BROADCAST engineering

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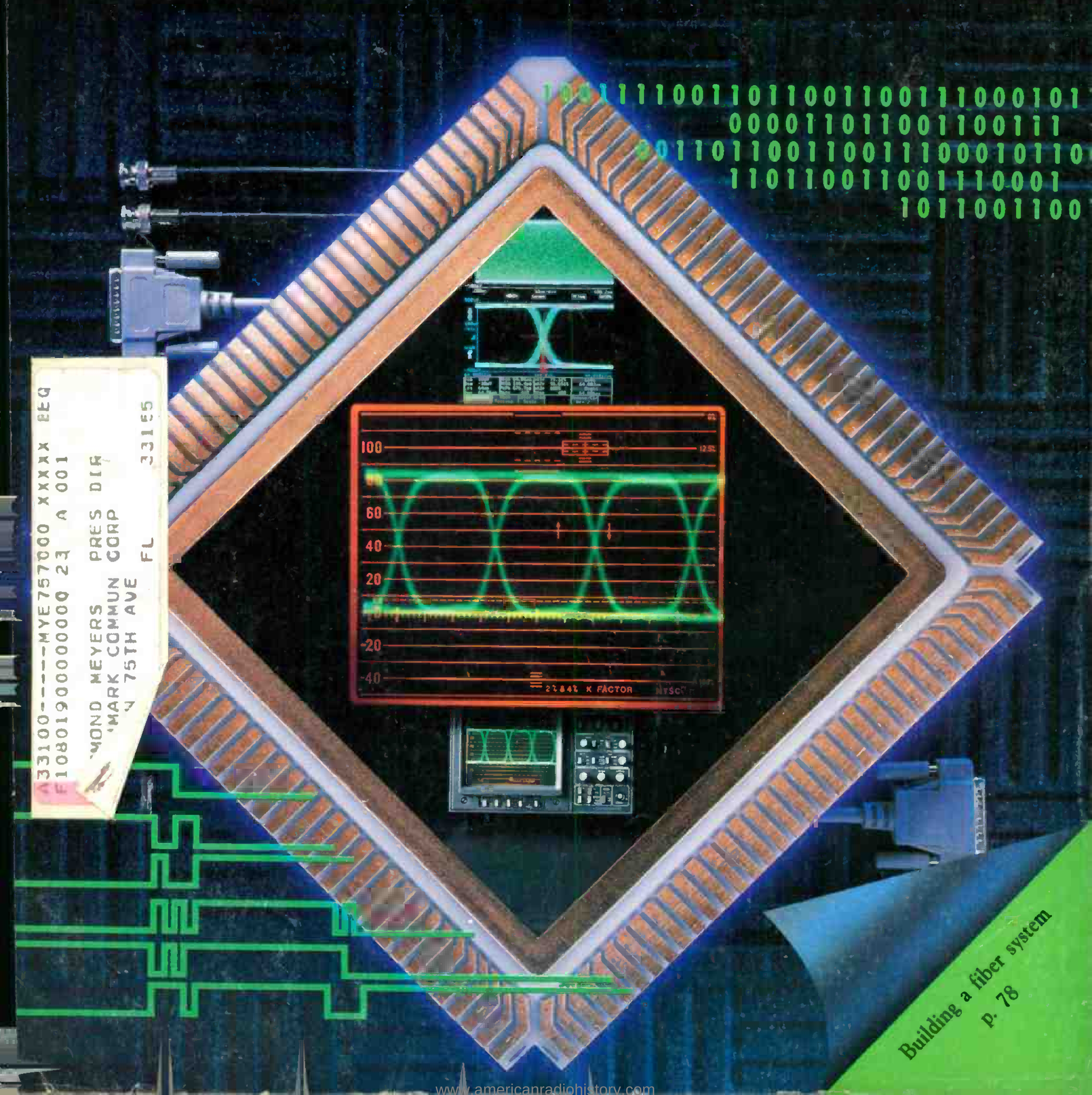
Annual station maintenance report



Building a fiber system
P. 78

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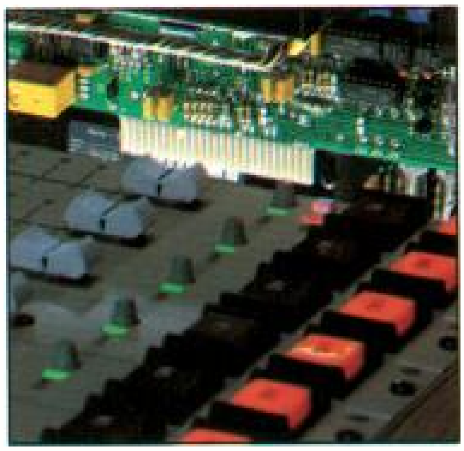
BROADCAST ENGINEERING



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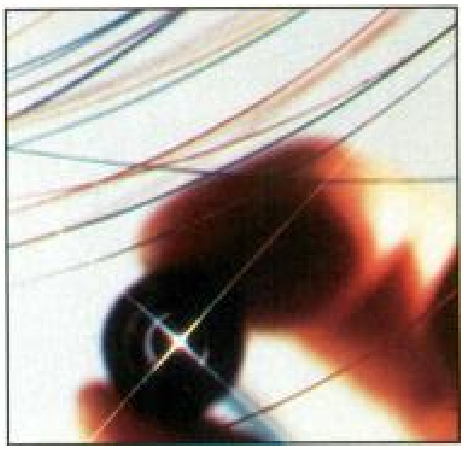

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MAINTAINING BROADCAST AND PRODUCTION FACILITIES:

As equipment becomes more complex and sophisticated, the types of skills needed to maintain it change dramatically. System-level servicing, as opposed to component-level servicing, becomes the primary tool.

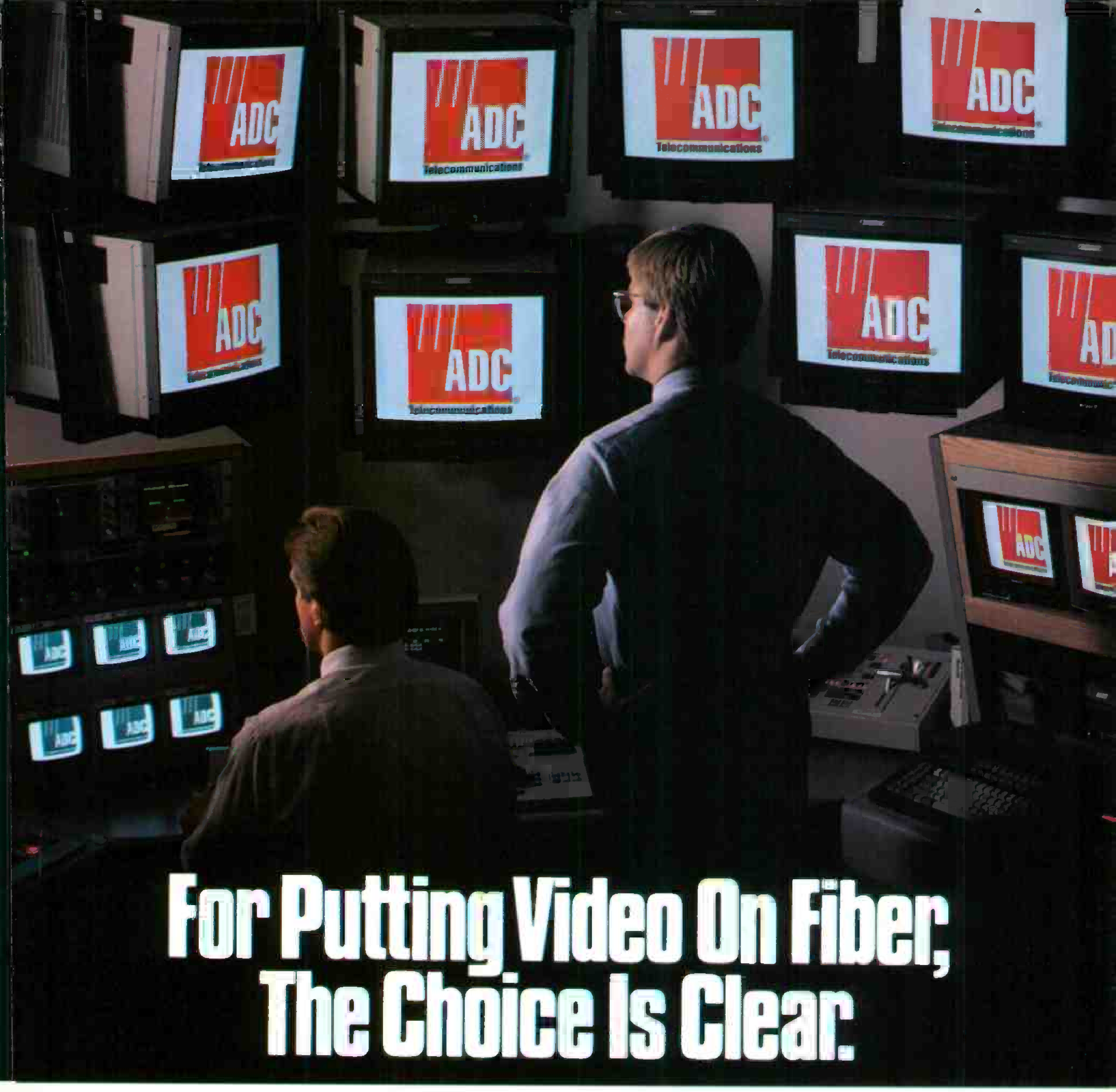
FEATURES:

OTHER FEATURES:

DEPARTMENTS

ON THE COVER

Modern broadcast and production equipment often relies on digital technology. The cover illustrates the importance of VLSI circuits in making digital audio and video signal processing possible. (Cover credit: Design by Tektronix.)



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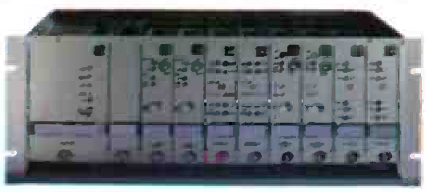

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Circle (5) on Reply Card

By Dawn Hightower, senior associate editor

New York ceremony awards Technical Emmys

The National Academy of Television Arts and Sciences (NATAS) presented the Technical Achievement and Scientific Development Engineering awards at its 1990-1991 annual technical engineering Emmy awards ceremony, September 24, in New York.

The Emmys were awarded to 15 companies and one individual.

The academy bestows the technical achievement Emmys to individuals or companies for engineering developments that are either extensive improvements or so innovative that they materially affect the transmission, recording or reception of television.

The following companies were awarded more than one Emmy: Sony was honored with three Emmy statues and NEC received two. Masahiko Morizono, chief adviser for technology, Sony, was the sole individual honored with an Emmy.

The following companies were each awarded with one Emmy: Accom, Abekas Systems, Faroudja Laboratories, The Grass Valley Group, Magni Systems, Matsushita Electronic Corporation (Panasonic), Philips, Radamec EPO Ltd., Telettra USA, Tektronix Television Division, Toshiba, T.S.M. and Vinten Broadcast.

Listed in alphabetical order is the complete list of the awardees and achievements honored with technical Emmys.

- *Accom* for digital encoding from 525/625 analog and digital component to analog and digital composite.
- *Abekas Video Systems* for multilayer real time component digital video compositing technology.
- *Faroudja Laboratories* for techniques for minimization of NTSC artifacts through advanced encoding techniques.
- *The Grass Valley Group* for multilayer real time component digital video compositing technology.
- *Magni Systems* for development of test signals and measuring equipment for performance evaluation of component video systems.
- *Mr. Masahiko Morizono* for technical vision and leadership in the TV industry.
- *NEC* for pioneering work and implementation of data compression techniques for real time TV transmission. Also for CCD imaging technologies.
- *Matsushita Electronic Corporation (Panasonic)* for CCD imaging technologies.
- *Philips* for the development of digital audio technology leading to the compact disc.
- *Ramadec EPO Ltd.* for computerized robotic camera systems.
- *Sony* for outstanding achievement in scientific and technological development. Also for CCD imaging technologies and the development of digital audio technology leading to the compact disc.
- *Telettra USA* for pioneering work and implementation of data compression techniques for real time TV transmission.
- *Tektronix Television Division* for development of test signals and measuring equipment for performance evaluation of compact video systems.
- *Toshiba* for CCD imaging technologies.
- *T.S.M.* for the development and implementation of TV camera robotics system.
- *Vinten Broadcast* for computerized robotic camera systems.

Consumer Electronics Group forms DAR subcommittee

The Electronic Industries Association's Consumer Electronics Group has formed a digital audio radio (DAR) subcommittee to initiate activities to centralize DAR system technical analysis, comparative testing, system selection and standards development. The committee is chaired by Randall Brunts of Delco Electronics.

The R-3 digital audio radio subcommittee was formed to organize and initiate a fair and impartial analysis, testing and standards-setting program in order to determine which DAR technical system will best serve EIA membership and consumers. Complete system performance that affects sound quality, such as program source encoder/decoder, transmission systems elements and the receiver, will be given primary consideration.

NAB wants FCC to scrap broadcast fines

The National Association of Broadcasters (NAB) wants the Federal Communications Commission (FCC) to scrap its new fine and forfeiture schedule, which is a price list for broadcast rule violations, because it was crafted without the required public comment period. This vio-

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BROADCAST ENGINEERING

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Gutsy move

It took guts, but two industry associations recently took the major step to combine the exhibition portion of their trade conventions. The Society of Broadcast Engineers (SBE) and the Radio and Television News Directors Association (RTNDA) boards of directors each voted unanimously to combine the exhibition area of their conventions beginning in 1993.

Each association will continue to maintain separate convention programs. Only the exhibition area is involved in the joint effort. Both groups have expressed interest, however, in holding at least one joint seminar on an area of common interest. That wouldn't be hard, given today's need for cooperation between the engineering and news departments.

The agreement was first announced at the October SBE convention in Houston. Reaction to the news from attendees and exhibitors was positive.

Exhibitors seem pleased with the prospect of having to attend one less show. Faced with rising costs, cost-conscious exhibitors are often torn between attending multiple and competing shows. This is especially the case where the product lines cross several markets or applications. Exhibitors want their products shown to as many prospective customers as possible. Unfortunately, it's seldom possible to cost-justify attending every trade show that claims to have attendees who can buy the hardware.

The joined forces of SBE and RTNDA may now be able to create a show with such powerful attraction for exhibitors that the net result is more than one plus one. Companies that previously attended only the spring NAB show may now give a second look to the larger SBE/RTNDA show floor. For a little extra expense, a new set of potential customers could be available to the exhibitor.

The attendee gains from the agreement, too. A larger exhibition means that more equipment and vendors will be on-site for inspection. A primary attraction of the SBE show was its smaller size, which allowed close contact with the vendors and equipment. That same advantage will be present with the new show floor, but more options for equipment and vendors will be available.

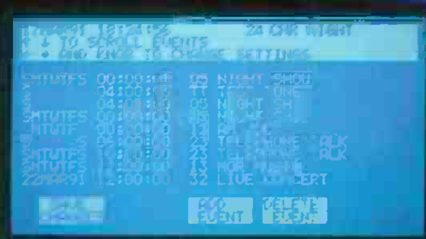
The final winners in this collaborative effort are the two associations. The leadership of SBE and RTNDA realized that one large and strong trade show will mean greater benefits to both memberships than would two smaller events. Deciding to unite efforts has been a tough pill to swallow for some board members, but they made the right choice.

SBE and RTNDA are to be congratulated on their effort to support each other — and the industry. It was a gutsy move, and one where everyone comes out winning.

Brad Dick

Brad Dick,
editor

PURE DIGITAL.



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Commissioner states views on DAB

By Harry C. Martin

FCC Commissioner Sherrie Marshall stated her views on the future of digital audio broadcasting (DAB) at the NAB's Radio 1991 Convention in San Francisco this September. DAB is viewed as a threat by many existing broadcasters, because the FCC has yet to decide what and how much spectrum will be dedicated to the new service, to what extent existing stations will be invited to participate, and how much new competition will be created.

In her speech, Marshall offered broadcasters positive forecasts "for surviving and perhaps even thriving" with DAB. She pointed out that existing radio stations are in a particularly good position to take advantage of DAB because they have significant experience in providing free, locally distributed and universally available programming. However, significant questions remain as to how DAB will be implemented and how it will impact local radio broadcasters.

Marshall predicted that DAB would be available through national, multiple channel, satellite-originated sources delivered via wire or satellite directly into the home. Such services most likely will include a combination of commercially sponsored and subscription programming services. The same multichannel packaging that is reshaping the video world, the commissioner said, will allow a program provider to reach a mass audience by capturing many narrow audiences.

Marshall noted that current developments in channel compression may allow existing FM stations to compete on a multichannel basis. However, "in-band" DAB technology, if implemented, would pose the following significant policy questions:

- Would terrestrial broadcasters have to wait to implement DAB until in-band is perfected, while satellite-delivered DAB is permitted to get a head start?
- Would AM broadcasters end up as a permanent technological underclass absent a DAB spectrum allocation for their use?
- Would such an allocation create a technological parity that would unfairly diminish the investment premium paid for and expected by FM broadcasters?

The commissioner pointed out that implementation of any DAB scheme depends upon the spectrum allocation decisions to be made at the February 1992 World Administrative Radio Conference (WARC), which will convene in Spain. The U.S. position on spectrum for DAB has not been determined.

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

Entrepreneur's preference urged

The FCC is considering the adoption of an "entrepreneur's preference" in comparative hearings. The preference would be available to a party who successfully pursues an FM allotment through the commission's rulemaking process. At least three rulemaking petitions advocate the adoption of such a preference, and NAB has filed comments supporting the idea.

NAB's position is that currently there is little incentive for an existing broadcaster to seek out an FM frequency, because once allotted, the frequency is open for applications from all newcomers. The entrepreneur who has expended the considerable effort and money in locating the vacant frequency receives no preference in the ultimate licensing process. In fact, a broadcast entrepreneur usually is at a disadvantage vis-a-vis other applicants in a hearing because an existing operator has little flexibility to structure its ownership to take advantage of comparative preferences. Few broadcasters are willing to take the initiative to propose new FM channel allocations under these circumstances.

Under the proposed entrepreneur's preference, the party who invests "sweat equity" in finding a vacant frequency would be given a preference that would be weighed against other available preferences, such as those awarded for media diversification, integration of ownership into management, local ownership and minority control.

FCC chairman advocates "video dial tone"

In a September address in New York, FCC Chairman Alfred C. Sikes advocated as a national goal the provision of a "video dial tone" as early as customer demand warrants. The video dial tone concept entails allowing local telephone companies to offer their customers easy video access to a multiplicity of video services, including 2-way interactive services.

Sikes outlined a 6-step program to allow market forces to work in developing video dial tone capabilities:

- Make sure the telephone company does not have to get local permission to install and operate a data, voice and video network.
- Make sure the phone companies, where they are monopolies, serve as common carriers, but allow them to offer a full range of advanced information services as well.
- Make sure the telephone company's network is open and that access to transmission paths or network computer functions is reciprocal.
- Make sure the telephone companies, not regulators, price retail services that are competitively provided.
- Allow phone and cable TV companies to enter into arrangements that would allow cable operators to invest in, not simply lease, facilities for carriage of video programming.
- Restrain telephone companies — at least on a transitional basis — from full program involvement.

Existing TV stations, Sikes pointed out, have little chance to be true integrated, broadband network providers. However, broadcasters will want a significant role in how such providers are regulated, because such providers may well have control of their distribution channels. Cable companies, on the other hand, are working to upgrade their plant and to block the telephone companies from competing as broadband video providers.

Sikes sees these conflicts being resolved, at least to some extent, through teaming efforts where broadcasters and cable operators would provide programming but use telephone company facilities to create or expand their services. In this connection Sikes noted that, due to legal restrictions, telephone companies have virtually no experience in video markets.

Sikes favors continuing restraints on the telephone companies to prevent them from full involvement in provision of video programming, at least on a transitional basis.

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"When I joined WTVH two years ago, the existing cart handling equipment was more than 15 years old. There was a real need for a new, more reliable cart machine. I took a serious look at the machines out there, then settled on the Odetics TCS2000.

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The efficiency of the Odetics equipment has streamlined our entire operation. Our older technology machine would hold only 24 spots at a time. We load over 400 spots into the new machine. Also, we use the Odetics machine's multi-cut feature, and that's increased our on-line spot capability by about 33 percent.

At WTVH we run 2-1/2 hours of local news every day, so last-minute changes are routine. Using the Odetics keyboard, we can insert new material up to 30 seconds before going on air. Deletions need only two seconds lead time.

One of the most useful aspects of the machine's software is the reports it generates. For example, I can pull a report any time showing what spots are needed that are not already in the machine. In the past, we might not know we were missing a spot until just before air time.

This machine has certainly made my own job a lot easier. That's what I like most of all. I don't hear any more comments at staff meetings about spots being lost on-air, and it's a pleasure to see those blank discrepancy reports.

If you're considering installing a new cart machine, give me a call at (315) 425-5555. I'll be glad to talk with you firsthand about the advantages the Odetics TCS2000 has brought to WTVH."

Jim Bernier, Director of Engineering
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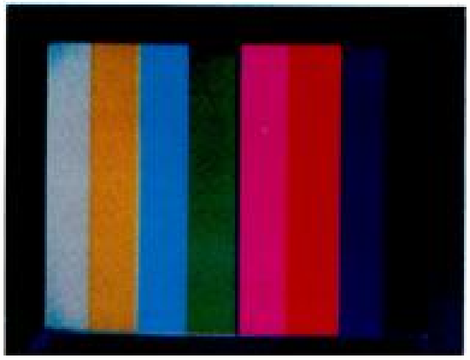
Part 2

Strictly TV



PCs for TV

TV multimedia

By Rick Lehtinen, technical editor

Last month's column discussed how a station could build an inexpensive PC-based station ID system that could play computer-generated ID slides and play back audio tags. This month we will address how an emerging technology called *multimedia* may impact the TV business.

TV multimedia

Multimedia generally implies the use of a computer to control several pieces of audio and video equipment. The output of this equipment may be displayed on audio and video monitors, or it may be transformed into signals that can be displayed on the computer's screen. To be useful in television, the system must have a high-quality video output. One way to do this is to synchronize the computer to the video and key the computer images over it. Devices that do this are often called *genlocks*. Another way is to reclock and interpolate the computer display, and make it a video signal. Devices of this type are called *scan converters*. In most cases, scan conversion is the better process, but it's usually more costly.

A multimedia system is similar to an edit controller. Both orchestrate the movements of VTRs and ATRs.

A multimedia system is similar to an edit controller. Both orchestrate the movements of VTRs and ATRs. Newer non-linear editing systems are even closer to multimedia. They store images on a random-access medium, such as laserdisc, recordable optical disc or CD-ROM. The editing system or multimedia controller accesses each item off the disc as it is required, regardless of the order in which it was recorded. The latest multimedia systems and non-linear editors use digital compression techniques and special cards to store high-quality imagery with greatly reduced memory requirements.

Two paths

One area in which editors and multimedia diverge is in the treatment of audio. An editor is likely to treat audio as a linear signal, to which it will add and subtract during processing. A multimedia system may also work this way, or it may store the audio as data files, usually compressed. These are reproduced using special audio playback cards. The system may also make use of the musical instrument digital interface (MIDI) protocol to control various synthesizers, instruments or signal-processing devices. In this manner, a multimedia system often re-creates, rather than merely replays, the audio.

Another difference between editors and multimedia is their range of peripherals. Using GPI triggers and other interfaces, editors often activate still-stores, character generators, switchers and mixers. Multimedia systems could also do this, but their application is usually live, not recorded. Thus, a multimedia system may control a room full of presentation, lighting and sound equipment, in addition to the video and audio playback devices.

User access is also another issue. A fast-paced business, such as broadcasting, often needs control panels with one function per button. This promotes operator familiarity and speed. There has been some backlash against soft keys, particularly if the menu is more than a few layers deep. However, today it is possible to buy a complete computer for less money than it takes to manufacture some control panels. This has led some broadcast manufacturers, and nearly all multimedia providers, to adopt a PC as the universal front-end. The subject of system control is open for further study. Touch screens and voice recognition will likely figure heavily in next-generation products.

Multimedia impact

So what effect will multimedia have on television? It is an enabling technology that could help thousands of people who might never have considered creating video to enter the arena. At least a portion of these people may come to depend on true video facilities for effects and video processes beyond their own desktop capabilities. This may increase the demand for traditional video production facilities that can market to this segment. Similarly, the video facility too firmly rooted in the status quo may find itself threatened as new users undertake the simpler video production tasks on their own.

Today it is possible to buy a complete computer for less money than it takes to manufacture some control panels. This has led some broadcast manufacturers to adopt a PC as the universal front-end.

Another multimedia fallout may be pressure on traditional equipment manufacturers. They may be forced to offer lower-end products (less expensive) to compete with the PC-based systems. For instance, there are now PC-based products that can provide many types of video production effects: switching, still-store, CG, paint, 3-D animation and even special effects. (See "PC-Based Effects Systems," February 1991.) The advent of these less-expensive products may actually be good for the market. Such products can introduce many new users to the arena of video production.

The PC-based systems will not in the short term completely replace the high-dollar production hardware. Such equipment offers the professional users many operational advantages that PC-based systems are not yet able to provide. In addition, the issue of image quality always comes to mind when comparing the output of video production systems. The jury is still out on whether these PC systems will be able to compete at the broadcast and production house levels when maximum image quality is of primary concern.

Acknowledgments: The author wishes to thank Henry Mistrot, Video Associates, Austin, TX, for help in the creation of this article.

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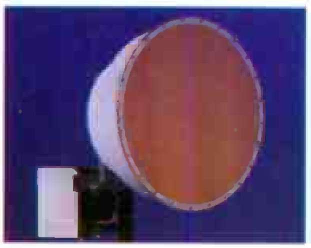

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Antenna systems

Shunt feeding and folded unipoles

By John Battison, P.E.

Last month, I discussed early AM antenna systems and the isolation problems and vulnerability to lightning engendered by their "above-ground" nature. These problems led to the development of the *shunt-fed* antenna, which was also desirable because of its lower cost.

A shunt-fed system does not require an expensive base insulator, a lighting transformer or a choke system. Static discharge resistors or coils are not needed, and as many antennas as the tower can support can be hung on it with little affect on its operating impedance. In many cases, a single capacitor in the feedline is all that is needed to cancel the reactance. Therefore, the cost of an ATU is avoided. Because of its bandpass characteristics, however, a T-network ATU may be needed to restrict the harmonics that could be radiated without one (depending on the transmitter used).

However, the FCC will license stations using simple shunt-fed antennas only if all of the following conditions are met: 1) operation is daytime only, 2) no critical hours operation is required, and 3) the antenna is non-directional. Because of the shunt feed, radiation calculations during critical hours and for directional antenna operation are not feasible. Therefore, the simple shunt-fed antenna is not used as much as its ultimate development, the *folded unipole*. The folded unipole can be used wherever a vertical antenna is appropriate, and presents some additional advantages in certain applications.

Another problem with the standard shunt-fed antenna is its requirement for high-RF voltage to overcome the high capacitive reactance it exhibits when antenna height falls below approximately 0.2 wavelengths.

Furthermore, experience has shown that as the feed point is raised, the driving-point resistance also increases and can go to 100Ω or more. Reactance will increase simultaneously. For these reasons, it is seldom possible to drive a shunt-fed antenna directly from a 50Ω transmission line. If the feed point is adjusted to give 50Ω resistance, the reactance will probably become unwieldy and require a capacitor to cancel it out.

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

Folded unipole

Issues of cost, zoning or FAA regulations often require AM broadcasters to use antennas much shorter than a quarter-wave — perhaps as short as 45°. However, FCC rules specify a minimum radiation efficiency that not many 45° antennas can meet (even if one does, coverage will probably be poor).

The solution is a *folded unipole* (or *monopole*). The basis for the antenna is a simple "top-loading" feature, which consists of wires connected to the top of the tower and hung down the sides to form a skirt. This top-loading increases the base impedance considerably and results in surprisingly good efficiency.

For a station with a short tower (especially if its ground system is also poor), the installation of a folded unipole can make a substantial improvement, providing the equivalent of a quarter-wave antenna. Measurements have shown that a folded unipole can develop a *higher* field intensity than an equivalent-height, series-fed antenna.

The basic construction is shown in Figure 1. It consists of three or six wires that are dropped from 30-inch arms mounted on top of the tower, forming a skirt. The wires are brazed to the arms and insulated from the tower on the way down, terminating in a circular bus at the tower's base, connecting all wires. Insulated tensioners maintain a stable skirt.

Base input impedance is measured at the bus lead with an in-line bridge. Shorting stubs are connected from the drop wires to the tower to tune the system to the desired impedance. Start with the short at the top (where impedance should read j+), and move the short down the tower until $Z_B = \pm j0$, with resistance at some acceptable figure. Provided that R is reasonable and the drive is adequate, this impedance can be connected directly to a transmission line, but a matching network is preferable.

Other applications

Sometimes a tall FM/TV tower is pressed into service to carry AM as well.

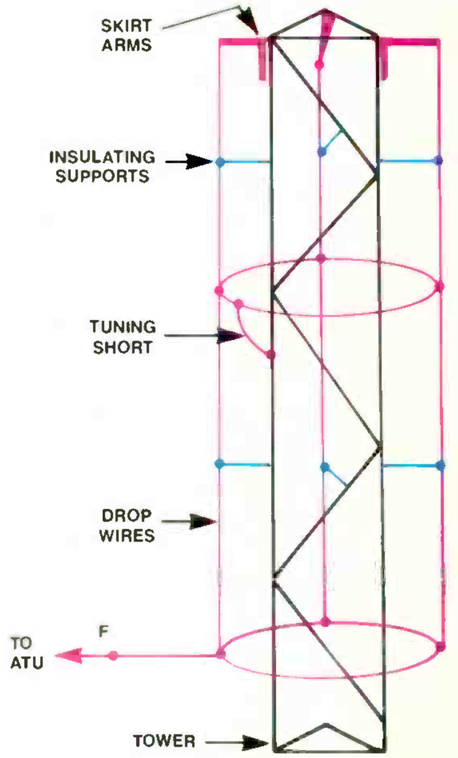

Figure 1. *Basic folded unipole, with three drop wires is shown. Wires are brazed to arms at the top of the tower, and supported by insulator down the sides of the tower. Terminating bus at base connects all drop wires to ATU. Tuning short is adjusted for desired impedance, measured at point F.*

When an AM tower is *greater than* 90°, matching problems can occur. (Yes, a tower can be *too tall* to work properly on AM.) This kind of application is usually planned for in advance, and the tower can be sectionalized to avoid being too tall for good AM operation.

Folded unipole theory can also be applied to *detuning* towers that are close to AM radiators and affect their operation. (See "re: Radio," March, April and September 1991.)

Don't assume that the folded unipole is a universal panacea. But a given station with a short tower and a poor ground system (either by design or deterioration) is likely to see a considerable improvement in audio quality and signal strength with the application of folded unipole operation.

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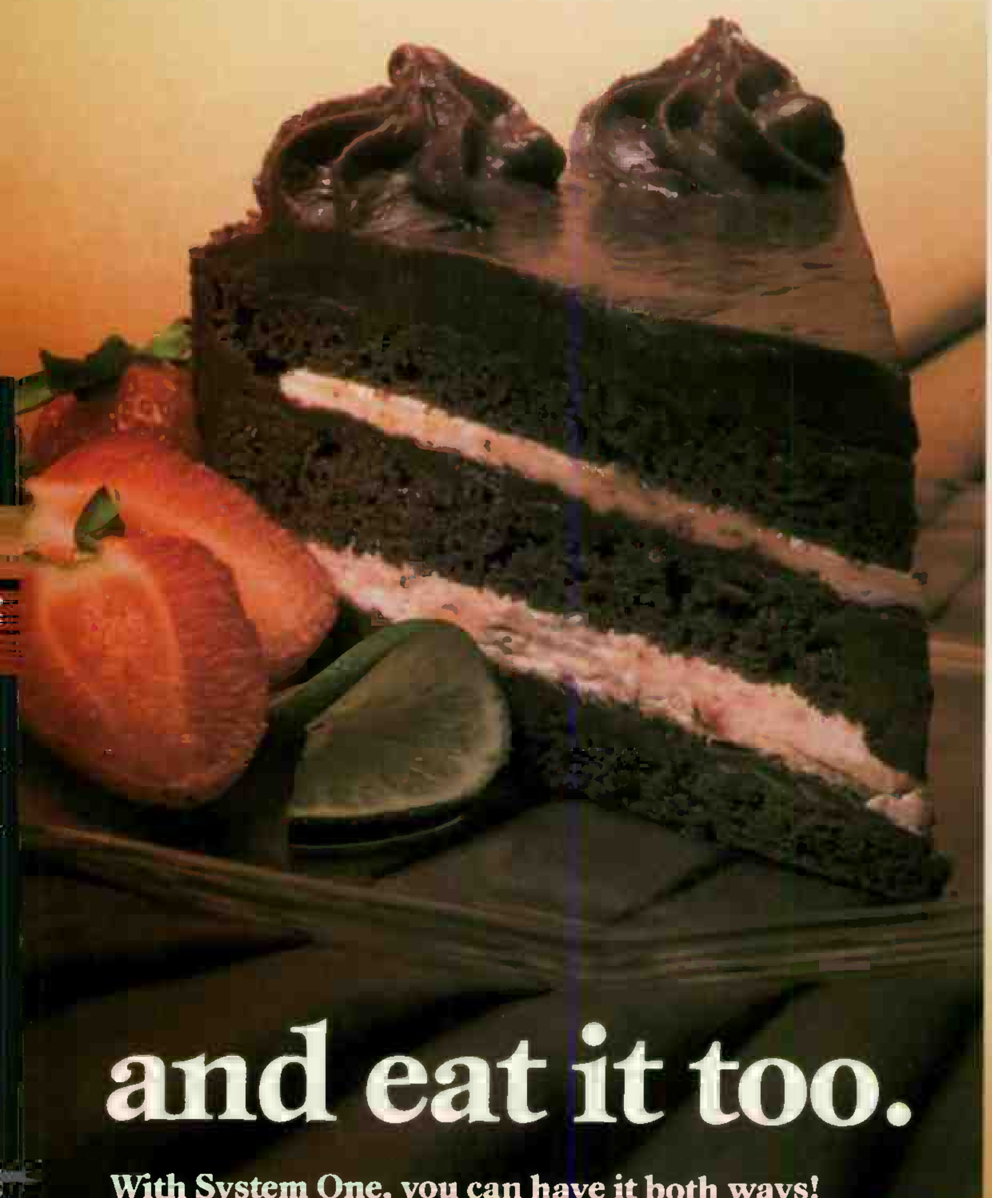

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SBE gavel passes to Farquhar

By Bob Van Buhler

New SBE president Richard Farquhar accepted the leadership position from immediate past president Brad Dick at the annual convention in Houston. Farquhar previously served as vice president for the past two years, and as secretary for two years.

Newly elected vice president Jerry Whitaker from Beaverton, OR, is a broadcast technical author and editorial consultant. He holds the grade of Member and Fellow within the society. Whitaker was instrumental in the founding and growth of the SBE National Convention since it was first established. As vice president, he will assume the duties of CompuServe Sysop for the SBE Forum and will handle relations with the trade press.

Looking back

At his inaugural annual meeting in Kansas City, MO, in 1989, Dick's first promise was to hold directors and officers accountable to the membership for attendance and voting records. This was accomplished by regularly reporting the performance of the national officers to the membership through national office communications and publication in the yearly ballot.

The accountability of directors and officers is now codified in the bylaws, which permits the removal of directors who don't attend board meetings and participate in the society's business. Members voted for this proposed bylaws change by a margin of seven to one.

Also under Dick's leadership, the board of directors recruited and hired Steven Ingram, a full-time executive director.

The high point of Dick's presidency was the formation of a strategic plan for the society. Through the efforts of the directors and officers, the society has a game plan for the 1990s and beyond. These articulated goals represent a road map for the society, with clear destinations and priorities.

Dick noted that the past two years were ones of growth and improvement. Membership is up 18% for this year, and SBE member certification grew from 50% to 63% during his 2-year presidency.

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

SBE and other groups

During the national convention, the SBE board of directors inked agreements with other organizations for future cooperation. Most important was the decision to combine the exhibition portion of the national convention with the Radio-Television News Directors Association (RTNDA), starting in two years. Separate but simultaneous conventions will be held with a common exhibit hall beginning in Miami, in September 1993.

The focus on radio and TV technology, which is common to SBE and RTNDA, is expected to generate added exposure for exhibitors and to help both conventions to grow.

The joint convention addresses common industry complaints that manufacturers and other potential exhibitors find it difficult to attend the numerous national conventions and shows.

The officers of the Korean Broadcast Engineers and Technicians Association (KBETA) signed an affiliation agreement with SBE. They have promised to cooperate in the formation of SBE chapters in Korea and other Asian countries, and to exchange documents and information to the international broadcast community.

In addition, delegations from Mexico and the Philippines attended the SBE Convention and made contact with SBE leaders.

The convention floor

The 1991 SBE Convention was also a joint event held concurrent with the Texas Association of Broadcasters (TAB) annual meeting. The TAB event was originally scheduled to be held in San Antonio, but was moved to Houston in order to take advantage of the added traffic generated by the SBE show.

The presence of the TAB attendees swelled the exhibit hall, helping to offset a predicted drop in attendance because of tough economic times.

SBE brought 109 exhibitors, all technically oriented, to share the floor with the 31 TAB exhibitors. The TAB exhibitors were a mixture of Texas broadcast manufacturers and suppliers, programming and service providers, and government and civic organizations.

Digital dominates

New technologies dominated the discussion at the convention. There was an on-site meeting of the Committee for Digital Radio Broadcasting (CDRB), and special digital radio sessions were held during the *Broadcast Engineering* seminars.

The Canadian Broadcasting Corporation (CBC) provided a report on its field tests with digital radio, giving engineers a glimpse at the real world capabilities of the Eureka 147 system.

On the TV front, station automation, audio production with MIDI and computerization of audio post-production were among the subjects examined at length.

Engineers who didn't attend the convention missed the sessions on automated TV plants and video cart machine automation, video library systems and newsroom hardware and software.

Michael Rau, senior vice president of engineering and technology for the National Association of Broadcasters (NAB), addressed the conference. He reviewed NAB's assessment of the many technical developments in the industry, including HDTV, in-band and Eureka 147 digital radio and RDS.

Election results

The society elected three new directors in its annual election. Michael Fast of Baltimore, Troy Pennington of Birmingham, AL, and Frederick Baumgartner of Indianapolis, were chosen to serve by the membership.

Returning to the board will be directors Terrence Baun of Milwaukee, Paul Montoya of Denver and Edward Roos of Palm Beach, FL. All of the new directors will be the last to serve 3-year terms. Bylaw revisions adopted by the membership will restrict future directors to 2-year terms. Previous bylaws specified a renewable 3-year director term.

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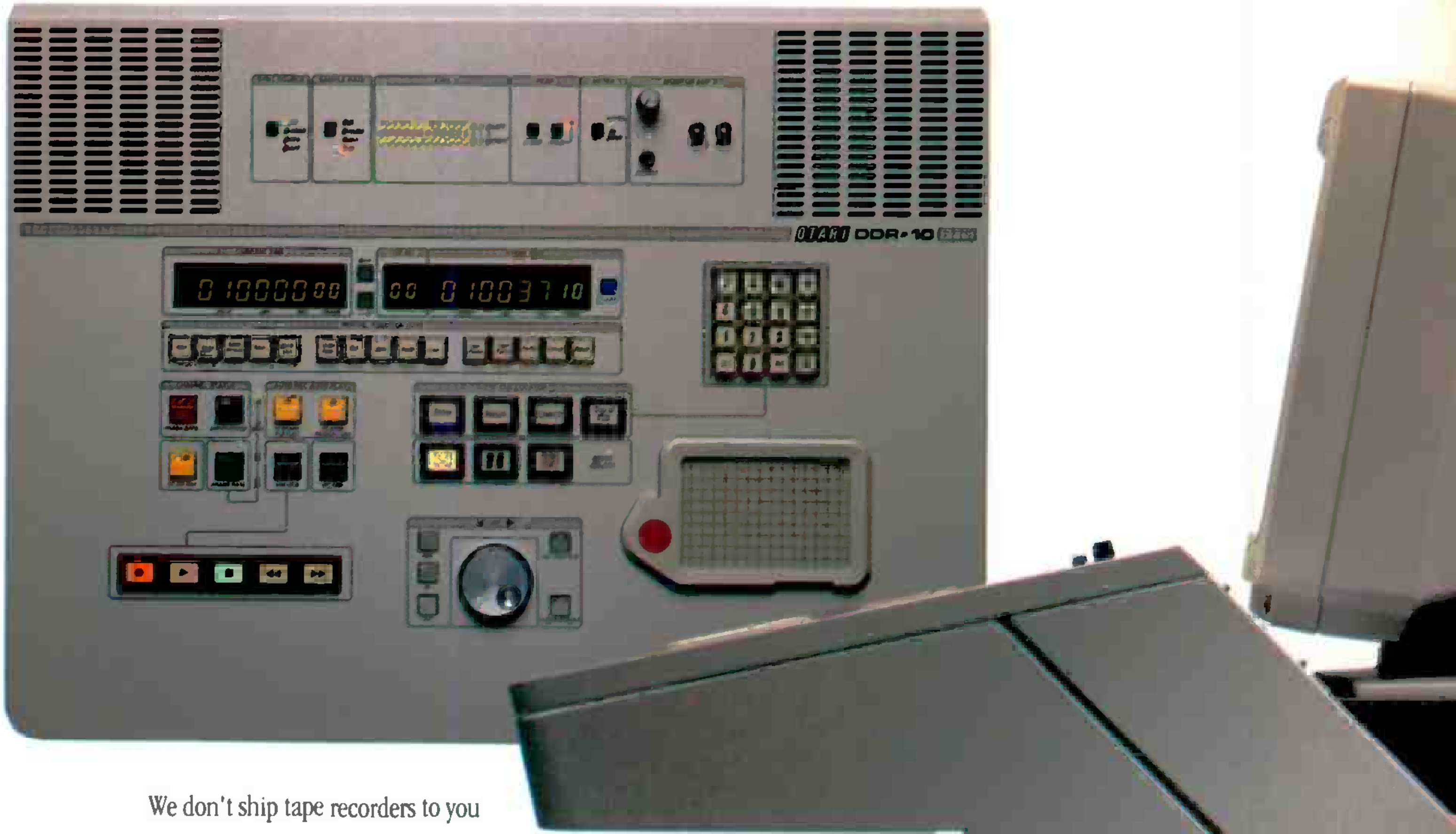

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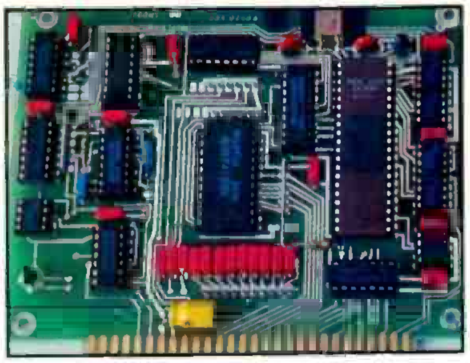

An in-depth look at analog ATR circuits

Taking EQ one step further

By Gerry Kaufhold II

Last month we looked at the equalization circuits of a typical analog audiotape recorder. Recording speed, frequency and the tape head gap all affect record frequency response. Depending on the tape formulation, magnetic audiotapes require fixed boosts of approximately 6dB for frequencies below 400Hz, and approximately 10dB for frequencies above 4kHz.

