BROADCAST ENGINEERING

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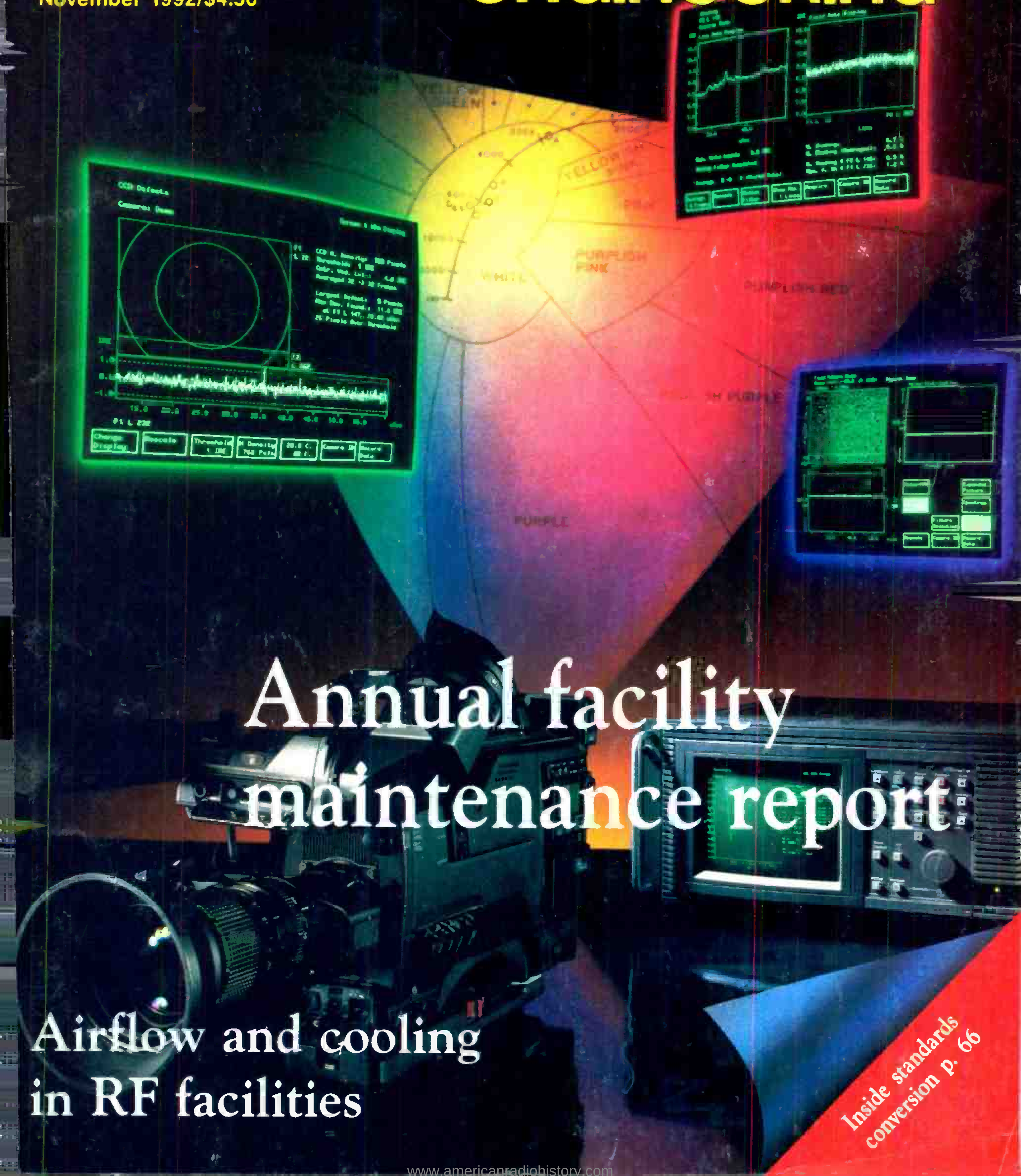

Annual facility maintenance report

Airflow and cooling in RF facilities

Inside standards conversion p. 66

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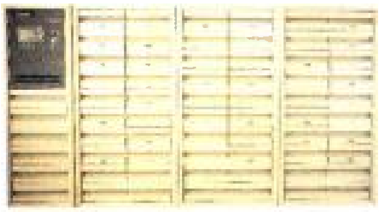

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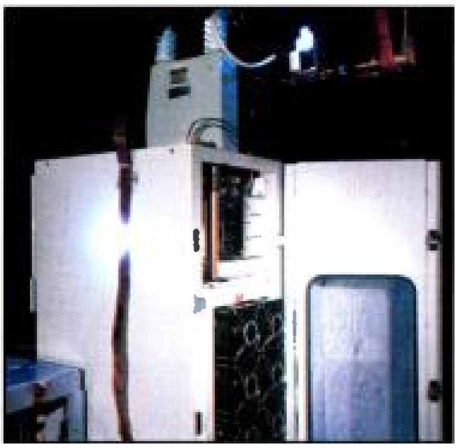
Contents

BROADCAST engineering

November 1992 • Volume 34 • Number 11

Page 30



Page 60

Page 66

ANNUAL FACILITY MAINTENANCE REPORT:

Those responsible for maintaining today's broadcast and production facilities must be more skilled than ever. Because the equipment is sophisticated and complex, the maintenance staff must excel in knowledge as well as speed of repair.

FEATURES:

OTHER FEATURES:

ON THE COVER

One important key to maintaining today's high-tech systems is the use of even higher-tech test equipment. Camera performance measurements is one new area where powerful digital technology in test equipment is providing solutions to long-standing measurement problems. (Cover credit: Tektronix.)

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The V-Series headsets, models V-220 and V-210. (Model V-200 headphone not shown.)

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News

By Dawn Hightower, senior associate editor

Test results available for first digital ATV system

The Advanced Television Test Center (ATTC) has announced the availability of the "Record of Test Results for DigiCipher HDTV" — the first digital advanced TV (ATV) system tested at ATTC under the auspices of the FCC Advisory Committee on Advanced Television Service (ACATS).

This report on DigiCipher HDTV — developed by General Instrument Corporation on behalf of the American TeleVision Alliance — represents the second in a series of five reports to be used by the FCC ACATS for comparing the performance of the systems seeking to become the HDTV broadcast transmission standard for North America.

The cost of the volume is $400. Discounts for an order of five or more sets is $350. Special offer: Order and prepay for this and the next three digital system's reports for $1,500 and receive the 2-volume Narrow-Muse report included in this price. Contact Janet Martin at ATTC for copies. The phone number is 703-739-3850.

RBDS standard receives approval

The Radio Broadcast Data System (RBDS) standard has received approval by the National Radio Systems Committee (NRSC) on initial ballot. This achievement was jointly announced by the Electronic Industries Association's Consumer Electronics Group (EIA/CEG) and the National Association of Broadcasters (NAB).

The standard is expected to usher in a new era in data transmission, as radio manufacturers and broadcasters prepare to integrate RBDS signals into their product.

When the standard is released, manufacturers can move rapidly to develop a market for RBDS. Several receiver manufacturers expect to display products at the 1993 Winter Consumer Electronics Show.

FCC urged to close door on telco entry

The National Association of Broadcasters (NAB) urged federal regulators to close the door on the nation's telephone companies before they are allowed to assume de facto control of cable television and other video programming outlets within their service areas.

The NAB wants the Federal Communications Commission (FCC) to reconsider its decision granting telephone companies the right to own 5% interest in any programming they might distribute over their phone lines. Perhaps more harmful are other FCC actions that allow telcos to finance up to 100% of a cable or video programmer's operation, to consult and manage a programmer and to enter into joint ventures with a video programmer.

NAB said by taking these actions, the FCC has gone beyond the intent of Congress expressed in the 1984 Cable Act, gutting statutory safeguards meant to protect consumers and preserve a competitive marketplace.

NAB also supports no other relationship between telcos and programmers except that of a common carrier.

NAB asked the commission to reconsider its recommendation that Congress repeal the statutory ban on telco ownership of video programming within the telephone service area. Lifting the ban could work against the video dial tone by allowing telcos to buy cable systems instead of building video dial tone systems.

DAR working group makes significant progress

At a meeting of the Electronic Industries Association's (EIA) Digital Audio Radio (DAR) subcommittee, Working Group A (DAR systems) and Working Group B (testing) chairman reported that significant process is being made toward the start of the testing process.

Working Group A has almost completed the process of obtaining detailed information about proponent systems. Working Group B's efforts to develop testing guidelines is continuing on schedule.

As of Sept. 23, the following is a list of EIA DAR Subcommittee System Proponents: Amati Communications Corporation, AT&T Bell Laboratories, Digital Planet, General Instruments, Kintel Technologies, Mercury Digital Communications, M.I.T., National Aeronautics and Space Administration (NASA)/Voice of America (VOA), Strother/LinCom, Thomson Consumer Electronics, for EUREKA-147 DAB, and USA Digital Radio.

American Digital Radio, which had earlier expressed an interest in submitting a system for testing, has withdrawn its system for consideration. ■

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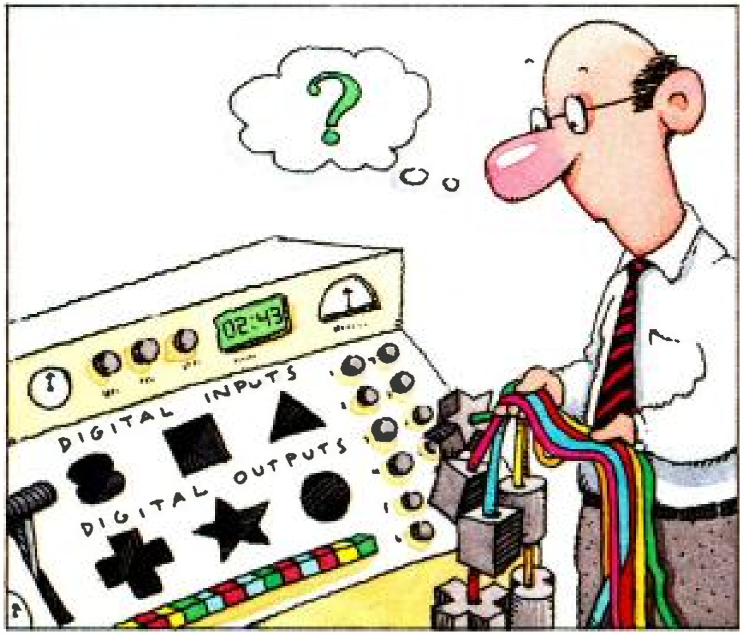
Digital Standard:
Indecision is our own worst enemy

If we're not careful, the digital audio equipment industry could become its own worst enemy. The broad acceptance of digital audio has resulted in a wide array of digital audio products manufactured by dozens of companies. The problem is that all of these devices do not handle digital signals in precisely the same way. Thus, broadcasters are now faced with a serious dilemma when purchasing digital products — will product "A" connect properly with product "B," the result of which must be stored on product "C?" Often, the answer is "maybe."

Three important connectivity issues must be addressed as a part of a total solution. The first is maintaining an adequate number of bits per sample between digital audio devices. The second issue involves the sample rate.



The AES/EBU standard has resolved nicely the first two connectivity issues. Unfortunately, until recently there has been no solution to the third problem of handling compressed digital audio.

The third digital domain connectivity issue centers on the lack of a standard for exchanging compressed audio. Broadcasters must be able to transmit, store and edit compressed audio anywhere along the audio chain. This processed signal then must be transmitted — all without degradation of the final product. Providing this processing and transmission capability is the most difficult problem to overcome because of the variety of algorithms currently used by manufacturers.

Recently, Scientific-Atlanta announced it will publish the interface specifications for its compression algorithms in a way that solves all three digital connectivity issues. This solution is not SEDAT-specific and can be implemented in any manufacturer's digital audio equipment. (SEDAT is Scientific-Atlanta's digital audio compression system.)

Advantages exist for manufacturers and their customers in the adoption of this solution. The standard would enable manufacturers to use one design instead of several, thereby lowering engineering development costs, which means less-expensive products for customers. Also, a single standard permits higher unit volumes, which also helps lower costs.

Users will be able to preserve digital audio quality throughout the broadcast facility by decreasing the number of encode/decode cycles. It will be possible to receive, record, edit and transmit programming entirely in a compressed or non-compressed digital format.

Once we have a digital interface standard, manufacturers can begin selling solutions — not just products. More important, the adoption of an industry standard will provide a smooth migration path toward an all-digital, all-compressed audio path culminating in a future DAB transmission capability.

Kent Malinowski,
Vice President, Broadcast Radio and Data Systems, Scientific-Atlanta

Editor's note: A manufacturers' ad hoc committee on digital audio interface standards has been formed by Bob Weirather, director of strategic marketing for Harris-Allied Broadcast Division. Comments on this issue can be directed to Weirather or Malinowski in care of the editor of *Broadcast Engineering* magazine.

FCC Update

Radio ownership rules now in place

By Harry C. Martin

In mid-September, the FCC's new national and local ownership rules for radio stations went into effect. A single entity may own or have an attributable interest in up to 18 AM and 18 FM stations. After two years, the limit will increase to 20 AM and 20 FM stations. An entity also may have a non-controlling interest in an additional three AM and three FM stations if those stations are controlled by minorities or small businesses. A small business is defined as one whose total annual revenues are less than $500,000, and whose total assets are less than $1 million.

Local limits. In markets with fewer than 15 stations, a single entity may own up to three radio stations, no more than two of which may be in the same service (AM or FM), provided that the owner's stations represent less than 50% of the total number of stations in the market. In markets with 15 or more stations, a single entity may own up to two AM stations and two FM stations, provided that the combined audience share of the stations does not exceed 25%.

Market defined. The commission will define the radio market as the area encompassed by the principal community contours (5mV/m for AM and 3.16mV/m for FM) of the overlapping stations proposing to have common ownership. The number of stations in the market will be determined by counting the number of commercial stations whose principal community contours overlap the principal community contours of the station or stations owned and those proposed to be owned by a single entity. Operating commercial full-power stations but not unbuilt CPs, non-commercial stations, translators or silent stations will be counted.

Market share. In determining whether the 25% audience share benchmark has been reached or exceeded, the commission will consider the combined metro market audience share of the purchasing and to-be-purchased stations. If survey data is unavailable on a metro market basis, survey data for each of the counties touched by the principal city contours of the acquiring and to-be-acquired stations will be considered.

The commission has devised a formula to "weight" the survey data proportionately, according to relative county populations. Under the weighting formula, the entire population of a county is taken into account.

New forms. The FCC is modifying FCC Forms 301, 314 and 315 in accordance with the new ownership rules. Until printed copies of the revised forms are available, applicants proposing common ownership of overlapping stations may continue to use the old forms but must attach a separate exhibit, including the specific market size and audience share information necessary to demonstrate compliance with the revised ownership rules.

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

EBS updating proposed

The commission has announced proposals for updating and improving the Emergency Broadcasting System (EBS). Under the proposals, the current 2-tone EBS monitor/generator would be replaced by a new alerting system device. The devices would accommodate specialized digital alerting codes that would permit selective interruption of local programming. For example, a local station's EBS device could be coded so that only tornado warnings for the station's home county could cause regular programming to be suspended. Such interruptions would be accomplished automatically without the need for local operator input. Likewise, at the end of an emergency message, the local station could automatically be returned to normal programming from a central EBS location. In the event of national emergencies and tests, where the suspension of regular programming is mandatory, the new emergency alert devices would send (and receive) special alerting codes that would cause suspension of regular programming at all monitoring facilities within their range. Other EBS proposals include:

- Making cable television and other media, including cellular and personal communications networks, subject to the system.
- Allowing self-testing, silent testing and monthly on-air audible testing of the proposed new EBS device.
- Revising the test script to reflect the changes in the system.
- Amending the EBS rules to prohibit false and deceptive uses of EBS alerting signals and codes.
- Mandating equipment standards for EBS devices.
- Promoting the use of PSAs to heighten awareness of EBS.
- Revitalizing state and local EBS plans to include amateur radio participation.
- Renaming EBS to reflect the incorporation of other technologies.

Auxiliary application processing transferred to Gettysburg

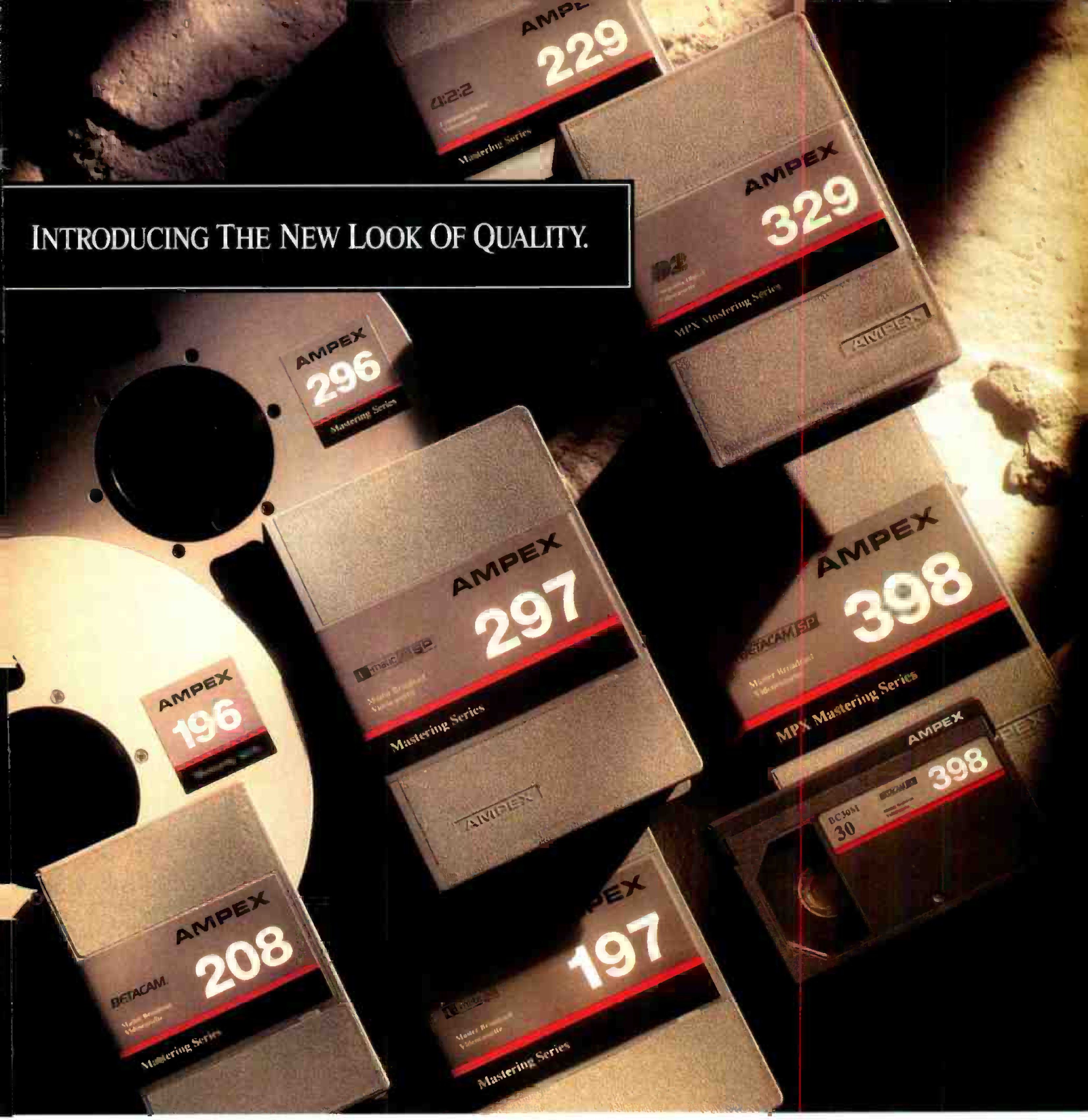
Effective Oct. 1, the commission transferred processing of certain Mass Media auxiliary service applications from the Mass Media Bureau's Washington, DC, offices to the Private Radio Bureau's offices in Gettysburg, PA.

The following types of applications will no longer be processed in Washington, DC: aural STLs, aural intercity relays, aural microwave boosters, TV pickups, TV STLs, TV relay stations, TV translator relay stations, TV microwave booster stations, remote pickup broadcast stations and low-power auxiliary stations.

All filings, applications, requests for modifications, renewals or STAs for these types of facilities *that require payment of a new fee* must be sent to the Federal Communications Commission, Broadcast Auxiliary Radio Services, P.O. Box 358700, Pittsburgh, PA 15250-5700. Written requests not requiring a fee should be sent to the Federal Communications Commission, Broadcast Auxiliary Radio Services, 1270 Fairfield Road, Gettysburg, PA 17325.

Telephone status inquiries concerning applications filed after Sept. 21 should be directed to 717-337-1212, between 8 a.m. and 4:30 p.m. Eastern time.

Written and telephone inquiries concerning auxiliary applications filed on or before Sept. 21, which will continue to be processed in Washington, DC, should be addressed to the Federal Communications Commission, Auxiliary Services Branch, 1919 M Street N.W., Washington, DC 20554; telephone 202-634-6307. ■



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Part 1

Strictly TV

Digital distribution and routing

Digital audio

By Graham Roe and Robin Caine

The push of technology has extended the signal types found in broadcast and production facilities. Video can be analog composite or component at various bandwidths, or digital component or composite in parallel or serial forms. Audio is also involved, with traditional technologies for analog, while digital audio mostly exploits the AES/EBU interface at various sampling frequencies and carrying a range of auxiliary data.

Changes are needed for distribution and routing of digital vs. analog signals. The signal router of the 1990s is expected to do more than route. Digital signals may carry data that must be identified and processed accordingly. At the same time, any standards issues must be buried below the control surface.

Digital audio often appears in islands within a studio or broadcast center, interconnected through analog routing. Eventually, full integration into the digital domain will eliminate intermediate A/D and D/A converters, each a source for noise, distortion, cost and unreliability.

Until then, the AES/EBU digital audio interface provides a method of connecting stereo signals that is more foolproof than the analog equivalent. Original audio quality, signal polarities and left and right channel identity, are all protected by digital data from operator error.

The AES/EBU bitstream (100kHz-4MHz) propagates well on twisted pairs, if a single cable type is used. The system tolerates frequency response variations if the binary levels can still be resolved. Fixed equalizers permit twisted pair lines up to 400m. However, junctions of different cable types form impedance transformations, producing significant effects over lengths of only approximately 20 meters, and EQ effectiveness is lost.

The solution is strict use of only *one cable type*, and digital distribution buffer amplifiers. These DAs terminate the signal with a transformer and use balanced output drivers and transformers. Timing can be regenerated by an on-board phase-locked oscillator, relaunching a signal as clean as the original.

Roe is technical director and Caine is head of digital audio for Pro-Bel, Ltd., Reading, England.

Synchronization

To mix two digital audio signals requires that they are sample-aligned. Alignment is inherent in most processing functions, but it does imply that the whole system runs at one frequency synchronously. With the cost and operational complexity of multiple synchronizers, it is sensible to run a broadcasting center in a synchronous mode. To do so requires the distribution of a reference signal.

With a master oscillator at the point of reference, signals returned from a distant A/D converter will be delayed with respect to the reference. Input interfaces must be independent of the phase of the applied signal. This is achieved with phase-locked clock regenerators in each receiver. No matter what phase an input signal presents, it can be received and registered such that coincident samples are always available for processing, protecting against loss of synchronism.

Eventually, full integration into the digital domain will eliminate intermediate A/D and D/A converters, each a source for noise, distortion, cost and unreliability.

Consider a digital audio recorder locked to its record input rather than the reference. If the transport loses lock from a remote source during playback, the output loses synchronism, but the phase-lock buffered receiver continues to operate with an output consisting of normal audio until a single sample is lost or repeated in each channel. Inaudible in average listening situations, this condition consists of a slight click every second for a frequency error of 20ppm.

Such a failure mode is unacceptable for recording purposes, but from a broadcaster's point-of-view, the loss of quality is sufficiently small to allow a source to remain on air rather than lose the program. "Soft" failure counters the criticism that digital signals fail catastrophically without warning.

The signal router of the 1990s is expected to do more than route.

Router requirements

A serial bitstream crosspoint router is simple. It needs only to provide for sufficient amplitude and bandwidth for all expected signals. It is standards independent and has no synchronization problems because it is unaware of clock rate. All the digital compatibility problems are passed to the destination, which has to re-lock at every transition.

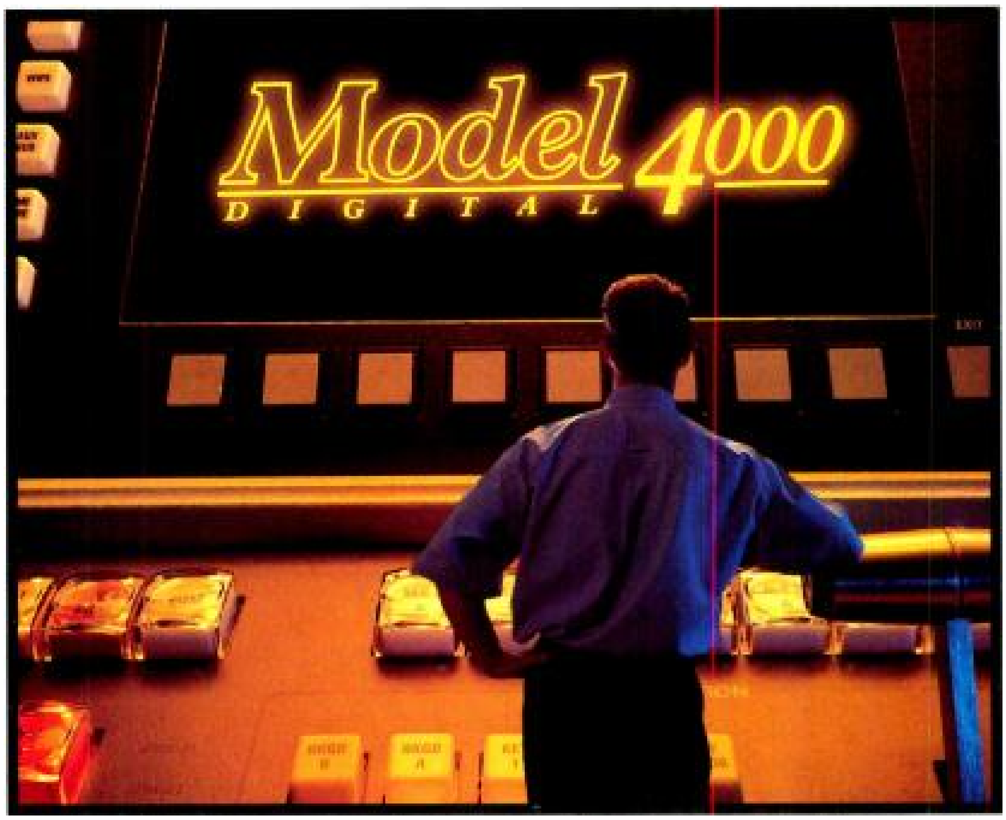
The conventional crosspoint matrix is cheap and compact for smaller routers. One disadvantage of the crosspoint is an almost inevitable corruption of data at switch transitions. Probably a single corruption will not matter because digital filtering in D/A converters will mask it to −50dB below peak signal. Signals requiring perfect transient performance may be processed by a re-framer to remove corrupt samples and re-phase the output into a continuous standard bitstream.

In a synchronous environment, a time-division multiplex (TDM) approach to routing may be more appropriate. This technique places all the signals sequentially on a parallel data bus and selects the required time slot to access the signal required. No crosspoints are involved, and the router hardware is expandable linearly, not as a product of inputs and outputs.

In large routers, TDM techniques result in smaller and less-expensive equipment than conventional equivalents.

An overview of digital video signal distribution and routing will be presented next month. ■

The future looks awesome from here.



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Part 2

re: Radio

Improving older installations

Power dividers

By John Battison, P.E.

This month we will discuss power-dividing networks, such as those found in AM phasers. It is quite common to lump together the power-dividing network and its matching network into a single item, but this procedure is not always advisable.

Figure 1 shows a simple 2-tower power-dividing network. This one is known as a "series" type because the power fed to the towers can be considered as derived in a series circuit.

Figure 1(b) is the actual power divider. L_1 can be likened to a resistive power divider with taps on it providing desired power outputs. C_1 and L_1 form a tuned circuit. It consists of reactance and resistance: The resistance is actually the load that the transmitter works into. The reactance is almost always inductive and, as is often the case in RF work, a higher RF is preferable to a lower one. Just as in a ground system, I^2R losses increase as the ratio of "lossy" resistive values to the load resistance decreases.

When the towers are connected to the taps on the power divider, its resistance changes, thus changing the impedance that must be matched to the common point.

Figure 1(a) depicts a matching network of the *tee* variety, although it can be of any form that will accomplish the desired match to the power divider. Experience has shown that a tee makes for the easiest adjustment of common point impedance when changes are necessary. Because the ratio of desired transmitter load to the power-divider impedance is not normally large, this type of network is suitable, and makes the job of adjusting the common point impedance easy.

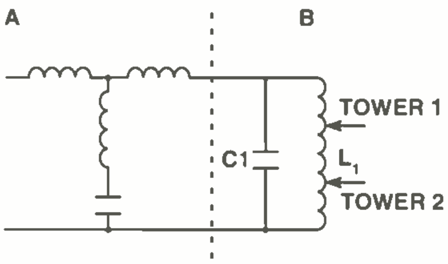

Figure 1. A tee matching network is shown in (a), with a series power divider in (b).

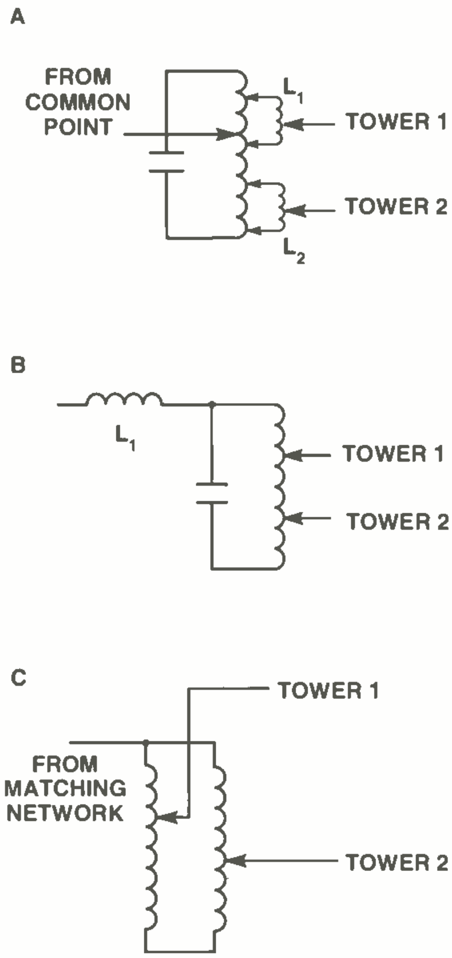

Figure 2. A simple tank circuit is used as a power divider in (a), and modified in (b) with an L-match. A shunt power divider is illustrated in (c).

