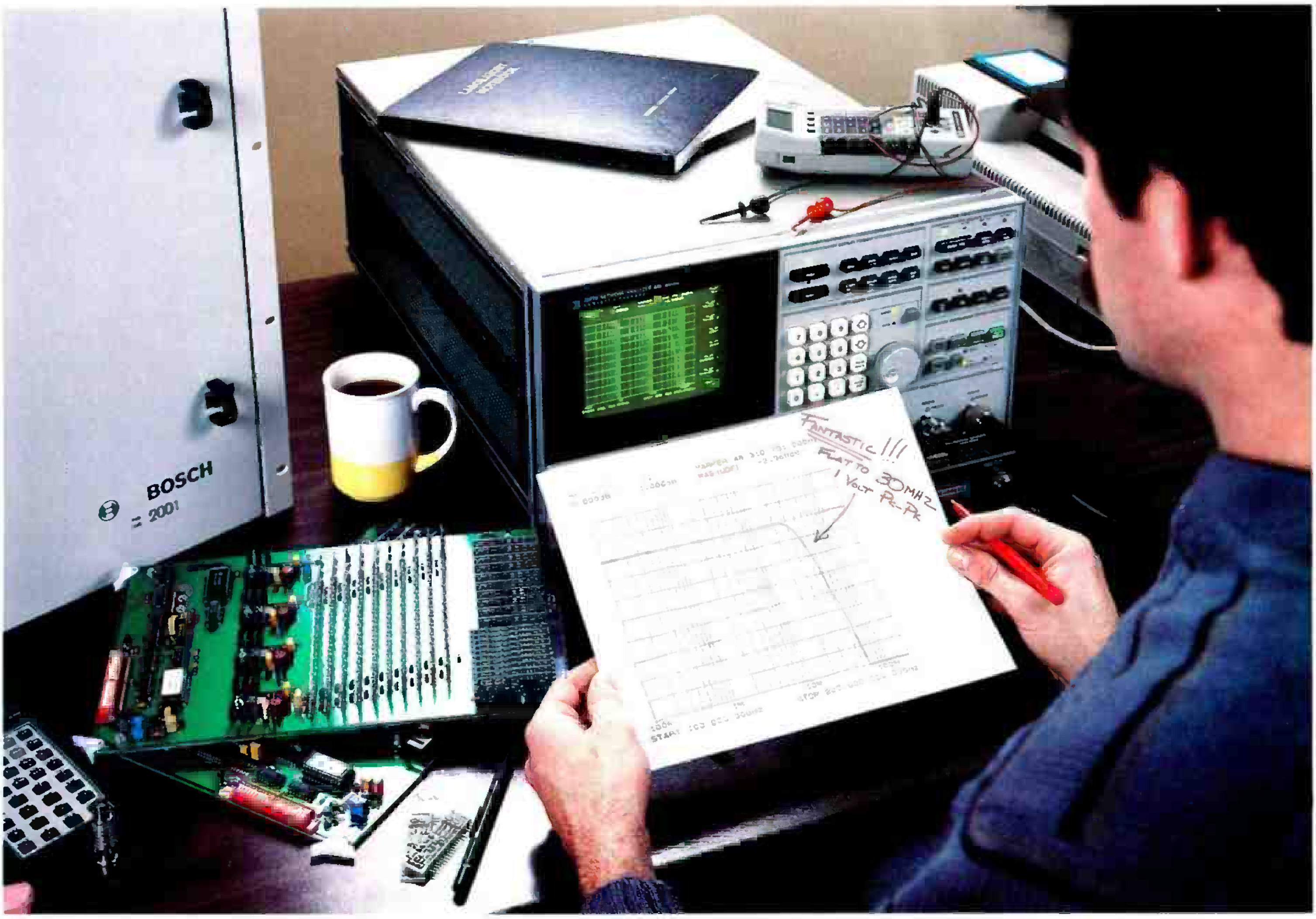

(Chart/image on analyzer is actual output from the 2001 switcher.)

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the proper soil moisture level (4% to 12%), salting can reduce soil resistivity from 10,000Ω/m to less than 100Ω/m.

Salting of the area surrounding a ground rod (or group of rods) follows a predictable life-cycle pattern, as illustrated in Figure 4. Subsequent salt applications are rarely as effective as the initial salting. Various approaches have been tried over the past 10 years to solve this problem.

One of these approaches is shown in Figure 5. This chemically activated grounding electrode consists of a 2½-inch-diameter copper pipe filled with rock salt. Breathing holes are provided on the top of the assembly, and seepage holes are provided at the bottom. The theory of operation is simple. Moisture is absorbed from the air (when available) and absorbed by the salt. This creates a solution that seeps out of the base of the device and conditions the soil in the immediate vicinity of the rod.

Another approach is shown in Figure 6. This device incorporates a number of ports (holes) in the assembly. Moisture from the soil (and rain) is absorbed through the ports. The metallic salts subsequently absorb the moisture, forming a saturated solution that seeps out of the ports and into the earth-to-electrode hemisphere. Tests have shown that if the moisture content is within the required range, earth resistivity will be reduced by as much as 100:1.

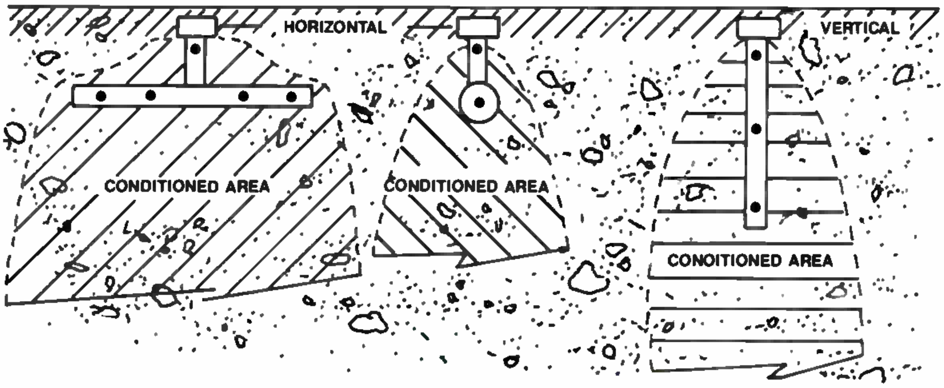

Figure 6. Another approach to the chemically activated ground rod. Multiple holes are provided on the ground-rod assembly to increase the effective earth-to-electrode interface. Note that chemical rods can be produced for a variety of configurations. (Reference 5.)

Designing a ground system

After the required ground-rod configuration has been determined, the individual rods must be connected together. Many different approaches may be taken, but the goals are all the same: Establish a low-resistance and low-inductance path to surge energy.

Figure 7 shows a studio building ground system using a combination of ground

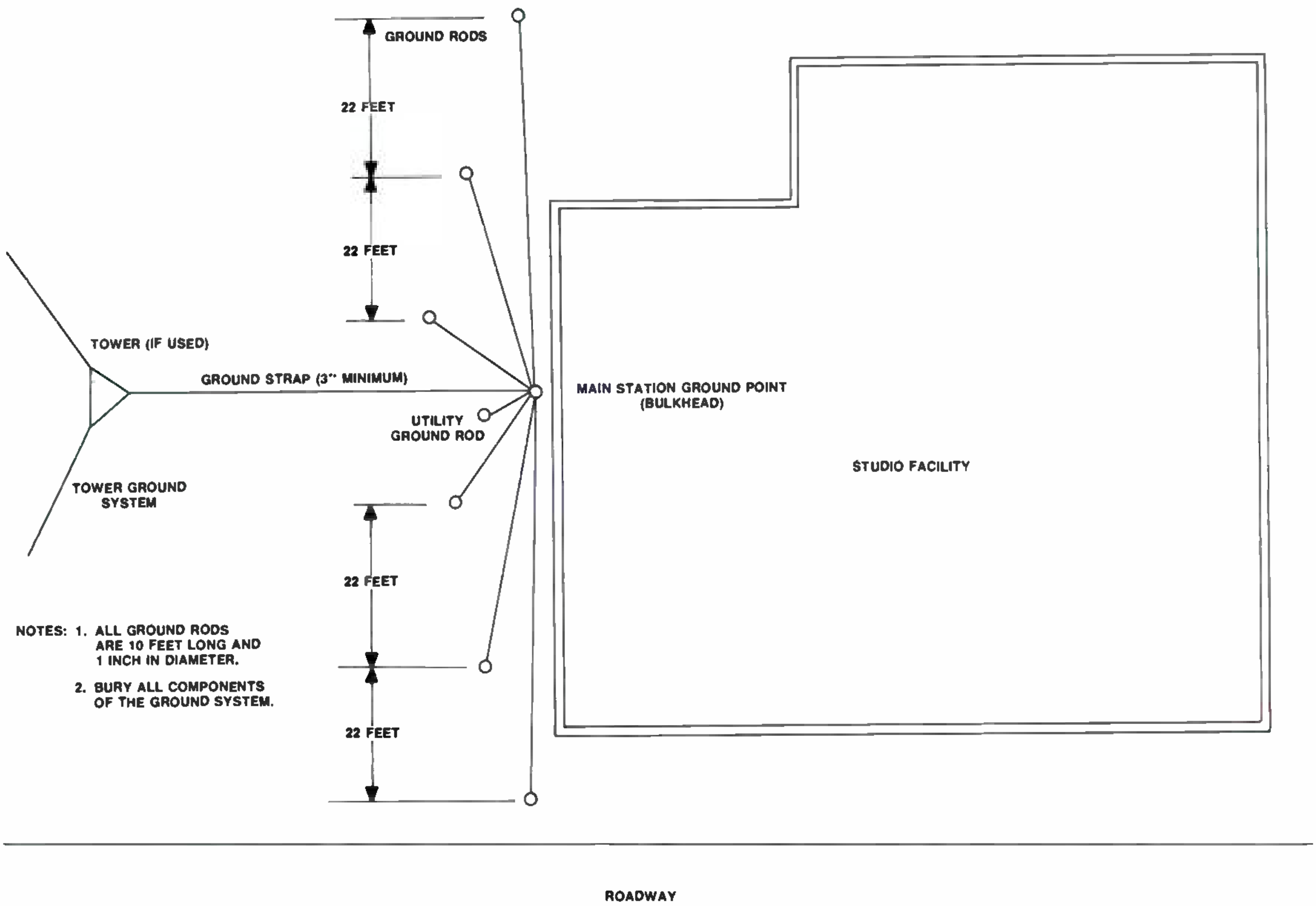

Figure 7. Studio facility ground system using a hub-and-spoke approach. The available real estate at the studio site dictates the exact configuration of the ground system. If a tower is located at the site, the tower ground system is connected to the building ground as shown.

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rods and buried bare copper radial wires. This design is appropriate if the building housing the studio facility is large or located in an urban area. The approach shown in Figure 7 also may be used if the studio facility is located in a high-rise building that requires a separate ground system for the station. Most newer office buildings have grounding systems designed into the structure. If a comprehensive building ground system is provided, use it. For older structures (constructed of wood or brick), a separate ground system may be required.

Figure 8 shows another approach, in which a perimeter ground strap is buried around the building, and ground rods are driven into the earth at regular intervals (2.2 times the rod lengths). The ground ring consists of a 1-piece copper conductor that is bonded to each ground rod.

If a tower is located at the studio site, connect the tower ground system to the main station ground point via a copper strap. The width of the strap must be at least 1% of the length, and not less than three inches wide. The studio ground system is not a substitute for a tower ground system, no matter what the size of the tower. The two systems are treated as independent elements, except for the point at which they interconnect.

Tie the utility company power system ground rod to the main station ground point as required by the local electrical code. Do not consider the station ground system to be a substitute for the utility company ground rod. The utility ground rod is important for safety reasons and must not be disconnected or moved.

Do not remove any existing earth-ground connections to the power-line neutral connection. To do so may violate local electrical code.

Bury all elements of the ground systems shown in Figures 7 and 8 to reduce the inductance of the overall network. Do not make sharp turns or bends in the interconnecting wires. Straight, direct wiring practices will reduce the overall inductance of the system and increase its effectiveness in shunting fast rise-time surges to earth.

In most areas, soil conductivity is high enough to permit rods to be connected with No. 6 (or larger) bare copper wire. In areas where the soil is sandy, use copper strap. A wire buried in low-conductivity, sandy soil tends to be highly inductive and ineffective to fast rise-time current surges. As a rule of thumb, make the width of the ground strap at least 1% of its overall length.

Bonding ground system elements

Do not use soldered-only connections outside the equipment building. Crimped/brazed and exothermic (*Cadwelded*) connections are preferred. For a proper bond,

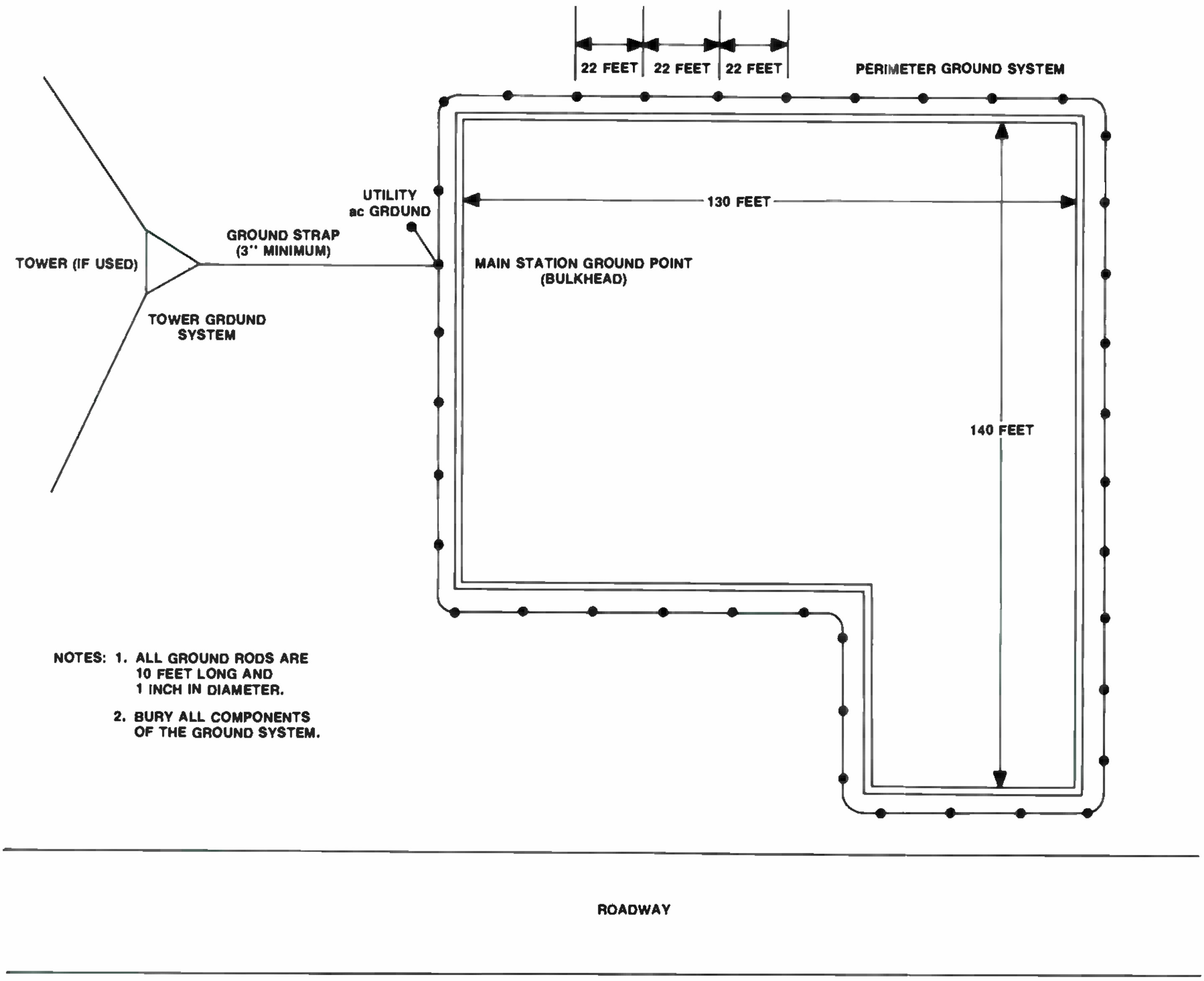
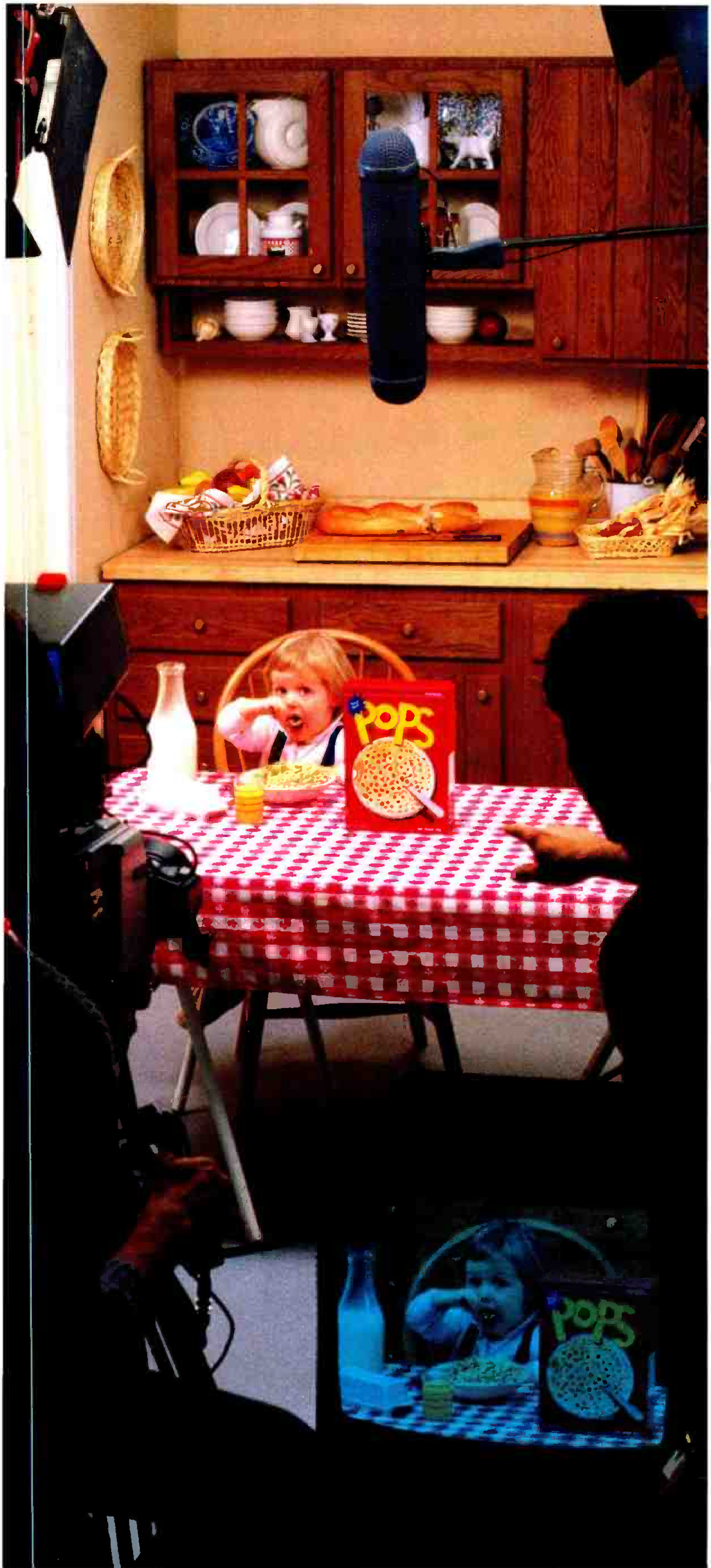


Figure 8. *Studio facility ground configuration using a perimeter ground-rod system. This approach works well for stations with limited real estate available.*



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all metal surfaces must be clean, any finish removed to bare metal and surface preparation compound applied. Protect all connections from moisture by appropriate means (sealing compound and heat-shrink tubing).

It is not uncommon for an untrained installer to use soft solder to connect the elements of a ground system. Such a system is doomed from the start. Soft-soldered connections cannot stand up to the acid and mechanical stress imposed by the soil.

The most common method of connecting the components of a ground system is silver soldering. The process requires the use of brazing equipment, which may be unfamiliar to many broadcast engineers. A high-temperature, high-conductivity solder is used to complete the bonding process.

The best approach to bonding involves a process called *Cadwelding*, in which molten copper is used to melt connections together to form a permanent bond. This process is particularly useful in joining dissimilar metals. In fact, if copper and galvanized cable must be joined, Cadwelding is the only acceptable way. The completed connection will not loosen or corrode, and it will carry as much current as the cable connected to it.

Cadwelding is accomplished by dumping powdered metals (copper oxide and aluminum) from a container into a graphite crucible and igniting the material by a flint lighter. Reduction of the copper oxide by the aluminum produces molten copper and aluminum oxide slag. The molten copper flows over the conductors, bonding them together. (Cadweld is a registered trademark of Erico Corporation.)

Conductors to an earth-ground system, or to components of the system, must be kept short to be effective. The inductance of a conductor is a major factor in its impedance to surge energy. Any bends in the conductor will increase its inductance and decrease the effectiveness of the wire. Bends in ground conductors should be gradual. A 90° bend is the electrical equivalent of a ¼-turn coil. The sharper the bend, the greater the inductance.

Because of the fast rise time of most lightning discharges and power-line transients, the *skin effect* plays an important role in ground conductor selection. When planning a station ground system, view the project from an RF standpoint.

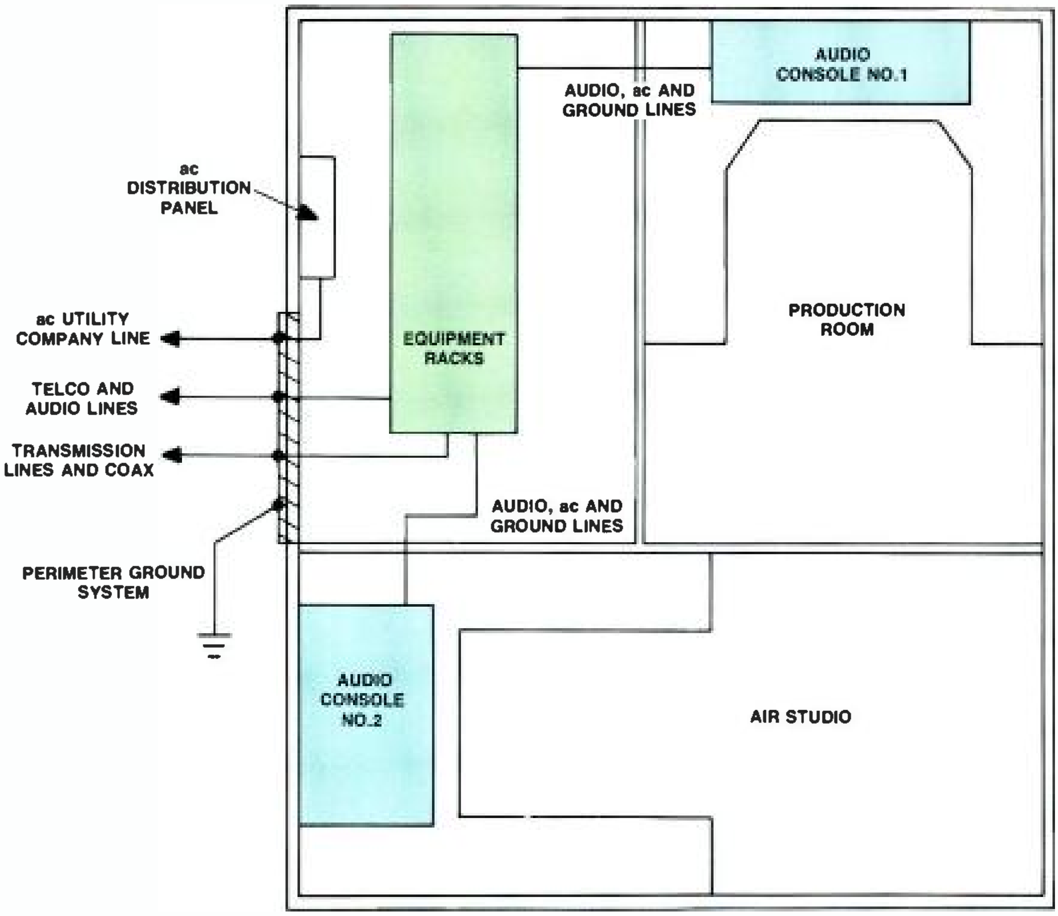

Figure 9. The basic design of a bulkhead panel for a studio or transmission facility. The bulkhead establishes the grounding reference point for the entire facility. (Reference 1.)

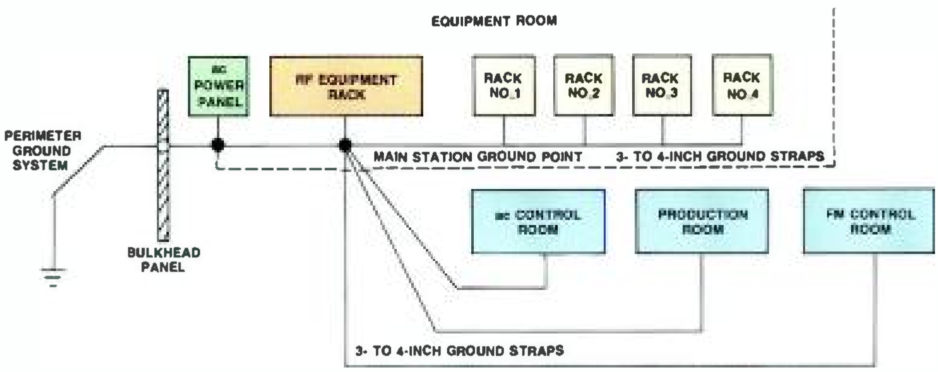

Figure 10. A typical grounding arrangement for a studio facility with a remote transmitter. The main station ground point *is the reference from which all grounding is done. If a bulkhead entrance panel is used at the facility, it will function as the main ground point.*

Bulkhead panel

The cornerstone of any facility grounding system should be a *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 9 shows a typical bulkhead installation for a radio station.

The bulkhead panel size depends on the spacing, number and size of the coaxial lines, power cables and other conduit entering the building. Construct the panel of copper or brass. Do not use steel, unless it is stainless steel (18-8 type or equivalent).

The bulkhead panel must be constructed of heavy material because of the significant current it will carry during a lightning strike or ac line disturbance. The recommended material is 1/8-inch C110 (solid copper) ½ hard. Use 18-8 stainless-steel mounting hardware to secure a subpanel (if used) to the bulkhead.

Because the bulkhead panel establishes the central grounding point for all equipment within 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.

The bulkhead panel establishes the *main station ground point*, from which all grounds inside the building are referenced.

Studio ground system

Installing an effective ground system to achieve a good earth-to-grounding electrode interface is only half the battle for a studio facility. An equally important ele-

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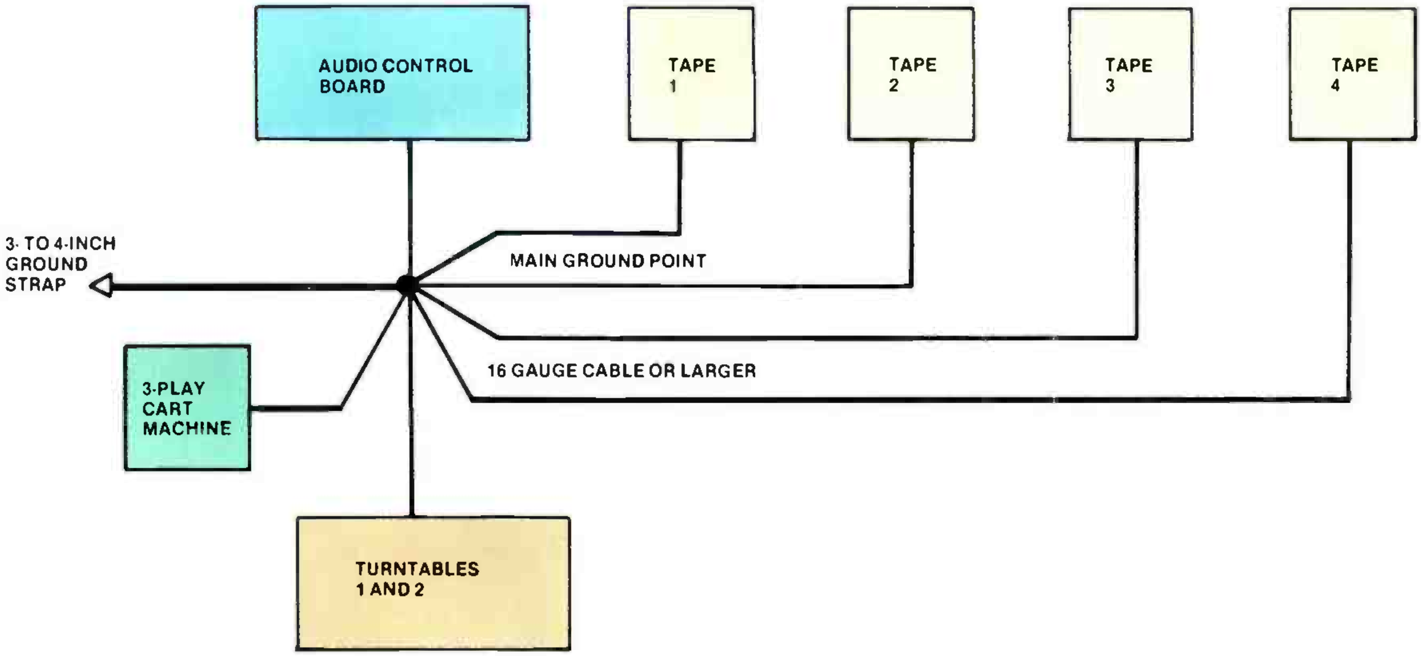

Figure 11. *A typical grounding arrangement for an individual equipment room at a broadcast facility. The ground strap from the station ground point establishes a* local ground point *in the room, to which all source and control equipment is bonded.*

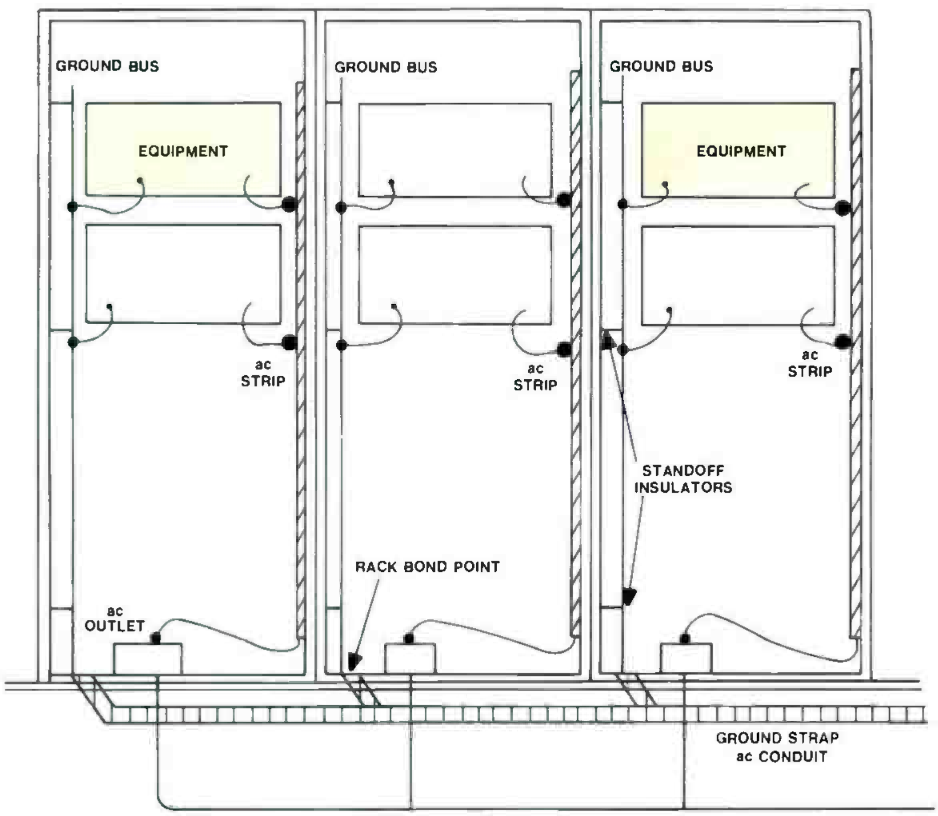

Figure 12. *The recommended grounding arrangement for equipment racks. For easier assembly of multiple racks, position the ground connections and ac receptacles at the same location in all racks.*

ment of any station ground is the configuration of grounding conductors inside the building.