In playback mode, the equalization circuits compensate for the tape's uneven frequency response by attenuating the low- and high-frequency signals. This gives the deck a flat frequency response. Equalization controls allow the user to trim the circuits to maintain proper frequency response as the recorder system ages.

This month we'll take a brief look at *active equalization*. The equalization circuits mentioned so far have not taken into account the way human hearing works or the frequency content of the material being recorded. Active equalization improves recording by considering these things. It also gives the benefit of lowering the apparent signal-to-noise ratio.

Active equalization

The circuit in Figure 1 operates in parallel with the fixed equalization system discussed last month. A frequency discriminator monitors the relative signal strengths of low-, medium- and high-frequency inputs. A comparator circuit trips if a certain minimum signal level is not present. This cuts in the active equalizer, overriding the standard fixed circuitry.

The rear graph in Figure 2 shows a typical spectrum analysis of modern, highly produced popular music. There is a wide range of frequencies. The distribution of frequencies and sound levels is fairly uniform between 20Hz and 20kHz. With signals such as these, the comparator deactivates the active equalizer. The equalizer applies fixed gains to the low- and high-frequency portions of the signal. The wide range of frequencies will mask high-frequency tape *hiss* and low-frequency *rumble* from the listener's ears.

The forward graph in Figure 2 shows a quiet solo passage. A high-frequency instrument, such as a piccolo, is the only one playing. This signal will only use half the dynamic range of the tape if the fixed frequency equalization is used alone. The lack of mid- and low-frequency acoustic energy must be taken into account. For the quiet solo passage, the frequency discriminator keeps the active equalizer active.

Kaufhold is an electronics industry analyst based in Tempe, AZ.

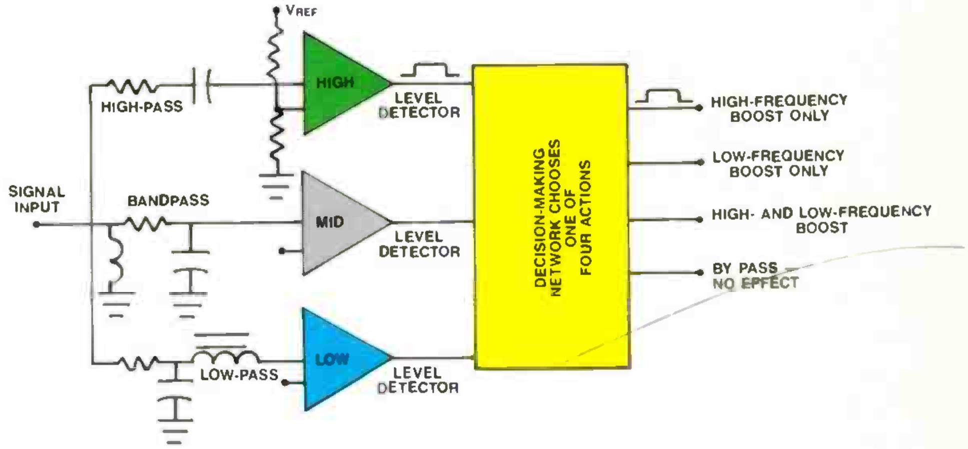

Figure 1. *The frequency and acoustic energy-sensing circuit activates appropriate portions of the active equalization circuitry, depending on program content.*

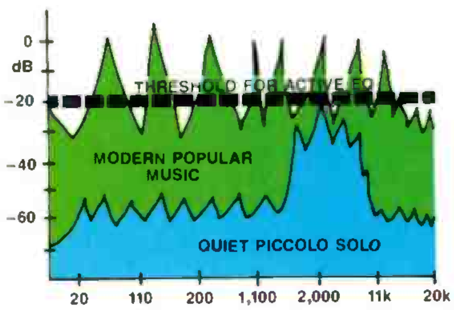

Figure 2. *The frequency and acoustic energy content of two different signals indicates the application for active equalization systems.*

Because there is little low-frequency energy, the normal low-frequency boost is not applied. On playback, the fixed attenuation of the playback equalizer actually reduces the low-frequency response. This eliminates rumble that might detract from the quiet sound of the piccolo solo.

The midrange is neither boost nor cut. The active equalizer gives the high frequencies an extra 6dB of gain by the active equalizer. Therefore, even the quiet passages provide a signal that is quite near the tape's recording saturation level.

Enhanced playback

In playback mode on a normal tape player with fixed playback equalization, the piccolo solo will sound somewhat louder than when it was recorded. However, the higher signal level will mask the background tape hiss.

In playback mode with an active equalization circuit, the frequency discriminator of the active equalizer will recognize that the signal was enhanced during recording. Sometimes this takes place via proprietary encoding systems, and other times by analysis of the playback frequency spectrum. The active equalizer will turn on its high-frequency attenuator circuit, reducing the playback level of the quiet piccolo solo to its original level. This will also reduce tape hiss by the same amount, further masking high-frequency noise.

Next month we will examine an audiotape recorder's analog servo control loop. This is the control system that keeps the tape moving at a constant velocity with respect to the fixed record and playback heads.

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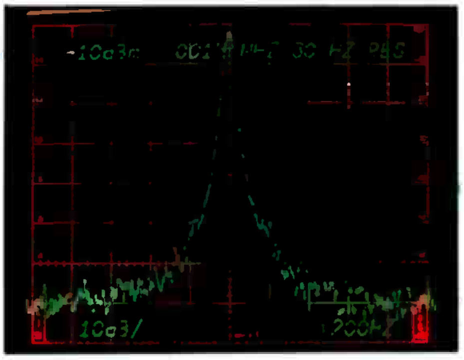
Part 3

Troubleshooting



Optimizing 2-track analog ATRs

Tape path failures

By M. Raymond Jason

Tape-path failures are manifested as frequency response problems, signal-to-noise ratio degradations or high-frequency instabilities. The physical balance of a tape path is delicate, so avoid altering components or alignments unless you have first isolated a problem as mechanical in origin.

Isolating mechanical problems

The best way to verify that a machine's *playback* electronics are not the source of trouble is to employ the flux-loop method described in last month's column.

On the *record* side, you can measure bias/erase frequency and distortion, and obtain some comparative indication of their amplitudes by using a flux loop as a pickup on the record or erase head. These tests should be performed in record mode with no signal input. Measured amplitudes should approximate those from known-good units of the same model ATR. Because the pickup point is the head itself, these tests are sensitive to all failures between the bias oscillator and the head windings. Check record electronics with an oscilloscope at the output of the record amplifier. A low-pass filter to block bias allows measurement of audio distortion and frequency response.

If these tests uncover no defects, yet the machine's audio performance remains poor, a tape-path failure must be the cause.

Troubleshooting tape-path problems subdivides three ways: 1) tape guidance and tensioning, 2) head alignment, and 3) head surface condition. Guidance and alignment ensure that the tape and head gaps bear correct relative positioning. Surface condition and tensioning are critical to the micro-geometry of the tape-to-head interface, and therefore to accurate magnetic recording.

Because tape *heads* are finely adjustable along or around multiple axes, and tape *paths* are relatively inflexible, the logical approach to troubleshooting or alignment always starts with guidance, then proceeds to heads.

Tape guidance

The plane of the tape's surface should be consistently perpendicular to the deck plate. There should be no warping, in which the top edge of the tape is not directly above the bottom edge (assuming a horizontal deck plate). Nor should there be tilting, in which the direction of tape travel diverges from perfectly parallel to the deck plate. Scraping sounds or oxide shedding indicate that the tape is being forced to tilt or warp. Careful observation of reflections off tape from a flashlight is useful. You should see no ripples or curls.

Most 2-track ATR transports use non-shimmed fixed guides at the entrance and exit of the head stack. Heights of all adjustable elements in the path should be set relative to these guides, starting with the supply reel turntable. The machine's service manual should provide details. If you alter the tape path vertically, you may need to replace or rotate fixed guides because of their wear grooves. For similar reasons you may also need to relap or replace the heads.

Finally, ensure that the play tensions are correct as described by the service manual before moving on to head alignment.

Head alignment

A line drawn through the gaps on a head should be parallel with the plane of the tape (correct *zenith*), perpendicular to the direction of tape travel (correct *azimuth*) and centered within the area of maximum pressure (correct *wrap*). Furthermore, the two gaps should be equidistant from their respective tape edges (correct *height*), and the tape's bend angle around the head should be optimized (correct *penetration*).

Full head alignment should be performed when a new ATR is purchased or upon head replacement. After a day or two of use, many heads already contain wear patterns that make further alignment, particularly height and zenith adjustments, difficult or impossible.

Check *zenith* visually, using a flashlight, relative to the fixed guides or capstan, and from head to head. Check *record-head height* by recording 100Hz at standard level, then "developing" the tape using a magnetic developer (liquid-suspended iron powder) and a microscope. The tracks should be equidistant from their respective edges. Correct the height if necessary. Next, check *play-head height* by recording 5kHz, flipping the tape over, and checking for equal level on the two channels.

Check *rough wrap* by "painting" the heads with a non-permanent marker, then playing several minutes of tape. Using a magnifying glass (or microscope, if necessary), verify that the gaps are laterally centered within the area worn clean of marker ink by the tape. Set *fine wrap* for the play head by recording 20kHz at 15ips (or 10kHz at 7.5ips) while gently adjusting play-head wrap for maximum output level.

Play-head penetration should be the minimum required for good high-frequency stability, typically less than ±0.1dB of wobble on an analog meter for 20kHz playback at 15ips (10kHz at 7.5ips). *Record-head penetration* can be visually matched to the play-head setting.

Azimuth is set with a standard alignment tape. On most headstacks, these alignments are interactive to some degree, so you may need to iterate the previous steps several times.

Head wear

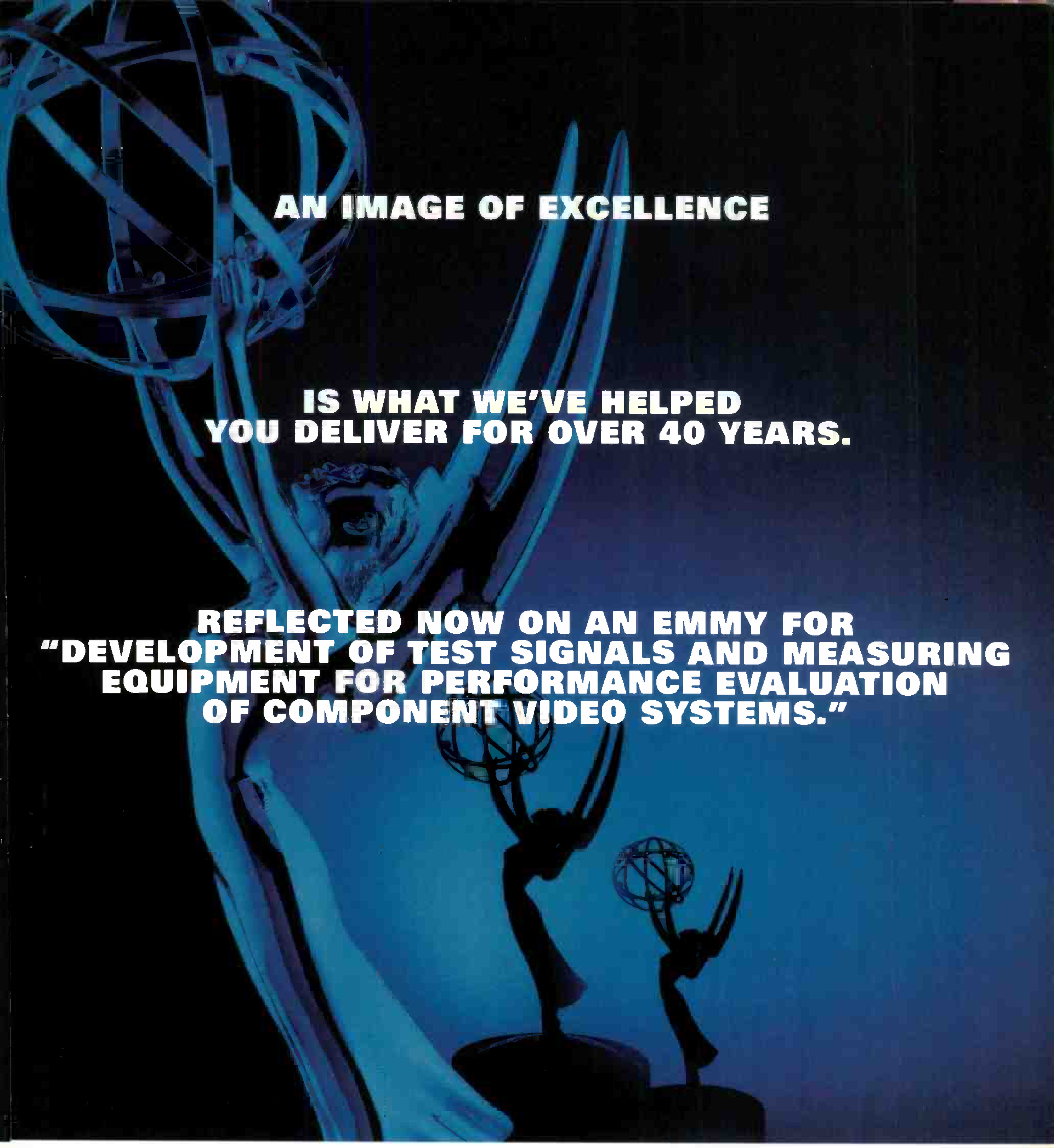
Normal wear usually entails the development of a rectangular flat spot centered over the head gaps.

Problematical wear results from poor wrap, zenith, height or penetration. In each case, the wear pattern differs from normal, either the pattern isn't rectangular (e.g., trapezoidal), it's not centered over the gaps or both.

To check head performance, compare standard alignment tape playback response to flux-loop response on the play head. If these responses differ by more than 1dB at 10kHz, it's time to relap or replace the play *and* the record head (assuming they are both of the same age). Or, record a 20kHz tone at 15ips (10kHz at 7.5ips). If the peak-to-peak instability (on an analog meter) of the tone is greater than ±0.1 or 0.2dB upon playback, the heads need relapping or replacement.

Whenever record or erase heads are replaced, the bias oscillator must be realigned in frequency and amplitude, along with the bias traps.

Jason is an electronic engineer at National Public Radio, Washington, DC.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Part 2

Management
for engineers

Working smarter

How to organize a meeting

By Judith E. A. Perkinson

In order to make attending meetings as painless as possible, they should be conducted with a purpose. Organizational skills are essential for conducting a meaningful meeting. If you plan on having your staff take an hour from their work, have a set purpose and goals that you want to accomplish.

Don't hold a weekly staff meeting just because it has always been done. The meeting is not a purpose, it is a habit. If you are going to a call a meeting, it should have a motive. Why should the staff be there? What needs to be discussed? What is going to be accomplished by meeting?

Necessary attendees

No one wants to waste an hour listening to issues that have nothing to do with them. When you are planning a meeting, identify the purpose and decide who should attend. If it does not affect the entire department, do not have the whole department attend. You can offer the option of attending to those individuals who may want to listen and learn, but only require the attendance of those people who are essential to the purpose of the meeting.

This consideration communicates your respect for the staff, and lets them know that their time is valuable and that you recognize them as professionals.

This is also the time to consider if other people from other departments need to be included in the meeting. If the problem affects the sales department, then include key people from that department.

You should include those people in the meeting depending on what they can bring to the process of accomplishing the goals of the meeting. In most instances, participants should include:

- Those who will affect or be affected by the issue or subject.
- Those who will provide valuable information about the issue or subject.
- Those who will be making decisions concerning the issue or subject.

Perkinson is a senior member, the Calumet Group, Inc., Hammond, IN.

When there is potential conflict, it may be necessary to have the meeting chaired by a neutral facilitator.

No matter who is included, be sure they have a reason for being there. Furthermore, be sure that they are the best people to help you successfully complete the goal of the meeting.

Don't start the trip without a map

In the project management series (see the October and November 1990 "Management for Engineers"), the importance of having a written plan before you begin a project was stressed. That plan gave the project direction and structure. In meeting management, that direction and structure begins with a written agenda. Before you plan and call a meeting, take the time to organize what needs to be accomplished and the steps you want to take.

Every meeting should have an agenda. This will force you to examine the organization of the meeting, make sure that subjects flow in a logical sequence, and gives you the foundation for your meeting plan.

Well-planned meeting time

The agenda will provide a list of topics to be covered and the order in which they are to be presented. The next step is to calculate how much time each section of your agenda should take. By doing this, you will know if you have placed more on the agenda than can reasonably be accomplished in the time you set aside.

If you don't have a clear purpose for the meeting, your agenda may become overcrowded. Know what you want to accomplish, and you will be less likely to stray from the program.

Another common mistake is to underestimate the amount of time needed to complete an agenda item. So allow time for participants to ask questions or discuss issues. It is also up to the person running the meeting to control the flow of participation. (This will be discussed in next month's column.)

Be sure to give some thought as to how long it will take to present, process and respond to each agenda item. Check the relevancy of each subject in relation to the purpose of the meeting. If it looks as if you have too much on the agenda, reconsider the items, pare down unnecessary topics and focus on the purpose of the meeting.

Get the word out

If you are planning a meeting, make sure everyone knows when, where and what time it will take place. After you have made a list of people you want to attend, make sure they are present. A poorly attended meeting is as great a waste of time as a poorly planned one.

If the meeting is worth holding, it is worth taking the time to contact the people you want to be involved. Personal contact is important if an individual's attendance is critical to the purpose of the meeting.

Preparation

Worthwhile meetings begin with you. Preparation and organization are vital to good meeting management. When you develop a reputation for holding good meetings, it pays off. The right people attend, more work gets accomplished and less time is wasted. And you will be holding meetings that run like a well-oiled machine

Next month, we'll look at how to conduct a meeting.

MEETING CHECK LIST:

- What is the purpose of your meeting?
- Who should attend?
- Do you have an agenda?
- How much time will it take?
- Do people know about the meeting?

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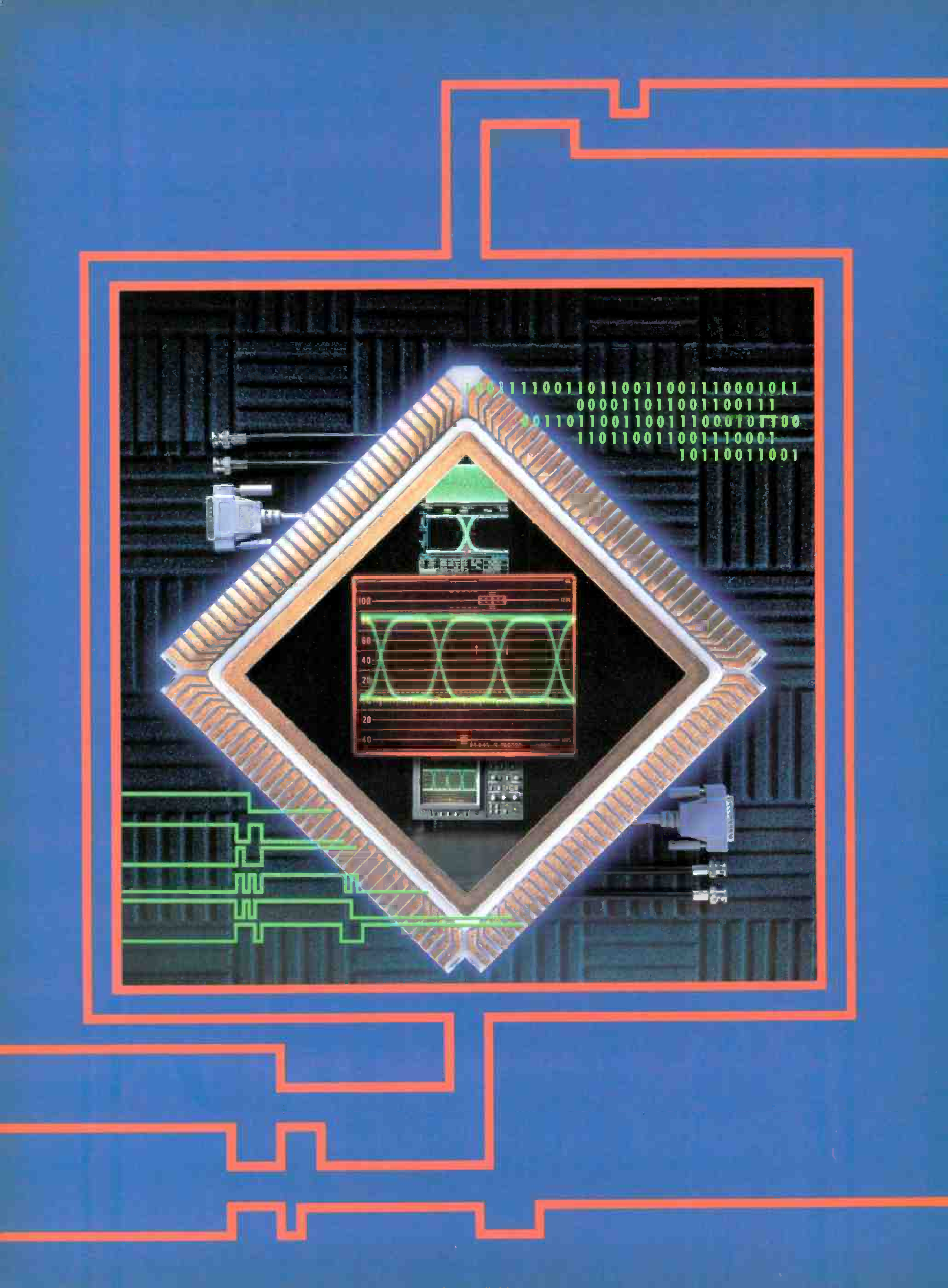

Annual station maintenance report

Maintaining today's sophisticated equipment requires special skills.

Few things are more important than keeping the facility up and operating. There is no room for down time. The term *zero defects* might describe how today's broadcast and production environments must operate.

This places increased emphasis on equipment maintenance. The person who can repair today's hardware is a valuable and important part of any operation. Sometimes, the successful maintenance technician can rely on experience. However, today's hardware is often so reliable that experience on any one device is limited. Furthermore, when the device does fail, there's no time to learn how to repair it.

This special issue addresses three important areas of technology within broadcast and production facilities: analog equipment, serial digital video signals and high-power tubes. Each of these areas requires special skills to properly maintain the hardware.

Although digital is the key word in hardware today, much of the equipment used still relies on analog techniques. Today's sophisticated analog equipment provides high-quality performance. Keeping this equipment operating properly can be a challenge if you don't use the proper techniques. "Analog Troubleshooting Basics" will highlight some procedures that will lead to rapid repair of this type of equipment.

The new generation of digital video equipment places special requirements on troubleshooting and repair. This is especially the case with serial digital signals. Although few standard test signals and practices currently exist, there are a few "tricks of the trade" that can be applied. "Monitoring the Serial Digital Signal" offers guidelines to checking those serial video signals.

Most broadcasters still use tubes in their transmitters, and today's tubes are reliable and efficient. Yet, to maintain long life, they need proper care and treatment. "Caring for High-Power Tubes" looks at how tubes are constructed, with an eye to the steps an engineer can take to ensure their long life.

In today's tight economy, many stations are looking for ways to extend the life of high-dollar equipment. TV transmitters are first among those expensive items that can be brought back to life through good engineering management. "Rebuilding TV Transmitters" provides a real-life example of how one station saved tens of thousands of dollars by rebuilding the station transmitter. The result was improved signal delivery in a cost-effective way.

No matter how good your maintenance techniques are, systems occasionally fail, and a quick fix is the only answer. This is often the case with coaxial cable. Often buried underground or clamped to a tower, coax can be difficult to troubleshoot. Part 2 of "Testing Coaxial Lines" looks at ways that standard equipment can be used effectively to isolate problems in coaxial cable.

Finally, this month's lineup contains the first of a 3-part special report on the design of fiber-optic cable systems. "Building Fiber-Optic Transmission Systems" provides a tutorial approach to understanding how fiber can be used as a replacement for coax and even RF links. The first part of the series outlines the basic factors in designing a fiber system.

Brad Dick

Brad Dick, editor

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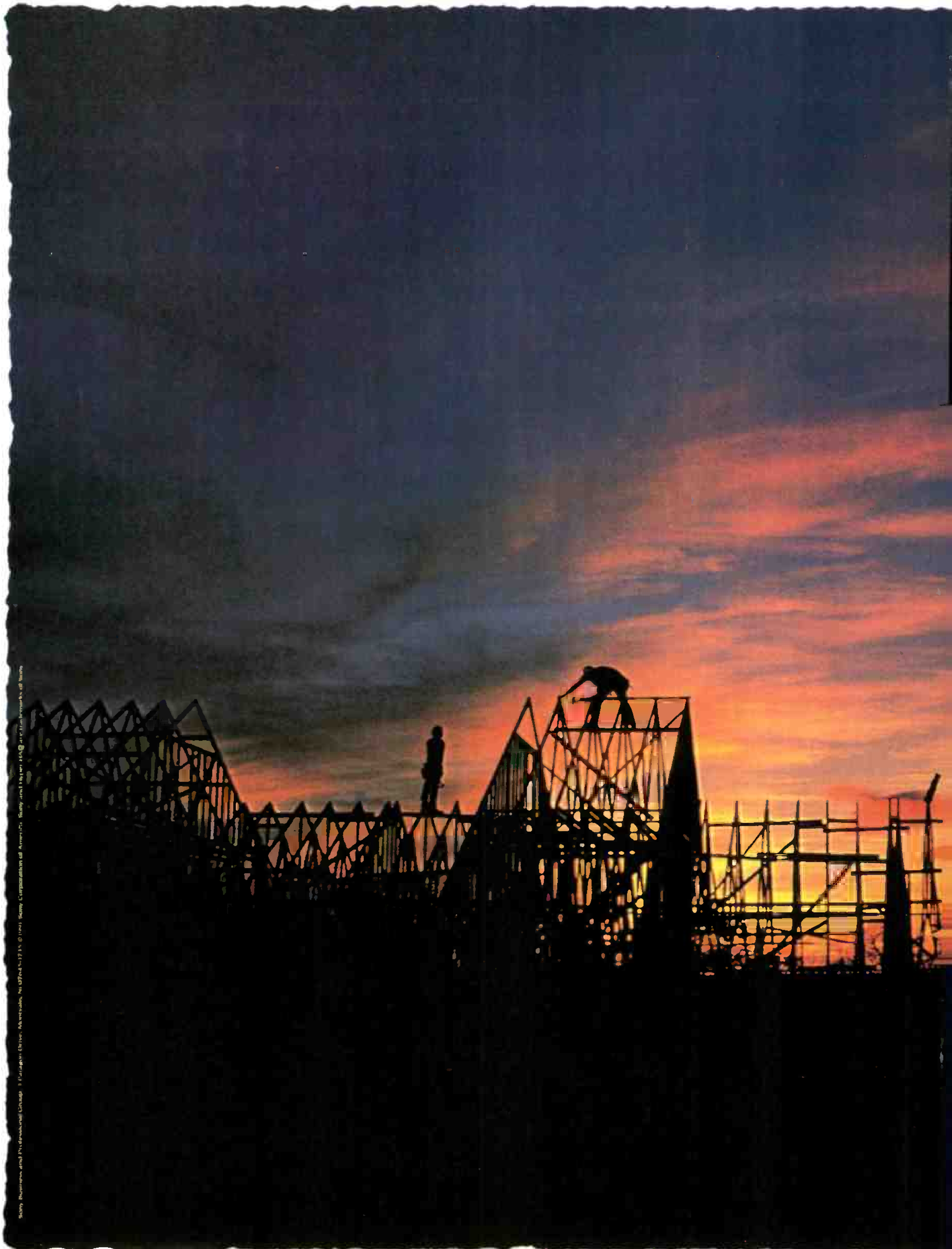

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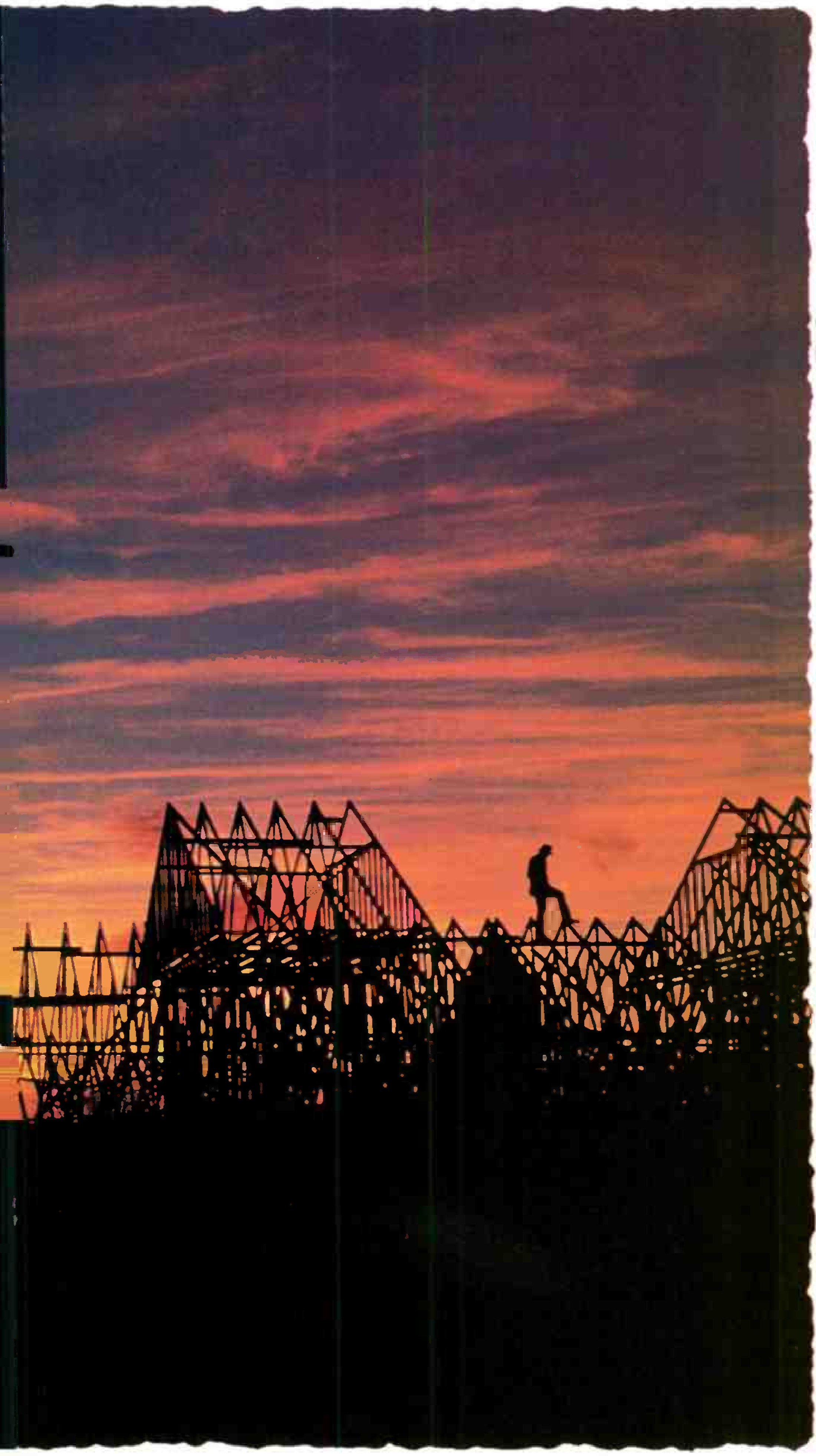

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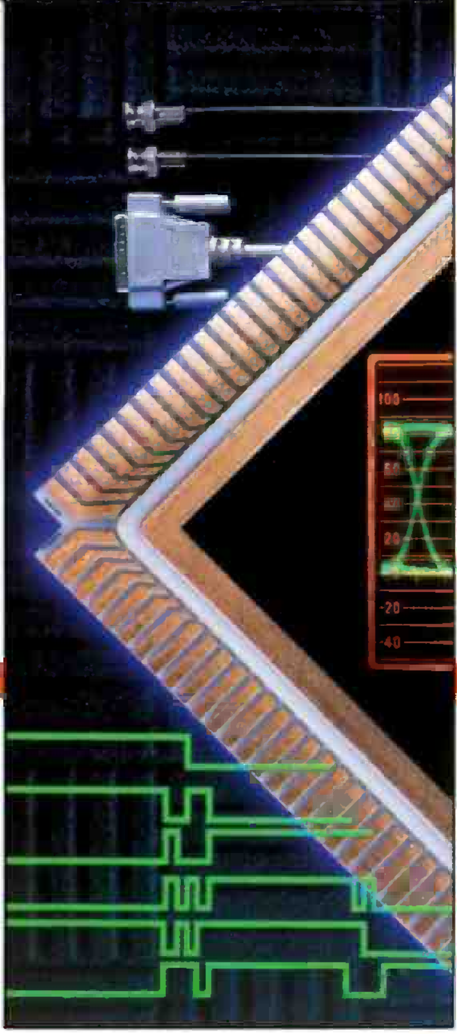

Analog troubleshooting basics

Most equipment in today's broadcast facilities is still analog — and still needs repair.

By Roald Steen

Analog broadcast equipment includes most audio, video and RF amplifiers, transmitters and many tape decks. In fact, the bulk of all older broadcast equipment uses analog signal paths.

Repair techniques for troubleshooting an analog system are quite different from repairing digital hardware.

Each major piece of broadcast equipment in a facility should have a technical log listing all of its problems as they are observed, and how each problem is solved. This log allows the maintenance technician to determine if the problem is a new one or a recurrent one.

Once you have found out as much as possible about the problem (either in the form of a report from the person who observed the defect, or by doing as many tests as you can without disassembling the system), you are ready to start the troubleshooting procedure.

A primary rule in analog troubleshooting is to proceed from the simplest possible problem toward more complicated causes. Before you begin any in-depth troubleshooting, start with the obvious points — make sure all the necessary parts are plugged in, turned on and connected.

Also, check to see that all switches are in the right positions and that no knobs are loose, because this could cause a control to appear to be in a different position than it really is.

Steen is an electronics instructor in the Minneapolis/St. Paul area.

In analog equipment and digital equipment, a large proportion of all malfunctions are mechanical instead of electronic. Among the possible causes for mechanical malfunctions are switches that don't make proper contact, plugs that are not firmly seated in their sockets, and relays that have become worn or are in need of contact cleaning or burnishing.

Check faulty equipment whenever possible by substitution. For example, you may quickly determine if a distortion problem is caused by a microphone by substituting the microphone with another one. A visual inspection will often give you clues to the nature of the problem, especially if you remove the chassis of the equipment that you are troubleshooting.

Look for cracks on circuit boards. Deposits indicate that it may have been wet; brown or black areas may indicate components that have overheated. Furthermore, look for cracked components and loose leads and wires.

Power supply

Many electronic problems are found in components that pass high currents, because they aren't always able to dissipate heat as effectively as necessary.

The power supply is one of the modules in a broadcast system that has to deal with high current levels. Begin with a visual inspection of the fuses.

Sometimes, fuses will blow without clear visual indication. If in doubt, a voltmeter will tell you if the fuse works by checking the output voltage from the fuse. You may also remove the fuse to determine if it is open on the ohmmeter function of the multimeter. If you have disconnected a circuit that receives current from the power supply, the power supply may appear in good working order even if it has a malfunction. Some problems only become apparent in the form of reduced voltages once the power supply is connected to a load.

Safety

Concern for personal safety is critical when troubleshooting electronic equipment. Be especially careful when you are working around power supplies and broadcast transmitters. TV monitors also contain high voltages that can be dangerous.

When checking a power supply, be careful not to touch any "hot" sections. It's best to remove metal jewelry when working with high voltages.

Another safety precaution is to keep one hand in your pocket while testing a power supply. This is done to avoid touching a high voltage with one hand and a ground point with the other. If this condition should occur, the shortest point to ground is across the chest, maximizing the risk of cardiac arrest from electric shock.

Keep one hand in your pocket (preferably the left), because if your right hand does touch a high-voltage source, the shortest path to ground is usually through the right foot to the floor. Therefore, the

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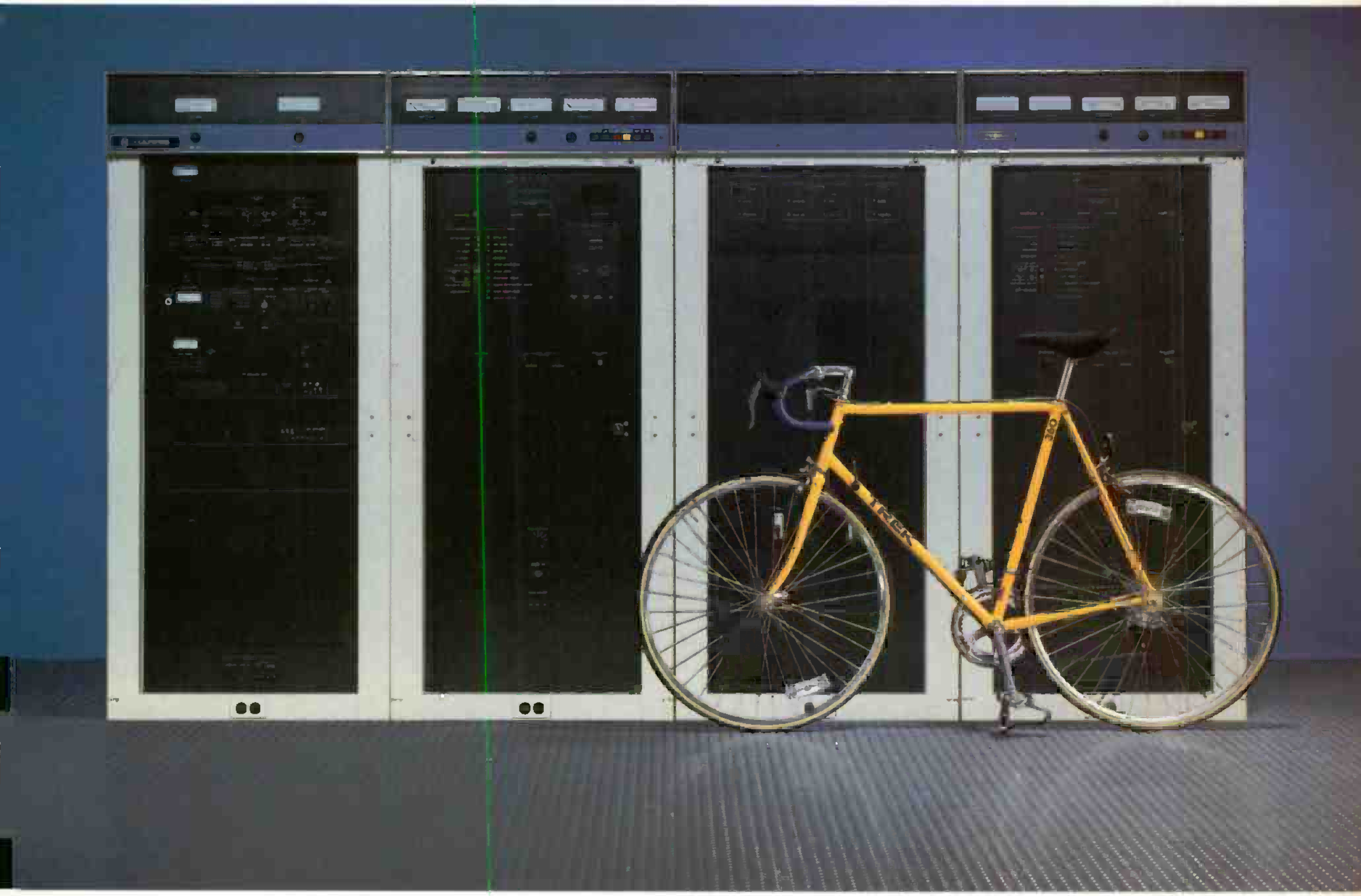

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impact on the heart is reduced. Insulated shoes will help minimize the risk of this occurring. However, they should not be regarded as immunizing you from shock. At high voltages and frequencies, insulated shoes may not afford much protection.