Figure 2 shows three types of power-divider designs. Figure 2(a) is probably the simplest "normal" approach. If the operating parameters of the DA allow, it can be possible to adjust the input impedance of this circuit to match the desired transmitter load. Coils L_1 and L_2 in Figure 2(a) are usually referred to as *Jeep* coils. The adjustable taps on the main power divider provide a vernier adjustment of power into each tower, and the taps on L_1 and L_2 allow fine tuning of final power levels.

In Figure 2(b), an inductance L_1 is added to the circuit between the top of the power divider and the connection to the transmitter. This causes the circuit to resemble an "L" network, and the common point can be higher than the impedance of the divider.

Some engineers at older 2-tower stations may encounter *unequal resistance* power dividers. These basically employ two L-networks in parallel at a common connection. The only means of adjusting the two powers is by changing the L-network input resistance. Both the shunt and series legs have to be adjusted to provide input resistances that are inversely proportional to the desired power. In addition to the change in power division, there is also a rather large, unwelcome change in phase using this process. If you work with one of these, I suggest that you change it as soon as possible, unless it is just sitting there doing its job and adjustments are not required.

Figure 2(c) shows the well-known *shunt* power divider. It is often used in 3-tower or smaller arrays. In effect, there is a separate power divider for each tower, and they are all in parallel. That is the limiting factor, because when resistances are added in parallel, the total resistance goes down. With more than three towers, the input resistance becomes extremely low, and a corresponding increase in current and circuit losses thereby occurs. Extremely heavy inductances and high-current capacitors are then needed, along with heavier wiring in the phaser.

The circuit shown in Figure 2(b) is also known as a *series* power divider. A number of towers can be driven from this coil by merely adding connections, or taps, to L_1. It is obvious that maximum power will be obtained by the highest tap on L_1. The reference tower usually is connected here, and the other towers adjusted as necessary. As the taps proceed down the coil, the available power is clearly less.

In future columns, the DA system out to the tower bases will be covered.

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

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Part 3

Management for Engineers

Dealing with the difficult employee

Handling a troublemaker

By Judith E.A. Perkinson

Many of you may know a guy like Charlie. He is the kind of person who lives to make trouble. If he isn't directly confronting someone, he is stirring up his coworkers. If he isn't in trouble, he is causing it. Charlie is a capable employee, but people have difficulty working with him.

Kinds of troublemakers

Charlie is a troublemaker. There are a wide variety of troublemakers:

- *Tattletales* cause trouble by destroying the cohesiveness of the group. Tattletales are the first to snitch when something goes wrong. Sometimes the information is reliable, but often, it is their way of getting back at the group, because it does not accept them.
- *Instigators* are always riling everyone up. They take a non-issue and turn it into a crisis. Instigators often let another person carry the gauntlet while they sit back and watch.
- *Nitpickers* spend too much time and energy looking for and pointing out other people's mistakes, policy deviations or inconsistencies in decision making. They enjoy holding management to the letter of an agreement, contract or policy.
- *Gossips* spend the majority of their time talking about other people and their business. Gossips can't seem to concentrate on their own work.
- *Sluff offs* are pros at getting out of and/or avoiding work. Sometimes, it takes more time and effort to avoid doing the job then it would have if the troublemaker had just done it. Unfortunately, this avoidance can take up your time as a supervisor.
- *Against-the-worlds* are against everything the company wants to do. It doesn't matter what it is, if the company wants it, then they are against it. Logic does not seem to play a strong part in their decision making. They seem to live to be oppositional.

What everyone should know about troublemakers

Not surprisingly, many managers find troublemakers so offensive that they find it hard to look beyond the trouble they make. However, if you take a close look at these troublemakers, you may find some positive characteristics that are obscured by the struggle to deal with them. Did you know that most troublemakers are *bored, underused, creative and bright?*

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

The following are additional characteristics that you should understand:

1. Troublemakers often do not feel recognized. Making trouble is a way of getting attention.
2. Troublemakers do not identify themselves as part of the system. Causing trouble is a way of forcing themselves on the system.
3. Most troublemakers have, at one time, tried to be heard or make suggestions, and do not feel they have been acknowledged. Making trouble is their a way of forcing management to recognize their existence.
4. Many troublemakers are full of righteous indignation. They feel justified in their behavior. Causing trouble is their way of passing sentence on management for its poor performance.

In general, troublemaking is not a mindless, unmotivated act. It is born out of frustration, boredom, anger and resentment. That's why it is possible to turn a troublemaker into a productive and valuable employee.

How to deal with a troublemaker

The following are suggestions to deal with a troublemaker:

- *Put your anger behind you.* As a supervisor, it is important to look beyond your own frustration. Troublemakers are easy targets of frustration. Because it is important for a supervisor to be in control, it may be easy for a troublemaker to maneuver you into a power play.
- *Redirect the energy.* In many respects, troublemakers are like children trying to get attention. Often, if children cannot get attention for doing something positive, they will try to get attention by doing something bad. Attention, whether negative or positive, is still attention. Take the steps necessary to redirect the energy of the troublemaker into a more productive pattern.

There are many ways to redirect the energy. Remember that many troublemakers are bored, underused, creative and bright. They already possess all the raw material you need to reshape them into a good employee.

Redirection of the energy is done by putting in place two important components:

1. Challenge the troublemakers. They need activities or responsibilities that offer them an opportunity for productive success. The opportunity must be meaningful and real.
2. A reward and punishment system that rewards the productive success and punishes the negative behavior. Good behavior should be acknowledged to meet the attention needs of the individual. Negative behavior should be punished in order to ensure that a clear line is drawn between acceptable and unacceptable behavior.

One word of caution: Be sure that you do not withhold opportunity as a punishment. This is almost guaranteed to put you back to square one. All punishment for negative behavior should follow the 5-step employee improvement process discussed in October's column.

Some of the activities you might try to offer the troublemaker include:

- Placing them on a special project.
- Putting them on a team.
- Training them.
- Having them train someone new.
- Putting them in a focus group or task force.

Challenge the troublemakers

Be sure that the activity you choose will challenge the person. Troublemakers are a short step away from being terrific employees. Taking that step requires a meaningful challenge.

However, you must be sincere. The rewards you stand to gain from an honest effort to turn a difficult employee around are tremendous. But they cannot be accomplished without a commitment on your part. Troublemakers are the easiest type of difficult employees to reform. They also make the best employees when you are finished. They are worth the effort. ■

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SBE Update

SBE announces new officers

By Dawn Hightower, senior associate editor

The San Jose Convention Center in San Jose, CA, played host to the 7th annual Society of Broadcast Engineers National Convention, Oct. 14-17. Officers and board members were announced at the membership meeting.

The newly elected officers are: president, Richard Farquhar, Television Systems, Canal Winchester, OH; vice president, Charles Kelly, Broadcast Electronics, Quincy, IL; secretary, Marvin C. Born, WBNS stations, Columbus, OH; treasurer, Robert Goza, KMOV, St. Louis, MO. This is Farquhar's and Goza's second term, while Kelly and Born are first time officers.

Six board seats also were filled, each for 2-year terms. The board members include: Phil Aaland, KCET, Hollywood, CA; David Carr, KHOU-TV, Houston; Dane E. Ericksen, Hammett & Edison, San Francisco; Ed Miller, WEWS-TV, Cleveland; Robert A. Reymont, Nationwide Communications, Mesa, AZ; Martin Sandberg, Current Technology, Richardson, TX. Aaland and Ericksen were re-elected to their seats.

In addition, the following board members are continuing their terms: Fred Baumgartner, Indianapolis; Terrence Baun, Criterion Broadcast Services, Milwaukee; Michael Fast, Lutherville, MD; Paul Montoya, Broadcast Services, Lakewood, CO; Troy D. Pennington, WZZK Radio, Birmingham, AL; and Edward Roos, WPTV, West Palm Beach, FL. Brad Dick, *Broadcast Engineering* magazine, continues as immediate past president.

The SBE presents awards

The Fairmont Hotel was the site of the convention's annual Awards Banquet at which a number of members and chapters were presented with awards.

Terry Baun received the Broadcast Engineer of the Year Award. He is certified as a Professional Broadcast Engineer by the society, and is a principal of Criterion Broadcast Services.

Baun has been involved with the Wisconsin Broadcasters Association/Wisconsin SBE Statewide Engineering meetings and has served on the national board of SBE since 1987. He has received Chapter 28's Wulliman Award for service to the Milwaukee chapter, and has presented sessions on contract engineering and BBS use at SBE Ennes Educational seminars.

Paul Lentz, Sylvania, OH, was named a Fellow of SBE. He is retired from WTOL-TV in Toledo, OH, where he served as manager of engineering. Lentz is responsible for the National Frequency Coordinator list and is a former SBE national secretary.

Jerry Whitaker received the first SBE Educator of the Year Award. He is a technical writer and former associate publisher of *Broadcast Engineering* magazine. He served the SBE as vice president in 1992.

Julius Barnathan and Hilmer Swanson received Honorary Memberships.

Barnathan is former president of Broadcast Operations & Engineering for ABC. Currently, he serves as a part-time consultant to Capital Cities/ABC. Among his achievements are fostering closed-captioning for the hearing impaired and assisting in the invention and use of video slow-motion.

Swanson is a senior scientist at the Harris Broadcast Division in Quincy, IL. His work includes the development of pulse duration modulation in 1969, progressive amplitude modulation in 1975 and Polyphase PDM in 1979.

The following awards also were presented during the program:

The Honorable Don Ritter, 15th District, Pennsylvania, received a special award for his support in sponsoring H.R. 3501, which would require an engineer to be appointed to the FCC.

The SBE Technology Award was presented to George Yazell of Lakeland, FL.

The Best SBE Regional Conference or Convention was awarded to Chapter 16, Seattle. Bob Ingalls was the show manager. He was assisted by Al Harwood and Earl Fleehart.

The Best Technical Article/Program by an SBE member was awarded to Paul Stoffel, Chapter 24, Madison, WI, for "Summary of FCC Panel Discussion." In addition, Stoffel's "An EBS Review" won Best Non-Technical Article/Program by an SBE member.

The Best Article/Paper/Program by an SBE student member was awarded to Robb Hagen, Chapter 24, Madison, WI, for "Investigating 3M."

The SBE will join forces with the Radio and Television News Directors Association (RTNDA) to present "Newstech '93."

The Best Newsletter Editor of the Year was awarded to Bill Harris, Chapter 48, Denver. He was assisted by Gerry Quinn and Andre Smith.

The Best Chapter Frequency Coordination Effort was presented to Chapter 24, Madison, WI. The coordinator is Chris Cain.

The Chapter with the Greatest Growth in New Members was awarded to (tie) Chapter 15, New York City and Chapter 105, Houston.

Chapter 50, Ft. Collins, CO, won the Most Certified Chapter award.

The Chapter with the Highest Member Attendance was awarded to (tie) Chapter 50, Ft. Collins, CO; Chapter 51, Tri-Cities (Kenniwick), Washington; Chapter 75, Little Rock, AR; and Chapter 112, LaCrosse, WI.

The Most Senior Chapter was presented to Chapter 9, Phoenix.

The Chapters with the Best Chapter-Society Liaison was presented to (divided) Chapter 112 (less than 100 members on the roster), LaCrosse, WI; and Chapter 24 (greater than 100 members), Madison, WI.

Looking toward 1993

In gearing up for 1993, the SBE will join forces with the Radio and Television News Directors Association (RTNDA) to present "Newstech '93." The convention will be held in Miami Beach, FL, Sept. 29-Oct. 2. Newstech '93 will feature a combined exhibit floor, which will allow engineers and news directors to travel the aisles together in one show. However, the SBE and RTNDA will maintain separate conferences at the convention center and headquarters hotel. ■

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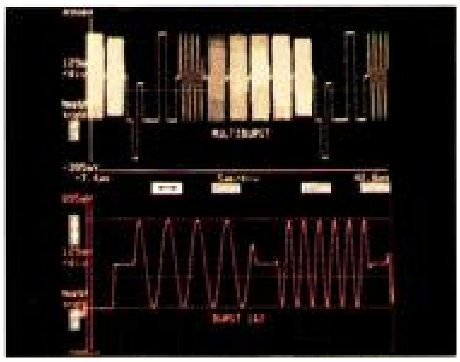
Part 3

Troubleshooting



Maintaining telephone systems

Repairing PBXs

By Steve Church

Last month, we were standing before a malfunctioning PBX cabinet and were in the process of tracking the problem to the appropriate module. It was interesting to discover that the typical PBX system is modular, and that the troublesome module could be isolated with just of bit of reasoning and swapping. Indeed, owing to the modularity, troubleshooting phone systems can often be simpler than maintaining studio and transmitter equipment.

After completing the first phase of diagnosis, the defective board is now in your hands. All you have to do is contact the cooperative PBX manufacturer, get a schematic, call tech support and go to work with a scope, soldering pencil and handful of parts. However, that's not the case. When you make contact with the manufacturer, you will discover that phone system manufacturers are as eager to give you this kind of assistance as the PD is to let you air an hour of test tones during morning drive. The phone people do not publish the kind of service manuals and schematic documentation that engineers are used to getting from broadcast manufacturers. Indeed, as a rule, they regard this kind of information to be strictly proprietary. Therefore, as you might expect, component-level technical assistance is non-existent. This is just as well, because many of the components will have weird markings, may be unique to a particular system, and/or will not be available from any common parts house. How can the modules be repaired? The same way your local phone installation/service company does it.

Owing to the modularity, troubleshooting phone systems can often be simpler than maintaining studio and transmitter equipment.

Church is president of Telos Systems, Cleveland, OH.

Turning to the right source

Here's a secret: The local phone people face the same problems — they can't fix the boards either. Fortunately, they have some sources to turn to for help. We also can call upon these specialists. A number of professional outfits exist only to handle phone system module sales and repairs. You simply request the board you need and mail back the defective one. If you're in a hurry, overnight shipping is almost always available. You'll have the most options and the best luck if you own one of the more popular systems.

Although the usual customers of these companies are phone installation companies and "Fortune 500" corporations with telecommunications staffs, most are willing to work with anyone who has the technical sophistication. Because you are a low-volume customer in dealing with these specialty outfits, you can command their respect and attention by keeping their reward-to-hassle ratio reasonable. The situation is analogous to the relationship broadcasters have with a high-volume parts distributor when we need just one or two items for a repair job.

One way to locate additional sources of information and supplies is through *clearing-house*-type publications. These catalogues provide a wide range of companies providing parts and supplies for telephone repairs. Two publications that list such supplies are: Telecom Gear, 15400 Knoll Trail, Dallas, TX 75248; 214-233-5131 and The Mart, 250 E. Arapaho, No. 125, Richardson, TX 75081; 214-238-1133.

When you need something, randomly pick a few companies and call until you find the item for which you're looking. For the long term, you will probably want to establish a rapport with one or two reliable vendors, and give them your business exclusively. As with anything else, competance and reliability vary considerably. It's generally best to find a company that has a single focus on the manufacturer of your phone system. It also helps if a supplier is geographically near you. Because there are hundreds of these companies, it should not be difficult to find one within driving distance so that you can quickly get parts in an emergency situation.

A number of specialist outfits exist only to handle phone system module sales and repairs.

Better yet, to avoid being at the mercy of overnight availability, stock a few spare modules. The price for refurbished units is usually reasonable, especially for the most common parts.

In addition to these third-party repair companies, you might consider the local authorized dealer. I've found that although some will look unkindly upon users attempting their own repairs, others will be reasonably respectful of your broadcast engineering ability and will assist at a reasonable level. Indeed, you may eventually find yourself called upon by them for some moonlight help with special installations requiring some of your audio expertise. The authorized dealer certainly is the only place to go when a system or card is under warranty.

If you have a local dealer install your phone system, you should obtain all of its associated documentation. Unfortunately, many dealers will not pass this along, thinking that you may not want to be troubled. In a few cases, it may be a deliberate strategy on their part to keep you dependent upon their service. Whatever their motive, you should insist upon getting the manuals, because they rightfully belong to you. ■

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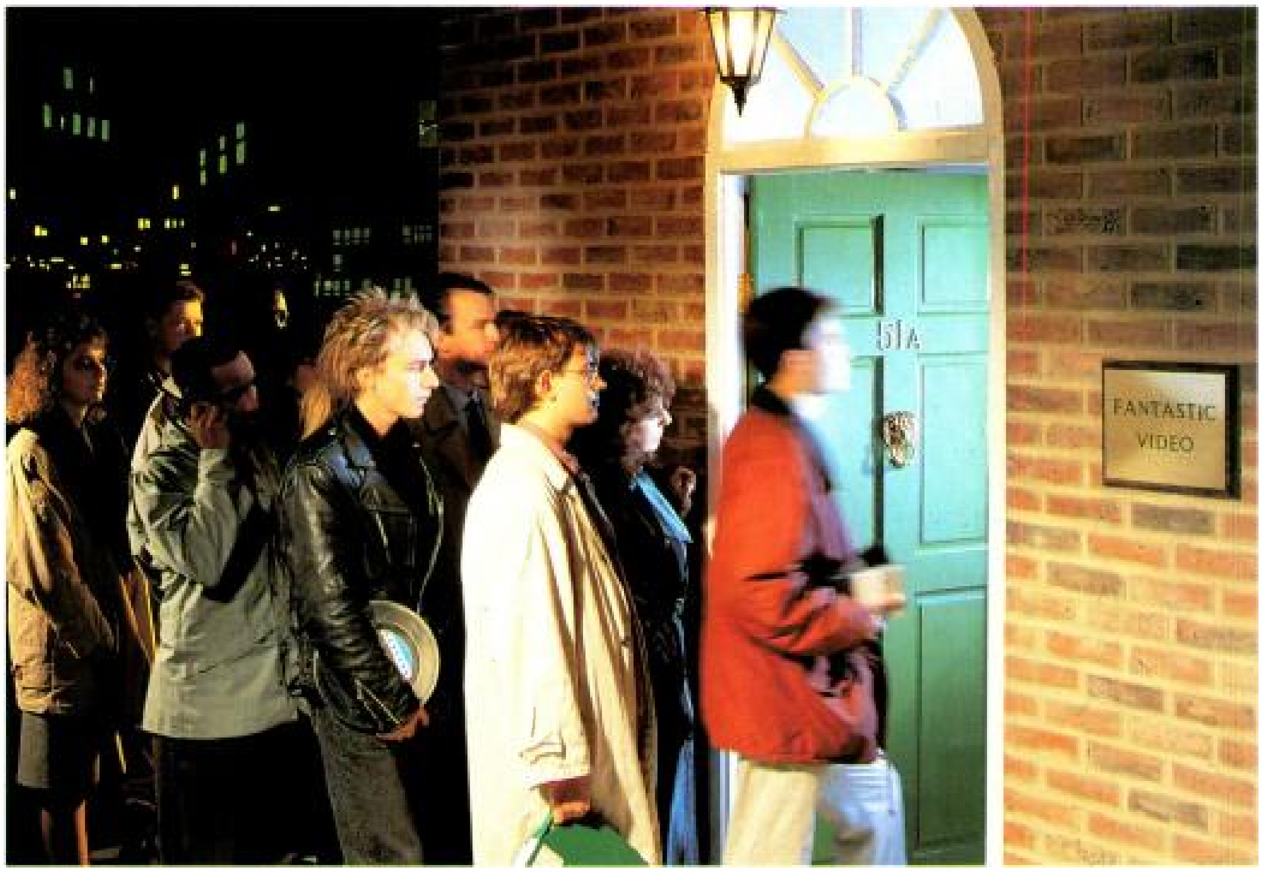

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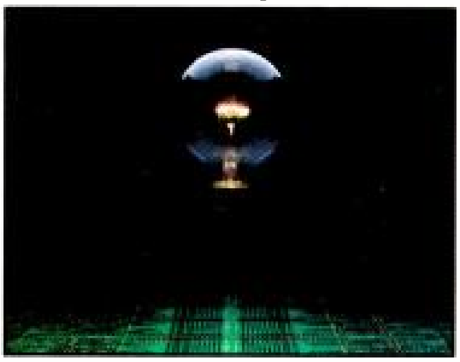
Part 1

Technology News



N-Way technology

TeraSwitch for HDTV

By Curtis Chan

In the past decade, deregulation of the industry, development of fiber optics and advances in microprocessor technology have transformed and spurred growth in voice response systems, local and wide area networks, video conferencing and personal communication networks. With the information age upon us, effective use of the storage and transmission of information is critical for a company to stay competitive.

The majority, if not all, of the applications are based upon computers. Trickle-down theory applies and the computer age has hit the broadcasting industry. Computer-based technologies have been an integral part of the modern broadcast network and facility for some time. From the news correspondent to automation systems, computers perform numerous tasks ranging from word processing to managing and processing a multitude of different information bases as well as performing housekeeping and communications chores. However, computers working alone do not do much good if they can't communicate with one another.

The preferred way that computers communicate is through local area networks (LANs) or wide area networks (WANs), using industry standards, such as ethernet or token ring. These systems are analogous to a many-to-many data communications concept. In reality, we can consider this concept, in part, as many one-to-one links. The difficulty with this approach to networks is that the number of necessary nodes is equal to $n(n-1)/2$, where n is the number of computers. For a 4-computer network, the number of links is six. But for a 100-computer network, the number is 4,950 and jumps to 499,500 links for a 1,000-unit network. For a typical facility or network using computers to link almost every aspect of the operation, the amount of processing power needed to tend the network is daunting and expensive.

In a typical news environment, traffic or station automation system using multiple computers linked via ethernet or token ring, there are obvious advantages and concerns. In ethernet, the pros are that many computers can share the same cable and that there is no need to remove a message once the message is sent. The difficulties involve the need for a minimum packet size. Performance is degraded because of collisions at heavy traffic intervals, and some sending nodes may not even be able to send because of the potential for multiple collisions.

Similarly, in a token ring environment, every sender will have a chance to send, and the maximum sending delay is deterministic. Some drawbacks are that every additional computer introduces additional delay because it needs to determine whether the message sent from its neighbor is a token or a message. Also, a message must be removed, otherwise it would circulate in the ring forever.

An example

Let's consider an integrated automation network combining media management, traffic management and peripheral/logging management on the top level. All signals are routed into a fault tolerant automation system, which, in turn, feeds an ESbus/ESnet control network. The control network then feeds a bank of intelligent processors which, in turn, controls their respective equipment, such as carts, VTRs, robotics, effects devices and still-stores. As you can sense, the amount of processing and housekeeping power needed to create a reliable broadcast and fault tolerant system is large. This increasing problem results in a continual quest to find a lower cost and more efficient process to deal with multilink hookups.

This problem can be thought of as the "problem of 10 friends." Imagine that the main traffic computer is friend 1 and the media management computer is friend 2. Friend 1 wants to invite every friend to his party on Saturday and calls them one by one. Friend 2 also wants to invite every friend to her party on the same Saturday and calls them one by one. After awhile, friend 1 and friend 2 realize a conflict exists. They would have to resolve it and inform every friend again. Imagine the complexity in a network of 1,000 computers.

Hardware needs

The other area of high opportunity is the ability to cost-effectively switch and route a multiplicity of signals in real time at fiber-optic speeds. Imagine the capability for a broadcast station to route and switch HDTV, digital audio, control, data, SMPTE time code, voice and communications signals together in real time, all from an integrated module.

Next month, we will look deeper into this concept.

Editor's note: The author would like to thank Larry Tseung, president of Multipac Inc., Irvine, CA, for providing information for this column.

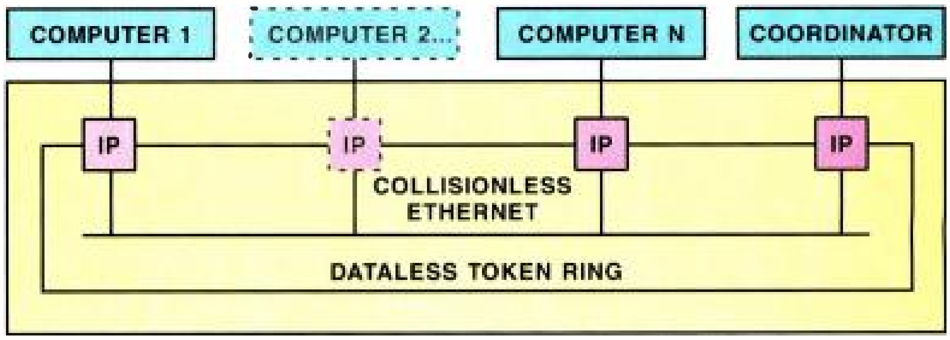


***Figure 1.** Inside the TeraSwitch, numerous intelligent processors are connected in a dataless token ring and to a collisionless ethernet.*

Chan is a principal of Chan & Associates, Fullerton, CA.

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Annual facility maintenance report

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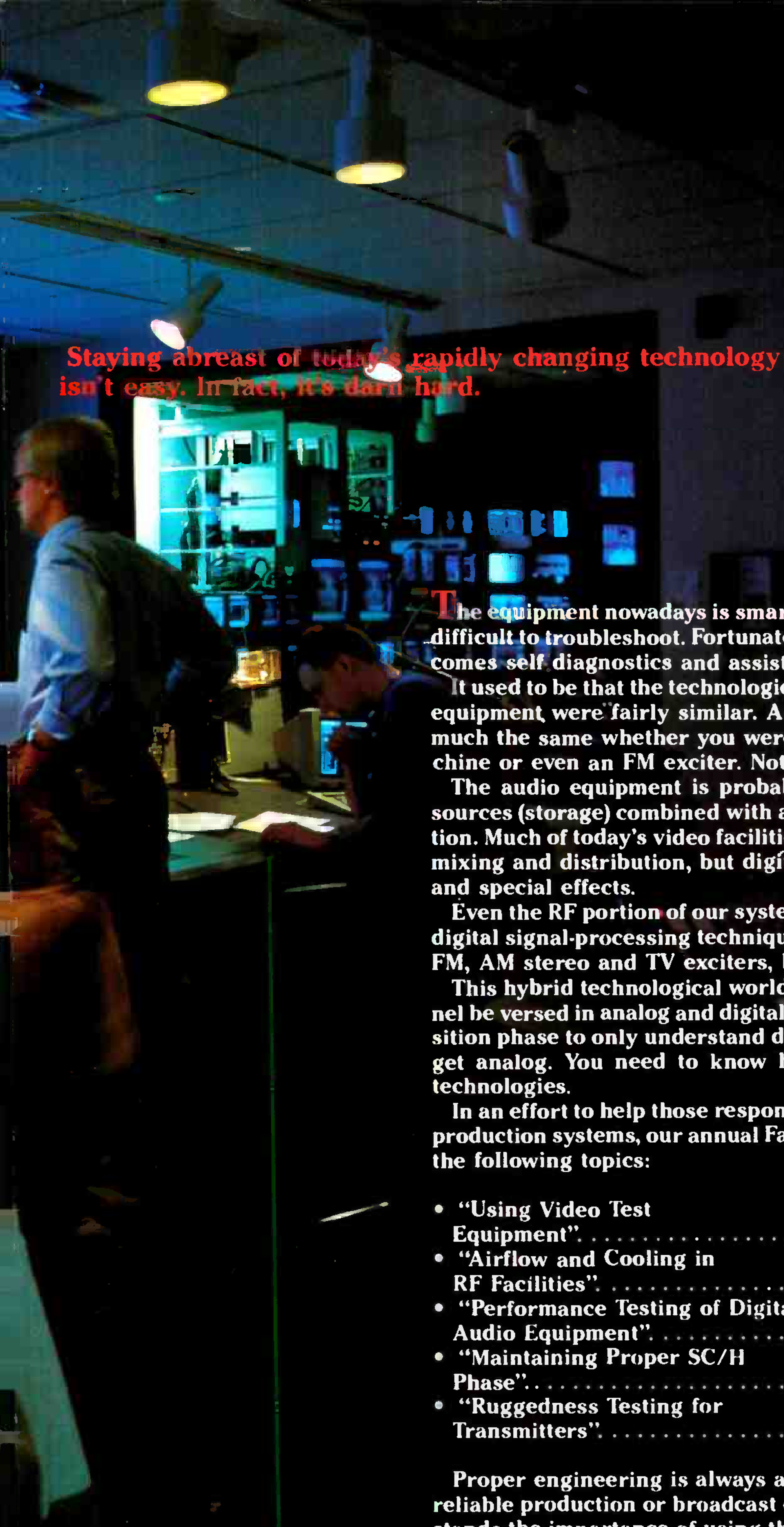

Staying abreast of today's rapidly changing technology isn't easy. In fact, it's darn hard.

The equipment nowadays is smarter, more complex and increasingly difficult to troubleshoot. Fortunately, along with this complexity often comes self diagnostics and assisted troubleshooting.

It used to be that the technologies used in broadcast and production equipment were fairly similar. Analog signal processing was pretty much the same whether you were working with a mixer, a tape machine or even an FM exciter. Not so today.

The audio equipment is probably a combination of digital signal sources (storage) combined with analog mixing, routing and distribution. Much of today's video facilities rely on analog signal acquisition, mixing and distribution, but digital techniques are used for storage and special effects.

Even the RF portion of our systems use a combination of analog and digital signal-processing techniques. From remote-control systems to FM, AM stereo and TV exciters, both types of signals are used.

This hybrid technological world requires that maintenance personnel be versed in analog and digital techniques. It's too early in the transition phase to only understand digital and it's not late enough to forget analog. You need to know how to troubleshoot both types of technologies.

In an effort to help those responsible for maintaining broadcast and production systems, our annual Facility Maintenance Report examines the following topics:

Proper engineering is always an important key to an efficient and reliable production or broadcast operation. Be sure your staff understands the importance of using the latest techniques to keep your facility in a leadership position.

Brad Dick,
editor


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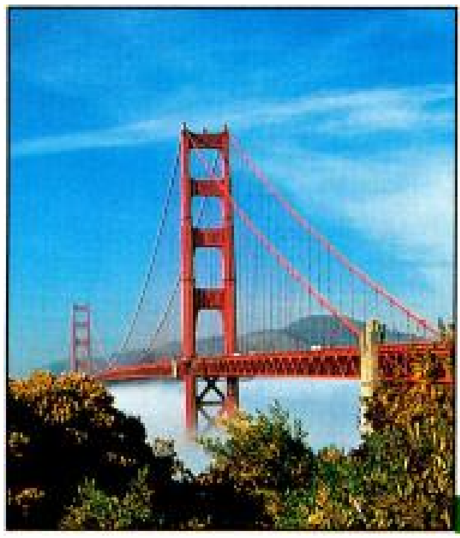


Courtesy of San Francisco Convention & Visitors Bureau.
Photo by Regis Lefebure.