Many different methods can be used to implement a ground system for a radio or TV studio facility. However, some conventions should always be followed to ensure a low-resistance (and low-inductance) ground that will perform as required. Proper grounding is important, whether or not the studio is located in an RF field.

Figure 10 shows a recommended grounding arrangement for a typical broadcast facility. Construct the building ground system using heavy-gauge copper wire (No. 4 or larger) if the studio is not located in an RF field. Use a wide copper strap (at least three inches wide) if the facility is located near an RF energy source.

A common method to determine the required size of a ground strap (in inches) inside the building is to specify the minimum width of the strap as 1.5% of its length. For example, if the total grounding run from the bulkhead panel to the farthest piece of equipment is 350 feet, a ground strap of 5.25 inches should be used. For short runs in an RF field, do not use a ground strap that is less than three inches wide.

Run the strap or cable from the perimeter ground system to a main station ground point. Branch out from the main ground point to each major piece of equipment and to the various studio/equipment rooms. Establish a local ground point in each room or group of racks, as shown in Figure 11. Use a separate ground cable for each piece of equipment (No. 14 gauge or larger).

The ac line ground connection for a particular piece of equipment often presents a built-in problem. If the equipment is grounded through the chassis to the equipment room ground point, a ground loop may be created when it is plugged in (if it has a 3-prong plug).

The solution is careful design and installation of the ac power-distribution system to minimize ground-loop currents, while providing the required protection against ground-current faults. (See "Controlling ac Line Disturbances" in the November 1987 issue.)

Some equipment manufacturers provide a convenient solution to the ground-loop problem by isolating the signal ground from the ac and chassis ground. This feature offers the user the best of both worlds: the ability to create a signal ground system and ac ground system free of interaction and ground loops.

It should be emphasized that the design of a ground system must be considered as an integrated package. Proper procedures

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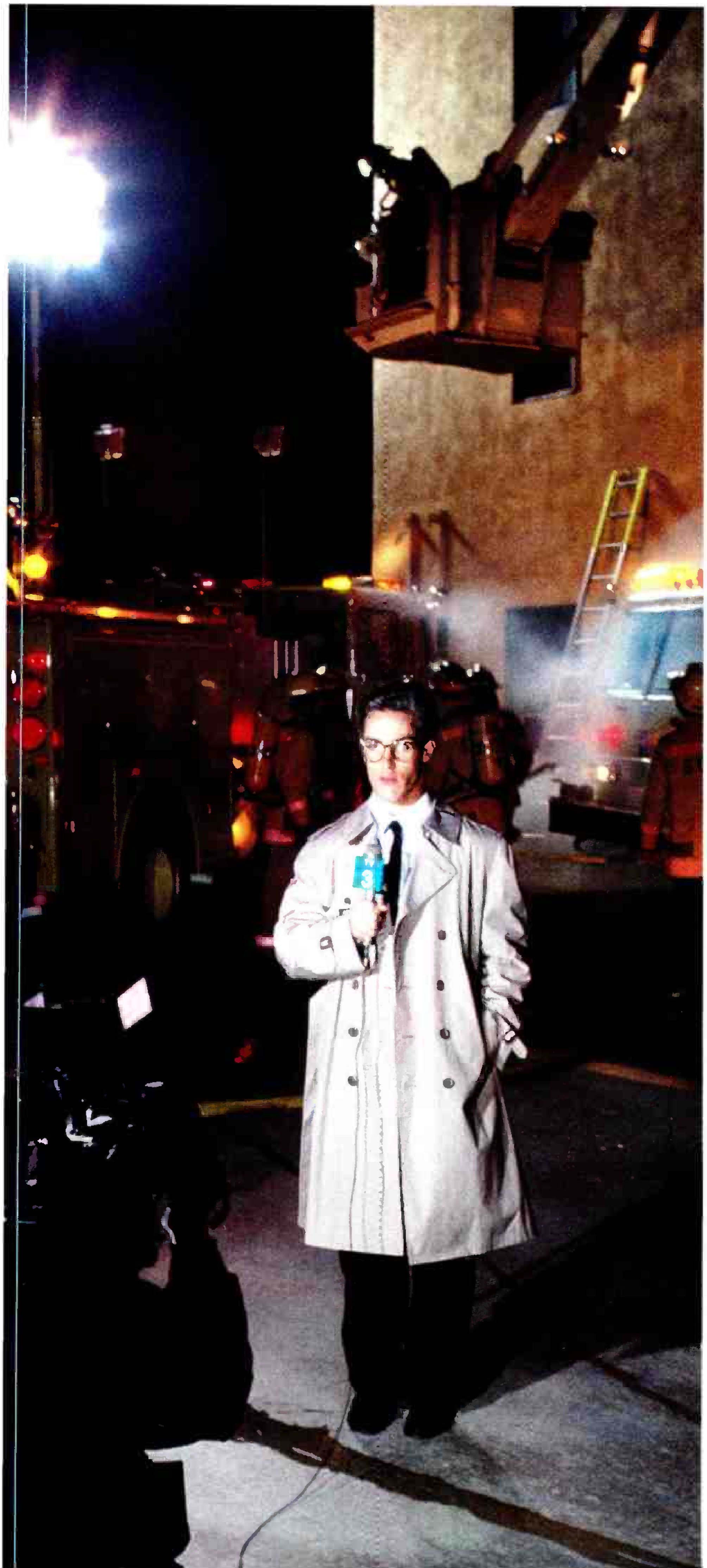

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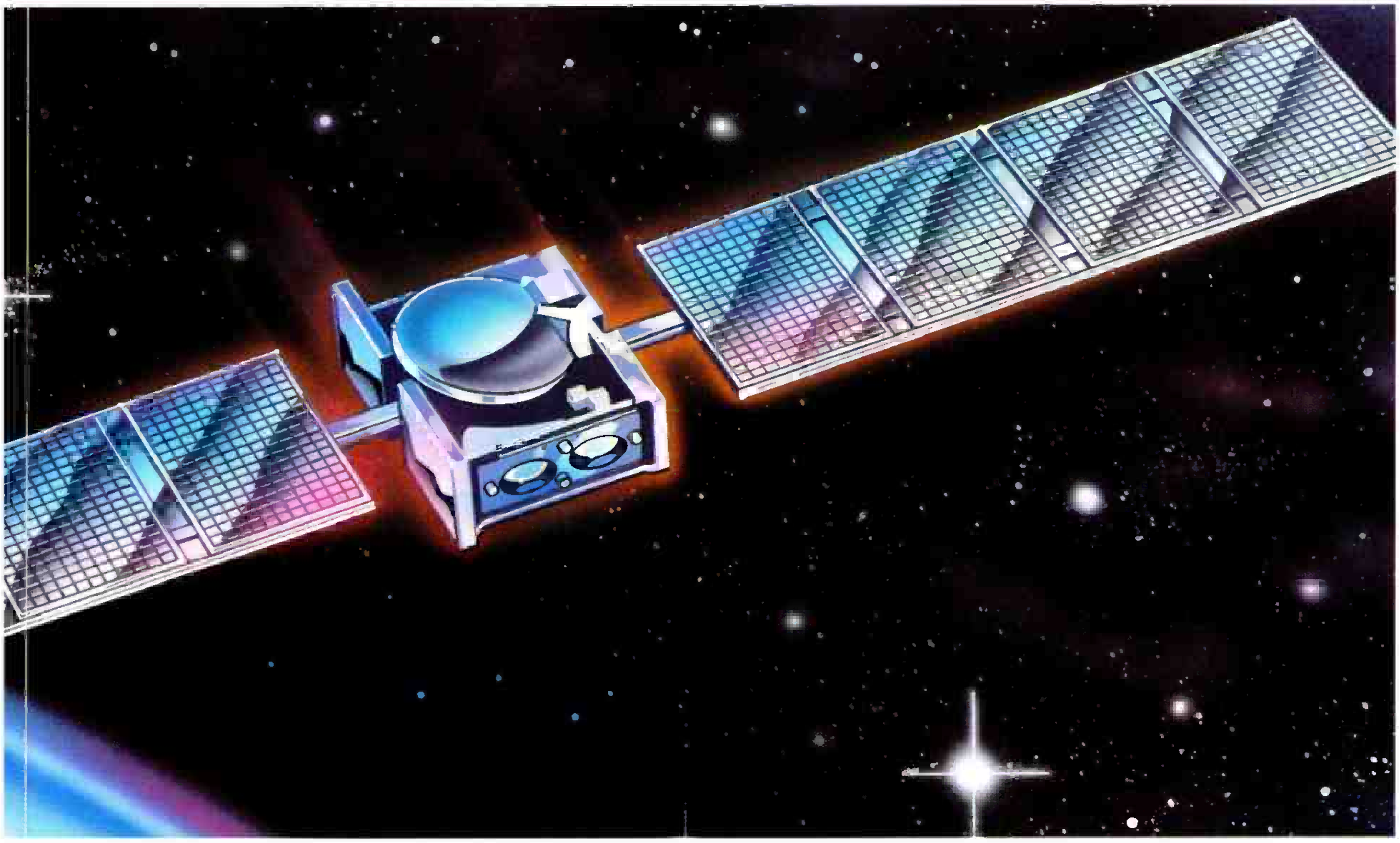

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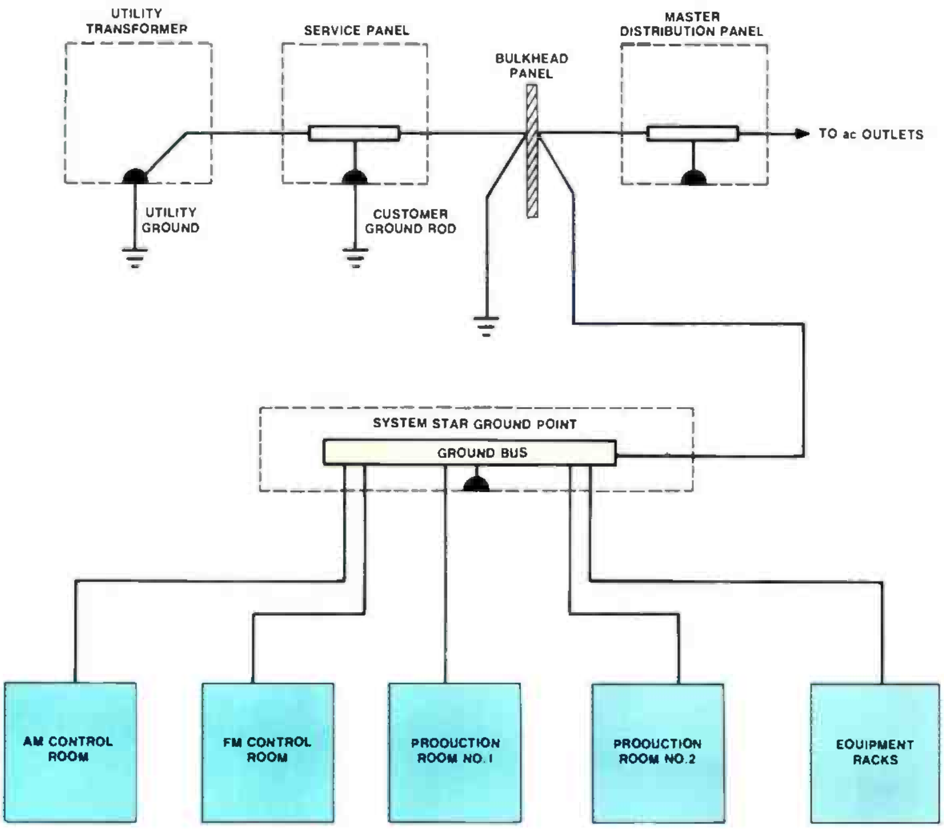


Figure 13. Simplified ac power and station signal grounding arrangement. Careful installation of equipment is important because just one incorrect connection can make an otherwise perfect ground system unacceptable.

Continued from page 58

must be used at all points in the system. It takes only one improperly connected piece of equipment to upset an otherwise perfect ground system. The problems generated by a single grounding error can vary from trivial to significant, depending upon where in the system the error occurs.

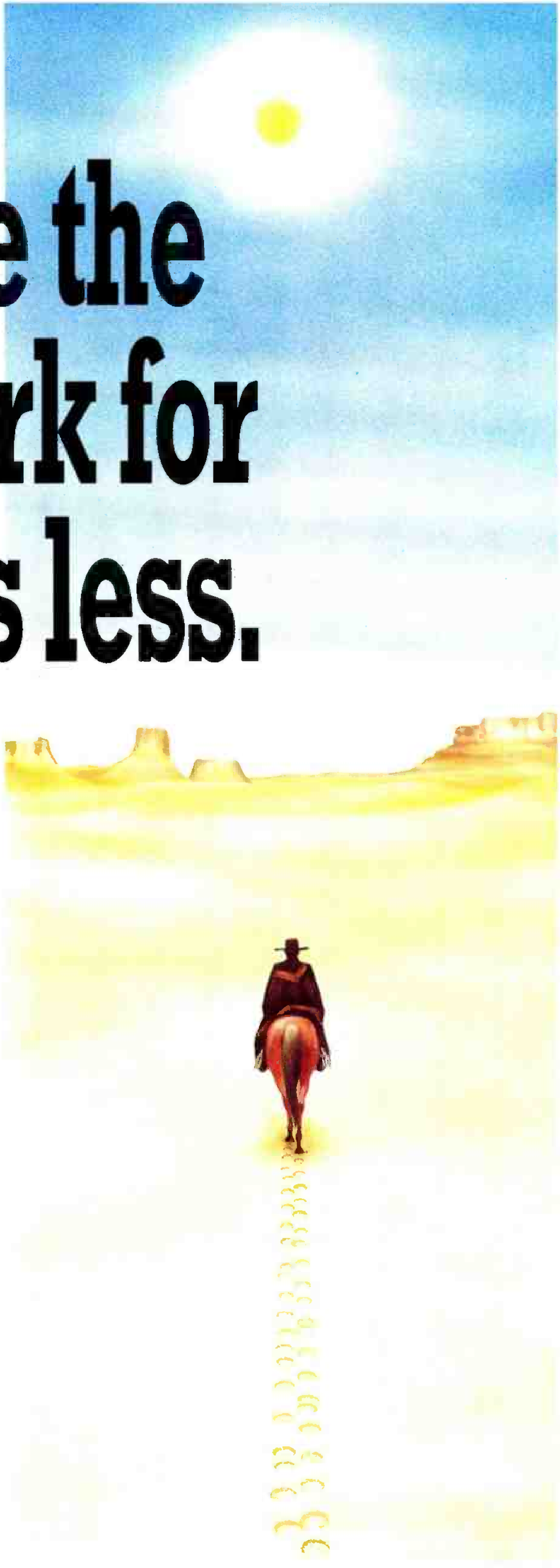
This consideration leads, naturally, to the concept of ground-system maintenance for elements inside the studio building. Check the grounding arrangement from time to time for faults or errors. Whenever new equipment is installed or old equipment is removed from service, give careful attention to the effects such work might have on the ground system.

Grounding equipment racks

The installation and wiring of equipment racks must be carefully planned to prevent problems during day-to-day operations. Figure 12 shows the recommended approach.

Bond together adjacent racks with 3/8- or ½-inch-diameter bolts. Clean the contacting surfaces by sanding down to bare metal. Use lockwashers on both ends of the bolts. Bond racks together using at least six bolts per side (three bolts for each vertical rail).

Run a ground strap from the *main station ground star point*, and bond the strap to the base of each rack. Silver solder the strap to a convenient spot on one side of



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the back portion of each rack. Secure the strap at the same location for each rack used. A mechanical connection between the rack and the ground strap may be made using bolts and lockwashers, if necessary. Be certain, however, to sand down to bare metal before making the ground connection. Because of the importance of the ground connection, it is recommended that each attachment be made with a combination of crimping and silver solder.

Install a vertical ground bus in each rack (as illustrated in Figure 12). Use copper busbar about one inch wide and ¼-inch thick. Size the busbar to reach from the bottom of the rack to about one foot from the top. The exact size of the busbar is not critical. However, it must be sufficiently wide and rigid to permit drilling 1/8-inch holes without deforming.

Mount the ground busbar to the rack using insulated standoffs. The easiest method is to use porcelain standoffs commonly found in high-voltage equipment. These are readily available and reasonably priced. Attach the ground busbar to the rack at the point at which the station ground strap attaches to the rack. Silver solder the busbar to the rack and strap at the same location in each rack used.

Mount a vertical power strip inside each rack to power the equipment. The power strip doesn't need to be insulated from the rack. Power equipment from the strip using standard 3-prong grounding ac plugs. Do not defeat the safety ground connection. Equipment manufacturers use this ground to drain transient energy.

Mount equipment in the rack using normal metal-mounting screws. If you're in a high-RF field, clean the rack rails and equipment panel connection points to ensure a good electrical bond. This is important because, in a high-RF field, detection of RF energy can occur at the junctions between equipment chassis and the rack.

Connect a separate ground wire from each piece of equipment in the rack to the vertical ground busbar. Use No. 12 stranded copper wire (insulated). Connect the ground wire to the busbar by drilling a hole in the busbar at a convenient elevation near the equipment. Fit one end of the ground wire with an enclosed-hole solderless terminal connector (No. 10 size hole or larger). Attach the ground wire to the busbar using No. 10 (or larger) hardware. Use an internal-tooth lockwasher between the busbar and the nut.

Fit the other end of the ground wire with a terminal that will be accepted by the equipment. If the equipment has an isolated signal ground terminal, it should be tied to the ground busbar.

In Figure 13, each of the grounding elements that has been discussed is integrated into one diagram. This approach fulfills the requirements of personnel safety and broadcast equipment performance.

Plan ahead

There is nothing magical about implementing an effective ground system for a radio or TV facility. Disturbances from the outside world can be diverted from the station if the ground system has been planned carefully and installed properly. It is much easier—and cheaper—to install a ground system right the first time than it is to redo a poor system or to try to live with an inadequate grounding design.

References

1. Block, Roger. "How to Ground Guy Anchors and Install Bulkhead Panels." *Mobile Radio Technology*, February 1986.

2. Mullinack, Howard G. "Grounding for Safety and Performance." October 1986.

3. Stuart, Bud. "Maintaining an Antenna Ground System." *Broadcast Engineering*, October 1986.

4. Schneider, John. "Surge Protection and Grounding Methods for AM Broadcast Transmitter Sites." *Proceedings* of the 1987 SBE National Convention and *Broadcast Engineering* Conference, St. Louis.

5. Carpenter, R.B. "Improved Grounding Methods for Broadcasters." *Proceedings* of the 1987 SBE National Convention and *Broadcast Engineering* Conference, St. Louis.


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Choosing the right components is basic to the ultimate reliability of a broadcast transmission system.

Selecting coaxial cable

By Robert D. Perelman and Thomas M. Sullivan

Parts is parts. Wire is wire. Right? Well, in the case of RF components, not so.

In the design and implementation of a new transmission facility, the focus is usually on the selection of the transmitter and antenna, but only secondary consideration may be given to the antenna feeder cable. This can be a serious mistake. The overall performance of the system depends upon the efficiency and reliability of the RF transmission path between the transmitter and the antenna. The transmission system includes not only the cable but also connectors, hangers and grounding straps. These components form the *cable system*.

The mechanical and electrical characteristics of the cable system are critical to proper operation. Mechanical considerations determine the capability of the cable to withstand temperature extremes, lightning, rain and wind. In other words, they determine overall reliability.

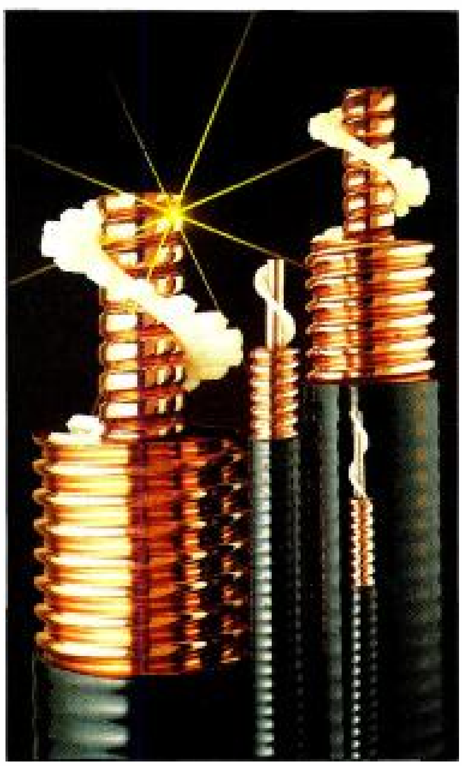
Electrical considerations directly affect overall transmitter efficiency. In the extreme, using the wrong cable can cost the station expensive downtime and repairs.

A number of different types of coaxial cable are available. The choice depends on the power level required, the length of the run from the transmitter to the antenna, and the installation method preferred.

Rigid coaxial cables, constructed of heavy-wall, copper tubes with Teflon or ceramic spacers, provide electrical performance approaching that of an ideal transmission line. They are, however, expensive to purchase and install. Corrugated copper outer conductor cables possess the combined characteristics that make them suitable for most AM/FM, and some TV, applications.

For the purposes of this article, we will examine the selection and installation of flexible coaxial cables. We'll discuss rigid line in another issue.

Perelman is marketing manager for special coaxial cable products, and Sullivan is an applications engineer for coaxial cable at Andrew Corporation, Orland Park, IL.



Selecting coaxial cable for a transmitter plant is not an easy task. A number of important specifications must be considered. Shown are various sizes of flexible air-dielectric cable. (Photos courtesy of Andrew Corporation.)

Cable basics

A coaxial cable is a transmission line in which the concentric center and outer conductors are separated by a dielectric material. When current flows along the center conductor, it establishes an electric field. The electric flux density and the electric field intensity are determined by the dielectric constant of the dielectric material. The dielectric material becomes polarized, with positive charges on one side and negative charges on the opposite side. Therefore, the dielectric acts as a capacitor with a given capacitance per unit length of the coaxial line.

Properties of this field establish a given inductance per unit length of the coaxial line. The transmission line also exhibits a given series resistance in ohms per unit length. If the transmission-line resistance is negligible or if the line is terminated properly, you can use the following simple formula to determine the characteristic impedance of the line:

$$Z_0 = \sqrt{L/C}$$

where:

L = inductance in henries/ft
C = capacitance in farads/ft

Coaxial cables typically are manufactured with 50 or 75 characteristic impedances. However, other characteristic impedances also can be created by changing the spacing between the center and outer conductors.

A signal traveling in free space is unimpeded and has a free-space velocity equal

Continued on page 70

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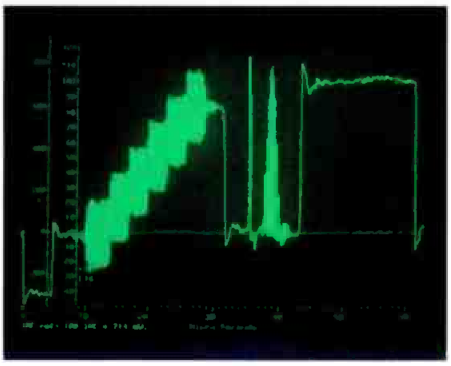

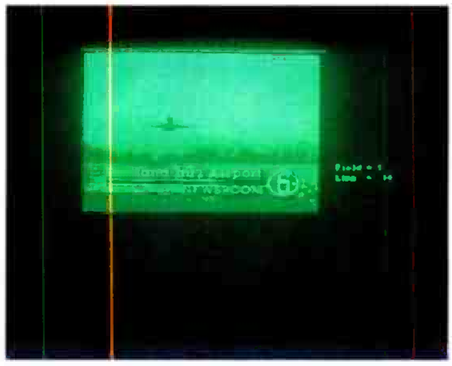

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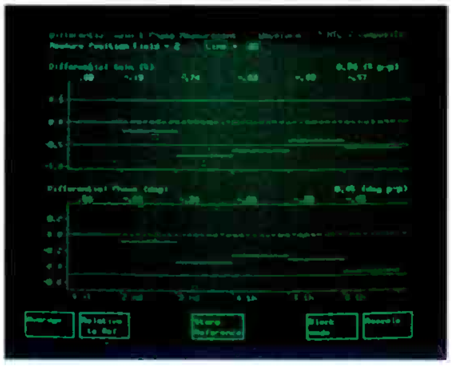

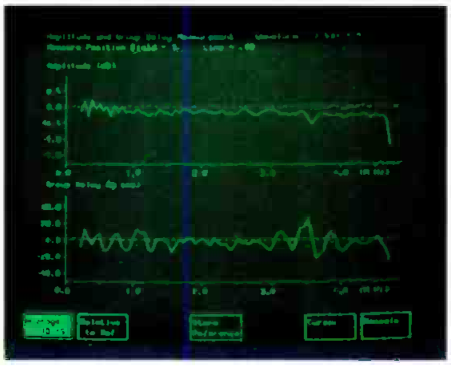

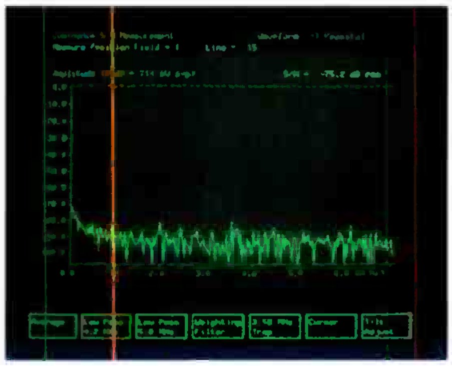

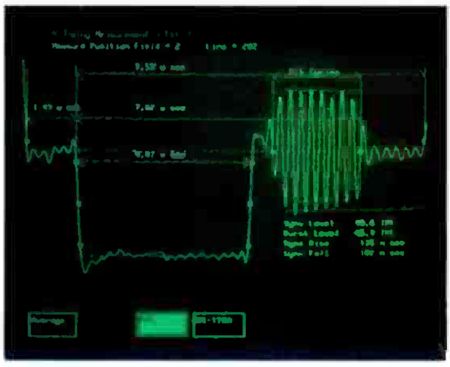

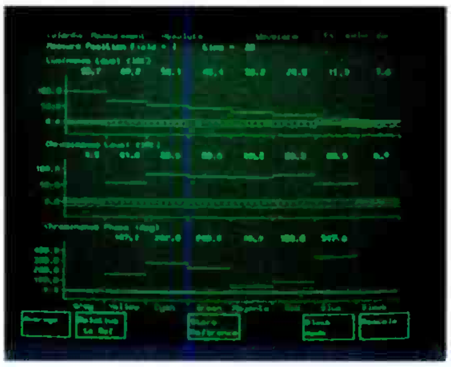

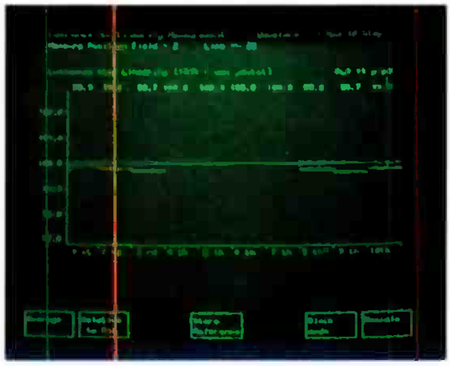

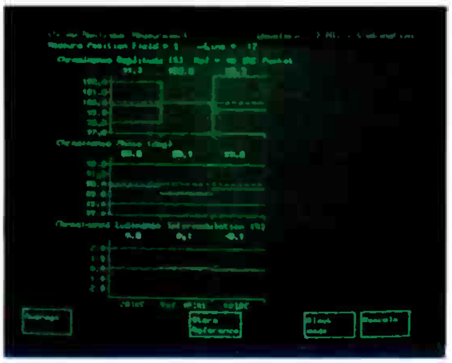

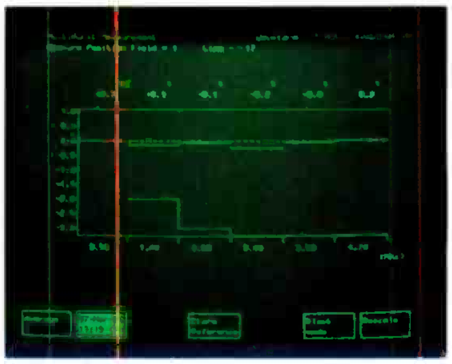

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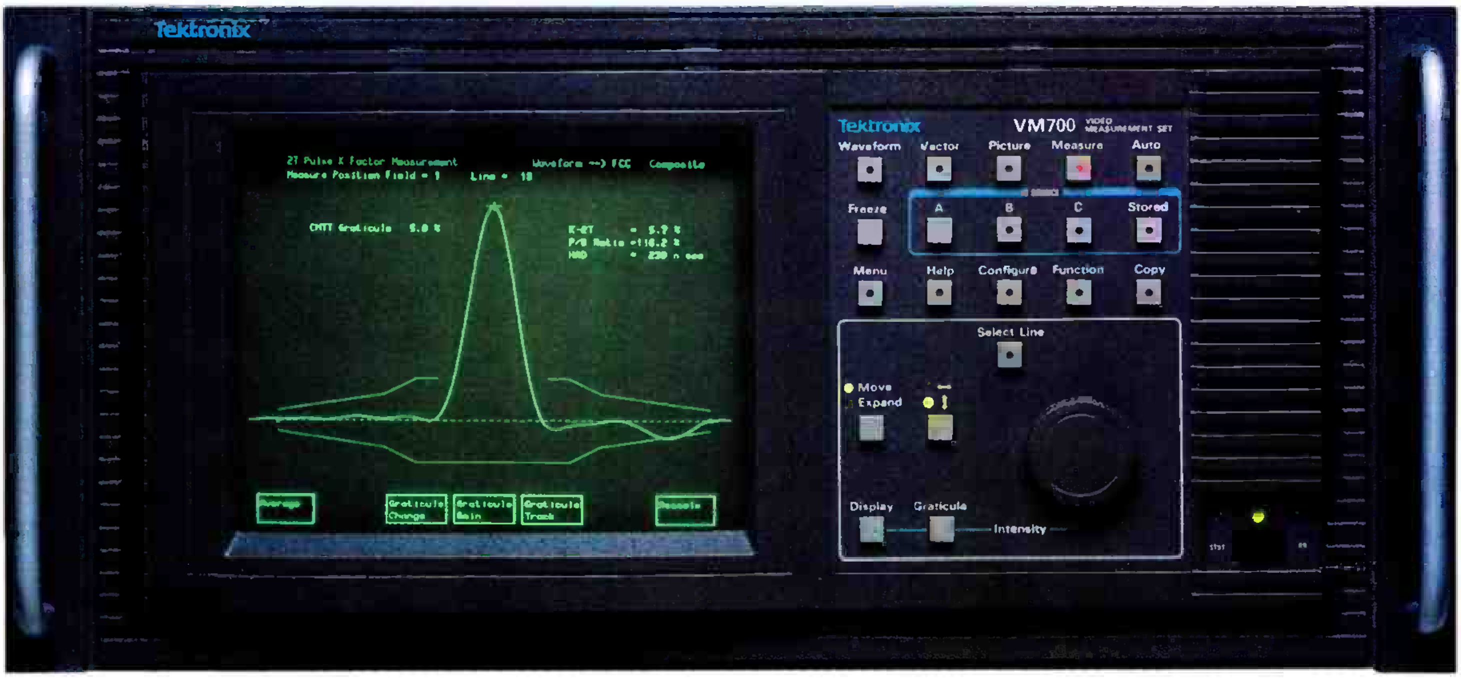

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Low-density foam cables are designed to prevent water from penetrating and traveling along the length of the cable. The outer conductor is locked mechanically to the foam dielectric by annular corrugations.