Try to avoid working on transmitters or large power supplies alone. Even if you are with someone who is not a trained broadcast engineer or technician, that person can be invaluable in getting help should an accident occur.

Test instruments

Once you have checked mechanical components and your power supply, it's time to begin analog troubleshooting. How you will proceed depends on what types of test equipment are available.

The minimum test equipment you will need includes a multimeter, an oscilloscope and a signal generator. This test equipment will uncover most problems that occur in audio equipment.

If you service a lot of RF equipment, you may want some more advanced pieces of test gear, such as a frequency counter, a frequency selective voltmeter and a spectrum analyzer.

A variety of probes and connectors should also be part of your test set. These are essential to the efficient application of any test equipment package.

Test equipment can also malfunction. Test equipment that isn't operating properly can, of course, indicate problems that do not exist or send an engineer on wild troubleshooting goose chases. Probes and probe leads are subject to much wear and tear, and therefore will often develop malfunctions and intermittents.

Many types of analog test instruments need periodic calibration. You can perform some calibration tasks yourself by checking instruments against each other. Other types of calibration must be performed in a manufacturer's laboratory.

If you encounter test results that don't make sense, make sure that the problem is not in the test equipment by checking the circuit with another test set or probe. Consider the possibility of intermittents in the test leads.

The inputs to many types of test instruments are fused to protect the instruments against overvoltages and high currents. If the test instrument does not show the expected reading, it may be caused by a blown input fuse.

Signal tracing

Signal tracing, signal injection and continuity testing are among the most useful troubleshooting techniques when you are repairing analog equipment.

Signal tracing simply follows the signal from the point where it originates, or from where it enters the device under test (DUT), to the point at which the signal disappears. An oscilloscope is usually the best instrument for tracing a signal.

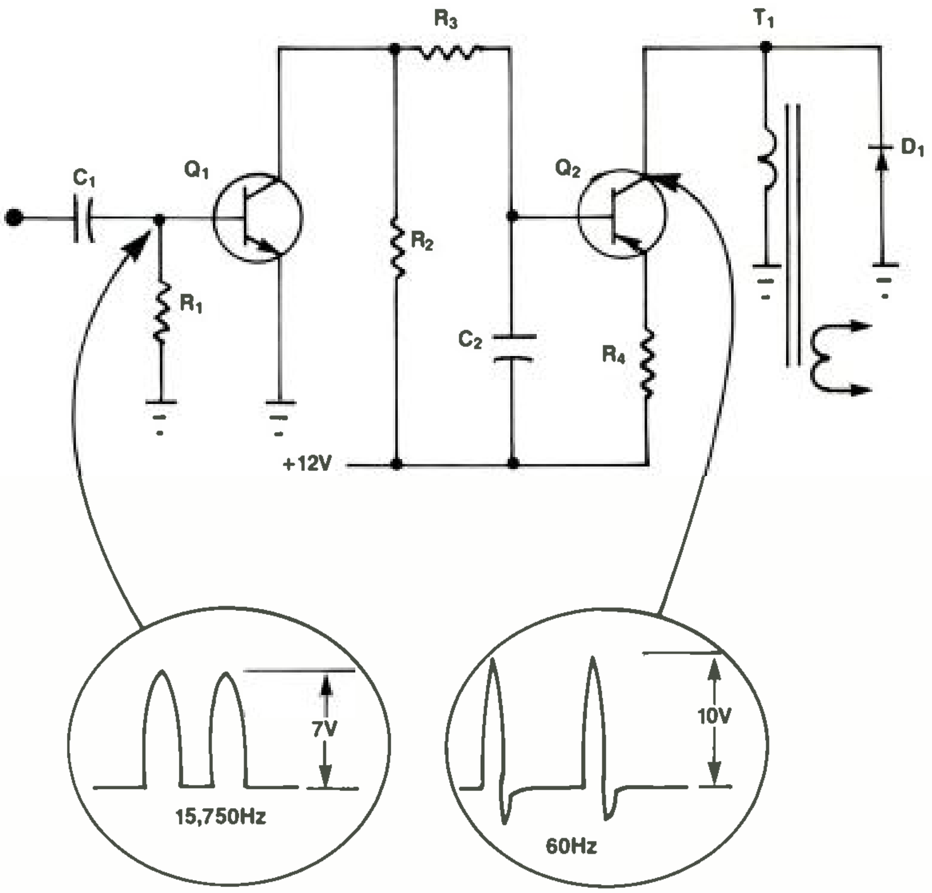

Figure 1. A service schematic showing level, frequency and waveform that should be found at various test points. For waveform displays, the manual should include the proper scope time base settings.

Use the manual to follow how the signal moves through the device that is being fixed. Good manuals will give indications of signal *levels* at a number of test points throughout the set. They may even give illustrations of the waveforms that should be seen on an oscilloscope at those points. (See Figure 1.)

Make notes on the schematic, especially if you're dealing with a type of equipment that is frequently serviced. Note signal levels and waveforms that you are seeing.

Once the signal disappears while tracing it from stage to stage, you know the general area of trouble. But don't fail to consider that the problem could still be in the output coupling of the preceding stage.

Signal injection

When injecting a signal, start with a steady-state tone from a signal generator at the DUT's input, and monitor its output on an oscilloscope. If the equipment is faulty, an improper display or no display will be seen on the scope.

Move the injection point forward from amplifier stage to amplifier stage through the device until the problem clears. Be sure to use the right frequency and level on the signal generator at each stage. Once the scope display becomes normal, it's fairly safe to assume that the trouble is in the stage immediately preceding the one being fed by the signal generator at the time.

If the manual does not give a clear indication of signal levels at each amplifier stage, you may determine the correct signal level by observing the same stage in a set that is in good working order.

Continuity checks

Continuity tests are performed with the ohmmeter function of a multimeter. These are used on passive parts of the chain (interconnecting paths, transformers) to verify that they are passing signals. First, shut down the system under scrutiny. Interconnecting paths should be tested without the presence of their normal signal flow.

A coaxial cable can be checked — after you have disconnected it from its input and output — by checking the resistance between its shield and center conductor. The ohmmeter should show an infinite resistance. (See Figure 2.)

Next, use a clip lead at the far end of the coax cable to connect the center conductor to the shield on that end. In a good coax cable, the ohmmeter should show a short. Some coax cable problems don't show up in a continuity test, such as signal attenuation, but this test will at least tell you if the cable has an open or a short. (See Parts 1 and 2 of "Testing Coaxial Lines," in the October and November 1991 issues.)

Similar continuity tests can also be used

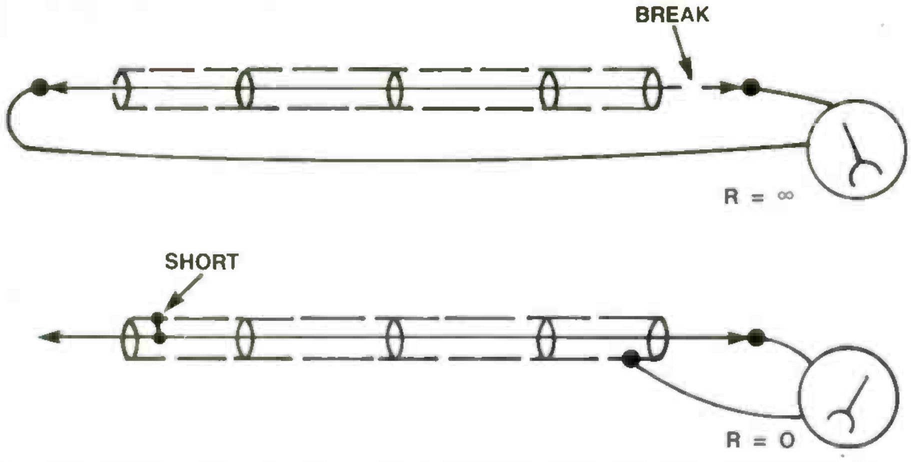

Figure 2. Checking for cable shorts and opens is a simple process using an ohmmeter.

to check other types of interconnecting wiring or to locate cracks on circuit boards.

Isolating the component

Once you have determined the problematic *stage* in an analog broadcast system, it's time to isolate the *component* that has malfunctioned. Here again, a quick visual inspection may be your best start.

Check to see if anything has come loose, or if there is visible evidence of a crack or some other problem on a component. Check for deposits from moisture or corrosion. Also, check for excessive heat in the form of melting or charring.

The multimeter may reveal a malfunctioning bipolar transistor when, compared with a transistor that is in good working order, it shows an excessively high or low emitter-to-collector voltage.

Some components can best be checked out-of-circuit. Components with only two leads can be checked out-of-circuit by removing only one lead.

Several transistor checkers are commercially available. They are most reliable when testing out-of-circuit transistors and diodes, but may also give a valid indication for in-circuit components. Transistor checkers even work for some integrated circuits.

If you don't have a transistor checker, the ohmmeter function of the multimeter may serve as a transistor checker by enabling you to check the transistor's junctions. Remember, however, that a transistor that passes junction tests may still malfunction in circuit. As the transistor passes current and heats up, it may fail even though it looked fine when examined out-of-circuit.

Intermittents

The malfunctions that tend to cause the most trouble are intermittents. A log is especially useful in dealing with an intermittent problem, because it helps trace its history. Trends or the existence of a specific set of problem-causing conditions may become obvious from reading the log and doing a little deductive reasoning. (For example, a transmission line difficulty may occur only when it rains.) Without the log, these causes might remain mysterious for some time. The log also tells you what remedies have been tried before, and with what results. If you work in a large shop with many operators and multiple maintenance technicians, a log is even more essential for basic communication and common awareness of equipment service histories. *Continued on page 100*

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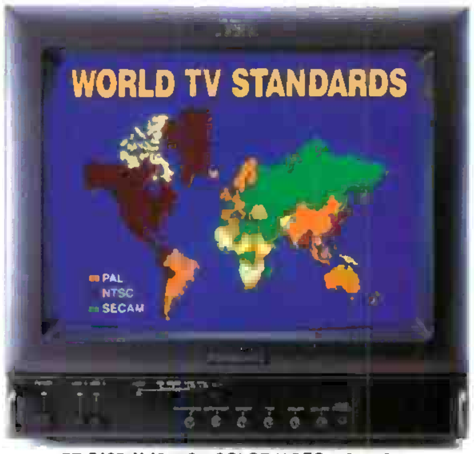

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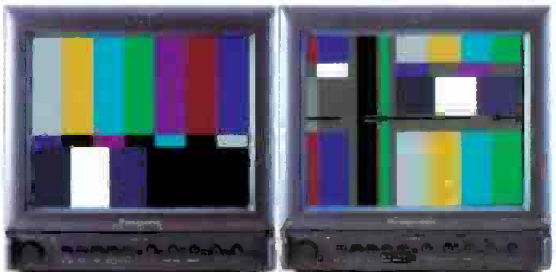
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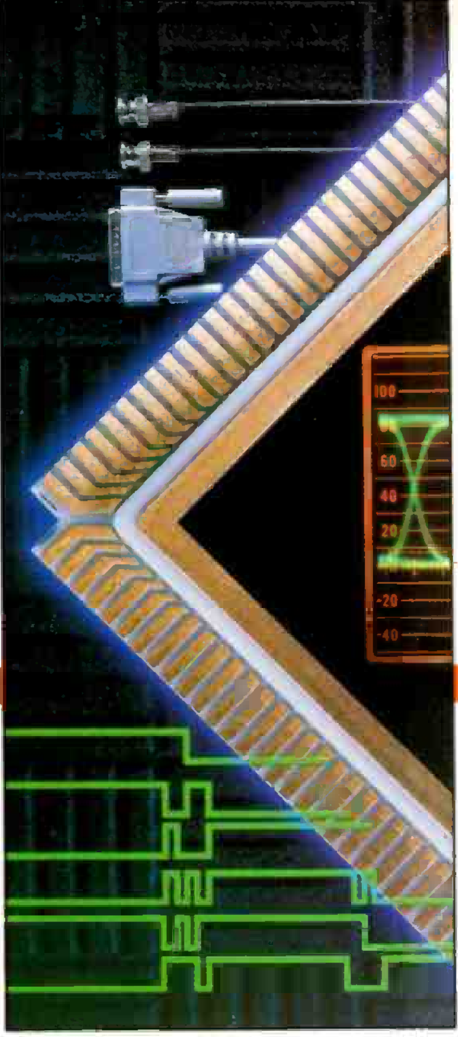

Monitoring the serial digital signal

Understanding the basics of serial digital video can open a new avenue for distributing digital video signals.

By Ken Ainsworth

Serial digital video equipment offers many advantages. First, it uses coax, not bulky multiconductor cables. This means facilities can use existing wiring, and that new cable installations are much cheaper than with parallel digital video. Furthermore, parallel cables have a maximum usable length of approximately 50m (due to timing skew between bits). Serial links of more than 300m have been demonstrated by several manufacturers.

However, serial also presents some new challenges. Engineers must understand and deal with these to achieve reliable, predictable system operation. Serial has high bandwidth requirements, and noise and distortion affect digital transmission systems differently than the more familiar analog systems. These differences can surprise the video engineer who is venturing into serial. A basic understanding of digital transmission system characteristics is helpful when planning an installation and developing a strategy for maintaining it.

Understanding PCM

Most of today's digital systems use pulse code modulation (PCM). In serial systems, each video sample is coded into a sequence of 10 binary symbols. This requires considerably more bandwidth than the original signal. However, as long as the receiver circuitry can differentiate a binary 1 from a 0, additive noise does not degrade the recovered signal. This allows PCM signals to be repeated and regenerated as needed without degradation, which simplifies distribution.

Serial brings with it some new challenges. Engineers must understand and deal with these to achieve reliable, predictable system operation.

PCM adds noise and distortion to the original message signal in two ways: quantization noise and detection error. Quantization noise results from representing the analog signal by a finite number of discrete levels. With uniform quantization, 10-bit representations yield a little more than 60dB S/N. Eight bits give just a little more than 48dB. Detection errors occur when a receiver incorrectly interprets a transmitted pulse. This can come about by a low S/N or distortion in the channel. In most PCM systems, the relationship between S/N ratio and the probability of detection error is extremely steep. A change of just a few decibels in S/N will cause the error rate to change by several orders of magnitude. (See Figure 1.)

In a typical PCM system, the detection error is practically zero when the S/N exceeds 15-20dB. Beyond this point, quantization noise dominates. Designers typically set up PCM systems to operate in this quantization noise-limited region, sometimes referred to as the *saturation region*. The flatness of the output S/N in the saturation region gives PCM considerable tolerance to changes in the channel S/N.

This is sort of a double-edged sword. The insensitivity to input S/N also gives you no warning if you are close to entering the detection error-limited region — the *digital cliff* or *crash-point*. One of the challenges for serial installations is to find out where the system is operating with respect to this threshold point.

Serial error rates

An operating serial system requires an unusually low error rate. Although bit error rates (BERs) of 1×10^{-6} are adequate for many digital transmissions, serial systems demand a BER of less than 1×10^{-9} and probably less than 1×10^{-13}.

There are several reasons for this. The scrambling system used in serial systems multiplies channel errors by six at the receiver. A single channel error has a 50% probability of causing an error in the most significant bit (MSB), and a 70% probability of causing an MSB or MSB-1 error.[1] Therefore, one out of two channel errors

Ainsworth is a senior engineer for Tektronix's Television Division, Beaverton, OR.

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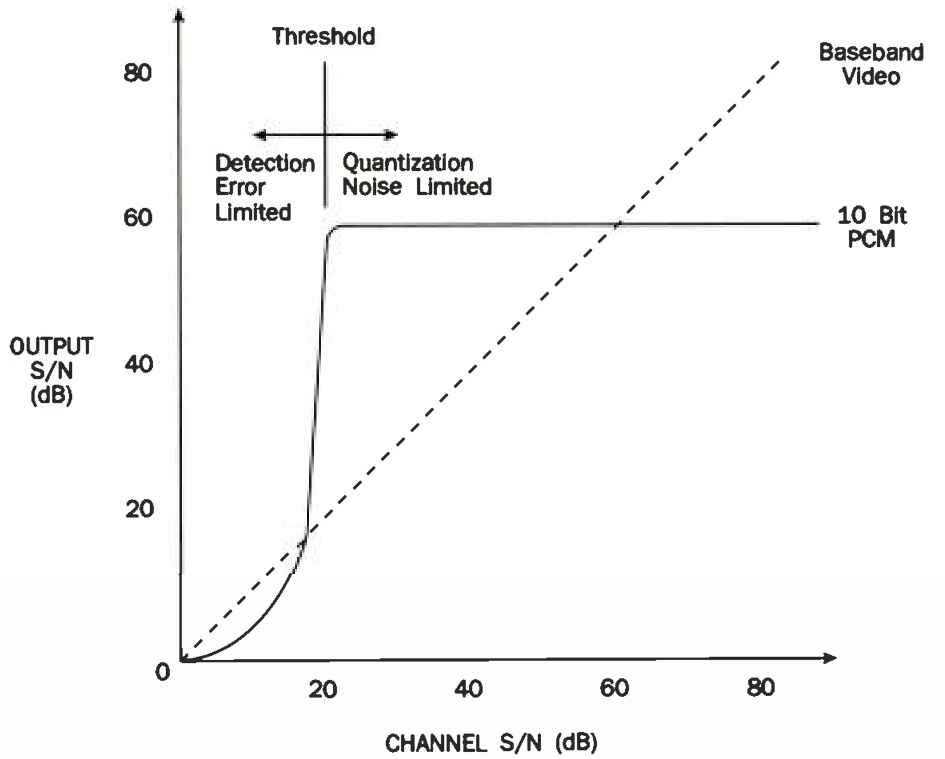

Figure 1. *The relationship between S/N ratio is such that a change of just a few decibels will change the error rate quite a bit. The detection error is practically zero when the S/N exceeds 15-20dB. Beyond this point, quantization noise dominates. This is called the saturation region.*

will cause a visible picture defect, seen as a short black or white dash. Picture monitors spatially map the video. This makes even occasional errors visible. Also, technical quality standards in most video facilities are high. Although no error rate standards for serial exist yet, acceptable performance will likely dictate between one error/minute and one error/day. For 143Mb/s NTSC, this corresponds to channel bit error rates of 2.3×10^{-10} and 1.6×10^{-13}, respectively.

Bandwidth requirements

The non-return to zero inverted (NRZI) channel coding used in serial video contains significant spectral energy up to the clock frequency. For 143Mb/s NTSC, this is approximately 30 times the bandwidth of the baseband signal. This wide bandwidth is a result of the PCM representation of the signal, and it places severe demands on the channel (usually coax) and the receiver. Reflections in the channel can distort the transmitted pulses and increase the detection error. Also, coax can be quite lossy at the higher frequencies and needs equalization in the receiver for everything but extremely short runs.

Serial monitoring needs

Users can successfully install short serial systems without any special test gear. "Short" is defined as a coax path in which the loss is well within the equalization capabilities of the receiver. It is often desirable to determine how far the link is away from detection error-limited operation. This is called the *link margin.* It is also useful to know if transmission impairments are causing a higher-than-necessary error level. Test equipment can help solve these problems and speed fault diagnosis if a system fails.

Monitoring serial signals can be broken down into five classes. The first is straightforward and familiar. Simple content/picture monitoring involves converting a serial signal to analog, and using it to drive a conventional picture and waveform monitor. This allows the signal to be viewed and identified. Experience has shown that most serial errors produce visible picture defects. These can often be spotted with a picture monitor. However, staring at a monitor can get tedious.

A better way to monitor error rate is to determine if the received message matches the transmitted one. Embedded indicators, such as parity check codes, help confirm that the message was correctly received.

One proposed monitoring scheme detects if an entire field's worth of video was correctly received.[2] The system is called error detection and handling (EDH), and it generates a cyclic redundancy code (CRC) check word for each video field. This check word travels with the video in an ancillary data packet. At the receiver, circuitry compares the transmitted CRC with one that is calculated from the incoming video. If they don't match, the system flags the video field as erred. (See Figure 2.)

Tests have shown that EDH is a sensitive and accurate way of determining if serial data errors are occurring in a link. SMPTE is considering EDH for possible standardization.

Figure 3 shows how EDH data might be displayed. Note that rather than indicating an error rate, the display indicates the number of program seconds that contained errors. Many experts feel this is a better indication of a link's condition than a straight BER number, particularly if the errors occur in bursts.

The kind of processing necessary for EDH is also well-suited to provide other information about the serial signal, such as the presence of embedded audio and other ancillary data, and simple format errors.

Channel monitoring

A third monitoring scheme examines the communications channel. Poor pulse shape can raise the detection-error threshold and degrade the link margin. Parameters, such as pulse amplitude and

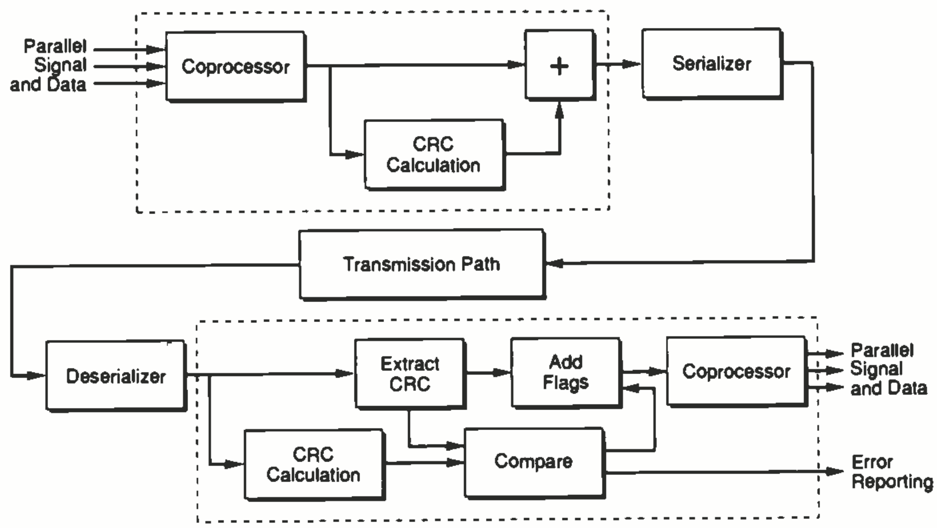

Figure 2. *The error detection and handling (EDH) system generates a cyclic redundancy code (CRC) check word for each video field, which travels with the video signal. At the receiver, circuitry compares the transmitted CRC with a locally generated one to catch errors.*

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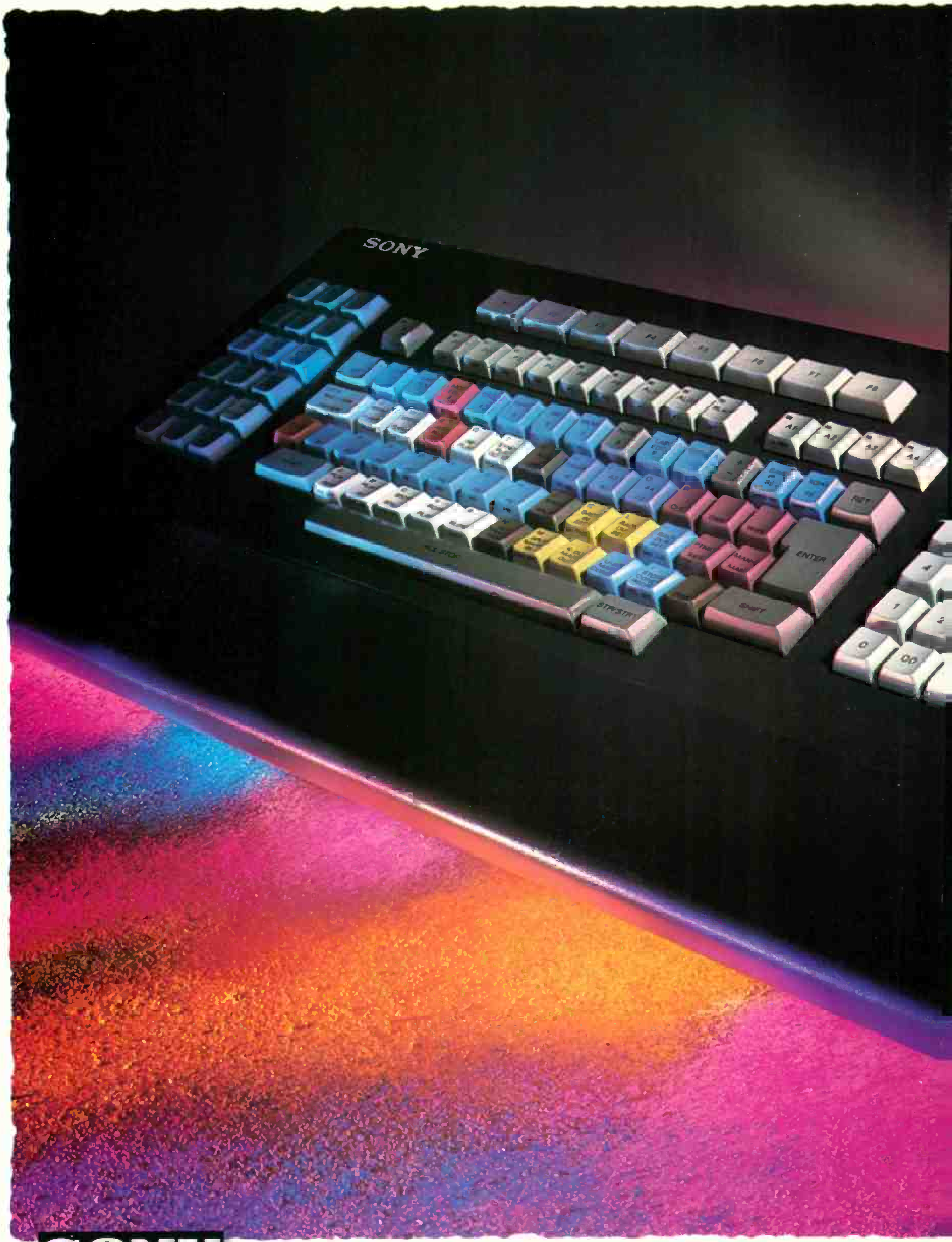

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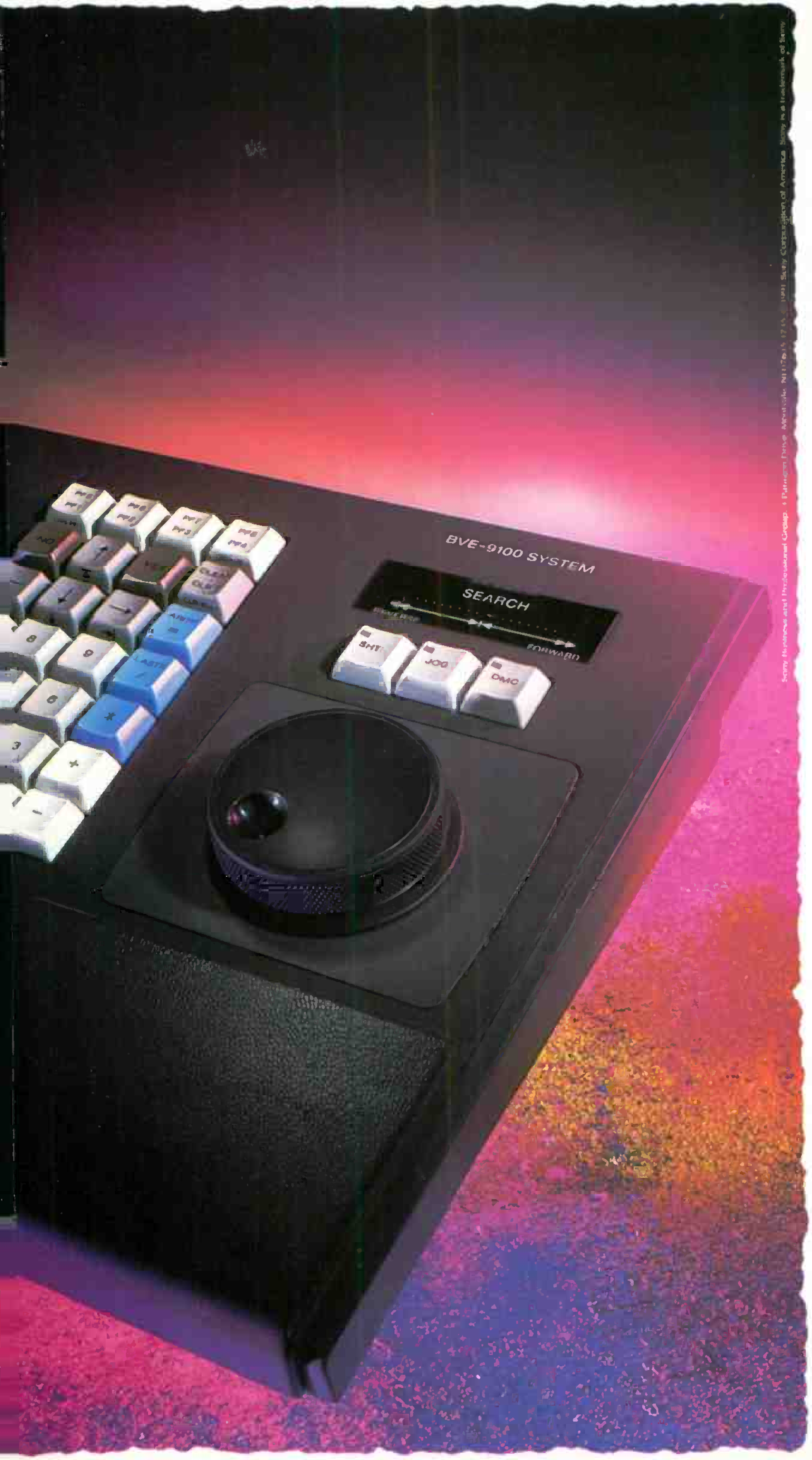

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Continued from page 34

rise time, and aberrations caused by reflections in the channel, jitter and additive noise are all important. They should be examined to ensure the best link performance.

Figure 3. *One possible EDH display indicates the number of program seconds that contained errors instead of a straight bit error rate number.*

The philosophy of the serial system has been to specify the transmitter waveform and the frequency response of the coax channel. Receivers are then designed with varying degrees of performance, depending on the application. Figure 4 illustrates recommended specifications for 143Mb/s NTSC.

A common method for estimating the health of PCM systems is the "eye pattern" of the signal. Eye patterns are typically formed by triggering an oscilloscope at some fraction of the clock frequency and applying the PCM signal to the scope's vertical channel. The resulting overlayed display shows the region over which the transmitted levels can be unambiguously separated — the so-called "eye opening" of the signal.

The eye pattern is the primary means for evaluating channel performance. High bandwidth analog, digitizing and sampling scopes can all make this display. Although a 1,000MHz bandwidth is required to faithfully display small signal aberrations, in most cases, 300MHz will do the job. The return loss of the scope input is more important than the bandwidth. Using a 75Ω feedthrough terminator on a 1MΩ, 20pF scope input will display pulse distortions that are actually caused by the poor termination. The best scopes for this use are those with 75Ω inputs, or 50Ω scopes with a 50/75Ω min-loss pad.

Passive loop-throughs

A powerful channel-monitoring tool is the passive loop-through oscilloscope. The passive loop-through allows the scope to sample the serial link channel at various locations in the system. It can often help find channel problems that would be awkward to detect using a 75Ω terminated scope.

Figure 5 shows a transmitter output that is displayed on a TV oscilloscope using equivalent time sampling. This measurement was made near the transmitter end of the link. Figure 6 shows the effect of an 18-inch open stub placed on the line near the transmitter. Such a stub might have been unwittingly installed as a troubleshooting aid. Although the stub would be of no consequence with 5MHz baseband video, it renders the 143Mb/s serial system inoperative.

Figures 7 and 8 demonstrate the problem that 50Ω line sections can cause. An 18-inch length of coax was inserted into the 75Ω channel. (This might occur if the signal passed through a 50Ω patch cord.) In Figure 7, the 50Ω section was inserted between the transmitter and the loop-through monitor, with the remainder of

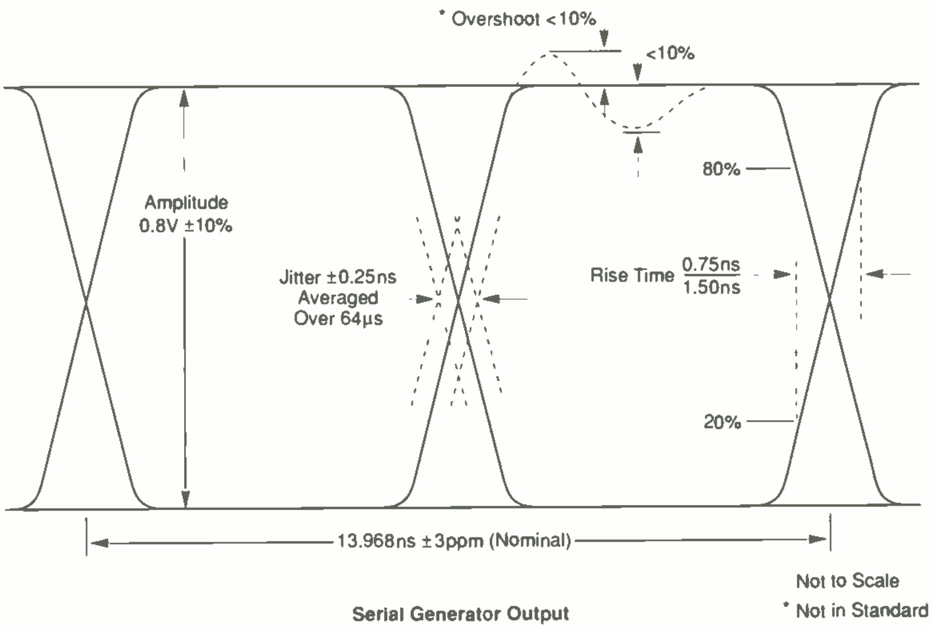

Figure 4. *Recommended specifications for 143Mb/s NTSC serial video.*

Multifunctional MP-10 portable mixer for retransmittals

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MAIN CHARACTERISTICS

- Dual Mode Dialler, which permits telephone communications in either pulse of tone dialling modes, through a programme output with an impedance matching circuit.
- Two independent circuits which enable different communication modes (2 or 4 wire) with a double hybrid control unit.
- Five transformer balanced mixing inputs selectable MIC/Line level inputs and one additional for the technician or commentator´s headsets, with the possibility of user selectable PHANTOM power feed.
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- Several Mixers may be cascaded together for the purpose of increasing the number of input channels.
- In addition to the control technician´s headphone output, there are three headphone outputs for commentators and guests. All are 600 Ohms.
- The Mixer provides a transformer balanced programme output, an electronically balanced auxiliary output and a bus output for cascade connections.
- The talkback output is also transformer balanced.
- A level meter on the front panel permits to measure the programme and talkback signals and to check the condition of the internal batteries.
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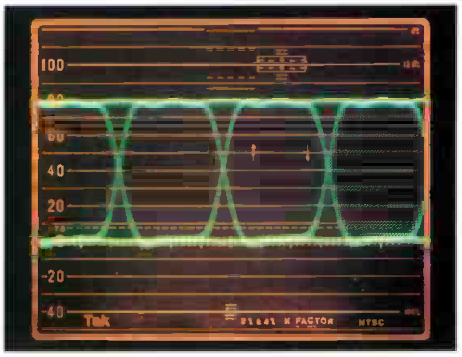


Figure 5. This normal eye pattern display shows the region over which signal bits can be clearly discerned as being 1s or 0s. The narrower the eye, the worse the bit error rate.

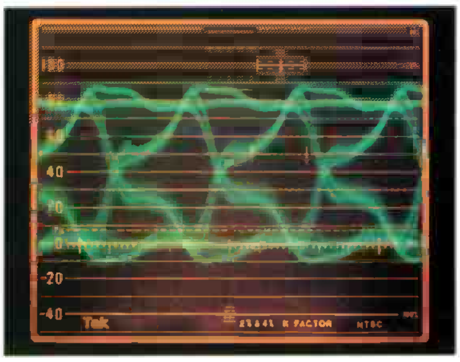


Figure 6. An 18-inch coaxial stub on the line, although transparent to baseband video, renders a 143Mb/s link inoperative.

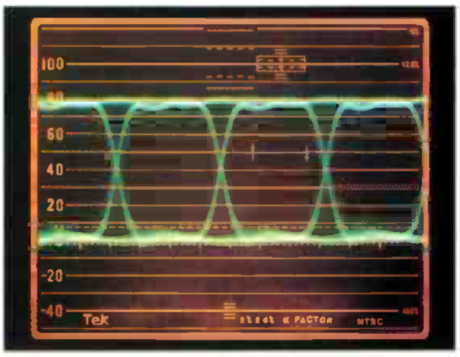


Figure 7. This eye pattern shows the effect of inserting a 50Ω section of line between the transmitter and the monitor, with the remainder of the 75Ω link on the scope's other side. Compared with Figure 5, there is extremely slight eye closure just after a bit transition.

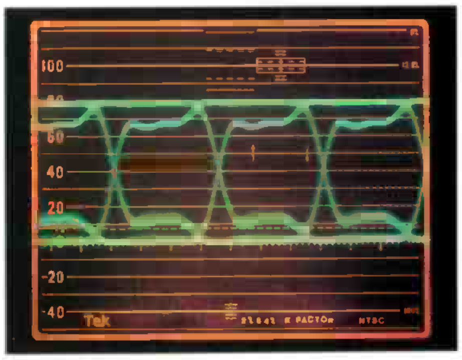


Figure 8. In this figure, the 50Ω section was moved to the other side of the monitor. Reflections are now causing approximately 30% eye closure.

the 75Ω link on the scope's other side. Compared with the output (see Figure 5), there is extremely slight eye closure just after a bit transition. In Figure 8, the 50Ω section was moved to the other side of the monitor, placing it in the receiver half of the link. Note that there is approximately 30% eye closure.

High-quality double-shielded coax is important, particularly at the receiver end of the link where the signal levels may be small.

These effects are explained in Figure 9. The signal that goes through the 50Ω section reaches 96% of its final value immediately, and 99% after twice the electrical length of the 50Ω cable. This is a small amount of distortion. On the source end of the 50Ω line, however, there is a −20% reflection that heads back toward the transmitter. This reflected pulse leads to the large eye closure.

As expected, the threshold point for these two links is substantially different. At 143Mb/s, an all 75Ω link started showing errors at 375m. Placing the 50Ω line on the transmitter side decreased this to 370m. The same line section placed on the receiver side caused this to fall to 325m (distances are for Belden 8281 coax).

These performance differences illustrate an important point. Passive loop-through oscilloscopes are ideal for discovering channel reflection problems. But passive loop-through inputs are vulnerable to nearby channel reflections. Some operational gear may use passive loop-through inputs, such as for a DA input. These systems will require careful inspection for reflections.

What's really important

Experience with 143Mb/s systems has shown that pulse amplitude and large channel reflections hurt system performance the most. Pulse amplitude affects some automatic receiver equalizers, and it directly changes the signal power in the channel. Large reflections reduce the eye opening, consequently raising the detection error threshold.

High-quality double-shielded coax is important, particularly at the receiver end of the link where the signal levels may be small. Inferior coax can add unnecessary noise. Less important parameters are rise time, jitter and small channel reflections, such as from 50Ω connectors. Jitter may become an issue when using many serial regenerators.

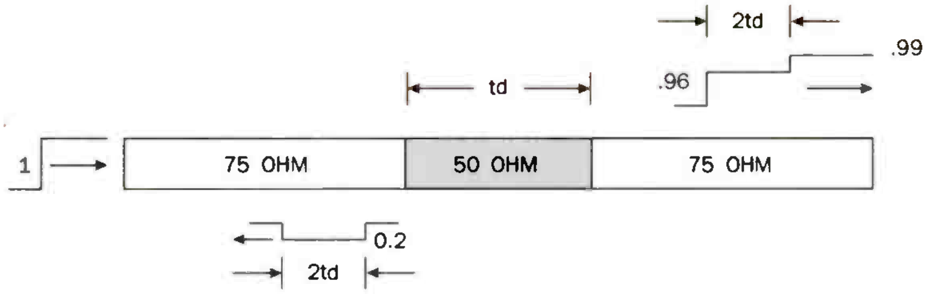


Figure 9. A signal passing through a 50Ω discontinuity on a 75Ω line will be only slightly affected downstream of the discontinuity, as in Figure 7. Reflections on the upstream side will cause major disturbances. (See Figure 8.)