AES show review

Highlights of the 93rd AES Convention.

By Skip Pizzi, technical editor

This fall's AES Convention was the society's 93rd, but its first to be convened in the city of San Francisco. The show was held from Oct. 1-4 at the Moscone Center. The new locale appeared to be well-received by exhibitors as well as attendees.

More than 14,500 people attended the convention, which featured 303 exhibitors displaying their wares on approximately four acres of show floor and suite space. Elsewhere in the Moscone Center, six lecture halls housed a wide range of technical papers, workshops and seminars. Among the topics covered were psychoacoustics, digital signal processing, interfacing digital equipment, grounding and isolation, adaptive filters, audio measurement, data compression, architectural acoustics, analog/digital conversion, fiber optics, loudspeakers, microphones, hard disk recording, multimedia, and audio education. Other sessions covered the role of women in the audio industry, the use of computers in audio and MIDI machine-control applications.

An all-day seminar on the first day of the convention considered the subject of "Silicon in Audio," in which 10 leading manufacturers presented their views on developments and future trends in audio semiconductors. The convention program also offered attendees technical tours of several well-known Bay-area facilities.

In addition, the AES presented a joint forum with the National Academy of Recording Arts and Science (NARAS) on the subjects of recording techniques and audio preservation. This 2-part affair featured some legends of the industry who discussed important issues in audio recording's past, present and future. A primary subject was the challenge faced by today's archivists in their efforts to preserve our aural heritage.

Fresh concepts

An innovative element of this convention was the "New Ideas Room," a special exhibit space dedicated to small, cutting-edge companies and inventors. For two days of the convention, 10 such operations discussed and demonstrated their concepts and hardware.

More new ground was broken at the inaugural meeting of the Digital Manufacturers Alliance, a group formed to improve compatibility between the digital audio products of different companies. The meeting discussed extremely preliminary matters. Prospective members were asked to provide their input and to consider joining the alliance. Most of the manufacturers attending responded positively. Some suggested that the group should model itself after the successful MIDI Manufacturers Association, while others emphasized that without this kind of an alliance, equipment interfacing problems will only become worse with time. It was generally agreed that the group should address uniformity in three separate areas of interconnection: electrical parameters, data format and synchronization. Other discussion considered the possibility of compliance testing, the issuance of identifying stickers for compliant hardware and the need for equipment design confidentiality among member companies.

In another first, the convention program featured two Spanish-language panel discussions on the professional audio industry and issues in Latin America.

Awards and elections

At the annual awards banquet, the Gold Medal (AES's highest honor) was presented to Ray Dolby, founder of Dolby Laboratories, for introducing the era of improved audio reproduction in the theater, studio and home through unique methods of noise reduction.

The AES Bronze Award, which honors audio pioneers Alexander Graham Bell, Emile Berliner and Thomas Alva Edison, was presented to Daniel Gravereaux for his work toward the advancement of the society.

A new award, the Distinguished Service Medal, was presented to Robert O. Fehr for his 20 years of service as editor of the *Journal of the AES*.

The society's new officers also were announced at the convention. President-elect is Richard C. Cabot, vice president and principal engineer of Audio Precision. Freelance recording engineer Ron Streicher is the society's new secretary, while Leo de Gar Kulka, founder of the College for Recording Arts and well-known Bay-area engineer, will serve as AES treasurer. (De Gar Kulka also chaired the 93rd AES Convention.) Newly elected members of the AES Board of Governors include Laurel Cash-Jones, David Clark and John Strawn.

On the show floor

Although no official acknowledgment was made at the convention, rumors persisted on the floor about future merging of the AES and SMPTE conventions. Although many manufacturers expressed hope that such a merger would come to pass, most also were pleased with the traffic at the 93rd AES.

Several new digital audio recording formats were introduced at the show for 2-track and multitrack applications. Interestingly, trends toward *higher* (20-bit linear PCM) and *lower* (data-compressed) digital audio resolutions were in evidence throughout the convention. New digital mixing console technology was another standout area.

Editor's note: A brief summary of some of the new products introduced at the convention begins on page 28.

YOU NO LONGER HAVE TO BE AFRAID OF THE DARK.

JVC PROFESSIONAL

Every once in while a new video camera comes along that will set the standards by which all other cameras of its type will be measured against.

JVC presents its low-light, 2/3" 3-CCD, high resolution KY-27 video camera.

The KY-27 features JVC's exclusive LoLux technology, which enables the camera to shoot in available light as low as 2 Lux. The latest in the long line of technological firsts from JVC, LoLux combines 24dB of electrical gain with an additional 6dB, which is produced by JVC's unique CCD pixel readout system, for a total of 30dB. All without the noise and picture degradation normally associated with this degree of gain.

In addition to 750 lines of horizontal resolution and 62dB signal to noise ratio, the KY-27 boasts a full range of automatic features, such as enhanced ALC, Full-Time Auto White and Full Auto Shooting. And the camera performs equally well when docked to your favorite VTR, or in stand-alone ENG and studio configurations.

Once you're armed with the KY-27 you'll never be afraid of shooting in low-light conditions ever again.

For additional information please visit your JVC dealer or call **1-800-JVC-5825.**

Circle (16) on Reply Card

New product highlights from AES

Wireless receiver

By Lectrosonics

• **DR 195:** provides low distortion and signal-to-noise ratio; features two independent receivers blended in a ratio diversity design; two separate LED strips indicate the level of the incoming RF signals; expanded scale modulation metering; dual-band compander.

Circle (358) on Reply Card

Digital recording/editing system

By Digital F/X

• **Digital Master EX:** direct-to-disk digital recording/editing system; 4-channel, 16-track system provides true graphic waveform editing, SMPTE synchronization with chase lock; four independent digital/analog I/O; non-destructive editing feature allows edits to be undone; variable speed playback, record; 4-channel even playlist editing; DAT backup and restore with custom operating system; SCSI hard disk drives compatible with Atari STe computer with 4Mb of RAM.

Circle (356) on Reply Card

Universal sync generator

By NVision

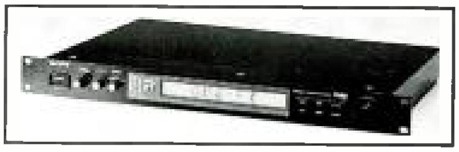
• **NV5000 series:** timing reference for NTSC and PAL video, AES/EBU and SDIF-2 digital audio; three digital audio sample frequencies; simultaneous outputs locked and available simultaneously; can function as a free-running master sync generator, or may be locked to an external 5MHz rubidium timing reference or external NTSC or PAL video source.

Circle (359) on Reply Card

Digital audio effects processor

By Sony

• **DPS-F7 Digital Dynamic Filter Plus:** produces sound effects with natural sound quality by using 10 powerful algorithms, such as parametric equalizer, exciter and dynamic switcher; offers 100 factory preset filter effects programs and 256 memories for user-created effects.



Circle (365) on Reply Card

Degausser

By Garner Industries

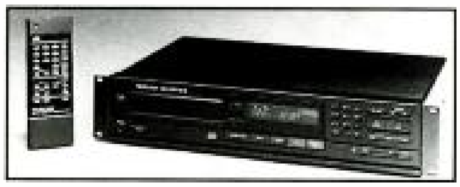
• **Model CF750:** satisfies the National Security/Central Security Service specification L-14-4-A for erasing Type II magnetic media; continuous duty degausser capable of erasing a wide rage of media, including S-VHS, 8mm and 3480 cartridges; will erase completely saturated 750Oe media to −90dB in 22 seconds.

Circle (357) on Reply Card

CD player

By Tascam

• **CD-401MKII:** rack-mount CD player; features cue to music and pitch control.



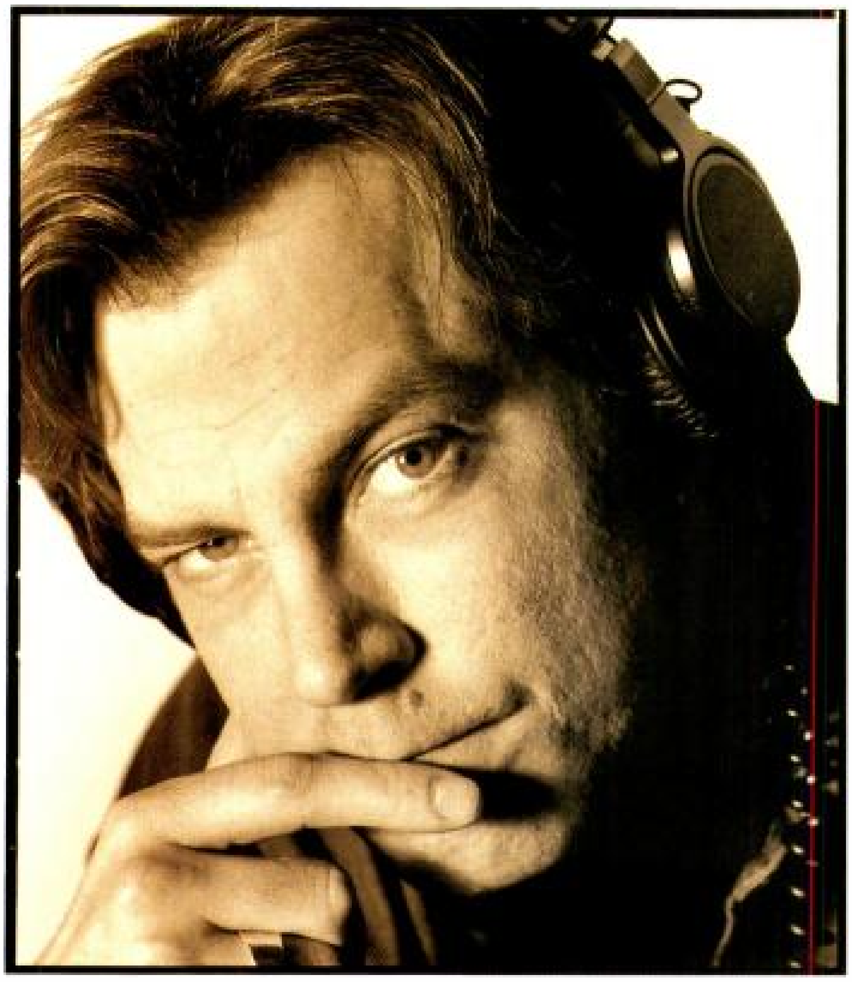
Circle (372) on Reply Card

Digital workstation

By Solid State Logic

• **Scenaria:** 38-channel digital audio/video editing system allows audio clip or time-code based dynamic automation on all channels of gain, stereo pan, 4-band

Continued on page 77



Using video test equipment

Look before you leap into any repair is the first step in maintaining video equipment.

By Mark Everett

The Bottom Line

Whether you are new to the video maintenance field or fairly well versed, sometimes it is advisable to sit back for a moment and examine the problem before you panic. After all, most equipment can be fixed. By troubleshooting and keeping aware of essential service instrumentation, you can stay one step ahead of the maintenance game.

$

Everett is product manager at Videotek, Pottstown, PA.

Problem solving and field service can be easy and even fun if you have the correct equipment, sufficient information and a positive attitude. Equipment, information and attitude are easy words, but they are often difficult and/or expensive to acquire.

Before you leap

Typically, the first rule of servicing is to look for the obvious. A close, cautious and meticulous visual inspection often will resolve the problem. Many engineers can recall their days of field service when they sometimes traveled hours just to flip a power switch on. Always check or replace the power cord, input and output cables and other interconnection cables. If you don't have spares available, trade cables from a known working device to a suspected broken one. Assume nothing. The videotape just might be clear mylar without any magnetic coatings. Believe it or not, it has happened.

Testing by substitution is usually quick and can provide meaningful results. However, substitution may require some test equipment. A color bar generator is a wonderful reference for cable continuity testing and monitor alignment. It also is a good substitute for almost any video-generating device. As long as the generator produces accurate and stable color bars conforming to NTSC, RS-170A or SMPTE standards, you can use it as a substitute for many sync generator functions.

Be prepared. Take time to learn how the bars from this generator look on the various pieces of equipment used in your system when everything is working properly. You might even record a sample for later performance evaluations. SMPTE color bars are useful for making quick evaluations of system performance. The test signal has low- and high-frequency components, so a coarse bandwidth analysis can be made. It produces specific colors to confirm system chroma phase settings. The saturation or color intensity gives a general indication of system gain over the "normal" frequency range.

Seeing the problem

The next piece of equipment you will need is a good scope. An oscilloscope is great for technicians or engineers who know how to use it, but dangerous in unskilled hands. A better choice for video troubleshooting is a TV waveform monitor and vectorscope. A variety of these units is available. Some are combination units with waveform and vector functions sharing the same screen. Unless a combo unit is available, use both waveform and vector-monitoring scopes, because many of the field problems encountered are color related. Problems with hue settings, color balance and saturation inaccuracies are virtually impossible to correct without a vectorscope. Know how your correct color bars look when displayed on the vectorscope. Furthermore, learn how to distinguish the yellow bar from the others, no matter where the phase or burst reference is located. The more you know about how your system looks and measures when operating properly, the better

The standard vector display shows chrominance amplitude and phase angles of SMPTE color bars.

Courtesy of Videotek

equipped you will be to isolate future problems quickly.

Is there a problem with white balance? If so, the center vector dot will appear as a large smear or will be offset in some direction away from the exact center of the vector display. Pointing a camera at something white and then filling the screen with that white should produce the single dot in the center of the vectorscope. The location of the vector dots, when referenced to their position with the color bar generator, can help solve other problems. The distance of each of the dots from the center of the display represents chroma saturation or color intensity.

If all of the dots are closer or further away from the center than the ideal target locations indicated by the graticule, then you probably have a problem with color gain. Before you make gain judgments, however, assess that the waveform or vector monitor is operating properly. Do not use a color bar chart and camera instead of a color bar generator in such tests. Although charts are appropriate in certain applications, lighting, camera adjustments and lens settings all affect the appearance of the color bar chart.

If roses are blue

Look closely at the vector display and you will see six boxes located around the screen. These boxes are marked for the three primary (R for red, B for blue, G for green) and three complementary (Mg for magenta, Cy for cyan and Yl for yellow) colors. You also can use something in a scene, light it well and fill the camera screen with the object to check the approximate color rendition. If you are pointing at a red sweater, for example, and the vector dot is heading toward the blue box, you know there is a phase error that must be corrected.

To solve such problems as the red of the sweater being blue, use the vectorscope to backtrack through the system, checking the output of each device until you locate the offending piece of equipment. It is safer to eliminate potential offenders than twisting knobs or replacing unrelated equipment before you gather information.

The waveform monitor is equally necessary and useful in assessing video problems. Knowing how color bars appear under normal circumstances helps to make judgments when things are amiss. A color bar display has sync, burst and active video. The active video includes gray, white and black portions, as well as the six colors. It also may include other color items in the lower third of the display.

A waveform display shows sync as the most negative going point (−40IRE) and the white bar at the most positive going point (+100IRE). The sync, black, gray and white bars are all low-frequency components of the entire signal. The color bars and burst are high-frequency components. Therefore, before a "low chroma" judgment can be made, the rest of the signal must be observed. Low chroma is noticeable in the waveform display when the color bar portion of the display is of lower than normal amplitude when the sync and white bars are at the correct amplitude. Chroma phase cannot be determined on a waveform monitor, so the vector display is still required.

Filters are located on the waveform monitor that allow for certain portions of the signal to be displayed. The flat filter is not a filter — the entire signal is displayed. The low-pass or EIA filter is a low-frequency filter that passes only low-frequency components and stops color information from being displayed. The chroma filter shows only chroma components and blocks the low frequency from the screen. These filters can assist in the viewing judgments described earlier.

Combination waveform monitor and vectorscope instruments allow added flexibility of viewing waveforms and vectors on the screen simultaneously. Perhaps the most obvious and useful display is one with a flat filter, the second with a low-pass filter, the third with a chroma filter and finally a vector display — all overlaid. This is a complete way to view the traditional color bars in an almost traditional fashion.

Be prepared

Certainly, there are other test signals and other test devices that all have a purpose and an appropriate use. The items mentioned in this article represent a minimum list of problem-solving equipment you can use when assessing video equipment. Obtain a complement of test equipment and learn how to use it *before* an emergency strikes. If and when an emergency does occur, stay calm, use some common sense and any problem can be solved.

➡ *For more information on video test equipment, circle Reader Service Number 301.* ■

CABLE OPERATORS, BROADCASTERS, NEWS DIRECTORS, FACILITY DESIGNERS, TELEPRODUCTION HOUSES AND EVENT VIDEOGRAPHERS ALL AGREE ON ONE THING:

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Since 1986, Sony has led the way in digital video recording. We've developed a host of advanced features never before achieved in video recording, like multi-generational transparency, pre-read editing, 4 digital channels of CD-quality audio, elimination of moiré and signal dropouts, and more. In a remarkably short time, the success of these revolutionary recorders has shifted the entire industry to a new direction: the path to digital video recording.

Which Way Should You Go?
Everyone now agrees digital video is the way to go, but what's the best way to get there? The road is littered with complex considerations.

Is this the right time to make the move? Can you move step-by-step? Is composite or component the better choice for your application? Which format is best? How does digital fit into your existing analog facility? Is digital right for every application?

These questions may seem daunting, but the answer is quite simple: Sony.

Follow Our Lead.
Sony pioneered digital video technology. No other manufacturer can offer more experience. Not only did we create the first commercially available digital recorders, but both our D-1 component and D-2 composite recorders have been refined in our advanced, second generation series of products.

Sony D-1 recorders set the standard for digital recording; our D-2 recorders have been embraced as the industry standard. And, the newly developed Serial Digital Interface is rapidly becoming the standard for connectivity.

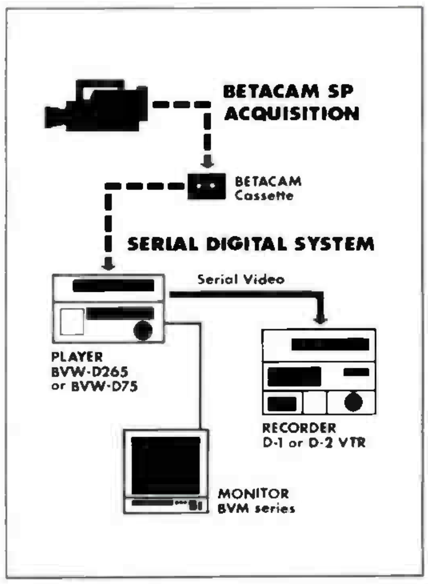
What's more, the Sony D-1 and D-2 formats form the core of a large community of digital video users. So exchanging materials is simple and easy.

D-1: Setting The Standard For Digital.
With the introduction of our D-1 component digital recorders, Sony unveiled the digital universe. Today, D-1 defines the state-of-the-art in uncompromising component video production.

The latest generation of D-1 products combines the highest quality digital recording with

THE BVW-D75 (PICTURED) AND THE BVW-D265 ARE A SIMPLE WAY TO GO DIRECTLY FROM ANALOG COMPONENT VIDEO TO EITHER COMPONENT OR COMPOSITE DIGITAL SYSTEMS.

THE NEW BETACAM SP RECORDERS GIVE YOU DIRECT INTEGRATION INTO YOUR SERIAL DIGITAL SYSTEM.



simplicity of operation and affordability. The new DVR-2000 Player/Recorder features Automatic Playback Equalization. For improved operating performance, it has an Error Checking and a Logging system, as well as Periodic Maintenance Prompting. And for fast, convenient machine set-up, the DVR-2000 features eight Custom Menu Presets.

The DVR-2100 features all the advancements of the DVR-2000 plus Sony's exclusive Dynamic Tracking® feature to provide production quality playback from –1 to +2 times normal speed for added creative capability.

If your move to digital requires the ultimate in quality and performance, Sony D-1 is the clearest route.

THE ULTIMATE IN QUALITY AND PERFORMANCE, D-1 DEFINES THE STATE-OF-THE-ART IN COMPONENT DIGITAL VIDEO PRODUCTION.

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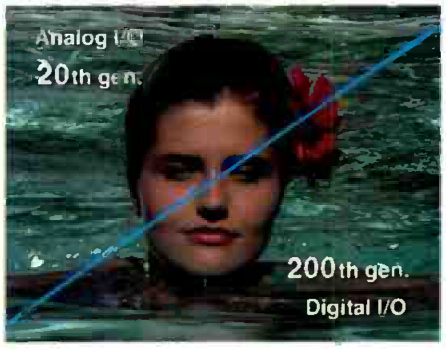
D-2: The Industry Standard. Sony D-2 has been characterized as the composite digital workhorse. Whether you select the DVR-20 or DVR-28, D-2 offers digital quality in a compact, easy-to-use package well-suited for the composite video environment.

As with D-1, D-2 products have been significantly refined in the new second generation line. For super responsive jog and shuttle, the advanced transport incorporates Ultrasonic Guides. To make editing easier, Digital Jog Sound provides frame-accurate digital audio recovery in the jog mode. And Automatic Equalization and Automatic Edit Tracking, combined with the Error Logger, make D-2 user-friendly and trouble-free.

In fact, D-2 is so easy to use it has become the de facto standard for composite digital production.



WITH NO VISIBLE DIFFERENCE BETWEEN 20th GENERATION ANALOG AND 200th GENERATION DIGITAL, THE ADVANTAGES OF DIGITAL ARE MORE THAN CLEAR. (ACTUAL IMAGE GENERATED FROM SONY D-2.)

For More Detailed Directions To The World Of Sony Digital Video, Get The Book.

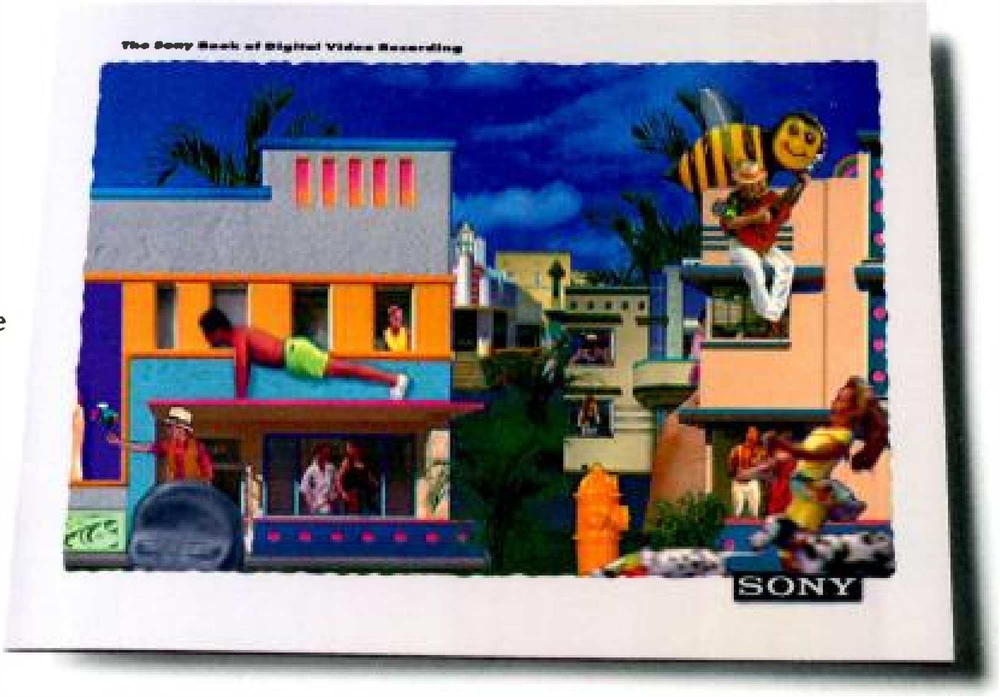
You Can Get There From Here.
Whichever path to digital is the right one for you, Sony can show you the way by offering the most extensive, most flexible line of digital video recorders available today. Whether D-1 or D-2 is the appropriate choice, Sony makes it easier for you to get there.

There's no better way to ensure top quality in your video production than by starting with the highest quality recorded image. The best format for video acquisition is still component. So why invest in lesser quality?

Thanks to our newest Betacam SP® recorders with digital inputs and outputs, your current Betacam SP camcorder is all you need to start the digital production process. The BVW-D75 Recorder/Player and the BVW-D265 Player can convert your component analog video signal directly to either component serial digital or composite serial digital, respectively. So no matter where you're headed in the digital world, Sony can take you there.

And, in addition to D-1 component and D-2 composite digital VTRs, Sony offers a complete family of digital switchers, digital routers, digital multi-effects and digital/analog converters. And now we have the Serial Digital Interface to put it all together.

So no matter when, where or how you decide to move to digital, Sony is ready to get you there.



Actual image generated from Sony D-1

Make The Right Connections.
To make it easier to work in the digital world, Sony helped develop Serial Digital Interface (SDI).

SDI uses nothing more than a familiar coaxial cable for digital to digital interconnection between composite and/or component devices. It allows for quick, easy and efficient connection. It even allows analog VTRs (such as Betacam SP products with SDI inputs and outputs) to be readily integrated into digital production systems.

SDI sounds simple to use. And it is. It's the product of years of research spearheaded by Sony. The result: wiring, connecting and timing a digital video suite has become simple to achieve.

You've now read just the beginning of the Sony digital video story.

Sony provides just about everything you'll need for the journey into digital recording. Whether you're just getting started or well on your way to a full digital system, we're on hand to help you go the distance. And only Sony offers such an unparalleled reputation for product quality and reliability plus experience and support.

If you'd like more details, call 1-800-635-SONY, ext. 814. We'll send you the Sony Book of Digital Video Recording.

We think you'll find it compelling reading. And further proof that, on the road to digital, the best companion you can have is Sony.

Digital frame produced by Forti-Layne Entertainment in cooperation with Limelight Video.

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ficiency, temperature rise and manufacturer's airflow requirements. Other factors worth considering are ambient air pressure (as dictated by altitude), average and extremes of climate, site accessibility, building materials, surrounding topography and adjacent land use.

Figures 1, 2 and 3 depict three of the most common configurations for RF facility airflow design. Each layout has merit for particular applications.

The closed system

Figure 1 describes a site layout that works well in all climates, as long as the transmitter is small and the building is sealed and well-insulated. In fact, this closed configuration will ensure the longest possible transmitter life and lowest maintenance cost, because it is completely closed. No outside air laden with moisture and contaminants circulates through the transmitter.

Sites using this arrangement have observed that periodic transmitter cleaning is seldom required. In a typical closed system, the air conditioner is set to cool when the room temperature reaches 78°F to 90°F. This setting is not particularly critical, and is determined by your station's willingness to trade off electrical usage for comfort. Although most broadcast transmitters are rated to operate in ambient air of up to 122°F, long-term operation above 95°F is considered unwise.

> ***Proper air handling makes the difference between a low-maintenance site and a perpetually troublesome facility.***

The closed system also uses a louvered emergency intake blower, which is set with its own separate thermostat to pull in outside air if the room temperature reaches 95° to 100°F. This blower is required in a closed configuration to counteract the possibility of *thermal runaway* should the air conditioner fail. Without such an emergency ventilation system, the transmitter would recirculate its own heated air as the room became hotter.

During winter months the closed system is self-heating (unless the climate is harsh or the transmitter is particularly small), because the transmitter's exhaust is not ducted outside, but simply empties into the room. Also during these months, the emergency intake blower can be used to draw cold outside air into the room instead of using the air conditioner, although this negates some of the cleanliness advantages inherent to the closed system.

An exhaust blower should not be substituted for an intake blower, because positive room pressure is desired when venting the room in any way. This ensures that all air in the room has passed through the intake air filter. Furthermore, the louvered emergency exhaust vent(s) should be mounted high in the room, so hot air is pushed out of the building first.

The closed system usually makes economic sense only if the transmitter's exhaust heat load is manageably small. A typical 1kW solid-state AM transmitter will produce approximately 800W or 2,730 BTUs of heat energy (combining exhaust and cabinet-radiated heating). Add this BTU figure to your local HVAC consultant's recommendation for cooling your building in your area, and you likely will have a modest air-conditioning requirement.

A typical 5kW solid-state AM transmitter will produce no more than 4kW in combined exhaust and cabinet heat, or 13,650BTUs. Adding in your building cooling requirements will still result in a feasible air conditioner size in all but the hottest environments.

FM transmitters also can be economically cooled in a closed system up to the 5kW TPO level. In power levels above that, less-expensive, outside air ventilation systems are customarily used (as will be described).

Periodic maintenance of a closed system involves checking and changing the air-conditioner filter periodically, cleaning the transmitter air filter as needed, checking that the emergency vent system works properly, and keeping the building sealed from insects and rodents.

The open system

Figure 2 depicts a site layout that is the most economical to construct and operate. Its main attribute is that no cooling or heating is done to the transmitter's air supply.

This is not a closed system; outdoor air is pumped into the transmitter room through air filters. The transmitter then exhausts the hot air back outside. If the duct work is kept simple and the transmitter has a definite exhaust port, this direct exhaust system works adequately. Many transmitters do not lend themselves to a direct exhaust connection, however, and a hood must be constructed over the transmitter to collect hot air. In a hooded arrangement, it is often necessary to install a helper fan in the system, typically at the wall or roof exit, to avoid back pressure.

When designing the transmitter room with open ventilation, there is the option of installing an isolation wall and an air conditioner. The wall serves to separate conditioned air from non-conditioned air. Separating the room results in a cleaner environment for the conditioned area, because large volumes of outside air will not be passing through it.