Continued from page 66
to the speed of light. In a transmission line, capacitance and inductance slow the signal as it propagates along the line. The amount the signal is slowed is represented as a percentage of the free-space velocity. This velocity is called the *relative velocity of propagation*, and it can be determined by the following equation:

$$V_p = \frac{1}{\sqrt{L \times C}}$$

where:
L = inductance in henries/ft
C = capacitance in farads/ft
and

$$V_r = (V_p / c) \times 100\%$$

where:
V_p = velocity of propagation
V_r = velocity of propagation as a percentage of free-space velocity
c = 9.842×10^8 ft/s (free-space velocity)

The principal mode of propagation in a coaxial line is the *transverse electromagnetic mode* (TEM). This mode will not propagate in a waveguide, and that is why coaxial lines can propagate a broad band of frequencies efficiently.

Coaxial cables use two types of dielectric construction to isolate the inner conductor from the outer conductor. The first is an air dielectric, with the inner conductor supported by a dielectric spacer and the remaining volume filled with air or ni-

Continues on page 74

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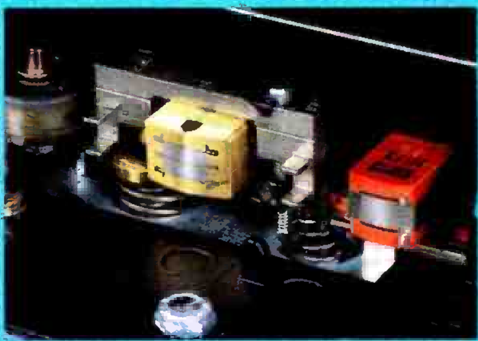

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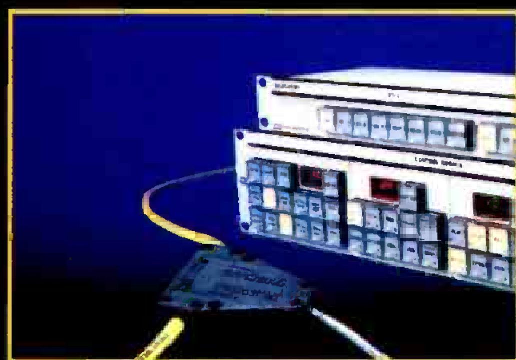

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CABLE SIZE (INCHES)	MAXIMUM FREQUENCY	VELOCITY	PEAK POWER	AVERAGE POWER 1MHz	AVERAGE POWER 100MHz	ATTENUATION* 1MHz	ATTENUATION* 100MHz
1 5/8	2.7GHz	92.1%	145kW	145kW	14.4kW	0.020dB	0.207dB
2 1/4	2.3GHz	93.1%	210kW	210kW	20kW	0.016dB	0.169dB
3	1.64GHz	93.3%	320kW	320kW	37kW	0.013dB	0.14dB
4	1.22GHz	92%	490kW	490kW	56kW	0.010dB	0.113dB
5	0.96GHz	93.1%	765kW	765kW	73kW	0.007dB	0.079dB

* Attenuation specified in dB/100 ft.

***Table 1.** Representative specifications for various types of flexible air-dielectric coaxial cable. Coax manufacturers can be valuable sources of information when you are selecting a transmission line.*

Continued from page 70
trogen gas. The spacer, which may be constructed of spiral or discrete rings, usually is made of polyolefin or Teflon. Air-dielectric cable has lower attenuation and higher average power ratings than foam-filled cables, but it requires pressurization to prevent moisture entry.

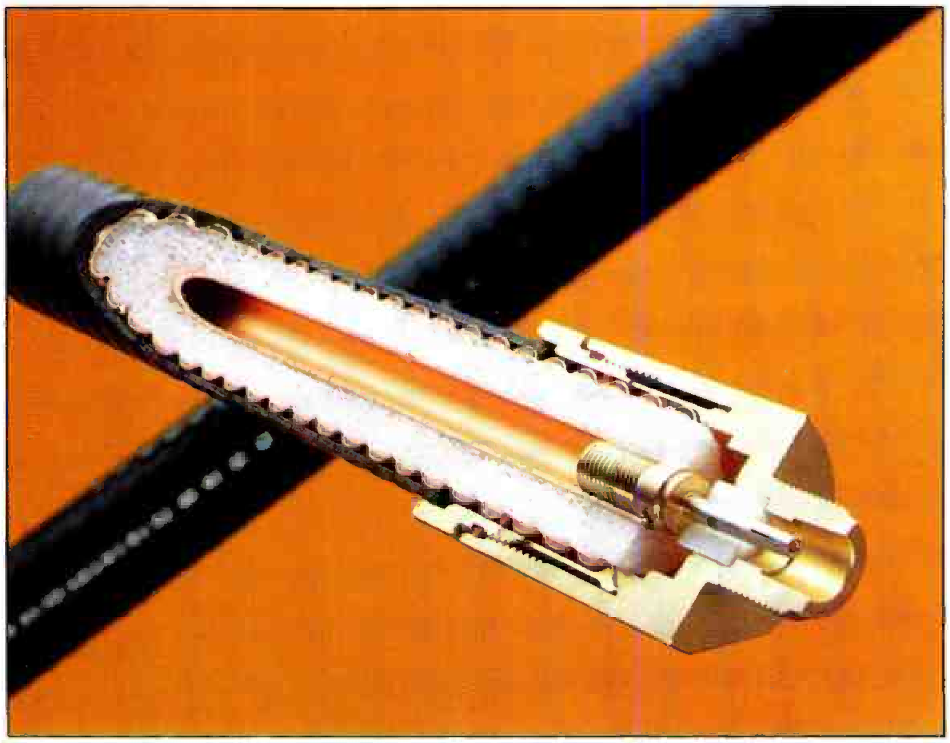
Foam-dielectric cables are an alternative to air-dielectric cables. Foam-dielectric cables are ideal for use as feeders with antennas that do not require pressurization. The center conductor is surrounded completely by foam-dielectric material, resulting in a high dielectric breakdown level. The dielectric materials are derived from polyethylene-based formulations, which contain anti-oxidants to reduce dielectric deterioration at high temperatures.

Center conductors are made from copper-clad aluminum or high-purity copper and can be solid, hollow tubular or corrugated tubular. Solid center conductors are found on cable with diameters of ½-inch or less. Tubular conductors are found in ⅞-inch or larger-diameter cables. Although tubular center conductors are used primarily to maintain flexibility, they can be used to pressurize the antenna through the feeder.

Mechanical parameters

Corrugated copper cables can withstand repeated bends with no change in properties, which is important for ease of installation. Low-density foam- and air-dielectric cables generally have a minimum bending radius of 10 times the cable diameter. So-called superflexible versions have a much smaller bending radius.

When a larger cable must be used to meet attenuation requirements, short lengths of a smaller cable (jumpers or *pigtails*) may be used on both ends for ease of installation in low-power systems. The trade-offs are slightly higher attenua-



Cutaway view of a 7/8-inch connector interface. This weatherproof design is self-flaring for easy assembly and good electrical contact.

tion and some additional cost.

The *tensile strength* of a cable is defined as the axial load that may be applied to the cable with no more than 0.2% permanent deformation after the load is released. This figure, divided by the weight per foot of cable, indicates the maximum length of cable that is self-supporting and, therefore, readily installable on a tower with a single hoisting grip.

The *crush strength* of a cable is defined as the maximum force per linear inch that may be applied by a flat plate without causing more than a 5% deformation of the cable diameter. Crush strength is a good indicator of the ruggedness of a cable and its capability to withstand rough handling during installation.

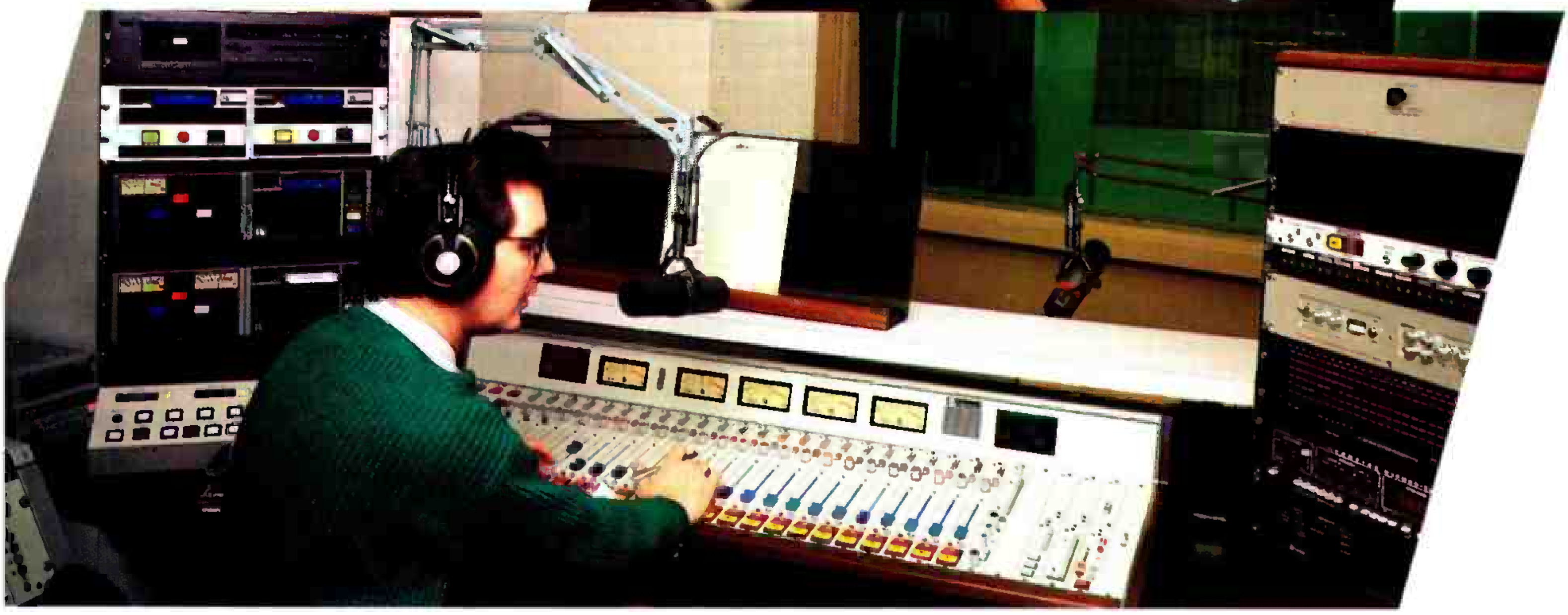
Cable jacketing affords mechanical protection during installation and service. Cables typically are supplied with jackets consisting of low-density polyethylene blended with 3% carbon black for protection from the sun's ultraviolet rays, which, given enough time, can degrade clear plastics. This blend has proved to be an effective protective agent, yielding a life expectancy of more than 20 years.

For indoor applications, where fire-retardant jackets are specified, cables can be supplied with a fire-retardant material, usually listed by Underwriters Laboratories. Note that under the provisions of the National Electrical Code, outside plant cables such as standard black polyethylene-jacketed coaxial cables may be run for as far as 50 feet inside a building with no additional protection. They also may be placed in conduit for longer runs.

Ron Gaier, Chief Engineer, WHIO AM-FM-Dayton, Ohio, Cox Broadcasting.

Newscaster Dawn Matthews on the Auditronics 212 in WHIO-AM news studio.

"Reliability makes Auditronics boards winners with us",



Jim Jones on the Auditronics 224 in WHIO production.

says WHIO AM-FM chief engineer Ron Gaier. "Our job in engineering is to keep the station on the air, so our three Auditronics consoles' record of zero failures makes me very happy."

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Maintaining a broadcast tower

By Carl Bentz, technical and special projects editor

The transmitting tower is the most visible and expensive component of most broadcast transmission systems. A comprehensive maintenance program is essential to the safety of personnel in the vicinity of the tower, as well as to the long-term survival of the structure.

Rules for safety

The FCC addresses tower safety in Volume 1, Part 17 of its rules. The commission specifies the painting and lighting requirements for towers ranging from heights of less than 250 feet to more than 2,000 feet.

By naming paints, colors, lamps and lighting filters, the commission addresses the safety concerns that relate to aircraft. The Occupational Safety and Health Administration (OSHA) focuses on personnel safety matters. OSHA's main concern is for the people who must work on and around the tower structure.

Many cities have statutes that apply to broadcast antennas and towers and the safety of the general public. In some cases, local regulations are far more stringent than any restrictions made by the FCC and OSHA.

It may appear to some that the various tiers of regulations are overkill. Yet, the tower represents a liability for which the broadcaster is solely responsible. The regulatory efforts at each level are intended to aid the radio/TV industry in reducing such liability.

On the tower

Most of the work on existing towers is limited to two projects: replacing lamps and/or colored lighting filters and occasional painting. Make sure a reliable tower service company is contracted to perform these tasks. Replacement lamps should be kept in stock to assure that any failures can be corrected quickly.

Painting is a long-term project. Even though a reputable service company is contracted to do the work, the station engineer should oversee the project. Not only must the paint and its application answer FCC and FAA requirements, but painting may have a direct effect on the longevity of the structure. Galvanized metal usually does not require painting as non-coated metals do. Even so, the zinc coating of galvanizing eventually will wear away.

Seven points are suggested by NAB with regard to contracting the tower painting project:

- Purchase the paint yourself, in accordance with FCC rules.
- Require brushing, scraping and priming of the structure before the final coat of paint is applied.
- Permit painting to be done only when the tower is dry and the relative humidity is low.
- Allow painting to be done only if the tower temperature is at least 50°.
- Apply paint as specified by the manufacturer.
- Inform the painters that the job will be inspected as the work progresses.
- Require evidence that the painting company has insurance coverage for its employees.

Insurance coverage should include worker's liability, contractor's public liability, contractor's protective liability, automobile liability and direct-damage insurance. Ask your insurance representative to investigate the evidence of coverage.

Inspections

Just as preventive maintenance of any station equipment may help avert costly problems, the same is true of tower maintenance. Insurance requirements often specify that complete inspections of the tower be made annually as a requisite for renewal of coverage. In some areas, local statutes also require inspections to be made and the results approved by a professional engineer. During such inspections, search for any signs of wear, stress or corrosion of the tower, attachments and hardware.

Check guy wires, guy attachments on the tower, guy anchors and insulators (if used). Include all ladders, catwalks, ice bridges and other ancillary parts of the tower in the inspection. Pay special attention to concrete foundations, the ball gap on AM towers and weep holes on base insulators (if used).

In addition, check guy tensions, linearity and plumb of the tower. These checks can be made occasionally by station personnel if the proper equipment is available. Your tower structural consultant should be able to assist in developing an inspection plan.

Inspections throughout the year, especially after storms or high winds, can help you pinpoint a potential tower failure and prevent it.

Low-density foam cables are designed to prevent water from traveling along their length, in case it enters because of damage to the connector or the cable sheath. This is accomplished by mechanically locking the outer conductor to the foam dielectric by annular corrugations. Annular or ring corrugations, unlike helical or screw-thread-type corrugations, provide a water block at each corrugation. The closed-cell polyethylene dielectric foam is bonded to the inner conductor, completing the moisture seal.

Electrical considerations

VSWR, attenuation and power rating are key electrical factors to consider when selecting a cable system. High VSWR can cause power loss, voltage breakdown and thermal degradation of the system. High attenuation means less power delivered to the antenna, higher power consumption at the transmitter and increased heating of the transmission line itself.

If a system suffers from inadequate power-handling capabilities, the result can be thermal breakdown and damaged cable. The power rating must be specified carefully to account for temperature extremes during service.

VSWR is a convenient way to check the construction quality of coaxial cable. High VSWR indicates non-uniformities in the cable that can be caused by variations in the dielectric core diameter, variations in the outer conductor, poor concentricity of the inner conductor, or a non-homogeneous or periodic dielectric core. Although each of these may contribute only a small reflection, they can add up to a measurable VSWR at a particular frequency.

Attenuation is related to the construction of the cable and varies with frequency, product dimensions and dielectric constant. Larger-diameter cable has lower attenuation than smaller-diameter cable of similar construction operating at the same frequency. It follows, therefore, that larger-diameter cables should be used for long cable runs.

Air-dielectric cable exhibits less attenuation than comparably sized foam-dielectric cable. The attenuation characteristic of a given cable also is affected by any standing waves present in the cable resulting from an impedance mismatch. Table 1 shows a representative sampling of coaxial cable specifications for a variety of cable sizes.

Installation considerations

A coaxial cable is of no use whatsoever if it can't be connected reliably to other parts of the transmission system. Connector design, therefore, takes into account several key requirements. The connector interface must create a weatherproof bond with the cable to prevent water from penetrating the connection. This is ensured by using O-ring seals. The cable-connector interface also must provide a good electrical bond that does not introduce a mismatch and increase the VSWR. Good electrical contact between connector and cable also assures that proper RF shielding is maintained.

Tower windload

Windloading is always a concern when a tower is designed. Overall cable diameter and the configuration in which it

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is hung affect the tower windload. These factors are especially important when several cable runs are required. If these runs are mounted side by side, they increase the windload. Windload reduction can be achieved by a cluster-mount arrangement in which the cable is mounted in a side-by-side circular configuration.

Proper installation of a cable system requires various accessories. The method used to hang a cable system determines both immediate and long-term performance. Three basic types of hangers are available for use with flexible cable systems.

The wrap-type hanger offers quick and easy installation, but long-term use presents some hazards. Many such hangers are nylon and are limited in mechanical durability. Others are made of malleable metal and installed by twisting wires together. These hangers have a low resistance to cable slippage, and the clamping force is determined by the installer.

Clamp hangers are similar to a conduit-type hanger, but the halves are easier to spread apart. Clamp hangers require hardware for mounting to the tower bracket and for clamping cable. This type of hanger provides dependable support, and should be used wherever possible. The additional time required for installation is not significant.

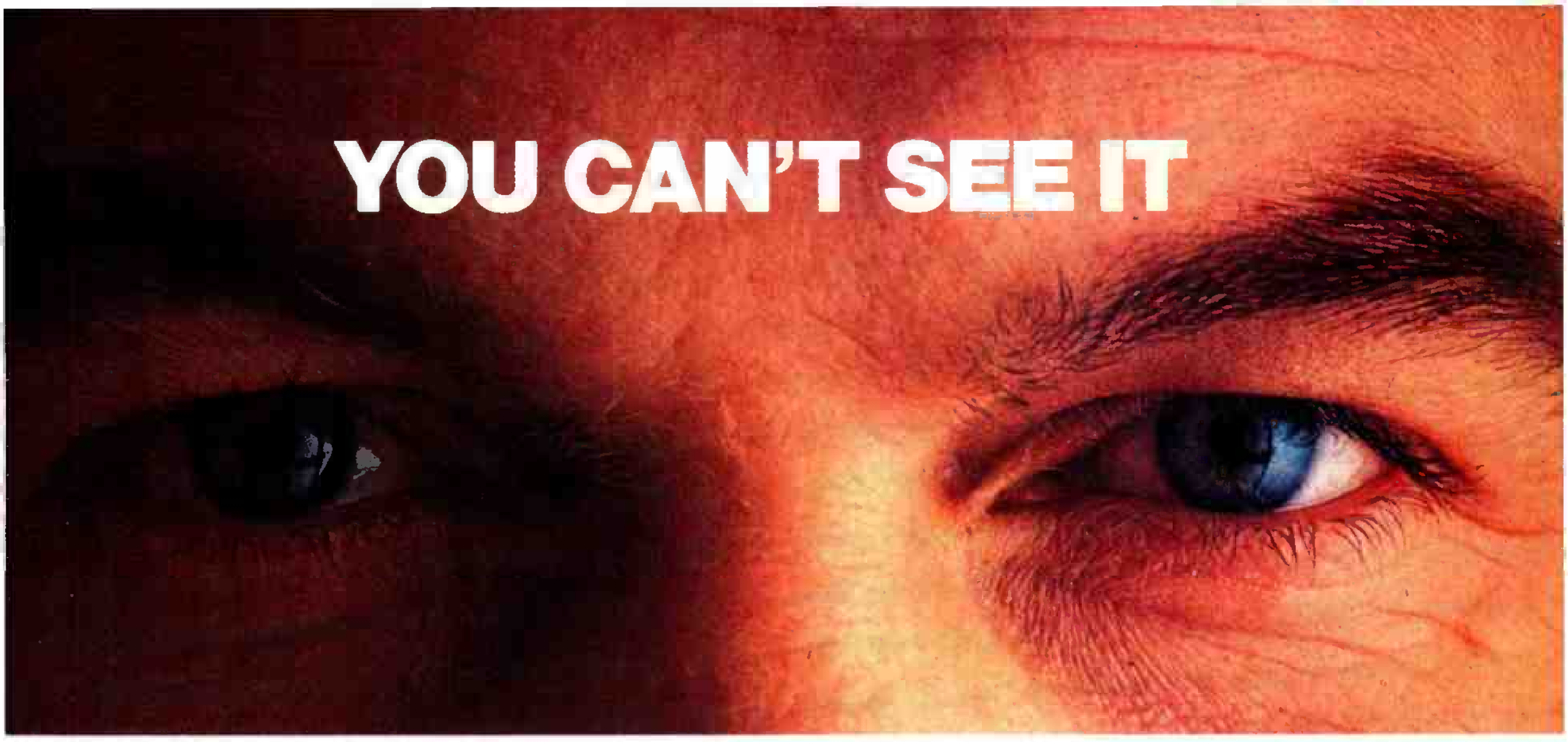
Corrugated cable offers a convenient and effective method of grounding anywhere along the line by stripping the jacketing, attaching a ground strap and covering the connection.

Lightning protection is important to the long-term survival of a system. Corrugated cable offers an easy and effective method of grounding anywhere along the line by stripping the jacketing off. A ground strap then can be attached and the connection covered to protect it from the environment. Braided copper straps from the cable to the tower should be avoided because they accumulate moisture, resulting in corrosion and eventual breakage. Use a solid copper ground strap instead.

Consider all factors

Many items must be considered in the planning and specification of a transmission-line system, including: attenuation, power, VSWR, weight, windloading, cable bend radius, jacketing requirements and environmental factors. Cable accessory items, often overlooked, are critical to the reliability and efficiency of the system.

Choosing the least expensive cable is not always the most economical decision for either the short- or long-term. The total installed cost of the cable system must be considered, and the lowest total *installed cost* does not always mean the lowest-priced cable. For the long-term, it is crucial that the cable installation be able to withstand environmental stresses and still deliver specified performance. The cost of unnecessary downtime or repairs can far outweigh the cost differential of a marginal cable installation.



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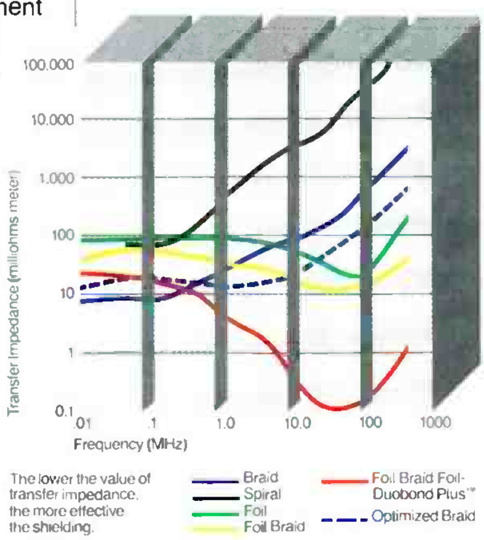

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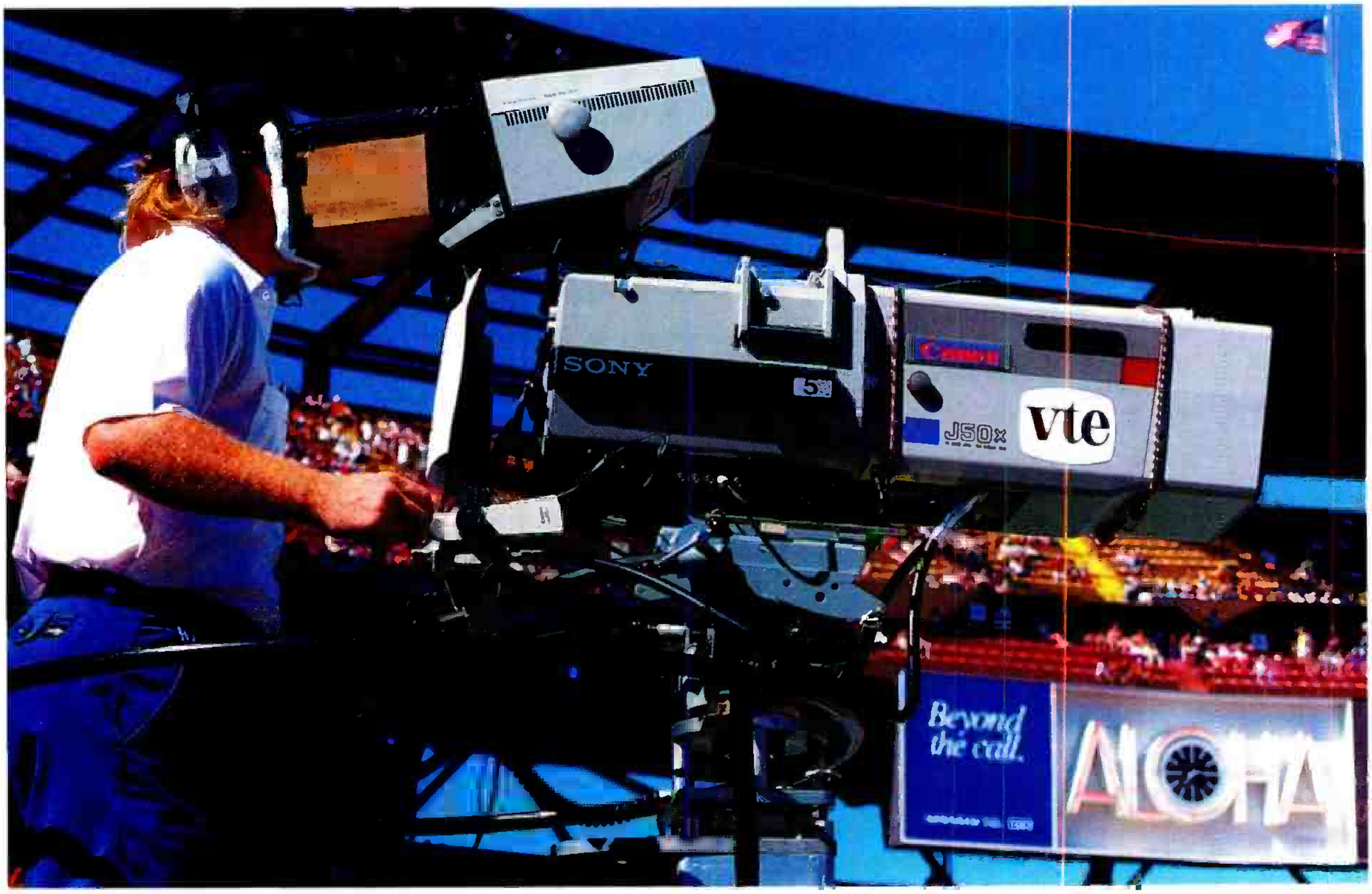
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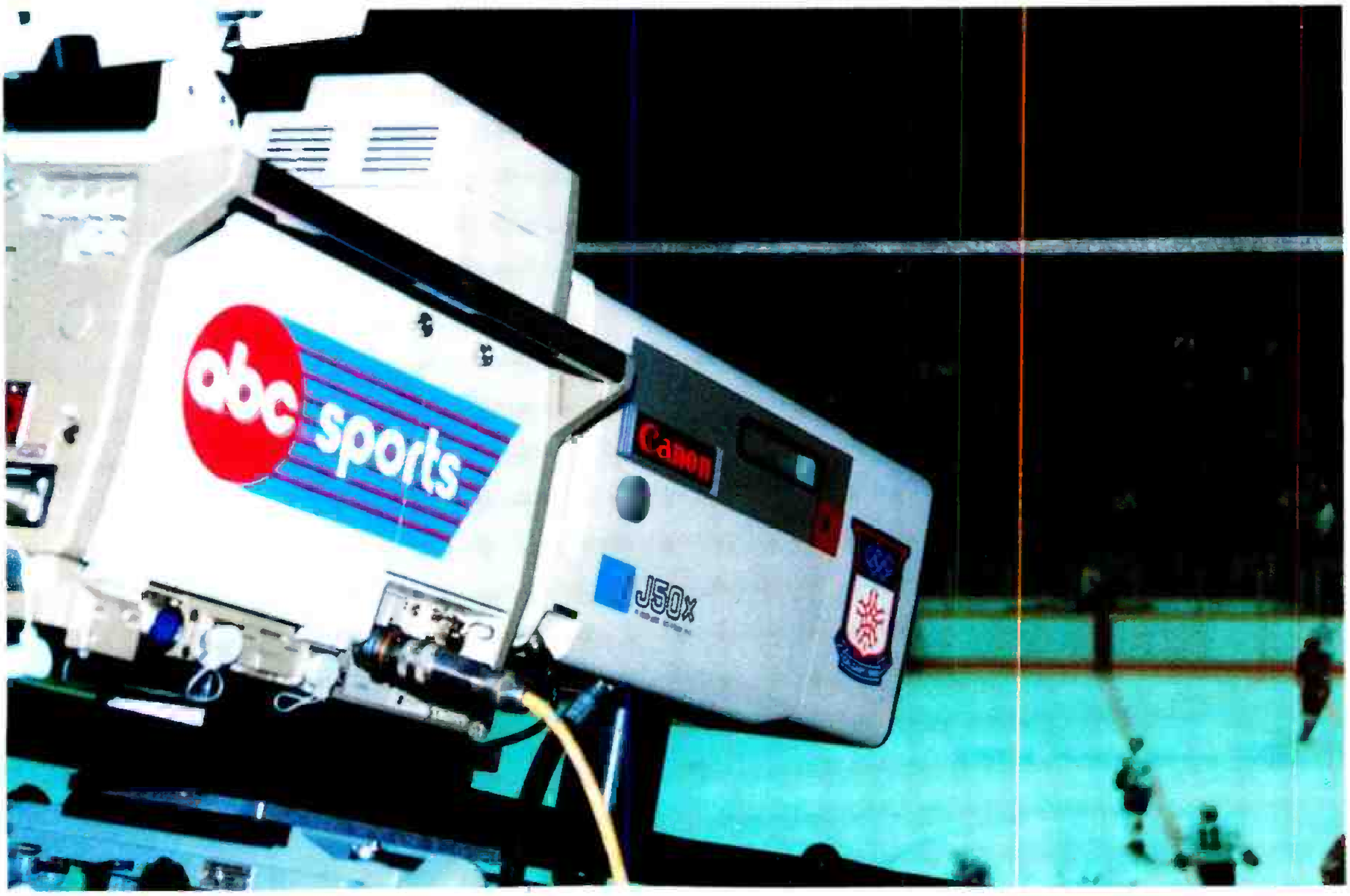
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Combining resources to improve FM coverage has led many stations to use sophisticated multiplexer systems.