Receiver performance is generally the largest single factor affecting link dynamic range. Optimizing the previous parameters can make a good receiver even better.

Other monitoring

The final two monitoring methods are digital format error checking and ancillary data (including audio) content monitoring. Some limited format checking can be done in the receiver, as discussed previously. To do much beyond this requires a tool, such as a logic analyzer. This typically involves converting the serial data to parallel and then feeding the analyzer. Content monitoring of ancillary data is accomplished with an appropriate data decoder.

Stress testing is highly recommended when a system is first installed. Logging the results and repeating the tests at intervals will pinpoint deteriorating performance.

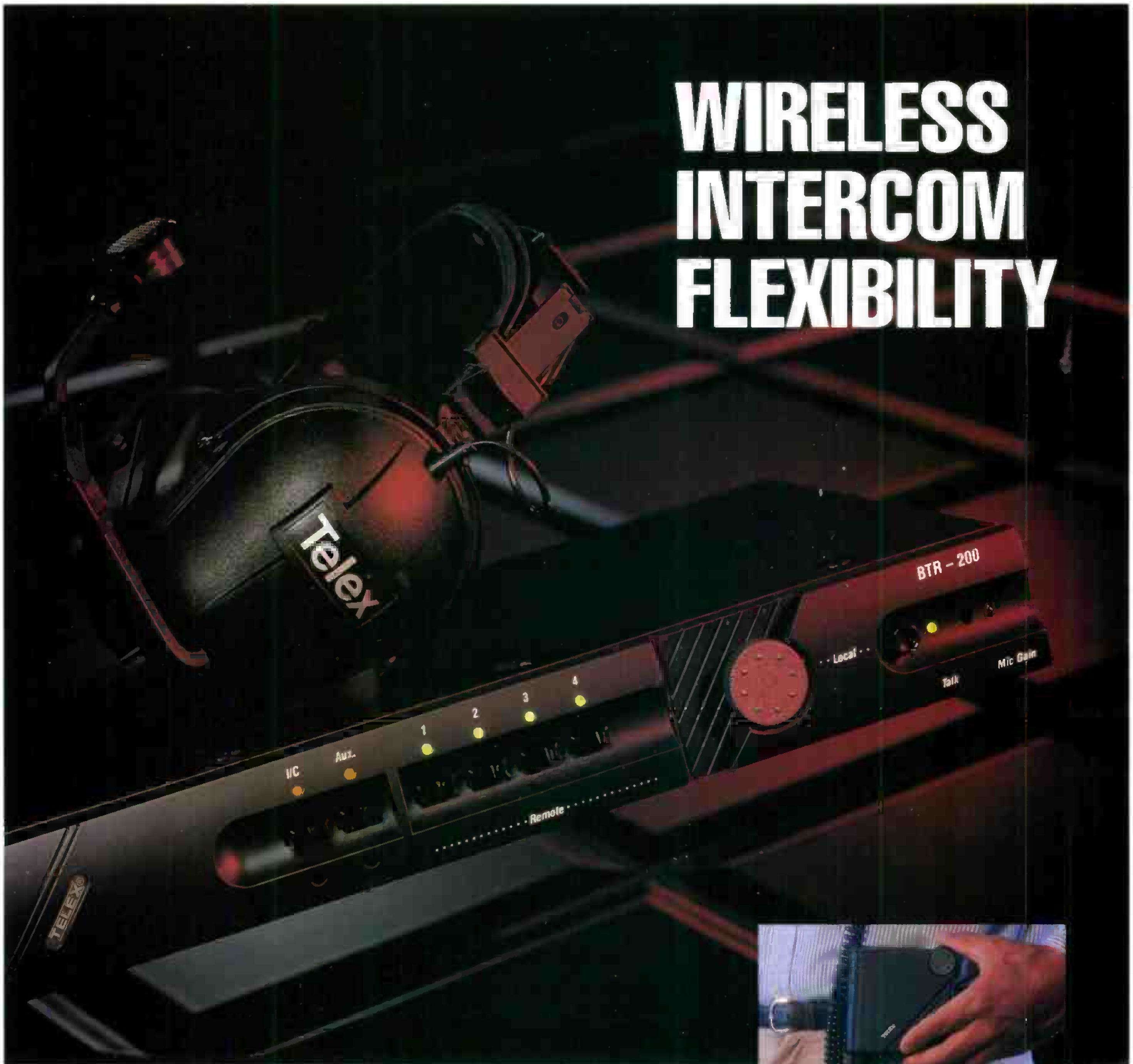
Stress testing

Simply monitoring error rate will not tell how far a serial link is from threshold. As discussed earlier, this is because the error level is practically zero above a certain channel S/N. Error monitoring will tell you when you've reached threshold. Although this is nice to know, the link is effectively broken at this point. For example, an experimental 143Mb/s system showed no errors at 370m, occasional errors at 380m and large numbers of errors at 390m (Belden 8281 coax).

You can estimate the link margin or headroom by measuring how much stress must be added to the system before the link enters threshold. One common method is to add additional loss to the channel. This can be done by adding coax until the error rate becomes observable on a picture monitor or EDH indicator. The results can be quantified in "meters of coax" or (preferably) in decibel loss at half the clock frequency.

It is easy to transfer this latter method between different types of coax. For example, Belden 8281 coax has approximately 7.5dB of loss per 100m at 71.5MHz (half of 143Mb/s). Thus, a link that entered threshold with 50 additional meters of 8281 would have 3.7dB of margin.

Other stresses might include varying the transmitted pulse amplitude, adding noise and jitter, and using bit sequences that



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stress equalization and clock recovery circuits.[3]

Stress testing is highly recommended when a system is first installed. Logging the results and repeating the tests at intervals will pinpoint deteriorating performance.

Monitoring topologies

Figure 10 shows two suggested monitoring connections. In Figure 10(a), a serial source connects to a single input receiver, such as a video processor or VTR. The input signal loops through the waveform

A serial overview

Serial digital is created by converting parallel digital video into serial form and transmitting it one bit at a time. Because video is represented with 10-bit words, the serial clock rate is 10 times that of the parallel clock. There are three rates: 143Mb/s for NTSC composite, 177Mb/s for PAL composite and 270Mb/s for 4:2:2 component.

A typical serial system consists of five parts: a transmit co-processor, a serializer, a transmission channel, a de-serializer and a receive co-processor.

The transmit co-processor adds a line rate synchronizing signal to the incoming parallel video. This timing reference signal (TRS) synchronizes the serializer and de-serializer. TRS is only added to composite video, because the EAV and SAV signals in 4:2:2 component perform this function. The serial signal has space allocated for ancillary data, such as AES/EBU digital audio. The co-processor can insert this data.

The serializer latches the parallel data from the co-processor and shifts it out one bit at a time, using a phase-locked clock running at 10 times the parallel clock rate. Serial systems always use 10-bit representations. If 8-bit video is input, then the serializer sets the two LSBs to zero.

Next, the serial data is scrambled. The scrambler alters the data spectrum to enhance clock recovery at the receiver and to reduce the signal's DC component. The scrambled signal goes to a coder that represents 1s as data transitions and 0s as no transition (NRZI coding). An output stage provides the power to drive the channel, nominally 75Ω coax.

The loss of metallic cable, expressed in decibels, is proportional to the square root of frequency. For example, if the loss at 50MHz is 5dB, then the loss at 200MHz should be 10dB. This loss charateristic is specified for the serial channel. Cable lengths up to about 300m are the most common.

Other channels, such as optical fiber, may be used as long as a compatible receiver equalizer is employed.

monitor just before terminating at the receiver. This allows content monitoring of the incoming signal and inspection of the eye pattern. The receiver's regenerated output loops through the second input of the monitor, and then either terminates or is sent to another device. An EDH-equipped monitor can then measure the serial receiver's error rate. This is possible because the regenerated serial output is derived from the equalized and detected input, and will, in general, contain the same errors that are experienced by the receiver.

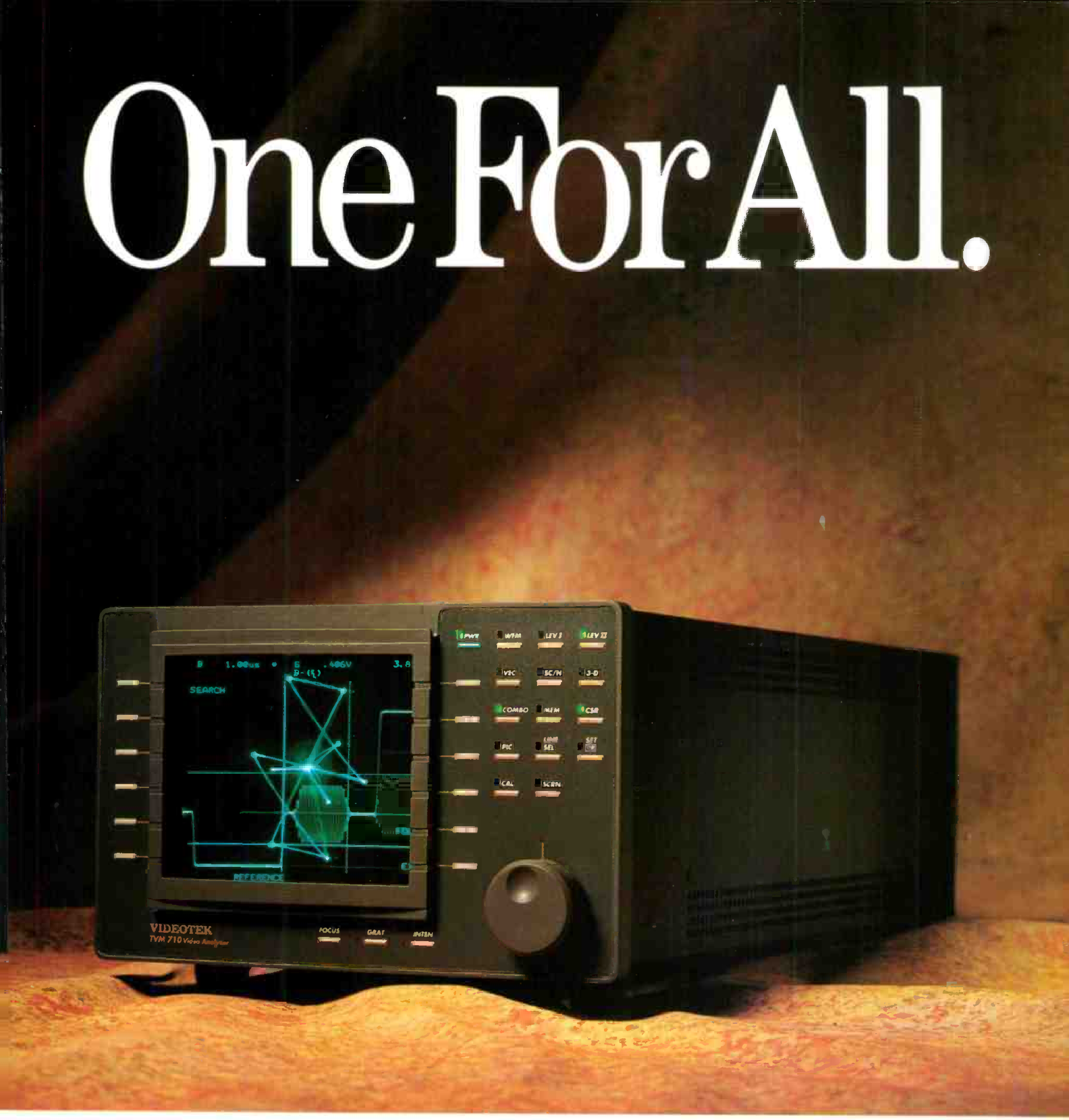
Continued on page 114

At the de-serializer, an equalizer compensates for the transmission channel losses. These equalizers are often automatic, based upon the signal's amplitude and presumed loss characteristics for the channel. Next, a clock recovery circuit extracts timing information from the signal and uses it to lock-up a 10 times parallel rate oscillator. This clocks the de-serializer.

The signal is then converted from NRZI to NRZ coding, descrambled and fed to a shift register, which does the serial-to-parallel conversion. TRS (or EAV/SAV for component) is recovered prior to parallel conversion to frame the shift register. This ensures that the recovered parallel words consist of the proper bits, not bits from two adjacent words.

If the de-serialized signal is composite, then non-video data, such as TRS and ancillary data, are removed by the receive co-processor. The co-processor might decode this data or strip it off, depending on the application. Because the 4:2:2 component standard allows ancillary data, stripping isn't required for component video.

Serial's primary use is to interconnect digital video equipment. Interfaces are already showing up on a variety of tape recorders, switchers, routers, DAs and video processors. However, because serial can be repeatedly regenerated and has good immunity to noise (such as hum), it can also help with difficult analog signal distribution problems. In this case, the footprint of the A/D and D/A conversion process must be traded off against the advantages gained by digital distribution.



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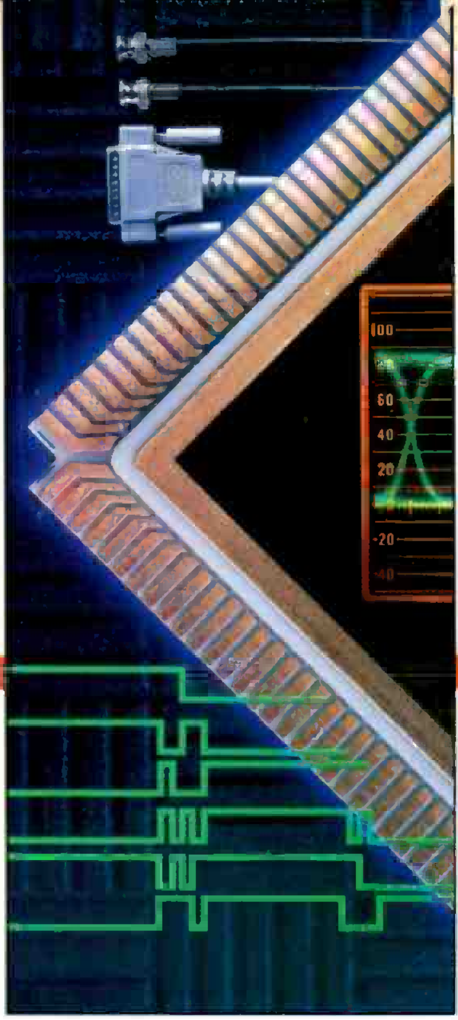

Caring for high-power tubes

By following a few simple steps, you can increase the life of your transmitter's tubes — which can save money.

By Brad Dick, editor

Although solid-state technology is becoming more familiar in the RF world, tubes are still the most common amplifier device in broadcast transmitters. The advantages of tubes are numerous and have been discussed in previous articles in *Broadcast Engineering* magazine. (See "Solid-State vs. Tubes in TV Transmitters," May 1991.) Because tubes still compose the backbone of the RF section of radio and TV stations, the care of these devices is paramount to long-term and profitable operation. If tubes are installed properly and maintained carefully, they can provide reliable service.

Tube basics

A vacuum tube consists of a vacuum envelope containing various electronic elements used to emit, control and collect a flow of electrons. (See Figure 1.) A filament or cathode provides a source of electron emission. The control grid, screen grid and suppressor grid control the flow of electrons within the tube. A plate or anode collects the electron flow. Electrical energy that is not transferred to the load is converted to heat at the anode.

The electron emitters in vacuum tubes can be either directly or indirectly heated. This article will look only at the directly heated (filamentary) tubes. Although there are similarities between the two types of tubes, the proper operating techniques for filamentary tubes are not necessarily correct for tubes with indirectly heated cathode emitters. In particular, the operation of cathode-type tubes at reduced heater voltage can be destructive to the tube. Keep this in mind when considering the adjustments on your particular transmitter.

Filament designs

Directly heated tubes have either spiral, parallel bar, hairpin or mesh filament structures. The *spiral* filament structure consists of one or two strands of wire, which are spiral wrapped around a central support rod. This design is found in older, lower-power tubes. Spiral filaments are subject to sagging and shorting between the turns.

The *hairpin* structure, which is shown in Figure 2, is found in the majority of today's tubes. It consists of a number of parallel elements bent into the shape of a hairpin. The hairpin filament support structures have built-in spring compensation, which allows for the thermal expansion of the filament. These filament structures can have all tube voltages applied without filament warm-up. Although the tuning will drift somewhat because of the slight movement of the tube elements as they reach thermal equilibrium, there is no danger of shorting. Some tube designs require surge current limitation for the filament when initially turned on. This protection should be provided for in the transmitter's design and should not be bypassed.

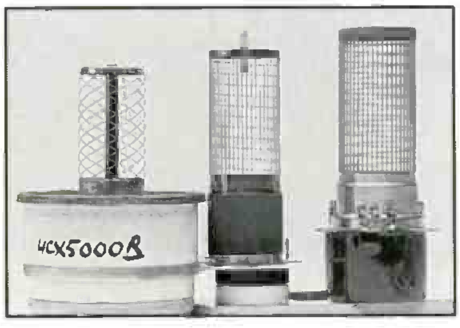

Figure 1. Interior elements of a tetrode. Mesh filament is on the left, control grid center and screen grid are on the right.

Mesh filaments are composed of filament wires woven to form a basket-type structure. (See Figure 3.) The wire joints are spot welded or diffusion bonded at the intersections. Mesh filaments are being used in more new tube designs, because they allow a denser, more closely spaced structure. This provides higher stage gain, increased efficiency and higher frequency operation.

The mesh structure relies on thermal expansion of the ridged upper filament support structure to compensate for thermal expansion of the filament. Mesh filaments require a longer warm-up period than hairpin designs. This is because the thin, low-mass filament wires come to temperature immediately as voltage is applied. As they heat, they expand, and until the more massive and slower to heat support structures reach their operating temperature to compensate for this expansion, the filament wires warp in and out. A warped

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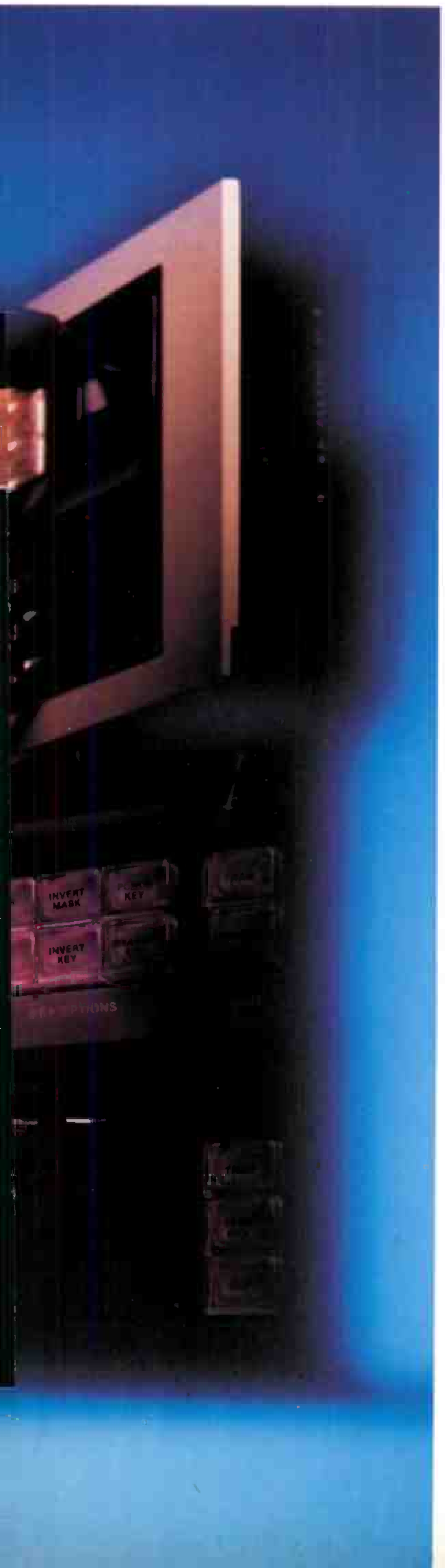

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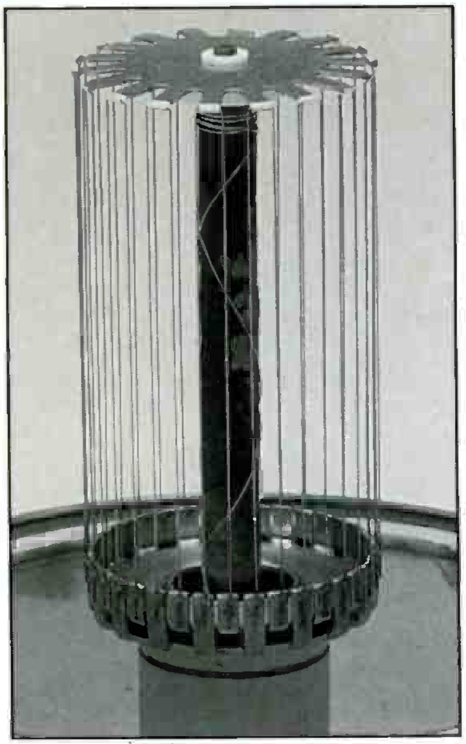

Figure 2. Hairpin filament structure. The current path is up one leg, across the top and down the adjacent leg.

filament greatly increases the possibility of a thermal grid-to-filament short.

Grids

Grid structures are generally composed of wires spot welded together to form a circular structure that completely surrounds the emitting surface of the filament. The grid controls the flow of electrons from the filament. Grids are coated with various materials compounded to suppress the emission of electrons from the grid.

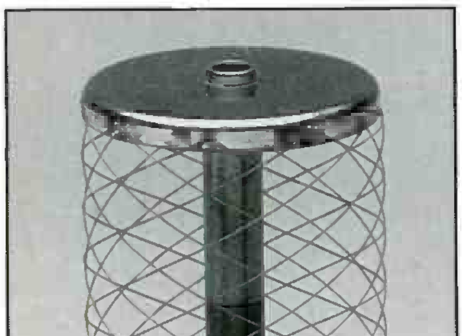

Figure 3. Mesh filament structure. The current path is from base, up through the mesh filament, across the top and down through the center support rod.

Anodes

Anodes are copper cylinders or drawn cups that collect the flow of electrons within a tube. Air-cooling fins or water-cooling jackets brazed to their exterior are used to remove the heat generated from power that is not being completely transferred to the load.

Plating

The external metal parts of tubes are plated with nickel or silver. Socketed tubes should be silver plated. The soft silver provides a better contact interface than the much harder nickel. The silver deforms slightly under contact pressure, providing greater contact area. Silver plating has a dull, whitish cast, whereas nickel has a hard metallic appearance.

Nickel is resistant to discoloration because of the heat from normal operating temperatures. However, silver will easily tarnish. Often, the heat patterns on silver-plated tubes are helpful in problem analysis. If a nickel-plated tube shows any sign of heat discoloration, a serious cooling or operational problem exists.

Safety considerations

Power tubes and the transmitters in which they are installed have lethal voltages. You must be extremely careful when working with these devices.

Access panels to all high-voltage cabinets should always be installed. Interlocks should never be bypassed. High-voltage cabinets should be equipped with a shorting bar connected directly to the equipment ground. Use the bar to ground all high-voltage areas before reaching into any high-voltage area or circuit.

All high-voltage circuits should have bleeder resistors in place to discharge any residual voltage to ground when the equipment is turned off. Remember, this process may take several seconds. Don't assume that the circuits are discharged — use the shorting bar.

Tube installation

Prior to installing a tube, inspect the socket. Look for any broken pieces of fingerstock. These small particles can fall into other circuits, causing shorts and other damage. If any pieces are missing, find and remove them before you install the replacement tube.

Don't be too concerned, however, if a few pieces of fingerstock are gone. The contacts can break off on occasion and as long as they are located and removed, the socket ring does not require replacement. However, if more than 20% of fingerstock is broken off, the entire contact ring should be replaced. Consecutive gaps around the tube can cause improper tuning, instability and premature tube failure, as shown in Figure 4.

Repair kits are available from the manufacturer for most sockets. Replacing a single ring is far cheaper than replacing the entire socket. If you have trouble locating repair kits, contact the transmitter manufacturer or a tube rebuilder.

Socket problems

Loose contact by fingerstock with the tube will always lead to problems. Some socket designs have a wire-wound spring encircling the outside circumference of the fingerstock to increase individual finger contact pressure. These springs should be replaced if they break or lose tension. Adequate contact pressure is vital for proper operation and long tube and socket life.

Some sockets have stops that are set so that the tube has the grid contacts in the middle of the contact area when the tube is fully inserted. This positioning can be checked by inserting and then removing a new tube. The scratch marks on the grid contacts will show the position of the tube relative to the socket contacts.

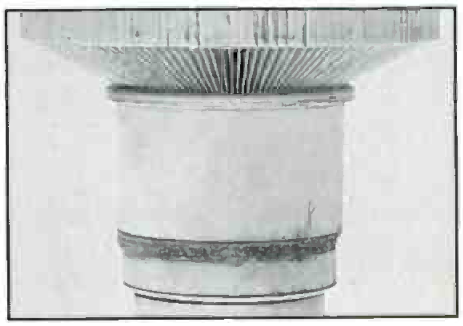

Figure 4. Note the burned and melted grid ring near the base of the tube. Failure was caused by poor contact between the grid ring and socket.

Tube insertion

Inserting a replacement tube must be properly done. Gently rock and slightly rotate the tube as it is being inserted into the socket. This will help avoid bending and breaking of fingerstock. Be sure to apply sufficient force to seat the tube all the way into the socket. Never use a lever or hammer on the tube to set it into the socket. Manual pressure should be adequate.

An intermediate point is reached when the grid contact fingerstock slides up the tube sides and first encounters the contact area. It's important that the tube is fully inserted in the socket beyond this initial point of resistance.

Tubes without sockets

Many industrial and AM transmitter tubes are not socketed but installed by bolted or clamped connections. Stainless steel has a much lower coefficient of thermal expansion than copper. Therefore, clamped stainless steel anode connections should have some method of strain relief to prevent excess pressure from collapsing the tube's anode as it heats up.

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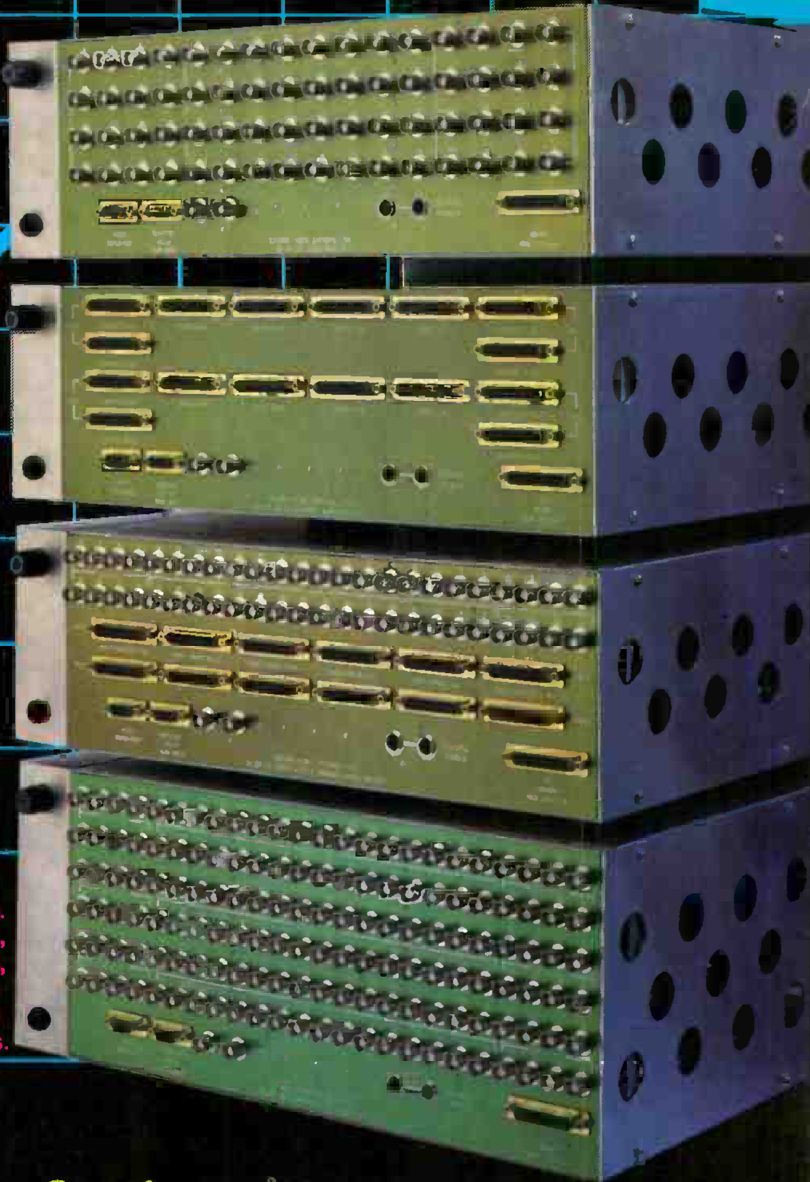

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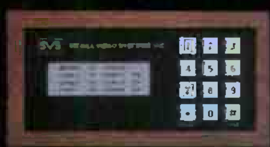
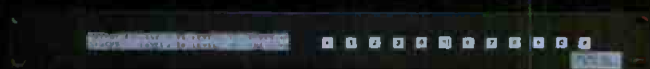


Desktop keypad control panel



Rackmount keypad control panel

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All bolted or screwed connections should be tight. Verify that the clamps are snug and provide a good electrical contact around the entire circumference of the tube. Because of the RF fields present, all clamps and bolts should be made from non-magnetic materials. Copper, brass or non-magnetic series 300 stainless steel fasteners are preferred. Stainless steel is not a good conductor of electricity, and although it may be used for clamping, it should not be part of the current path.

Tube cooling

With the single exception of the temperature necessary to obtain proper filament electron emission, heat is the enemy of vacuum tubes. Although the transmitter may be properly designed for adequate cooling, incorrect installations can result in tube damage or shortened life. (See Figure 5.)

Air-cooled power tubes generally don't require special maintenance throughout their normal operating life. However, it is critical that the socket is in good condition and the cooling fan filter is cleaned or replaced periodically.

Tubes are typically cooled with squirrel cage blowers. Check the impeller blades occasionally, and make sure they aren't filled with dirt, which can drastically reduce their efficiency and airflow through the tube. If the blades are dirty, scrape them with a screwdriver blade or knife to remove caked on dirt. A brush can also be an effective cleaning tool.

Also, check the cooling fins on the tube anode. If they are plugged, remove the tube and use an air hose to blow the dirt from the fins. Blow the cleaning air in the reverse direction of normal airflow through the tube. Pay particular attention to the area of the tube where the cooling fin attaches to the anode. The greatest blockage occurs at the point where the cooling air first hits the fins. This is also the point of maximum temperature and, therefore, maximum heat transfer to the airflow.

Air-cooled tubes require greater airflow when operated at higher altitudes because of the decreased density of the air. The

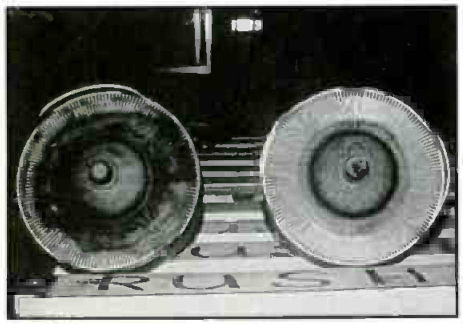

Figure 5. Comparison of normal heat dissipation from the tube on the right vs. darkening of the silver coating caused by excessive dissipation (heat) on the left tube. The cause is either restricted air flow or improper loading.

Photo courtesy of Econco

tube data sheet will provide the correct information for high-altitude operation. External arcing at high altitudes may occur, requiring a lowering of plate and screen voltages.

Air-cooled tubes should have an air interlock switch to prevent the application of any voltages to the tube unless cooling air is flowing. The switch should be checked for proper operation. Without adequate cooling airflow, the heat generated by the filament alone can destroy a tube.

AM and FM transmitters should never have air duct work fastened directly to the exhaust port. Ducting increases back pressure, restricting airflow, which can result in excess tube temperature. Some exhaust ducting use fans to help move exhaust air. However, if improperly designed, they can actually reduce airflow. Keep in mind that if this fan fails, it will definitely reduce cooling airflow.

Try this technique if your installation requires exhaust ducting. Construct a hood over the transmitter with a 6-inch open air gap between the transmitter and the duct work. This will trap and exhaust the hot air without increasing back pressure.

Tube life

The proper adjustment and regulation of filament voltage is the single most significant area where a tube user can affect tube life and performance. The following are some critical factors to consider:

- The metering of filament voltage on the majority of equipment is not accurate. Often, the metering is a multimeter that is switched to read various operating parameters. To be useful for filament metering, the meter must be calibrated to read voltage at the tube socket and must be capable of being read accurately to one tenth of a volt.

- Often, the filament voltage is measured at the input to the filament transformer. In high-current circuits, such as the filament, the voltage drops in the wires going to the tube can be significant. All filament meters should be calibrated with an accurate iron vane or rms-responding digital meter. The calibration voltage should be measured at the tube socket or connections with the filament operating. This will compensate for any I/R losses. In locations where the line voltage fluctuates more than 5%, the supply to the filament transformer should be equipped with a constant voltage transformer or regulator circuit.

The thoriated tungsten filaments used in power vacuum tubes depend upon sufficient filament temperature to provide adequate electron emission. Power tubes should not be operated in an *emission-limited* mode. The use of filament voltage to control output power is not the correct method of operation. It will destroy a tube quicker than operation at overvoltage.

Each tube is unique. Although one tube may make full operating power at a filament voltage of 7.3V, its replacement may require 7.4V to attain the same power. For this reason, all tuning should typically be done at the rated filament voltage. After tuning is complete, the voltage can then be reduced to provide extended life.

Although cathode-type tubes can be damaged by operation at reduced filament voltage, operation at a reduced voltage *after* tuning has been completed will generally extend the tube's operating life. It is important to initially operate and tune the tube at its rated filament voltage for the first 100 to 200 hours. Only then can it be reduced as described later.

Initial operation and tuning

Upon initial installation, the filament should be run for a period of 100 to 200 hours at its rated filament voltage. This initial operation allows the getters — materials that absorb and hold residual gas — to complete the vacuum of the tube in its actual operating environment. After this initial run-in time, it is excellent practice to operate the filament at a reduced voltage, provided that proper operating parameters can be maintained.

First tune and operate the transmitter at normal conditions with the filament at rated voltage. Then, without changing any other adjustments, reduce the filament voltage until the tube output begins to fall. This point is the beginning of *emission-limited* operation. *Continued operation at this point can be destructive to the tube.*

Increase the voltage by 0.1V to 0.2V above the lowest point where the tube worked properly. This will help maximize tube life with no reduction in performance. The 0.1V to 0.2V setting above the emission-limited voltage allows for minor line fluctuations and requires less frequent adjustment as the tube ages. A power tube operated at a properly reduced filament voltage can reduce tube operating costs by almost 50%.

Continued on page 58

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The effects of this practice are shown in Figure 6. The first tube, shown in *red*, was operated at its rated filament voltage of 7.5V for its entire life. The tube failed at 5,400 hours.

The second tube, shown in *blue*, was initially operated for 200 hours at the rated voltage of 7.5V. The filament voltage was then dropped as low as possible for normal operation. This tube lasted 10,000 hours. This simple procedure can reduce tube costs by almost 50%.

Tube failure point

The normal end of a power tube's life occurs when the filament's emission falls below the point where it is no longer able to sustain full output power, or distortion levels exceed allowable limits while operating at its rated voltage. This failure is due to decarburization of the filament.

During tube manufacturing, carbon is burned into the raw thoriated tungsten filament. This process is called carburization. As a tube operates, the carbon is slowly burned out of the filament, which is decarburization.

Three primary factors determine the life of a tube. The first factor is the amount of carbon originally processed into the filament. The maximum amount of carbon that can be burned into a filament is limited by increasing fragility as the carbon level is increased.

Second, the residual vacuum level in a tube affects its life span. The rate of decarburization is a function of residual gases, primarily oxygen and nitrogen, reacting with the filament. Good vacuum processing and proper gettering result in the lowest residual gas levels. (Getters are materials placed within the tube envelope that when heated absorb and hold residual gases within the tube, which improves the ultimate tube vacuum.) Gettering action continues throughout the life of the tube. However, the most beneficial action occurs in the first hours of operation.

Third, the rate of decarburization is proportional to the filament's operating temperature. The filament temperature is determined by power on the filament and is therefore controllable by adjustment of the filament voltage.

These various items taken together determine the normal life of a tube. In broadcast transmitters, which operate into a fixed load, the vast majority of failures are due to loss of emission as a result of decarburization.

Tubes will continue to be an important part of many broadcast transmitters. Because of their reliable operation, maintenance is usually simple and quick. By following the few simple procedures described in this article, you can help ensure the longest life possible for your transmitter tubes.

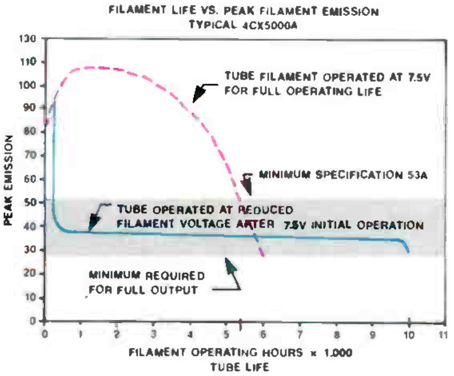

Figure 6. *This chart depicts the operating life for two tubes. The red trace shows the life of a tube operated at its rated filament voltage for its entire life. This tube failed at 5,400 hours. The blue trace shows a tube operated at a reduced filament voltage after initial burn-in. Its life was 10,000 hours. The result is approximately a 50% reduction in tube costs.*

Editor's note: This article was prepared from the booklet, "Tube Topics, A Guide to Vacuum Tube Users in a Transistorized World." It is available from Econco.

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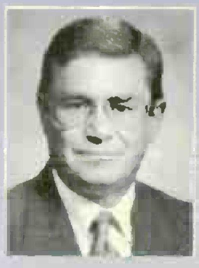

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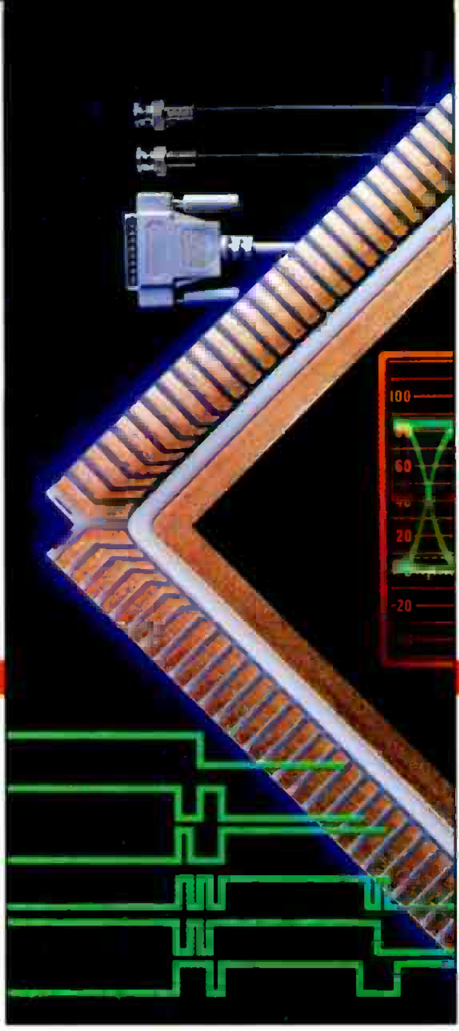

Rebuilding TV transmitters

The task: to inspect, clean and rebuild the transmitter cavities. The result: The station saves the expense of replacing transmitters.

By Don Newman

After more than a decade of dependable service, the time had come for some major maintenance work on the transmitters at WABC-TV, Channel 7, in New York. This article will detail the planning, implementation and benefits of the project. A unique aspect of the project is that station staff worked closely with GE Support Services/RCA Broadcast organization to bring the project to a successful conclusion.

Station background

WABC-TV operates two RCA TT50FH 50kW transmitters from the top of the World Trade Center. Both transmitters were purchased new and installed in 1979. They have been in service for more than 12 years.

Each transmitter consists of two independent transmitters operated in combination. This provides 50,000W of RF output into a filterplexer, which feeds the transmission line and antenna. If one side shuts down because of a failure or because it needs maintenance, the system can still deliver half-power — 25kW.

The station is committed to maintaining full-power operation 24 hours a day, seven days a week. This is accomplished by operating the primary transmitter into the main antenna, while operating the secondary transmitter as a hot standby into the auxiliary antenna. If the primary transmitter shuts down, applying plate voltage to the standby transmitter puts it into operation without loss of power or air time.

Newman is a technical specialist for General Electric Support Services, Mt. Laurel, NJ.

Reasons for the rebuild

In late 1990, station engineering management decided to rebuild the transmitters' existing visual PA, aural PA and visual IPA cavities. The decision to rebuild the cavities was based on the length of service, plus the fact that the station was having increasing difficulties keeping the cavities properly tuned. Universal joints on the tuning controls were becoming sloppy, and in some areas they had become totally inoperative. This made it necessary to move tuning controls by hand, a difficult situation at best.