> ***Besides electrical damage, a transmitter's worst enemies are dirt, dust, airborne chemicals and moisture.***

When building either the open system or the hybrid arrangement shown in Figure 3, there are some important addition-

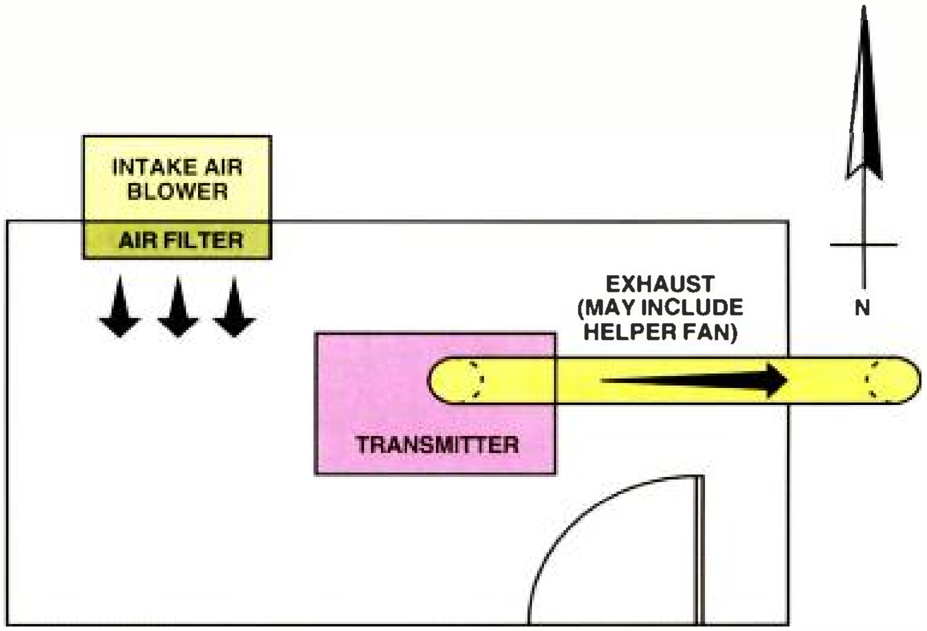

Figure 2. *An open ventilation plan, using no air conditioning.*

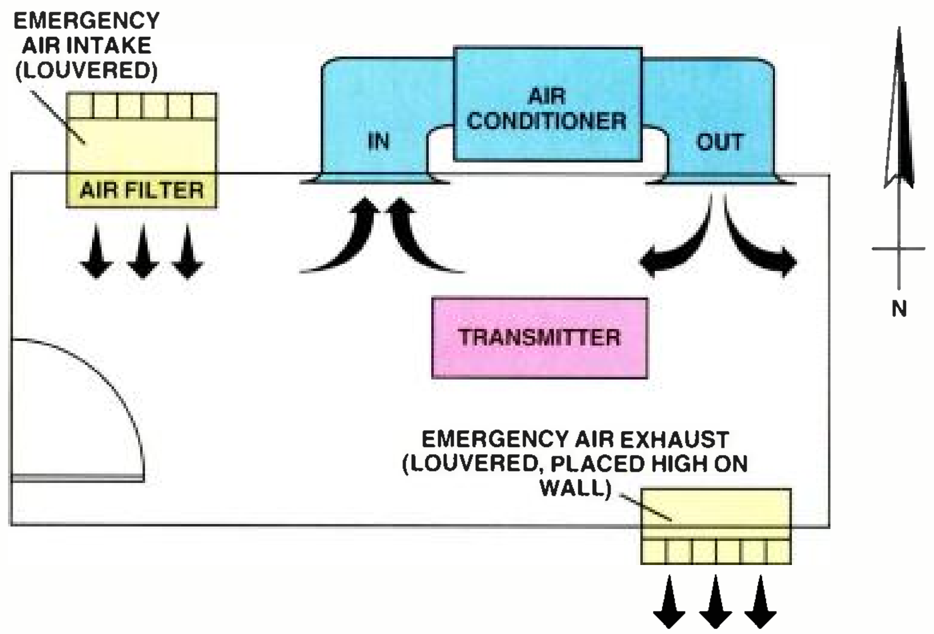

Figure 1. A closed ventilation design, with backup inlet/outlet system.

ter is its *quantity*. Average transmitters are not specifically designed to bring outside air into the transmitter building or exhaust this air out of the building on their own power. Rather, they are designed with the assumption that ambient air will be available at adequate volumes and pressure, and that their exhausting of heated air will either be unimpeded or assisted by outside means. Additionally, for transmitters employing power tubes, the service life of a tube is directly related to its filament temperature. Filament voltage management efforts are quickly undone by inadequate airflow across the base of the tube. Elevated temperatures here will shorten tube life.

The second desired attribute of air delivered to a transmitter is *cleanliness*. This implies freedom from dust and other particulates, as well as freedom from excessive moisture. Other than direct electrical damage, a transmitter's worst enemies are dirt, dust, airborne chemicals and moisture. Although the transmitter's own air filter may capture a lot of common dirt and dander, smaller particles can pass easily into the transmitter. Once inside, this fine dust often tends to collect in places where its potential for damage is the greatest. The accumulation of foreign matter on transmitter parts, especially tube sockets and fins, seriously degrades their heat-transfer properties. This means that for a given amount of airflow, less actual cooling of the components will occur, and operating temperatures will rise. (When applied to transmitter dirt, Murphy's Law further stipulates that any dirt collecting on a conductor will act as an insulator, and any dirt collecting on an insulator will act as a conductor.)

Numerous factors enter into the airflow design considerations for an RF facility. Obvious items include transmitter size, ef-

Airflow and cooling in RF facilities

There's more than one way to keep the transmitter cool and clean.

By Kirk Harnack

The Bottom Line

Many equipment failures and repair expenses are caused by transmission equipment choking in dust and suffering through intolerable temperatures. Yet, nearly all of these problems can be prevented with a good ventilation system. Whether constructing a new RF facility or improving an existing one, proper attention to airflow will pay off in reduced maintenance costs, less downtime and longer equipment life. Ventilating in the most appropriate way for your facility and climate can keep operating expenses down as well. $

Harnack is president of Harnack Engineering, a contract engineering firm in Memphis, TN.

When William Wordsworth wrote, "An ampler ether, a diviner air," he wasn't making a pun about broadcast transmission facilities, but he couldn't have put it any better if he had been. The importance of air handling in a station's RF facility is second only to proper electrical operation of the transmitter. Other factors held equal, proper air handling and cooling can mean the difference between a long-lived, low-maintenance transmitter site and a perpetually troublesome facility.

As broadcast engineers, it is incumbent upon us to design or improve these RF facilities for optimum air handling and cooling characteristics, thus maximizing the endurance of the transmitter and other equipment, Done properly from the beginning, the dollars invested will pay short-term and long-term benefits in reduced maintenance and downtime. This premise is confirmed repeatedly when checking the reliability record of various transmitter sites against their relative merits for good airflow, filtration and conditioning.

Valuable airflow information can be found in some manufacturers' technical and installation manuals. Although usually not written as a complete discourse, details regarding ambient temperature stipulations and limits on altitude and back-pressure values are often provided. It is the responsibility of the station engineer — through proper site design — to ensure that the manufacturer's airflow criteria are met or exceeded.

Any broadcast transmitter generates a certain amount of heat in the process of creating and amplifying the desired signal. For transmitters of typical radio broadcast power levels, this heat is dissipated by forcing air over hot surfaces within the unit. Fans and blowers in standard transmitters are designed to pull ambient air into the transmitter cabinet, blow it across heat-transfer devices (heat sinks and/or tube fins), and exhaust it outside the transmitter's cabinet. The purpose of this article is not to specify particular blower, duct, and air handler sizes for your installation, but it will show you various real world scenarios for ventilation system layout and other considerations.

The importance of air handling is second only to proper electrical operation of the transmitter.

Design

The primary goal of designing an airflow system for a new transmission facility is to provide maximum effectiveness for the lowest long-term cost. The term *maximum effectiveness* relates to how well a given system delivers the desired quantity and quality of airflow. *Lowest long-term cost* entails capital investment and recurring costs.

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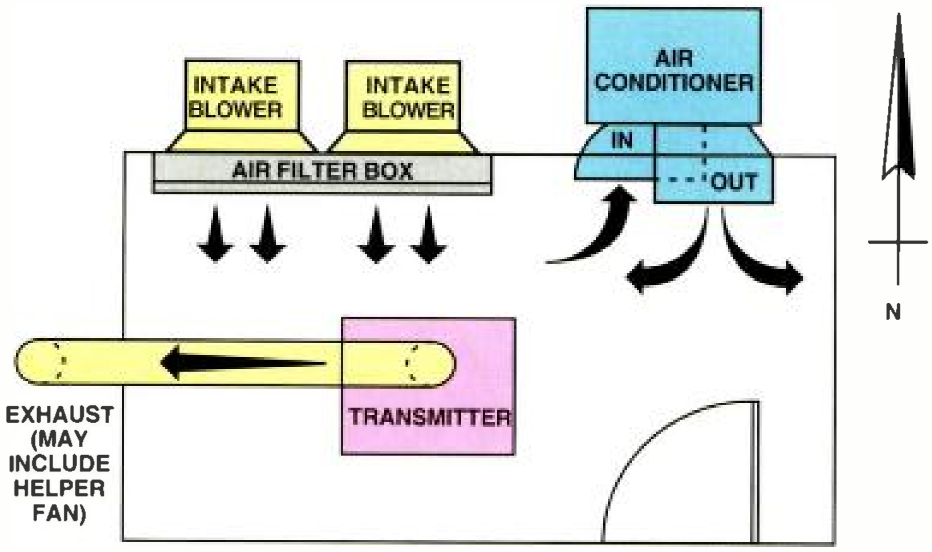

Figure 3. *A hybrid approach, with air conditioning in addition to filtered outside air.*

al considerations:

The room must be positively pressurized so that only filtered air, which has come through the intake blower and filter, is available to the transmitter. With a negatively pressurized room, air will enter through every hole and crack in the building, and will not necessarily be filtered. Under negative pressure, the transmitter's blower also will have to work much harder to exhaust air.

The intake blower should be a "squirrel cage" type rather than a fan type. A fan is meant to move air within a pressurized environment — it cannot compress the air. A squirrel cage blower will not only move air, but also will pressurize the area into which the air is directed. Furthermore, the intake air blower must be rated for more cubic feet per minute (CFM) than what the transmitter will exhaust outside. A typical 20kW FM transmitter will exhaust 500CFM to 1,000CFM. In that case, a blower of 1,200CFM would be an appropriate size to replenish the transmitter exhaust and positively pressurize the room.

As broadcast engineers, it is incumbent upon us to design or improve these RF facilities for optimum air handling and cooling characteristics.

In moderate and warm climates, the intake blower should be located on a north-facing outside wall. If the air intake is on the roof, it should be elevated enough so that it does not pick up air heated by the roof surface.

Use high-quality, pleated air filters, or if space and budget allow, a bag filtration system. Home-style fiber-glass filters are not worth their lower price in this case. Local conditions may warrant using a double filtration system, with coarse and then fine filters in series.

Get advice from a knowledgeable HVAC shop when designing filter boxes. For a given CFM requirement, a larger filtration area will result in a lower required air velocity through the filters. This lower velocity will then result in better filtration than would forcing more air through a small filter. In addition, the filters will last longer. Good commercial filtration blowers designed for outdoor installation are available from industrial supply houses, and are readily adapted to RF facility use.

Transmitter exhaust may be ducted through a nearby wall or through the roof. Avoid ducting straight up, however. Many stations have suffered water damage to transmitters in such cases because of the inevitable deterioration of roofing materials. Normally, ducting the exhaust through an outside wall is suitable. Be sure to bend the duct work downward a foot or two outside the building to keep direct wind from creating back pressure in the exhaust duct. Minimize all bends in the duct work. If a 90° bend must be made, be sure to use a large-radius bend and install curved helper vanes inside the duct to minimize turbulence and back pressure. Never make a 90° L- or T-bend without oversizing it and using internal vanes to assist the turning airflow. A competent HVAC shop can help you choose the right duct size for your application.

For moderate and cool climates, an automatic damper can be employed in the exhaust duct to direct a certain amount of hot exhaust air back into the transmitter building as needed for heating. This will cut down on outside air requirements, providing clean, dry, heated air to the transmitter when it's cold outside.

The hybrid system

Figure 3 depicts a hybrid site layout that is often used for high-powered transmitters or sites with multiple transmitters. As with the layout in Figure 2, the room is positively pressurized with clean filtered air from the outside. A good deal of this outside air is then drawn through the air conditioner to cool it for delivery to the transmitter area. Although not all of the air in the room goes though the air conditioner, enough does to make a difference in the room temperature. In humid areas, much of the moisture is removed by the air conditioner. The transmitter's exhaust is directed outside in this case.

This hybrid system is often the choice for larger transmitter sites where a closed system would prove too costly, but an unconditioned system would run excessively hot during the summer months.

Some closed or hybrid systems use *two* parallel air conditioners. Most of the time, only one is in use. The two units' thermostats are staggered slightly so that if one cannot keep the air below 90°F, the other will turn on to assist.

Materials

Many transmitter sites are built of materials that tend to release dust inside the building. Particularly troublesome are buildings with unsealed or unpainted concrete walls and floors. Carpets and rotting ceiling tiles also are sources of dust.

Efforts to seal a building and make it as dust-free as possible pay off well in reduced equipment trouble. Concrete sealer and paint are inexpensive and easy to apply once the surfaces are cleaned. An older building can be sealed inside by installing dust-free white paneling (the kind used in the bathrooms at many fast-food restaurants) and sealing the seams and corners with caulk.

Paying attention to these construction and ventilation details when designing or remodeling will undoubtedly increase the mean-time between failure (MTBF) at your transmitter site. It also makes good economic sense because maintenance costs are reduced and equipment lifespan is increased. Most importantly, it keeps the station on the air consistently and reliably, under whatever conditions the environment may present.

➡ *For more information on airflow and cooling equipment, circle Reader Service Number 302.* ■

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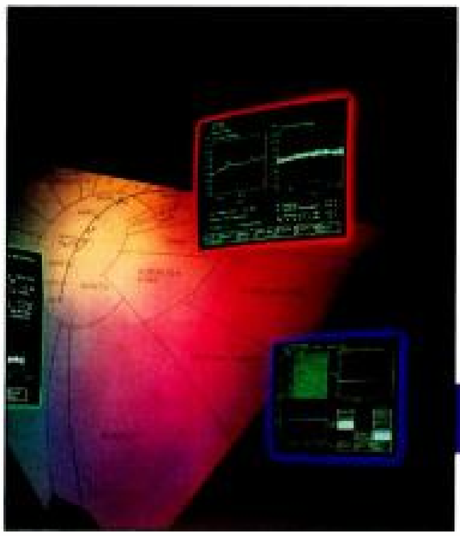


Performance testing of digital audio equipment

The new AES digital audio testing standard is reviewed and explained.

By M. Raymond Jason

The Bottom Line

As broadcasters continue to upgrade their facilities, new digital audio equipment represents a significant and continuing investment. To maximize the impact of these new purchases and to maintain their value, appropriate maintenance must be applied. Now, a new standardized set of procedures for testing the performance of digital audio has been established, and broadcast engineers must become conversant with it. Without such understanding, the full promise of digital audio systems will never be realized.

$

Jason is an electronics engineer at National Public Radio, Washington, DC.

The Audio Engineering Society (AES) took a big step late last year toward making the digital side of audio engineering easier. It published the "AES Standard Method for Digital Audio Engineering: Measurement of Digital Audio Equipment," AES17-1991. For the first time, engineers have authoritative guidance on how to judge the objective performance of CD players, DAT recorders and open-reel digital recorders, along with many other types of digital gear.

Most of the tests described in AES17 can be performed with high-quality *analog* test equipment. What we most often care about, after all, is how the real analog audio on the output compares to the audio input to a device. True digital-domain testing (using generators and analyzers that work with digital code rather than analog voltages) is needed only for a few areas: characterizing D/A or A/D converters, and testing digital inputs or outputs.

Perhaps the most important motivation for the new standard is the consideration that digital audio, as currently implemented, exhibits different strengths and weaknesses than analog audio. Because the goal of performance testing is to locate the perceptually relevant bounds of equipment operation, appropriate test strategies must be developed that pertain to the weaknesses you are trying to expose.

This review of AES17-1991 is *not* a replacement for the standard. It is meant to be an introduction and a guide to the tests it includes and what equipment you'll need. See the references listed at the end of this article for obtaining the actual standards documents.

AES17-1991 overview

The standard is organized into three major sections. The introduction describes the scope of the standard, measurement conditions and technical definitions. (The definitions are invaluable in their own right, providing a common language for discussion of digital equipment.) The body of the standard details specific tests, while the final section provides normative (integral to the standard) and informative (tutorial) references.

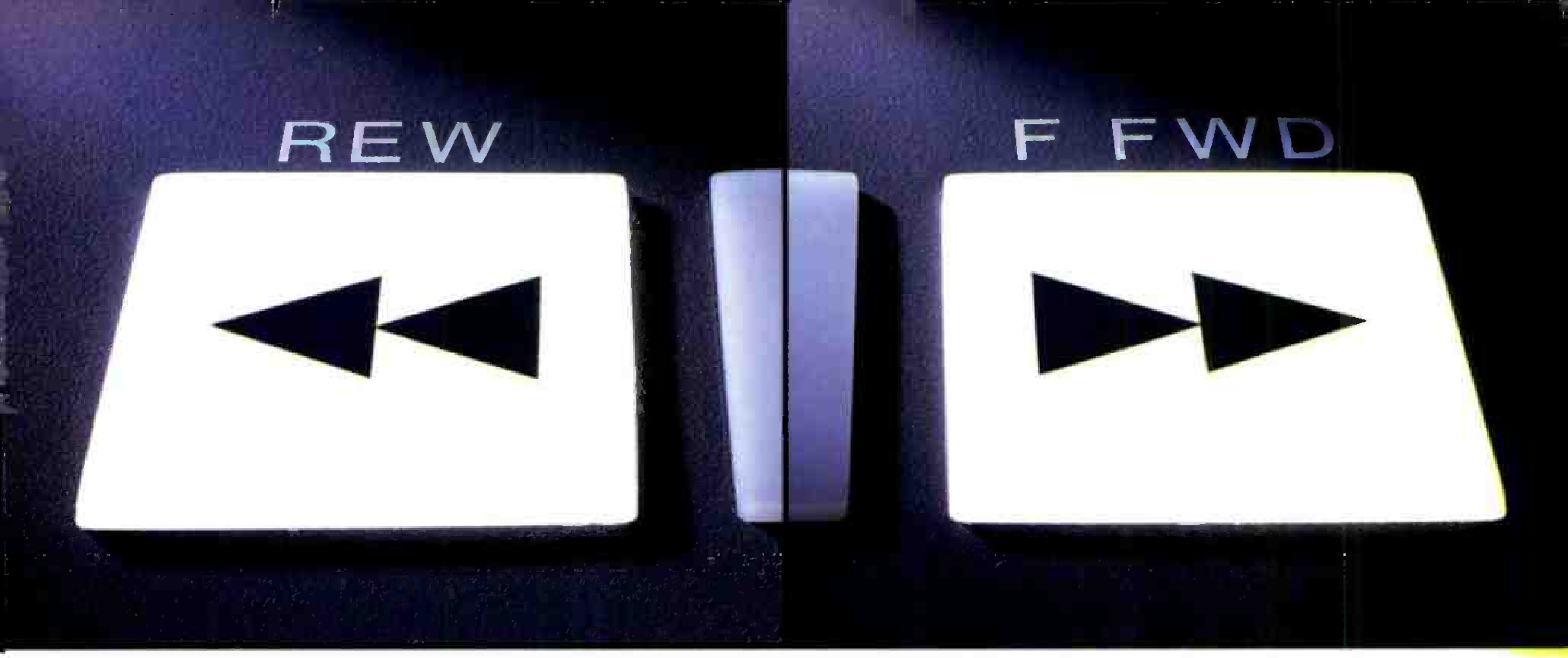
Excluded from the standard are low-performance voice-grade digital equipment and reduced-bit-rate perceptual coders. Likewise, the standard provides no guidance for testing digital reverberators, pitch-shifters or equalizers. Some of these devices may receive coverage in future supplements. Tests for clock jitter artifacts, absent from the current standard, will be added.

The current version of the standard also fails to directly address the equipment manufacturer's task of writing specifications for digital gear. Future revisions may include better coverage of this important area.

Setup requirements

AES17 specifies ambient temperature (23 ± 5°C, or 73 ± 9°F), power-line voltage (within 2% of nominal), power-line frequency (within 1% of nominal), and device-under-test (DUT) warm-up period (30 minutes).

Test equipment must be state-of-the-art (see Table 1), and must perform "at least three times better than the specification being verified." This means, for example, that if a DUT's THD+N is specified as



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Residual distortion	≤ (DUT spec)/3 (see text)
FILTERS	
Weighting	CCIR 468-4
Third-octave	ANSI S1.11-1986
Notch	$1 \leq Q \leq 5$
Standard low-pass	Passband response deviation ≤ ±0.1dB, 10Hz ≤ f ≤ UBEF* Stop-band attenuation > 60dB, f > 1.2 × UBEF*
Standard high-pass	Passband response deviation ≤ ±0.5dB, 1.3 × UBEF* ≤ f ≤ 200kHz Stop-band attenuation ≥ 40dB, 10Hz ≤ f ≤ UBEF*

*UBEF = upper band-edge frequency

0.001%, your generator plus analyzer must exhibit no greater than 0.00033% THD+N. Clearly, AES17 demands flexible, high-quality test gear. Furthermore, the standard may serve well as a set of guidelines (or help in justification) when upgrading your test equipment.

The standard provides no explicit recommendation for preferred operating level, although −20dBFS (20dB below digital full scale) is used for several of the tests.

The tests

The 39 tests described in the body of AES17 are organized as follows: input characteristics, output characteristics, linear response, amplitude non-linearity, signal-to-noise measurement and crosstalk/separation.

Figure 1 is a block diagram of a typical digital audio system. Keeping such an im-

Table 1. Test equipment requirements for AES17-1991. To measure today's high-quality digital audio gear, only state-of-the-art test equipment will do. AES17-1991 does not mandate automated generators and analyzers. However, many of its tests would be impractical without them.

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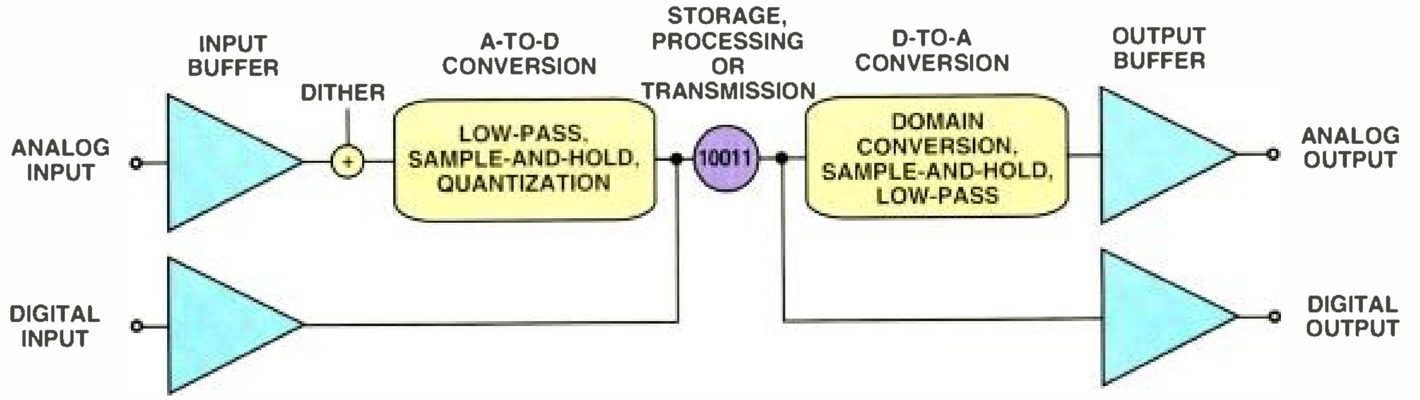

***Figure 1.** Block diagram of a typical digital audio device, including analog and digital ports. (Playback-only devices, such as CD players, reflect only the right half of the diagram.)*

age in mind will help you stay on track when navigating the depths of AES17. Figure 2 illustrates a typical test setup. Note that each element in Figure 2 may be analog or digital, depending on the domain(s) in which the tests are being performed.

Input characteristics

Although aliasing is a characteristic of analog-to-digital conversion and would most directly be measured at the digital outputs of a DUT, AES17 permits analysis in either the analog or digital domain. Aliasing performance can be measured using the DUT's analog ports by first applying 997Hz at −20dBFS to establish an output reference. Then, sweep the input from the upper band-edge frequency (typically 20kHz) to at least four times the sampling frequency. Filter the DUT's output with a standard low-pass filter and a notch tuned to the input signal. Report the rms level of aliasing components in decibels relative to the reference.

AES17 also includes tests for ADC overload (or rollover) behavior, analog input amplitude that produces digital full scale, maximum input amplitude before clipping and *input logarithmic-gain stability* (input gain stability measured in decibels). The latter's inclusion in AES17 was based on a common failing of early ADCs — wide gain variation with temperature. Today, this is much less of a problem, but the test remains useful for older equipment.

Output characteristics

The other half of a digital recording system, and the essence of CD players, is the conversion of a list of numbers back into high-quality audio. Points of interest regarding objective performance in this area include the digital-to-analog converter (DAC), the anti-imaging filter (digital plus gentle analog low-pass in the case of

oversampling circuits, or analog brick-wall for multibit PCM), output de-glitching sample-and-hold circuits, and the output buffer.

The first test in this section of the standard, *out-of-band spurious components*, measures the rms summation of all voltages present above the upper band-edge frequency, at the analog output, with no signal fed to the DUT. The standard recommends (but does not require) spectral analysis. To test *suppression of imaging components*, use the same test setup, but apply nominal-level tone (−20dBFS), sweeping from 10Hz to 10kHz (or to half the upper band edge, if lower than 20kHz). Notch out the input frequency at the DUT output. Report the total rms output signal above the upper band edge as a function of input frequency. Again, the standard leaves spectral analysis optional.

AES17 concludes this section with procedures for measuring output level and temperature stability, and calls for reporting of the DUT's digital audio output format, such as AES3-1992.

Linear response

This section of AES17 is where you'll find tests for frequency response, single-channel phase response, interchannel phase response, group delay, absolute delay through a device and absolute polarity. Also included is a test for *maximum signal level vs. frequency*, the result of which is a graph of maximum input level meeting a user-specified THD+N at the output, as a function of input frequency, across the audio band.

In all cases, you can perform measurements in this section using the DUT's analog inputs and outputs. Because many digital systems employ high-frequency pre-emphasis to improve their noise specification, use −20dBFS input signals to prevent overload. Test frequency response from 10Hz to the upper band-edge frequency.

AES17 recommends direct measurement of phase response, using fast Fourier transformation of pseudorandom noise or impulses. Phase measurement by observation of input and output sine waves on an oscilloscope is acceptable for DUTs that process audio in real time. To use this method, subtract DUT input-to-output time delay from the observed phase shift.

Amplitude non-linearity

Any deviation from level linearity (*level-dependent logarithmic gain*) is exhibited as a variation in the input-to-output gain of a DUT as a function of signal input level. The standard calls for separate measurements of A/D and D/A stages, and therefore requires digital-domain testing except for CD players, whose signal source is a test disc.

Intermodulation (IM) measurements include a primary 1:1 twin-tone test with one tone at the upper band-edge frequency and the other tone 2kHz below. Measure the rms sum of the second- and third-order difference frequency components as seen on a spectrum analyzer or through a 1/3-octave filter. A secondary test is described, analogous to the SMPTE 4:1 twin-tone measurement, employing 41Hz and 7,993Hz tones.

Finally, this section offers (read this carefully) a test of *modulation noise* and a test of *noise modulation*. In the first test, *signal modulation noise*, amplitude modulation sidebands are measured by feeding a −5dBFS sine wave at 0.4999 times the upper band-edge frequency. Full-wave rectify the DUT output, then measure using 1/3-octave filtering from 50Hz to 500Hz; display the result graphically. *Low-level noise modulation* measures modulation of the noise floor in 1/3-octave bands from 200Hz to 20kHz. Vary a 41Hz input signal in 10dB steps from −40dBFS down to

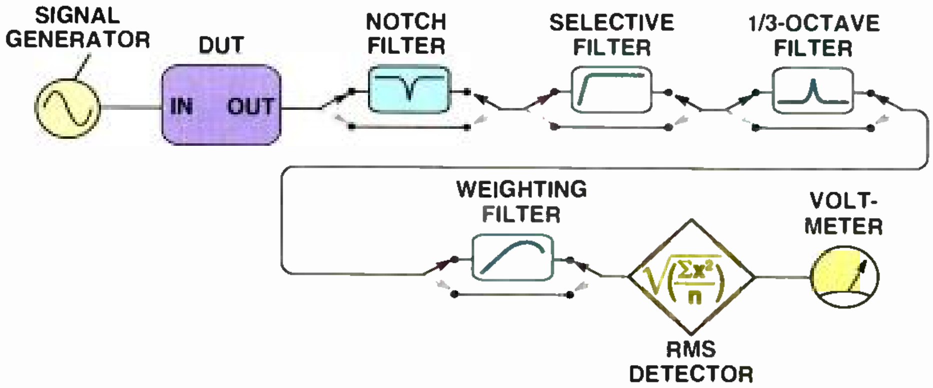

Figure 2. *Setting up for testing digital gear is similar to analog testing. Note, however, that each element in the illustration may be analog or digital, depending on the domain(s) in which you're performing the tests.*

the idle-channel noise level. Notch the output at 41Hz. Report the maximum noise modulation, in whatever ⅓-octave and between whichever amplitude steps it occurs.

Tests for harmonic distortion plus noise did not make it into the first issue of the standard, although some standard's committee-approved text "to appear in a future draft revision" was included as an annex.

Signal-to-noise measurement

So-called *idle-channel noise* is the CCIR-weighted, rms DUT output with no signal present. If using the analog input, electrically terminate it. If using the digital input, apply *digital zero* (all 0s, or silence). Report idle-channel noise in units of dBFS CCIR-RMS.

To measure the *idle-channel noise spectrum*, use the same setup, but filter the DUT output in ⅓-octave bands from 20Hz up to the last ISO center frequency below the upper band edge. Report levels in dBFS.

The digital version of a classic signal-to-noise (S/N) ratio test differs from analog S/N in that the noise of a digital device is measured in the presence of signal. Apply a 997Hz sine wave to achieve −60dBFS at the DUT output. Using a notch filter to remove 997Hz, bandlimit the output to the upper band-edge frequency, and filter it with the standard weighting filter. Report digital S/N in dBFS CCIR-RMS.

AES17 offers an optional procedure for reporting power-line (mains) related noise products. Set up according to the previous test, but add a 400Hz high-pass filter on the DUT output; report the decibel difference between this reading and the noise level without the high-pass filter.

Crosstalk and separation

Separation is the absence of crosstalk from one stereo channel to another. AES17 points out that measurement methods for the two are identical, and thus provides a single procedure for both.

The *interchannel crosstalk and separation* test is essentially identical to normal analog practice, with the exception that the user may choose to test at the digital inputs and outputs. The standard calls for an input signal level of −20dBFS, and for tuned ⅓-octave filtering of the output of the undriven channel(s) prior to measurement.

Non-linear interchannel crosstalk measures intermodulation products in the "measured" channel (which is fed a −20dBFS sine wave) caused by crosstalk from the "driven" channels (all the remaining channels of the DUT, with inputs tied together and overdriven at +3dBFS by a different frequency). Separate procedures are given for high- and low-frequency effects. This test requires two separate signal generators.