Multiplexing FM transmitters

By Bill DeCormier

The "use it or lose it" aspects of FCC Docket 80-90 have been the impetus for many FM stations to shop around for the ways and means to bring their broadcast power up to the licensed limits. Applications for the necessary construction, rights of way, zoning variances and other permits accelerated shortly after the March 1984 edict was issued. Unless existing stations meet certain minimum operating limits, they will be locked in at their current levels. The commission then can issue new licenses for other FM stations willing to operate in the *dead space* created by the reduced coverage areas of existing facilities.

The station owner facing the prospect of raising a 10- or 20-year-old antenna several hundred feet up a too-short tower is in for a shock. If you were to go out shopping for a new car without the benefit of having priced a new automobile in several years, you could sympathize. The term "sticker shock" hardly describes the trauma.

DeCormier is FM broadcast/RF custom engineering manager at Dielectric Communications, Raymond, ME.

Finding a site

There aren't enough judiciously placed skyscrapers to accommodate all the FM stations in need of a high perch for their antennas. And when tall building sites are available, they usually are expensive.

Most often, a station must vie with its competitors for adequate high ground to erect an appropriate tower and transmitter building. Then there is the added difficulty of finding a spot where zoning ordinances or airport restrictions allow tall structures.

Enter the concept of the *community broadcast site*. As many as 10 FM stations can operate efficiently from a single tower by using an FM multiplexer system.

A 3-station partnership brings each station's cost down to a little less than it would cost one station alone without a multiplexer. Six stations using the same tower and multiplexer can reduce the start-up costs of a $1 million tower to $166,000 each. Each station's share of a $360,000, 6-station FM multiplexer would be $60,000—a small initial price to pay for the more than $800,000 saved on the shared tower.

If you're in a market with 20 FM stations, and three or more of your biggest competitors decide to go into partnership to achieve licensed capacity with the aid of a multiplexer system, you may not be invited to participate.

Who will advertisers prefer, all else being equal? The 75kW station or the 100kW station? You'd better do something. And quickly!

Multistation FM combiners have gained considerable interest since the FCC's 80-90 decision. Systems can be large or small, but the idea is always the same: Feed two or more transmitters into a single wideband antenna.

Design considerations

Designing a multiplexer system to fit the needs of your station and those of your partners' stations requires the specification of some basic parameters. Ask yourself these questions:

- What power level will be going through the multiplexer?
- How many stations will be involved?
- Do you want excess capacity for adding more stations later?
- What kind of performance characteristics do you require?
- How much floor space is available for a multiplexer? (A 6-station system requires floor space of about 20×55, or 1,100 square feet.)
- How many outputs do you want?
- Is your antenna going to be a single-feed or dual-feed configuration?
- What type of monitoring system do you prefer, and what should be done with the data that the system provides?
- Do you want the capability of bypassing the output splitting device so that you can feed all the stations into either half of the antenna?

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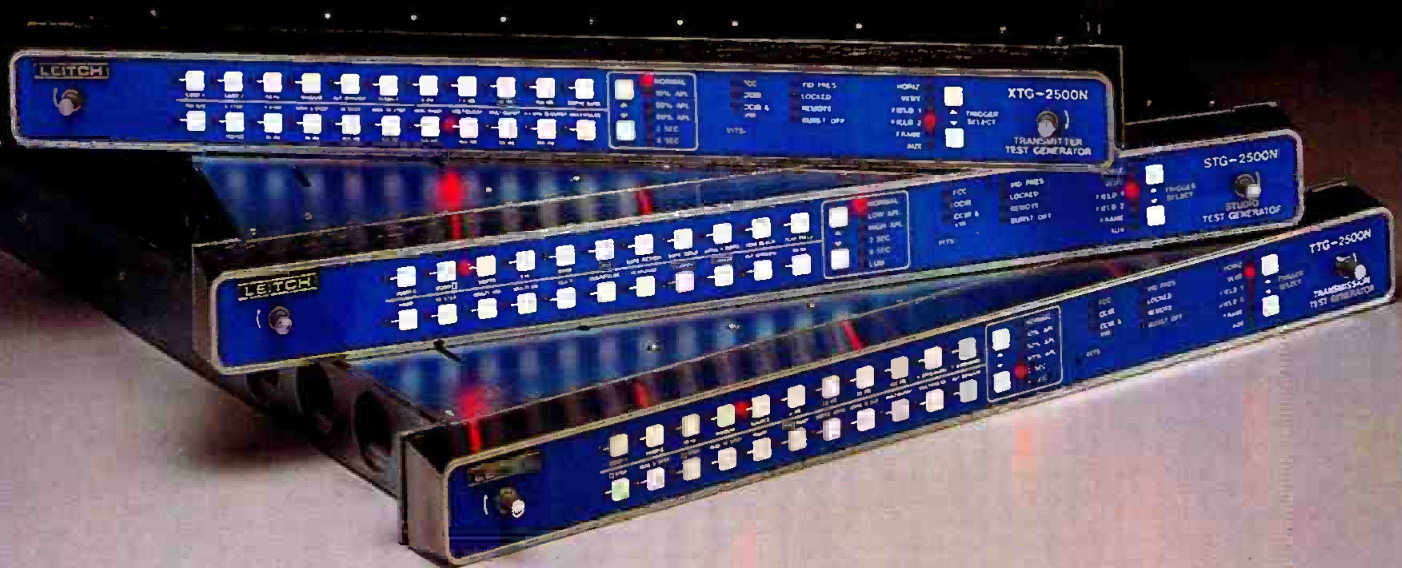

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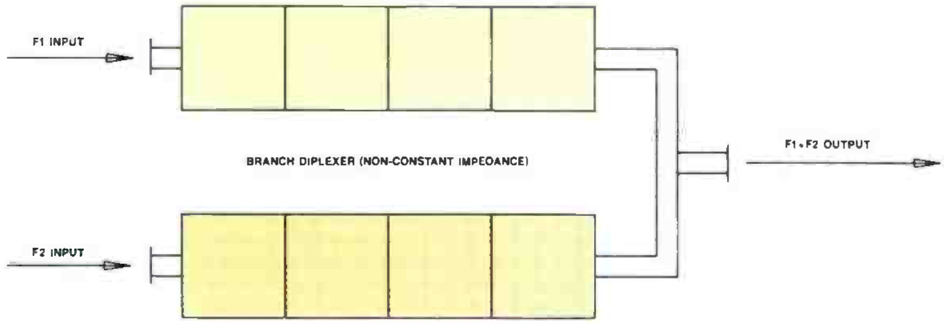


Figure 1. A non-constant-impedance branch diplexer. In this configuration, two banks of filters feed into a coaxial tee. With this design, the electrical parameters are basically a function of the filter characteristics.

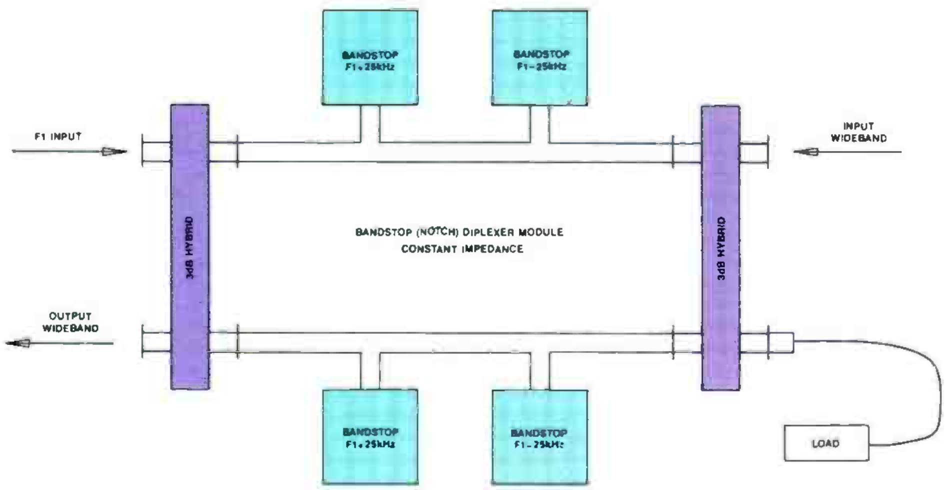
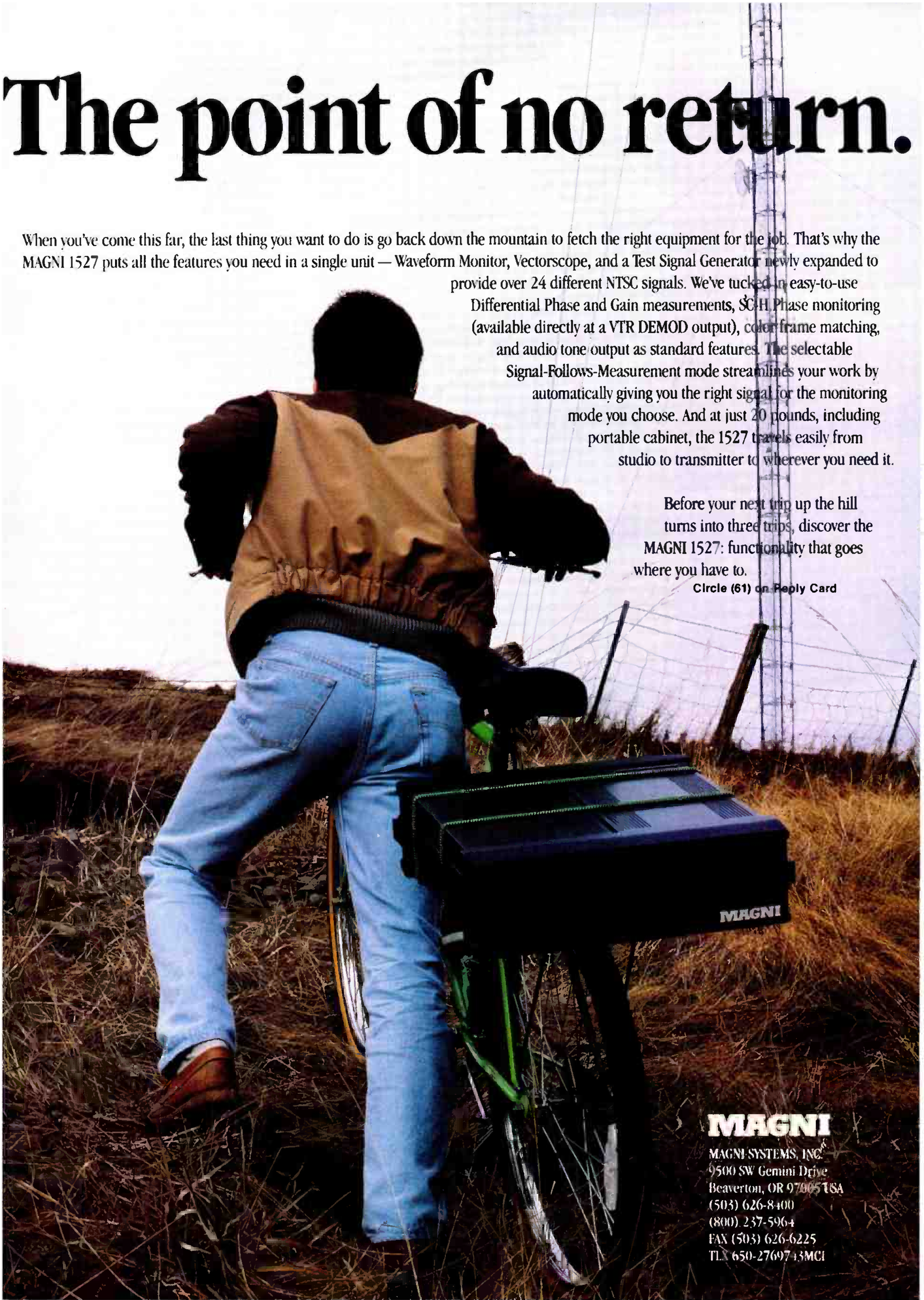


Figure 2. A bandstop (notch) constant-impedance diplexer module. This design incorporates two 3dB hybrids and filters, with a terminating load on the isolated port.

• Do you want the capability of a spare wideband input? In other words, if one of the modules were to fail, would you want the capability of feeding into the spare input to keep everyone on the air?

Meeting the last objective will require installation of a patch panel. You will need to be able to reroute the input power, not only at the input to the module, but also around its output. Because the failed module is symmetrical in many respects, it will pass power in the forward *and* reverse directions. The module must be taken out of the link in order to bypass it.

To accomplish all of this means you will have a large patch panel on the output side. Panels for this type of installation are made of 6- or 9-inch coax and can han-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Large multiplexer systems require a great deal of floor space. Depending on the number of stations to be combined, the multiplexer may be configured to fit the physical space available. Note the use of casters on the individual modules of this combiner to make installation easier.

dle an enormous amount of power. Patch panels are the most elegant way to bypass a module, but they are also the most expensive way. A less expensive approach involves the use of an extra-long *U-link* to bridge between the appropriate ports.

The type of monitoring system chosen for the facility is another important part of the planning process. By monitoring forward and reflected power at the input of each module, you can identify module failure. By monitoring forward and reflected power at the output of the combined system, you can identify antenna failure. A 6-station system has 27 connections that could be left loose following maintenance. A schematic with LEDs is helpful to pinpoint a loose connection.

If you are going to spend a bundle on upgrading your FM transmission plant to its licensed capacity, you'll want more than a casual understanding of the intricacies of the hardware involved. You'll also want to know about the various fail-safe devices or redundancies that can be included in your system to assure that you and your multiplexer partners are never off the air for more than the few minutes it takes to bypass a failed module.

Non-constant-impedance diplexers

The *branch diplexer* is the typical configuration for a diplexer that does not exhibit constant-impedance inputs. As shown in Figure 1, the branch diplexer consists of two banks of filters, each feeding into a coaxial tee. The electrical

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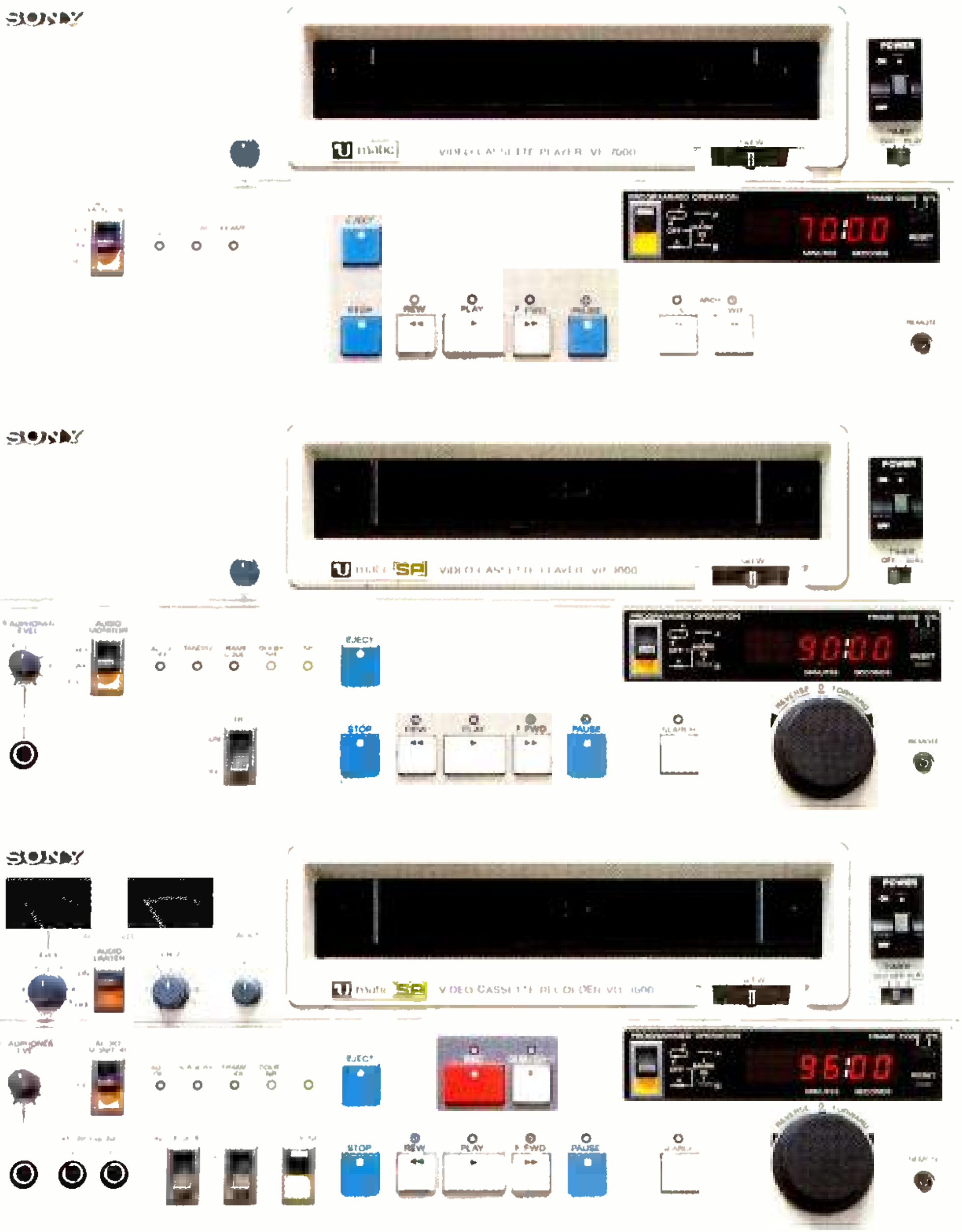

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length between each filter output and the center line of the tee is frequency-sensitive, but this fact is more of a tuning nuisance than a genuine user concern.

For this type of diplexer, all the electrical parameters are a function of the filter characteristics. The VSWR, insertion loss group delay and rejection/isolation will be the same for the system as they are for the individual banks of cavities. The major drawback of this type of combiner is the limit of isolation that can be obtained for closely spaced channels.

As the frequency spacing approaches 800kHz, the number of filter cavities necessary to obtain 50dB isolation can exceed five, if the required passband bandwidth is to be retained. In addition, all the power for each station passes through a single bank of cavities. The cavities must be rated for twice as much power as similar cavities in a *constant-impedance* configuration.

Performance specifications

The typical performance of a non-constant-impedance diplexer where two FM channels are spaced 2MHz apart is as follows:

- VSWR <1.05:1 at F0 ±200kHz
- Insertion loss <0.25dB at F0, <0.30dB at F0 ±200kHz
- Group delay <±25ns at F0 ±150kHz
- Isolation >50dB for frequencies >±2MHz from carrier

Constant-impedance diplexers

Constant-impedance diplexers employ 3dB hybrids and filters with a terminating load on the isolated port. (See Figures 2 and 3.) The filters in this type of combiner can be either notch-type or bandpass-type. The performance characteristics will be noticeably different for each design.

Bandstop diplexer modules

Bandstop (notch) constant-impedance diplexer modules are configured as shown in Figure 2. For this design, the notch filters must have a high Q response to keep insertion loss low in the passband skirts. The high Q characteristic results in a sharp notch, typically providing 35dB to 40dB of notch depth at carrier and falling to 14dB at ±50kHz and 8dB at ±100kHz.

Because this bandwidth is inadequate for FM broadcasting, at least two cavities are located in each leg of the diplexer. They are adjusted so that one is tuned high and the other is tuned low. With one cavity tuned 25kHz high and the other tuned 25kHz low, a reject response of 50dB is achieved at carrier, 65dB at ±25kHz and 20dB at ±133kHz. With this dual-cavity reject response in each leg of the bandstop diplexer system, the following analysis explains the key performance specifications:

Narrowband input

If frequency F1 is fed into the top left port of Figure 2, it will be split equally into the upper and lower legs of the diplexer. Each of these signals will reach the filters in their respective legs, be rejected/reflected back toward the input hybrid, recombine and emerge through the lower left port, also known as the *wideband output*.

The VSWR looking into the F1 input is approximately 1.05:1 at all frequencies in the band. Within the bandwidth of the reject skirts, the observed VSWR is equal to the termination of the wideband output. Outside of ±250kHz the signals will pass by the cavities, enter the rightmost hybrid, recombine and emerge into the dummy load. Consequently, the out-of-band VSWR is, in fact, the VSWR of the load.

The insertion loss from the F1 input to the wideband output is on the order of 0.1dB at carrier ±125kHz. This insertion loss depends on perfect reflection from the cavities. As the rejection diminishes on the skirts at ±150kHz, the insertion loss from F1 to the wideband output rises.

The limitation in reject bandwidth of the cavities causes the insertion loss to rise at the edges. The isolation from F1 to the wideband input is respectable. It consists of a combination of the reject value of the cavities plus the isolation of the rightmost hybrid.

A signal entering at F1 splits and proceeds in equal halves to the right through both the upper and lower legs of the diplexer. It is rejected by the filters to the tune of 50dB at carrier and 20dB at ±130kHz. Any residual signal that gets by the cavities reaches the rightmost hybrid. There it recombines and emerges from the *load port*. The hybrid exhibits 35dB isolation from the load port to the wideband input port. This hybrid isolation must be added to the filter rejection to obtain the total isolation from the F1 input to the wideband input.

Wideband input

If any frequency in the FM band is fed into the wideband input, the signal will split equally and proceed to the left along the upper and lower legs of the diplexer. Normally, F1 is not fed into the wideband input. If it were, F1 would be rejected by the notch filters and would recombine into the load. All other signals sufficiently removed from F1 will pass by the cavities with minimal insertion loss and recombine into the wideband output.

The VSWR looking in the wideband input is equal to the VSWR at the output for frequencies other than F1. If F1 were fed into the wideband input, the VSWR would be equal to that of the load.

Isolation from the wideband input to the F1 input is simply the isolation available in the leftmost 3dB hybrid, which is nominally 35dB. This usually is inadequate for

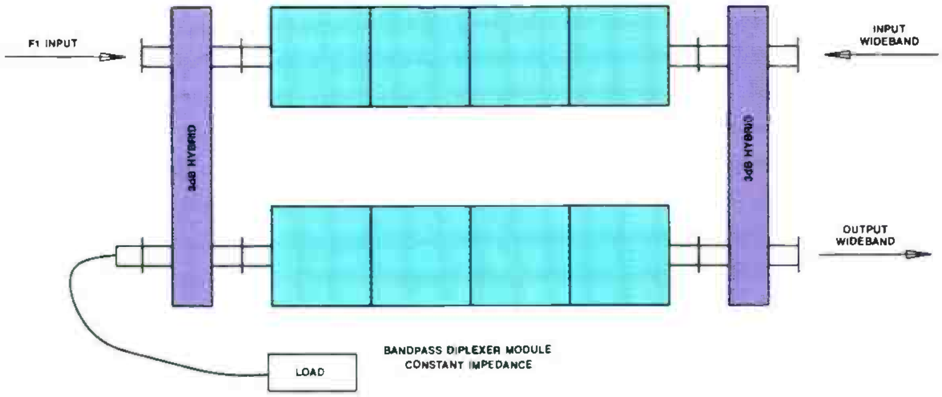


Figure 3. A bandpass constant-impedance diplexer module. This design takes the best features of diplexers and combines them in one module.

high-power applications. To increase the isolation from the wideband input to the F1 input, it is necessary to use additional cavities between the F1 transmitter and the F1 input that will reject all frequencies fed into the wideband input by at least 20dB.

The 20dB isolation of these cavities and the 35dB of the hybrid result in a total isolation of 55dB. This usually is adequate (with typical transmitter turnaround loss) to eliminate intermodulation products above the FCC 80dB limit.

Unfortunately, adding these cavities to the input line also cancels the constant-impedance input. Although the notch diplexer, as shown in Figure 2, is truly a constant-impedance type of diplexer, the constant impedance is presented to the two inputs by use of the hybrids at the respective inputs.

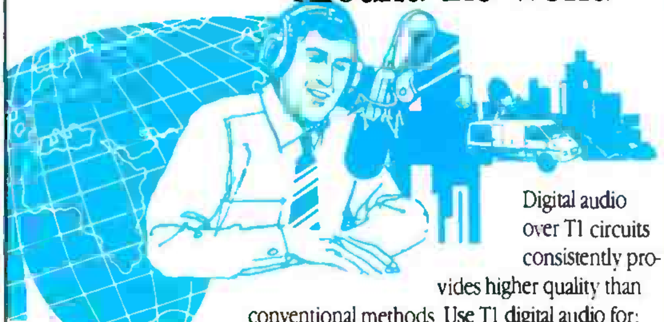
The hybrids essentially cause the diplexer to act as an absorptive type of filter to all out-of-band signals. The out-of-band signals generated by the transmitter are absorbed by the load rather than reflected to the transmitter.

If a filter is added to the input to supplement isolation, the filter will reflect some out-of-band signals back at the transmitter. The transmitter then will be seeing the passband impedance of this supplemental filter rather than the constant impedance of the notch diplexer. This is a serious deficiency for broadcasters who want a true constant-impedance input.

Bandpass constant-impedance diplexer

The bandpass constant-impedance diplexer module is shown in Figure 3. This system takes all the best features of diplexers and combines them into one module. It also provides a constant-impedance input that does not need to be supplemented with input cavities, which rob the constant-impedance diplexer of its constant-impedance input.

The bandpass filters exhibit exceptional bandwidth, providing 1.05:1 VSWR across ±200kHz, insertion loss of 0.28dB at carrier, and rise to 0.30dB at ±200kHz. Rejection is 25dB at ±800kHz. This, when supplemented by isolation of the hybrids, will provide ample transmitter-to-trans-



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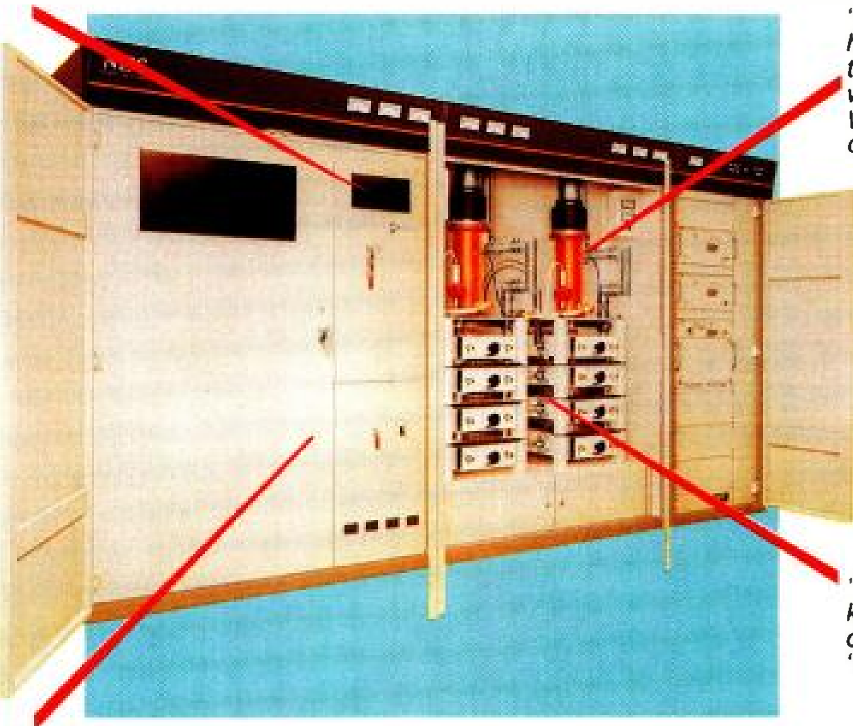

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mitter isolation. Group delay is exceptional at ±25ns for ±150kHz. In fact, this system provides performance specifications similar to a branch-style bandpass system. It has the additional capability of providing port-to-port isolation of greater than 50dB between channels separated by only 800kHz, as well as a true constant-impedance input.

Narrowband input performance

The hybrids shown in Figure 3 work identically to those described in Figure 2. However, the bandpass filters cause the system to exhibit performance specifications that exceed the bandstop system in every way. Consider a signal entering at the F1 input in Figure 3.

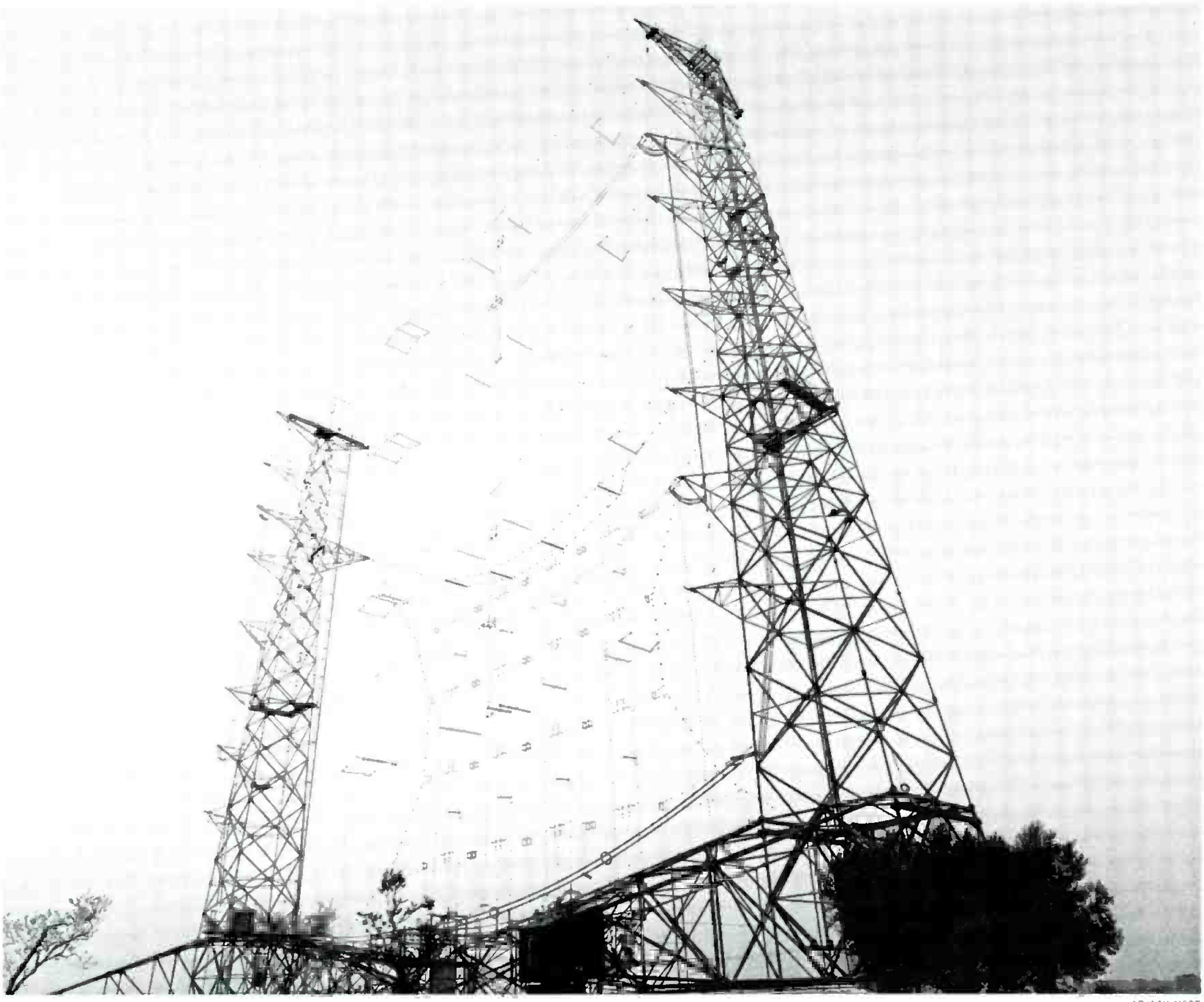
Within the passbands of the filters, which also are tuned to F1, the VSWR will be 1.05:1 at carrier, and <1.10:1 at F1 ±150kHz. Because of the characteristic of the leftmost hybrid, the VSWR is, in fact, a measure of the similarity of response of the top and bottom bands of filters. The insertion loss looking from the F1 input to the wideband output will be similar to the individual insertion loss of the top and bottom filters. It is approximately 0.28dB at carrier and 0.30dB at ±200kHz. This is virtually flat across the FM channel.