Other factors influencing the decision were the condition of the cavity fingerstock, which was deteriorating with age. The Kapton plate-blocking capacitors, although still holding, were suspect. The cavity walls had, in some cases, become so worn that it was necessary to tune them slightly off their desired positions, and then compensate in other sections.

The environment was another problem. There are many corrosive elements in New York City's atmosphere from smog and from the nearby ocean. This also adversely affected tuning. Cavity walls and other areas in the transmitters had become so contaminated that it was difficult to maintain satisfactory operations.

A final justification was cost. Extending the transmitters' life saved the station a lot of money. The station estimates that the rebuild added five to six years of life to its transmitters. The cost to WABC-TV was approximately $70,000, which included all parts and labor. Had WABC-TV purchased new transmitters, the cost would have been more than a million dollars, plus installation and the hassle of getting through the shakedown period, which is typically at least one year. There would also have been the effort of disassembling and removing the old transmitters. (See the related article, "Is It Worth It?" p. 64.)

Clean up work

Transmitter clean up began in January, when the transmitter engineers disassembled each cavity's inner and outer covers for cleaning. They used general-purpose cleaners to remove accumulations of dirt and grease.

This job involved 12 cavities, each containing four inside covers and four outside covers. The initial cleaning took five weeks, with noticeable improvements observed along the way.

After the initial cleaning, engineers determined that all the cavities' covers could be restored. This alone represented a savings of more than $8,000. The station then called RCA Broadcast in Mt. Laurel, NJ, and requested a complete list of replacement parts for each cavity. They ordered the required parts in March 1991, and had them delivered to the site before starting the major rebuild.

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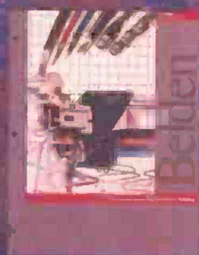

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A contact ring and filament contact from one of the transmitters shows heat discoloration, tarnish and accumulations of dirt and grease due to environmental pollutants.

Planning ahead

In a job of this magnitude, which started on April 1 and continued through April 26, planning was crucial. There could be no interruptions once the job was started. The 24-hour schedule had to be maintained, including transmitter backup capability.

The station contracted with RCA Broadcast to provide an on-site technical specialist to supervise the work. Two station engineers and the contract supervisor were scheduled for five 8-hour shifts, midnight to 8 a.m., Monday through Friday. This schedule provided for completion of one side of each transmitter per week. The crew could have finished faster by working weekends, but the station chose a less-aggressive timetable to reduce the likelihood of human error.

At midnight on April 1, the station shut down one side of the current standby transmitter, leaving the other side operational. If the on-air transmitter suffered a failure, the station could still maintain half-power operation.

Each cavity required complete disassembly, with removal and cleaning of the old parts. The engineers used silver polish to remove corrosion and restore the original silver surfaces. Furthermore, any arc marks and worn areas on cavity walls were removed by electroplating. New parts were then installed where needed, and the units were reassembled.

To achieve the desired results, engineers laid out each step prior to starting work. The crew rebuilt one cavity at a time. Then, they tested it at full power before proceeding to the next one. This way, any problems encountered when the transmitter was powered up for testing could quickly be identified and repaired. Also, they completed and tested both sides of one transmitter before starting work on the second.

The job proceeded as planned and, with one exception, was completed on time. The exception occurred when a blower motor with defective grease seals blew grease into the system. This required extra cleaning time.

Because the rating sweeps were due to start, the cavities on the last side were left unfinished. Their completion was scheduled at a later date.

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A stitch in time

An important benefit of doing a job of this nature is that it can uncover other potential problem areas. Rework of this scale will often reveal problems that ordinary routine maintenance procedures may miss.

The true cooling criterion is air density — any reduction is detrimental to tube life. In one case, a blower boot was found to have incorrect mounting brackets. This caused air leakage. The diminished air supply to the cavities may have caused inadequate cooling.

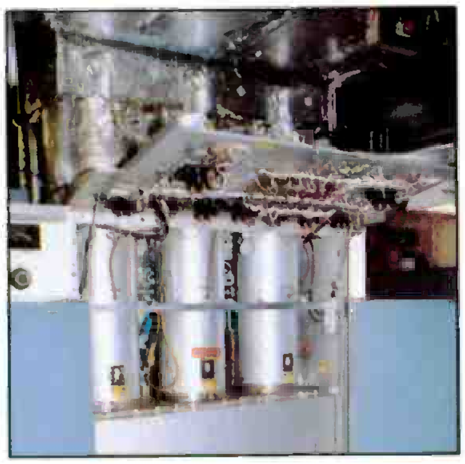
The engineers also found and replaced a bad vent fan. In both transmitters, some of the sound-deadening foam material had deteriorated and broken loose. It lodged in the honeycomb material of the sliding RF shorts that surround each cavity, restricting air conduction.

Furthermore, the engineers found a burned set of bleeder resistors in one transmitter. They fixed a bent elbow in one transmitter's visual output transmission line. They also replaced a sticking screen voltage meter. The 4N25 opto-isolator ICs in some of the overload sequencer modules were found to be defective and were replaced.

Why bother?

The rebuild fixed some serious problems and headed off others. One of the first benefits of the cavity rebuilding was an improved tuning process. Each refurbished cavity now provides excellent operation. The previously erratic visual frequency response is now completely solid. With the transmitters in like-new condition, there is no longer a need to compensate for worn tuning areas. All tuning controls responded properly. In addition, future cavity component failures are now likely to be minimal.

WABC-TV's decision to rebuild the transmitters proved to be advantageous. The station feels it has achieved its goal with minimal cost. The transmitters are like new, and will provide the optimum performance and stability that is essential to the station's operation. WABC-TV recommends that other station engineers consider this overhaul at their own stations.



The rebuilt aural power amplifier (PA), visual intermediate power amplifier (IPA) and visual PA of one side of one of the transmitter pairs.

Various parts that were replaced during the WABC-TV transmitter rebuilding project.

Acknowledgment: GE Support Services thanks Ray Johns, assistant director of engineering and Don Di Franco, transmitter engineer at WABC-TV, for their assistance in developing this article.

Is it worth it?

By Marvin Born

Looking at the financial aspects of rebuilding vs. replacing a transmitter reveals many zeros in the numbers. The article "Rebuilding TV Transmitters" listed the cost of the reconditioning at $70,000 for two dual transmitters vs. $1 million to replace them — a difference of $930,000.

How would the numbers look if the $930,000 was placed in the bank? The authors estimate the rebuild will allow the station to hold off purchasing a new transmitter for five years. At 10% interest for five years, compounded monthly, the account will equal $1,573,200. That would cover half the cost of a new transmitter system. If the money was placed in the bank for only one year, the future value is $1,027,383, or $97,383 paid in interest.

Most stations aren't able to pay $1 million in cash for equipment or place $930,000 in an account to draw interest. So what is the real cost of rebuilding vs. replacing if both scenarios are financed using 10% interest compounded monthly? (For simplicity, no down payment will be used.)

Because the rebuild is expected to last five years and a new transmitter is expected to last 15 years, we will use five and 15 years, respectively, to compute the monthly payments.

Initial investment:	$70,000	$1,000,000
Monthly payments:	$1,487	$10,746

Born is vice president of engineering, WBNS stations, Columbus, OH.

Total cost at the end of each year:

Year 1 — $17,844	$128,952
Year 2 — $35,688	$257,904
Year 3 — $53,532	$386,856
Year 4 — $71,376	$515,808
Year 5 — $89,220	$644,760
...	
...	
Year 10 —	$1,289,520
Year 15 —	$1,934,280

As you can see, the cost of the first year's payments for new transmitters exceed the total cost of rebuilding.

Now we can play with the numbers a bit. If the station was to rebuild the transmitters paying cash for the repairs plus putting the $10,746 per month in the bank, the down payment on the new transmitters could be $644,760 after five years. This would leave $355,290 to be financed for the 15-year life of the new transmitters.

Financing $355,290 for 15 years would require payments of $3,817 per month, or a total of $687,136 over the 15 years.

If the transmitters were purchased new (without the rebuild) and financed, the total costs would be $1,934,280. If the original was rebuilt and used for five years, then replaced as described, the cost would be $687,136 plus $70,000 or $757,136.

Subtracting $757,136 from $1,934,280 gives a savings of $1,177,143 by rebuilding the original for five years while building an annuity for the replacement.

These figures show how much a station can save by rebuilding a transmitter instead of buying a new one. Is it worth it?

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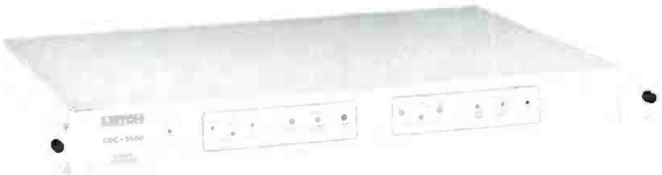

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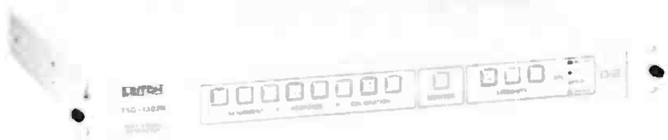

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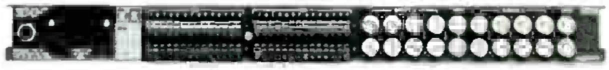

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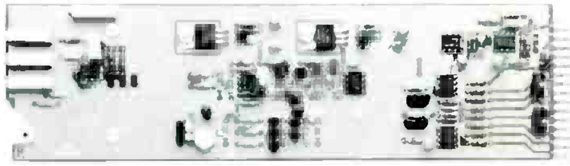

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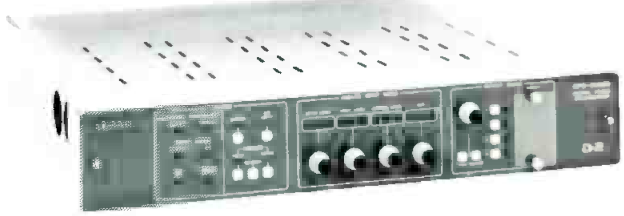

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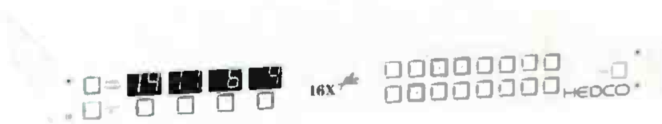

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Testing coaxial lines

Budget applications of TDR can solve transmission line problems.

By Don Kolbert

Part 1 of this series, which began in October, introduced the technique of time domain reflectometry (TDR) to measure the length of transmission lines. It also showed how cable measurements can be made with inexpensive "service-type" test equipment when the more expensive industrial/scientific instruments are not available.

Part 2 will show how to use TDR to measure impedances and identify faulty cable fittings and connectors. The effect of impedance mismatches on voltage standing wave ratio (VSWR), and the characteristics of an oscilloscope for best results in TDR measurements will also be covered.

When dealing with transmission lines, such as line pairs and coaxial cables, a few electrical parameters have great influence on the cables' ability to transfer energy from one place to another. Among these are surge impedance (Z_O), the dielectric constants (k) of the insulating materials, and the velocity of propagation (V_P) of electromagnetic waves, both in free space and within the transmission lines.

In a coaxial cable, with a single center conductor and an outer conductor, the surge impedance is determined by this relationship:

Equation 1: $$Z_O = \frac{138}{\sqrt{k}} \times \log_{10} \frac{D}{d}$$

where k = the dielectric constant of the insulating material
D = the inside diameter of the outer conductor
d = the outside diameter of the center conductor

In 2-conductor transmission lines, the surge impedance is determined by this relationship:

Equation 2: $$Z_O = \frac{276}{\sqrt{k}} \times \log_{10} \frac{2S}{s}$$

where k = the dielectric constant of the insulating material
S = the spacing between the centers of the two conductors
s = the diameter of the conductors

(Diameters and spacings can be measured in either centimeters or inches.)

If the inductance and capacitance per foot (or meter) of the transmission lines are given by the manufacturer, the surge impedance can be calculated by this relationship:

Equation 3: $$Z_O = \sqrt{(L/C)}$$

where L = quoted inductance per unit length
C = quoted capacitance per unit length

Note that the actual *length* of the line is not a factor in any of these formulas. The surge impedance of the line is independent of cable length, and wholly dependent on cable type.

One common variety of $^1/_2$-inch foam dielectric coaxial cable has an inductance per foot of 0.058 microhenries (μH) and a capacitance per foot of 23.1 picofarads (pf). Its surge impedance is therefore:

$$Z_O = \sqrt{(0.058 \times 10^{-6}/23.1 \times 10^{-12})} = 50\Omega$$

Most transmitters use 50Ω or 52Ω coaxial transmission lines to feed energy to an antenna. (Translator manufacturers offer either 50Ω or 75Ω lines.) Receivers have traditionally employed 75Ω or 300Ω input impedances. The 75Ω may either be coax (single-ended) or 2-conductor (balanced), and the 300Ω is 2-conductor balanced (commonly called 'twin lead'). This report will deal with single-ended cables that are most commonly used in broadcast transmission. (Some of the references listed at the end of the article describe the procedures used with balanced transmission lines.)

Crimps and mismatches

Because the surge impedance of a transmission line is based upon its cross-sectional characteristics, its impedance can be changed if the cable is compressed or bent past its recommended bend radi-

Kolbert is chief engineer at KLSE-FM and KZSE-FM, Rochester, MN.

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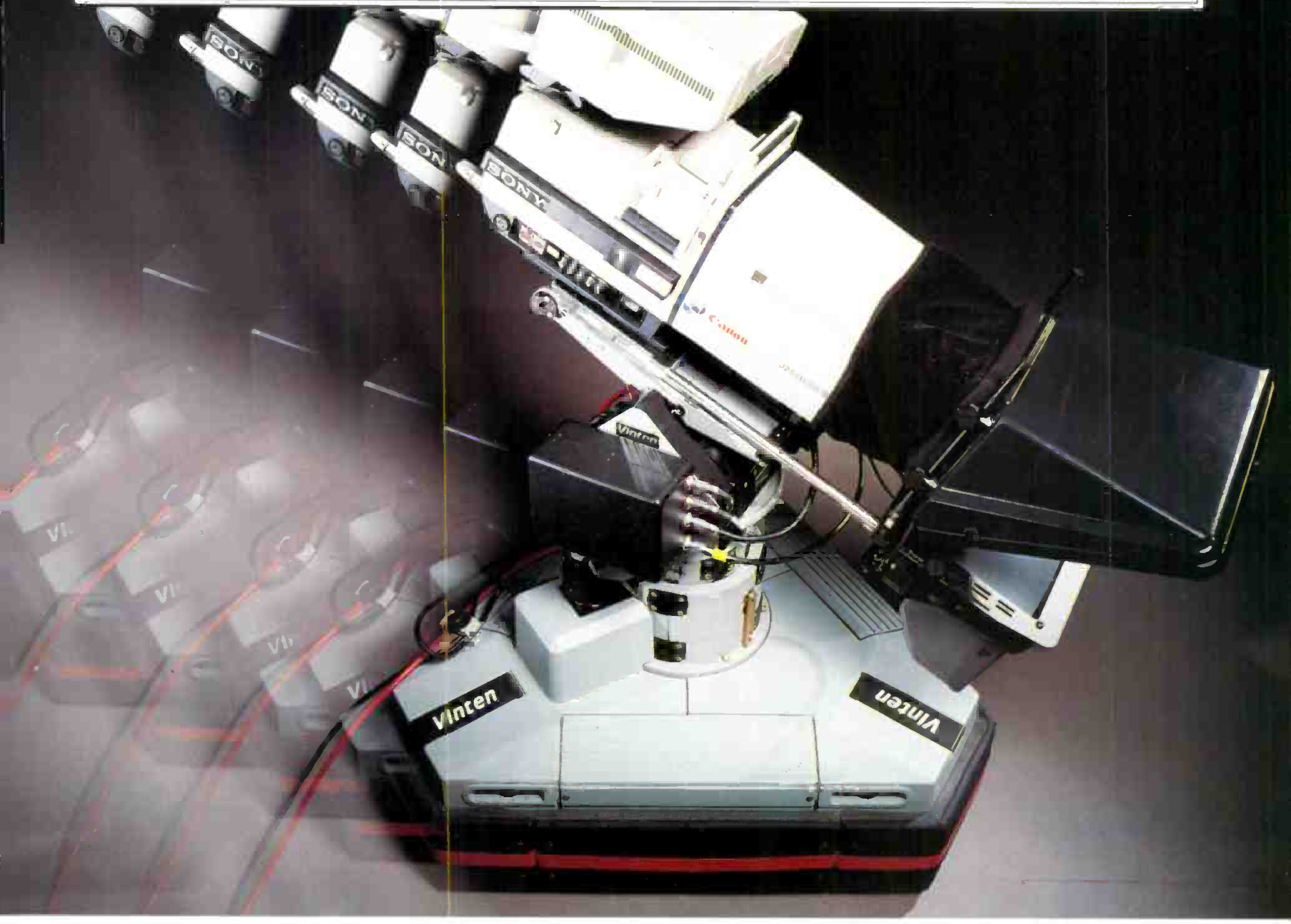

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ρ	MULTIPLIER	Z_1	
		$Z_O = 50\Omega$	$Z_O = 75\Omega$
+1.000	∞	∞	∞
+0.980	100	5,000	7,500
+0.970	60	3,000	4,500
+0.961	50	2,500	3,750
+0.905	20	1,000	1,500
+0.818	10	500	750
+0.667	5	250	375
+0.333	2	100	150
+0.000	1	50	75
−0.333	0.5	25	37.5
−0.667	0.2	10	15.0
−0.818	0.1	5	7.5
−0.905	0.05	2.5	3.75
−0.961	0.02	1.0	1.50
−0.970	0.167	0.833	1.25
−0.980	0.010	0.500	0.75
−1.000	0.000	0.000	0.000

***Table 1.** ρ values, multipliers and their corresponding Z_L values for 50Ω and 75Ω surge impedances (Z_O).*

us. The inner and outer conductors would no longer have the same spacing between them at that point, causing a change in impedance there. (See Equation 1.) This change of impedance causes some of the energy in the line to be reflected in both directions. Some of the energy never reaches the load. Standing waves are created, which in turn cause energy to be radiated by the transmission line. (A perfectly matched transmitter, line and load system has no standing waves, no lost energy except for dielectric losses, and no radiation from the transmission line itself.)

A crimp in a line will cause an increase of capacitance at that point. This will cause the impedance to be reduced. The resulting TDR waveform is shown in Figure 1.

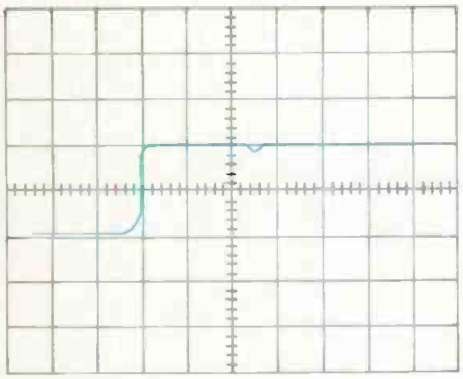

***Figure 1.** Simulated display showing the effect of a crimp in a transmission line.*

Now, consider a 75Ω load connected to the end of a 50Ω coaxial cable. The TDR waveform that results from the mismatch at the end of the line is characterized by an upward deflection of the waveform shown in Figure 2, similar to that exhibited by an open condition. In the mismatch, however, the $E_{REFLECTED}$ (E_R) is not the same amplitude as the $E_{INCIDENT}$ (E_I). The voltage ratio of E_R to E_I is denoted by the Greek letter rho (ρ):

Equation 4: $\rho = E_R/E_I$

The absolute value of ρ may be either positive or negative, depending on whether a mismatched impedance is higher (positive) or lower (negative) than the source impedance. For the example shown in Figure 2, E_R = 1 division and E_I = 5 divisions. That means ρ = 0.2. If the vertical sensitivity is set at 0.2V per division, that would mean that E_R = 0.2V and E_I = 1V.

To determine the load impedance (Z_L) once ρ is known (and verify that it is equal to 75Ω), employ this useful formula:

Equation 5: $Z_L = Z_O \dfrac{1+\rho}{1-\rho}$

The distance to the impedance mismatch will be calculated as shown in Part 1, using $D = V_P \times T/2$. For RG-58/U, the V_P is 0.65 ft/ns. If T = 280ns, D = 91 feet to the mismatch.

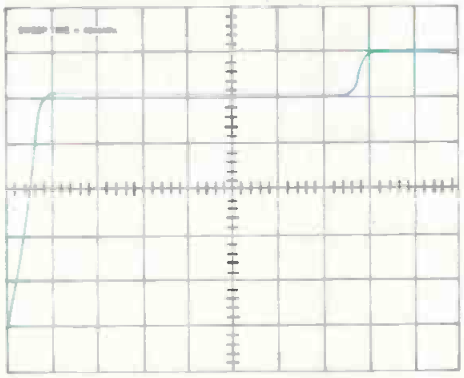

***Figure 2.** Simulated display showing the effect of connecting a 75Ω load to a 50Ω transmission line (cable).*

Table 1 shows 16 ρ values, the corresponding multiplication factors, and the resultant Z_L for 50Ω and 75Ω values of Z_O.

Mismatches can even occur between connectors and sections of transmission line. Manufacturers will often specify what type of cable a connector is to be used with instead of listing its surge impedance. Although this may be adequate for ordering connectors for a given installation, consider the spare parts stock issue. What happens when you reach in the parts drawer for a BNC or N connector and grab the first one you see? Unless you have an experienced eye, you're liable to pick the wrong one and create a mismatch.

If you try to use a 50Ω N connector on a 75Ω N fitting, you will not only have an impedance mismatch, but you will also split the 75Ω female fitting. This will, of course, create an intermittent connection, especially when the cable is hanging loosely or when there are extreme temperature changes.

A 75Ω connector placed between two sections of 50Ω cable will cause an upward bump in the waveform, as shown in Figure 3.

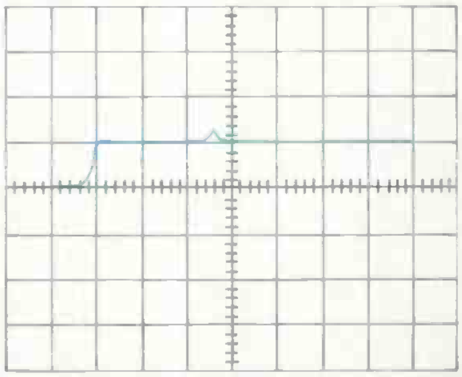

***Figure 3.** Simulated display showing the effect of placing a 75Ω connector between two sections of 50Ω cable.*

Naturally, voltage standing wave ratio (VSWR) has a part in this analysis. Remember that VSWR = Z_1/Z_2, where Z_1 and Z_2 represent the two impedances involved in the mismatch (the larger impedance is always the numerator so that VSWR is ≥ 1). VSWR is, in fact, what Z_0 is multiplied by in Equation 5 to find Z_L:

Equation 6: $\text{VSWR} = \dfrac{1+\rho}{1-\rho}$

So, a 50Ω to 75Ω mismatch not only has a VSWR based on 75/50 = 1.5, but also a VSWR derived as follows:

$$\text{VSWR} = \frac{1+0.2}{1-0.2} = 1.5$$

Meanwhile, power is proportionate to the square of voltage, and ρ is the ratio of E_R to E_I. It follows that the ratio of reflected power (P_R) to forward power

Continued on page 74

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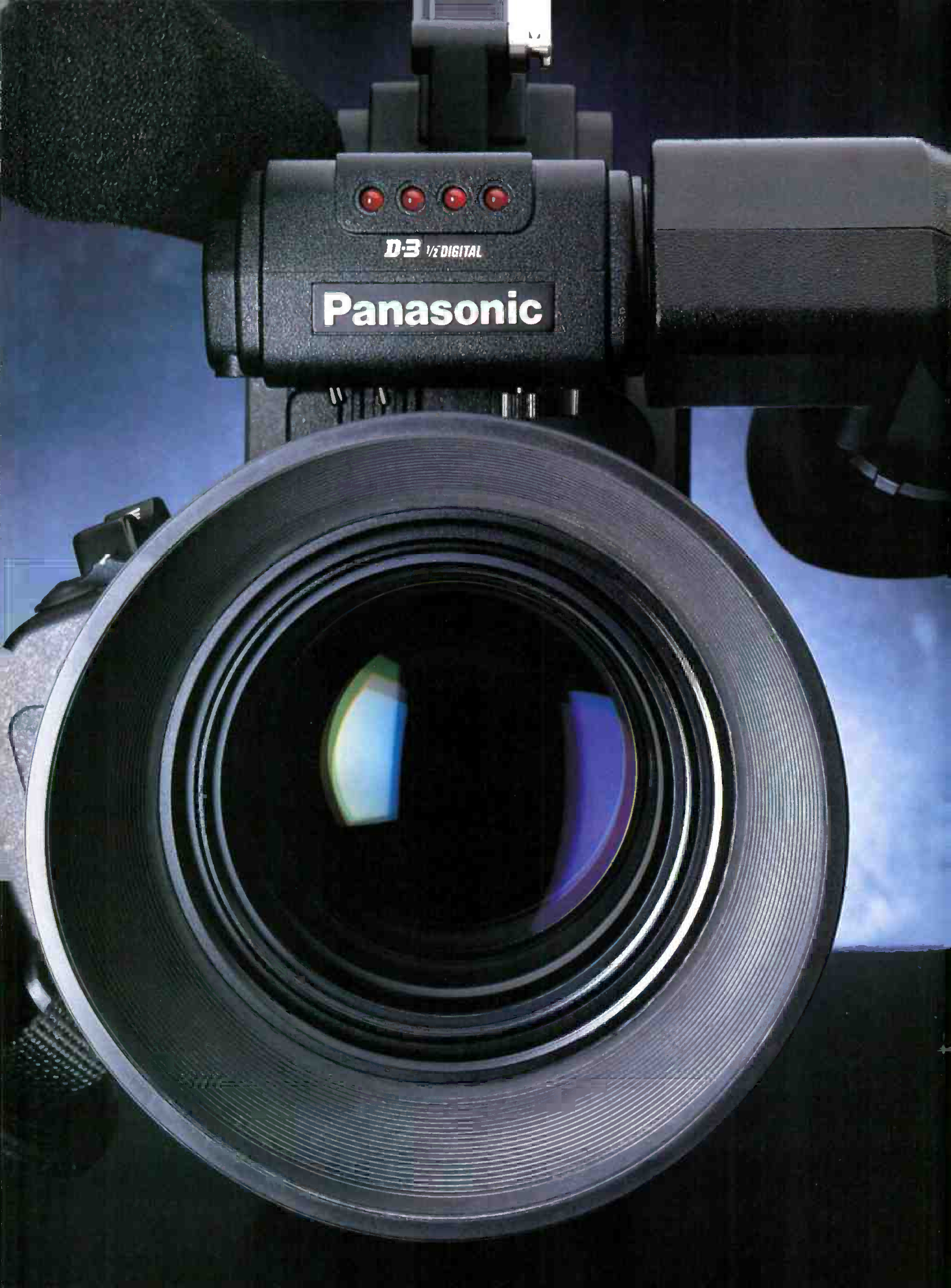
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Continued from page 70
(P_F) is equal to ρ^2. Therefore, if you know ρ and the forward power, the reflected power can be calculated in this manner:

Equation 7: $P_R = \rho^2 \times P_F$

Multiple mismatches

Unfortunately, if there is more than one discontinuity in the cable system, it becomes more difficult to determine the impedance of the second and subsequent mismatches.

Some TDR manufacturers have attempted to provide correction factors to account for multiple mismatch errors, but they won't work for all situations. In general, the larger the first mismatch, the greater the error in calculating the second mismatch. When the values of the mismatched cable sections and/or loads are known, you can work backward and calculate what the ρ values should have been. When the cable values and/or loads are unknown, only the first mismatch can be calculated accurately.

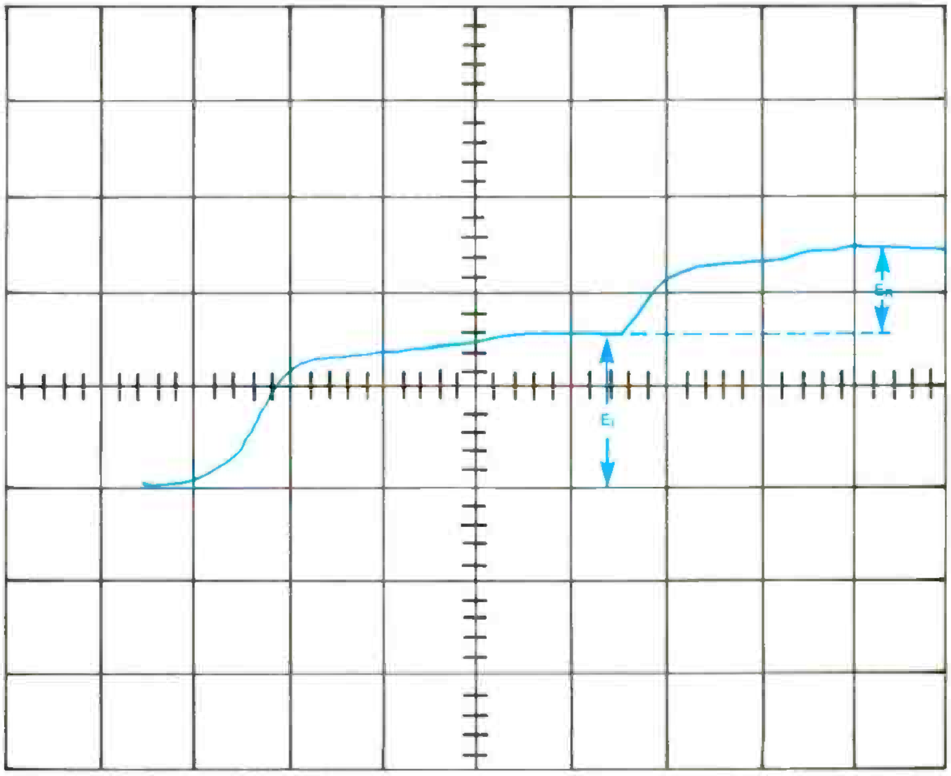

Figure 4. *Simulated display illustrating the phenomena of "dribble up" caused by high-frequency losses in a transmission line.*

Mismatches can even occur between connectors and sections of transmission line.

Note that when a 75Ω cable is connected to a 50Ω pulse generator, the first mismatch has already occurred, so the second mismatch will not have the proper value of ρ. A simple L-pad between the 50Ω generator and the 75Ω cable can create the proper impedance match and avoid this problem.

"Dribble up"

If you tried some of the TDR techniques from Part 1, you may have noticed that some cables take a long time to 'charge up.' This is sometimes described as *dribble up* and is caused by high-frequency losses. It is particularly noticeable in long lengths of cable. Cables often have a fast rise time for the first half of the pulse step, and then a slow charging rate for the last half. Therefore, the step response (rise time) is often measured from 0% to the 50% point (this value of rise time will give a more accurate indication of the cable's bandwidth than the 10% to 90% figure used in amplifiers). Dribble up is not usually a problem in short cable runs.

Because of dribble up you will have to be careful where, on the vertical scale, you measure the ρ value. Be sure to measure the pulse amplitude for the incident and the reflected voltages at the point where they have reached full charge, as shown in Figure 4.

Test equipment requirements

Keep in mind that most service-type oscilloscopes are limited in vertical amplifier bandwidth and horizontal sweep frequency ranges. They also use analog technology, for the most part.

The vertical amplifier bandwidth will affect the displayed pulse rise time, thus limiting your ability to define beginning and ending points on the waveform, and masking some of the cable characteristics that occur closest to the test instruments. Limited horizontal sweep frequency range will affect the resolution required to accurately determine distances.

Consider these characteristics, therefore, the next time you buy an oscilloscope. You (and your manager) may cringe at the price of a 100MHz oscilloscope, but it could be an extremely wise investment. It assures you a rise time of 3.5ns (a leading-edge error of about 1 foot with polyethylene dielectric cables) and typically provides a horizontal sweep frequency of 5ns/division (with a 10× magnifier), which would allow a distance resolution of 1.75 feet per major division and 0.35 feet per minor division. (These figures take into account that the waveform represents round-trip time, so it's 3.5ns/2 and 5ns/2 times the velocity factor.) A special feature called *delay time multiplication* is available with most 100MHz oscilloscopes, and it allows extremely accurate timing measurements.

Cables often have a fast rise time for the first half of the pulse and a slow charging rate for the last half.

In Part 1, the pulse generator was briefly mentioned. The rise time of the pulse becomes even more critical when your oscilloscope has a fast rise time. In fact, the total rise time ($T_{R\ total}$) of the pulse generator and the oscilloscope is as follows:

Equation 8: $T_{R\ total} = \sqrt{(T_{R\ pulse}^2 + T_{R\ scope}^2)}$

An oscilloscope with a 3ns rise time and a pulse generator with a 3ns rise time would have a total rise time of:

$$T_{R\ total} = \sqrt{(3^2 + 3^2)} = \sqrt{18} = 4.24\text{ns}$$

If your equipment uses digital computers and control logic, rise times become extremely significant, particularly where gates are concerned. You simply can't look at rise times with a 10MHz oscilloscope when the synchronization of a control function depends on multiple gate inputs reaching the turn-on threshold within 2ns or 3ns. The 100MHz oscilloscope provides waveform analysis and time domain reflectometry to a high degree of accuracy.

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Building fiber-optic transmission systems


Photo courtesy of AT&T Bell Laboratories.

The advantages of fiber outweigh the complex design process.

By Brad Dick, editor

The use of fiber-optic cable is increasing rapidly. Lower cost, the need for additional bandwidth and higher quality are all driving forces behind this growth. If your facility isn't already using fiber, get ready, it's on the way.

Fiber-optic cable (FO cable) is no longer something that only NASA or the telephone company uses. It can provide cost-effective solutions to many of the problems faced in today's audio and video applications. These solutions, now easy to implement with modern equipment, not only improve quality, but can also do so in low-cost form. If you're installing new cable, you need to give fiber a close look. It could shed some new light on your problems.

This article will describe the process of determining the technical requirements for a fiber-optic system. This 3-part series (Parts 2 and 3 will appear in the December and January issues) will provide the background needed to understand fiber terms, to determine specifications, and then to design your own system. Part 1 reviews the terminology of fiber cable and how cable is constructed. Part 2 will show you how to determine the mechanical and optical specifications for a system. Part 3 will review fiber systems and cost-performance trade-offs.

The language of fiber

To better understand FO cable, some basic terms must be defined. All FO terminology can be divided into two basic groups: the fiber or cable, and the optical. Each of these areas will be addressed separately.

Optical fibers have at least two, but most often, three distinct regions. These regions are the core, the cladding (or clad) and the buffer coating (or coating).

The core of an optical fiber is that central region of the fiber. (See Figure 1.) Most of the light travels in this area.

The cladding area surrounds the core, confines the light to the core and provides additional strength to the fiber through an increase in diameter.

The buffer coating insulates the core and cladding from the environment. The buffer coating helps the fiber retain its intrinsic strength.

The fiber's core, cladding and buffer coating can be made of different materials. The actual fiber used for communication applications is composed of either glass or plastic materials. The core and cladding also can be made from either glass or plastic materials. However, the buffer coating is always made of a plastic material.

The variety of materials used in the core and cladding results in a variety of fibers being produced. They are summarized in Figure 2. Most, but not all, fibers used in communications have glass cores and glass claddings.

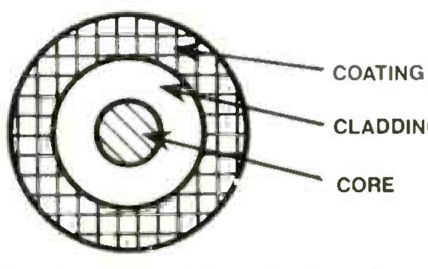


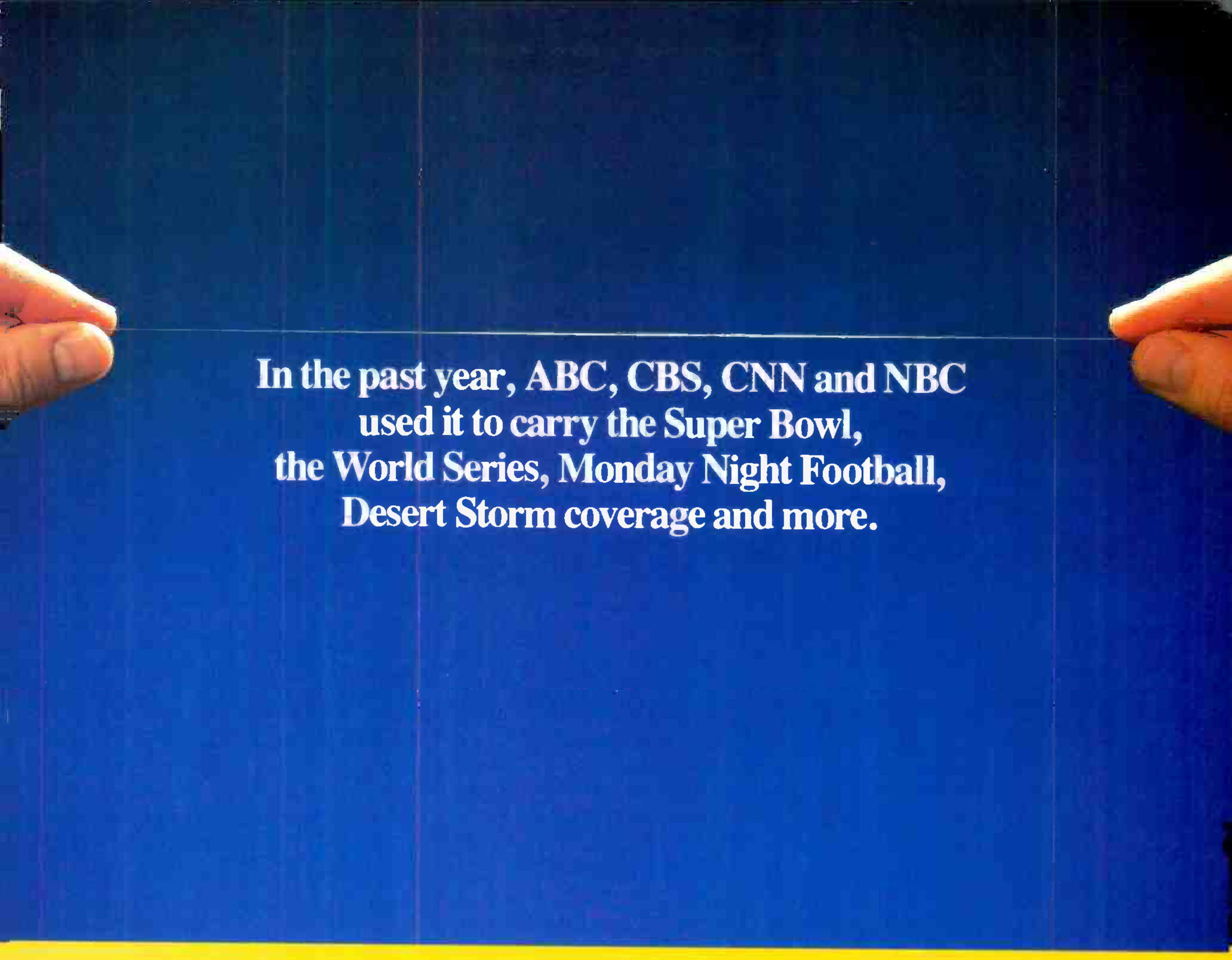
Figure 1. *Fiber cables usually have three distinct regions: the core, the cladding and the buffer coating. The core carries most of the light. The cladding confines the light to the core and the buffer acts as a protective coating.*

The buffer coating may not be required if the cladding is a plastic material. In this case, the plastic cladding provides additional strength and insulates the fiber from its environment.

Fibers have a wide range of dimensions. However, the all-glass fibers most commonly used in audio and video applications have core diameters of eight to 10 microns for single mode fibers, and 50 to 100 microns for multimode fibers. Fibers with glass cores and plastic cladding have core diameters of 110 to 200 microns, and cladding diameters of 125 to 380 microns. Fibers with plastic cores and plastic cladding have core diameters of greater than 220 microns and cladding diameters of greater than 250 microns.