Finally, *input-to-output leakage* measures feedthrough of signal present at the input of a DUT, such as a recorder, when the DUT is in playback mode. Feed a full-scale sine wave to all input channels simultaneously while the DUT's output is set to digital zero. Measure each output channel, using ⅓-octave filtering, while sweeping the input from 10Hz to the upper band-edge frequency.

In the 1990s, the authors of AES17-1991 have led us to another milestone in audio engineering. This era has its share of strange new devices, from DAC to DSP, and samplers to synchronizers. It's up to each of us, through continuing education and putting new standards, such as AES17-1991 into practice, to carry on or be left behind.

References

To ensure that your methods are fully in accord with AES17-1991, you should acquire a copy directly from the Audio Engineering Society, 60 East 42nd Street, New York, NY 10165-2520; 800-541-7299. The standard relies on, and so you should also obtain, the following normative references: AES3-1992, ANSI S1.11-1986, CCIR Recommendation 468-4 (1986), and IEC Publication 268-3 (1988). The non-AES references listed are all available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036. Attention: Customer Service, 212-642-4900.

➡ *For more information on digital audio test equipment, circle Reader Service Number 303.*

■

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Maintaining proper SC/H phase

Keep errors to a minimum by carefully monitoring SC/H phase.

By Eric Wenocur

The Bottom Line

Time is running short. The videotape you've been editing is almost finished. With two hours to air, you only need to add closing titles. Then, to your horror, you discover that the video jumps horizontally every time the playback hits an edit. What happened and can it be fixed? Read on to discover the answer. $

Newer analog and digital component and composite recording formats have demonstrated many improvements over older formats. However, they are not immune to a problem that occasionally plagues older formats in almost every editing suite. That problem is an unwanted horizontal shift at edit points, when a tape is played through a time base corrector (TBC). The most probable culprits are *SC/H phase* and *color framing* — both are familiar, confusing and widely misunderstood terms.

SC/H phase defined

Subcarrier-to-horizontal sync (SC/H) phase defines a timing relationship between the color reference and horizontal sync in a composite video signal. That relationship is:

$$H = (2\times3.579545/455)$$

This unusual mathematical relationship exists between horizontal sync, subcarrier and number of lines per frame. It causes the phase of the color burst to change by 90° for every field. Meanwhile, the phase of chroma in the picture changes by 180° after every two fields (or each frame). Consequently, in every other field, chroma and burst are in phase, but 180° reversed from the previous frame.

By RS-170A, the proposed specification describing the color video signal, SC/H phase is measured at line 10 (the first line with burst after the vertical sync period). If the subcarrier and horizontal sync relationship is correct, the zero-crossing point of subcarrier — extrapolated backward in time from the beginning color burst — crosses the 50% amplitude point of the leading edge of H-sync. In addition, field No. 1 is defined when subcarrier is positive-going as it crosses H-sync on even lines. (See Figure 1.) Color-frame-capable machines record a color-frame pulse (CF pulse) on the control track to mark field No. 1.

Burst changes phase for each field. As a result, one SC/H phase cycle contains four fields, which are grouped in *color frames*. Fields 1 and 2 form the *A* color frame; fields 3 and 4 form the *B* frame. The sequence of color frames must alternate between A and B in standard video. (See Figure 2.)

Subcarrier-to-horizontal sync (SC/H) phase defines a timing relationship between the color reference and horizontal sync in a composite video signal.

Tolerable SC/H error has a range of ±40°. However, with errors greater than 90°, the TBC will probably produce a shift in the output to the correct phase relationship. If the shift occurs, the amount of change will be 140ns or one-half cycle of subcarrier, regardless of the actual initial error value.

TBC operation

The horizontal shift results from color-

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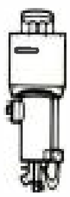

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frame inversions and improper SC/H phase. The VTR color framer uses the CF pulse to determine the tape color frame and with that locks the tape to house sync. If the tape contains reverse color-frame video (from an insert made in 2-field mode), the VTR locks, based on the control track, but the TBC sees the video as opposite to the house color frame. If the SC/H phase varies sufficiently from 0°, the TBC assumes the color frame has changed and shifts the picture, even though the color frames and CTL are in phase with one another. Such a picture shift occurs whenever a TBC receives an SC/H phase inconsistency from tape.

Tolerable SC/H error has a range of ±40°.

Several ways exist to make a TBC produce correctly color-framed video at all times and maintain correct hue in the picture. One method is to delay the readout of digitized video from the TBC memory by 140ns when wrong color-frame video comes in. This places the picture burst and subcarrier back in phase with the TBC burst, but it also shifts the picture horizontally by one-half cycle of subcarrier. *Direct color* TBCs use this method, which explains the prominence of horizontal shift with Type C VTRs.

A second method for dealing with color-frame errors in TBCs is to invert the subcarrier of the video before it is locked with H-sync.

Formats and color framing

Some recording formats are less vulnerable to problems than others. In heterodyning 3/4-inch U-matic VTRs, the SC and H relationship is unlocked. No SC/H or color-frame information is retained in the recorded signal as such. When the playback is processed by the TBC, freshly generated subcarrier replaces the jittering off-tape SC and establishes an SC/H relationship for the video before the subcarrier and H-sync are relocked.

TBCs designed specifically for 3/4-inch VTRs attempt to lock only the off-tape H-sync to its reference, so new subcarrier can always be generated in phase with house sync. The output video always has the same SC/H as the output sync and burst, no matter what comes off the tape. Any shift is unlikely.

Component TBCs handle chroma and luminance in separate paths. These devices establish the phase for picture subcarrier before it is recombined with the luminance. Again, no shift is likely to occur.

A shift can occur, however, if a TBC designed for a Type C VTR is used for ¾-inch playback. Such TBCs attempt to genlock off-tape subcarrier and H-sync to the in-house reference. Subcarrier from a 3/4-inch VTR locks arbitrarily so that each time the tape is played, a 50% chance exists for the SC/H phase to be out-of-phase with house sync when it enters the TBC memory. A horizontal shift may occur.

Color-framing Type C VTRs

Type C VTRs use direct color recording, which retains the SC/H relationship of the input signal. In these VTRs, a color-frame detector differentiates the four color fields. In the record or assemble modes, a CF pulse is written to tape for every field No. 1 to identify the start of the sequence. During playback, the color-frame pulse detector and a 4-field capstan servo (sometimes called a *color framer*) enables the VTR to slew the tape position, with the result that a specific color frame is played in sync with the house reference.

Subcarrier inversion is not an option to fix color-frame errors on Type C VTRs operating at play speed, because these machines reference off-tape subcarrier as well as H-sync. The TBCs can use subcarrier inversion to process non-play speed video, however, because the TBC uses digital decoding to separate luminance and chroma, inverts the subcarrier and then recombines them.

In record mode, a VTR does not change SC/H phase of the video. However, in 4-field play mode, the VTR capstan servo slews the tape position to match house sync. Picture position is consistent if the "color-frame playback adjustment" is optimized. The adjustment centers the range of the off-tape color-frame detector in the VTR. An indicator shows when the optimum point is reached and may help to determine if a tape has SC/H phase problems. The adjustment is necessary each time a new tape is set up for playback. A compromise setting of the CF adjustment may eliminate H-shift.

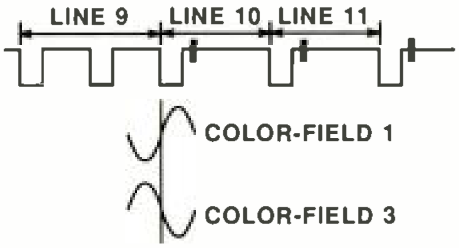

***Figure 1.** Subcarrier/horizontal sync (SC/H) phase describes the alignment of the zero crossing of subcarrier with the 50% point of the leading edge of sync. In color field 1, the reference subcarrier is positive-going on even lines.*

In 2-field play, the capstan servo may not align the off-tape color frame with house reference, so the color-frame phase reach-

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ing the TBC may be in or 180° out of phase. As a result, the TBC causes a picture shift if the out-of-phase condition exists. Good tapes can appear to have inconsistent horizontal positioning because the capstan servo is in 2-field mode.

If a 1-inch tape has video SC/H inconsistencies from scene to scene (or if the SC/H phase of a scene is at an ambiguous value), an H-shift may occur. The capstan servo may lock fine, but if the SC/H phase of the video changes, the picture may be shifted as the TBC sees a mismatch to house.

izontal shift.

Without an editing controller, a 50% probability exists that the capstan will lock on a frame with the off-tape CF pulse out of phase. Under control of a time-code editor, if the same frame is requested twice (i.e., for a match-frame edit) the H-position will be consistent.

Betacam SP and later MII machines use 4-field servos. If the tape has CF pulses recorded, the playback deck tries to find a match to house sync in 4-field mode with either component or composite inputs. On studio recorders, CF pulses are added to component recordings.

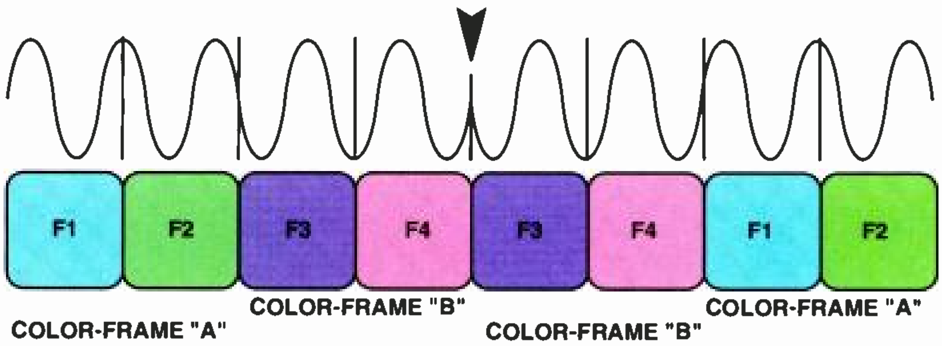

Figure 2. *An alternating sequence of A and B color frames describes proper color framing. If two A or two B color frames occur sequentially, a 180° inversion occurs, causing a mismatch.*

When insert or assemble edits are made in 4-field servo mode, the VTR slews the tape prior to the edit, and the color-frame sequence is not broken. In contrast, when in 2-field servo mode, the VTR does not slew the tape to bring the new video consistent with previously recorded color-frame sequences. A 50% chance exists that a mismatched color-frame edit will be recorded, placing two "A" or two "B" color frames adjacent to one another.

Working with Betacam and MII

The component video recorders, Betacam and MII, were originally designed as 2-field machines. Component video has no subcarrier and consequently no SC/H relationship, so a color framer is not used. When it was realized that some systems were being used for composite recording and playback as well, circuits were added to help improve the picture quality of composite source material.

For SC/H reconstruction, a color-frame pulse is added to line 15 of the B–Y channel on tape. On playback, the CF pulse alerts the encoder to the current color frame and establishes the phase of subcarrier during encoding. If the VTR has only a 2-field servo, it cannot slew itself to correct a mismatch. When the encoder detects such a mismatch, it instructs the TBC to delay the video readout by 140ns, inverting the subcarrier and making it match house sync. Although potential artifacts are eliminated, this produces a horizontal shift.

Computerized editing

In a properly timed facility, sources used in editing lock to house sync and are correctly SC/H phased. Assuming that a VTR is in 4-field mode (color framer on), the sequence of events leading to an edit is as follows:

1. The editor cues all machines to the preroll point, and then starts them in play.
2. The VTR 4-field servo locks the off-tape color-frame phase to the color-frame phase at its input.
3. The editor then slews source VTRs to the desired sync relationship with the recorder, based on time code or control track counters.
4. Once synchronized, the sources are released and continue to run locked to house reference.
5. The recorder punches in at the desired frame.

This sequence works well when using 2-field servo VTRs as source machines (U-matic, non-SP Betacam, early MII). Because they are incapable of color framing themselves, their servos slew tape positions so that the desired frame is being played when they reach the edit point. The TBC resolves the problem of picture position. The only machine concerned with color framing in this scenario is the recorder, because it is the only 4-field device. Even if the recorder is bumped during preroll, it will relock to color-frame phase with input video.

Complications begin when the recorder and source VTRs use 4-field servo mode. A conflict exists if the editor requests a source VTR to sync up on a frame that is the opposite color frame from house at the edit point. If the source VTR was bumped so that its off-tape color frame does not match house, when the VTR is released by the editor, its own color framer will re-slew it so that it does match house. The editor will then bump the machine back to the desired frame for the edit, the VTR color framer will slew it back into phase with house and the battle will continue until the edit aborts.

Framestores and effects devices

H-shift problems can occur with any device that captures video frames. For example, framestores, synchronizers, still-stores, DVEs and graphics units can result in color-frame discrepancies.

A 2-field framestore cannot store all four fields of the complete color-frame sequence, and thus introduces an inherent color frame error. If the framestore and the source passing through it are genlocked to the same sync, the output signal from the framestore will always be on the opposite color frame from the house sync, because it is delayed by two fields. When the video color frame is opposite to house, the video must be delayed 140ns for the output hue to be correct. However, this produces the familiar horizontal shift, when compared to the input video.

Although buying a 4-field framestore will solve this problem, there are other ways to avoid the H-shift. If a single video path is used, the H-shift is avoided by using digital decoding circuitry. A digital filter separates luminance and chrominance, and inverts the subcarrier phase as needed. The filter may feature comb, notch or adaptive modes. Comb decoding performs best for vertical lines. The notch is preferred for horizontal lines. Adaptive decoding analyzes the picture content and switches between comb and notch modes to match the mode to the subject matter, albeit with possible visible artifacts. (Older TBCs supporting Type C VTRs with vari-speed playback usually use non-adaptive digital decoding. The drawback is a reduced resolution on still-frames.)

Some TBC/video processors contain adaptive digital decoders that can be enabled by the user. With decoding on, these TBCs can play a Type C tape with mismatched color-frame edits without producing an H-shift. Such units generally can be used in a 2-field configuration, and adaptive decoding provides an acceptable bandwidth freeze with no horizontal position change (unity picture position). However, even these advanced systems do not prevent shifts caused by bad SC/H re-

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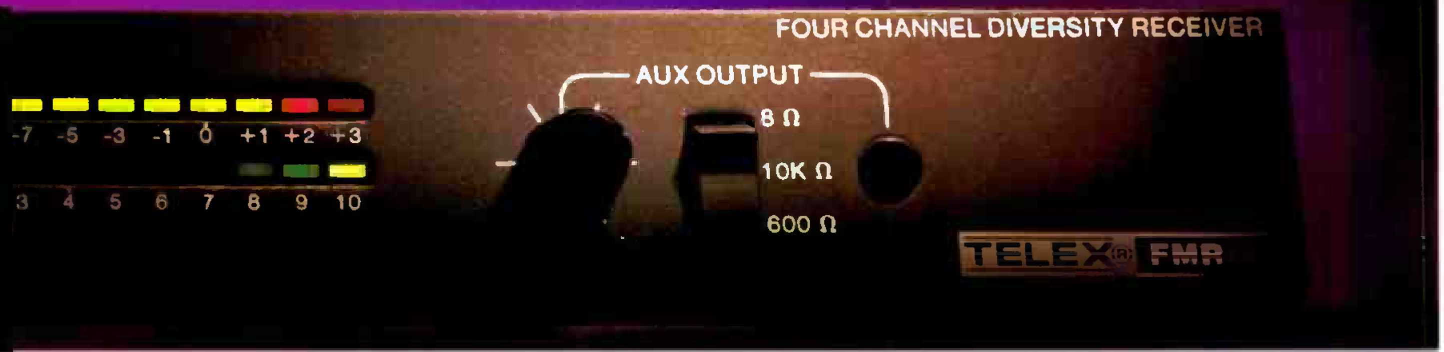

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corded into the video.

Another solution to H-shift is a 2-field framestore that routes chroma and luminance through separate paths (for example, a component 3/4-inch TBC). The subcarrier can be inverted instead of shifting the entire memory contents.

If a framestore includes a heterodyne processor for 3/4-inch VTRs, it is possible to invert the chroma before the recombined signal is fed into memory. This solves H-shift, but the separation filters reduce the bandwidth.

Some situations exist where it is not possible to achieve unity picture position in a processor used for straight freezes of full-bandwidth video. It depends on the unit being used. In addition, some framestores and DVEs may lose their color-frame lock if the input video or burst is momentarily lost. When relock is re-established, a 50-50 chance exists that the video includes an H-position inconsistency.

SC/H phase in a facility

Concern about color framing is virtually useless if video passing through a facility does not have acceptable SC/H phase. For facilities with no 4-field VTRs, this is of little consequence. However, the use of 1-inch and 4-field 1/2-inch VTRs makes proper SC/H phase a necessity.

SC/H phase should be accounted for on any device that generates new sync. This includes master sync and test signal generators, all TBCs (including those integrated into VTRs), framestores, production switchers, cameras, and character and graphics generators. The composite sync

In heterodyning 3/4-inch U-matic VTRs, the SC and H relationship is unlocked.

and black reference for all equipment also must have solid SC/H phase, because most devices produce an output SC/H with the same timing as the gen-lock signal.

In distribution, routing switchers do not change the SC/H phase of video they distribute. Cable, as a component, causes no problem unless lengths extend several hundred feet. Care should be taken, however, when using equalizing DAs. An active equalizer circuit can introduce high-frequency group delay, causing an SC/H change of several degrees per 1,000 feet of equalization. Regenerative pulse DAs also can cause SC/H changes.

Adjusting for SC/H phase

The SC/H phase can be adjusted when a device is timed to the system. The newer generation of waveform monitors and vectorscopes enable direct measurements of SC/H phase. Some show a visual representation of the relative positions of the leading edge of H-sync and subcarrier at line 10. Others show a vector against a graticule marked in degrees. With either type, it is a relatively simple matter to adjust the particular device under test for proper alignment of these two components.

When the SC/H phase can be observed, adjustment is simple. Some devices include a control specifically for the SC/H relationship of their output. More likely, SC and H phase controls are used. After setting the device H and SC phase timing, connect an SC/H phase measurement unit to the output of the device being tested. It should be close if the device is timed against a reference with good SC/H phase.

If you must bring the SC/H phase closer to zero, adjust the H-phase control only slightly. A small change of this control will make a big difference in SC/H phase, but

Continued on page 76

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By Nicholas G. Richards and Martha B. Rapp

The Bottom Line

The conditions under which your transmitter is expected to operate are stringent. The engineer's job is to keep it running, and to safeguard the facility from conditions that threaten station operation. In addition, the engineer must ensure that protective devices avoid potentially catastrophic environmental damage to the transmitter. To that end, ruggedness testing information offers more than crystal ball predictions to assist in your task.

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Richards is radio product development manager and Rapp is manager of marketing communications for Harris Allied Broadcast Division, Quincy, IL.

The bane of broadcast transmitters is their unending battle with violent electrical storms, extreme temperature variations, power line transients, wide line voltage and frequency variations, and even loss of phase or phase imbalance. Furthermore, the transmitter site often is located on a mountain, adding the problem of operating at high altitude. Welcome to the real world of transmitter operation.

It is a world where brutal, unpredictable and uncontrollable environmental conditions sometimes threaten to knock the station off the air without warning. It also is a world far removed from the laboratory conditions in which the transmitter was designed. It is into such a world that solid-state transmitters have been introduced and are expected to function reliably.

Factory ruggedness testing

Solid-state devices offer the industry many positive features. However, they are inherently susceptible to each of the conditions that threaten to damage a transmitting system. Undoubtedly, some method is needed to allow manufacturers to ensure maximum reliability as early as possible in the transmitter design process.

Factory ruggedness testing anticipates and simulates worst-case/real world conditions on new transmitter designs. The testing generally focuses on such areas as VSWR conditions, power line transients, line voltage and frequency variations, electrostatic discharge, temperature fluctuations, brownout, AC restart, phase faults (including loss, imbalance and reversal), lightning strikes and accidental shorting of the power supply.

How are these tests conducted? The following tell you what factory ruggedness testing should confirm:

- *VSWR*. VSWR can be triggered by numerous causes. It shows varying levels of severity, lasting from milliseconds to indefinite lengths of time. Static, lightning and momentary component breakdown

Factory ruggedness testing anticipates and simulates worst-case/real world conditions on new transmitter designs.

can cause short-term conditions. Pattern changes, ground conditions, a broken feedline, a damaged tower or a defective component may produce longer term conditions.

Factory testing should determine that the transmitter can withstand a continuous, infinite VSWR condition at any phase angle, with no resulting damage to any component.

A network used to simulate this condition is illustrated in Figure 1. It consists of a half-wave line enclosed in a protective cabinet for safety. A slot in the cabinet

A solid-state transmitter during cold testing in a −23° F refrigeration chamber.

enables a shorting probe to contact the inductors. Input impedance is 50Ω at the selected carrier frequency when the output is terminated with a 50Ω resistive load.

During testing, the shorting probe slides across inductors from input to output. The result is an infinite VSWR completely around the Smith chart. To escape damage, the transmitter should be able to detect VSWR; automatically foldback its power to the highest safe operating level, and then return to its normal power level once the condition disappears.

• *Static discharge.* Static discharge can produce serious damage to low-level, solid-state devices used in many modern transmitters. On an improperly designed transmitter, even accidental discharge from a finger touching a knob, switch or LED can damage components or change transmitter operating parameters.

This test simulates static discharge triggered by a person touching a transmitter cabinet during dry conditions. Although portable static discharge guns are available for this testing, a high-pot tester and a few other components can be used to provide the same stimulus.

Figure 2 shows a basic setup for static discharge ruggedness tests. A *chicken stick* connects the RC network to a high-pot tester that develops a charge of 20kV. The probe then applies repeated high-voltage/low-current discharges to selected areas on the transmitter cabinet, including all exposed knobs and buttons. Unusual transmitter action or failure indicates static discharge susceptibility.

• *High-voltage discharge.* High-voltage discharge testing simulates the effects of voltage transients on the station's antenna and transmission line due to lightning. It verifies that the transmitter is designed to survive with no damage to internal components. Ideally, the transmitter should remove carrier only long enough to protect itself and allow the VSWR to clear before reapplying power.

Figure 3 outlines a test facility for a solid-state radio transmitter. A high-pot tester is linked through a set of ball gaps to the output transmission line. The gap is set for breakdown at 12kV to 14kV, at least 25% higher than the transmitter's normal ball gap breakdown setting. While the transmitter operates at maximum rated power with high-density program modulation, voltage is slowly raised until the test ball gap breaks down. At this point, the transmitter's ball gaps should also break down and protect the transmitter.

• *Power supply crowbar.* Imagine what would happen if a technician inadvertent-

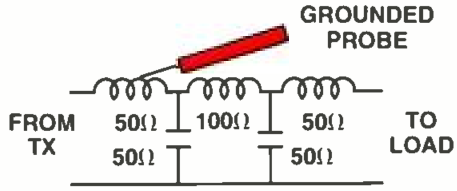

Figure 1. *A schematic for a VSWR simulator.*


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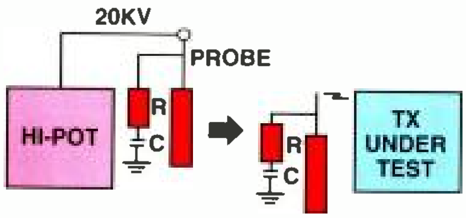


R= 500 OHMS
C= 200PF

Figure 2. *A setup for testing static discharge.*

ly left a wrench laying across the power supply output. Or, despite the warnings from transmitter manufacturers, what if someone cheated a door interlock and forgot to check the safety high-voltage shorting paddles? Testing simulates these conditions, ensuring that high-current overload circuitry or fuses can prevent damage to the transmitter during such conditions.

• *Power line transients.* Unwanted transient energy on incoming power lines caused by storms or other factors poses a threat to transmitter survival. Line transient testing confirms that protection circuitry can dissipate transient energy before the transmitter's internal components are damaged.

A surge generator/monitor rated for the required AC input voltage and current is used for such tests, as illustrated in Figure 4. During testing, transmitter ground is connected only to test instrument grounds, a floating air-cooled load is used and all other wiring to the transmitter is disconnected.

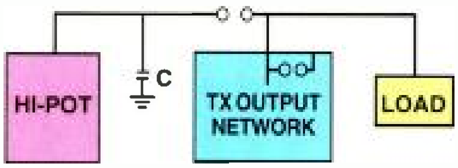
By remote control, surges referenced to ANSI/IEEE C62.41 are initiated. For safety reasons, personnel must not come into contact with the transmitter during these tests.

Some commercial surge generators/monitors allow for such testing options as wave type, peak voltage, wave polarity and wave phase. Because possible current and voltage combinations are infinite, a representative number is selected to enable transient testing to be limited to a reasonable amount of time — normally several days. Typically, 2,000 to 8,000 transients are generated during product development testing. Any failures are noted and proper protection is installed on susceptible circuitry.

• *Line voltage/frequency variation.* Abnormal line voltage variations are common when heavy industrial users share the same power line or when the transmitter is at the end of a long line. Line voltage/frequency variation tests confirm that a transmitter can provide full performance despite these conditions. Testing is easily accomplished by using a variable speed/variable voltage motor generator to supply transmitter power.

Although typical specifications call for normal full performance operation even with a ±5% to ±10% change in line voltage or frequency, limits of ±20% line voltage and 45Hz to 65Hz frequency are used during testing. These extended variations enable manufacturers to identify potentially unstable or out-of-design tolerance conditions.

• *Brownout.* Brownout testing verifies a transmitter can protect itself from damage due to sustained incoming AC line voltage below its nominal specified range. Testing is simulated by using a variac, an AC generator or an auto transformer to reduce input voltage to a level where the transmitter no longer operates — typically at 60% to 80% of nominal voltage. As voltage is lowered, all transmitter parameters are monitored. Brownout testing should confirm the transmitter is designed to shut itself off in an orderly manner at a certain voltage threshold, then resume operation once voltage returns to its proper level.



C= 1.85UF

Figure 3. *A setup for testing high-voltage discharge.*

• *Phase imbalance and loss of AC phase.* These tests confirm that a transmitter using 3-phase power is designed to protect itself from damage resulting from phase imbalance beyond its specified range, including a complete loss of AC phase. In addition to performance degradation, these conditions can cause motor and transformer windings to overheat.

Loss of phase is simulated by installing separate circuit breakers on each incoming line to the transmitter, then opening and closing one breaker at a time. Phase imbalance is simulated by using a multiple tap, 1:1 transformer across any two lines, and then adjusting the tap for the required unbalance. Care must be taken when selecting a trip point to prevent normal operating unbalance from causing false transmitter turn-offs. The transmitter should turn itself off automatically during either of these conditions.

• *AC restart.* AC restart tests confirm a transmitter is designed to automatically resume operation once normal conditions return after loss of primary voltage, phase imbalance or complete loss of AC phase. In no circumstances should any of these faults cause transmitter lockup.

Factory AC restart testing is conducted by disengaging then re-engaging the line breaker at various intervals. To simulate extremely short *off* times, contactors are used in series with a line with an OFF push-button. Lower power circuits can be tested by using solid-state relays driven by a variable pulse generator. Loss of AC under one-quarter cycle can be simulated.

Some transmitters feature backup battery-powered memory, which can provide AC restart capability even if power is off for days or weeks.

• *Phase reversal.* For all practical purposes, phase reversal (and its resulting reversal of air flow) is encountered only at initial transmitter turn-on after installation. The condition results in improper cooling over the short term. In addition, lack of air filtering can become a problem over the long term. Ruggedness tests for such conditions are simulated by simply reversing the phases, turning on the transmitter and then checking to ensure that proper turn-off occurs.

• *Temperature.* Although many transmitters operate in a closed facility with relatively stable temperatures, heaters and air conditioners do fail. Temperature testing verifies a transmitter is designed to operate under widely fluctuating conditions while meeting specifications *and* maintaining stress of all components below their maximum ratings.

Temperature testing is most easily conducted when a properly sized, thermal-controlled chamber is available. But because this is rarely the case, other means have been devised. For example, the transmitter may be placed in a plastic tent or a small room. In the case of highly efficient solid-state transmitters, which generate little heat, a combination of electrical heat and enclosure insulation may be required. During testing, chamber temperature is regulated by an adjustable, manually controlled vent.