Both the insertion loss and the group delay can be determined by the design bandwidth of the filters. Increasing bandwidth causes the insertion loss to decrease and the group delay deviation to decrease. Unfortunately, as the bandwidth increases with a given number of cavities, the isolation suffers for closely spaced channels because the reject skirt of the filter decreases with increasing bandwidth.

Isolation of F1 to the wideband input is determined as follows: A signal enters at the F1 input, splits equally into the upper and lower banks of filters, passes with minimal loss through the filters and recombines into the wideband output of the rightmost hybrid. Both the load and the wideband input ports are isolated by their respective hybrids to 30dB below the F1 input level. Therefore, isolation of the F1 input to the wideband input is 30dB, which is inadequate. Fortunately, it will be supplemented by the reject skirt of the next module, which will be explained at another point in this article.

Wideband input performance

A signal fed into the wideband input could be any frequency at least 800kHz removed from F1. As the signal enters, it will be split into halves by the hybrid, then proceed to the left until the two components reach the reject skirts of the filters. The filters will provide a short circuit at all frequencies 800kHz or more removed from F1. If the short circuits are in phase for the given frequency when the signal is reflected back to the right hybrid, it will



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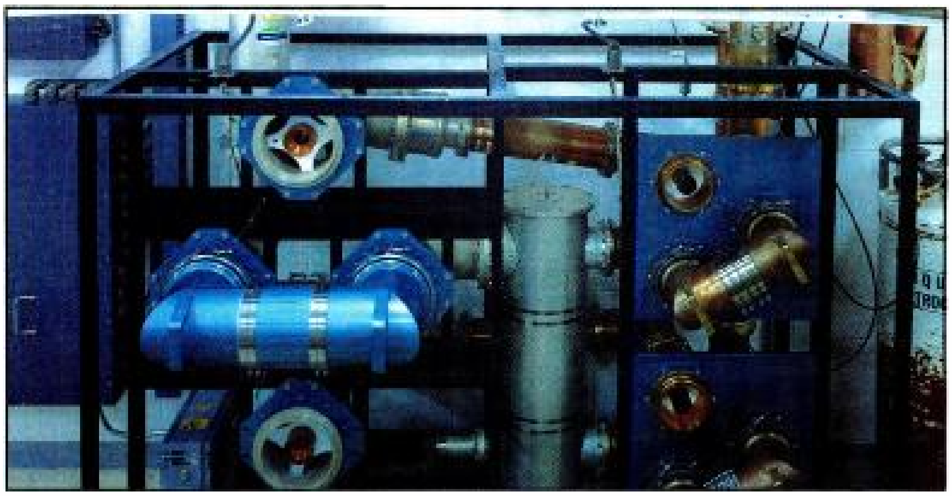

Patch-panel capabilities are important in any multiplexer design. The ability to patch around a problem is critical in reducing downtime due to component failure.

recombine into the wideband output. The VSWR under these conditions will be equal to the termination at the wideband output, typically <1.10:1. If the reject skirts of the filter are sufficient (>20dB), the insertion loss from wideband input to wideband output will be 0.03dB.

The isolation from the wideband input to F1 can be determined as follows: A signal enters at the wideband input, splits equally into upper and lower filters and is rejected by the filters by at least 25dB. Any residual signal that passes through the filters in spite of the 25dB rejection still will be in the proper phase to recombine into the load, producing 30dB isolation to the F1 input port. Therefore, the isolation of the wideband input to the F1 input is the sum of 25dB from the filters and 30dB from the left hybrid, for a total of 55dB.

Isolation of F1 to F2

Extending the use of the diplexer module into a multiplexer application supplements the deficient isolation described previously (narrowband input performance), while maintaining the constant-impedance input. In a multiplexer system you would simply connect the wideband input of one module to the wideband output of the next module. (See Figure 4.)

You have already observed the isolation from the F1 input to the wideband input to be deficient, but now observe the isolation of the wideband output to the F2 input of the next module to get the rest of the available isolation. Consider that F1 has already experienced 30dB isolation to the wideband input of the same module. When this signal continues to the next module through the wideband output of module 2, it will be split into equal halves and proceed to the left of module 2 (see Figure 3) until it reaches the reject skirts of the filters in module 2.

These filters are tuned to F2 and reject F1 by at least 25dB. The residual signal that gets through will recombine into the F2 input. But the combined total isolation of F1 to F2 is the sum of the 30dB of the right hybrid in module 1, plus the 25dB of the reject skirts of module 2, for a total of 55dB.

Intermodulation products

The isolation just described is equal in magnitude to that for a bandstop module, but it provides further protection against the production of intermodulation products. The most troublesome intermod products occur when an incoming signal mixes with the second harmonic of your

Main story continues on page 102

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VSWR BANDWIDTH	±200kHz	±130kHz w/dual cavities	±200kHz
VSWR	1.05:1	1.05:1	1.05:1
INSERTION LOSS BW	±200kHz	±130kHz w/dual cavities	±200kHz
INSERTION LOSS	−0.25dB	−0.15dB/NB input −0.03dB/WB input	−0.25dB/NB input −0.03dB/WB input
ISOLATION	>50dB	>50dB	>50dB
NEAREST ADJACENT FREQUENCY	1.8MHz	0.8MHz	0.8MHz
NEEDS SUPPLEMENTAL CAVITIES?	No	Yes	No
EFFECTIVE CONSTANT IMPEDANCE INPUT?	No	No	Yes
GROUP DELAY BW	±150kHz	±150kHz	±150kHz
GROUP DELAY DEVIATION	±25ns	±100ns	±25ns
GROUP DELAY SYMMETRY?	Yes	No	Yes
GROUP DELAY CORRECTABLE?	Yes	No	Yes
SYMMETRICAL INTERMOD PROTECTION?	Yes	No	Yes

Table 1. Performance characteristics of three multiplexer configurations, each using 4-cavity designs.

Main story continued from page 98
transmitter.

When the transmitter is operating on frequency A, the intermod will occur at the frequency 2A – B. This formula invariably places the intermod from your transmitter symmetrically about the operating frequency. By an interesting coincidence, the bandpass filters in the bandpass module also provide symmetrical reject response on both sides of your operating frequency.

Notice that the incoming signal is attenuated by 30dB in the respective hybrid and by 25dB in the filter, for a total of 55dB. If an intermod is generated in spite of this, it will emerge on the other skirt of your filter attenuated by 25dB. In the bandpass system, the incoming signal is attenuated by 55dB and the resulting outgoing spur by 25dB. The total 80dB is equal to the 80dB intermod requirement specified by the FCC.

It's interesting that the entire 80dB of attenuation is supplied by the diplexer regardless of the so-called turnaround loss of the transmitter. The tendency toward wideband final-stage amplifiers in transmitters requires constant-impedance inputs. The transmitters require increased isolation because they offer turnaround loss within 1.2MHz of carrier.

Accurate and complete monitoring is essential to a reliable multiplexer system. The arrangement shown features continuous monitoring of forward and reflected power for each of the six stations using the multiplexer. A computer processes electrical and environmental data to manage site operations.

Group delay

Group delay in the bandpass multiplexer module is the sum of the narrowband input group delay and the wideband input group delay of all modules between the input and the antenna. The narrowband input group delay is a U-shaped response, with minimum at center and rising to a maximum on both sides at the frequency where the reject rises to 3dB. Group delay decreases rapidly at first, then decreases slowly.

If the bandwidth of the passband is made such that the group delay is ±25ns, ±150kHz, then the 3dB points will be at ±400kHz, and the out-of-band group delay will fall rapidly at ±800kHz and, possibly, ±1MHz. If there are no frequencies 800kHz or 1MHz removed upstream in other modules, this poses no problem.

If upstream modules are tuned to 800kHz or 1MHz on either side, the group delay (when viewed at the upstream module) will consist of its own narrowband input group delay plus the rapidly falling group delay of the wideband input of the closely spaced downstream module. Under these circumstances, if good group delay is desired, it is possible to use a *group*

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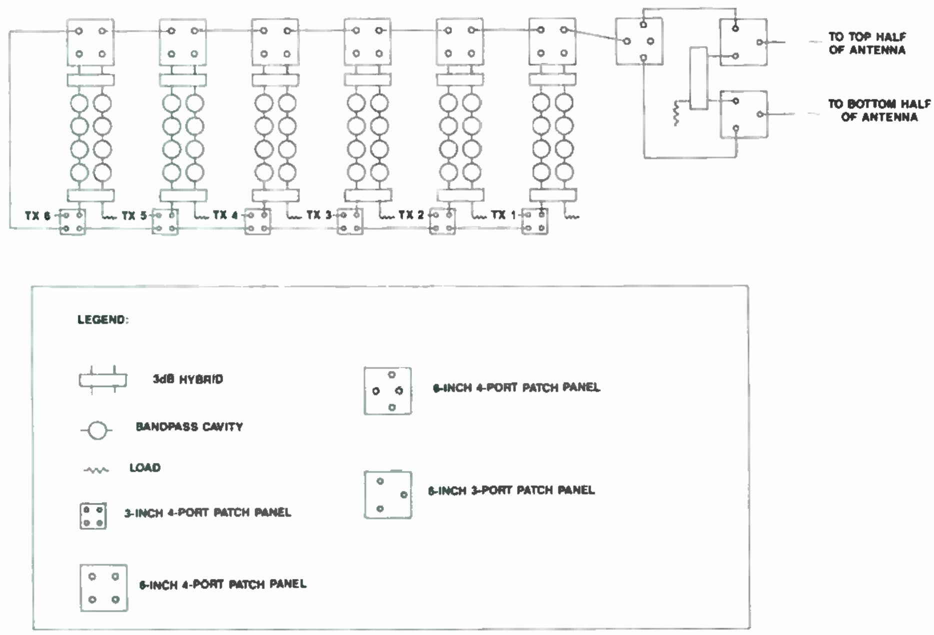


Figure 4. *Schematic diagram of a 6-module bandpass multiplexer. This configuration accommodates a split antenna design and incorporates patch panels for bypass purposes.*

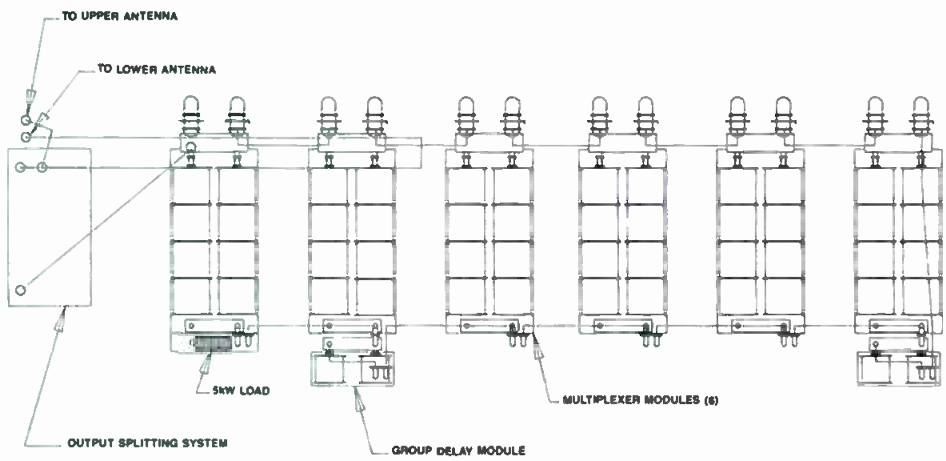


Figure 5. *Physical layout of a 6-module bandpass multiplexer incorporating a group delay module and output splitter. (The top view of the multiplexer is shown in this drawing.)*

delay compensation module.

A group delay compensation module consists of a hybrid and two cavities used as notch cavities. It provides VSWR equal to 1.05:1, insertion loss equal to 0.25dB and a group delay response that is inverted, compared with a narrowband input group delay. Because group delay is additive, the inverted response subtracts from the standard response, effectively canceling and reducing the effective group delay deviation to within ±25ns for ±150kHz.

It should be noted that the improvement in group delay is obtained at a cost of 0.25dB of insertion loss. In large systems, the insertion loss can be high on the 10th module because of the cumulative total of all wideband losses. Under those conditions, it may be more prudent to accept higher group delay and retain minimum insertion loss.

The bandpass constant-impedance diplexer is the only one described in this article that effectively provides a constant-impedance input with all other parameters set at acceptable levels. It acts as an absorptive filter to out-of-band emissions, including intermod products. Table 1 lists the key electrical performance specifications for the branch, bandstop and bandpass diplexer modules.

Configuration options

An economical multiplexer system can be built to meet all of the critical electrical performance specifications and retain emergency flexibility. Consider the following check list for a basic system:

• Specify one standard multiplexer module without input or output patch panels for each station.
• Use standard interconnect U-links between wideband inputs and adjacent outputs.
• Use an extra-long U-link for emergen-

• BASIC ELECTRICAL SYSTEM REQUIREMENTS:

1. Power level to be used.
2. Number of stations to be combined.
3. Excess system capacity desired.
4. Required performance characteristics.
5. Group delay compensation module options.

• INPUT/OUTPUT CONFIGURATION:

1. Number of input ports.
2. Provisions for a spare wideband input.
3. Number of outputs.
4. Single- or dual-feed antenna.
5. Output-splitting arrangement.
6. Patch panel or U-link to be used.
7. Variable orientation of output hybrid to accommodate patch panel or U-links.
8. Bolt-in *iris plates* for easy return or redesign.

• PHYSICAL SYSTEM DESIGN:

1. Space available for multiplexer.
2. Type of space available (ground-level or high-rise).
3. Degree of modular construction desired.
4. Casters to facilitate loading and unloading at installation.
5. Unitized frame support with adjustable-height casters.

• MONITORING SYSTEM PROVISIONS:

1. Type of interlock configuration.
2. Data-acquisition requirements.
3. Type of wattmeters to be used.
4. Data processing to be performed.
5. Control functions delegated to the monitoring system.
6. Amount of data to be relayed to studio.
7. Telemetry return method.
8. Provisions for manual override of monitoring system.
9. Data-display options for transmitter and studio.

Table 2. *Key design considerations for an FM multiplexer project. Because of the importance of careful design, consider hiring an outside consultant to review all plans and proposals.*

cy bypass at the high-power side of the modules.

- Use a 3-inch flexible transmission line long enough to reach from the wideband input of the last module to any transmitter. (When not used, the transmitter end of the coax should be connected to a termination load.)
- Run all output interlocks in series to all transmitters.
- Use input power monitors with integral trips.
- Use thermistor-type power meters for output monitoring.
- Use a good-quality remote control to provide trips on all forward and reflected power meters installed on output lines.
- Use an output splitting system if the antenna requires a dual feed.

This system will provide maximum flexibility for a minimum price while meeting basic protection requirements.

Premium multiplexer

A premium multiplexer system may be designed by specifying virtually all available options. The system would be configured from standard modular components. When planning such a system, consider the following suggestions:

- Use standard modular diplexer modules with input patch panels to enable normal use as well as emergency bypass to the spare wideband input.
- Specify large output patch panels for each module. When a module is bypassed, it must be bypassed at both input and output. U-links are needed to connect adjacent patch panels to both ends of the diplexer modules. An additional termination is necessary to terminate the spare wideband input. It will physically be located at the first module and connected through all the 3-inch patch panels.
- Specify a premium interlock system with a display panel for troubleshooting interlocks.
- Specify an output splitting system that permits operation of all transmitters into a dual transmission line or all transmitters into either line.
- Specify a premium monitor and control system that includes a sophisticated power metering and control capability. Include the necessary line sections and directional couplers.
- Consider the purchase of a monitor interface system that includes a personal computer to chart each meter and display forward and reflected power and VSWR. Configure the system to communicate through a modem to a second PC located at a studio. Set the software limits so that a warning will be generated when VSWR increases to 1.30:1 or higher. Set 1.50:1 as the VSWR trip point. The computer should reset trips two times, but require manual reset on the third trip. Configure each PC to drive a printer to provide a written history of system performance for troubleshooting and maintenance records.

Customized multiplexer systems

The examples given here provide the two extremes of the economy model vs. the top-of-the-line model. Actual systems designed with efficiency and an eye toward a reasonable return on investment will more likely find a middle ground, while still providing exceptional electrical performance. Consider the guidelines listed in Table 2.

Finally, if you are concerned that your multiplexer system will become obsolete five, 10 or 20 years down the road because analog transmitters have been replaced by digital transmitters, there is good news. The multiplexer systems and components described have been designed to withstand the rigors of 20-plus years of use, and provide bandwidth capabilities that will support wider modulation schemes than are presently used.

special report

Reducing IPM improves the quality of monaural and stereo AM signals.

Reducing IPM in AM transmitters

By Dominic Bordonaro

Before the advent of AM stereo, few AM broadcast engineers understood the term *incidental phase modulation* (IPM), let alone concerned themselves with its effect on their AM transmitters. But as more facilities convert to AM stereo, it is becoming evident that a lot more than amplitude modulation has been coming out of our antennas over the years.

IPM is important

IPM can be defined as *phase modulation* produced by an AM transmitter as a result of its *amplitude modulation*. In other words, as an AM transmitter develops the amplitude-modulated dated signal, it also is broadcasting a phase-modulated, or PM, version of the audio as well. Because the only difference between phase modulation and frequency modulation is 6dB per octave, you can think of IPM as a pre-emphasized FM version of your programming being broadcast along with the AM signal.

In theory, this is of little consequence because neither FM or PM affects the carrier amplitude. An envelope detector will ignore all of this IPM, right? That's correct, in theory. But because you're dealing in the real world, take a look at the effect of IPM on all those real world radios out there.

Bordonaro is chief engineer for WAAF-AM and WFTQ-FM, Worcester, MA.

Before you begin to ponder how all this affects stereo broadcasting, consider what IPM means to the mono broadcaster. An ideal envelope detector will ignore any IPM and reproduce only the AM components of the signal. That's exactly what happens with your modulation monitor. Modulation monitors are wideband, untuned devices that behave much like an ideal envelope detector.

Phase modulation goes undetected by a conventional modulation monitor. Historically, this is one of the reasons engineers seldom thought about IPM. They didn't know a problem existed. Unfortunately, there's usually only one modulation monitor listening to your station, but there are thousands of lesser-quality receivers out there, all more or less subject to the effects of IPM.

Inefficient use of spectrum

Let's first consider how excessive IPM affects the available spectrum. When a perfect AM transmitter is modulated with a 1kHz tone, two sidebands are created, one 1kHz above the carrier and one 1kHz below the carrier. On the other hand, phase modulation of the same carrier produces an infinite number of sidebands at 1kHz intervals above and below the carrier. The number of significant sidebands depends on the magnitude of the modulation.

With moderate amounts of IPM, the radio station's transmitted spectrum can be increased to the point at which the legal channel limits are exceeded. This is especially likely to occur with program material that is excessively pre-emphasized. Besides being a bad neighbor, this phenomenon can create problems for your own listeners as they try to receive your station on manually tuned radios. Any mistakes in tuning produce a hashy, spitting sound that makes listening to your station unpleasant. Because few people take the time to tune their radios exactly, your listeners won't like what they hear.

Slope detection

Slope detection is a method of recovering audio from an FM or PM signal by using one side (or slope) of a resonant circuit. As the frequency or phase of the signal changes, the detector's output voltage changes proportionately, resulting in demodulation. This same principle is in effect with a mistuned receiver tuned to a station with IPM. The IF passband's slope will demodulate the IPM, which adds with the AM envelope and produces distortion. Although this is most pronounced on a receiver that has been mistuned by the user, the effect can be produced on any radio with an asymmetrical IF passband.

For IPM to remain undetected by an envelope detector, all of the sidebands must be present at the detector. If the signal passes through a narrow passband IF on its way to the detector, as it does in every radio, then many of the sidebands

1. **Modulate transmitter with 1kHz tone at 95% modulation or 1% distortion, whichever comes first.**
2. **Adjust PA neutralization for lowest 2kHz and 3kHz sidebands on spectrum analyzer display.**
3. **Adjust PA grid tuning for lowest 2kHz and 3kHz sidebands on spectrum analyzer display.**
4. **With display expanded to 2dB/division, fine-tune the neutralization and grid tuning for symmetrical 2kHz and 3kHz sidebands around carrier.**

Table 1. *Tuning for minimum IPM is not difficult. Just follow these four basic steps.*

will be lost. If the IF passband is symmetrical, then the detected audio consists primarily of the harmonics of the audio. The result is similar to having a distortion generator built inside of every listener's radio. This also is the main reason your modulation monitor does not exhibit the added distortion noticed in the listener's radio.

Phase rotation

Phase rotation is a problem that shortwave broadcasters have been dealing with for years. As a radio signal travels through space and bounces off the ionosphere, the phase relationships between the carrier and modulation sidebands can be disturbed, resulting in signal fading and distortion. IPM remains IPM only as long as the phase relationships between the carrier and sidebands remain undisturbed. If the phase relationships change, then IPM becomes AM. When this effect is added with the AM sidebands that have also been disturbed, intolerable distortion can result. The station may be unlistenable in an area where it would have been listenable if it had been free of IPM.

Phase rotation also occurs within the coverage areas of AM stations. Stations operating on the high end of the band may find that skywave signals combine with the groundwave signal. Interference also can occur in the nulls of a directional pattern if the phase relationships between the sidebands and carrier are changed.

Unfortunately, the AM band is not an especially phase-stable medium. Transmitting and receiving antennas, tuned circuits and propagation effects all can serve to convert IPM into an AM component. The primary result is a decrease in the coverage area of the radio station.

Stereo transmissions

With all the reasons for the monaural broadcaster to avoid IPM, it's surprising there hasn't been a higher awareness of it in the past. Why the sudden interest in IPM? The reason is that IPM affects AM stereo broadcasting in more ways than those already mentioned.

All five of the originally proposed AM stereo systems used some form of phase- or frequency-carrier modulation. It appears that any undesired carrier phase modulation, such as IPM, would have a direct bearing on stereo performance. Although the effects of IPM on stereo performance vary from system to system, it is safe to assume that IPM is undesirable in any of the designs and that optimum performance is realized when IPM is minimized.

IPM causes

As a general rule, because IPM is a direct result of the modulation process, it is created in a stage that is being influenced by the modulator. The first place to look for IPM is in the PA stage. The classic cause of IPM in plate-modulated and pulse-modulated transmitters is imperfect neutralization of the final.

Because many older 1kW transmitters and almost all 5kW tube transmitters use triodes in the power amplifiers, this is a good place to look first. Adjusting the transmitter for the lowest IPM is an accurate way of achieving proper neutralization. The reverse is not true because other neutralization methods will not necessarily result in the lowest amount of IPM. In most cases, improper neutralization is the first place to look for IPM. If that's not the source, the next place to go is the PA driver stage.

As the modulation changes the driver loading into the PA grid, the driver output also may change. Often, an adjustment of the PA grid tuning will center the tuning even though the grid meter indicates otherwise.

The circuits that feed the driver stage usually are isolated enough from the PA that they do not produce IPM. An exception is when the power supply for these stages is influenced by the modulation. Aside from a design deficiency, IPM can be caused by a loss of capacitance in the power supply. In any case, when you're looking for the cause of IPM, remember that the transmitter's modulating circuits are influencing the phase of the carrier.

IPM corrective procedures

In order to correct IPM in a transmitter, you need a viewing method so that you can directly monitor the effects of different adjustments. There are several methods for displaying IPM, but none are as graphic as a spectrum analyzer. For the purpose of this article, we will use a spectrum analyzer, a tone generator and a distortion analyzer.

First modulate the transmitter with a pure sine wave, and make a THD measurement with a distortion analyzer. This will give you an idea of what the spectrum analyzer should look like when it is hooked up to the transmitter. If the transmitter has an excessive amount of harmonic distortion, you will not be able to tell the difference between the normal distortion sidebands and the IPM sidebands.

Figure 1 shows what an ideal transmitted spectrum would look like on a spectrum analyzer when modulated with a 1kHz tone at 100% modulation. Notice that there are just three components: one carrier and two sidebands. This transmitter would measure 0% distortion, because no harmonic sidebands are present. Also, no IPM is present, because it would show up as extra sidebands in the spectrum.

If, on the other hand, the ideal transmitter had an IPM problem, the spectrum analyzer display might look like Figure 2. The distortion analyzer still would read 0%, but the sidebands on the spectrum analyzer would not agree. You know that the transmitter is not producing any distortion sidebands, so you have to conclude that the sidebands you do see are a direct result of IPM.

The key is to start with a low harmonic distortion reading on the transmitter so that any sidebands will be recognizable immediately as the result of IPM. The most practical way to do this is to modulate the transmitter with a 1kHz tone to a modulation level that is as close to 100% as possible, without exceeding 1% THD. If the distortion measures less than 1%, no distortion sideband will be greater than 40dB below the 1kHz sidebands. Any sidebands that are greater than this value are the result of IPM, and they will be easy to spot.

After you have obtained a distortion reading of 1% or less, connect the spectrum analyzer, and examine the transmitter output. Figure 3 is a spectrum analyzer display photo from a typical 5kW transmitter with a measured THD of 0.3%. The photo was taken before any optimization had been performed. It's worth noting that this transmitter already was carefully neutralized using the traditional methods. Notice that the spectrum in no way agrees with the distortion measurement. Although the sidebands should be more than 50dB below the first-order sidebands, the

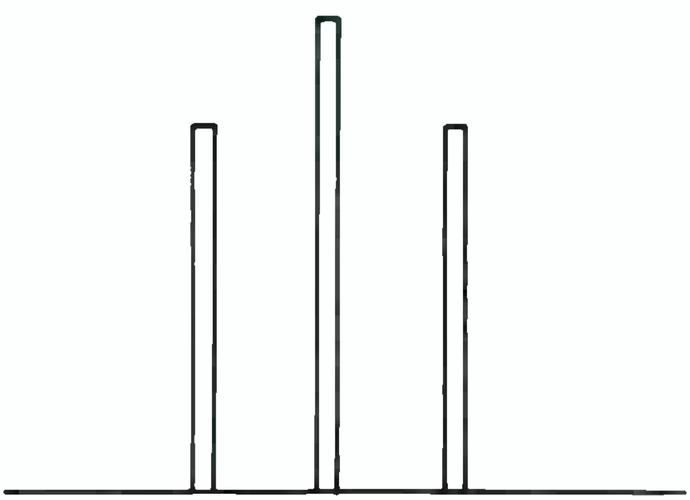


Figure 1. The spectrum of an ideal transmitter has no harmonic sidebands and measures 0% distortion.

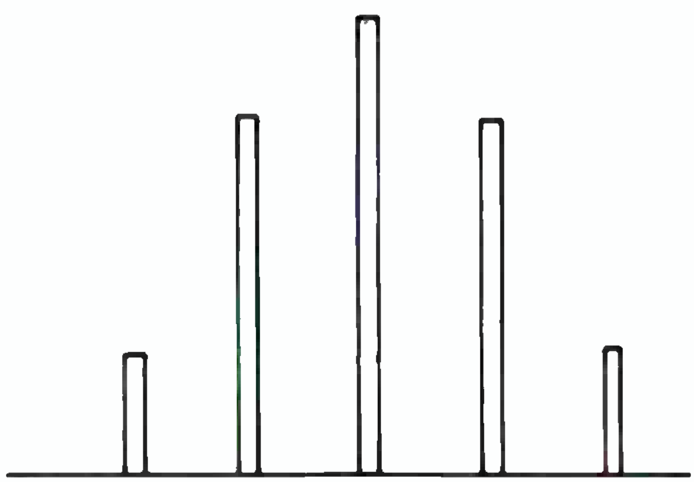


Figure 2. The spectrum of the same ideal transmitter shown in Figure 1, but with the addition of IPM.

second-order sidebands are only 30dB down. These extra sidebands are IPM, invisible to the modulation monitor but present just the same.

Now let's try to make the spectrum look the way it should. The first thing to suspect is the neutralization. On this particular transmitter, the neutralization is adjustable from the front panel, making it easy to optimize while the transmitter is operating. Some transmitters have no provision for adjusting the neutralization while the transmitter is on. In these instances, make the adjustment, then monitor the results. It may take a few tries to get the neutralization correct, but keep trying.

As the neutralization is adjusted, watch the IPM change. Figure 4 shows a dramatic decrease in IPM compared with Figure 3. The neutralization-control setting that produced this picture is close to the original setting.

All the sidebands are at least 50dB below the first-order sidebands, which is in agreement with the distortion measurement. More improvement is possible. Figure 5 is an expanded look at the same spectrum, using a 2dB/division resolution. A closer look at the second-order and third-order sidebands reveals some asymmetry around the carrier. AM theory says that perfect AM creates identical sideband pairs above and below the carrier. Any asymmetry around the carrier can be explained by only one thing: IPM.

Carefully rocking the neutralization control will reveal a point where the higher-order sidebands appear low, yet symmetrical. This is the point of lowest IPM, as shown in Figure 6. In this particular transmitter, improper neutralization was the only source of IPM. The proper tuning procedure is summarized in Table 1.

It is entirely possible that more than one source of IPM exists in a transmitter. If so, then each source will have to be minimized until a symmetrical spectrum emerges that agrees with the distortion measurement. Note that the PA neutralization will have to be adjusted in this manner each time the PA tube is replaced, because every tube has a different amount of interelectrode capacitance.

So far, we've considered only transmitters that use triodes in the PA stage. AM transmitters that use tetrodes or pentodes in their finals seldom have neutralization circuitry because the tube interelectrode capacitance is small enough that oscillation is not a problem.

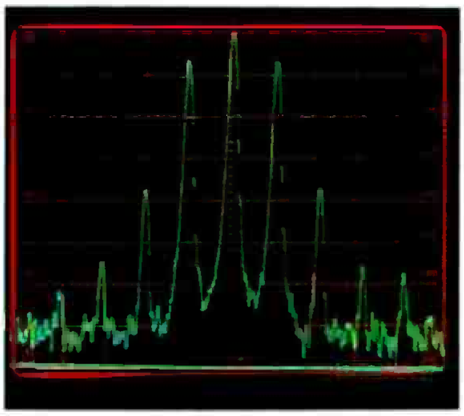
However, that doesn't necessarily mean IPM has been eliminated. If you suspect IPM from a tetrode or pentode stage, you can add neutralization circuitry to cancel precisely any interelectrode capacitance and eliminate the IPM. In this case, it is best to consult the manufacturer for the proper method.