Buffer coatings for all-glass fibers have standard diameters of 250 or 500 microns. However, other buffer coating diameters are available. (*Editor's note: The term "standard" means industry-accepted standard. It does not mean that the buffer coating diameter meets the requirements of a standard-issuing body.)*

The primary design difference between the two types of fiber, single mode and multimode, is the manner in which rays of light travel through the cable. In multimode fibers, rays of light travel in paths that are not necessarily parallel to the fiber axis, as shown in Figure 3(A). Some of the light rays move parallel to the axis and some do not. The result is that some



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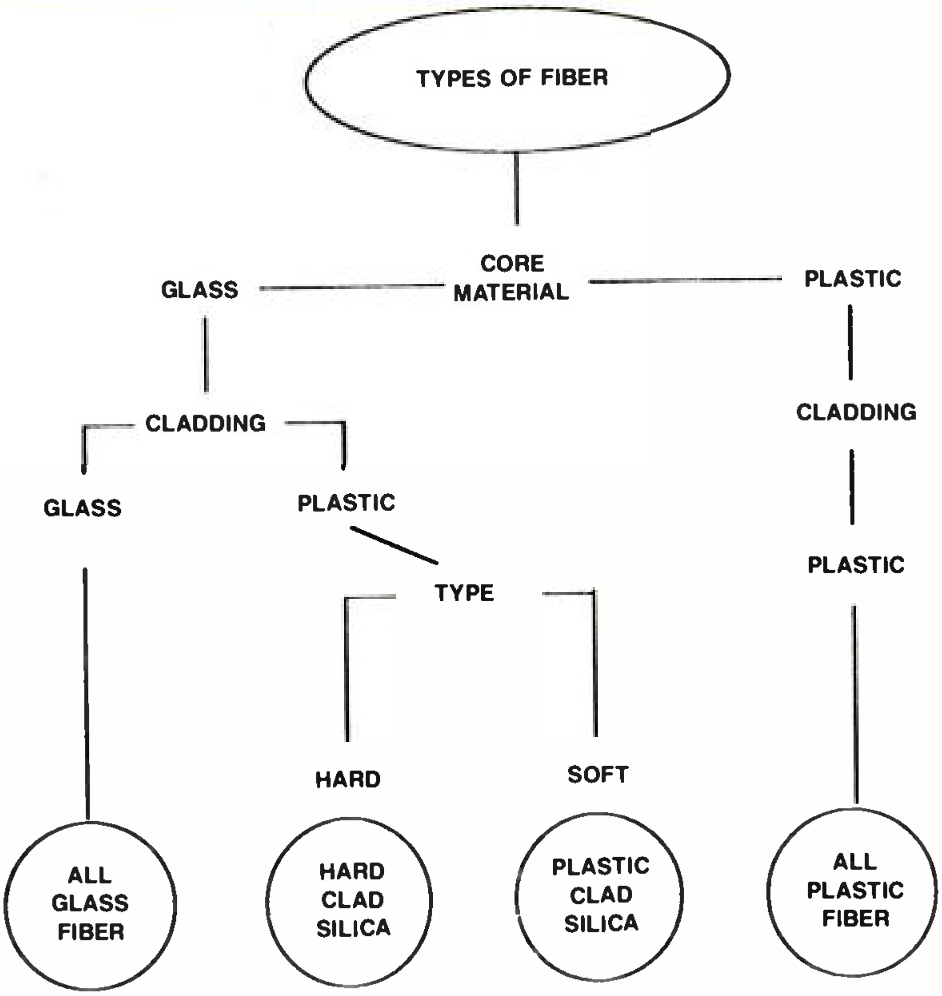

Figure 2. *Fiber-optic cable can be broken into four basic types: all glass, hard clad silica, plastic clad silica and all plastic. Most communication applications rely on glass cores and cladding.*

rays of light end up traveling a longer distance than others. Therefore, not all rays arrive at the end point at the same time. In single mode fibers, all rays of light travel parallel to the axis of the fiber, as shown in Figure 3(B).

This is an important difference between the two type of fibers. The result is that single mode FO fibers carry much more information than multimode cables. In multimode fibers, most of the light energy travels in the core. In single mode fibers, a significant portion of the light energy travels in the cladding.

Most data communication systems currently use multimode fiber. However, single mode fiber is expected to become the fiber of choice for most communications applications over the next five to 10 years because of its almost unlimited bandwidth and low attenuation.

Types of cable designs

The first step in packaging an optical fiber into a cable is the extrusion of a layer of plastic around the fiber. This layer of plastic is called a *buffer tube*, and it should not be confused with the buffer coating. The buffer coating is placed on the fiber by the fiber manufacturer. The buffer tube is placed on the fiber by the cable manufacturer.

This extrusion process can produce two different cable designs. In the first design, the inner diameter of the plastic (the buffer tube) is the same size as the outer diameter of the fiber, and is in contact with the fiber around its entire circumference. This is called the *tight tube* design. [See Figure 4(A).]

In the second design, the layer of plastic is significantly larger than the fiber, so that the plastic is not in contact with the fiber around the entire circumference of the fiber. This technique is called a *loose tube* design. It is illustrated in Figures 4(B) and 4(C).

Note that the loose tube design is available with either a single fiber per tube (SFPT) [see Figure 4(B)] or with multiple fibers per tube (MFPT). [See Figure 4(C).] The MFPT designs allow many fibers per tube. The 6-fiber-per-tube designs are often used for data communications, because this is the type specified by Bellcore for use by telephone companies.

Once a fiber or group of fibers has been surrounded by a buffer tube, it is called an *element*. The cable manufacturer uses these elements to build up the desired type of cable. In building the cable from elements, the manufacturer can create six distinct designs:

- breakout design
- MFPT, central loose tube design
- MFPT, stranded loose tube design
- SFPT, stranded loose tube design
- star or slotted core design
- tight tube or *stuffed* design

Breakout design. In the breakout design, shown in Figure 5, the element or buffered fiber is surrounded with a flexible strength member, often Kevlar. The strength member is surrounded by an inner jacket to form a *subcable*, as shown in Figure 5(B).

Multiple subcables are stranded around a central strength member or filler to form a cable core. This cable core is held together by a binder thread or Mylar wrapping tape. The core is surrounded by an extruded jacket to form the final cable. [See Figure 5(C).]

Optional steps for this design include additional strength members jackets or armoring. The additional jackets may be extruded directly on top of one another or separated by additional external strength members. [See Figure 5(D).]

MFPT central loose tube design. Here, the fibers are placed together to form groups. Sometimes, the fibers are laid along a ribbon in groups of 12, as shown in Figure 4(E). These ribbons are then stacked up to 12 high and twisted. This version of the central loose tube design is called *ribbon design*, and was developed by AT&T. The space between the fibers and the tube can be filled with a water-blocking compound.

The MFPT stranded loose tube design. In this design, shown in Figure 6, multiple buffer tubes [see Figures 6(A) and 6(B)] are stranded around a central strength member or filler to form a core. This cable core is held together by a binder thread or Mylar wrapping tape. The core is surrounded by an extruded jacket to form a finished cable, as shown in Figure 6(C). Optional jacketing, strength members or armor can be added.

The SFPT, stranded loose tube design. This type of cable is manufactured similarly to MFPT cable. The difference is that the cable has one fiber per tube and smaller diameter buffer tubes.

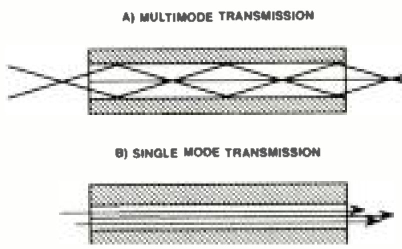

Figure 3. *Fiber cable can be divided into multimode and single mode types. In a multimode cable, the light travels along different paths, reflecting off the core/cladding boundary. In single mode cable, the light rays travel parallel to the axis of the fiber.*

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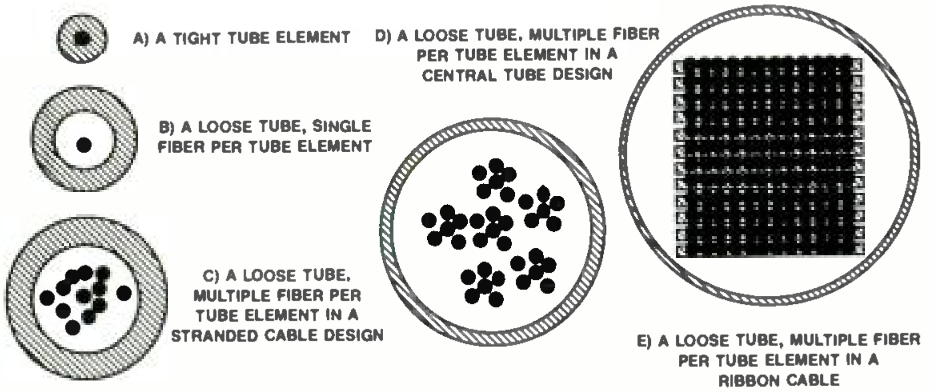

Figure 4. Loose tube cables are available in either single fiber per tube (SFPT) or multiple fiber per tube (MFPT). In both cases, the diameter of the plastic tube surrounding the core is larger than the outside diameter of the core, thus the loose tube connotation. A tight tube cable is shown in Figure 4(A). Here, the inner diameter tube is the same as the outer diameter of the fiber.

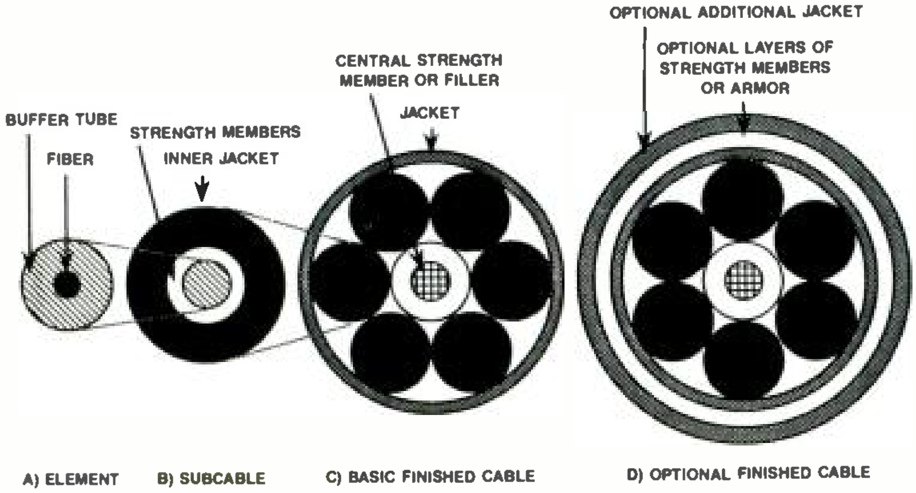

Figure 5. In the breakout type of cable, each element is surrounded by a flexible strength member, which is then surrounded by an inner jacket. This forms a subcable, which is incorporated into a larger cable. Optional additional jackets or armor can be applied, as shown in Figure 5(D).

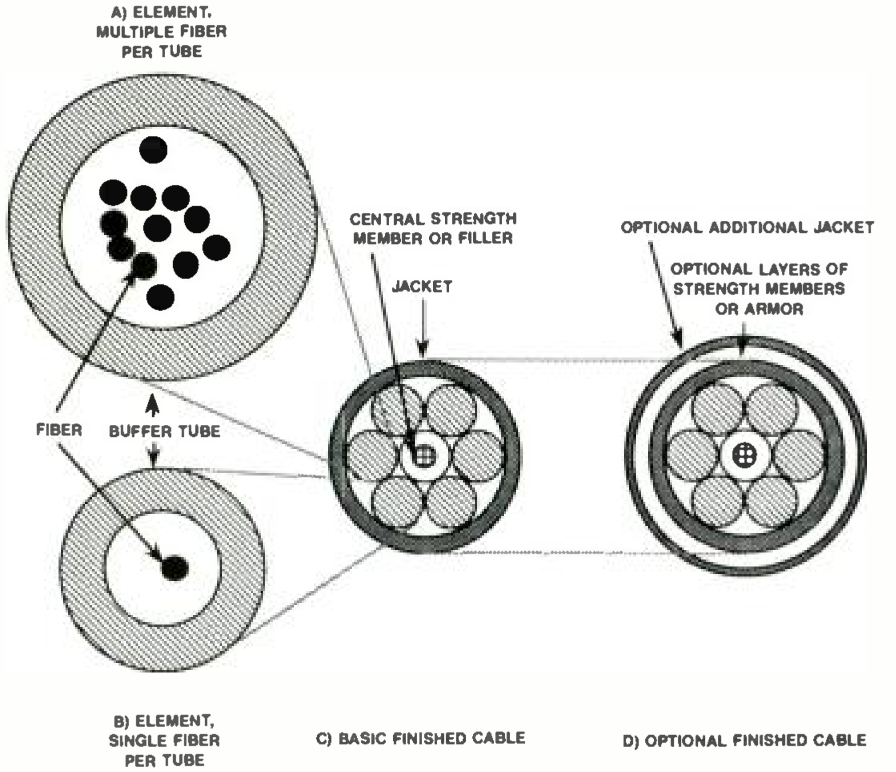

Figure 6. The MFPT, stranded loose tube design relies on a center strength member to form the cable core. Multiple elements are then added to build up the desired capacity cable.

The star or slotted core design. This design is seldom used in the United States. In this scheme, the buffer tubes (usually MFPT) are laid in helical grooves, which are formed in the filler in the center of the cable. The core is then surrounded by an extruded jacket to form a finished cable. One variation of this design, shown in Figure 7, is used by power/utilities. This optical cable provides a conductive ground path from end-to-end. Instead of a jacket, the cable has helically wrapped wires, some of which are conductors and some strength members.

The tight tube, stuffed design. This design is based on the tight tube element. The designs are common in that the core is filled or stuffed with flexible strength members, usually Kevlar. The design usually provides two or more fibers. (See Figure 8.)

Pick your advantage

Performance advantages exist for all designs, depending on what performance parameter is considered. For instance, the tight tube design can force the ends of a broken fiber to remain in contact even after the fiber has broken. The result is that transmission may still be possible. When reliability is paramount, this feature may be important.

Loose tube designs have a different performance advantage. They offer a *mechanical dead zone*, which is not available in tight tube designs. The effect is that stress can be applied to the cable without that stress being transferred to the fiber. This dead zone exists for all mechanical forces, including tensile and crush loads and bend strains. Tight tube designs do not have this mechanical dead zone. In the tight tube design, any force applied to the cable is also applied to the fibers. Loose tube designs also offer smaller size, lower cost and smaller bend radii than tight tube designs. In general, the environmental performances of the designs can be made equivalent.

When cable cost alone is considered, loose tube designs have the advantage over tight tube, breakout designs in long-length applications. However, when total installation cost is considered, the loose tube designs may or may not have a cost advantage. This is because loose tube designs have higher connector installation costs.

This cost factor is composed of two parts: labor cost and equipment cost. This cost is not required for breakout designs. Some of the cost trade-offs between loose tube and breakout designs will be examined in Part 2 of this series.

All designs, other than the breakout design, require handling of bare fibers or fibers with tight tubes. During this handling, fibers can be broken, especially where inadequately experienced person-

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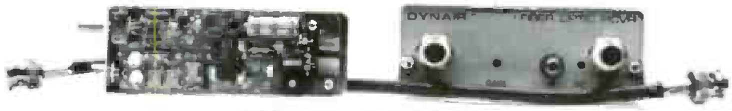

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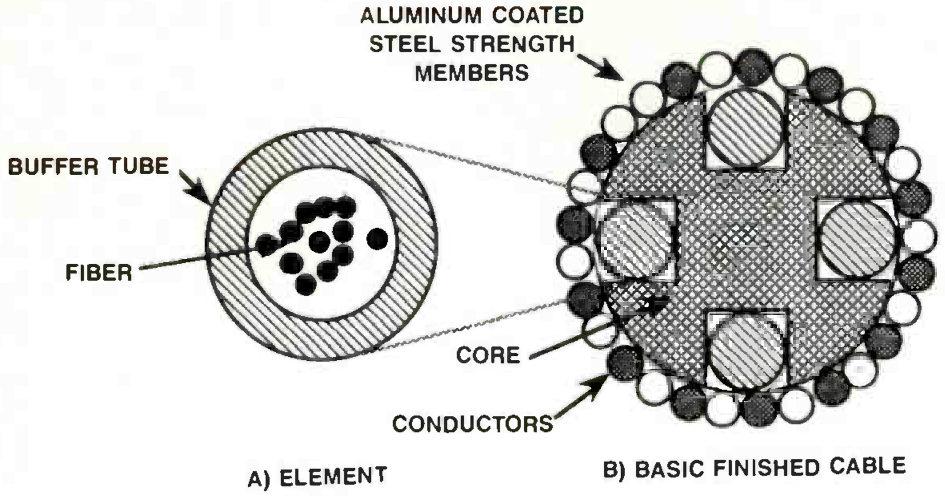


Figure 7. *Utility companies sometimes use the optical power ground wire type of cable, because it incorporates a metallic power ground wire within the design. The cable is based on a slotted core design, but with the addition of helically wrapped wires around the outside for strength and conductivity.*

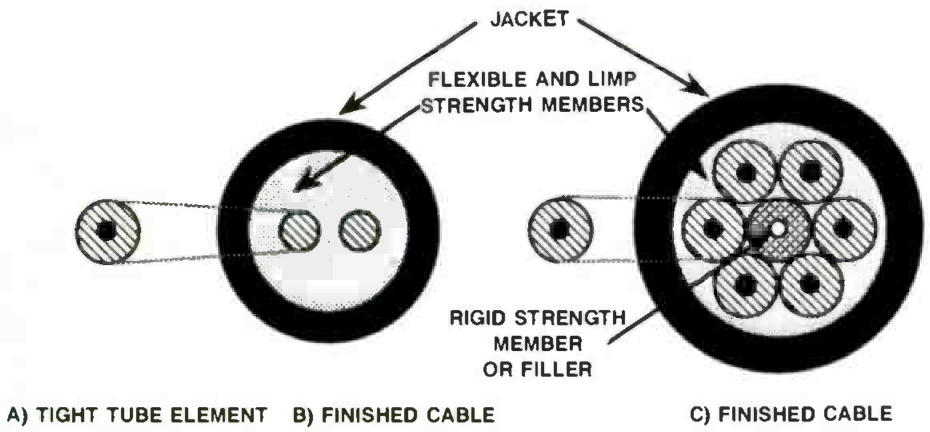


Figure 8. *The tight tube stuffed design relies on a core, which is filled with flexible strength members, usually Kevlar. Typically, two or more fibers are contained within the cable.*

nel are involved. This is why the breakout design offers a more convenient installation.

The next step

This completes Part 1 of the series. The basic fiber-optic cable terms and how fiber cable is constructed have been reviewed. The next step is to determine the cable's required mechanical and optical specifications.

The mechanical specification process looks at installation and environmental considerations. The optical specification process is the most complex of the two and can be approached in three basic ways. Part 2 will review these options. The final part in the series will review system specifications and look for possible cost-performance trade-offs that can be made.

Editor's note: This article is based on the publication "How to Specify and Choose Fiber-Optic Cables," by Eric Pearson, president, Pearson Technologies, Acworth, GA. Because of the limited space available, not all of the factors related to FO system design can be covered here. Readers may wish to consult the above publication for additional detailed information on the design process.

Fiber-optic STL systems

By Lonnie Pastor and Dean Rosenthal

You have probably heard how improved transmission quality, increased bandwidth and unique dielectric properties will make fiber optics the broadcast transmission medium of the future. KSMO-TV, an independent UHF station in Kansas City, MO, recently saved big money by taking advantage of another fiber characteristic — the ability to carry multiple light signals at various frequencies.

As part of a complete reconstruction that included new studios and a new antenna, the station needed a new STL. There were several problems in establishing the link, not the least of which was a tight budget. Conventional wisdom dictated microwave, but the necessary transmission hardware for the 17km link was a 6-figure proposition. The line of sight was poor. The area's 7GHz primary frequencies were used several times over. At 13GHz, the STL would have required two hops, more equipment and tower or rooftop leases. Rain fade at 13GHz was also a problem. A hot standby was advisable. This would have meant equipment expense far beyond the capital budget.

After researching the problem, KSMO engineers realized that fiber-optic video transmission hardware would cost a fraction of the price of microwave (not including the cost of the fiber plant itself). Installing new fiber was out of the question because of the inherent expense of the fiber and the labor to install it. However, KSMO's new transmitter was near a fiber-optic hub site operated by Kansas City Fibernet, a local alternate access telecommunications carrier. (Alternate access carriers provide signal transport in the local, wide and metropolitan area data network markets, as well as providing interconnection between end-users and their long-distance carrier's local point of presence.)

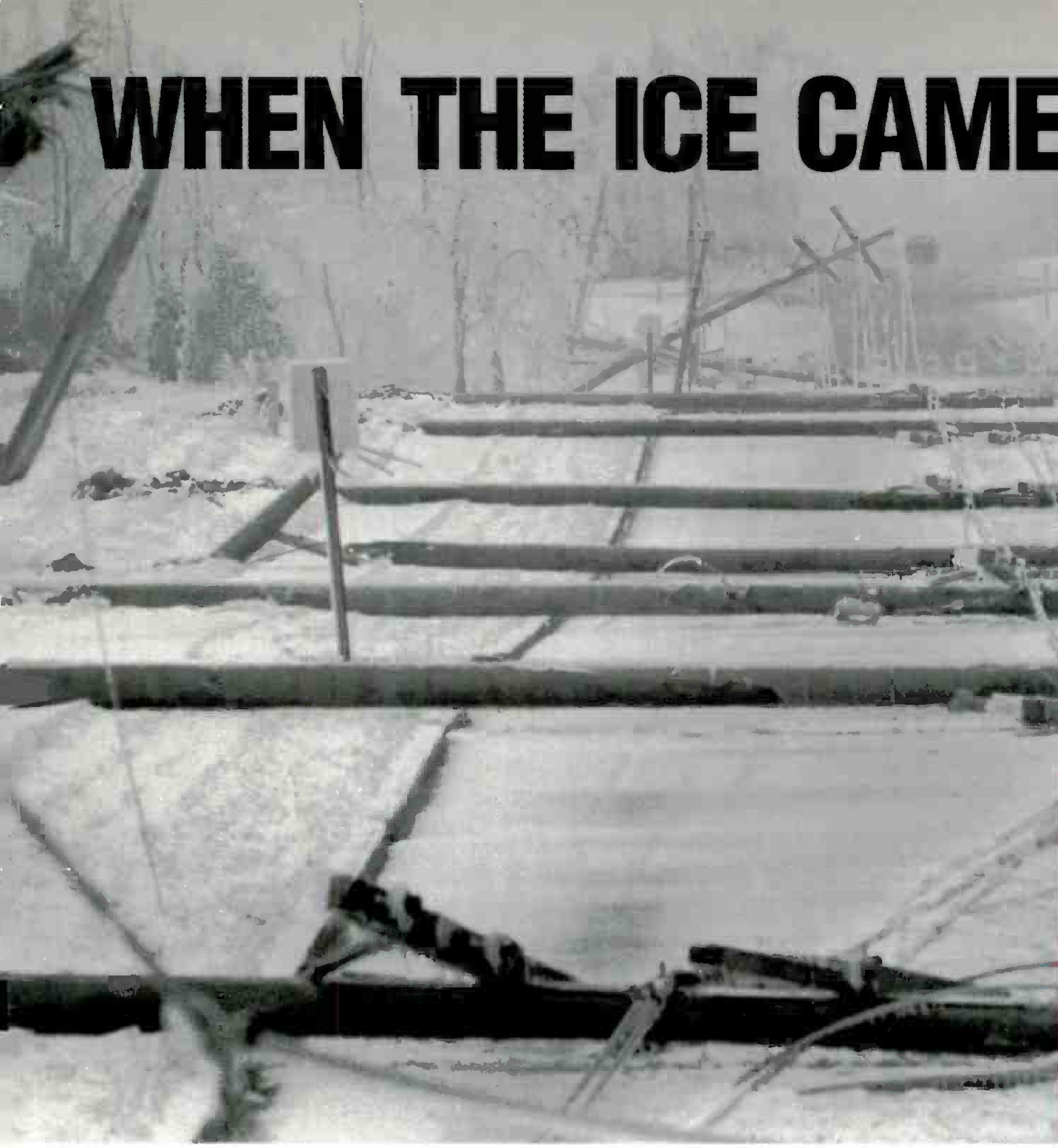
The station first approached K.C. Fibernet about providing a dark (unused) fiber, but there was none. They did find one fiber that could do the job, but it was in use. This is when wavelength division multiplexing (WDM) entered the picture.

Window of opportunity

Multiple optical signals can transmit simultaneously over the same fiber at different wavelengths. There are transmission *windows* at 840nm, 1,310nm

Pastor is business manager and Rosenthal is senior applications engineer for the Professional Audio & Video Group at ADC Telecommunications, Minneapolis.

WHEN THE ICE CAME,



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and 1,550nm. These are available using a wavelength division multiplexer, which is a passive optical device.

The existing signal was operating in the 1,310nm window. It was suggested that they could multiplex a 1,550nm signal with it.

K.C. Fibernet was charged with providing a specific level of optical performance for the KSMO STL. The company spliced two WDMs onto the fiber trunk cable. A fiber drop from one side of each WDM was pulled into KSMO's facilities and connectorized. This fiber link delivered a manageable loss budget, and a minimum of 40dB directivity (near-end isolation) for the WDM. (See Figure 1.)

Because of the need for tight spectral width and high launch power, a WDM must be fed by a laser transmitter. KSMO examined equipment from several manufacturers, and chose the ADC FN6000™ fiber-optic transmission system.

After the fiber was installed, operating the system became a simple matter. The on-air feed was connected to the fiber transmitter, and KSMO was up and running. Rain fade and congested airwaves became non-factors. Because of the inherent reliability of the fiber-optic system, KSMO opted to go without a hot standby. The degree of certainty allowed by fiber permitted KSMO's insurance provider to lower its transmission interruption insurance deductible from 24 to eight hours.

KSMO was able to transmit one NTSC composite video signal with stereo audio while delivering RS-250-B shorthaul performance over *existing* fiber plant. No other mode of transmission would have fit the budget.

Lessons

By using existing fiber plant instead of leasing a dedicated dark fiber, a broadcaster pays only for the bandwidth used. When a service provider can better leverage its existing plant by sending more traffic through it, the broadcaster is in a desirable position to receive a more reasonable tariff.

Broadcasters can now take advantage of high-performance, reasonably priced, easy-to-use fiber-optic video transmission hardware for STLs, TSLs, uplinks and downlinks. At the same time, they will improve their transmission quality and preserve their capital budgets. By using fiber already in the ground and on poles, wavelength division multiplexing becomes a win-win situation.

KSMO FIBER-OPTIC STL

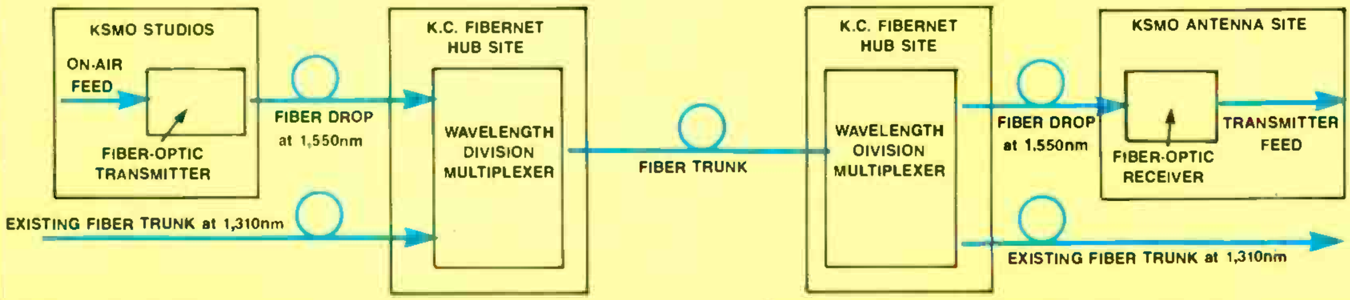

Figure 1. *KSMO's fiber-optic STL used wavelength division multiplexing (WDM) to achieve a high-quality STL path at a low price.*

The case for fiber

By Rick Lehtinen, technical editor

Before the advent of satellites, microwave and conditioned telephone, circuits were the only means of transmitting TV signals from city to city. This was an effective method, but there was difficulty reaching some areas. Accordingly, when satellite distribution became an option, broadcasters jumped at the opportunity. By 1985, all the networks used satellites to distribute their feeds. Although satellites are better than past technologies, they are not a remedy. Networks still face certain concerns in their use.

• *Reliability.* Reliability is a key concern of anyone who distributes TV signals. Satellites have a unique set of problems. Sun outages, for instance, occur whenever the receive antenna encounters so much solar noise that it blocks the desired downlinked signal. Similarly, severe rainfall or an accumulation of snow and ice in the receiving dish can render a satellite feed unacceptable.

Fiber-optic systems, on the other hand, aren't troubled by such factors. National fiber-optic networks that specialize in TV signal delivery have developed. These networks are engineered for high reliability. Redundant routes between cities can make the fiber systems even more robust.

• *Security.* Hackers and pirates have made headlines by interfering with the signals of several networks. Similarly, unintentional interference by careless operators or failing equipment has often caused difficulties. These problems are likely to grow more frequent as the number of uplinks increases.

Another problem with satellites is that unauthorized users can receive proprietary signals. To counteract this, users have invested millions of dollars in encryption and decoding equipment.

Fiber optics can provide a secure TV transmission medium because the signals cannot be intercepted. This is a major advantage, because the signal is secure even without the expense of scrambling.

• *Cost.* Fiber-optic and satellite transmission offer comparable costs. The initial setup to receive a fiber signal is usually much less than the cost of building an uplink or downlink, and the hourly costs are approximately the same.

The costs of fiber and satellite are affected by the potential for greater channel capacity per carrier. Fiber capacity is almost unlimited. New techniques allow simultaneous transmission of more data. On the other hand, satellite transponders will soon double or triple their capacity because of the introduction of digital compression techniques.

The cost of switching to fiber from an existing system is typically minimal. Fiber requires little, if any, training and no additional manpower. However, many facilities have made substantial investments in satellite earth stations and encryption equipment over the last five years. No doubt, these *sunk costs* will delay the adoption of long-distance fiber. Nevertheless, it is likely that some facilities will begin to take advantage of fi-

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ber, where appropriate, by gradually adopting it for their occasional-use traffic.

• *Quality.* The transmitted signals must always maintain broadcast quality. Satellite signals can degrade as the signal is affected by weather and interference. Fiber is generally immune to such impairment. Fiber delivers approximately 64dB SNR.

Digital techniques contribute to this quality level. Many fiber networks send video in the DS-3 signal standard, which operates at 45Mbps.

Last mile

As useful as fiber is, there will always be a place for satellites, microwave and coaxial cable in network signal distribution. One example is the *first and last mile.* Fiber is great going where it goes, as is a railroad track. However, when the desired destination is off the fiber path, the customer system must use other means to complete the journey. (See Figure 1.)

A TV switching center may consist of analog audio and video routing switchers, encoding and decoding equipment (codecs) and a digital cross connect (signal switch). The analog signal is routed to the codec, which converts it to digital. The digital switch then routes the signal to the correct destination. At the fiber's other end, the process is reversed.

Working together

In some situations, users can derive benefits by using fiber and other techniques together. Many fiber operators have discovered that the composite multiplexed audio-video signal from most microwave receivers can be fed directly down most analog fiber systems. This helps keep the video and audio pristine as it leaves the composite form only at the fiber terminus. This may also sim-

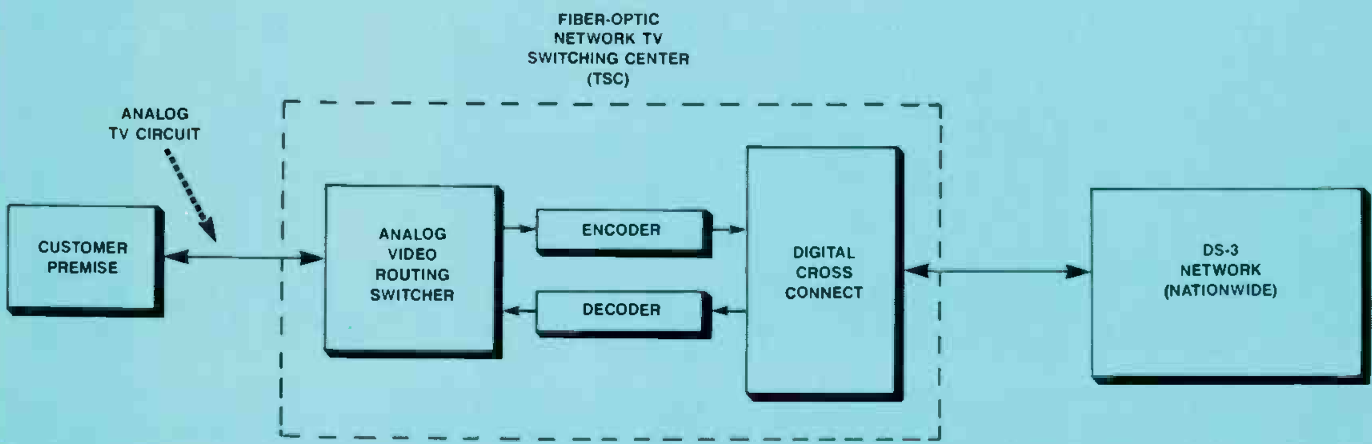
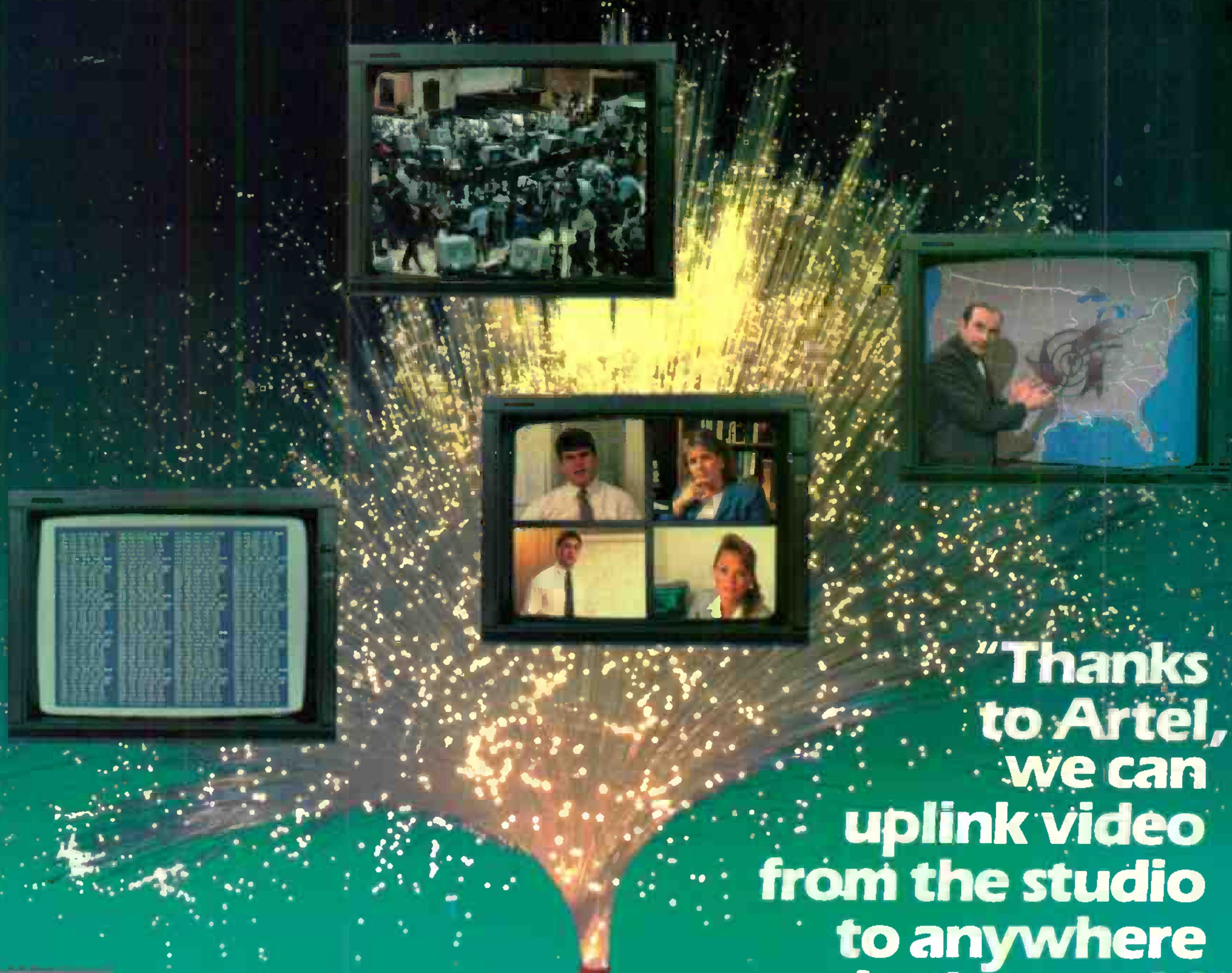


Figure 1. This fiber-optic TV switching center converts the customer's analog TV signal, delivered by conventional means, into a DS-3 digital signal that can travel down a national fiber-optic network.

FIBER OPTICS AND SATELLITES: A QUICK COMPARISON

Issue	Fiber	Satellite
Quality	64dB SNR returned.	50 to 60dB SNR returned.
Reliability	99.999% uptime.	Inherently weaker: • Rain attenuation. • Sun spots. • Earth-based microwave interference.
Security	Inherently secure from interception.	Easily intercepted. Security requires scrambling.
Costs:		
• Initial	Last mile installation typically $500 to $1,500 per point.	Uplink can cost $300,000 to $500,000.
• Monthly	$8,800 to $140,000 depending on distance and terms.	$50,000 to $150,000 depending on satellite availability and terms.
• Hourly	$400.	Comparable — $200 to $780 depending on vendor, satellite, rate period, etc.
Availability	Nationwide long haul network is growing.	Slightly constrained. Future capacity is contingent upon launches in 1992 and after.



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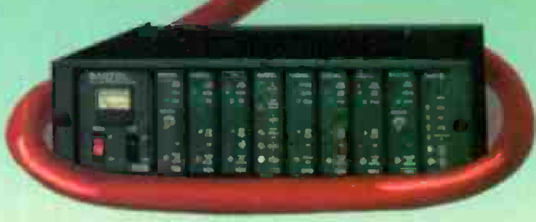

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plify the microwave system, because no provision for multiplexing and demultiplexing in repeaters along the path is needed.

Several sophisticated new fiber-optic snakes have adopted this technique. Some companies are even promoting it as a way to improve the quality of satellite feeds. The output of the satellite receive dish's low-noise converters are fed directly to a fiber. Only at the fiber's end do the signals enter the receiver for conversion. This may not only improve the signal-to-noise ratio of the incoming signal, it also puts all the satellite transponders down the fiber at once. (See Figure 2.)

Acknowledgment: Thanks to Howard Melseles, Vyvx National Video Network, Tulsa, OK, for assistance in the preparation of this article.

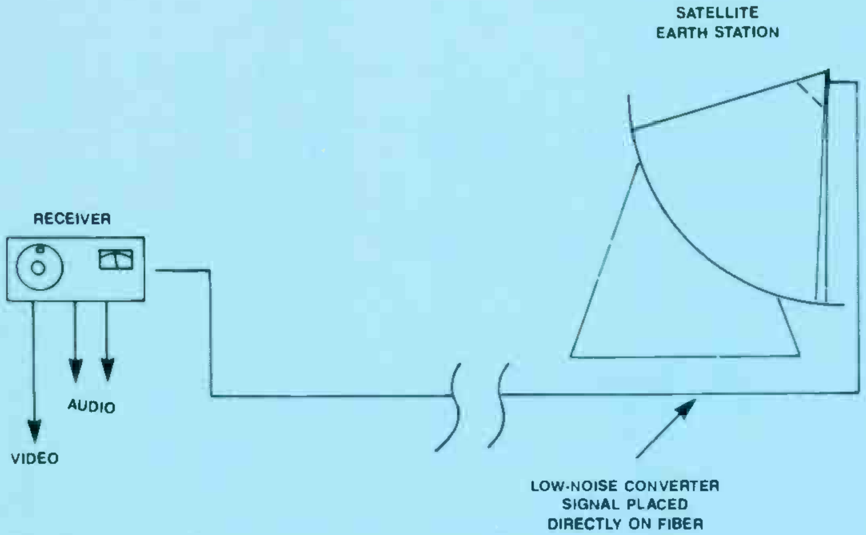

Figure 2. Fiber's broad bandwidth can enhance conventional satellite techniques. Several proposed systems improve system signal-to-noise and multiply fiber channel capacity by sending composite signals down fiber to the receiver. Signals are decoded by the receiver at fiber end.

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Deltec's Full-Featured Protection

For two decades, Deltec has been manufacturing high-quality ac power protection equipment, ranging from uninterruptible power systems (UPS) to isolation transformers, for a wide spectrum of applications in business, industry, government and education.

With product offerings in power ratings of 500VA to 150kVA, Deltec manufactures systems that ensure "computer-grade" power for sensitive loads — from personal computers to mainframes, as well as telecommunications systems, process control devices and other sensitive microprocessor-based equipment.

The performance and reliability of Deltec equipment have been demonstrated in a variety of environmental conditions throughout the world — from controlled computer rooms to the most severe industrial situations.

The first manufacturer to introduce the now-popular "line interactive" UPS technology, Deltec maintains true on-line operation along with significantly reduced size and increased operating efficiencies that allow users to enjoy substantially lower operating costs.

The technology features extremely low input current distortion. This eliminates troublesome problems that result when undesirable harmonic currents are imposed on the utility line. This design also offers high overload capacity, so there is no need to pay for an oversized UPS just to handle heavy startup load current.

"Deltec is one of the world's largest UPS manufacturers," said Susan Connell, Deltec's director of marketing. "Unfortunately, sometimes we're not recognized as such because many of our sales are through private label agreements with computer manufacturers throughout the United States, Europe, South America and Asia.