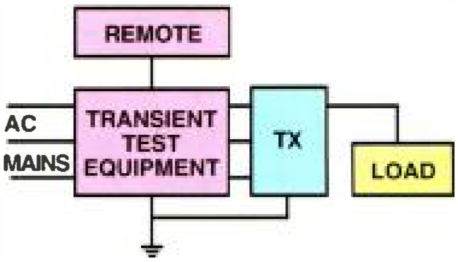


Figure 4. *A setup for testing line transients.*

Cold testing without a chamber is also possible. It may be easily conducted if the manufacturing facility is located in an area with subfreezing temperatures during part

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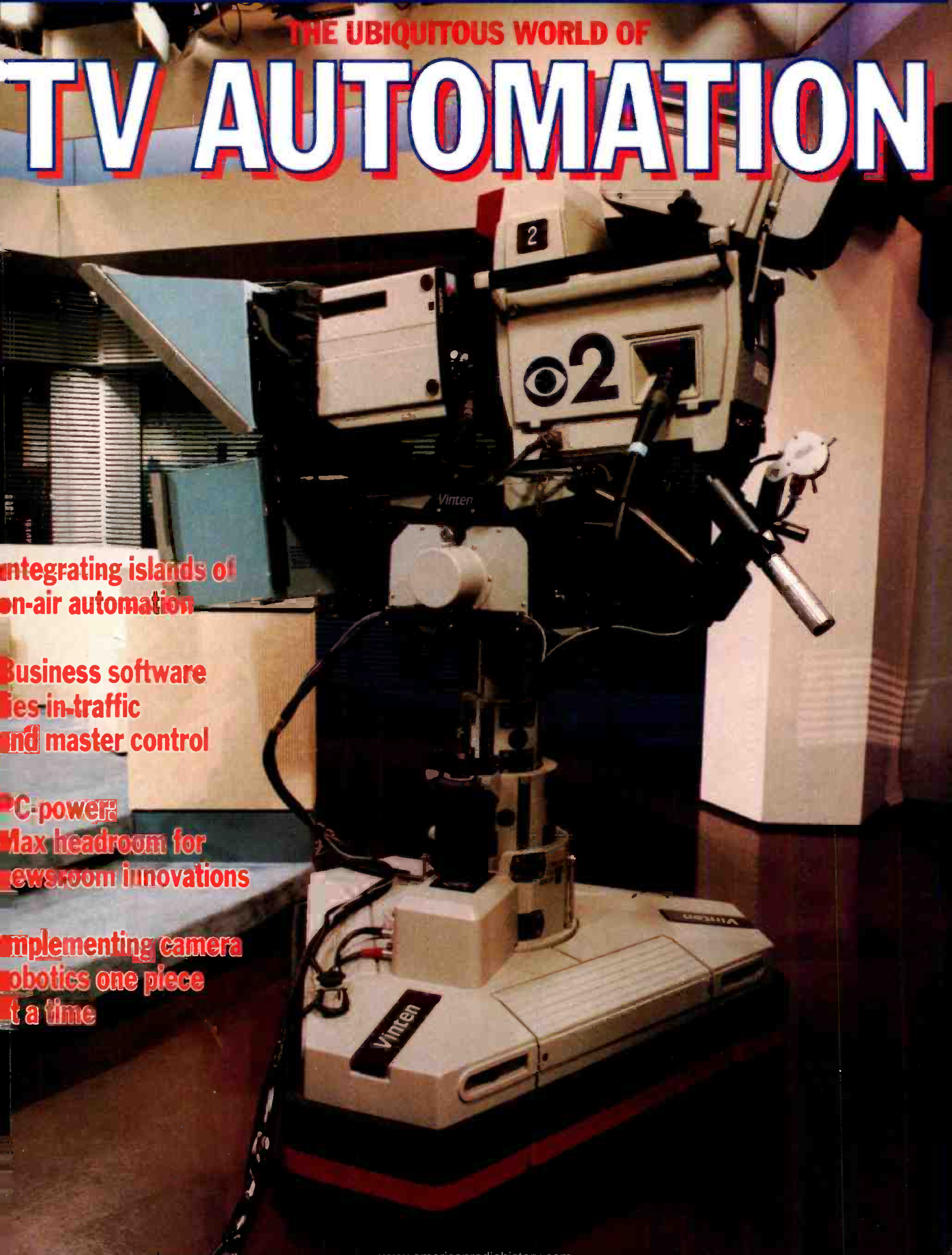

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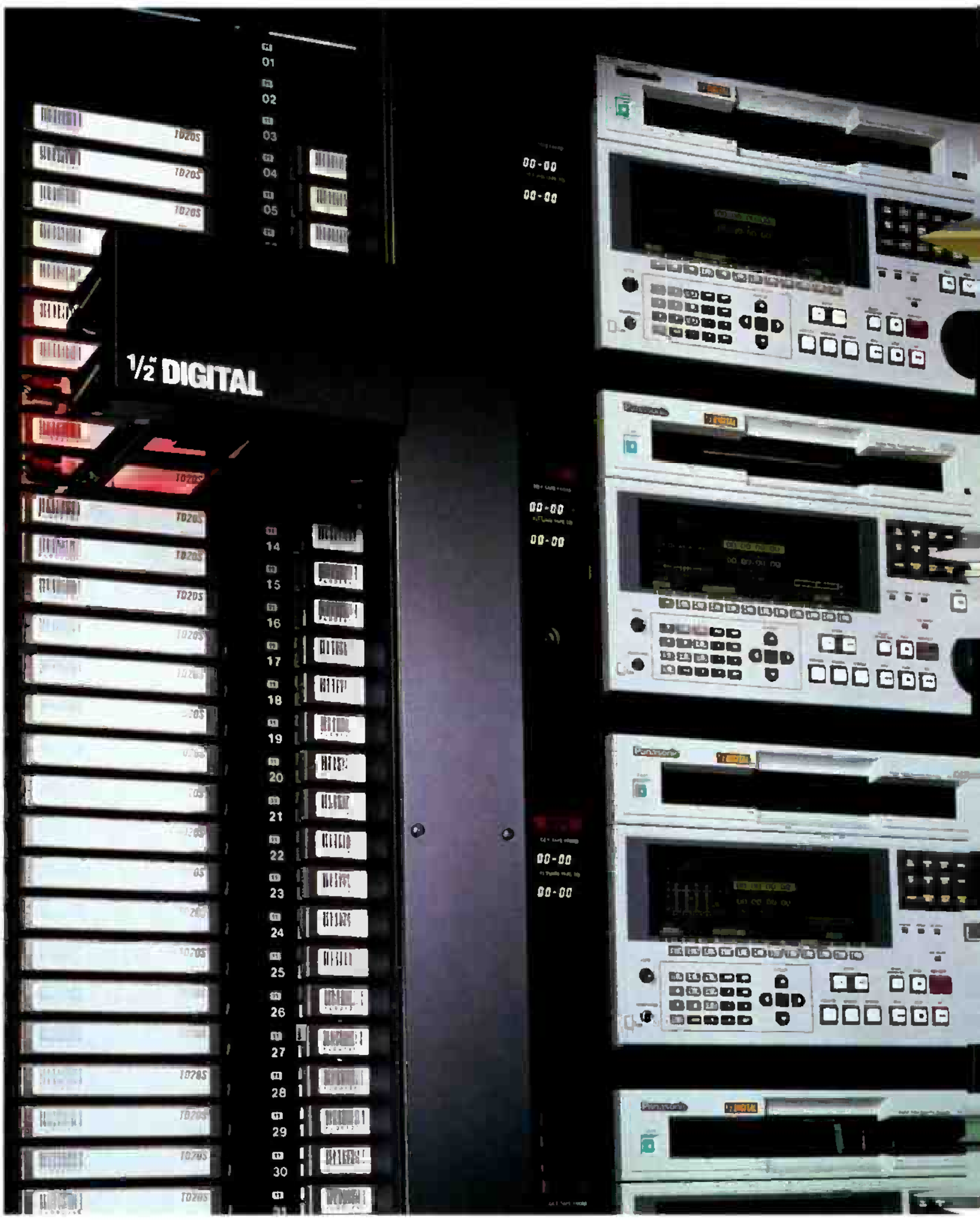

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On-air automation: Time is money

Integrating 'islands' of control accomplishes more with fewer people

Before the days of automation, a television station's engineering department had to manually load single commercial spots on stand-alone two-inch machines. Present-day automation systems not only provide convenient ways to assemble different commercials spots, but also re-route them. Odetics' Break-Tape Manager (BTM) is one example. According to David Lewis, vice president of Odetics Broadcast and Commercial Products Division, stations feeding two or more regions will usually carry the same program material on each feed. To maximize the revenue from each market, different commercials are inserted in each regional feed. Interfaced to an Odetics cart machine, the BTM automatically switches to the break tape for local commercial breaks, and then returns to the primary feed. Likewise, Alamar's on-air program channel and subrouting channel software options accomplish the same objective.

ABC's of modern cart machines

Moving into the 1990s, the introduction of the microprocessor has had a profound impact on cart machine technology. Today's cart machines still contain either analog or digital video decks (usually four to six), a physical tape library, the tapes and their bins, library control electronics and a video/audio switcher.

Unlike the first cart machines, which were mechanical devices used to load and unload tapes, modern multicassette systems add a higher degree of programing to the mechanical structure. Early machines required the operator to load the cassettes in order of play. A multicassette system has no such requirement—tapes can be in any order. In addition, the cart does not care if the programs are in stereo or mono. The multicassette system, however, does not manage the tapes outside the system, their program content or how many passes are on each tape.

The most sophisticated machine is a library system. In addition to handling the tapes, or the physical library, the machine also knows what material is on the tape, when the tape was dubbed, how many times it has run and the condition of the recording on the tape. In short, the library system takes care of the overhead associated with a tape operation.

Each deck now includes all the necessary electronics to be a self-contained unit. In some cart systems, the decks are actually stand-alone machines modified to be operated as part of the system. This allows rapid removal for maintenance. In addition, the library function has been added. There is the physical library, comprising 250 to 1,000 videotape bins in the

Engineers (l-r) Anthony Bradshaw, Stanley Faer and Barry Hicks operate the Utah Scientific TAS (Total Automation System) in Control Room B at CBS, New York.

machine, plus the mechanical and computer electronic equipment needed to load and unload the stored tapes into the videotape decks. However, modern machines can handle many spots per tape. Some cart systems can store 10,000 separate spots within the machine. Once the "mother" tapes are placed in the machine, there should be no reason to change a tape, other than wear. The program material is recorded by the machine directly to the mother tapes.

A variety of modern-day library systems exist. David Thomasberger, manager of M.A.R.C. for Panasonic Broadcast and Television Systems, explains: "Our multicassette cart library systems using either MII or D-3 video decks reduce tape stock by providing the ability to record more than one element to each tape. Typically, our systems can record up to 10 elements per cassette. We recently previewed a M.A.R.C. Type 3 system capable of housing 10 internal VTRs (five on each end), storing 800 cassettes and running two different playlists simultaneously." Asaca Corp. offers another approach. John Clemens, Asaca's marketing and sales manager, says: "Over the years, we have produced several models of tape library systems for all formats, including VHS, MII, 3/4-inch, Betacam, D-2, D-3 and UNIHI. One of the main features of our ACL line is that they are designed to house standard rack-mountable VTRs, making it attractive for stations to automate. Asaca will provide robotics for new media formats as well."

Two packages (Automation System Interface, ASI-1, and News Automation System, NAS-1) permit the Odetics TCS90 cart machine to interface with any third-party broadcast automation system.

Today, when a station can run 500 or more elements within a broadcast day, the programing of a modern cart machine can become an error-prone chore. Manually entering and checking 500 events can take hours. Manufacturers solved this problem by developing automated programing.

Ampex Corp. came up with a unique solution to this dilemma. Ken Shaw, senior product manager of the ACR group, says: "Ampex's ACR approaches the automation programing dilemma with a unique and sophisticated operating system. The multi-event software solves two conflict problems of modern cart systems. One, it solves the conflict of the location of the source material and, second, the cycle time.

Two kinds of automation

The golden age of television faded to black years ago. In an age of split-second timing, $10,000 make-goods and rating wars, broadcasting has become a bottom-line business. Furthermore, management wants to cut costs, programing wants improved quality and engineering is juggling old and new equipment. "Where's the beef?" you ask. The answer lies, in part, with automation.

Louth's Object Oriented Programming Software eliminates the need for external interface boxes.

Jerry Berger of Sony explains: "With automation, stations can realize a real opportunity. Automation by itself means to do more with fewer people. That is, free people from repetitive tasks and high reliability to be done with a machine." Berger continues: "The main parts of automation for distribution are master control, video routing, data exchange, user interface and confirmation for reconciliation. Library management is about managing mostly tape sources, recording and play. If it's a non-tape event, external to the studio news microwave feed, that would typically enter master control, and may not get to tape or may be a hot feed that a studio gets fed to master control automation (MCA). MCA includes everything, live and taped sources, satellite feeds not recorded on tape. The MCA manages all of the above in terms of data, also in terms of switching video and audio to the appropriate destinations."

George Fullerton, vice president of sales and marketing for Louth Automation, adds: "Each station has its own specific and standard automation functionality. This means that somewhere near 80% of all system functionality applies to all users, and the remaining 20% is special for each user. Software is the only cost-effective and cost-efficient way to deliver broadcast automation systems that are customized for the end-user."

Companies such as Louth Automation have devised innovative approaches to this often difficult problem. For example, Louth's Object Oriented Programming Software (OOPS) eliminates the need and cost of external interface boxes, because devices are treated as software modules or objects. Switchers, VTRs, multiple cart machines, still-stores, satellite feeds and any custom device—new or old—can be controlled directly by the company's ADC-100. Furthermore, existing applications can be incorporated into the system, just as a custom "as-run" logging program can be integrated or a newsroom system can work seamlessly with the NEWSTRAK version for total on-air device control.

OOPS evolution

Many experts view OOPS as the future of software development. The recently announced IBM-Apple cooperative development project will produce joint OOPS applications by

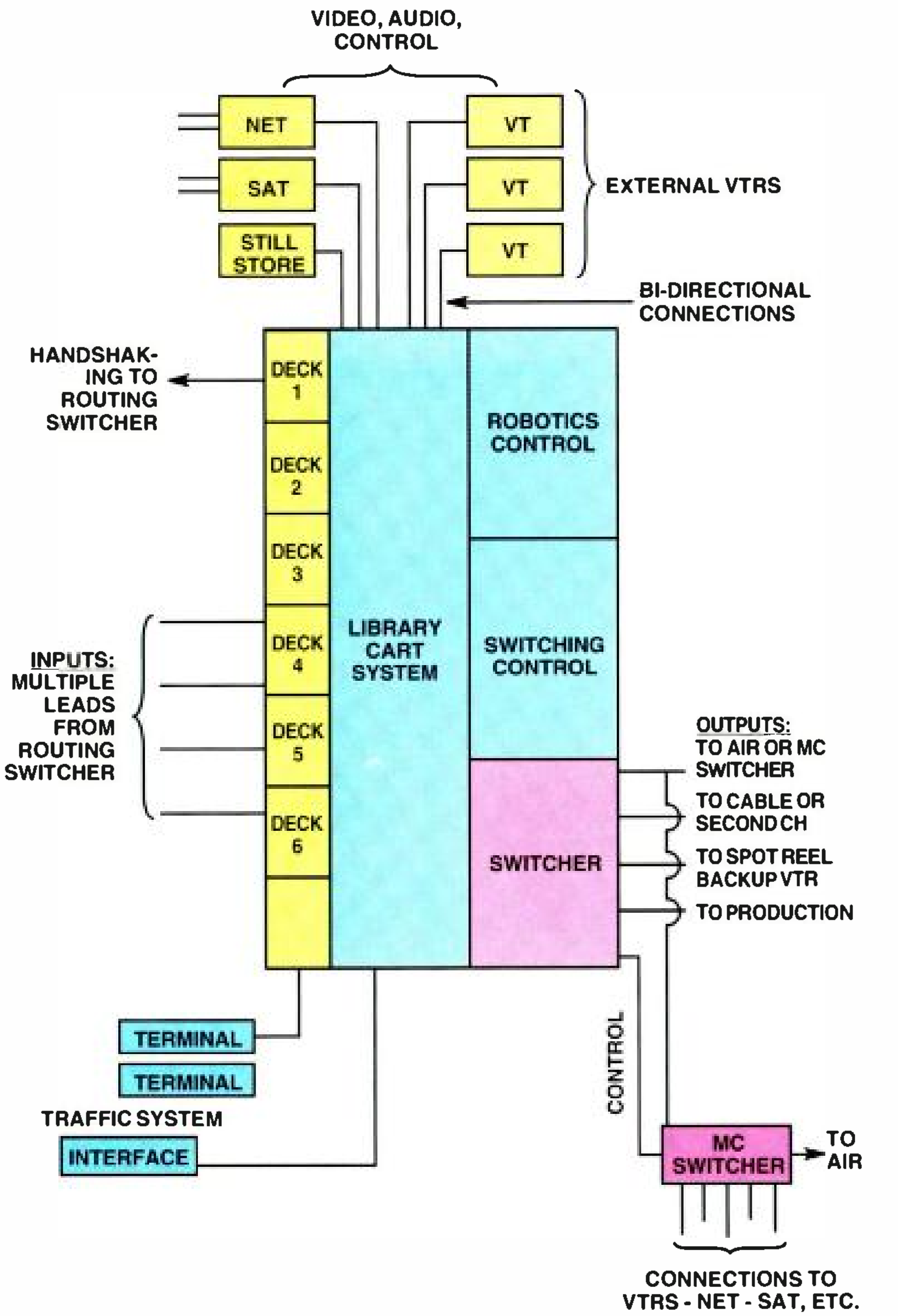

Figure 1. In one form of an integrated system, the library cart machine acts as the cart and system controller, with all external VTRs and sources operated as if they were internal to the cart machine. Such a system can operate entirely without a master control switcher. An interface to the traffic department ties programing into the station business system.

1995. OOPS is a modular approach to software development. One major advantage of OOPS is its ability to encapsulate new objects around existing objects, extending their functionality upward. In broadcasting, this becomes a big advantage because VTRs, carts, switchers, LANs and user interfaces can be treated as software objects.

The integrated system

An integrated cart system contains one master computer system that operates the equipment and other microprocessors that work as slaves. A microcomputer database houses the tape information, while another microprocessor controls the physical operations of the machine, such as loading and unloading tapes. The master computer controls the playlist, which not only contains the spots to be run by the decks, but also contains external machine entries—even network and other control room sources. In short, a station air log is possible.

What makes these cart machines different from a basic machine is the addition of an audio and video routing switcher. As many as 12 inputs and four to six outputs are available.

The crosspoints of this switcher are controlled by the playlist computer. Assume, for example, that your network program line is connected to a router input. Also assume that your six Beta and D-2 machines are connected to the router. The playlist computer can now switch between all of the possible video sources available in your facility. Furthermore, if you connect the play, stop and wind functions to the computer, your cart machine now can control and switch to air any machine or video feed (either internal or external) to the cart machine.

If you could program into the playlist the running times of program segments, it would be possible to start the system running and let it play your program tapes, run spots, go to network, play more spots and so on all day long. With such a system, it is quite possible to connect the machine directly to the transmitter, thus eliminating the master control switcher. The cart machine control computer terminal is your master control system.

Taking our system one step further, if all the tape decks could record, the playlist also could become a record list. Furthermore, program video feeds could be received within the machine, played later and never touched by human hands. All of this functionality is common in today's cart systems.

Integrated automation system

Figure 1 depicts an integrated automation system. Note that there is no host system interconnecting the other systems. The cart machine acts as cart and system controller. All external VTRs and video sources are directly connected and controlled as if they were internal to the cart machine. The switching is internal to the machine as well. This system actually can operate without a master control switcher by connecting one of the output lines directly to the transmission equipment. Although the interconnected system can operate with multiple outputs, the integrated cart system can easily feed two complete and different program lines, different commercials and different program material. In this system, the controlling cart is operating the external equipment at the machine language level, whereas the interconnected system controls

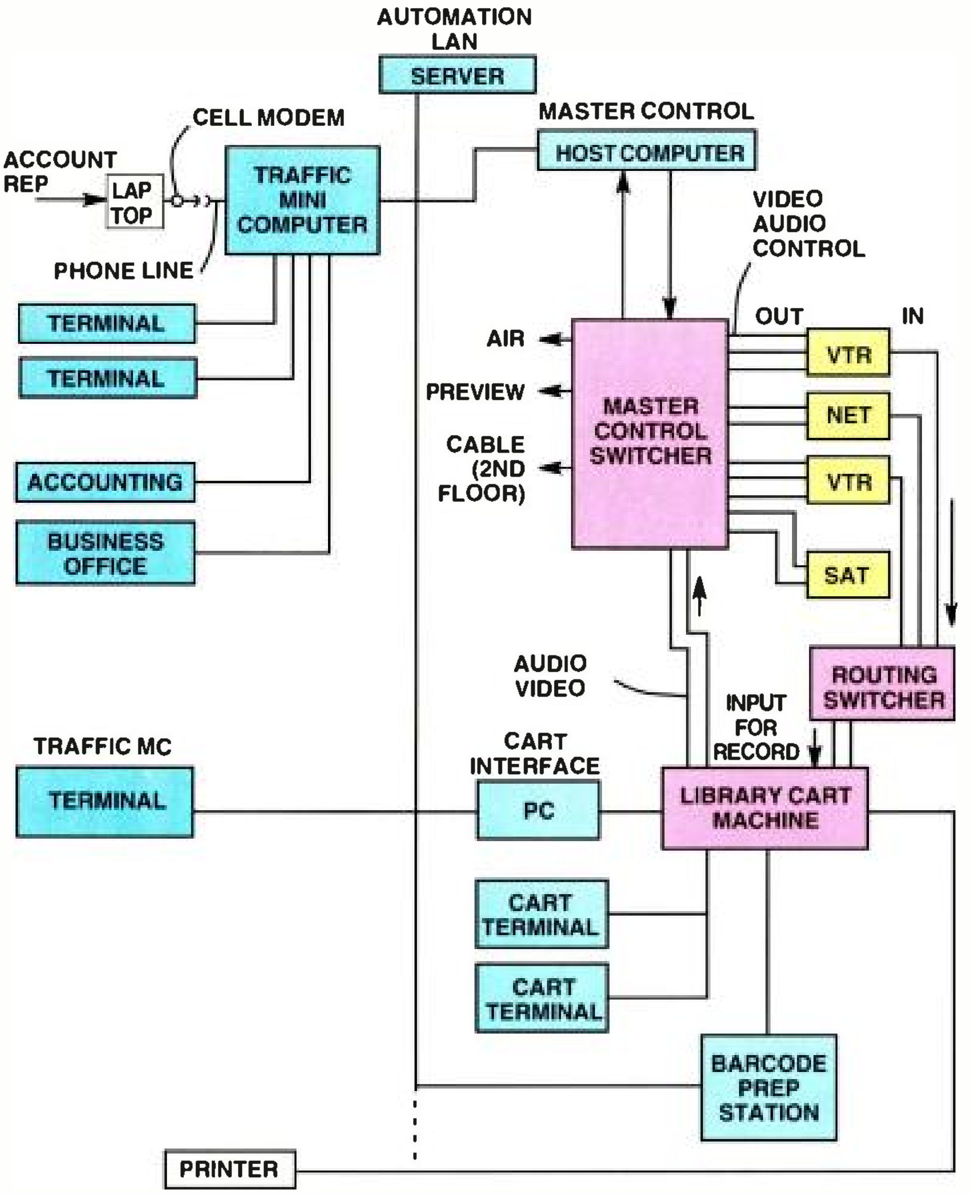

Figure 2. An interconnected automation system uses separate automatic functioning equipment linked together through bidirectional communications. One computer acts as host, which ties a number of separate islands into an operational system.

via communication ports, with each machine taking care of its own housekeeping duties.

Two feeds are better than one

Not only does the integrated cart machine play your program tapes and spots to air using one output, it also has three other output connectors. Putting these ports to use can lead to a bright future, such as a totally independent second station or cable feed. With an integrated cart machine, one program line can be fed on the air with commercial breaks, while a second set of commercials is placed on the cable system at the same time. Many stations have a direct microwave or fiber-optic line to the cable company.

It is also possible to program a totally independent second program line. One example would be to feed your local cable company a live newscast while the main air channel is carrying a tape or network feed. Such a newscast could be tailored to a known target audience. Your unused production control room can be connected to one of those routing switcher inputs. Is there a return here? Yes. As a manager, you purchase employe time in eight-hour blocks: one morning block and one evening block. But what do you do with employes between early-evening and late-night newscasts? Why not run a second cast in the early evening to feed the news-hungry people on cable? One derivative of this is the multistation software offered by Panasonic to its M.A.R.C. II clients. David Thomasberger, manager of the M.A.R.C. system, explains: "The multistation software allows a station to air two or more channels carrying different commercial and program material simultaneously. Two cassette dub stations screen all programing material and dub the commercial spots for the common cassette library, while a M.A.R.C. 400 compiles different commercial reels for each station." Phil Livingston, assistant general manager of technology and systems development for Panasonic, adds, "What increases their automation also has the ability to improve efficiencies."

Interconnected cart systems

Unlike the integrated machine, which can be compared to one brain telling all of the connected equipment what to do, an interconnected cart system can be thought of as having several specialized brains that are being told what to do by another computer.

Back to basics

A typical interconnected system can be thought of as a stand-alone cart machine with its decks and playlist connected to another master computer that hands off only the play information (playlist and roll commands) for that machine. The external machines are controlled by a master computer, not the cart machine. This master computer separates the data for each of its slaves and hands off the data. The routing switcher is still present. However, in this case, it could have 100 inputs and 100 outputs. More than likely, it will feed a few buses of a larger router, providing program, preview and preset, presented as a stand-alone master control switcher.

In such a system, the master computer will hand off a playlist and roll commands to each machine. Then, it will connect and switch that machine, network or other feed to the on-air line. Those interconnects are usually bidirectional via a local area network (LAN). For example, the computer can say: load six commercials and look ahead 50. The cart machine will check its library and find one missing. The missing cassette information will be passed back to the master display screen, where that item will be displayed in red.

A typical interconnected system could include a master control switcher, a video cart, stand-alone VTRs, a network satellite and independent satellite equipment. Even a still-store could be connected.

Interconnected systems

In Figure 2, an interconnected automation system can be compared to separate, automatic functioning equipment connected together with bidirectional communication. Typical-

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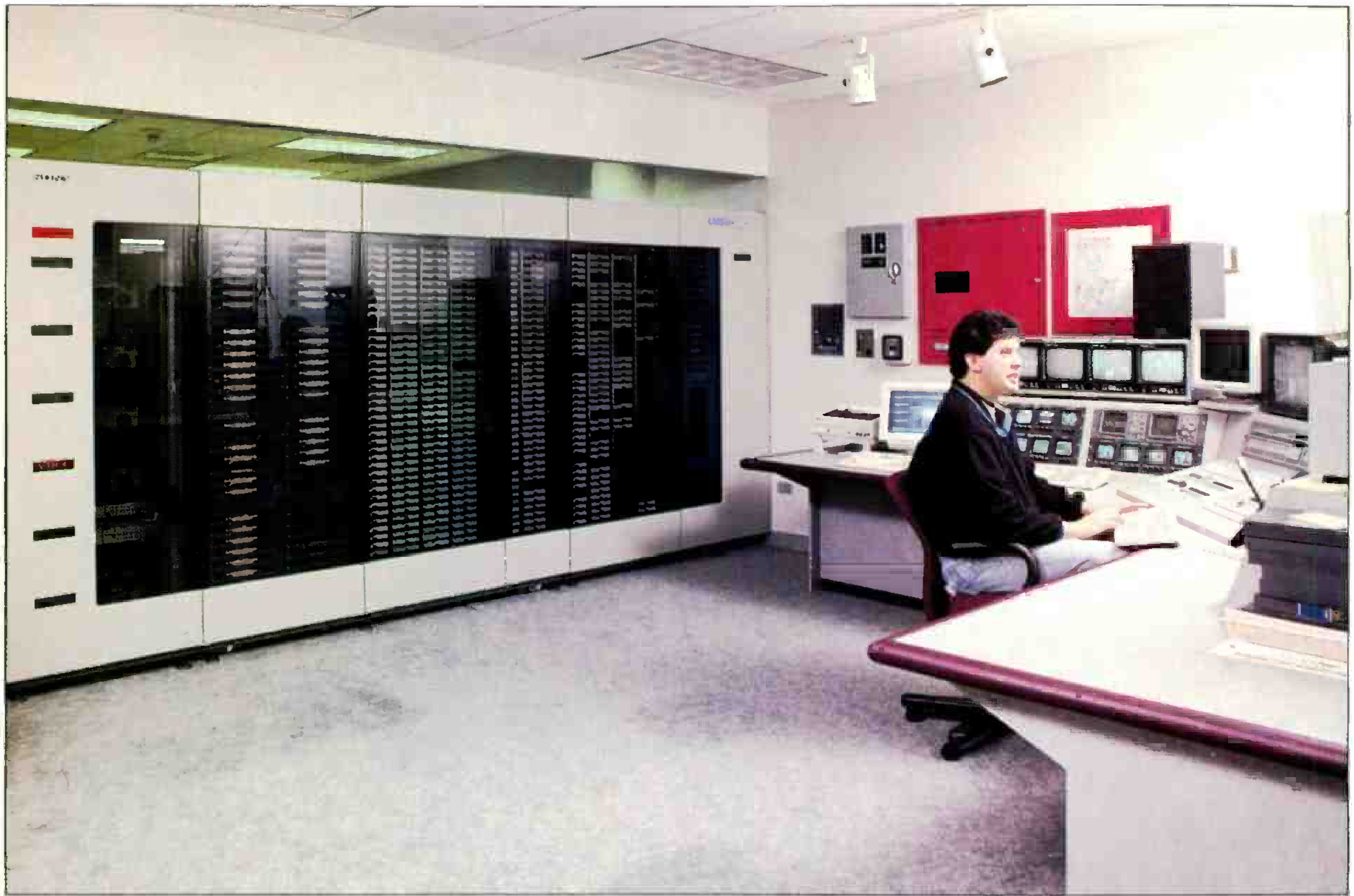

Time Warner's New York 1 News uses a Sony BVC-1000 LMS driven by NewsMaker newsroom software, to air 2,500 segments daily.

ly, one computer serves as host. As shown in Figure 2, the host is the computer that drives the master control switcher. It is connected via a LAN to the file server, the cart system and the traffic minicomputer.

With this system, an account representative with a laptop can visit a client and check availabilities via a cellphone modem. When and if a buy is made, the traffic department and the business office approve the sale. The data is then entered into the traffic system to become part of the log. At the same time, program information is entered to become part of the log.

Next, the complete log is downloaded via the LAN to the master control host, where it is searched for cart plays, program plays and remarks. A spot playlist is fed to the cart machine via the LAN, while the host generates a full log for the master control switcher.

To operate on the air, the host sends 64 events to the switcher memory and calls for the cart machine to load three minutes of commercials. In this case, a human must load a cassette into the stand-alone machine. Then, the host will roll the machine, read the user bits and recue.

At the programed time, the host triggers the switcher control automation rolling the program tape. Several seconds later, the switcher places the program on the air. When the break occurs, the host prerolls the cart, and the switcher places it on the air and cues the program tape. The cart machine plays the spots via internal control and tells the switcher it's finished. The switcher, knowing the length of the break, prerolls the VTR and places the program on the air. Next, the host downloads a new playlist to the cart machine, and the cycle begins again.

If traffic wants to make a change, it enters the information into its terminal.

The third cart system

For the record, there is another cart system known as a sequencer. Typically, it is a collection of VTRs that are connected to some type of programing system, which controls play and wind functions. Their outputs are connected to a switcher that also is controlled by the programing system. When the decks are played and switched, the output takes the form of an automated system. Sequencer systems do not have a mechanical system for handling tapes. However, sequencers are fairly inexpensive compared to fully automatic library video systems. Modern-day variations of the sequencer are abundant. For instance, Sony's soon-to-be-introduced Flexicart multicassette system is a modular and reconfigurable product that will be interfaceable to Alamar's and Louth Automation's systems. Says Jerry Berger, Sony manager of multicassette systems: "The Flexicart is not an LMS, but rather a multicassette affordable way to play, compile and record carts." Similarly, David Thomasberger of Panasonic says, "Our D-Cart, comprising up to four MII VTRs and 25 bins, offers sequencing and compiling at a cost-effective price."

Traffic control

Traffic, in the simplest terms, is the entry of commercial and non-commercial spots into an operational log that represents the broadcast-day playlist. Whatever the result, it is clear that automation and traffic must somehow be integrated for this technology to evolve. One such approach is through an integrated traffic inter-

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New automation systems mean business

Innovations in hardware and software help stations be more productive

Using generic and industry-specific software packages, TV stations are streamlining their business practices and increasing their productivity through the use of office automation systems.

Even though the word processing and spreadsheet applications used at these facilities are of the everyday variety, many stations have implemented specialized business automation software packages developed for broadcast station use. Most of these run on IBM PC-type systems, although many Apple Macintosh and a few Unix-based systems also exist. A growing number of software providers now offer versions of their systems for *both* IBM and Mac platforms.