AM transmitters with solid-state PAs are new enough to have been designed with IPM in mind. The production of IPM in this type of final stage is a function of design rather than adjustment, so be sure before you purchase a transmitter that the manufacturer has carefully considered this factor.

Usually, the only other source of IPM is found in the RF driver stage that feeds the PA tube grid. Any instability in this stage may cause the circuit to phase-modulate as its load—the PA grid—changes with modulation. Try changing the tuning, loading, drive, neutralization or any adjustable circuit associated with the stage. Often, slight adjustment of a control will reduce IPM significantly. Because every transmitter is different, there are no hard and fast rules here. Just remember to have enough grid current remaining after adjustments to modulate the positive peaks.

Helpful hints

A common problem that might crop up when you're trying to neutralize a transmitter is finding a tube that won't



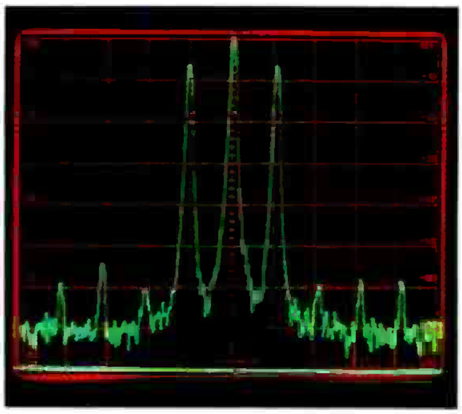


Figure 3. Although this transmitter measured 0.3% THD, the second-harmonic sidebands are only 30dB below the fundamental. The extra sidebands are the result of IPM.

Figure 4. This is the same transmitter as shown in Figure 3, after neutralization has been adjusted for lowest IPM.

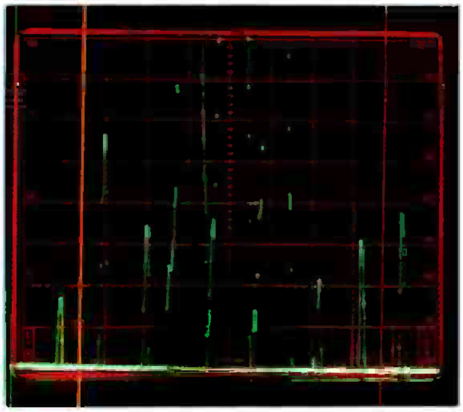


Figure 5. The spectrum of Figure 4 expanded to show the asymmetry of the second- and third-order sidebands.

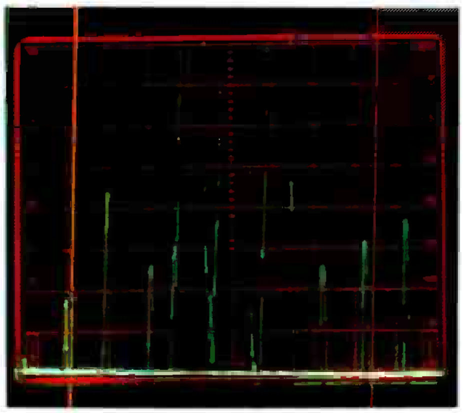


Figure 6. Fine-tuning of the neutralization brings the higher-order sidebands into symmetry.

neutralize completely. Either the neutralizing trimmer cap is at the end of its range or the trimmer doesn't seem to have much effect on the IPM. This problem can be caused by a neutralizing circuit that wasn't designed with enough adjustment range or by a tube whose interelectrode capacitance is out of tolerance. This condition seems to show up more often in rebuilt tubes than in new ones. Perhaps a rebuilt tube's interelectrode capacitance is not necessarily the same as it was when the tube was new. It's a good policy to have a few padder capacitors of different values on hand in order to bring the neutralization circuitry into range with any tube that might be encountered.

Another problem you might run into is a bad transmitter load. Although most

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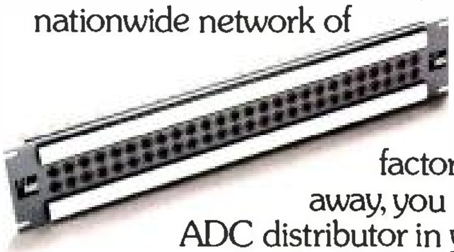

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antenna systems are fairly flat within ±2kHz from the carrier, it's still possible that the antenna system is causing an asymmetrical display on the spectrum analyzer. In this case, it is best to perform these procedures with the transmitter connected to the station's dummy load instead of to the antenna. IPM caused by asymmetrical antenna systems is a subject beyond the scope of this article. In any case, if you notice a difference in IPM when the antenna is connected, that area may be your next project.

Alternative methods

Because the average radio station doesn't own a spectrum analyzer, it would seem that the procedures outlined so far are of little use. However, before you dismiss the entire process as impossible, consider the following points. First, nothing is more revealing than looking at your radio station with a spectrum analyzer. Everyone should do it at least once. It's an eye-opening experience. Second, you don't have to own a spectrum analyzer to use one; you can rent one. Also, someone in your area—a friend at a nearby college or university, or an acquaintance in the radio business or some other electronics industry—might let you borrow a spectrum analyzer for a night.

If the AM broadcast service is to become a quality medium, we all must start treating the service with a little more respect. That means using the proper tools for the job instead of just trying to get by. If you can possibly arrange it, use a spectrum analyzer to perform these tests.

If a spectrum analyzer is totally out of the question, consider other ways of looking at IPM. One method is to use an oscilloscope, which means you'll need to obtain a sample of the carrier frequency from the oscillator. Connect the oscillator sample to the scope's external trigger input. Connect the transmitter RF sample to the scope's vertical input. Adjust the sweep time so that approximately 90° of the RF waveform is visible on the screen.

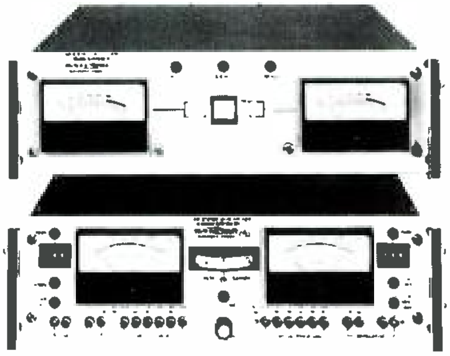
Examine the zero axis crossing of the waveform. Any side-to-side movement of this zero axis crossing represents carrier phase modulation. The trace will appear as a "smear," as opposed to a distinct line. This smear can be measured in degrees with the oscilloscope. If the sweep time is adjusted so that 90° of the RF waveform covers nine vertical divisions on the graticule, then each division equals 10°.

The other way of observing IPM is with a stereo modulation monitor. The AM stereo modulation monitor for one of the two systems in use has a provision for monitoring L−R information, while the other one can measure IPM directly. Although IPM is not exactly the same thing as L−R audio, any information that shows up in the L−R channel during monophonic operation is due to IPM. You can use either type of monitor to actually hear your transmitter's phase modulation and implement a minimization program.

Incidental phase modulation has been around for many years, causing problems that most of us have been unaware of. The advent of AM stereo has brought the issue of IPM to the attention of the industry, and that in itself may be part of AM stereo's greatest contribution—the improvement of the quality of AM. Eliminating IPM from an AM transmitter is not difficult, and it is often easily accomplished simply through better PA tube neutralization. The extra effort required to complete this task is well worth the benefits derived by the individual broadcaster as well as the entire AM broadcasting industry.

Editor's note: This article is based on a paper presented at the 1986 NAB Engineering Conference by Dominic Bordonaro.

DELTA BROADCAST PRODUCTS



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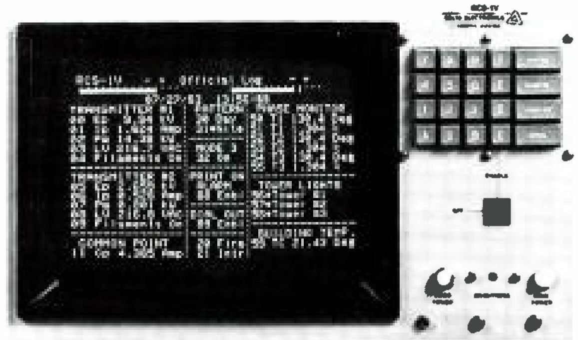

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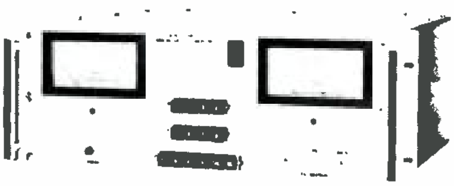

AAM-1

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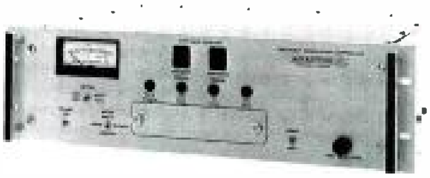
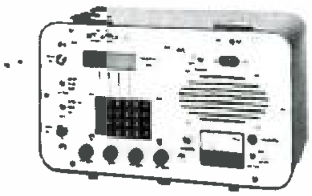


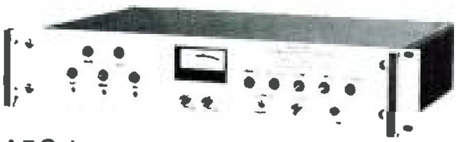
AMC-1/FMC-1

The only modulation control systems which provide a completely closed loop around the transmitter. The Amplitude and Digital Modulation Controllers sample actual modulation levels after the PA output network assures precise adjustment for optimum modulation levels. Both the AMC-1 and FMC-1 keep count of overmodulation bursts for signal control through a linear attenuator.



RG-4

High output Receiver/Generator. The Receiver/Generator combines a two-watt RF output and a correlation detector circuit that virtually eliminates interference problems. The RG-4 operates in the 100 kHz to 30 MHz range. It is designed as the ideal companion instrument for Delta's OIB-1, OIB-2, and OIB-3 impedance bridges.



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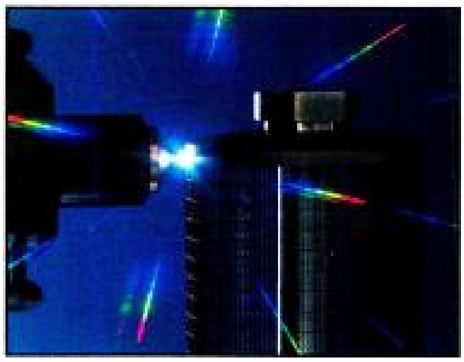

By Richard Dienhart

Advancements in solid-state technology have redefined the design, function and capabilities of almost every device in the communications environment. Development of the VSR-10 digital video recorder (from NEC), built exclusively around solid-state devices, represents the latest milestone in semiconductor development.

The application of solid-state technology for any product provides a number of user benefits, including:

• *Flat performance:* A solid-state device is rated at a specific level of performance on manufacture and test. That performance level remains consistent throughout the life of the device.

• *Dependability:* Over the length of time solid-state devices have been available, the collective experience of the computer and communications industries has confirmed that these components tend to be very dependable. Their reliability is due, in large part, to their low power consumption, low heat generation and non-mechanical nature. Mean time between failure (MTBF) has become a manageable number in operational planning.

• *Serviceability:* The use of solid-state devices in products has redefined the approach to equipment maintenance. The sealed-system nature of most systems, coupled with small size, now means that when problems occur, entire modules are replaced. The faulty parts are set aside for later repair or for return to the manufacturer for repair or exchange. The downside of this trend is that a facility's spare parts inventory requires a larger investment.

Solid-state technology, however, permits the use of microprocessor-based diagnostic techniques that make troubleshooting of equipment faster and easier. Availability of built-in memory analysis and similar aids leads the maintenance engineer directly to the problem area and provides ways to temporarily bypass the problem component in the bit-processing routine of the system. The equipment experiences less downtime for repairs and can be returned to service faster when a failure occurs.

• *High-speed processing:* The inherent speed of signal processing attainable with solid-state devices supports the many calculations required to process and manipulate complex signals, such as video. In addition, high-speed processing permits simultaneous data-handling by the same component.

• *Multitasking:* Perhaps the most significant aspect of solid-state technology is that it can be used in designs that process several different functions simultaneously. With this multitasking capability, equipment based on advanced solid-state technology can perform radically diverse operations at any given time, sharing the same basic data. This concept is central to the efficient use of solid-state technology as applied to the video recorder.

Dienhart is national sales manager, video products, NEC America, broadcast equipment division, Wood Dale, IL.

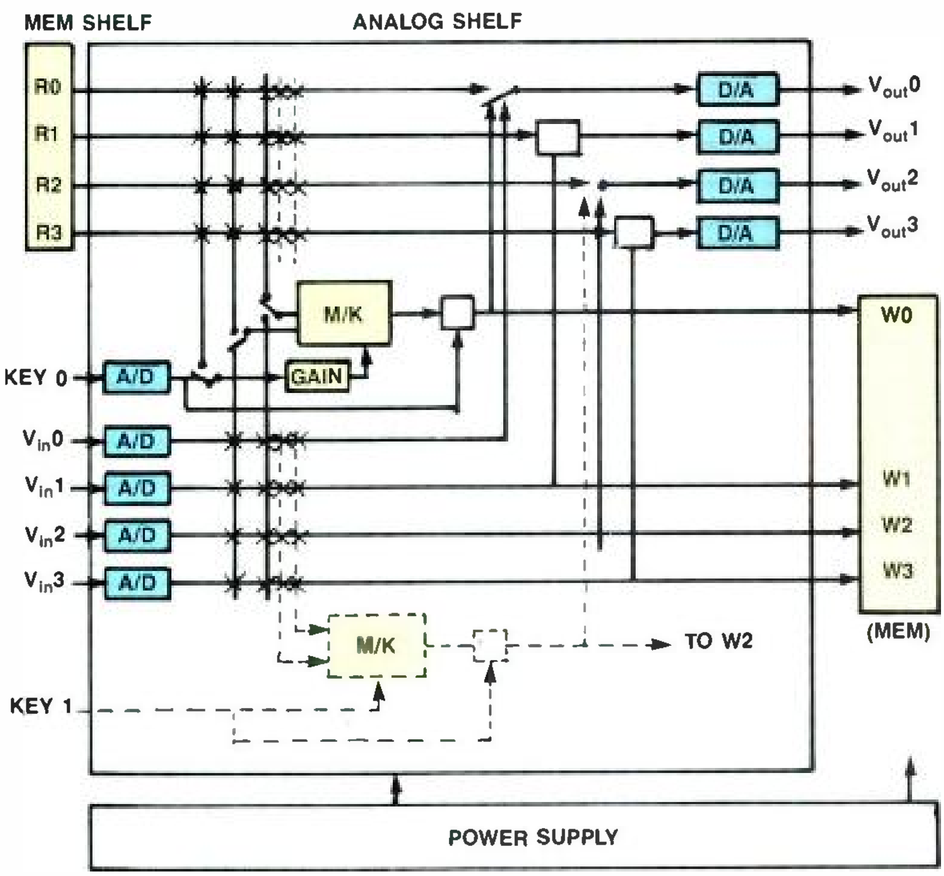

Figure 1. Simplified block diagram of the VSR-10 solid-state video recorder. The system is divided into three basic sections: the memory shelf, analog shelf and power supply.

System implementation

The VSR-10 solid-state digital video recorder incorporates dynamic random-access memory (DRAM) for data storage and high-speed video signal processing. The heart of the system is the μPD421000, a 1Mb DRAM memory chip. Each memory card includes 256 devices. A typical system configuration would include 12 memory cards in a given *memory shelf* for a total of 3,072 chips (384 megabytes of storage).

Recorder hardware design is straightforward. The basic system is built around three chassis: an analog shelf, memory shelf and power supply. Recorder functions are managed by a microprocessor-based control panel. Up to four control panels can be connected to the mainframe via serial interface.

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The analog shelf is the point at which most system interfacing takes place. I/O connections provided include four video inputs, four video outputs, two digital I/O ports, an external key input, hard disk I/O, and Ethernet port for networking. Four RS-422 serial control ports may be connected to the analog shelf to provide low-level communications to an external control computer.

The control panel is the point at which system management and creative supervision are maintained. Control panels for simple (sports) or complicated (post-production) work can be tied to the system to support the requirements of various productions. The production control panel uses a 3.5-inch floppy disk drive for operating system loading and off-line storage of program sequences.

The analog shelf contains control, analog-to-digital (A/D) and digital-to-analog (D/A) cards. (See Figure 1.) Configuration of the system permits the VSR-10 to accomplish more than simple record and playback of video. New features are available to users because of the unique attributes of solid-state recording.

As shown in Figure 1, each of the NTSC composite input ports feeds an A/D for conversion into the digital domain. Four *read ports* from memory are provided downstream of the A/D converters. A 4×1 input selection switch facilitates signal routing in the digital domain. Various combinations of internal and external signals may be applied to the digital mix/keyer (M/K) within the system.

A second digital M/K is available for simultaneous mixing of two signals in two separate control locations. Any internal or external input may be assigned to memory, passed through the M/K amplifier or read directly out of the VSR-10 to any of four NTSC composite or digital outputs.

Figure 1 illustrates how the three shelves of the VSR-10 mainframe interconnect. The memory shelf shown represents from one to four shelves (34s to 136s of recording time). *R0* through *R3* represent the channels available to read data from memory, while *W0* through *W3* represent the channels available to write data to a memory location. The power supply shown may be one or two shelves, depending upon the number of memory shelves in the system.

System operation

The recorder is designed so that it can perform various tasks at the same time, offering simultaneous control of the system from different locations, or control of several functions simultaneously from one location. Figure 2 shows some of the configuration possibilities.

The system uses first-in-first-out control-panel priority in which the first control panel to request system resources gets them. The next control panel has access to any unused resources, such as ports or memory space. An individual control panel must release its allocated resources before they can be assigned to another control location.

The *memory reservoir* may be assigned in any value to each of a total of four ports, up to the combined maximum capacity of the memory. This assignment may be performed in increments as small as four frames. Time division does not require an equal assignment of recording time to any of the four ports. Each port may be assigned to the exact number of frames or seconds of reading or writing time needed to perform the function assigned to the port.

Because record and playback of the same material can be accomplished in the digital memory simultaneously, with only one field of delay between record and play, playback of real time events can be

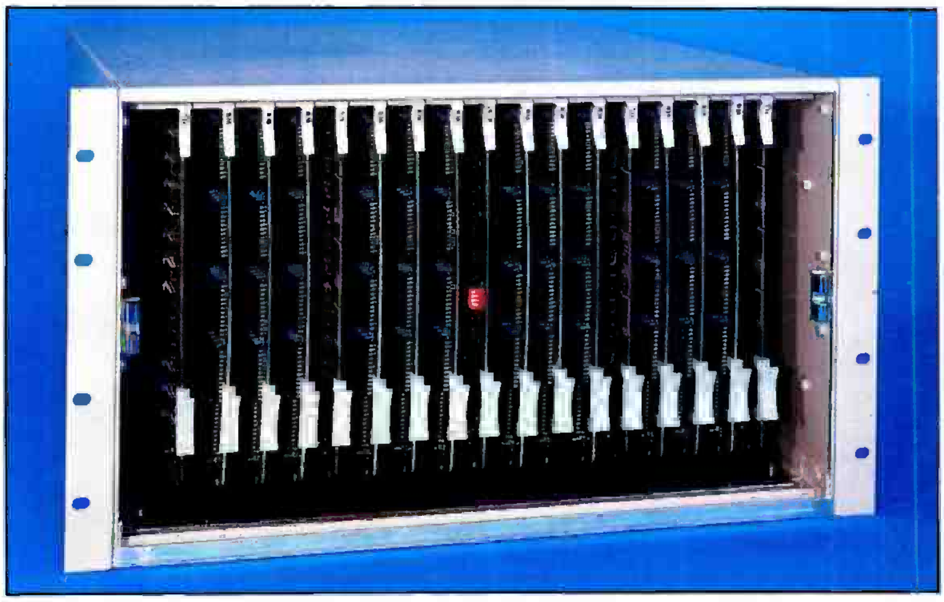
FREQUENCY RESPONSE (measured at A/D, D/A direct connection)	±0.3dB, 200kHz to 5MHz
K FACTOR (2T pulse and bar)	K<1
LINEARITY/DIF. GAIN	<4%
LINEARITY/DIF. PHASE	<2°
S/N	50dB OR GREATER (10kHz, 4.2MHz FILTER)
SYSTEM TIMING	INPUT/OUTPUT VIDEO PHASE ADJUSTABLE ±2μs
	COLOR PHASE ADJUSTABLE OVER 360°

Table 1. *Primary video specifications for the VSR-10 recorder. Because all processing within the system is done in the digital domain, these specifications will be valid for any number of generations.*

accomplished in variable-time slow motion *as they happen*. Individual field and frame identification and access mean that sequences read into the memory may be read out in any random order and in real time.

Inside the memory

Of the 17 boards contained in the memory shelf, 12 are dedicated to memory itself. The remaining boards handle various housekeeping functions. The memory consists of 384Mb, constructed from 1Mb



The standard memory shelf of the video recorder. Twelve of the 17 boards in this shelf are used for storing video data.

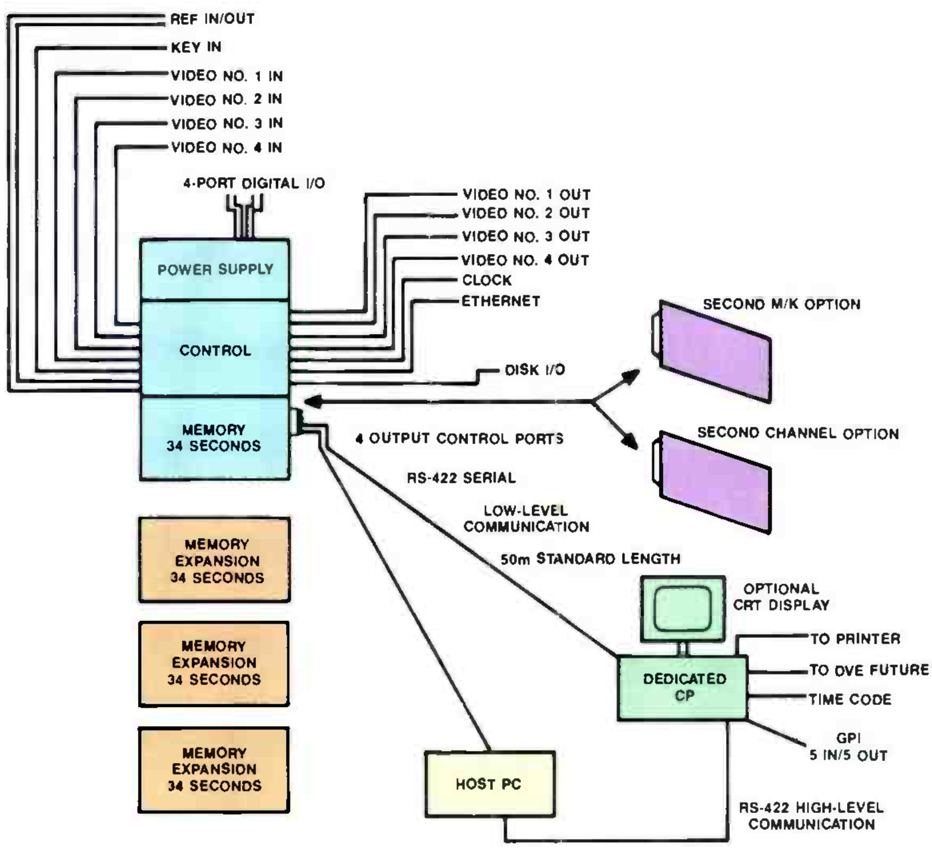


Figure 2. *Configuration options for the solid-state recorder. The system can be expanded from its basic complement through the addition of memory shelves and external controllers.*

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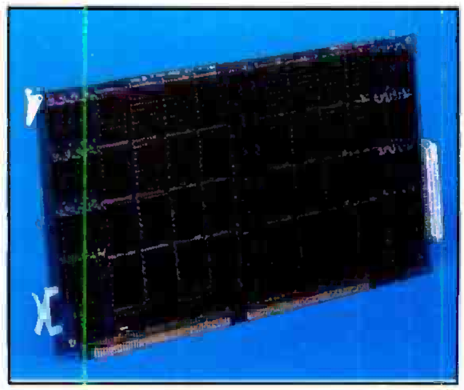


One of the memory boards removed from its card cage. The building block of the system is the μPD421000, a 1Mb DRAM memory chip.

DRAM devices.

The basic system provides 34s of video recording time. Capacity can be expanded through the addition of other memory units. The system also is designed to take advantage of future developments in solid-state memory technology. This is important because significant work is being done to develop 4Mb memory devices.

As currently constituted, the memory reservoir may be expanded to a total of 1.536Gbytes, or 136s of recording time. Further expansion of the system includes adding a second A/D-D/A board, which provides two additional external input and output ports.

Because the DRAM memory is volatile and not intended for archival storage, the system may be interfaced with an external storage medium, such as a digital tape recorder or hard disk-storage system.

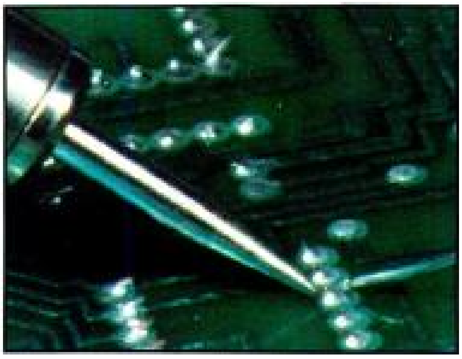
Data backup in the digital domain typically is addressed through use of a streaming tape system. Using present-technology streaming backup, the entire digital data contents of the basic VSR-10 can be transferred to tape in about two and a half minutes.

Equipment as complex as the VSR-10 must have provisions for computer-assisted testing. Through use of software routines, failed memory can be partitioned off, as in disk recorder technology. The full memory capacity can then be recovered upon replacement of the failed device. See Table 1.

Future directions

It has long been a goal of equipment manufacturers to reduce, or even eliminate, the mechanical components of product design. In most cases, mechanical systems are more expensive to manufacture and less reliable in the field than well-designed solid-state hardware. As advancements in memory technology are made, further improvements will be possible in storage capacity.

RF tuning for maximum performance



By Richard Walsh

Engineers at FM stations recognize that an improperly tuned or narrowband IPA or PA stage can degrade the performance of both the main and SCA channels. Furthermore, relying on transmitter front-panel metering alone does not ensure optimum performance. Maximizing the performance of these audio channels requires careful RF tuning.

AM noise method

The traditional procedure of tuning for maximum efficiency may result in less-than-ideal bandpass characteristics. Ideally, the RF amplifier should exhibit equal (flat) gain across the desired bandwidth. Tuning for maximum efficiency may result in a peaked bandpass at the carrier center frequency. A preferable tuning method is to adjust for minimum AM noise while modulating the carrier.

This procedure is particularly important if you are operating with an SCA channel and want to minimize main-to-SCA crosstalk. Some SCA generators are equipped with an integral incidental AM noise meter. If your generator is not, then the modulation monitor must be moved to the transmitter site for these tests.

Walsh is chief engineer for WHCN-FM, Hartford, CT.

Oscilloscope method

The oscilloscope is an effective tuning aid when operated in the X–Y mode. The horizontal axis is deflected by a sample of the composite modulation, while the vertical axis is deflected by a rectified signal from the transmitter's RF monitor sample. (See Figures 1 and 2.)

The transmitter is tuned while the displayed image is observed. Optimal tuning is achieved when the displayed horizontal image is as flat as possible. Any rotation from a horizontal trace indicates that the transmitter is not center-tuned. The more arched the display, the more narrowly tuned the RF amplifier. A thick horizontal line indicates a substantial quantity of AM noise.

The IPA tuning is especially critical in transmitters using IPA tubes in these stages. The oscilloscope tuning method provides a quick and accurate picture of the transmitter's tuning.

Power measurement method

None of these procedures provide any quantitative data concerning actual RF bandpass. An RF spectrum analyzer normally would be employed to check the transmitter's bandpass. Because this expensive device is seldom available, engineers will be happy to learn that they already may have the required equipment to produce similar results.

The key to this test is an FM exciter that uses a frequency-synthesized oscillator. This feature allows the exciter to become an integral part of the test procedure. It also is necessary to have a dummy load for the transmitter (see Figure 3). Performing this test into an antenna is illegal.

Many older transmitters (in which bandwidth problems are more common) have been updated with these newer exciters. These exciters are incorporated into most new transmitters.

Before conducting any tests on your transmitter, first review the exciter manual for the procedures to change the frequency. Exciters typically use DIP switches in a BCD format to alter the output frequency in 10kHz increments.

Make a chart of the switch settings vs. frequencies to simplify changes during the test. Use frequencies in 50kHz steps above

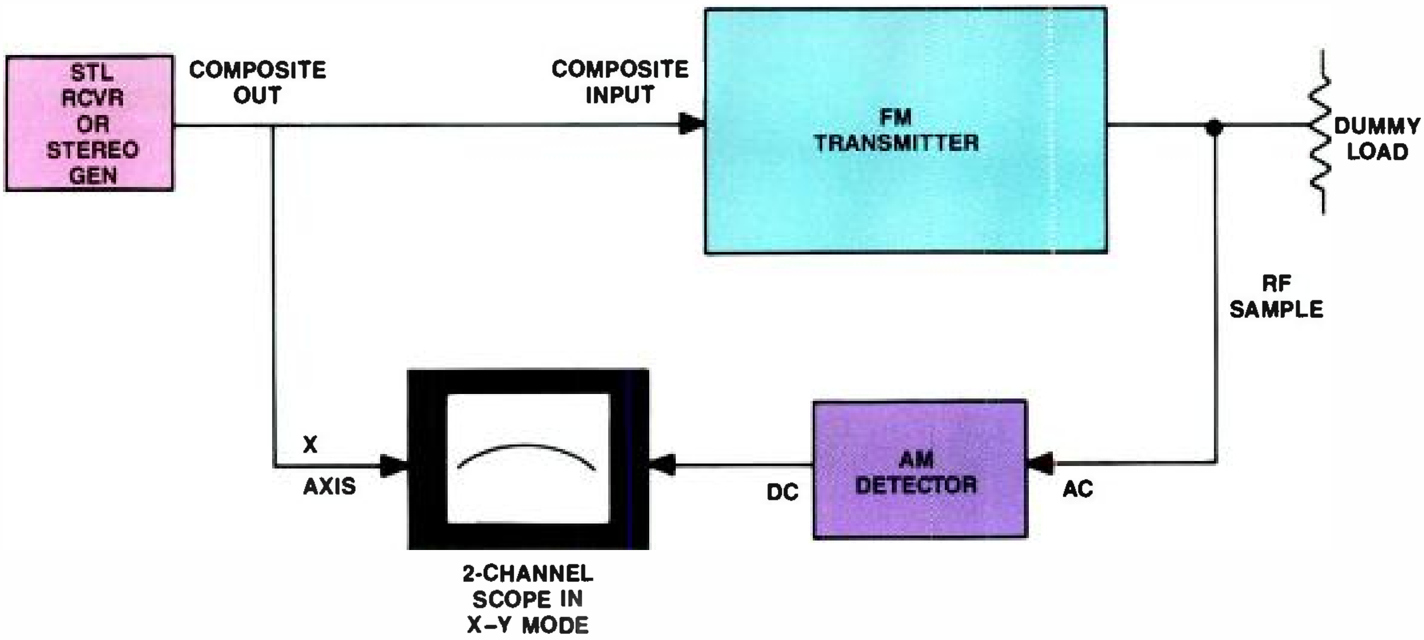


Figure 1. An oscilloscope and AM detector can be used to monitor the transmitter tuning.