"Our private label customers put our products through grueling tests because they demand the highest levels of quality and reliability to back up their sensitive systems. As a result, all of our customers can be assured of the highest standards in the industry.

"In addition, this extensive installed base enables Deltec to offer a worldwide network of factory-trained and supported field service engineers to assure maximum responsiveness."

Deltec was purchased by Fiskars Corporation of Helsinki, Finland, in January 1989. Among the world's oldest industrial companies, Fiskars (manufacturer of the famous orange-handled scissors) was established in 1649 and maintains Deltec as an independent operating unit.

With extensive modern facilities, Deltec is a major employer in the San Diego area, devoted to advanced research and development. The company continues to develop a sophisticated system of automating the many aspects of its test and manufacturing facilities.

Because of the numerous technological innovations, Deltec is able to offer leading edge technology and proven reliability at competitive prices.

Power System Protection Alternatives

By Jerry Whitaker, editorial consultant

Disturbances on the AC power line are what headaches are made of. Outages, surges, sags, transients: They all combine to create an environment that can damage or destroy sensitive load equipment. They can take your system down and leave you with a complicated and expensive repair job.

Ensuring that the equipment at your facility receives clean AC power has always been important. But now, with microcomputers being integrated into a wide variety of electronic products, the question of AC power quality is more critical than ever. The high-speed logic systems prevalent today can garble or lose data because of power-supply disturbances or interruptions. And if the operational problems are not enough, there is the usually difficult task of equipment troubleshooting and repair that follows a utility system fault.

Elements of the AC power system

The process of generating, distributing, and controlling the large amounts of power required for a municipality or geographic area is highly complex. However, each system, regardless of its complexity, is composed of the same basic elements with the same basic goal: Deliver AC power where it is needed by customers. The primary elements of an AC power system can be divided into the following general areas of technology:

- Power transformers.
- Power generators.
- Capacitors.
- Transmission circuits.
- Control and switching systems, including voltage regulators, protection devices and fault isolation devices.

The path that electrical power takes to end-users begins at a power plant, where electricity is generated by one of several means and is then stepped-up to a high voltage (500kV is common) for transmission on high-tension lines. Step-down transformers reduce the voltage to levels appropriate for local distribution and eventual use by customers.

Power distribution

The distribution of power over a utility company network is a complex process involving a number of power-generating plants, transmission lines and substations. The physical size of a metropolitan power-distribution and control system is immense. Substations use massive transformers, oil-filled circuit breakers, huge strings of insulators, and high-tension conductors in distributing power to customers. Power-distribution and transmission networks interconnect generating plants into an *area grid*, to which *area loads* are attached.

Most utility systems in the United States are interconnected to one extent or another. In this way, power-generating resources can be shared as needed. The potential for single-point failure also is reduced in a distributed system.

A typical power-distribution network is shown in Figure 1. Power-transmission lines operate at voltage levels from 2.3kV for local distribution to 500kV or more for distribution between cities or generating plants. Long-distance, direct-current transmission lines also are used, with potentials of 500kV to 600kV. Underground power lines are limited to short runs in urban areas.

Increased installation costs and cable heat-management considerations limit the use of high-voltage underground lines. Wide variations in standard voltage levels can be found within any given system. Each link in the network is designed to transfer energy with the least I^2R loss, thereby increasing overall system efficiency. The following general classifications of power-distribution systems can be found in common use:

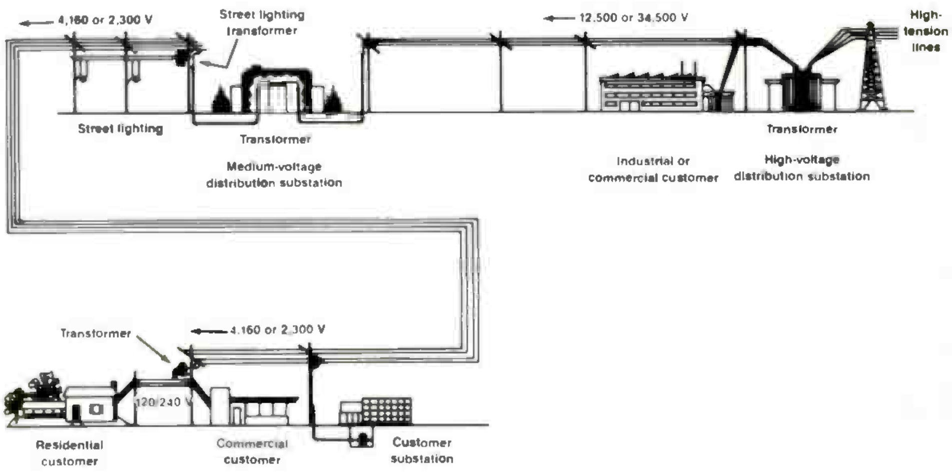

Figure 1. *Simplified power-distribution system.*

- *Radial system*. The simplest of all distribution networks. A single substation supplies power to all loads in the system.
- *Ring system*. Distribution lines encircle the service area, with power being delivered from one or more sources into substations near the service area. Power is then distributed from the substations through the radial transmission lines.
- *Network system*. A combination of the radial and ring distribution systems. Although such a system is more complex than either of the previous configurations, reliability is improved significantly.

Utility company interfacing

Most utility company-to-customer connections are the *delta-wye* type. This transformer arrangement usually is connected with the delta side facing the high voltage and the wye side facing the load. This configuration provides good isolation of the load from the utility and somewhat retards the transmission of transients from the primary to the secondary.

The individual 3-phase loads carry load currents. For a wye-connected system, it is important that the building neutral lead is connected to the midpoint of the transformer windings. The neutral line provides a path for the removal of harmonic currents that may be generated in the system as a result of rectification of the secondary voltages.

In some areas, an *open-delta* arrangement is used by the utility company to supply power to customers. Users often encounter problems when operating sensitive 3-phase loads from such a connection because of poor voltage-regulation characteristics during varying load conditions. The open-delta configuration is also subject to high third-harmonic content and transient propagation.

Other primary power connection arrangements are possible, such as *wye-to-wye* or *delta-to-delta*. Like the delta-to-wye configuration, they are not susceptible to the problems that may be experienced with the open-delta (or *V-V*) service.

The open-delta system can develop a considerable imbalance among the individual phases in either voltage or phase or both. This can introduce a strong 120Hz ripple frequency in 3-phase power supplies, which are designed to filter out a 360Hz ripple. The effects of this 120Hz ripple may be increased noise in the supply and possible damage to protection devices across the power-supply chokes. Depending on the loading of an open-delta transformer, high third-harmonic energy can be transferred to the load, producing transients of up to 300% of the normal voltage. The result could be severely strained rectifiers, capacitors and inductors in the power supply as well as additional output noise of the supply.

Phase-to-phase balance

The phase-to-phase voltage balance of a utility company line is important at most types of facilities, not only because of the increased power-supply ripple that it may cause, but also because of the possible heating effects. Even simple 3-phase devices, such as motors, should be operated from a power line that is well-balanced, preferably within 1%. Studies have shown that a line imbalance of only 3.5% can produce a 25% increase in the heat generated by a 3-phase motor. A 5% imbalance can cause a 50% increase in heat, which is potentially destructive. Similar heating also can occur in the windings of 3-phase power transformers used in industrial equipment.

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

Reliability considerations

Electrical energy is transmitted from the point of generation to end-users through a highly complex transmission and control system. This network consists of a grid of conductors with numerous embedded components. A typical system may consist of thousands of nodes. The network is further complicated by the interconnection of individual systems. These interconnected systems must be capable of supplying energy despite diverse and challenging physical conditions. Detailed reliability analysis is required to provide an acceptable level of performance to customers.

Control Concepts

When it comes to designing voltage surge suppressors for medical and industrial applications, Control Concepts can be found at the top of the list. The Binghamton, NY, company, which is a newly acquired subsidiary of the Liebert Corporation, has enjoyed an annual growth in sales of about 25% for the past several years, partly because of its dedication to these fields.

Control Concepts manufactures the Islatron line of power conditioners. They are strong enough to protect equipment from powerful lightning-induced voltages, and they also guard against everyday spikes and transients with the exclusive Active tracking filter.

The Islatron line is used principally to protect medical imaging equipment (MRI, X-ray and CAT scan systems) and sensitive industrial controls (programmable logic controllers and variable speed drives).

For the broadcast and video industries, Islatron protects video switchers, graphic generators, electronic editors, videotape decks, audio mixers and lighting control units.

Customer records prove that with an Islatron installation, operational time is improved by 25% while maintenance problems can be reduced as much as 75%.

Current Technology

Current Technology is a nationally recognized leader in power protection products. For 20 years, the Dallas-based manufacturer has protected the electronics investments of hundreds of America's top corporations.

Founder and president Barry Epstein, who holds 24 patents, designed the original Power Siftor, the foundation of Current Technology's current line. To this day, every Power Siftor bears the initials of the assembler in its serial number, and each assembler's compensation is based upon achievement of total zero defects during the product's warranty period.

Virtually all products achieve UL best performance ratings, and Current Technology's internal life test standard is more than 10 times the UL requirement. This year, Current Technology added power supplies to its product line in response to continued customer requests. All power supply products are required to meet a minimum 48-hour, full-load burn-in at elevated temperature without failure.

According to company test results, with the Power Siftor, hardware failures reduce by up to 75%, and software glitches decrease by up to 80%.

In addition to the Power Siftor series, Current Technology manufactures the DataSiftor series, Power Server, Power Supplies Plus series, and the Professional series.

Furman Sound

When Furman Sound, Greenbrae, CA, was founded in 1974, its initial product offering was a line of signal processors and mixers for pro audio applications. But for the past decade, Furman has also been known for an innovative line of power conditioning products.

The AR-PRO AC line voltage regulator is the latest in Furman's power conditioning line. It handles 30A at 120V through a twist-lock connector (a mating connector is supplied with the unit.) Housed in a 2-rack space, it supplies clean, regulated AC power at each of 12 rear-panel and two front-panel outlets.

It can supply a nominal 120VAC output from any input from 88V to 264V, making it an ideal power distribution system for equipment that may be transported anywhere in the world.

Special features include 21-LED bar graph meters for input voltage and output current, and three status lights indicating output regulation. The AR-PRO also provides complete spike and surge suppression and substantial RFI filtering. An AR-PRO may be turned on and off remotely, and multiple units may be turned on either simultaneously or in a delayed sequence by switching an internally derived control voltage. Adjustable rear rack ears are supplied with the AR-PRO for secure rack mounting.

Furman's other power conditioning products include 120V and 220/240V regulators and UPS, and the PL-PLUS rack-mount conditioner with slide-out lights for rack illumination.

Hipotronics

Hipotronics, Brewster, NY, has been manufacturing high-voltage, high-power test equipment for almost 30 years. It became apparent to the company that the available methods of voltage regulation and control were not reliable or rugged enough to meet its high-power requirements. Because of this shortcoming, it became necessary for Hipotronics to develop the Peschel Variable Transformer (PVT) and the Peschel Automatic Voltage Regulator (PAVR).

The PAVR has been in worldwide use with all types of broadcast transmitters (UHF-TV, VHF-TV, SW, MW and FM). The PAVR overcomes the problem of improper voltage caused by line sag, brownouts and other types of fluctuations, which degrades performance and shortens the life of the elements of a high-power transmitting tube. Among Hipotronics' customers are broadcast transmitter manufacturers, with several hundred units in operation.

The PAVR is a 50/60Hz, wye- or delta-connected (wye required for individual phase regulation, line balancing) dry-type, convection cooled regulator. It will regulate line voltage to ±1% of nominal, with input voltage variations from +9/−14% to as much as ±30%.

The PAVR is neither an impedance changing nor ferroresonant device and does not use SCRs. It is an electromechanical device, using an electromagnetic transformer action to regulate. It does not cause any sine wave distortion nor does it create any harmonics. The PAVR is available in all standard service line voltages with current ratings from 40A to 2,400A.

Superior Electric

This manufacturer of the STABILINE voltage conditioning line has been in the business 53 years, long enough to develop many different products and sell to a varied customer base. The original STABILINE product series has evolved into more than 360 standard catalog models from which to choose.

The STABILINE group includes automatic voltage regulators, power conditioners, cabinet and rack-mount uninterruptible power supplies, transient suppressors and filters, AC voltage monitor systems, and REMOTECTOR detector modules. Most are UL and CSA listed.

Because the customer base is so varied, Superior Electric is marketing the STABILINE with a 2-tiered approach, according to Michael Miga, marketing manager. The first tier is in the lower priced and lower power range (less than 10kVA). The second tier is 10kVA and above.

The company's first product offering was the POWERSTAT variable transformer, which remains the flagship line.

The home base for corporate and manufacturing operations is a 425,000-square-foot facility in Bristol, CT. Superior's parent company is Dana Corporation, an international conglomerate with headquarters in Toledo, OH.

It is not uncommon for a utility system to experience load swings of as much as 150MW per minute, mainly the result of changing heavy industrial loads. Such fluctuations introduce a host of challenges to reliability engineers. Primary design requirements include:

- The ability to handle large, constantly changing load demands from customers.
- A high degree of power-supply reliability.
- Tight voltage regulation across the system.
- A strong power source to provide for high inrush currents typically experienced at industrial plants.
- Rapid and effective fault isolation. Failures in one part of the system should have minimal effect on other portions of the network.

Utility companies are meeting these goals with improved reliability analysis, more operating reserve and computerized control systems. Rapid response to load changes and fault conditions is necessary to ensure reliable service to customers. Improved telemetry systems provide system controllers with more accurate information on the state of the network, and advanced computer-control systems enable split-second decisions that minimize service disruptions.

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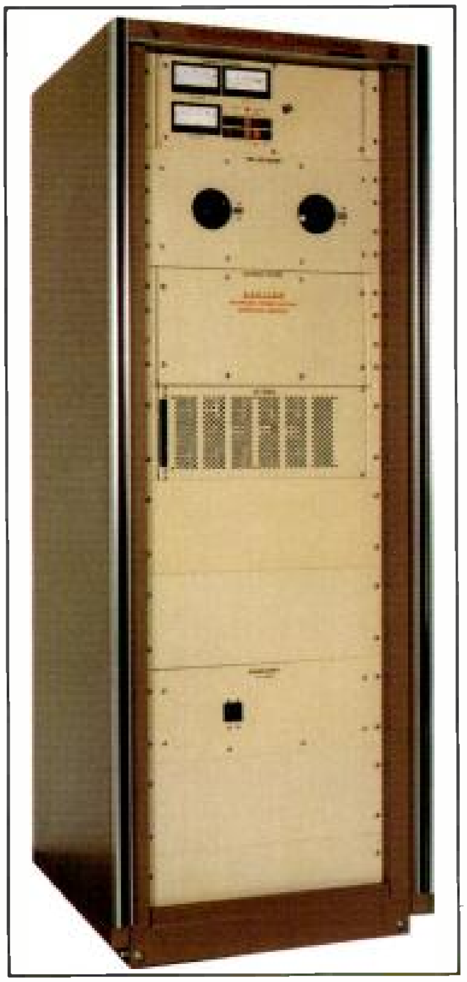
Field report



Continental XL-301 AM transmitter

By Dennis J. Martin

Solid-state technology has profoundly affected all areas of broadcasting. AM transmitters are also reaping the rewards of advancing technology. One example is the Continental XL-301.

An overview

The XL-301 is a modularly built, fully solid-state 1kW AM transmitter. Six rack chassis, or modules, mount in a single rack cabinet. The transmitter control module has five plug-in PC boards inside, as well as three analog meters, and all the transmitter's control switches on its face. The switching supply module contains two low-voltage, low-current switching power supplies. The RF module holds a control PC board and five plug-in PA modules. Other modules are the Tee network and the output filter. The power supply at the bottom of the transmitter provides the high-voltage (70V nominal), high-current (up to approximately 40A) power for the PA modules.

Three 110 CFM fans draw air through a large foam filter on the transmitter's rear door. These fans mount on the rear panel of the RF rack and provide low-velocity cooling for the PA modules. No other fans or blowers are used.

A combination of hinged and removable panels provide easy access to most of the transmitter. AC power requirements are 180V to 250V, 50/60Hz, single phase.

Simplified controls

The transmitter control panel is straightforward, and features a total of nine switches. The low, medium and high switches select one of three preset powers. An off switch turns the PA voltage off. Raise/lower switches control a motorized pot that adjusts power over more than a 30% range. A local switch disables remote-control operation. A lamp reset switch resets temperature and current fault LEDs. A fault reset switch resets PA modules locked out by detection of a fault.

The operating indicators are also straightforward. Two of the meters are for PA voltage and current. The third is a switch-selectable forward/reflected power meter. Three LEDs serve as troubleshooting aids for each PA module. These indicate lockout, temperature and current. The lockout LED illuminates when a PA module has been clamped off because of low-power operation or a detected fault. The temperature LED will illuminate if there is a high-temperature condition, which might be caused by the failure of one fan. The current LED shows that a module has suspended operation for a period of several RF cycles, possibly as the result of a power-line surge.

Performance at a glance:

- *Three preprogrammable power output levels*
- *Frequency response: ±1dB or better, 20Hz to 12kHz at 95% modulation*
- *Harmonic distortion: 1.5% or better, 20Hz to 12kHz at 95% modulation, 1kW*
- *Noise: better than −60dB, unweighted, below 100% modulation*
- *Maximum RF power output: 1.1kW*

How it works

The transmitter uses RF pulse-width modulation (PWM) at the carrier frequency. This maximizes the control pulse sampling rate. Because a high-level PWM filter (typically 70kHz) is not needed, it also decreases phase delays that can affect stereo operation.

The transmitter's design prohibits modulation excursions in excess of −100%. Positive peak modulation capability is 125% at 1.1kW. RF power output encompasses the limits of 10W minimum to 1.1kW maximum.

Five plug-in PA modules that use eight MOSFETs each develop the 1.1kW of rated power. One PA module covers the range of 10W to 40W. A second module increases power to 160W. Three are capable of 360W, and four are capable of 640W. All five modules together provide 1kW operation. Audio performance and efficiency remain largely unaffected at reduced power levels.

DIP switches and multiturn pots are used to program three levels of operating power. These preset power outputs are selected from the front panel.

The input to each PA module is a TTL RF signal, which means input tuning is not required. Module outputs are series-summed. However, a failure of one module does not cause a failure of the transmitter. An SCR on each PA module automatically bypasses those that are not operational. This feature allows the transmitter to continue to operate, albeit at reduced power.

Extensive fault detection protects the transmitter against damage. Each PA module has on-board temperature sensing and a crowbar circuit on its power supply line. Overcurrent protection operates within one RF cycle. VSWR monitoring protects all modules against problems that develop in the antenna system. MOVs in the power supply ward off transients. The transmitter normally requires no external AC power-line filtering or transient suppression equipment.

Simple installation

The transmitter was relatively easy to install — the most complicated aspect was the many available remote-control functions. Aside from the usual PA voltage and current outputs, there are samples of forward and reflected power and AC line voltage. Six remote status indicators, which include interlock and fault-sum readbacks,

Martin is maintenance engineer for KBIG-FM, Los Angeles. He wrote this article when he was chief engineer for KMET-AM/KOLA-FM, San Bernardino, CA.

aid in remote diagnosis.

Because the transmitter is factory-tuned to a specified load impedance (typically 50Ω, non-reactive), field tuning is not usually required. This can make installation a matter of connecting the audio, the antenna and the AC power, then turning the transmitter on.

Audio input is active balanced and adjustable over a −10dBm to +10dBm range. Input impedance is jumper-selectable to provide 150Ω or 600Ω source termination. A stereo interface comes as standard equipment.

Test results

The transmitter tested far better than either its published specifications or the company's expectations. (Being an unrestricted Class IV station, the tests focused on 1kW operation.)

Frequency response of the XL-301 at 95% modulation was specified as ±1dB, 20Hz to 12kHz. Measured results were +0, −0.7dB. Response was flat from 20Hz up to 2,000Hz. Above 2kHz, it fell smoothly to −0.5dB at 10kHz, and concluded at −1.9dB at 20kHz. (See Figure 1.)

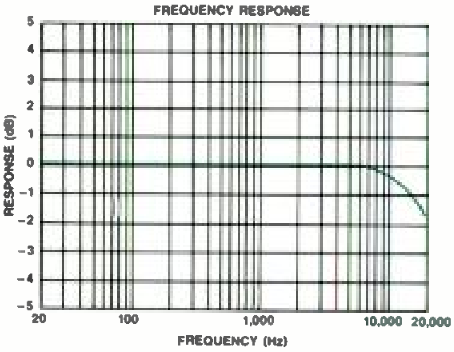


Figure 1. Frequency response at 95% modulation is perfectly flat from 20Hz to 2kHz. Between 2kHz and 20kHz, a smooth rolloff is observed.

Harmonic distortion is said to be 1.5% at 95% modulation, at 1kW. It was discovered that this was a compromise adjustment for multiple operating powers. If the transmitter was left at one power level, a single multiturn pot can be adjusted to minimize distortion. The following measurements were taken after this adjustment.

The transmitter was tested for second and third harmonic distortion of a 1kHz fundamental over a 30dB range (0dB = 95% modulation). Second harmonic distortion usually measured below 1%, but peaked to 1.1% at −7dB. In contrast, third harmonic was always below 0.6%.

THD+N also measured impressively low, less than 0.8% from 20Hz to 10kHz at 95% modulation. THD+N increased slightly as the modulation level was reduced. The maximum value measured was 1.05% at 10kHz and 50% modulation.

Intermodulation, the final distortion test, was 1.40% using 60Hz and 7kHz tones mixed in a 1:1 ratio, and 2.60% using a 4:1 ratio.

To determine whether noise was significantly affected by operating power, tests were performed at three power levels: 900W, 1kW and 1.05kW. (All noise tests conformed with the recommendations of NAB Standard E-416, unweighted. This called for full-wave detection, RMS meter calibration, VU meter dynamics and a 20Hz to 20kHz bandwidth.) At 900W, noise measured −69.1dB referenced to 100% modulation, −72.3 at 1kW, and −70.4dB at 1.05kW. The manufacturer specification for this test is a conservative −60dB.

One-third octave noise floor tests showed that noise at 20Hz was −105dB, and rose to approximately −77dB at 125Hz, then fell to more than −81dB at 20kHz. (See Figure 2.)

Carrier shift was difficult to measure because of its exceedingly small value. Best estimates put it at +0.5%. The manufacturer's specification is 2% maximum. A positive value of carrier shift may seem surprising to some. According to the manufacturer, this occurred because transmitter efficiency increases with modulation.

The next set of tests relied upon a waveform not commonly used in field-testing AM transmitters — square waves. After a bit of experimentation, it was decided to test at a level of 60% peak modulation, as indicated on a modulation monitor. This produced a PA current reading roughly 10% below that of a sine wave at 95% modulation.

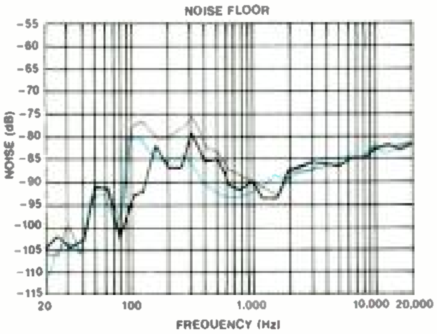


***Figure 2.** The noise floor is essentially the same for the three power levels tested. Across the band, noise components are below –76dB.*

Figure 3 is a scope photo of a 1kHz square wave applied directly to the input of the transmitter and demodulated by our modulation monitor. A slight amount of overshoot is visible — about 2.5% on the leading edge and roughly 1.6% on the trailing. Although it's symmetrical, one possible explanation for the 0.9% difference in overshoot is that the transmitter is more efficient with positive modulation.

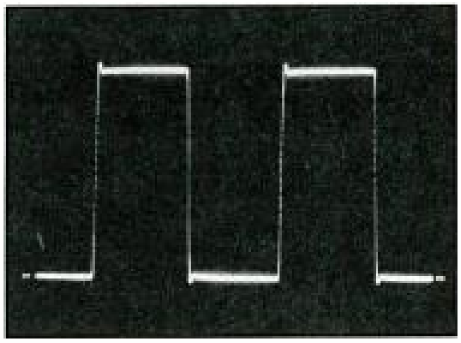


***Figure 3.** Response to a 1kHz square wave is excellent. Overshoot is minimal and measures roughly 2.5% positive, 1.6% negative. (Sweep speed = 200μs/cm.)*

The final test used a 100Hz square wave. This test revealed approximately the same overshoot (2.2% leading, 1.6% trailing), but also showed roughly 1.9% of trailing-edge droop with respect to the wave crest. This was excellent square wave response for the transmitter and modulation monitor.

Looking back

The transmitter's 1,300-mile journey west took its toll. We found an assortment of hardware that required tightening, and two connections in need of resoldering. Also, one trim pot (carrier regulator) was set incorrectly, and the (+/–) audio inputs were reversed. Otherwise, the overall construction and assembly were good.

The transmitter's manual is more than an inch thick, and it gives good insight into its operation.

Looking ahead

Despite the excellent audio performance and expected longevity of the Continental XL-301, certain financial aspects have impressed station management the most. Power bill savings for the transmitter and air conditioner have already been substantial. Furthermore, not having to buy four costly tubes each year will be a welcome relief.

Once again, solid-state technology has established a new level of performance, while rescuing broadcasters from steadily rising operating costs.

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, positive or negative. No report should be considered an endorsement or disapproval by *Broadcast Engineering* magazine.

Continued from page 30

Ambient conditions are always something to suspect when sorting out an intermittent. Naturally, a device that is exposed to the elements is even more susceptible to weather-related variations.

Other questions to consider include:

- Does the problem occur when the equipment is used at certain locations?
- Does the malfunction occur mostly when the equipment receives its power from certain types of power supplies, such as batteries or generators?
- Is there any relation to power service outages or surges or thunderstorms?

A frequent cause for intermittents is insufficient heat dissipation. A bigger and better heat sink or better ventilation may prevent transistors and other solid-state components from malfunctioning.

Check to make sure the air filter is clean when dealing with equipment that is equipped with a cooling fan. Sometimes, installing an additional cooling fan will remove the cause for intermittents. In other cases, positioning in a rack will cause overheating. Warmer-running equipment should be placed *high* in the rack, with sufficient space above and below. Avoid putting hot equipment low in a rack, because it adds to the heat load of the hardware above it. In most cases, a device is only heat-sinked enough to dissipate its *own* heat. Additional heat from a device below it can easily raise the ambient temperature in the device out of its operating range, even though the room seems adequately cooled.

Finally, a fair amount of equipment in today's broadcast facilities is *digitally controlled*, even though the signal paths remain analog, and is therefore considered analog equipment. Although signal-path troubleshooting techniques remain the same, solving control problems may require a different approach. This hybrid equipment is prone to many of the sensitivities (especially power-line related ones) and failures of fully digital equipment, and requires some versatility on the part of the maintenance engineer in alternating between analog and digital domains when troubleshooting.

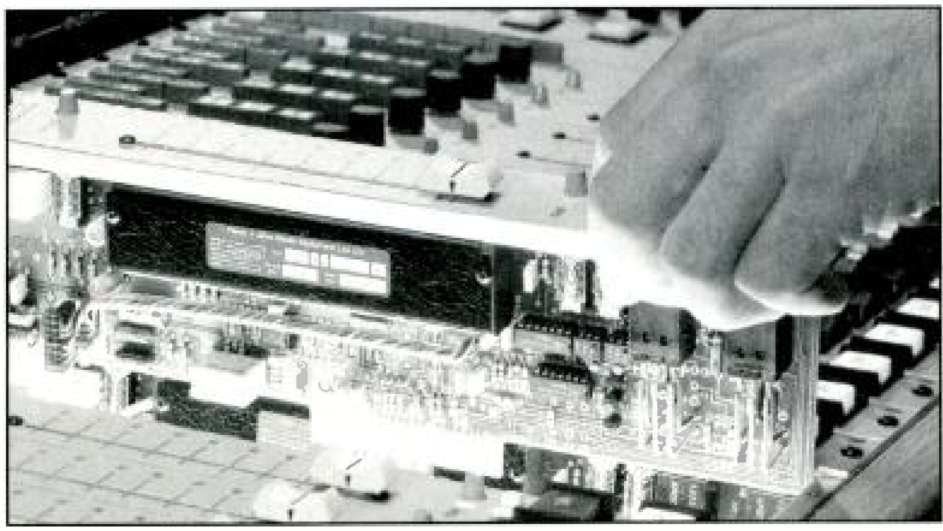


Photo courtesy of Wheatstone Corporation.

Conclusion

"Don't overlook the obvious" is always rule No. 1. Before starting to disassemble a failed unit, check to make sure that all user functions are appropriately set, and that all connectors and fuses are okay.

When dealing with a difficult problem, don't hesitate to call someone who has special knowledge of the equipment involved. Furthermore, once you have completed your repairs, test the system thoroughly to confirm that you really did fix the problem.

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News
Continued from page 4

lated the due process rights of broadcasters.

In comments to the FCC, the NAB charged the commission with skirting comment-and-review laws by styling its action as a "policy statement," rather than conducting the required rulemaking. According to the NAB in taking this action, "the commission has deprived FCC licensees of their procedural and substantive rights."

The NAB wants the FCC to throw out the new fine schedule and initiate a rulemaking that would allow broadcasters to review and comment on any FCC proposals that propose specific fines for rule violators.

Citing federal case law, NAB pointed out how the FCC's fine schedule does not constitute a policy statement exempt from notice and comment rulemaking requirements.

ATVA announces second HDTV system

The American TeleVision Alliance (ATVA) has announced its second, all-digital high-definition TV (HDTV) system, the Alliance Progressive. It has been precertified for testing by the FCC as a national standard for terrestrial broadcasting.

The Alliance is an HDTV joint development program of General Instrument and the Massachusetts Institute of Technology (MIT).

The Alliance Progressive is a replacement for MIT's hybrid Channel Compatible HDTV system, which was precertified as an all-digital submission by the FCC's Advisory Committee on Advanced Television in late March. The Alliance Progressive is scheduled for FCC testing in the spring of 1992.

SMPTE '92 sails into Sydney's Darling Harbor

SMPTE '92, the 5th Annual International Conference and Exhibition of the Society of Motion Picture and Television Engineers, Australian section, is moving to Australia's Darling Harbor Convention and Exhibition Centre on the shores of Sydney Harbor. It will be held from Aug. 31 to Sept. 3, 1992.

An outstanding growth for SMPTE in Australia has led to the new venue, and a new convention title and theme: "SMPTE '92 — New Horizons for Creative Production and Global Distribution."

An expanded conference program will address the development of technologies, such as DAB, HDTV and the digital production and transmission of images and sound. Practical and theory workshops and manufacturers' demonstrations will also be featured.

Zoning laws hurt broadcasters and consumers

The NAB, concerned about state and local zoning laws that place unreasonable restrictions on interstate communications, has asked federal regulators to assert their authority and remove the arbitrary local barriers that impede the best placement of broadcast towers and consumer antennas.

In comments to the FCC, NAB said it is time for the federal government to take steps to supersede state and local zoning laws, because they slap a patchwork of burdensome and inconsistent restrictions on the placement of satellite dishes, broadcast transmitters and consumer antennas.

The FCC's "licensing powers may be greatly impaired if a licensed station is not permitted to erect the tower it needs to broadcast its signal, or if the viewer or listener is restricted from employing the equipment necessary to receive such a signal."

NAB said the FCC has the authority to supersede local and state zoning laws. As part of its regulatory mandate, the FCC is charged with overseeing the regulation of the telephone, cable and broadcast industries.

NAB's reform proposal is not without precedent. In 1985, the FCC took a similar action that should have voided several local zoning laws that unfairly limited the placement of antennas used by amateur radio operators. In this vein, NAB said the FCC must close a federal loophole that allows communities to arbitrarily limit antenna use if they impose a blanket ban on such broadcast equipment.

WGBH initiates viewing process

WGBH-TV, Boston, has begun production of three of its programs — *The New Yankee Workshop, This Old House* and *The Victory Garden* — using the SuperNTSC encoder for advanced TV transmission (ATV) to all Public Broadcasting Service (PBS) homes. The encoding equipment provides enhanced signal quality and improved picture, with dramatic improvement visible on TV sets equipped with SuperNTSC receivers.

WGBH has also formed the Public Video Service, which is a home videotape service offering more than 500 public TV program titles. Following its launch this past winter, WGBH will expand the service from selected test markets to nationwide this fall.

STATEMENT OF OWNERSHIP

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

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9. For completion by non-profit organizations authorized to mail at special rates: Not Applicable.

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	Average No. Copies Each Issue During Preceding 12 Months	Single Issue Nearest To Filing Date
A. Total No. Copies Printed (Net Press Run)	39,148	43,400
B. Paid and/or Requested Circulation		
1. Sales through dealers and carriers, street vendors and counter sales	0	0
2. Mail subscriptions	35,387	35,407
C. Total Paid and/or Requested Circulation	35,387	35,407
D. Free Distribution (including samples) by mail, carrier delivery or other means	2,660	2,761
E. Total Distribution (Sum of C and D)	38,047	38,168
F. Office use, left over, unaccounted, spoiled after printing	1,101	5,232
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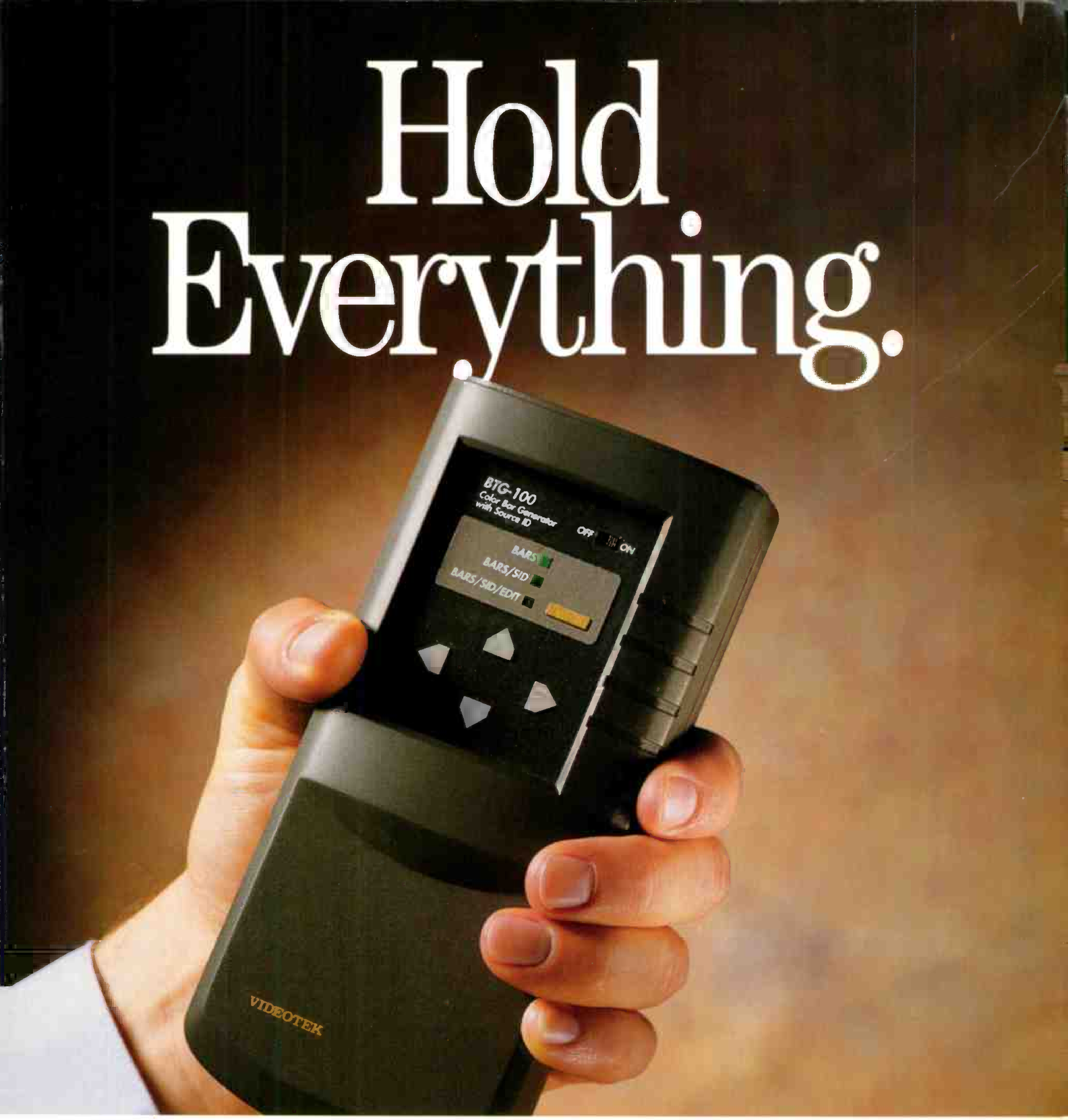
I certify that the statements made by me above are correct. (Signature of editor, publisher, business manager, or owner.)

Sandra Stewart,
Circulation Director


Hold
Everything.
BTG-100
Color Bar Generator
with Source ID
OFF
ON
BARS
BARS/SID
BARS/SID/EDIT
VIDEOTEK

People/ Business

Richard Broadhead has joined Jampro Antennas' sales and marketing team. He is responsible for sales and customer support in all states east of the Mississippi River.

John DeBrocke has been appointed Midwest regional sales manager for HM Electronics, San Diego. He oversees the management of all dealers, sound and communications contractors, representatives and house accounts in the Midwestern third of the United States. He also supervises the distribution of all the company's products in his territory.

John Marino and **Ken Springer** have been appointed to positions with the National Association of Broadcasters' (NAB) Science & Technology department. Marino is manager, technical and regulatory affairs. He is responsible for policy and technical support for NAB's representation of the broadcasting industry before the FCC and other federal agencies. Springer is staff engineer. He assists with policy and technical development of digital audio and digital TV systems.

Brian M. Maloney has been named vice president/general manager of the Harris Broadcast Division, Quincy, IL.

Mark Adams and **J. Robert Heron** have been appointed to positions with Thomson Broadcast, Englewood, NJ. Adams is camera product manager. He oversees all aspects of marketing the company's cameras throughout the United States. Heron is national sales engineer. He is responsible for supporting the company's line of 4:2:2 digital componen' products.

Thomas N. Thiele has been appointed director of Best Power Technology's Power Generation Division. He is responsible for continuing UBS product development, and marketing it domestically and internationally.

Joseph A. Sciulli, president and CEO of Telecommunications Techniques Corporation (TTC), has been named High Technology Entrepreneur of the Year for 1991 by the Montgomery County High Technology Council.

Michael Zablocki has been appointed vice president of sales and marketing for Nesbit Systems, Princeton, NJ.

Steve Cheung, Gail Moore, Mike Smyth and **Paul Smith** have been appointed to positions with Audio Processing Technology, Belfast, Northern Ireland. Cheung is sales and marketing manager. Moore is marketing assistant. Smyth is R&D manager, and Smith is R&D development engineer.

Jeff Kunzler has been named regional sales manager for Mitsubishi Professional Electronics Division, Somerset, NJ. His territorial responsibilities include 11 states in the Midwest.

Michael Skryha has been named national sales specialist for Toshiba Video Systems, Wayne, NJ. His responsibilities include training sales representatives and promoting the technical features and benefits of the company's products to dealers and end-users.

Mitch Hill has been appointed audio services manager and senior audio editor for Stewart Digital Video, Primos, PA.

Bob Adams has been named director of technical support operations for Liebert Customer Service and Support (CS&S), Worthington, OH. He is responsible for directing technical support operations for power, UPS and site products. He also directs CS&S and customer training.

Robert A. Slutske has been appointed marketing programs manager for complementary products for BTS, Salt Lake City. He is responsible for developing marketing strategies for products produced by a variety of manufacturers and distributed worldwide by BTS.

Albert A. Drewke has been named manager of technology for Varian's microwave equipment products business unit. He is responsible for applications engineering, new product development, research and development, and the business unit's bid process.

Robert I. Knudson has been appointed president of Alta Group, the San Jose-based division of Dynatech Broadcast Group.

Tom West has been named national sales manager for Lightning Master Corporation, Clearwater, FL. He is responsible for major account sales, and for coordinating the activities of the company's North American network of distributors and sales representatives.

Jonathan C. Stilwell has been appointed as an engineer for Hammett & Edison, San Francisco.

Scott Sajer has been named national sales engineer for Thomson Broadcast, Englewood, NJ. He is responsible for sales and engineering support for the company's ENG, EFP and studio cameras as well as Thomson's studio and ENG-sized HDTV cameras.

W. Kent McGuire has been appointed international and Western U.S. radio and TV sales representative. He works with the domestic dealers in the western United States.

John Puetz has been appointed digital audio products manager for ComStream Corporation, San Diego, CA. He is in charge of integration and marketing of the company's DCA201 digital audio card and future digital audio products.

Peter A. Hayes has been named vice president of marketing for E-mu Systems, Scotts Valley, CA.

Bob Adams, senior design engineer for Analog Devices, has been awarded a Society Fellowship by the Audio Engineering Society's board of governors.

Elizabeth Jefferson has been appointed district sales manager for the Sony Professional Tape Division, Park Ridge, NJ. She manages the sale of Sony professional tape products to production houses, broadcasters and corporate users in Texas, Oklahoma and Louisiana.