These systems can tie a station's traffic, videotape and master control operations into a single automated unit. Such an arrangement puts a station at the leading edge of operational efficiency.

Full production facility management also is available on some systems, allowing the advantages of automated control to be applied to the production side as well.

Integrating business and program automation

To fully enjoy the benefits of automation, the computerized functions of a station's business and technical operations should be interconnected. The level of this interactivity should be as high as possible, ultimately running all the automated functions at the station (including the newsroom's) on a single computer.

Short of that, separate computers used for different areas should communicate via LAN, as shown in Figure 1. For this to work effectively, each item must be carefully selected with respect to its interface characteristics. Most of today's broadcast equipment offers the standard RS-232 or RS-422 control interfaces for relatively easy interconnection with the master control computer.

Routing, switching, still-store and character generator control are common features included in program automation systems. Control of satellite dish-pointing and demodulator tuning is another useful feature found in many automation systems. Some also include an interface for robotic camera control. All of these must speak to the automation computer via their control ports (typically RS-422), and therefore require in-board support via the automation system's software, or an outboard protocol adapter/converter.

Meanwhile, a library computer maintains the inventory of programs and spots on hand. Adhesive bar code stickers are typically placed on all videotapes and cartridges, and read by manual bar code readers and those built into video cart decks.

To complete the system, the business computer system also must talk to the program automation system. Here again, protocol translation is required. An increasing number of program automation systems support such conversation with traffic systems, and vice versa.

When the system is properly implemented to a minimum level, a program log input from the traffic computer should be all that is required for the proper spots to be loaded and run as scheduled, and a reconciliation report to be generated, confirming the spots' airing and their air times. This function set should be a near-term goal for stations that have not yet reached such a level of automation. Stations considering automation systems and upgrades should verify that this kind of process will be routinely possible in any prospective purchase.

If the satellite downlink, routing switcher and videotape recording functions are under automated control, the business computer also

---

face. Douglas Hurrell, president of Alamar Electronics USA Inc., explains his interpretation of an integrated traffic interface: "A fully integrated traffic interface will convert a daily traffic log file to an automation event playlist format and reconcile the resulting as-aired log that is generated by the automation system. Transfer of this data can either be via ethernet or sneaker net. Reconciliation must take into consideration that the log will not reflect the order of or the information which was downloaded to it. Edits in on-air event data, use of alternate logs (such as in a sports rain delay) or manual override of the on-air master control switcher must all be taken into consideration when reconciliation is made."

Other islands exist, such as newsroom word processing, satellite control and physical plant heating and air-condition control. For now, let's examine the major islands of automations, and later build a few bridges between these islands.

Master control automation

The function of master control is to place the program material on the air for viewers to enjoy. The program material, in this case, contains news and entertainment material, commercials, PSAs, IDs and black. Occasionally, it also contains rewind video, noise and tape breakup. In a real master control, time is extremely important, because that is what customers purchase. In a well-run operation, every event runs in order for the exact time with no black, breakup or noise present. Ray Baldock, director of product development for Odetics, concurs. "The role of automation is changing. Carts now provide highly accurate switching of spots to air and can also automate program replay. Interfaces permitting schedules to be downloaded directly from traffic to the cart are now a standard feature of modern cart systems. Newer automation systems have added powerful capabilities for integrating multiple cart machines for those needing separate spot and program replay. Others are adding features to control recordings to be automated on the Odetics cart machine under full control of a record schedule, created and managed by the automation system. Such record automation systems also provide control of the router and many of the components in the signal path, including the earth station and the receivers. Thus, the automation system of the future should include features to manage the complete cycle."

Reducing errors

One way to reduce the possibility of error is to electronically operate the switcher. If you were to enter the should be able to order automated spot downloads, such as those offered by CycleSat.

Finally, business automation systems should allow telephone modem (or other digital telecommunication) access for off-site connection to the system. This can allow last-minute spot changes, thereby offering clients improved service by adjusting their spot orders to the outcome of a sporting event or the like. In addition, it can allow data input from (or output to) sales staff in the field. Other stations in a group also can be interconnected in this manner.

Improved, broadcast-specific business automation systems—with a high degree of interface-to-program automation—are an important element in the future success of broadcast operations. Managers and engineers will continue to have more things to keep track of, especially in the joint operations or "multicast" facilities that may be commonplace in the future. The approach should be "seamless, from sales proposal, order processing, sales analysis and log scheduling through to on-air automation," says Wayne Ruting, president and chief executive officer of Columbine Systems, Golden, Colo. Computers will be more widely applied, Ruting feels, "not only in demographics and scheduling, but also accounting and newsrooms, all running on one platform."

By the staff of *Broadcast Engineering*

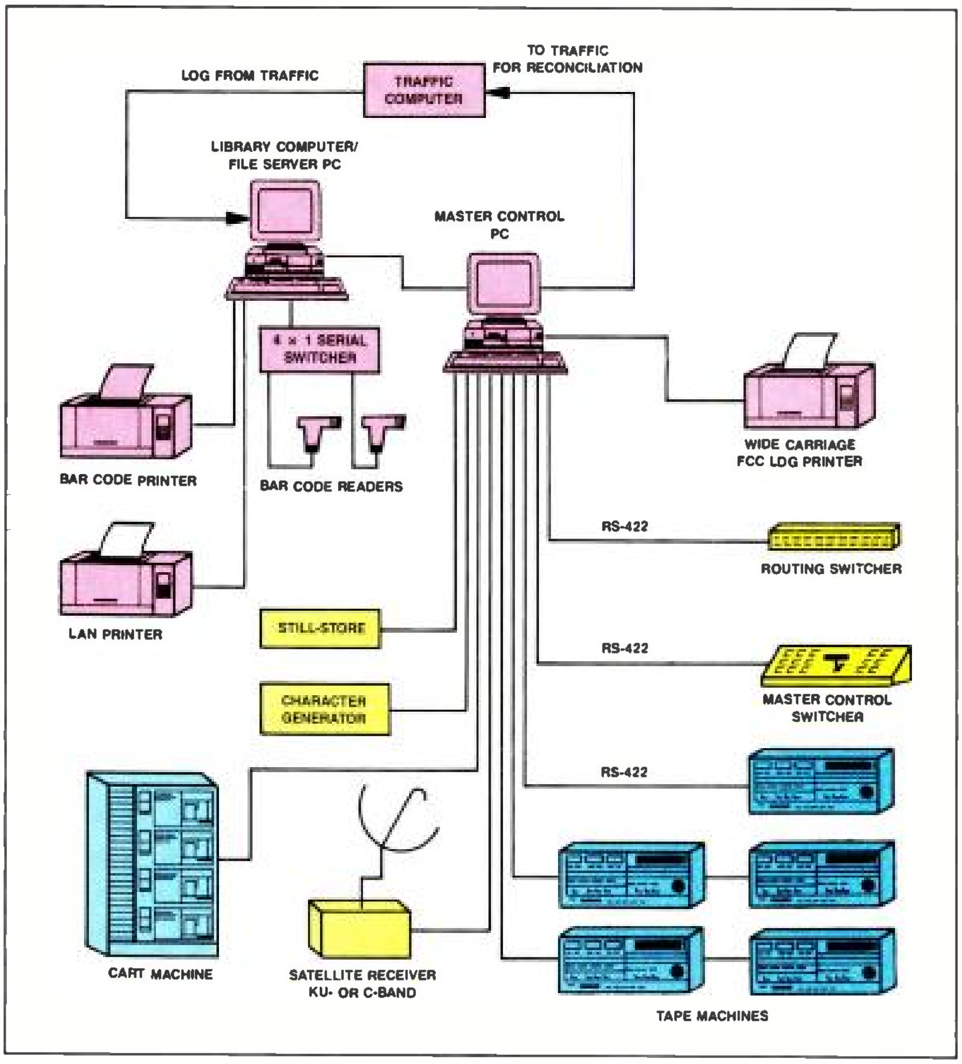


Figure 1. In this PC-based automation system, the master control computer handles on-air and videotape operations while following the electronic log provided by the traffic computer, and reporting back the as-run log for reconciliation. (Courtesy of Columbine Systems.)

proper roll time for each machine and have the switcher remember that time, then the operator could have the switcher place the source on the air after the proper preroll time. This simple change can reduce by half the number of steps to accomplish when placing a spot on the air. In addition, the operator does not have to keep track of the actual expiration of the roll time. The roll command line is connected to the switcher as well as the video and audio for switching.

This semi-automatic operation has been available for years, and several manufacturers have gone one step further by allowing the operator to type a playlist of events. The list contains the source and length, in order of presentation. The switcher electronics remembers the roll time required for each source. Together, these two actions allow the operator to roll the first machine manually and every event in the break to operate automatically on time. Generally, this playlist is placed in switcher memory 16 or 32 events at a time. As one break runs, the operator enters the next break by entering the machine and length. Program-length material is also entered, and the program time allows for the entering of the material for the next few breaks.

By attaching a microcomputer, such as a desktop PC, and writing software to hold the entire day's playlist, it is possible to program the switcher to operate continuously. The PC handles the housekeeping and hand the switcher its 16 or 32 events as necessary. Once the events are handed to the switcher, the operator can edit the day-long playlist as needed for the usual changes.

Again, this system eliminates some manpower elements and error-prone operations, but now adds its own requirement of entering a complete day's playlist, which is hundreds of events. The operator can now actually watch the spots run once he has the playlist correct. Switcher automation does not decrease man-hours, because the operator must always be present. However, automation does reduce errors and gives a smooth air look. The air look is constant, whereas manual operators have their own style, which can give the air look a slight difference as operators change shifts.

Business automation

Typically, the business office was the first broadcast department to be automated. Although payroll and accounting were first, the traffic department's preparation of the log is important to an automated master control. The traffic department enters the information as spots fare purchased and pro-

Continues on page 17

Newsroom automation: getting personal

PC platform continues to lower upfront costs, opens doors to modularity and upgradeable software, circuitry and functions

Unlike camera robotics, newsroom automation promises little in the way of staff reduction savings. But it can expand the quantity of stories a staff can process, in some cases multiplying the hours of news a station might offer in a day.

Connecting people, machines and stories

Whether PC- or mainframe-based, automated news systems provide a local area network interconnecting anywhere from half a dozen to more than a hundred workstations.

The volume of news a station handles—or wishes to handle—will determine fundamental, initial cost-benefit considerations, including the number of workstations needed and the choice of a local area network (LAN) architecture (Novell, Ethernet and other standards differ in minimum distance requirements between stations, cable types and other parameters). LAN architecture and LAN interconnection software will determine a system's transmission capacity and network redundancy capabilities.

A basic-level system provides word processing—entered by reporters at a workstation or fed by modem from other sources, such as laptop computers in the field—wire service ingestion, program lineup software and archive filing.

The next step up includes machine control features, allowing remote control of character generators, teleprompters (and concurrent closed-caption encoding), still store, tape and cart machines and other equipment needed to produce each story.

NewsMaker Systems' MS-Windows based machine control allows multitasking.

A virtually endless variety of more sophisticated features—such as archive search or story assignment software—can be added over time. Such features will undoubtedly continue to grow within broadcast applications and to carry over from other computer-using markets. "We rely heavily on 'Bug group' feedback—our users' regular lists of needs—to provide one major software update each year, plus small updates along the way," says BASYS marketing manager Kristin Schleiter.

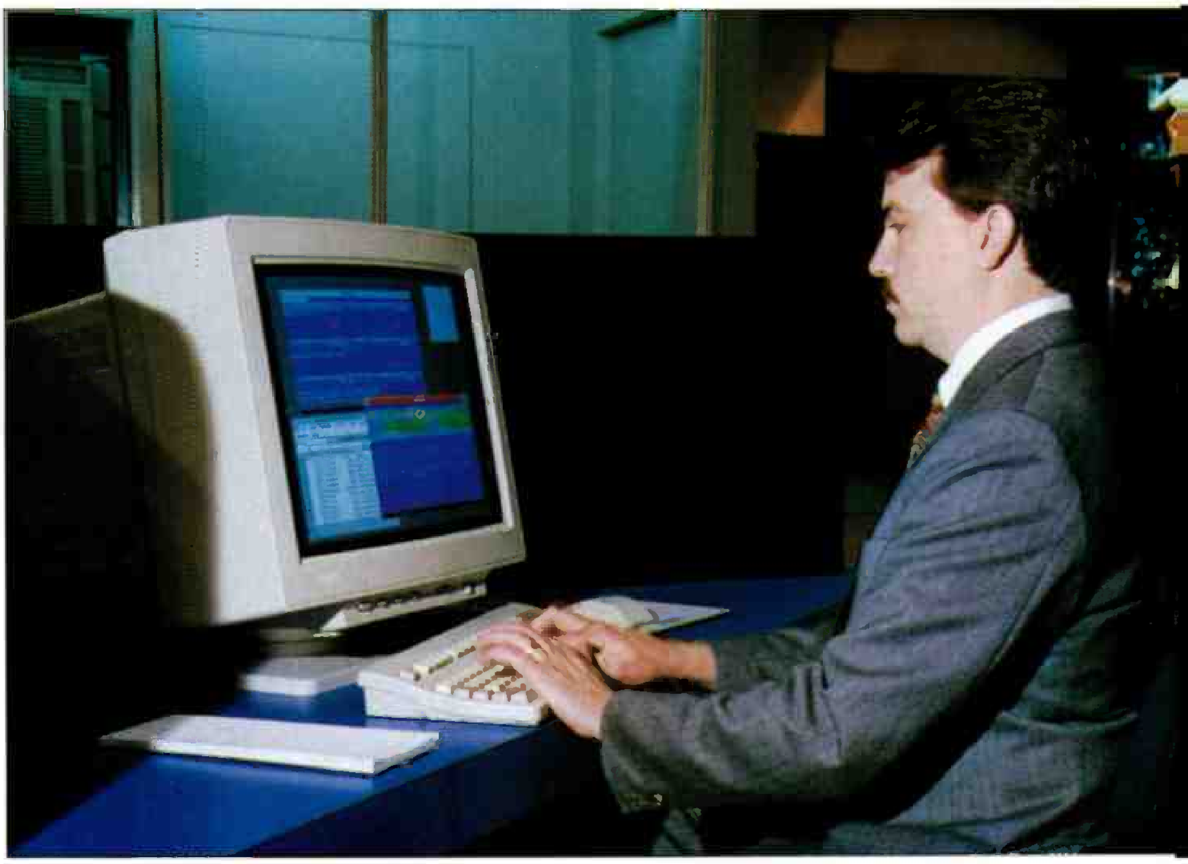
Electronic program rundown

Each of the manufacturers offers some form of script management, often customized for a client's particular needs.

Once a producer sits down at a workstation and begins to round up stories for a coming newscast, he or she can create a program rundown, identifying for each story the reporter or anchor; video source; tape cues; running time, and other directing cues.

Common software features allow a producer to account for air time as it goes by during a newscast. If a segment runs long or short, adjustments to the rest of the program can be controlled centrally.

And most systems allow a producer to reshuffle the order and timing of stories in real time. If a breaking story comes in during a news show, new



BASYS updates its News Computer System (right) software annually, as well as on an ad hoc basis, dependent on user group input. New parent Digital Equipment Corp. is adding financial support, hardware development and software support. To take increasing guess-work out of pacing a newscast, Dynatech NewStar II (opposite page) allows producers to program each anchor's reading speed into a "Living Lineup" program schedule.

copy can be typed in; the system automatically reconfigures the timing of the whole program.

Software features are continually being developed to make pre-show timing estimates increasingly accurate. For example, NewStar II's "Living Lineup" software enables producers to program each anchor's reading speed into the system, retained as a constant and factored into the word count. "It is another way to take the guesswork out of preparing a newscast," says Dynatech NewStar President Robert Miller.

NewsMaker Systems of Simi Valley, Calif., last month installed a NewsMaker Electronic Newsroom system for Time Warner's 24-hour cable news service, New York 1 News, that might be described as a "video jukebox," says company President Dean Kolkey.

With stories coming in high volume from 75 PC workstations, News 1's "program rundown management" software allows producers to create new "playlist" sequences at regular intervals, inserting new lead-ins, video segments from the field or script information into the sequence without disturbing the existing overall order or timing of segments.

Sky's the limit

Because New York 1 News uses a large number of one-man Hi8 camera crews on the street, NewsMaker incorporated an off-the-shelf circuit board (Novell's Netware Access Server, at less than $500), allowing reporters with laptop computers to access all functions in the system, scripting their stories, calling up stills or archived tapes, etc., from the field.

That ability to integrate circuit boards and new software options comes in handy in a variety of ways. By inserting an RS 422 card and Sony protocol, NewsMaker gives users the ability to control VTR functions from a PC.

Purchased by giant Digital Electronics Corp. in 1990, BASYS Automation Systems is now upgrading its News Computer System hardware to incorporate DEC's 500 mHz processing chip (up from 30 mHz). Development ventures with DEC, says Schleiter, are BASYS's ticket to staying on the circuitry and software cutting edge.

Kolkey expects not only continuing growth among first-time newsroom system buyers but also, over the next several years, a wave of buyers replacing their now five-year-old NewStar or BASYS mainframe systems.

PC-based systems are here to stay, says Dynatech's Miller, and "the days of proprietary solutions are no more."

By Peter Lambert, BROADCASTING

ON-AIR AUTOMATION

Continued from page 15

grams scheduled to air. The business computer then checks for conflicts and prints the log. The master control operator uses this log to enter his data into the master control computer while the cart operator enters his data in the cart database.

Total station automation

Taking connectivity a few steps further reveals some interesting possibilities. Most cart machines make an "as run" log as it operates. The switcher will also make an "as run" log. These two logs could be electrically combined to make an "as played" list, which would be handed back to the traffic system for reconciliation. If there was a connection to the transmitter control automation system to verify the station was on the air, the reconciled log could be electronically handed to accounts receivable for billing of the customers. Of course, the billing would be automated. You could reasonably expect the billing computer to debit the client's bank accounts for payment. But that may be a bit too far for now.

The local area network represents the bridges between the islands of automation to form a total interconnected automation system within the broadcast facility.

What's the bottom line?

Jerry Berger of Sony sums it up: "There are two areas to address: operational benefit and financial benefit."

The answer may not be the elimination of staff, but increased productivity. Take, for example, the need to supply a two-channel with a widescreen feed. A single-channel output TV station is typical. I want to double my output, i.e., I want to be able to distribute a 4/2 and a 16/9 signal (two different stations).

The Sony LMS can double the output with perhaps the same staff. In the end, where is widescreen going? The FCC decision [on advanced TV] will have no impact on multicassette systems."

By the staff of *Broadcast Engineering*

Broadcast Engineering would like to thank Marvin Born, WBNS stations, Columbus, Ohio; and Curtis Chan, Chan & Associates, Fullerton, Calif., for their valuable contributions to this article.

Robocam: the installment installment plan

No longer an all-or-nothing purchase, the automation of a standard three-camera setup can now be implemented one head or pedestal at a time

In the late 1980's, networks, and then the largest stations, switched to robotic systems in one capital-intensive, fell swoop. At large stations, those purchases were often made possible by significant savings in union staff compensation. With the robotics replacing half a dozen camera operators, large, and even mid-market, station systems typically have paid for themselves in two to three years.

Now, a prospective mid- or small-market buyer of camera robotics may gain similar savings in more incremental fashion, implementing the system in steps. Manufacturers such as Radamec EPO, TSM and Vinten Broadcast Inc. are competing hard to offer piece-by-piece options for stations with less to spend from a single year's budget. And the total price, they say, has come down significantly from the $100,000-per-camera range of the late 1980's.

Automating from the head down

The most basic level studio robotic camera system might include only control hardware and a new pan/tilt head for a camera pedestal.

Such a system could allow remote control of zoom and focus, as well as pan and tilt. At this basic level, camera motion functions—left-right, backward-forward, up and down—are left to a technician at each camera.

At this and other levels, some product lines offer the ability to switch to manual control of all head, pedestal and camera functions.

Also at this lowest cost level, a three-camera studio may choose to install automated pan/tilt heads on its existing pedestals one camera at a time, spreading out hardware costs over a longer period.

The same camera-at-a-time option applies to taking the financially significant next step of automating control of motion across the studio room floor. This requires the purchase of an XY pedestal—one that can be remotely commanded to move forward, backward, left and right (the X and Y axes)—in addition to the pan/tilt head.

One manufacturer estimates the XY pedestal constitutes about two-thirds the cost of a single camera channel. And for many stations, fully automating only one of three cameras—for that smooth move to the weathercaster's station or retreat to a wide closing shot—may suffice indefinitely.

XY pedestals control up and down (Z axis) movements as well. But as an intermediate step, a station can obtain a stand-alone unit for up and down control only. It can be attached to a station's existing pedestal, thereby further breaking the buyer's purchase plan into steps. The Z pedestal is less expensive than the XY, and it can be switched easily to manual operation.

Automating lens control can also occur as another discrete implementation.

Additional factors may figure into selection of pedestal and head hardware. For example, some pedestals cannot be rolled through a standard door, from studio to studio or to the repair shop. Some can.

At bottom, assessing whether each purchase gains production, as well as cost, benefits may become the deciding factor in adopting such a modular, step-by-step implementation of robotics.

Arguably, if the control system offers the ability to store and re-execute shots when a producer chooses, each level of automation—pan/tilt or lens or Z axis or XY axis—may improve on-air efficiency and continuity, if not also reducing staff head counts.

Control systems

All in all, says one manufacturer, the control hardware comprises only 10%-20% of system cost. But choices abound in this area, as the manufacturers compete to differentiate their systems by offering a variety of features and approaches to shot storage and recall in terms of efficiency and user-friendliness.

The number of workstations constitutes a fundamental element of implementation cost and strategy. And stations may find that the more user-friendly a system is, the more functions a single operator at a single station can handle.

In some cases, the control systems can be implemented in modular fashion in tandem with modular head and pedestal implementations. "Our systems can be built upon," says Richard Cooper, national sales manager of Radamec and other robotics for A.F. Associates. "A station could start, for example, with Z control system hardware, then later move up, adding XY control."

Control systems may also differ in terms of their circuitry basics. The choice of processing speeds, for example, will determine the ceiling on how rapidly complex functions can be executed. "You're only as good as your components," says Andrew Duncan, marketing manager of remote control systems for Vinten.

Relative training time may also become a consideration. For example, Vinten designed its Microswift control software and hardware to interface with the lens manufacturer's control system, "rather than using our own controls," Duncan says, adding that, therefore, no new lens control methods need be learned.

Shot storage and recall

The next level in control hardware and features would be shot storage. Tipping their hats to veteran camera operators, the manufacturers suggest the best veterans cannot consistently match the computerized repeatability—and predictability—afforded by shot-storage systems.

Some shot-storage systems offer on-air and off-air options. On-air shot recall coordinates all parameters of movement and lens smoothly, with airable results. The off-air option simply gets a camera in position as efficiently as possible during a period when that camera's feed is not switched to air.

Some systems store pedestal and head positions only; some store pedestal, head and lens information (iris, black level), bringing execution of all functions down to a single command key.

There are also a variety of approaches to identifying, storing and recalling shots—some more sophisticated, and expensive, than others. Basic alphanumeric approaches require that a controller pick a shot, give it a name and store the name. The controller can scan a list of names of

Radamec, like Vinten (see cover), is adding features and, at the same time, offering incremental purchase options

shots on his workstation screen, pick one, then enter that name, commanding a camera to repeat that shot.

Advances have led to "touch-screen" options, allowing an operator to recall a shot with one touch of the screen, rather than entering a shot name. But there are also differences among those.

Radamec and Vinten have developed "tablet" approaches that allow a more graphic identification process—"Jane Box Shot Left," for example, says Duncan. A computer mouse can touch the name on a tablet for recall.

Even more user-friendly, Radamec's See and Select system allows a controller to view 16 shot stills at a time, choose one, then command its execution by touching that shot on the screen, thereby eliminating the need to name a shot or, later, to remember the name.

At the same time shot storage is implemented, a studio may make a fundamental decision about whether to adopt a system that can move more than one camera simultaneously.

If the system allows control of only one pedestal or head at a time, a skillful controller may find his hardware falling behind his ability to prepare for the next shot or segment. A system capable of sending command signals to several cameras simultaneously "gives an editor or producer more real-time options," says A.F. Associates' Cooper.

Motion memory

The latest advances offer the ability to string shots together in a preplanned storyboard approach to production. Radamec's "continuous motion" or "motion memory" features allow a producer to execute a series of shots by storing the shots and the time between them. Each pedestal, head, camera and duration element of the sequence can be configured and reconfigured in rehearsal, until a producer is satisfied with the whole.

Navigation, collision control

The tough competition among system designers has led to notable advances in navigation and collision control systems.

Some pedestals require two command executions (left-right, to turn wheels, then forward or back), some only one command, to make one move. And while some pedestals regularly "forget" their navigation start-point mark on the floor, Radamec's Dead Reckoning system updates its position by reading a bar code on the wall. Additionally, Radamec uses infrared receivers and emitters around the pedestal base (rather than memorized boundaries) to avoid collisions.

By Peter Lambert, BROADCASTING

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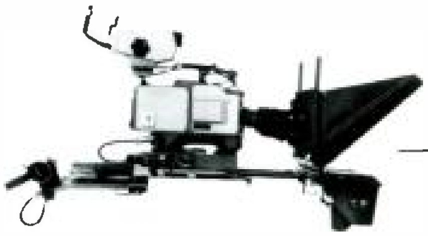

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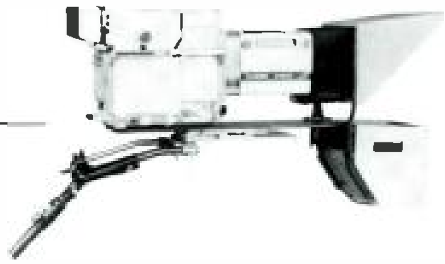

Radamec EPO RP2

The new EPO RP2 robotic camera system is not only small enough for close positioning in multiple camera sets, but perfectly sized to navigate smoothly, quickly and safely around studio floors without tapes or tiles.

It's a free-roaming studio pedestal with a unique navigation system that offers exact camera placement time after time. An optional collision avoidance system gives you added safety as well.

The RP2 incorporates an integrated extension of the Radamec EPO Advanced Robotic Control System (ARC), controlling camera height, pan, tilt, zoom, focus and X/Y floor positioning with a 500-shot storage and recall facility.

An optional, full-manual override—crab and steer—and an operator control on a X/Y basis ensures the RP2's *total* flexibility.

It's the first, second-generation robotic pedestal, especially designed for new ENG/EFP smaller cameras and large studio cameras. Only a company with the insight, experience and knowledge of Radamec EPO could have done it.

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of the year. In this case, the transmitter is simply placed on a loading dock, where the temperature is regulated by opening and closing dock doors. In warmer climates, refrigerated trucks may be used.

Prior to the testing of a complete transmitter, individual components normally are thermal tested in more readily available portable chambers. Subassembly testing enables the majority of problems to be addressed earlier in the design process. Practical testing of high and low temperatures must be conducted at least 10° outside of the specified ambient temperature range to provide a reasonable margin of operation.

A solid-state transmitter during high-voltage discharge (lightning) testing.

- *Humidity.* A typical humidity range specified for a transmitter is 0% to 95%, non-condensing. Humidity testing — conducted in conjunction with temperature testing of individual components — enables a manufacturer to identify and protect areas of the transmitter where high humidity may lead to component failure.

- *Altitude.* Broadcast transmitters must be designed to operate at altitudes ranging from sea level to 10,000 feet or higher. With solid-state transmitters that require low DC voltages, the breakdown of high voltage in air may affect the transmitter's output tuning network. Operation at high altitudes also will have a significant effect on the cooling efficiency of the air system.

Although altitude chambers are available for lease by some aerospace manufacturers for this type of testing, it is more cost-effective and practical for transmitter manufacturers to design for nominal conditions, then build in a significant safety factor. Extensive guidelines, formulas and curves aid transmitter manufacturers in designing for altitude. Considerations include high-voltage point surface roundness, voltage level, current, frequency, temperature, humidity, dust and desired safety factors. A manufacturer should be able to provide you with comprehensive altitude information for the transmitter you are considering.

Conclusion

Advances in measurement technology and testing procedures make it possible for transmitter manufacturers to conduct comprehensive ruggedness tests as a part of new product design. By allowing transmitter field-readiness to be verified before market introduction, ruggedness testing is proving highly successful in increasing reliability and reducing the number of initial field problems. The results of such testing should provide important criteria to broadcasters interested in purchasing transmitters designed to survive real world environments.

➡ *For more information on ruggedness testing, circle Reader Service Number 305.* ■

Inside standards conversion

In the ever-increasing world of international TV transmission, standards conversion has become a hot topic.

By Curtis Chan

The Bottom Line

International TV standards conversion is a part of everyday life, and does not have to be confusing. If you recall the days of black-and-white television, it seems amazing that TV pioneers were able to produce such good pictures (at that time) through such a crude system. Equally amazing is that the system was fairly well-defined (although line and frame standards have changed) back in the 1930s. Today, standards conversion technology has come a long way and its ultimate measurement in performance is better image quality. With the ever-increasing technology, picture quality will only get better.

Chan is a principle of Chan & Associates, Fullerton, CA.

Until the 1960s, different world transmission standards did not really matter. But as program origination and exchange became an increasingly international operation (compounded by the growth of satellite communications), the difference in transmission standards became an important concern. This problem was addressed by the standards converter. Revolutionary strides have been made in standards conversion technology since its conceptualization in 1959. Briefly, standards conversion is the process of changing the line and/or field rate structure of a TV signal. The process requires the generation of pictures from an insufficient amount of data in at least two dimensions: in time through picture fields, and vertically through the line structure of the picture.

Standards converters, like other video equipment, vary tremendously in performance relative to their price point. The price point corresponds directly to the performance of the system, as well as to the number of inputs, outputs, tape formats and TV standards that the product supports. Performance relates directly to the decoding, processing and encoding quality, as well as the quality of the motion-adaption technique. Therefore, the ultimate measurement of standards converter performance is image quality: smooth motion (minimal judder or motion blur), no perceptible loss of sharpness and no distracting artifacts.

The standards dilemma

Today's standards converter must extend well beyond the obvious NTSC, PAL and SECAM systems. These standards include the PAL-M and PAL-N in South America, NTSC-4.43 in Europe and NTSC-3.58 in Japan. There also are 2-wire or Y-C non-composite standards, which have approximately 15 variations. Add to these the various analog component standards, such as RGB and YUV in 525/60 and 625/50 line/field systems, and three standards for Betacam and MII. In addition, there are the more recent D-1 and D-2 serial and parallel digital formats, as well as D-3, D-Extend, DCT and HDTV. The application of the term "standards" could even be questioned here. The complexity of standards is dwarfed only by the market opportunities that exist.