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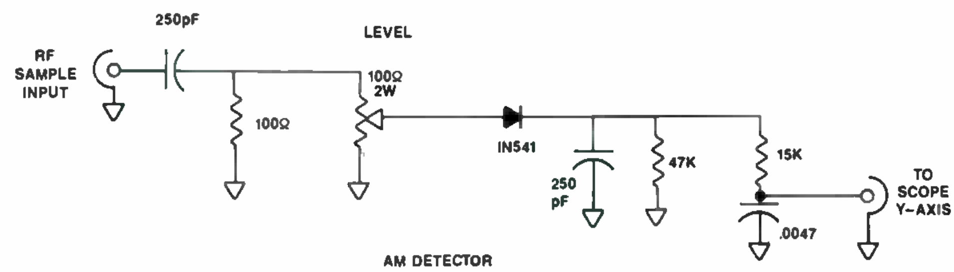
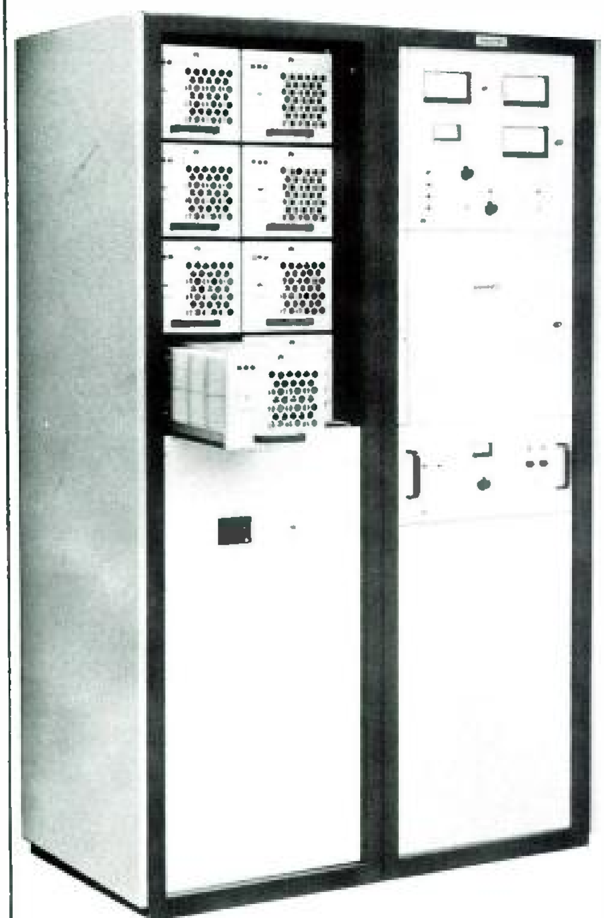


***Figure 2.** The AM detector shown here is required to drive the Y-axis on the oscilloscope.*



and below your center frequency, out to ±500kHz. Before testing the entire transmitter, verify the exciter's performance by coupling it to a small dummy load and an accurate wattmeter.

With the equipment connected, turn on the transmitter and raise the output to your authorized power. Remove all modulation, and allow sufficient time for the transmitter power output to stabilize.

Disable any automatic power control. Also monitor the ac power-line voltage during these tests. Any voltage changes will be reflected in the transmitter's output power and, therefore, will affect the results. In some locations, the power may be more stable when the station's backup generator is being operated.

After the transmitter is fully warmed up, check the tuning and power output to make sure it is operating at your reference level. Once they are set, do not change any transmitter tuning or power controls for the remainder of these tests.

If you have a frequency counter, monitor the exciter's frequency to confirm the accuracy of your DIP switch settings. Move the exciter's frequency up by 50kHz, and note the resultant power level. Continue to increase the frequency in 50kHz steps, recording the associated power-output level until the power drops to one-half the reference value. This is the upper-frequency −3dB point.

Return the exciter to the reference frequency, then step down in 50kHz increments to −500kHz. This should be the −3dB point. Smaller steps can be taken if more resolution is desired.

Graph the results

Plot the results on a graph, showing frequency vs. output power. You may want to convert your power readings to decibels relative to the reference power. From the graph, it will be easy to see how flat the transmitter really is.

For a station with no SCAs, the transmitter should be flat out to ±75kHz. It is desirable to have the transmitter flat out to ±300kHz or more, especially if stereo and SCA operation is required. A peaked graph indicates that the transmitter's Q is too high. An asymmetrical graph indicates mistuning or, perhaps, component failure. A narrow graph is not necessarily an indication of mistuning, but may be the reflection of an older, narrowband design.

Figure 4 shows the test results from a common older 10kW FM transmitter with severe IPA bandwidth problems. Notice how rapidly the power falls on both sides of the center frequency. This transmitter exhibited noticeable power-output variation during modulation.

A modern 10kW transmitter sweep is shown in Figure 5. Notice how much flatter the curve is over a broad region. This particular transmitter uses a tube IPA with

Field report

Calaway CED+ editor

By Arthur Schneider

At an NAB convention several years ago, Calaway Engineering, of Sierra Madre, CA, introduced a unique new videotape editing system. What made this editing system so different is that it was designed to be installed inside a personal computer.

Many current editing systems are dedicated devices, meaning the only thing you can do is edit videotape. What if the computer fails? The entire system stops until the problem is fixed. The CED and CED+ editors, on the other hand, are only a small part of an IBM or Compaq personal computer. Therefore, if a computer failure occurs, you may be able to have the computer repaired at a computer store. A technician easily could swap the editor hardware boards into another computer if necessary. In other words, with the CED editor, computer failure may not shut down production.

Schneider is a consultant and writer based in Agoura, CA.

Performance at a glance

- *Machine-controlled: 4 or 6, depending on configuration*
- *Machine-control methods: direct and interface/translator*
- *Features provided: variable speed, frame advance, mark in/out keys*
- *Video and audio switchers provided*
- *Error messages available*
- *Transitions: cuts, wipes, dissolves*
- *Transport controls: fast forward, fast rewind, play, stop, slow, cue, cue to in-point, 2X-play*
- *Interfaces available for a wide variety of machines*

Software

The CED software has the capability to create up to 12 macros, each with up to 26 characters per macro. The macros can be saved to disk and recovered along with the switcher E-mem register data. Another useful feature is the setup menu, which allows the user to select any of a group of 26 active configuration functions and store them on disk. These parameters can be recalled later and changed through the same menu.

The CED software is quite versatile, incorporating many of the list management functions that are available on more expensive systems. The company says that

SCED	SCED+	MK-II	NEW FEATURES
X	X	X	EXTENDED MOTION-CONTROLLER KEYBOARD (OPTIONAL FOR ALL SYSTEMS).
		X	PREVIEW SWITCHER PRESELECT SOFTWARE FOR RECORD MACHINE ASSIGNMENT.
		X	24 MACRO KEYS (12 SINGLE KEY AND SAME 12 SHIFTED FOR 13-24) INCLUDING ALL MACRO FEATURES: MACRO COUNTER, MACRO DELAY, MACRO PAUSE AND MACRO EDIT.
		X	EIGHT VTR PORTS CONNECTED WITH ANY SIX ASSIGNED AND SYNCHRONIZED SIMULTANEOUSLY.
X	X	X	EXIT TO MS-DOS WITHOUT REBOOT.
X	X	X	OUT EDIT PREVIEW.
		X	MULTIPLE RECORD.
		X	SUPER USER MODE.
	X	X	DISPLAY RECALLED EVENT NUMBER.
	X	X	MASTER/SLAVE LINK MARKS DISPLAYED.
		X	KEYBOARD ACTIVE IN PREVIEW FOR GOING DIRECTLY TO RECORD OR FOR MARKS DURING PREVIEW.
X	X	X	OPEN-END KEY (SHIFT SET-DUR.)
X	X	X	SAVE/RECALL MARKS FLIP-FLOP. (CURRENT MARKS ARE SAVED WHEN LAST SAVED MARKS ARE RECALLED.)
X	X	X	RESORT LIST WHEN SETUP FUNCTION 27 IS CHANGED.

Table 1. *Comparison of current Calaway editor features.*

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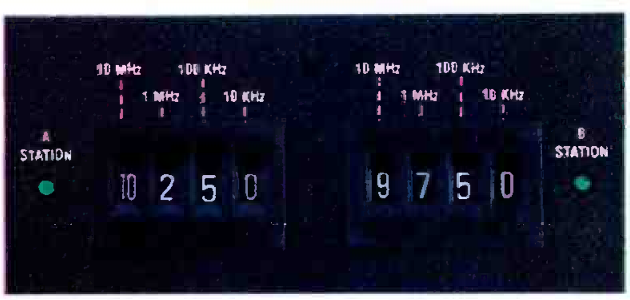

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additional software features, such as the sorted list and stored general-purpose interface (GPI) or master/slave information, are being implemented and will be available soon.

Hardware

The editor is available in four basic versions: the CED, CED+, SCED and SCED+. The CED and CED+ are the lower-priced versions and include a standard 4-machine interface. The SCED and SCED+ editors are capable of handling six machines.

The editors are designed for direct control of VTRs that operate with RS-422 protocol. This design eliminates the need for interfaces between the editor and machines. The primary difference between the CED and CED+ is the number of VTRs controlled (four for the CED and six for the CED+). The CED+ also has a slightly larger keyboard and offers 12 macros instead of 10.

The system hardware includes a color-coded custom keyboard and a preview switcher with sync and blackburst generators activated by a single contact closure to trigger the start of a dissolve or wipe. A rotary knob motion-controller with pushbutton mark in/out keys and single-frame advance or variable-speed control gives the user a positive feel on the VTR being accessed. Operating software and drivers for the audio and video switchers also are included.

Equipment supported

System options include an 8-inch floppy disk and controller to store edit lists in the CMX/ISC format, a general-purpose interface, slow motion and E-mem control features. Optional interfaces are available for a variety of ½-, ¾- and 1-inch VTRs and ATRs.

The editors will interface directly to the Sony broadcast series of VTRs including the BVU-800 and BVH-2000. The system also interfaces with the Pioneer LD-V6000 laserdisc player. The player requires an optional translator interface.

Video switchers currently supported include the Grass Valley Group 100 and 300 series, TEN-XL (cuts only), Crosspoint Latch 6109, Ross 210 and the CDL-480. Supported audio mixers include the Grass Valley Group AMX-100 and Graham-Patten 612/616.

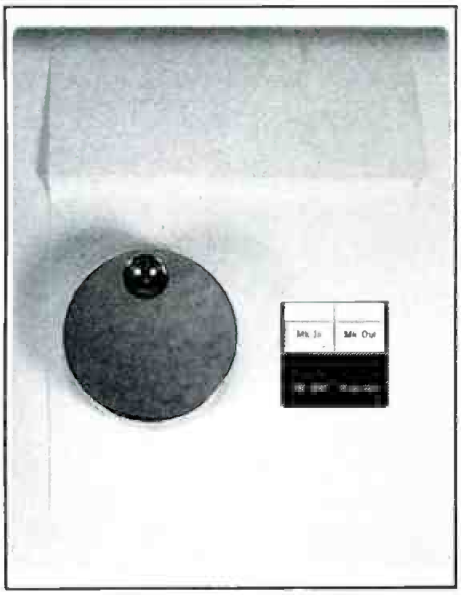
Virtually any computer printer can be used with the editor because the output is generated through MS-DOS rather than through special editor software. The resulting edit list is generated as an ASCII text file and may be read on any MS-DOS system. The command is Type Filename.ext. The edit list is stored in the computer in a CED format but may be output in a CED, CMX 217 or GVG/ISC format. The list also can be saved to 5¼-inch or optional 8-inch (CMX/ISC) disk. Some post-production facilities now have the capability to convert edit list files produced with MS-DOS to CMX/ISC 8-inch formats. The edit list has a capacity of 999 edits per file, and any number of files may be stored, subject to disk-storage capacity.

Field test

The field test was performed using three BVU-800 VTRs, each with a TBC-1 time base corrector. A GVG-100 production video switcher and a Graham-Patten 612 audio mixer were interfaced to create fades, dissolves or wipes. The audio mixer also was computer-controlled, allowing for audio-follow-video switches. This feature can be bypassed for manually controlled audio sources.

A source of frustration for many videotape editors is the frequent aborting of an editing system as it attempts to make an edit. This editor, however, never aborted during any of the tests. One reason for this

The CED+ keyboard provides color-coded and labeled keys for easier operation.



CED motion controller provides variable speed shuttle and frame advance, plus mark in/out keys.

performance lies in the algorithm used to cue and park the VTRs. The system showed none of the familiar VTR-bumping routines used in some systems. Once parked, the VTRs went into play and performed the edits as instructed. However, it is important that the cassette tapes contain high-quality, properly recorded time code. The VTRs also must be adjusted properly to good performance levels. The editor cannot overcome the lack of proper maintenance.

User-friendly

Some people are intimidated by computers and cannot decipher the technical literature. The manual for the CED system, however, is well-written and easy to understand. It uses little of the technical jargon that is so prevalent in equipment manuals today.

The CED editor is designed to work with an IBM-PC/XT computer having at least one floppy disk drive, 256K RAM, monochrome display card, two free hardware slots and version MS-DOS 2.1 or later. The CED+ editor requires a Compaq Deskpro computer with the same configuration and a total of three hardware slots. Calaway states that although the hardware and software may work with compatible computers, no tests have been made, and the company will not support other configurations.

The editor is a pleasure to use and al-

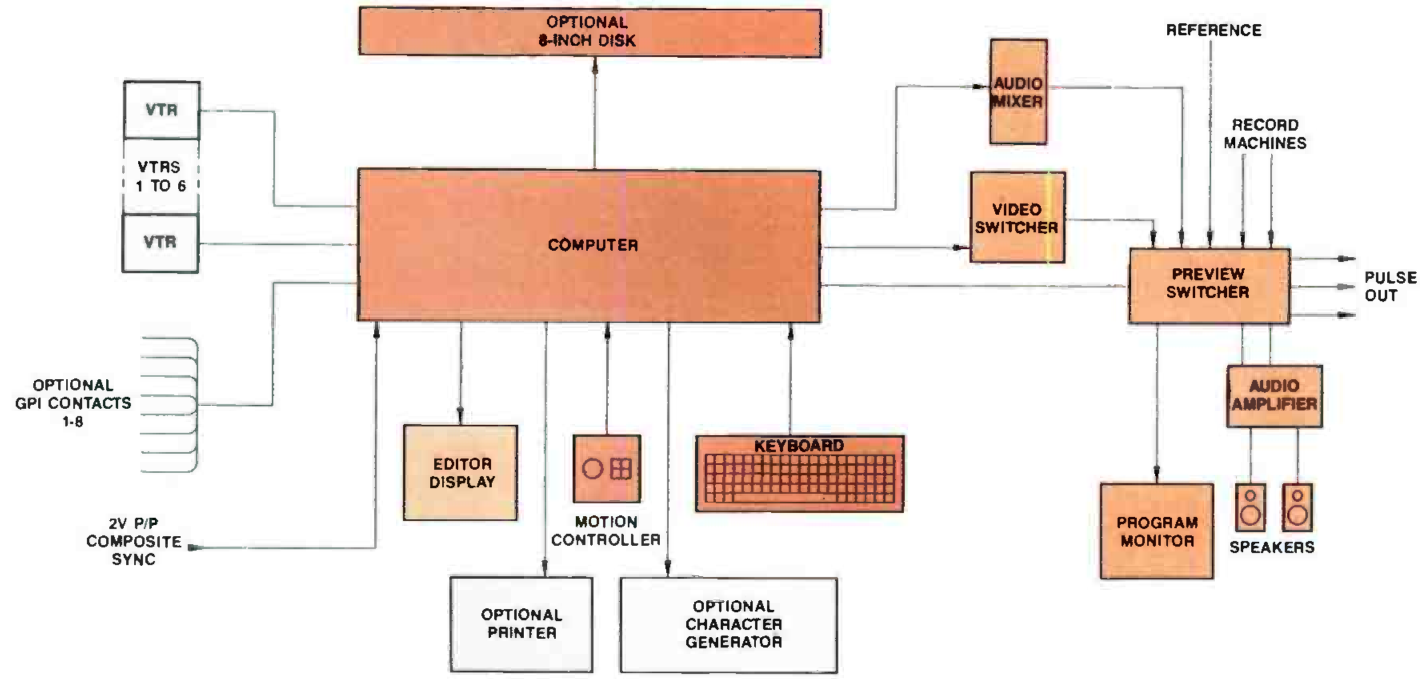


Figure 1. *The editor interfaces with up to six VTRs as well as a printer and character generator.*

lows the user to concentrate on the creative aspects of editing, not the mechanics of controlling hardware. After editing your tape, you can switch keyboards and proceed to revise the script on the same computer. How's that for versatility?

(Since the Calaway editor was reviewed, several changes have been made to the line of editing systems. The SCED+ Mark II features an 80286 processor with 1Mb of memory and several additional functions.

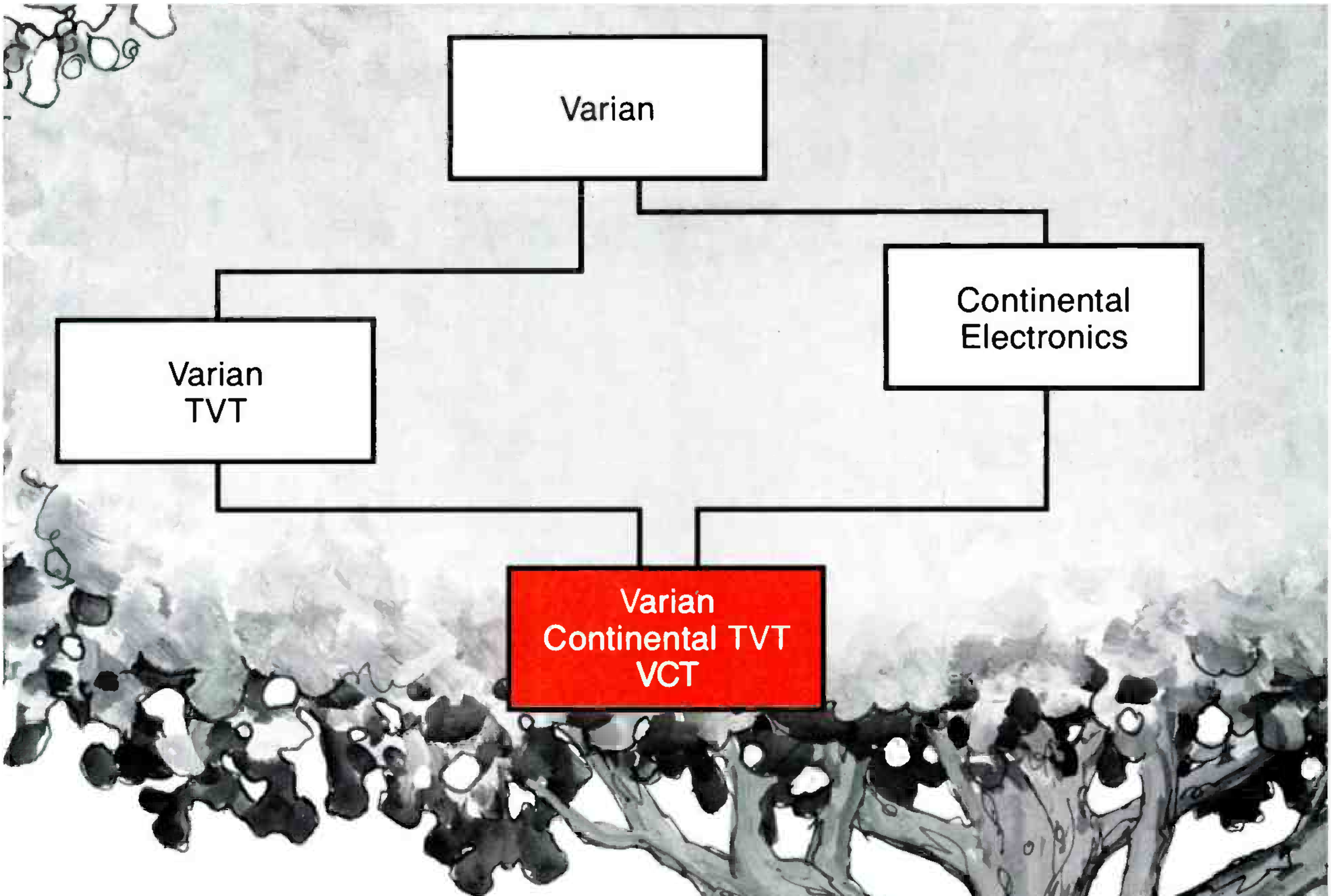
The SCED+ Mark II system now includes 24 macro keys with 24 keystrokes per macro and eight machine ports. The ports are active with any six machines assignable in software for simultaneous operation.

The SCED and SCED+ systems continue to be offered for installation in customer-furnished computers but also are available with the Mark I computer.)

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

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

It is the responsibility of **Broadcast Engineering** to publish the results of any piece tested, whether positive or negative. No report should be considered an endorsement or disapproval by **Broadcast Engineering** magazine. **BE**



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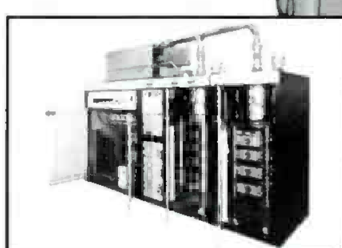


Officer elections are around the corner

By Bob Van Buhler

Nominations are now being accepted for the 1988 slate of officers and board members. Nominating chairman, Tom Weems, requests that anyone desiring to run for office contact him for additional details. Although the nomination process is simple, fulfilling your elected duties may be considerably more work.

If you are contemplating running for an office, keep in mind that board members and officers are not reimbursed by the society for their expenses. All travel, accommodations and related expenses would be your responsibility or your employer's.

Travel involves attending a minimum of two board meetings a year. In addition, postage, telephone costs and other expenses must be covered by the officer or board member. Activity at the national level, as at the local level, is not an honorary function; it's hard work.

Continued growth

The chartering of two new chapters and the formation of a third are indicative of the society's continuing growth.

SBE welcomes Chapter 107 in Charleston, SC, chaired by Lowel Knougg of WCSC-TV. Barry Mathis of Trident Communications is vice chairman, and Willie Bennett of WSSX-FM/WTMA-AM is secretary-treasurer.

Chapter 108 is the new California central coast chapter. Members are located primarily in the Monterey and Salinas area. Chapter chairman is Willis Wells of WSBW-TV, and vice chairman is Karl Kaufman of KSBA-TV. Secretary-treasurer is Dave Hudson of KSTS-TV.

Another chapter is forming in Jacksonville, NC. As soon as they have 10 paid members, they will become the 109th chapter to begin operations.

In addition to these new chapters, the Washington, DC, chapter is again meeting regularly. Efforts have been made in the past several years to bring a chapter back to that area. Until recently, the chapter had not been holding regular meetings. Fortunately, a lot of hard work on the part of Ward "Chip" Fetron of WAVA-FM, is beginning to pay off. Through his efforts, Chapter 37 in Washington is again meeting regularly. Engineer/manufacturer Bill Sachs previously served as chairman and is credited with much of the chapter's earlier success.

Van Buhler is chief engineer for WBAL-AM and WIYY-FM, Baltimore.

Chapter rebates

For all chapters filing the proper 1987 attendance reports and meeting notices, the checks will soon be in the mail. According to Helen Pfeiffer, executive secretary, chapter rebates will be mailed before July 1. Because rebates are proportional to chapter membership and the total national dues collected, chapters have an incentive to maintain and expand membership.

The only requirement for receiving the rebate is that the chapter's reports be complete and filed with the national office. If your chapter doesn't receive a rebate, it could mean the required reports were not filed properly by the chapter officers.

Many chapters choose to donate their rebates to the Ennis Scholarship fund or other Ennis Foundation programs. If you would like to know more about how your chapter can assist the society's educational efforts through the foundation, contact Jim Wulliman at the national office.

Sustaining membership campaign

The society's sustaining membership program has taken a giant step forward. Recently, 193 letters were sent to radio and TV managers soliciting their support for the society. Because SBE supports the bulk of the nation's frequency coordination efforts in addition to member services, such as career education programs and certification, stations may want to be financially supportive. The programs benefit managers of today's radio and TV stations.

Several stations, recognizing the benefit received from the society's work, already participate in the sustaining membership program. Encourage your manager to become a sustaining member. Joe Manning, KAET-TV, Phoenix, AZ, is coordinating the project. Contact him if you have questions or ideas.

Certification examinations

Certification examinations will be given at the national convention and **Broadcas Engineering** conference in Denver, Sept 22-25. The Application deadline i August 1. Contact your certification chair man for an application or additiona information.

Comprehensive study guides with sam ple questions and a list of reference text are available from the national office Guides are available for broadcast technol ogist, broadcast engineer AM-FM, senio broadcast engineer AM-FM, broadcast en gineer television and senior broadcas engineer television.

To obtain your copy, send a check o money order for $4.95 along with th guide title to SBE, 7002 Graham Road Suite 216, Indianapolis, IN 46220.

Scholarship announced

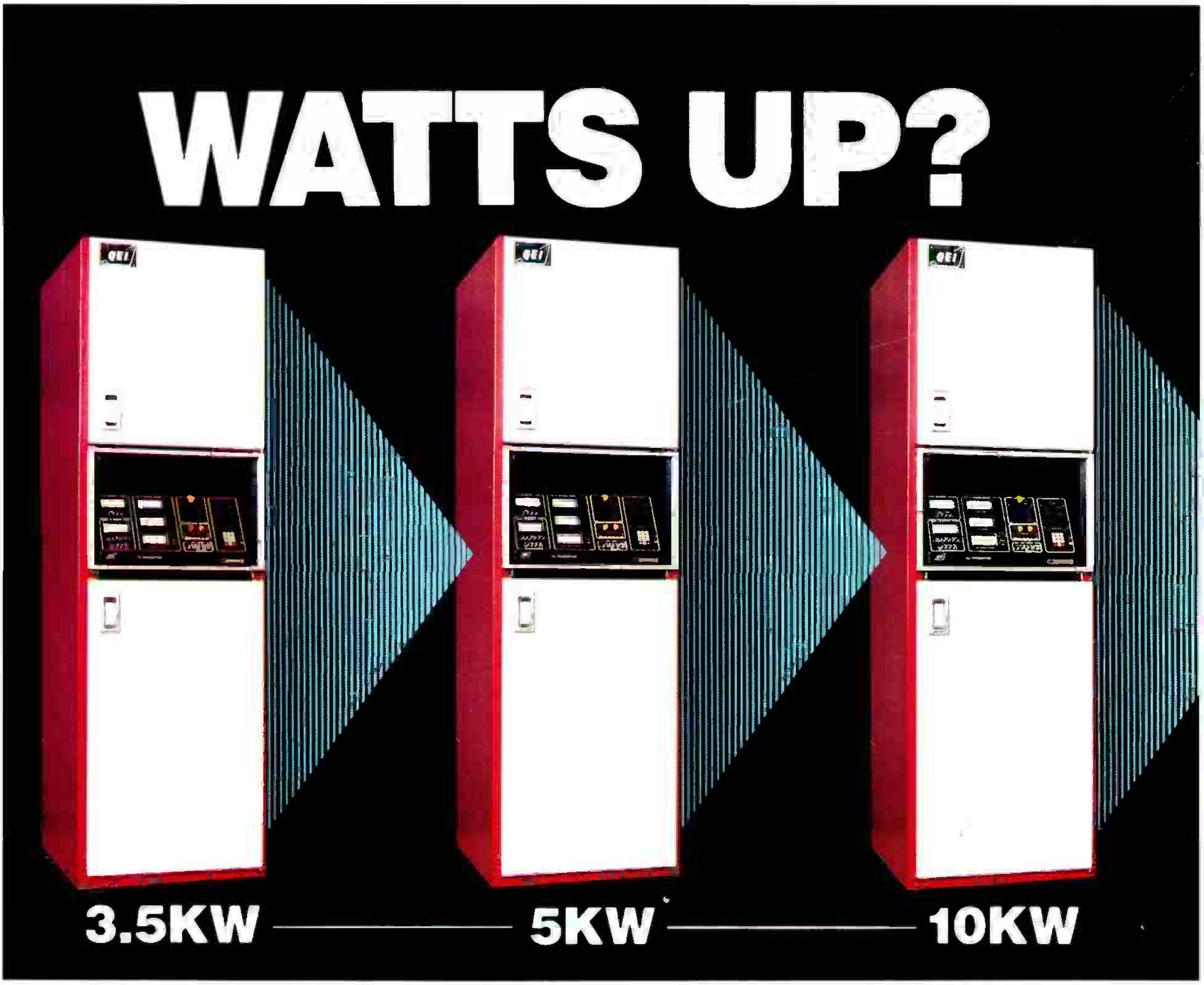
The Ennis Foundation has announce that a $1,000 scholarship will be mad through Alpha Epsilon Rho, the broadcas academic fraternity. For the second yea Roby Casper, of the University of Wiscon sin at Platteville, is the recipient. Casper' curriculum is preparing him for a caree in broadcast management. His major i engineering management, and his mino is business administration.

Ennis Foundation and Ennis Scholarshi grants will be announced soon. The tota award for this round of scholarships is like ly to be $2,500.

Awards committee

Judging soon will take place for the bes chapter newsletter. If you want your chap ter newsletter to be included in the con test, be sure that awards committee co chairmen Tom Weems and Phil Aaland ar on your mailing list.

Send meeting notices to Tom Weems Tektronix, 21300 Erwin Street, Woodlan Hills, CA 91367; and Phil Aaland, KGUN TV, P.O. Box 5707, Tucson, AZ 85703.



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If you're shopping for a 10KW unit in the first place, the QEI FMQ-10000 has lots to recommend it. No other FM transmitter packs this much power, reliability and performance into a single 24" wide rack cabinet. And the FMQ-10000 is designed to operate on single-phase power, so there's no need to pay for installing new three-phase electric service.

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News
Continued from page 4

Prior to this appointment, Steinberg ha[d] been with Ampex for 25 years, most re[cently] as president and chief executive of[ficer], chairman of the board and the[n] chairman emeritus.

Salek is NAB staff engineer

Stanley Salek, engineering manager, Cir[cuit] Research Labs, Tempe, AZ, joined th[e] National Association of Broadcaster[s] (NAB) Science and Technology Depart[ment] April 7 as a staff engineer.

He is a member of the Institute of Elec[trical] and Electronics Engineers, America[n] Electronics Association and Society of Mo[tion] Picture and Television Engineers, an[d] has an FCC general radiotelephon[e] license.

IEEE to sponsor certifications meeting

On June 16, the IEEE New York Sectio[n] Broadcast Technology and Vehicular Tec[h]nology Chapters are sponsoring a meetin[g] entitled: *Professional Certifications Pro[grams]: an Overview.*

There will be representatives from th[e] Society of Broadcast Engineers (SBE), th[e] National Association of Business and Ed[ucational] Radio (NABER), the Nationa[l] Association of Radio and Telecommunica[tions] Engineers (NARTE), and the Federa[l] Communications Commission (FCC).

The meeting will take place at 6:30 p.m[.] at the New York City Technical College[,] Klitgord Auditorium. For more informa[tion] call Mike Hayden at 212-246-2350.

NAB questions FCC proposal

The National Association of Broadcast[ers] has asked the Federal Communication[s] Commission to amend its rules to bar non[licensed] radio frequency devices from us[ing] broadcast bands allocated to the AM[,] FM and TV services. Such devices, whic[h] can cause inteference to station signals, in[clude] wireless microphones, persona[l] computers, garage door openers an[d] home security systems.