BTS reorganizes U.S. operations

BTS, Los Angeles, has announced a comprehensive reorganization of its U.S. operations to provide a more efficient framework for the company's expansion in the '90s. The company is separating its marketing, sales, service and business development operations from its manufacturing center in Salt Lake City, creating two independent units. No staff reductions are anticipated in the reorganization, and some new positions are being created.

MGI and Quantel announce agreement

Management Graphics Incorporated (MGI), Minneapolis, has announced a worldwide OEM relationship with Quantel, who will use MGI's Solitaire Image Recorders with its Paintbox AV creation systems.

Sprague Magnetics and Ampex announce agreement

Sprague Magnetics, Van Nuys, CA, and *Ampex*, Redwood City, CA, have reached an agreement that allows Sprague Magnetics to provide Ampex's customers ongoing service and support for Ampex audio recorders worldwide.

THE ASSAULTS:

...635A thrown in the path of a Seattle Transit bus and ran over repeatedly.

"Next time have exact change, pal."

...635A entombed in a watermelon and hurled off a three-story building.

"A splattering experience."

...635A attached to a basketball, bounced, and then slam dunked.

"No harm, no foul."

...635A run over by a ten-ton steamroller.

"Major headache."

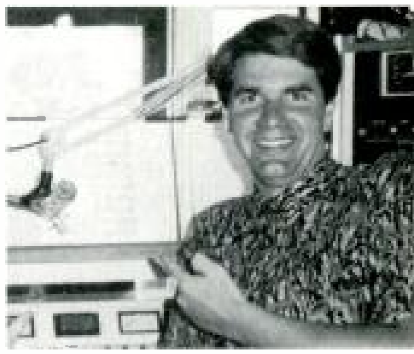
...635A blasted by a Seattle Police shotgun.

"Only a flesh wound."

635A

Television and *radio* *ENG* crews have for years used the 635A dynamic microphone from *Electro-Voice®* because of its superb sound clarity and ability to consistently ***survive*** the most severe field ***conditions***. As a result, it seems that almost every *field crew* has their own favorite story about the reliability and durability of the *635A*, better known as the *"Hammer."* ¶ The most recent story comes from *KPLZ*, a top radio station in Seattle, where morning crew *Kent & Alan* recently aired an ongoing segment dedicated to their *"Incredible, Indestructible 635A."* ¶ They explain: "We unleashed almost everything imaginable on our *635A* – drops, slam dunks, a lawnmower, ***a ten-ton steamroller***, a car crusher – and the only assault to inflict 'serious damage' was a blast from a Seattle Police ***shotgun***. To fix this serious damage, we had to go to the trouble of hooking up a wire. ¶ ***Frustrated*** by our attempts at physical damage, we decided to try a ***psychological*** approach. A life insurance salesman gave our 635A an hour-long presentation, but the mic emerged ***unfazed***. There were no noticeable effects or damage. ¶ The microphone looks and ***sounds just fine*** after going through these torture tests. Of course, it's bent and twisted a bit, but then again, aren't we all? The *635A* ***'Hammer' from EV*** is truly one incredible, indestructible microphone."

Kent – DJ from KPLZ, in Seattle.



"You Can't Keep a Good Mic Down"

...635A devoured by the jaws of a car crusher.

"Job stress."

...635A eaten by a lawn mower.

"Just a little off the top please."

...635A teed off by a wicked one wood.

"Par for the course."

...635A watched a bowling match from atop a headpin.

"Cheap seats."

Result of these heinous crimes:

THE HAMMER LIVES!

Alan – DJ from KPLZ, in Seattle.

EV®

Electro-Voice® a Mark IV company 600 Cecil Street Buchanan, MI 49107 616/695-6831 In Canada 613/382-2141

Circle (79) on Reply Card

The agreement allows Sprague to purchase all existing inventory of Ampex audio recorder parts. It also appoints Sprague as the sole authorized source for replacement parts for Ampex audio recorders. Sprague has assured Ampex that parts and service will be available to its customers through at least 1995. For additional information, contact Sprague Magnetics at 800-553-8712. In California call 818-994-6602.

Thomas & Thomas opens on West Coast

Thomas & Thomas, a manufacturers' representative company, has been launched by former Midwest Communication's sales engineers, branch managers and vice presidents.

The company will initially handle Ampex, TSM, Hitachi, Ikegami, Pesa, Schwem, Harrison Audio, Superior Satellite Engineers and Microdyne.

All of the representatives have extensive experience in broadcast TV and video equipment sales. They will be responsible for sales as well as follow-up service and warranty work.

James Grunder appointed distributor for Hamlet Video

James Grunder & Associates, Mission, KS, has been named as the exclusive U.S. distributor for Hamlet Video International's waveform/vector and stereoscope units.

I.Den acquires Jazz systems

I.Den, San Diego, has acquired the Jazz product line from Electrohome Limited, Kitchener, Canada.

I.Den will distribute the product line through its six international offices.

Moseley purchased by senior management and investors

Moseley Associates, Santa Barbara, CA, has been purchased from GRC International by Moseley's senior management and investors.

Vistek wins top Montreux award

Vistek Electronics Limited, Palo Alto, CA, has received the 1991 Peter Wayne Award for outstanding design and technical innovation at the Montreux International Television Symposium.

The award was presented to Vistek for its pioneering work in motion compensation for international standards conversion as incorporated in its V4501 vector motion compensation system.

Studer acquires Digitec

Studer Revox AG (SRAG), Regensdorf, Switzerland, has completed the acquisition of a majority interest in Digitec S.A., Chatou, France.

Digitec has changed its name to Studer Digitec S.A., and operates as a full family member under the Studer Division of SRAG.

AVS Broadcast appoints ComLogic as distributor

AVS Broadcast, Chessington, England, has appointed ComLogic as the West Coast distributor of its FloatingPoint character generator.

AF Associates, Northvale, NJ, is the East Coast sales and service organization for FloatingPoint.

DATA Group is formed

The Digital Audio Technology Alliance (the DATA Group), composed of communications companies interested in the development of digital audio technology, has been formed.

The companies initially participating in the alliance include SCI, LDL Communications, and du Treil, Lundin and Rackley (DLR).

The DATA Group will attempt to test and develop a successful in-band digital audio broadcasting (DAB) system that meets certain implementation and technical criteria.

APT relocates sales and marketing division

Audio Processing Technology (APT) has relocated its sales and marketing division, formerly situated in Bedbroke Oxford, England, to its corporate headquarters in Belfast, Northern Ireland.

Tannoy named Bruel & Kjaer distributor

Tannoy/TGI, Ontario, Canada, has been named as the exclusive U.S. distributor of Bruel & Kjaer audio products.

Canon USA relocates Broadcast Western region

Canon USA, Broadcast Equipment Division, Costa Mesa, CA, has relocated its Western regional offices to Irvine, CA. The address is 15955 Alton Parkway, Irvine, CA 92718-3614; telephone 714-753-4000; fax 714-753-4337.

R.F. Industries appoints reps and distributors

R.F. Industries, San Diego, has appointed A.R. Gray, Quebec; Masco Electronics, Brea, CA; and More Sales, Phoenix and Albuquerque, NM, as sales representatives.

The company has also appointed Grove Technologies, Las Vegas; Marketronics, Sunrise, FL; Primus Electronics, Joliet, IL; and Allcan Electronics, Alberta, Canada as distributors.

BBT system used in fiber-in-the-loop trial

BroadBand Technologies, Research Triangle Park, NC, has announced a fiber-in-the-loop technology trial with BellSouth in a residential development in Chattanooga, TN.

BellSouth has begun installation of BBT's fiber loop access system (FLX 100), which will demonstrate the consumer and technical benefits of extending the reach of fiber-optic technology in residential applications. The community will eventually include around 400 homes in an area covering approximately 470 acres in eastern Tennessee. The residential development, called Council Fire, is the site of BellSouth's first deployment of the FLX system. The first phase of installation and testing will include plain old telephone service (POTS) to approximately 30 homes.

The distribution trial will provide BellSouth direct insight to customer usage and requirements.

TTC announces LP Com acquisition

Telecommunications Techniques Corporation (TTC), Germantown, MD, has acquired LP Com, a subsidiary of Tektronix.

Richardson Electronics signs agreement

Richardson Electronics, LaFox, IL, and *Ward Leonard Resistors* have signed a worldwide distribution agreement naming Richardson as a stocking distributor for Ward Leonard's wire-wound resistor products.

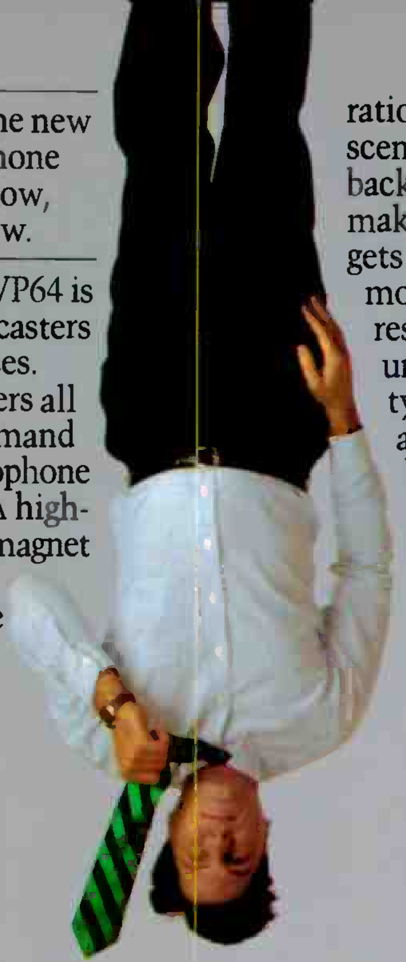
Richardson has also been named as a stocking distributor for Powerex's entire line of power semiconductors.

Clarification

We would like to acknowledge A.F. Associates' help in supplying three of the photographs used in the September "Advantages of 3-Stage Switcher Design."

We wish to give credit to ADC Telecommunications for the photograph of fiber-optic cable on page 56 of the September "Fiber-Optic Routing Switchers" article. It was inadvertently left off.

If You Were Dropped 6 Feet, Head First, Would You Still Be Able To Cover The Story?



Probably not. But the new Shure VP64 microphone could go on with show, after show, after show.

The new Shure VP64 is good news for broadcasters — and their audiences.

In short, it delivers all the qualities you demand for a broadcast microphone — and then some. A high-energy neodymium magnet in the VP64 maximizes signal-to-noise ratio. Result: your on-the-scene reports cut through background clutter to make sure your audience gets the message. What's more, the frequency response is tailored for unbeatable speech clarity and crispness, while all but eliminating boominess and low frequency background noise.

And you won't find a better looking, easier-handling microphone anywhere. All of which makes the competitively priced VP64 the best value in it's class.

See the biggest news in broadcast microphones today at your Shure dealer. For more information, call 1-800-25-SHURE.

The Sound Of The Professionals®...Worldwide.

SHURE®

Circle (60) on Reply Card

New products

Tape storage
By 3M Company
• **DAT Hanger Bars:** locking case for shipping or storage of DAT cassettes; case large enough to hold two cassettes; design permits cases to be hooked onto special aluminum bar for convenient storage; maintains dust-proof seal to protect the cassette.
Circle (391) on Reply Card

Analog audio medium
By Ampex Recording Media
• **#499 Grand Master Gold:** mastering tape for analog audio; low noise and distortion from operating levels of +9dB or greater; high output, wide dynamic range and low print-through characteristics; in 1/4-, 1/2-, 1- and 2-inch widths.
Circle (392) on Reply Card

Portable mixer
By Comrex Corporation
• **Talk Console:** lightweight unit combines two microphone inputs, line-level input, mix-minus feed, two headphone outputs, two self-adjusting hybrids, telco couplers and dialing pad; remote contact closures available to start tape recorder or delay unit; may be used with frequency extender systems for expanded bandwidth response.

Circle (396) on Reply Card

Audio system testing
By Audio Precision
• **Portable One *Plus*:** 2-channel test set with graphic seeps, hard-copy output; provides graphic and numeric data from frequency, distortion and phase sweeps; with external source sweep offers recorder and disc reproduction or end-to-end transmission channel measurements.
Circle (394) on Reply Card

Digital audio distribution
By BEC Technologies
• **Pro-Line/Pro-Series:** modular system for 64-channel bidirectional, full duplex communication; AD16 16-channel 16-bit A/D converter, DA16 18-bit D/A converter; MP16 16-channel mic pre-amp; FB2 FO transceiver; can be configured for operation as digital audio snake with 1,000-foot twisted pair cable; to 10,000 feet with fiber transmission path.
Circle (395) on Reply Card

DAs, processing systems
By Aphex Systems
• **Model 8126:** modular audio distribution amplifiers without transformers; servo-balanced output stages; input includes RF suppression; red/green LED indicates module status; 11 modules fit in one rack. • **9000 series:** includes 9251 aural exciter, 9301 compeller, 9611 expander/gate, 9651 expressor; all in modular form permitting 11 units to fit in 9000R rack system, which is compatible with dbx modules.
Circle (393) on Reply Card

Aural STL
By Dolby Laboratories
• **DP5500 DSTL:** spectrum efficient 950MHz digital studio-transmitter link; increases fade margin, reduces interference problems; AC-2 audio coding data reduction algorithm with digital modulation requires occupied bandwidth less than 300kHz.
Circle (399) on Reply Card

Digital audio product
By Apogee Electronics
• **AD-500 A/D converter:** portable stereo device serving all 16-bit audio applications; handles signal levels to +27dBu; operates at 32kHz, 44.1kHz, 48kHz and 44/056 sample rates with crystal locking to PAL, NTSC or 60Hz monochrome video; locks to external AES/EBU, optical, word clock and SPDIF sources; capable of locking to one input frequency while providing an output at another rate.
Circle (351) on Reply Card

Clock systems
By ESE
• **ES-2695, ES-2743A converters:** allows conversion between SMPTE and ESE time codes; allows a clock system of 100 ESE slave clocks to be driven from a SMPTE time-code source.

Circle (355) on Reply Card

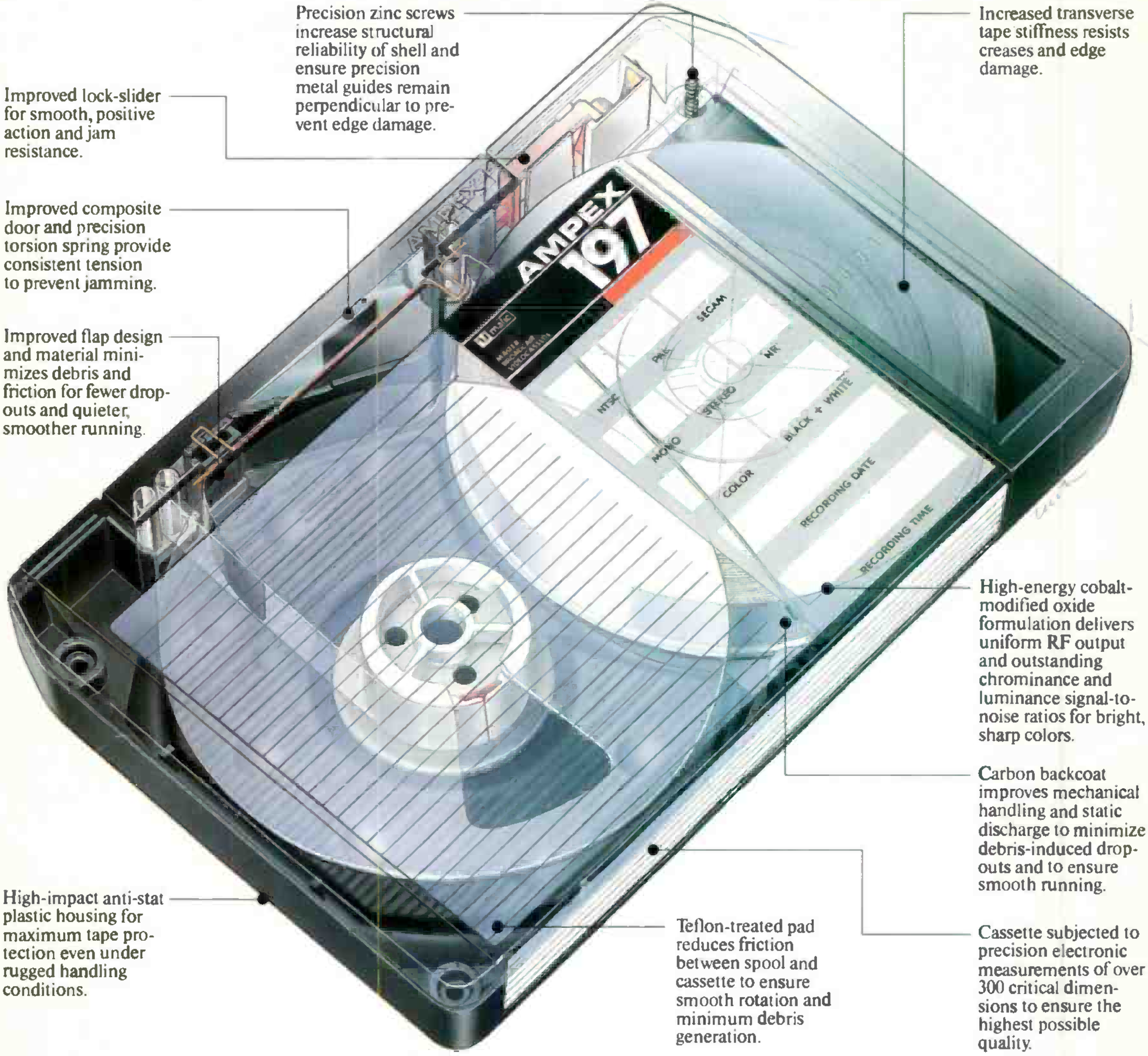
Product catalog
By Jensen Tools
• **1991-1992 Master Catalog:** 256-page publication of tools, analyzers, monitors, meters, soldering supplies and more; includes most major brands of inspection and field-service instrumentation.

Circle (359) on Reply Card

Workstation enhancement
By Digital Audio Research
• **SoundStation upgrades:** AutoConform for automated processing in transferring, track laying and conforming audio to edited video with standard EDL formats; multitrack emulation to 16 tracks without long lock-up times and spooling delays typically associated with tape transports; automatic sorting of source events by reel and source time code.
• **SoundStation SIGMA:** integrated digital audio production system; touch-screen console controls assignment or copying of 4-band EQ, gain and pan parameters with each segment of audio; for 8- or 16-channel simultaneous analog or digital record and playback.
Circle (353) on Reply Card

Audio processors
By Gentner Electronics
• **Lazer 2.0:** digital limiter with stereo generator for FM broadcast; wideband AGC in addition to 3-band, wideband and composite limiting; 25μs and 50μs pre-emphasis selections; "watchdog" feature monitors operation to detect changes in operation following lightning or reset conditions.
• **Prizm 2.0:** 4-band preprocessor using fully digital signal path; wideband AGC circuit and "watchdog" monitoring system.
Circle (402) on Reply Card

At Ampex, we engineer to meet your needs.



U-matic is still a workhorse of the video industry. And Ampex makes a full range of U-matic products as rugged and long-lasting as the format itself.

Our 197/187 Master Broadcast Videocassettes are continually being improved to meet the changing needs of the marketplace and the changing challenges of your environment. So we always build our U-matic products with the latest manufacturing technologies to make our cassettes tougher, more durable, and a lot more reliable.

But when you asked for even more performance from the U-matic format, we created Ampex 297 SP. This is tape designed for the new generation of SP recorders—and for the most demanding users.

And as you demand even more from your U-matics, you can be assured that our U-matics will continue to meet the challenge, whether it's in ENG/EFP, editing, duplicating, or any other application.

From the tape to the flaps to the doors to the box, we engineer Ampex U-matic tapes to roll right through the toughest job—even on older systems. And it's all backed by the industry's most acclaimed customer service and technical support.

Ampex 197/187/297. Engineered to meet your toughest needs.

AMPEX

Ampex Recording Media Corporation, 401 Broadway, M.S. 22-02, Redwood City, CA 94063 (415) 367-3809

Circle (61) on Reply Card

Digital audio equipment
By Comrex
• **DXR/DXP audio codecs:** rack-mount and portable units for full-duplex audio communication with 7.5kHz bandwidth; compresses signal bandwidth for transmission over channel path normally able to carry only a 300Hz to 3kHz frequency range; compatible with 56kb/s and 64kb/s digital services.

Circle (352) on Reply Card

PC TBC
By Digital Processing Systems
• **Personal TBC II:** time base correction unit on a PC plug-in card; 4-pin DIN S-VHS input; four BNC connectors and RS-232 serial port; offers proc-amp, timing and color balance control through PC for desktop video or editing system; infinite correction window for synchronizer applications with VCRs, videodisc and camcorder sources.

Circle (354) on Reply Card

Video capture camera
By For-A Corporation of America
• **HMC-1040 multicam:** 720 × 485-pixel resolution with direct interface for NTSC RGB monitors, D-1 component DVE or PC graphics equipment; single CCD senses R,G,B color information sequentially through rotary color filter; produces inputs for graphic systems devoid of color registration error.

Circle (356) on Reply Card

Solid-state recorder
By Getris Images
• **ARAMIS option:** silicon recording option for VENICE 2-D/3-D animation system; modular design permits 10-80s recording of 4:4:4:4 live video or animation sequences along with key information.

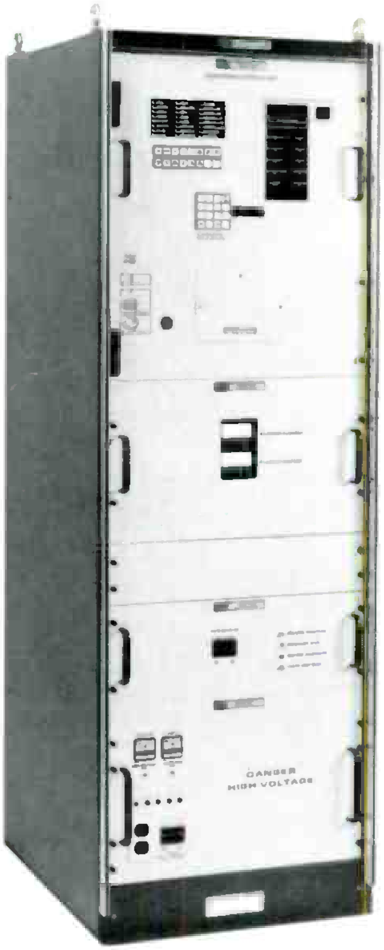
Circle (357) on Reply Card

Audio logger
By Eventide
• **VR240 signal logger:** DAT-based system tracks AM, FM, TV programming to 24-channels on a single machine; one cassette holds 168 hours, less with multiple channels used; log contest, request lines, other stations, public service scanner signals, etc.; date-time search function permits fast location of an segment; single or dual transport versions include automatic switching for two week unattended logging in a single-channel operation.

Circle (401) on Reply Card

10

Reasons To Specify MCL Klystron High Power Amplifiers.



Microprocessor main-frame shown (standard logic unit is similar, except with analog metering).

1 MCL's versatile Klystron High Power Amplifiers are designed for SATCOM C-Band and Ku-Band applications, as well as for other bands, and are recognized throughout the industry for their wide spectrum coverage and consistent, reliable performance. **2** Designed to operate under various environmental and specialized mechanical conditions, and engineered for minimal maintenance. **3** Full microprocessor or standard CMOS Logic system control. **4** Modular construction for rapid sub-assembly access. **5** Motorized channel selectors available (most models). **6** RS232, RS422, IEEE488, or Remote Contact Interfaces. **7** Electrical/mechanical "no-step" or SCR AC line regulation. **8** Beam supply on casters, all other assemblies on slides. **9** Ruggedized for transportable applications. **10** MCL's design, manufacturing and quality control processes ensure the highest quality satellite communications amplifiers and allied equipment available on the market today. All at competitive prices.

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Circle (75) on Reply Card

Video switcher systems

By James Grunder & Associates

• **Models 6119, 6119Y/C:** production switchers for composite and component video signals; 12-wipe pattern generators with GPI triggering, two linear keyers, integral colorizer; automatic horizontal and vertical timing; variable border, soft edge control for wipes; DSK feature using matte key; full control of 6119Y/C from external computers, editors through serial interface.

Circle (358) on Reply Card

Analog O-scopes

By John Fluke Manufacturing

• **PM-3090 oscilloscopes:** 4-channel operation with bandwidths to 200MHz; sensitivity to 2mV per channel; makes dual trace differential measurements from two traces; for maintenance and adjustment of digital HDTV, computer and communications equipment; a product from Philips Test and Measuring.

Circle (360) on Reply Card

Metal-working tools

By Leads Metal Products

• **Chassis punches:** $^{1}/_{16}$ DIN for 45mm × 45mm square and $^{1}/_{32}$ DIN for 45mm × 22.5mm rectangular holes; hardened steel design with easy removal of slug; for hand or hydraulic driven knock-out in material to 14 gauge; resharpening service available through the manufacturer.

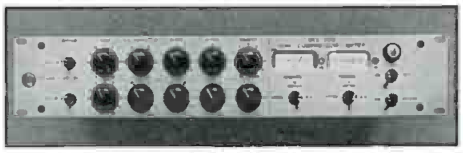
Circle (361) on Reply Card

Audio processing

By Summit Audio

• **Model DCL-200:** dual-channel audio compression and limiting using 12AX7A tube gain-stage design; 1:1 to 7:1 compression ratio variation; adjustable threshold, output levels and attack, release times; operable as dual, mono or stereo-linked unit over 5Hz-70kHz range.

Circle (365) on Reply Card



Automation networking

By Louth Systems

• **ADC-100 system:** PC-based automation control using Ethernet; up to eight controllable devices connect to a server through serial protocol; PC workstations network to server via Ethernet LAN; multiple channel output capability allows each device to be used as an individual channel base; multiple play and record lists possible; menu operation with mouse, trackball and keyboard control.

Circle (362) on Reply Card

Digital audio equipment

By nVision

• **NV4448:** sample rate converter tracks an input range of 28kHz to 54kHz with output at standard rates from 32kHz to 50kHz; synchronous conversion from 44.1kHz to 48kHz at 24-bit accuracy; asynchronous conversion with distortion less than 0.05%.

• **EM1020 codec:** full duplex stereo audio per AES/EBU specifications; 18-bit, 64× oversampled A/D conversion; 20-bit 8× oversampling on D/A conversion; 44.1kHz or 48kHz sampling rate; 2-way stereo conversion on single card.

• **EM1021 digital DA:** options provide balanced or coaxial I/O with linear preamp and equalizer; input impedance adjusts from 75Ω to 250Ω.

Circle (410) on Reply Card

Circle (74) on Reply Card

Circle (73) on Reply Card

Microwave link

By Optical & Textile

• **ENG/EFP TV link:** 19.6-channel microwave system operating between 2.460GHz and 2.700GHz with 20MHz spacing; external switch controls operating frequency with synthesized control; 6.8MHz and 7.5MHz audio subcarrier channels; compact transmitter measures 2.5" × 3.5" × 2.5;" 1W output with 12VDC input; 6" × 4" × 3" receiver mounts on tripod with receiving antenna.

Circle (363) on Reply Card

ENG/EFP cassettes

By Sony Magnetic Products Group

• **HMEX Hi-8ME videotape:** metal evaporated recording media for ENG and EFP applications; manufactured with vacuum evaporation process for high-particle packing density using cobalt alloy particles; 1.5× greater retentivity than standard 8mm metal tape; 5dB increase in RF output and carrier-to-noise ratings; cassette engineered to reduce electrostatic discharge noise, jitter.

Circle (364) on Reply Card

Liquid level sensing

By TankMate

• **Model MK IIIS:** capacitance probe capable of sensing level information in tanks to 12-foot depths; precision determination of cooling system liquid volume in holding vessel with unit designed to meet sanitation standards; controller unit has capacity for eight separate probes if expanded monitoring is required.

Circle (367) on Reply Card

Aural STL

By TFT

• **Model 9200/9205:** mono studio-transmitter link with synthesized frequency control; single-channel or redundant dual-channel stereo operation in 800-960MHz or other bands permitting STL service; 7.5W RF output from transmitter; receiver input rated at 15μV sensitivity with 50dB S/N ratio; channel spacing of 200kHz and 100kHz available; multiplex/service channel optional.

Circle (415) on Reply Card

Satellite tracking

By Superior Satellite Engineers

• **AutoTrak, AutoAccess revisions:** software upgrades to support steerable satellite antenna systems; permits antenna systems to 10m diameters to track movement of inclined-orbit satellites and to re-establish the link with a satellite at any point along an inclined orbit; AutoPeak module handles peaking of antenna on a satellite in geostationary orbit after manually positioning the antenna on nominal look angles.

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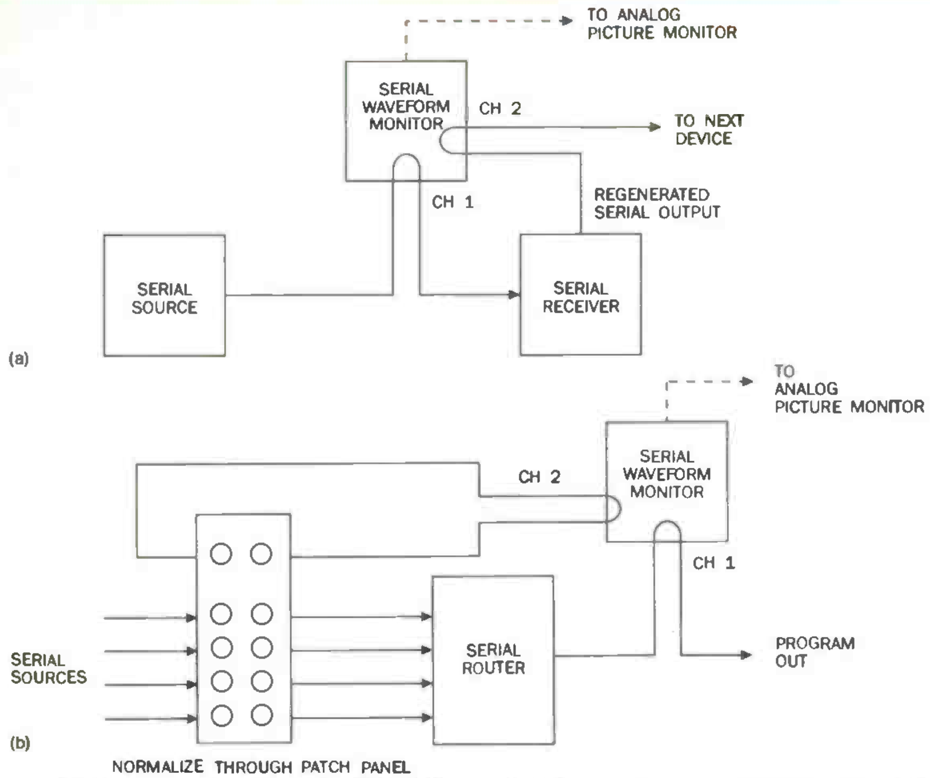

Continued from page 46

Figure 10(b) shows a serial router with a single output. The channel 1 monitor connection allows content and error rate monitoring, as well as checking the program out eye pattern. The second input can be put in series with any of the input signals via the patch panel.

As simple as it sounds, one of the most useful troubleshooting aids is being able to determine if a serial signal is present in the cable.

Summing up

Serial digital video represents a new way of distributing digital video in a TV plant. It will solve some of the problems of parallel distribution, but will bring with it some new ones. Understanding what makes serial tick, together with a strategy for monitoring link performance, will minimize these problems.

Figure 10. *Two suggested monitoring connections. In (a), the serial signal loops through the waveform monitor before termination at the receiver. In (b), any router input can be monitored via the patch panel.*

Footnotes:

1. Ainsworth, K.M. and Andrews, G.D., "Evaluating Serial Digital Video Systems," presented at the Fourth International Conference on Television Measurements, June 20-21, 1991.
2. Elkind, Bob and Fibush, David, "Proposal for Error Detection and Handling in Studio Equipment," presented during the 25th SMPTE Television Conference, Feb. 1-2, 1991.
3. *Sony SBX1602A Serial Interface/Transmission Decoder Specification*, pp. 22-23, Sony Corporation, 1991.

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December...

TECHNOLOGY FORECAST FOR 1992

• State of the Industry Report
One way to help make the correct decisions is to pool the knowledge of your fellow professionals. The annual State of the Industry Report has become the hallmark barometer for the broadcast industry's health and direction.

• View from the Top
Learn what future technological developments are foreseen by three experts in the industry. Peek into their research laboratories and see what may be appearing soon in your facility.

• Profiting from Technology
The most successful stations look to value-added areas to help increase their profits. Often it's the station technical staff that helps the manager see how technology can improve the bottom line. The article looks at ways technology can reduce costs and provide additional revenue sources.

January...

REMOTE PRODUCTION SPECIAL REPORT

• Fiber's Digital Solutions
Remote broadcasts can be a lucrative — or a losing — proposition. The difference usually depends on the technology needed to distribute and back-haul broadcast audio. The article shows the reader that the dial phone is no longer the only way to relay the signal back to the studio. Digital telephone techniques (ISDN, Switched 56) and analog and digital fiber systems are available to improve the transmission process.

• Remote Production Equipment
Remotes can be difficult if the right equipment isn't available. Selecting from the wide variety of equipment on the market can be just as challenging. The article will walk the reader through the decision-making process to select the best equipment for any remote production or recording application.

• News Coverage: Behind the Scenes
No event receives more attention than a presidential news conference. In addition to the standard technical equipment needs, security arrangements add a whole new layer of problems for engineers and producers. The article will take the reader behind the cameras, and show what equipment is used and how reporters and technical crews must work within a strict arena, controlled by the Secret Service.

• Intercom System Design
As stations try to originate programming from remote and studio locations, communication becomes the difference between delight and disaster. The article reviews the different types of intercom system designs, and offers suggestions on how to select the options your facility may need.

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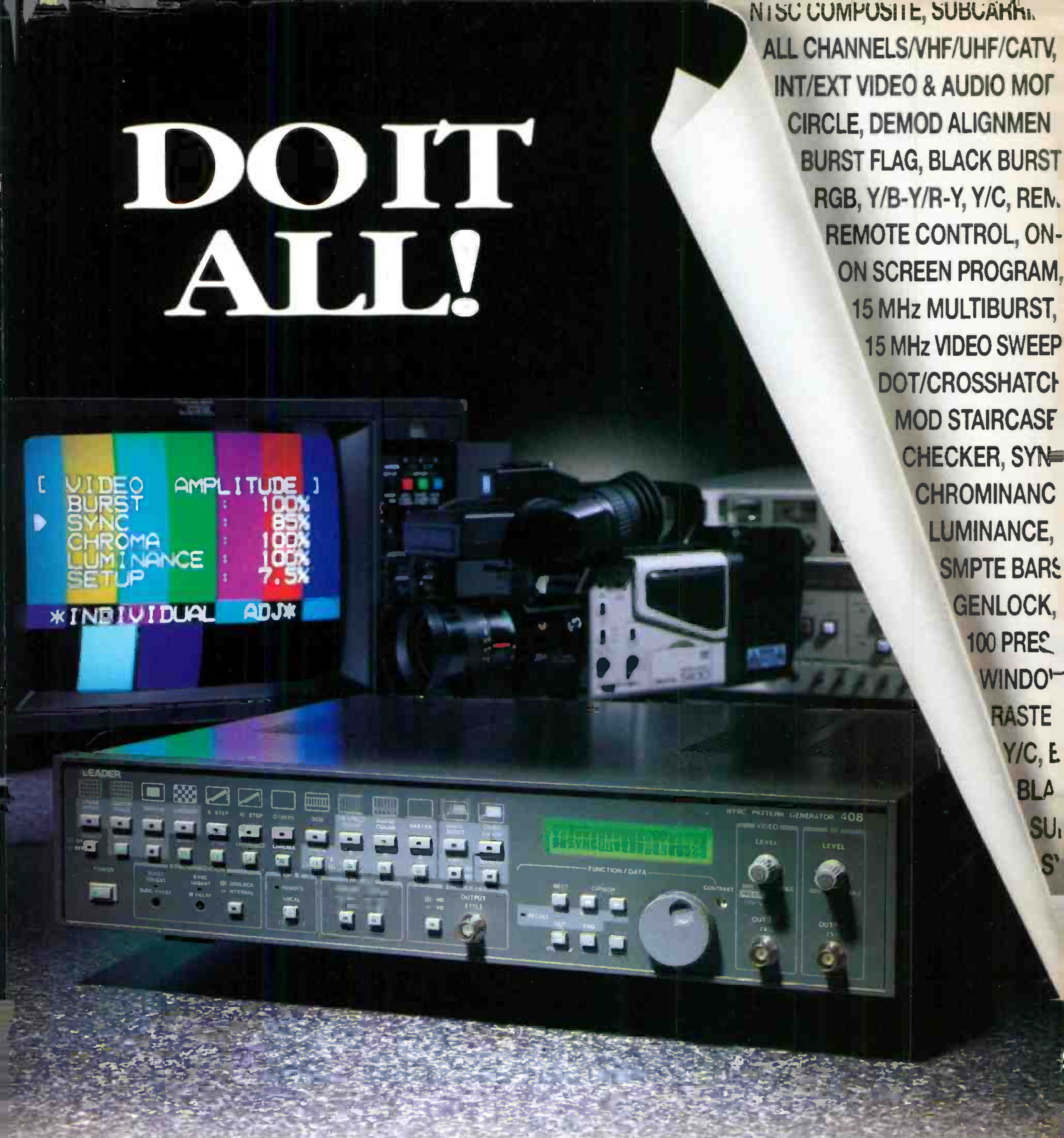
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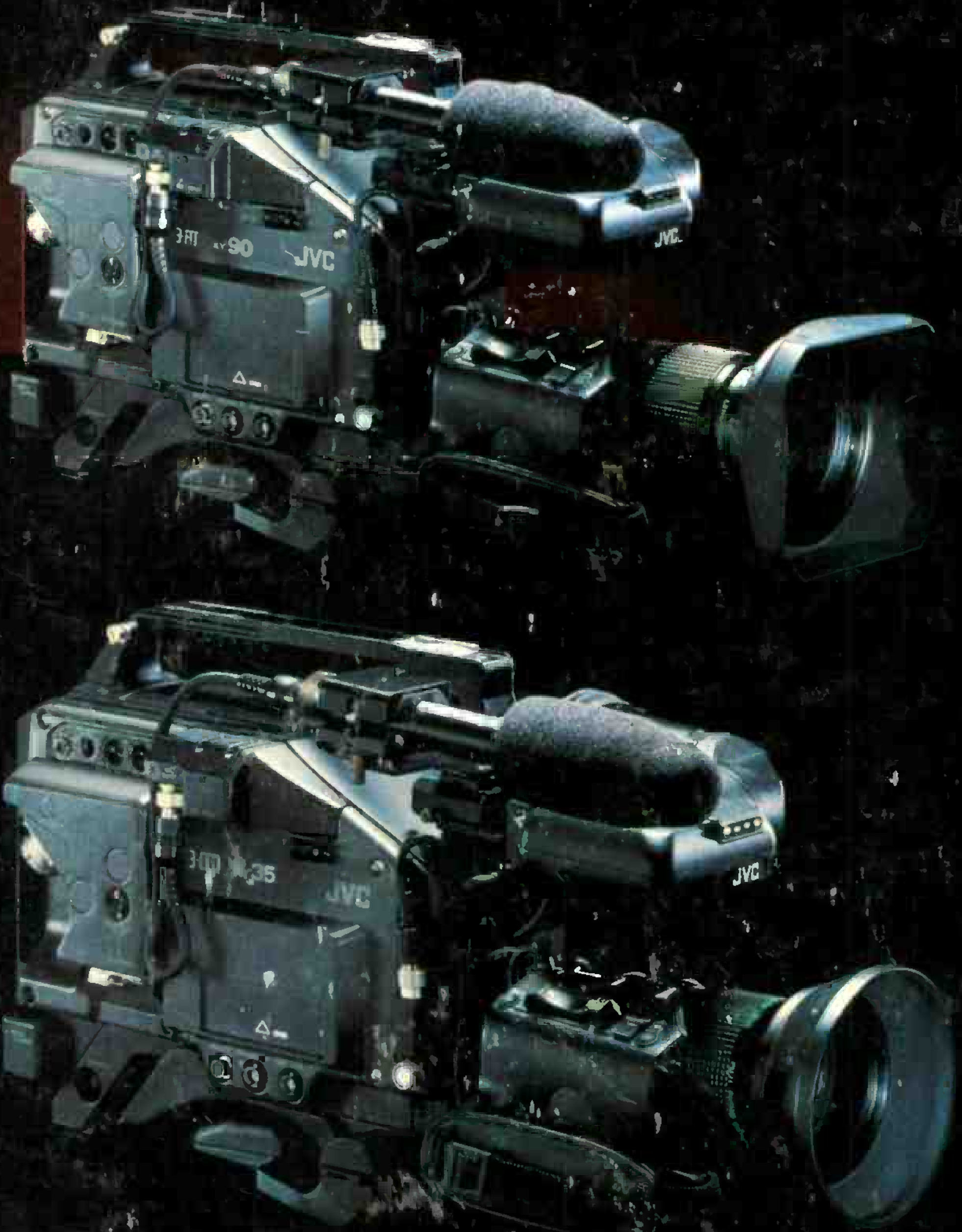

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