The commission has proposed to amen[d] its rules to "promote more effective us[e] of the spectrum while providing addition[al]...flexibility in the design, manufactur[e] and use of such devices."

NAB said it agrees with the commis[sion]'s grandfathering proposal to minimiz[e] the impact on equipment manufacturers[.] However, it said that the suggested 10-yea[r] period is excessively long and propose[d] five years instead.

New products

Low-print audiotape

Ampex has introduced the 478 low-print audio mastering tape. It features low-print performance, and a high-speed backcoating process provides the packing needed for flangeless use. It is available in CCIR and NAB formats and in an expanded number of configurations.

Circle (350) on Reply Card

Synchronizer, fader and controller

The Reflex fader

Audio Kinetics has introduced the following products:

- The ES 1.11 synchronizer provides a range of facilities from one machine chase functions to a large machine control network for use within a multiroom complex.
- The ES Eclipse controller is an EBU/SMPTE 16-machine controller.
- The ES SSU is a self-contained system services unit that provides an EBU/SMPTE bus with all the auxiliary features required within a machine control network. The module provides event and system relays as well as providing a system timecode source to drive external equipment. This unit operates on any ESbus system, but when it is used with the AK-ESbus, various time-code and sync source references can be distributed throughout the bus.
- The Reflex is a centrally controlled fader, muting and auxiliary switching automation system retrofittable to audio mixing consoles without any mechanical modification.
- Master cables for the Pacer Chase Synchronizer include the Sony BVU800, 3M M79, Studer B67, Fostex E2 and the National Panasonic 8500 and 9600.
- Slave interfaces for the Pacer Chase Synchronizer are the Sony BVU800, 3M M79, Studer B67 and Fostex E2.

Circle (351) on Reply Card

High-resolution film rendering

Cubicomp has introduced the model 522-00 PictureMaker's high-resolution film recorder support. The software, integrated with RACE render accelerator boards, enables Matrix film recorders to output 2,000-line PictureMaker images.

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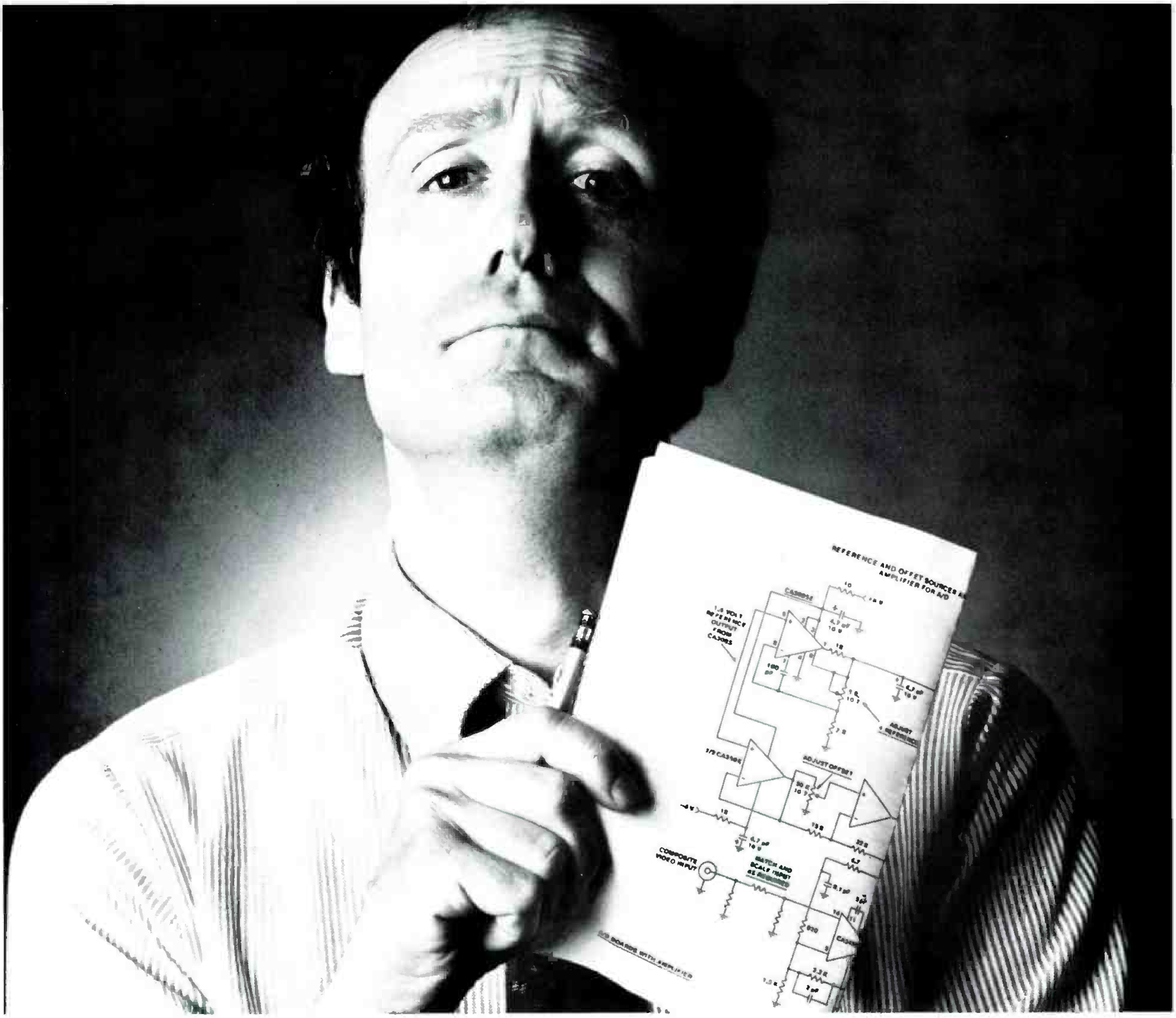

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Magneto-optical videodisc recorder

Asaca/Shibasoku has introduced the ADR-5000/5500 magneto-optical videodisc recorder. The 5000 is available in the 4fsc composite digital and the 5500 is available in the 4:2:2 component digital domain. The recorder uses high-density (more than 10Mb/s) recording techniques, and can play back up to 10 minutes of continuous motion (18,000 still pictures) per disk drive unit. High-speed access and simultaneous erase/record allow versatility in multigeneration overlays for animation and computer graphics. The high-resolution video is complemented by two channels of 16-bit digital audio and a time-code track.

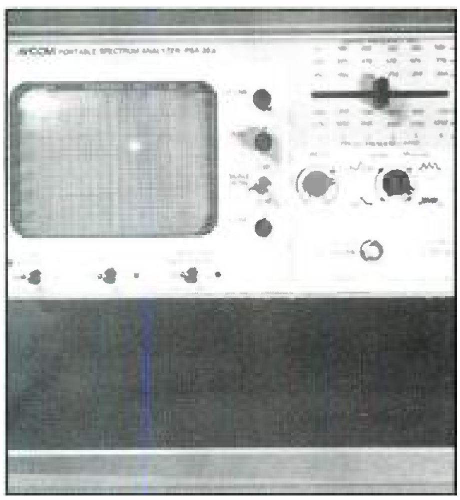
Circle (353) on Reply Card

SCPC test analyzer and spectrum analyzer

AVCOM of Virginia has announced the following products:

•The STA-70D SCPC test analyzer. It displays SCPC and FM signals and their frequencies from 0MHz to 110MHz, and has an on-screen dynamic range of more than 60dB. Vertical display sensitivity is switchable from 2dB to 10dB per division. A built-in audio demodulator allows the analyzer to function as a fixed tune receiver at zero span. This function allows for simultaneous listening and viewing of carrier signals.

•The PSA-35 portable spectrum analyzer features a standard center frequency band calibrated from 1,250MHz to 1,750MHz to cover European BDC frequencies, and a switch selectable 2dB/division or 10dB/division sensitivity function. The analyzer offers frequency coverages of 10MHz to 1,750MHz and 3.7GHz to 4.2GHz. It features a built-in dc clock with +18Vdc for powering LNAs and BDCs, calibrated signal amplitude display and rechargeable internal battery with built-in charger.



PSA-35 spectrum analyzer

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Announcing Master-21 from GVG.

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Hand-held LCR meter

Beckman Industrial Instrumentation Products Division has introduced the LM22A hand-held LCR meter. It measures capacitance, inductance, resistance and dissipation. Seven inductance ranges provide accurate readings from 19μH to 199.9H. Eight capacitance ranges cover 19pF to 1,999μF. Two different internal test frequencies are used to optimize the accuracy of readings between the high and low capacitance and induction ranges. The meter has its own 9V battery. Input protection and overrange indication is provided on all ranges.

Circle (355) on Reply Card

Mixer

Precision Design has introduced the ROAM-8 mixer. It is powered by ac or dc through an internal battery pack or external supply from +12Vdc to +30Vdc and will feed a studio line directly or plug directly into a standard telephone line via a self-contained network. Each of eight channels provides 3-band EQ and are mic or line selectable. Other features include a built-in limiter circuit and a pink noise generator. The mixer can send audio through the phone network and allows the received telephone audio to join the mix bus of the mixer.

Circle (356) on Reply Card

Waveform monitor/vectorscope

Leader Instruments has introduced the model 5870 waveform monitor/vectorscope. It incorporates an SCH phase meter, a waveform monitor and vectorscope in one half rack unit. The SCH mode provides on-screen digital readout of SCH phase. The waveform monitor offers overlaid or side-by-side display of A and B inputs for precise matching of amplitude and timing; chroma, IRE and flat filters in a single or dual filter mode; full raster line select capability with CRT readout; and memory storage/recall of up to nine field/line combinations. The vectorscope features overlaid display of A and B inputs for precise phase matching; R-Y mode; internal Z-axis blanking for single line selection; and continuous phase adjustment. The waveform and vector displays also can be superimposed for hands-free monitoring; remote-control capability of all front-panel functions is provided.

Circle (357) on Reply Card

Pre-amp and short shotgun microphone

Beyerdynamic has introduced the following products:

- The pre-amp for lavalier microphones is standard on all MCE 5 omnidirectional condenser lavalier microphones and MCE 10 supercardioid condenser lavalier microphones. The pre-amp permits the use of battery power or any phantom power supply from 12V to 48V.
- The MCE 86 short shotgun microphone weighs 95g. The condenser element and hypercardioid polar pattern provide high sensitivity, off-axis rejection and accurate sound source reproduction. Frequency response is 50Hz to 18kHz. Maximum SPL at 1kHz, with less than 1% THD, is 148dB. The microphone can be powered by any phantom power source generating 12V to 48V.

Circle (358) on Reply Card

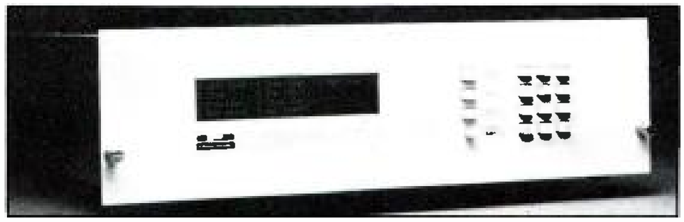
Graphics supermini computer

Lazerus has announced the 832 graphics supermini computer. It features 28 MIPS processing power with expanded display list and frame buffer memory. It provides a complete graphics environment in one work station. The parallel processing environment allows both fast vector generation and fast pixel manipulation. Other features include input by scanner, video, bitpad, keyboard, mouse and integral gen-lock to standard video; output is 32-bit true color for 16.7 million colors, RGB high resolution, RGB medium resolution, NTSC RS-170A or PAL, film recorders and printers.

Circle (359) on Reply Card

Options for time/frequency system

Kode, a division of Odetics, has announced the addition of two options for SatSync, a satellite synchronized precision time and frequency system. The first option is a disciplined rubidium oscillator that allows SatSync to offer stratum one performance as a frequency reference and continuous submicrosecond timing accuracy. The second option is a time tagging feature that allows SatSync to tag the time of randomly occurring events, with submicrosecond resolution. It also has the capability to generate a trigger pulse at a preset time of year.



Circle (360) on Reply Card

Cell pack

Energex has announced a cell pack with 3-wire multipin mount for rebuilding worn-out snap-on batteries. It is available in a 4Ah 13.2V/14.4V cell pack. The cell pack features matched capacity, 1-hour fast charge cells, high-temperature sensors monitoring all cells, two spare plug-in fuses and extra wide tab stock and multiple weld points.

Circle (361) on Reply Card

Cardioid microphone

Bruel & Kjaer has announced the type 4011 high-performance cardioid microphone. It is a prepolarized condenser microphone, with a first-order cardioid directional characteristic. It combines a flat on-axis frequency response with a uniformly smooth off-axis phase and frequency response. The microphone has a nickel diaphragm and a P48 phantom-powered transformerless pre-amplifier. Each microphone is individually calibrated, and can handle 158dB SPL before clipping occurs. The mic has a −20/0dB attenuator, user-selectable via a switch recessed in the XLR connector.

Circle (362) on Reply Card

RF hybrid

Dielectric Communications has introduced the 180kW UHF 3-tube Magic Tee. It delivers transmitter power to the notch diplexer if tube failure occurs in a 3-tube system. The tee has no moving contacts anywhere in the RF path, except for the aural detuners. These features allow switching between visual amplifiers in any combination. The tee uses standard 3dB hybrids. The system comes with heat exchangers, test loads, notch diplexer, all test and reject loads and monitoring couplers.

Circle (363) on Reply Card

Expanded EDL and sound-sweetening system

CMX has introduced the following products:

•The 3400A software version 600 allows for the expanded EDL function through the use of full alphanumeric reel names. The software also allows for the highlighting of all lines of a featured event, including master/slave information. Any existing 3400A can be upgraded. The version 600 software option will be standard on all CMX 3400A systems delivered after April.

•Features and options including the Gismo have been added to enhance the capabilities of the CASS-1. The options include track-select that allows an editor to arm up to 48 channels on a multitrack tape recorder through software; the CMX I^2 (intelligent interface), a synchronizer that addresses a broad base of machine types through the CASS system; the KSM (keystroke memory file) improvements include nine hot keys along with KSM editing.

Circle (364) on Reply Card

Circle (115) on Reply Card

Circle (117) on Reply Card

Circle (116) on Reply Card

Isolation communications system and wireless intercom

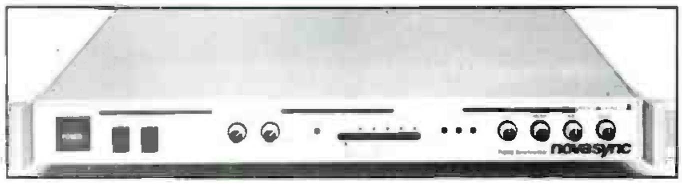
Clear-Com has introduced the following products:

- The ISO-4000 station ISO system for teleproduction applications. It includes 2-, 4-, 8- and 16-channel intercom stations for both conference line, point-to-point and mixed function applications; single, 2-channel/dual listen, and 2-channel full stereo/split-ear digitally controlled beltpacks; 2-channel capability over single standard mic cables; full stereo/split-ear IFB over single standard mic cables; full-duplex, multichannel wireless beltpack system; and full factory system design support, including AutoCad system block diagrams.
- The W series wireless intercom system consists of the WBS-6 base station, WTR-1 portable transceivers and a series of accessories. The series features full-duplex operation. Up to six WTR-1 portable transceivers can be supported by adding WBS-R receiver modules to the WBS-6 base station. A dynamic compandor circuit provides wide audio frequency response. The WBS-6 base station connects directly to a standard intercom line. Two 9V batteries power the WTR-1 for eight continuous hours.

Circle (365) on Reply Card

Frame synchronizer

Nova Systems has introduced NOVASync, a video frame synchronizer that combines frame synchronization, auto default, video AGC, input switching, black source, color bars and processing amplifier in a one-rack-unit-high package. It features full bandwidth, 8-bit encoding and 14.3MHz sampling for maximum transparency. A/B video inputs plus synchronous alternate inputs enable flexible system integrations. Automatic gain control raises or lowers video level to compensate for signal loss or termination errors. Auto default to black, color bars or an alternate input such as a character generator or still store allow system flexibility.



Circle (366) on Reply Card

Universal battery support system

Christie Electric has introduced the CASP/1000 Wonder Box, a universal battery support system. The system rejuvenates NiCad batteries by erasing memory and restoring faded capacity. The system also recharges zinc-silver, lead-acid or lithium batteries. The support system uses the ReFLEX charging method to restore batteries. Up to six batteries of varied types may be connected to the system at the same time. The system multiplexes from battery to battery automatically, giving each battery the type and amount of charging current it needs. The unit has three color-coded control keys. The system operates on mains power and accepts inputs from 90Vac to 265Vac, at frequencies from 47Hz to 440Hz.

Circle (367) on Reply Card

Foam-packed cases

Jensen Tools has introduced Pelican cases made of cycolac resin. The cases have replaceable ¼-inch Neoprene "O" ring seals to make them airtight and to enable cases to keep up to 50 pounds of equipment afloat. Pressure purge valve releases the seal for change in altitude. The cases are packed with layers of foam, prescored into ½-inch cubes to allow the user to pluck and fit foam to the exact shape of the case contents. Other features include molded oversized handle, positive-locking molded latches and padlockable locking flange.

Circle (368) on Reply Card

PC control terminal

Moseley has introduced the PC Control Terminal option that emulates the control terminal with a personal computer and compatible software. Interconnection is available via an IBM AT-compatible personal computer for serial access to monitor and control the MRC-2 remote-control system. The multitasking system automatically stores data to hard disk while other programs are running. The PC control option adds both feedback-oriented and time-oriented functions to the system. The option is capable of multiple steps with logic branching at many levels to accommodate control and switching of multiple transmitters and antennas.

Circle (369) on Reply Card

Graphics supercomputer

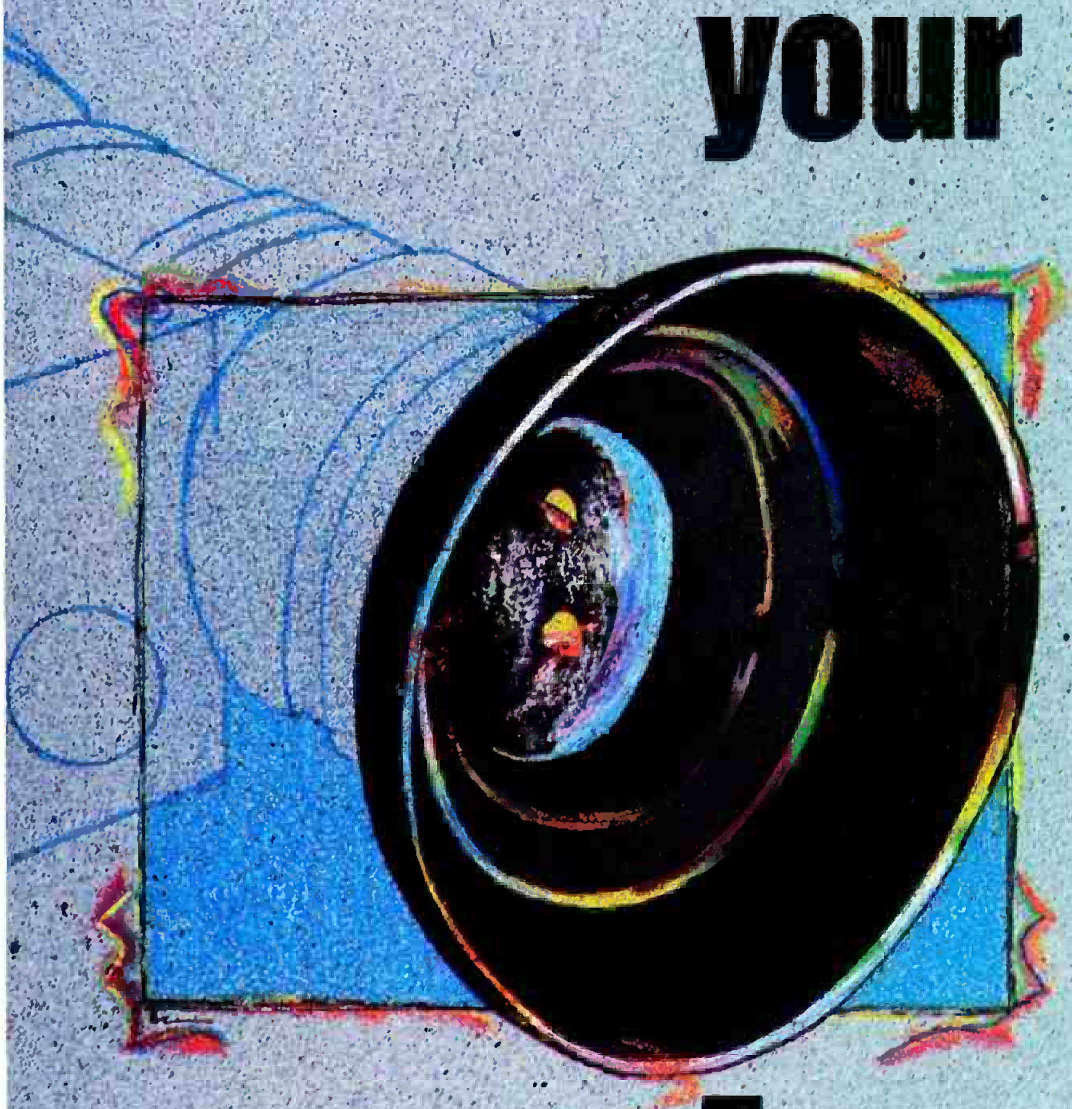
Stellar Computer has announced the following products:

•Stellar Graphics Supercomputer model GS1000 delivers 20-25 MIPS integer performance, 8.6 MFLOPS floating point performance as measured by the 100x100 all Fortran Linpack benchmark, and 150,000 Gouraud-shaped, Z-buffered polygons per second graphics performance. The architecture uses application-specific integrated circuits and includes multiple, parallel functional units and large main and cache memories all coupled with a central, very high-bandwidth DataPath. The computer comes with the Stellix operating system, a multiprocessing, multiprogramming, multitasking software environment based on UNIX[R] V release 3 with BSC 4.2/4.3 extensions. The computer supports Fortran 77 with VAX[R], Cray and Convex extensions, and C. Both programming languages are delivered as optimizing and vectorizing compilers.

•StellarVision is an interactive visualization environment. It offers a comprehensive set of tools. User interfaces include the X Window System, Version 11, and PHIGS+.

Circle (370) on Reply Card

Focus on your future



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Video imaging system board

IDR has introduced the IDR capture, merge and display (CMD) board. It is a high-performance video imaging board that turns a PC-AT compatible computer into an integrated full-color image processing system. It can display a full-motion video image—together with a virtually unlimited number of windows containing captured still video images, graphics and text—on an RGB analog TV monitor, in more than 16 million colors. The board consists of three Intel 82786 graphics co-processor chips, each supporting 1Mb of random access memory; an on-board time-base correction circuit; and high-speed A/D and D/A converters. The 3Mb of on-board memory allows three full screen digitized images.

Circle (371) on Reply Card

Label printing software

Panduit has introduced the PAN-MARK software program to produce Panduit computer printable labels and data plates. The program can produce number, letter and number/letter legends; UPC-A, Code 39, and interleaved two of five bar codes; serialization in up to 24 combinations; and bar codes in combination with number, letter or serialized legends. One command loads all sizes of the selection of standard labels and data plates. To use the program, the operator types the information into a WYSIWYG multiple-label screen graphic. The software program requires an IBM-PC, XT, AT or compatible personal computer, minimum 512K memory, two drives, DOS 2.1 or higher. A graphics card is not needed.

Circle (372) on Reply Card

Commercial insertion system

Rational Broadcast Systems has introduced a multichannel commercial insertion system that provides for automatic insertion of commercial breaks across an unlimited number of channels with no prespot editing or tape editing. The system accesses a pool of SMPTE time-code-tagged commercials on tape. The company will integrate the system with existing tape machines or will supply a complete turnkey package including tape machines and required video equipment.

Circle (373) on Reply Card

75W TWTA

Stantel has introduced the W2MC15N and PW2C15N. The TWT provides 49dB of gain at a working power output of 75W over the 14GHz to 14.5GHz band with low gain variation and ripple. Its double-depressed collector is optimized for efficiency and to minimize heat sink requirements. Performance and long life are ensured by an osmium-coated cathode and a 12-position switch located on the front of the power supply. The PSU/TWT interface is controlled by an electronic circuit that automatically sets up the tube electrode voltages through a low-voltage control cable.

Circle (374) on Reply Card

Rack-mount cabinets

Winsted has introduced rack-mount cabinets that feature a 30° sloping profile with 21 inches of rack space. The sloping module can be combined with System/85 modules.

Circle (375) on Reply Card

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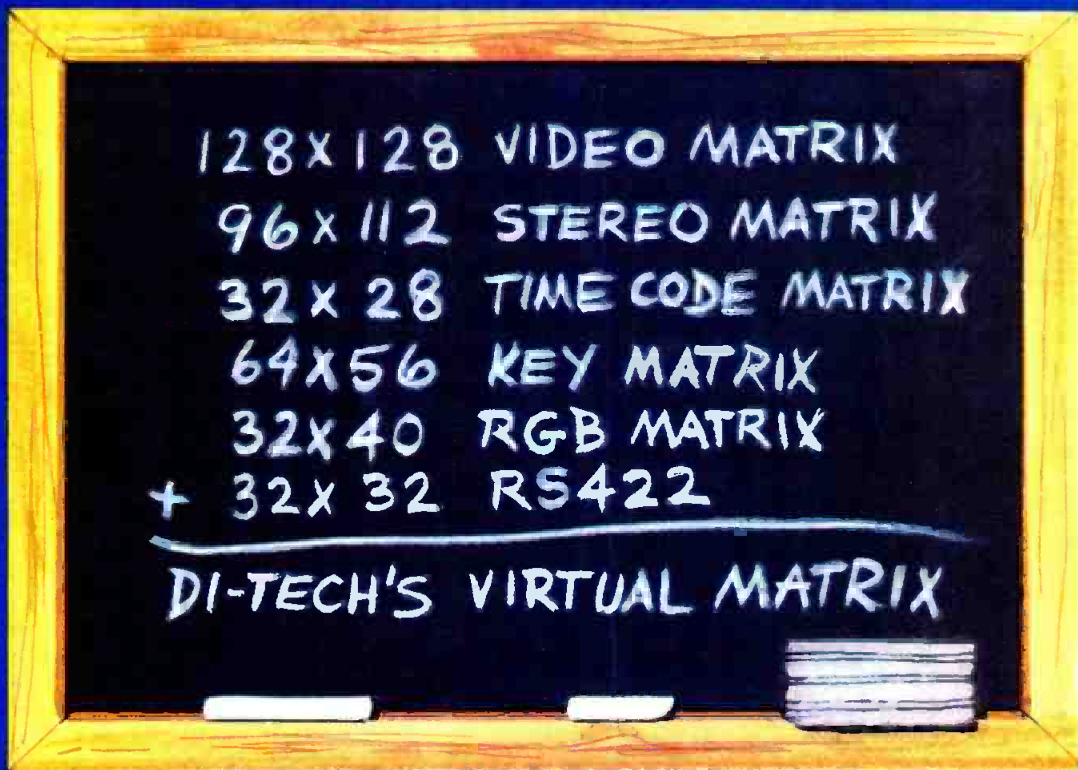

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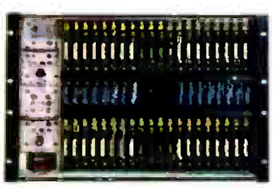
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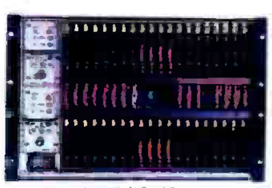
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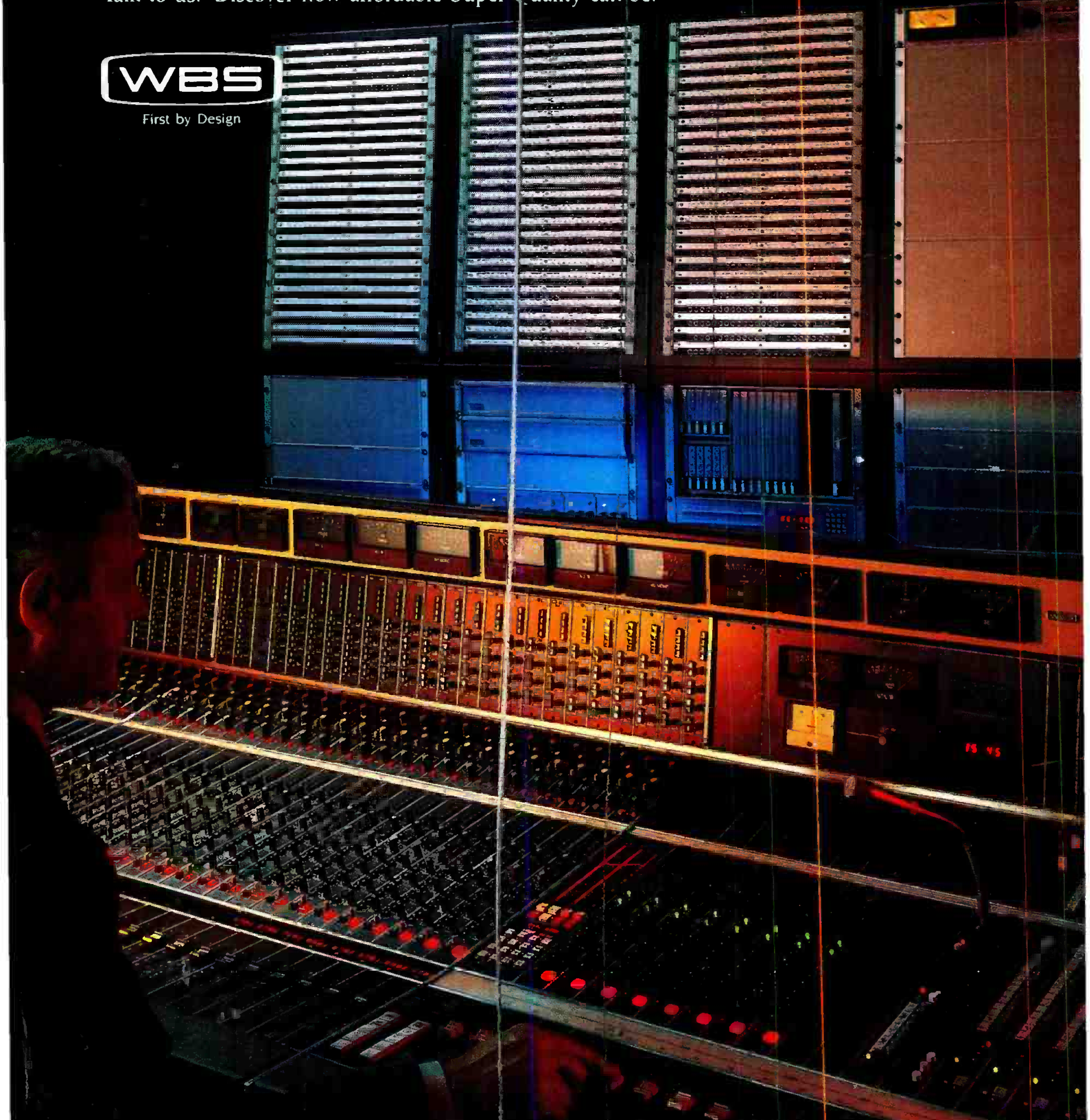

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