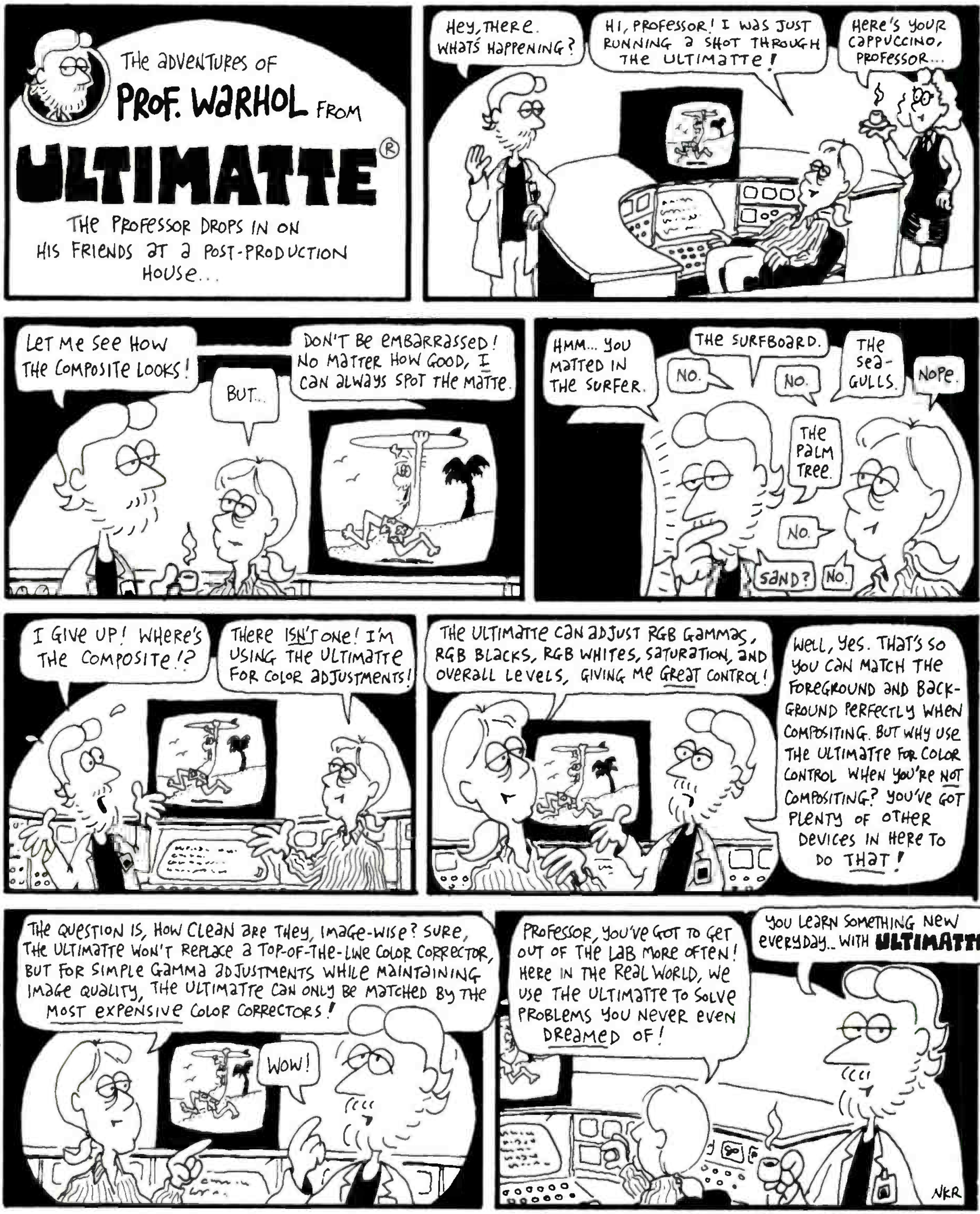
Steps in conversion

The *decoding* of signals is the first process in the chain by which a converter's performance is assessed. The use of a comb filter decoder can be used to separate the coded input into luminance and chrominance components. In some instances, where the chroma is not consistent across the filter apertures, the decoder must smoothly adapt to a more simple decoding process. The terms *real time adaptive* and *comb filter decoders* describe such converters.

Remember that all decoders reduce the bandwidth in one way or another, particularly for PAL, PAL-M and SECAM. Converters use spatial and temporal low-pass digital filters, both of which reduce bandwidth in their respective dimensions, partially because of their spatial/temporal frequency response.

All converters employ digital techniques and must *sample* the incoming signal. In order to retain the widest possible band-

Continued on page 70



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Circle (55) on Reply Card

Standards conversion from our point of view: the manufacturers respond

Standards conversion manufacturers were asked to comment in regard to their conversion processing as well as the following questions:

1. What video attributes, if any, are being compromised in your approach to conversion processing?
2. At what level of correction does your conversion method fail?
3. What preparations have been or are being made to implement the bidirectional conversion between NTSC, PAL and/or SECAM to HDTV and ACTV?

The following responses were received:

AVS

The formula for a competent motion-compensated standards converter has three stages:
1. *Motion estimation*: The process of generating a vector list of all the motion vectors in the picture.
2. *Motion assignment*: The process of assigning a vector to each output pixel using the previously calculated vector list.
3. *Interpolation*: The process of interpolating the output pixels using the allocated motion vectors.

The AVS Cyrus uses a reliable motion estimator technique based on the Pel Recursive method. This method has been chosen because it produces accurate vectors for small movements. To cover the larger movements, the method is applied recursively by displacing the previous picture by an amount estimated from the latest measurements. Another advantage of this method is that it generates one vector per pixel. This density of vectors greatly eases the method of vector assignment, eradicating possible errors in the assignment process as compared to some motion estimator techniques that generate one vector per block (e.g. 8×6).

Care has been taken in the design of the converter not to compromise picture quality. However, failure does occur in such complex systems, and the rate varies from converter to converter. Some converters with high failure rates attempt to disguise the artifacts by defaulting to linear conversion in the areas of failure. This results in the loss of sharpness in areas of motion. Cyrus, however, relies completely on the vector information to generate the final standards converted image. Therefore, the picture always remains sharp because it never defaults to linear conversion. This approach is essential in applications where high motion vector reliability is required.

Cyrus performs highly transparent bidirectional conversion between all standards. All studio inputs and outputs are available in Cyrus with extremely high specifications.

CEL Broadcast

CEL Broadcast has concentrated its product range on reliable workhorses that present some of the best in value engineering.

The quality of any standards converter is generally dictated by the core design of the decoding and encoding processors, together with the rationales adopted in the digital standards conversion processing.

CEL has used analog and hybrid techniques in decoding, offering stable high-resolution results. The P256 Worldmaster, Standi and Tetra-plus are capable of accepting a wide range of video quality inputs, even in adverse conditions.

The P256 Worldmaster uses highly optimized 2-field conventional digital processing with linear temporal and vertical filtering. Many observers report that subjectively this is as good as, if not better than, more expensive 4-field designs.

The 4-field P165-50 Tetra-plus and Standi systems can dynamically optimize the temporal filtering according to the motion detected in the source for best portrayal.

In addition, CEL offers a bolt-on PAL/NTSC digital encoder called the P171. This can increase the precision of the necessary encoding process by several orders of magnitude. Furthermore, it offers the additional benefit of adaptive comb filtering at the output with the reduction of cross luminance and chrominance artifacts.

To date, CEL has not entered the arena with a motion vector-compensated design. The cost of such equipment presently restricts it to the top sector of the market. Also, high-definition downconversion is not presently offered. However, the Worldmaster can optionally accept VGA graphic inputs up to 800×600, as well as all world broadcast TV standards.

I-DEN

The I-DEN IP-450 is a multidimensional, full transcoding standards converter developed to be functional, full-featured, yet affordable. The system supports the most popular world standards as inputs

Continued on page 73

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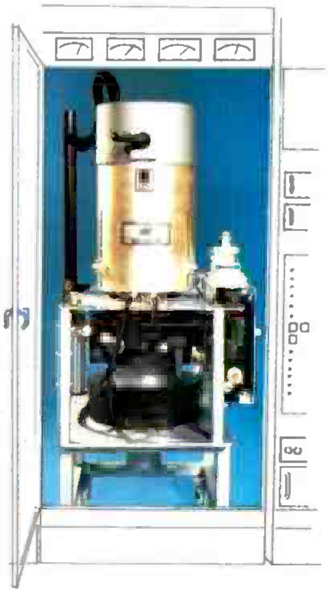

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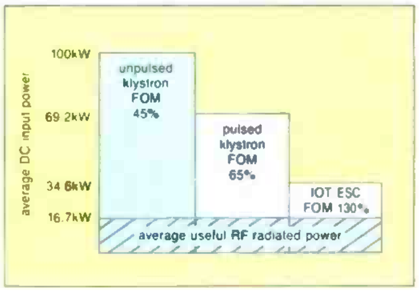

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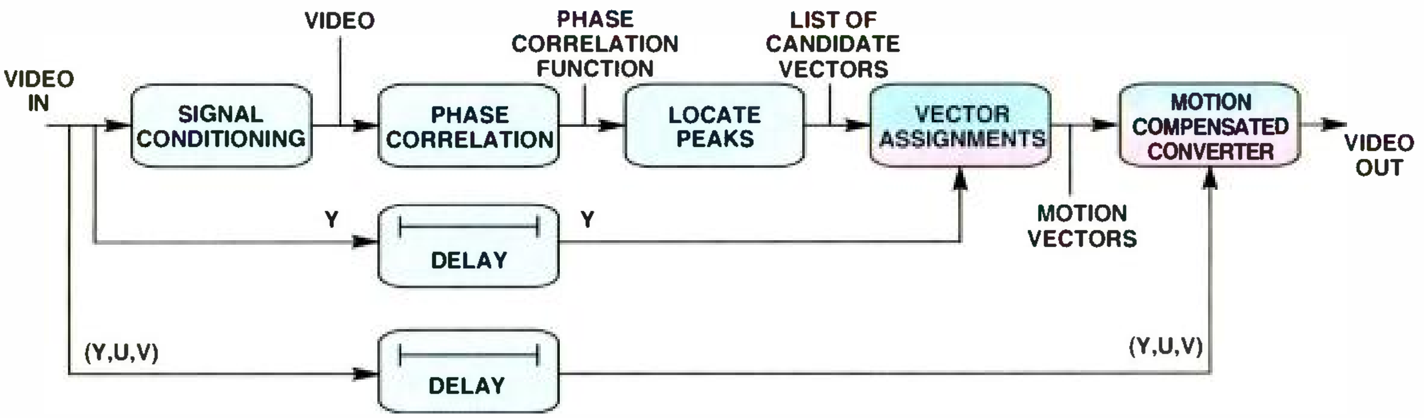


Figure 1. A diagram of the phase correlation process.

width, converters attempt to use as high a sampling rate as possible. Although the choice of sampling frequency is not normally the limiting factor in determining the bandwidth of the standards converter, most units now conform to the CCIR 601 recommendation. The use of 4:2:2 architecture enables the converter to conform to world standards. In addition, 13.5MHz is mathematically related to both 525- and 625-line signals.

The technique perhaps most common to all standards converters is *interpolation*. This process uses information from a number of adjacent TV lines and fields, while applying a weighting factor to each of these lines and fields. They are then combined to generate the output line. The values of the weighting coefficients (or apertures) are proprietary, because different values yield different conversion characteristics. Historically, much of the preliminary work was performed by the BBC research department during the late '70s, which eventually lead to the famous ACE converter of the '80s.

One way to achieve the correct average would be to repeat every fifth input field for 625 to 525 conversion or, when converting from 525 to 625, omit every sixth input field. This would solve the program duration problem, where a 1-hour program would result in either a 50- or 72-minute length, but would prove unacceptable temporally (that is, field related) because of motion judder. This is due to the 10Hz difference in the field rate. The trick is to intelligently interpolate between neighboring fields and lines of the original standard. Some companies use an aperture that takes a contribution from four lines from each of four fields, making a total of 16 input lines contributing to every output line.

Some companies have devised their own forms of interpolation techniques.

- *Spatial interpolation* uses two or more lines from each field of the input standard and are combined in various proportions to create the new line in the output standard. Newer systems use either 2- or 4-line spatial interpolation to improve vertical resolution.
- *Temporal interpolation* or *field interpolation* uses similar techniques as spatial interpolation to create new fields. In newer designs, the weighting coefficients are calculated in real time by the system CPU and written into the filter hardware. Older designs used large look-up ROM tables.
- *Motion adaptive interpolation* approaches the problem by detecting motion in small local areas of the input scene and applying that motion to adapt the interpolation aperture on a pixel-by-pixel basis. (Less-advanced systems use a fixed 3-D interpolator, which lacks vertical resolution in static areas of the picture or produces a high degree of judder.) With a 2-D horizontal/vertical filter, the response is altered to a "bell" aperture, allowing full temporal resolution (motion).

A "flat" aperture with an enhanced cutoff frequency will maximize vertical resolution (static pictures). Again, the trick is to reduce the amount of temporal filtering when the picture doesn't include motion, and gradually fade in more of the filter function as motion in the source signal increases.

What's wrong with my standards converter?

The interpolation process places restrictions on stationary and moving picture information. The interpolation process can be considered a form of low-pass filtering, and can limit bandwidth on stationary information. It is also a function of the motion of the picture. Furthermore, interpolation handles information that may already have been distorted in a TV signal chain in which numerous filtering processes are at work: camera lag or shutter, DVEs, noise reducers, encoders, decoders, A/D and D/A converters and the TV signal.

The display phosphor lag and the response of the human eye further add to the distortion. These subjective artifacts can be observed as a result of standards conversion, with the most commonly noted artifacts being judder and softness. Judder manifests itself as a temporal alias. It is caused by the narrow temporal apertures with objects that are moving faster than the Nyquist limit of the temporal sampling frequency. Softness is caused by the use of a temporal aperture that is too wide. Narrowing the temporal aperture improves resolution by extending the temporal frequency response.

Compromises

A typical TV scene contains a random selection of moving and stationary objects. To obtain the best compromise during conversion, the aperture selected must reduce motion judder while maintaining a reasonable picture resolution. Early BBC achievements resulted by tailoring the shape of the vertical and temporal apertures simultaneously to reduce visible artifacts in the converted picture. Today, many high-performance systems use similar techniques in which vertical response is a function of motion, and temporal response is a function of vertical detail.

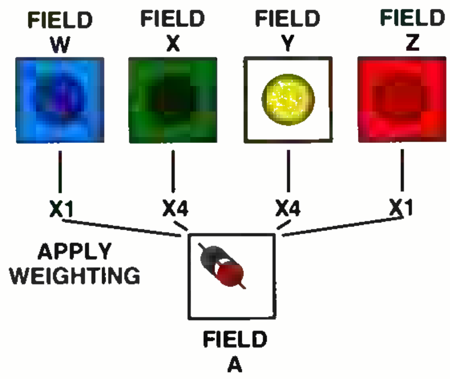


Figure 2. *Interpolation of a moving object using temporal construction.*

This seemingly simple task is actually quite tricky. For example, consider a ball moving slowly across many fields. If you blend these frames together, you get a blurred image of the ball. If it is moving fast, you may see two balls. From another point of view, there are approximately five 625-line fields for every six 525-line fields. It follows that there should be approximately 1.2 times as much movement between fields of the 625-line picture as occurs between fields of the 525-line image.

Realizing that interpolation processing yielded somewhat sketchy results, converter designers turned to motion adaption. This technique, in its simplest form, analyzes the picture as static or moving, then chooses the appropriate aperture. Not surprisingly, this approach yielded unsatisfactory pictures because few programs contain only static or moving objects. Unfortunately, the adaption process can also introduce artifacts as apertures are changing, depending upon the picture content. Because of this, few people rely on the sole use of motion adaption.

Modern approaches

Until recently, the fundamental conversion process of standards converters had not changed much. This does not mean that standards converters are inherently bad. On the contrary, depending upon the level of investment, each category of standards converter is optimized for its particular market niche. It wasn't until the last decade that quantum leaps have been made in conversion. Some of the direct benefits stemmed from algorithms developed for data reduction. These algorithms were targeted to reduce the amount of information required for the transmission of moving pictures. This work led to the development of techniques grouped under the heading *motion estimation and compensation*, which was later recognized for its use in standards conversion. But what exactly is the difference between motion estimation and compensation? Motion estimation is the process of measuring and analyzing the motion in a picture sequence and generating appropriate vector fields. Compensation is the process of applying the generated vector fields to the conversion.

The ability to predict the output of a pixel across an image is the key to the latest generation of converters. Priced from $75,000, such converters use sophisticated motion adaption or compensation. What makes these converters different from others is the way in which they deal with motion compensation or adaption. The most highly rated techniques today involve block matching and gradient approximation.

Block matching

In block matching, the system compares a small area of a picture (a block) with previous picture information and, by finding the best match, deduces the motion of that area. Each pixel in a small block is translated by every possible vector within the block to see if it matches the next field. If a match is found, then that vector is assumed to describe the motion of the block of pixels. By establishing the vector, the converter creates a new image of the moving object by shifting that block of pixels by an amount equal to the vector times the output field offset. Adequate results are usually obtained, assuming the system finds the correct vector. However, there are fundamental limitations to this type of system, which fall into three categories:

1. aperture effect
2. detail
3. low resolution

In aperture effect, if a block is too small, it will provide good resolution but will cause problems with spurious matches, giving high error rates. Increasing the block size reduces errors with large motion at the expense of resolution. In other words, small areas of the scene or even pixels may have different motion vectors (speed and direction) so that if a large block is looked at, some of the smaller detailed areas will be overlooked. This will result in an increase of judder artifacts and loss of resolution.

In order for a vector system to work, it must be able to distinguish an object from the rest of the picture. However, this is nearly impossible in a completely uniform picture sequence. Thus, in block matching with small areas of the screen, a plain area of the picture doesn't have to be large to confuse the system. Finally, block matching attempts to produce a motion vector describing the movement of a small block of pixels (8×8, for example). Provided an object uses all 64 pixels, the motion will be correct. However, at the edges of those objects, many could be part of the background but will still be moved with the recalculated object. This leads to the breakup of the moving object's edges, or reduced detail and resolution.

Another area in which simple block matching should be addressed is the complexity that rises with the search area. For example, take an 8x8 area of picture (eight pixels by eight lines) and compare it with all other possible 8x8 areas within a larger area (16×16). To achieve this requires 8×8×16×16 calculations. These calculations must be repeated for every pixel in the picture. Complexity quickly increases as the area of search widens and as the area to be matched widens. To some degree, a hierarchical strategy can alleviate some of the problem. This type of strategy involves applying the search to a defocused picture where each point represents several of the original points blurred together. The estimate formed from this can be applied to a smaller area in more detail. This process is then repeated as needed. Employing these and similar techniques allows this form of technology to be useful in low-grade video applications.

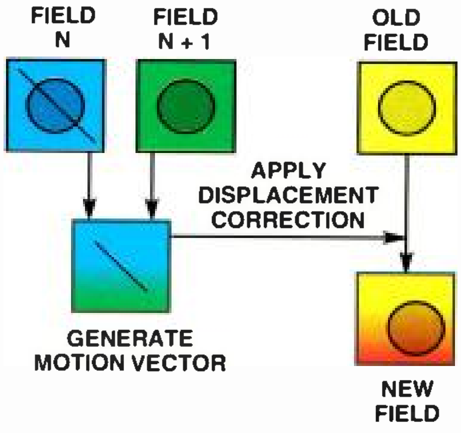


Figure 3. *A motion vector repositions the object in the newly created output frame without altering the shape or introducing blurring.*

Gradient approximation

Another approach to motion evaluation is *gradient approximation*. Unlike block matching, which attempts to match areas of pictures, this method relies on the characteristics of moving objects and attempts to track their motions. A moving object in a scene tends to have a blurred edge in its direction of motion. This may be used by considering the edges of objects in more than one scene to give an estimate of motion. The "gradient" of this change from scene to scene is the measure of the velocity of the object. The major problem is that the edges of objects are often poorly defined. Therefore, you must perform the calculation over several fields, improving the estimate each time. The behavior of this method is dependent on typical characteristics of video. Furthermore, it may vary with different sources (tube or CCD camera) or previous processing, such as noise reduction or data rate reduction. Processing across several fields also may cause problems with complex motions, such as rotation or cuts.

Phase correlation

Phase correlation, which was originally part of the BBC developments in the late 1980s, is now an integral part of several high-end standards converters. Unlike other measuring methods targeted for teleconferencing, phase correlation was developed for real time broadcast video. And unlike block-matching systems, which analyze the video directly to estimate motion, phase correlation is a 2-step process that uses the phase differences of its 2-D spectrum. First, the frequency spectra of two fields of video is obtained by using Fourier transforms to reduce the number of calculations needed. The procedure analyzes the phase difference between the spectra and generates a 3-D correlation surface. The surface has peaks at positions

Continued on page 74

Continued from page 68
and outputs: NTSC, PAL, PAL-M and SECAM. All formats, composite video, Y/C, Y/R–Y/B–Y and RGB sync are also available in and out.

The conversion process uses a 2-field filtering method. Motion detection automatically selects between 1- and 2-field conversion, based on the amount of motion in the video. The automatic changeover process ensures a high-quality image with a minimum of judder.

A 21-line interpolation from NTSC and 25-line interpolation to NTSC process is used in conversion. The interpolation assembles the video into *blocks* that are averaged from 21 to 25 lines, or 25 to 21 lines. By using the blocking method, the video is reassembled into a more natural looking picture than other processes.

Composite video inputs are subjected to a logical comb filter. This ensures wide bandwidth performance and clean separation of luminance and chrominance signal components.

A straightforward control panel allows quick integration of the unit into any system. Additional features include full-frame TBC/FS functions, proc-amp with presets, freeze, integral color bars and blackburst, auto chroma control and DOC.

Quantel

Quantel is unique because it offers standards conversion as an automatic and standard facility in all of its graphics creation, storage and presentation devices. Quantel systems already handle conversions between all major standards on a regular basis. To meet the requirements of broadcast graphics, the process is high-quality, flexible and fast.

This performance is achieved by storing all images on disk at their original recorded resolution and converting on replay (automatically and at a speed transparent to the operator) using dedicated custom hardware. In use, a Paintbox, Paintbox HD or Picturebox can therefore contain a mixture of images at virtually any resolution and aspect ratio, including 525, 625, all proposed HDTV standards and beyond.

Because the process is completely bidirectional and all Quantel systems are internally digital component, the only potential compromises are imposed by the source and replay formats. Even here, the user is offered as much flexibility as possible. For example, a 525 unit can replay a full HD image at lower resolution (re-aspected or letterboxed) or a user-defined section of the image at its original resolution.

Snell and Wilcox

Snell and Wilcox designs and manufactures a complete range of standards converters: 2-field, 4-field, motion compensated, film and HDTV models.

Theoretical boundaries force the designers of all linear converters to make engineering compromises. Most designs today are based on the BBC 4-field approach. Even motion-compensated converters are not immune, with some designers resorting to hierarchical or recursive scanning approaches to compensate for inaccuracies or unreliability caused by lack of processing power.

Alchemist with Ph.C (phase correlation motion estimation) makes no compromises. Its design goal is to deliver an output good enough to be considered an original source. Rather than simply applying vectors to the result (read side) of a conventional linear interpolator, Alchemist and Ph.C work together as a logical and coherent system. Alchemist, as a standards converter, was developed in tandem with the motion estimator. It takes full advantage of proprietary, predictive interpolation algorithms, which were designed specifically for motion estimation, to perform a non-linear, forward-looking write-side vector modification in order to build output pictures.

Almost all linear converters fail on fast-moving images. Motion-compensated conversion copes with this problem, but some less-sophisticated systems still have trouble resolving complex motion, especially concealed and revealed objects and large area displacement.

Massive processing power and subpixel accuracy were envisioned for Alchemist with Ph.C, enabling it to track high velocities and resolve fine detail. To resolve revealed and concealed objects, the unit's proprietary bidirectional vectoring algorithm projects objects either forward or backward in time, depending on where the most information in the original scene is detected.

Snell & Wilcox has addressed the need for studio-quality HDTV downconverters and upconverters. The range includes the HD2100 downconverter; the HD3100 production cross-converter, which performs conversion between field rates as well as line rates; and the HD5100, a studio-quality upconverter.

Thomson Broadcast

The Thomson TTV 7810 motion vector-compensated standards converter was originally conceived as part of Europe's research and development program for HDTV. Its design philosophy is based on the premise that standards conversion should be performed in the digital domain during the digital production process and before transmission.

From a design standpoint, there are three principal motion estimator techniques to choose from: block matching, phase plane correlation and Pel Recursive/gradient technique. Unlike the first two (which are block-based), the latter is a pixel-based technique. Based on displaced field-difference computation, this technique uses predictors updated by gradient computation. It is capable of handling wide-range and complex movements in the picture.

Among the criteria for the TTV 7810 was the need to perform artifact-free standards conversion, not only for today's television, but also for HDTV. Because of pixel-based motion estimation with subpixel precision, the unit is well-suited for handling complex moving patterns, including zoom and rotations, and for preventing geometric distortions and loss of resolution. Its wide-range motion estimator and wide-range motion-compensation interpolator makes it ideal for converting fast-moving pictures. The unit features fully digital processing with four digital CCIR 601 inputs and four digital CCIR 601 outputs. It is bidirectional, accepting 525- and 625-line video signals for conversion. A redundant power supply also is featured.

The Thomson standards converter converts incoming interlaced video into a progressively scanned picture. Then, by using Pel-Recursive motion estimation, it computes one motion vector for every single pixel with the precision of a quarter of a pixel. The wide dynamic range of motion estimation/compensation (±31 pixels horizontally, ±15 pixels vertically) is particularly useful when processing the rapidly moving pictures typical, for example, in sports programming. This means that the unit is capable of processing an NTSC video signal that displays a downhill skier moving as far as 2.6 picture widths/second horizontally and 1.9 picture heights/second vertically without motion artifacts.

Video International Development

The Video International proprietary method of motion vector interpolation differs from other conventional methods in the advanced method used to process the generated motion vectors (i.e., the method used to select the vectors that will be processed further over those not generated by motion, which cause false images). This method was developed after studies and computer simulations of the BBC-developed phase correlation method revealed shortcomings. It is based on work by the Heinrich Hertz Institute of Germany.

The two important attributes of the DTC 4500 motion vector interpolation processor are: 1) its size, a complete 4RU-height motion vector standards converter; and 2) uncompromised video quality even during difficult motion sequences.

Automatic fallback to 4-field interpolation is a feature that sets the unit apart from other motion vector converters. This feature is activated when motion vector information becomes too fast and may cause false images.

Development of bidirectional converters for conventional and HDTV standards is ongoing. Additional products will be introduced in the future.

Vistek

The Vistek VECTOR-VMC TV standards converter is designed to offer bidirectional conversion between all existing and proposed world TV standards, providing a portrayal of motion with no compromise in signal quality.

The motion measurement technology used in the VECTOR-VMC effectively eliminates the motion artifacts (such as judder) associated with interpolating standards converters. The development of a new approach to the problem was considered necessary after extensive development of the phase correlation system with the BBC and thorough evaluation of gradient methods. The resulting advanced 3-D predictive, spatial correlation system is not restricted with a maximum vector range, number of available vectors and so on.

Vistek's PHAME algorithm operates in the spatial domain. The use of hierarchical estimation techniques allows an accurate estimation of small objects with a high degree of tracking range. Also, it can be implemented in real time, achieved through the use of such technology as ASIC and other custom-integrated circuit technology. The hardware implementation of the PHAME algorithm consists of a number of identical processors in a single instruction multiple data (SIMD) configuration, with each processor handling a specific spatial picture zone. The architecture has been optimized to ensure ease of expansion to cater to HDTV motion estimation.

➡ *For more information on standards converters manufactured by specific companies, circle the Reader Service Number that follows the company's name:*

- **AVS (circle Reader Service Number 307)**
- **CEL (circle Reader Service Number 308)**
- **I.DEN (circle Reader Service Number 309)**
- **Quantel (circle Reader Service Number 311)**
- **Snell & Wilcox (circle Reader Service Number 312)**
- **Thomson Broadcast (circle Reader Service Number 313)**
- **Video International Development (circle Reader Service Number 314)**
- **Vistek (circle Reader Service Number 315)** □

corresponding to an object's motion. As the surface is analyzed, each peak represents a possible vector with which certain objects might be moving. Next, these candidate vectors are used in an assignment stage that tries to find a suitable vector for each pixel in the first field. Then, each pixel is translated by the vectors suggested by phase correlation to see if the result matches the next field. The vector assignment process reduces the needed computation by trying only those vectors identified by the phase correlation process. Another advantage is that it is possible to match the correct vector to individual pixels rather than to a block of pixels. This is feasible because time is saved by not checking blocks with spurious vectors. Thus, the high cost of entry is outweighed by the significant improvements in video quality. (See Figure 1.)

Vector motion compensation

Perhaps the most recent entry into standards conversion is vector motion compensation, which combines a technique known as spatial correlation with a 3-D motion predictor. This method generates missing information by using predictive analysis to estimate the correct information in each area of the picture.

The difference between interpolation and motion compensation can best be described in conjunction with Figure 2.

Figure 2 depicts the result of temporal construction by interpolation of a simple object moving across the screen. Assume that the temporal weighting coefficients are 1:4:4:1 (Field W contributes $^1/_{10}$ to the output picture; Field X contributes $^4/_{10}$; Field Y, $^4/_{10}$; Field Z, $^1/_{10}$.)

The addition of each field contribution scaled by its coefficient gives the output picture. Thus, in case 1, if the object is stationary or moving slowly, it will contribute almost equally from all locations with the output being a near-reproduction of the input where:

Field A= [1×(Field W)+4×(Field X)+4×(Field Y)+1×(Field Z)]÷10

However, in case 2, if the object is moving, the output picture contains an image that isn't a true representation of the original. As the speed increases, the output image gradually separates into four discrete images.

The problem is compounded because interpolation also is performed vertically across lines. This is not because interpolation-based converters are inferior. It simply has to do with the scheme of implementation.

In contrast, vector motion compensation operates by analyzing the motion in a picture to make an accurate prediction of the location of a moving object at the required moment in time. A vector is generated that defines the direction and amplitude of the required movement to place the object in its new position. Literally, the vector is used to reposition the object, as shown in Figure 3. Increasing the speed of motion merely modifies the amplitude of the displacement vector V, and the ball retains its correct shape with no blurring of the image.

The vector motion compensation scheme uses a hierarchical, successive matching system that combines the advantages of low error rate and large tracking speeds associated with large block sizes with the resolution of extremely small blocks. This staged approach applies intelligence in optimizing between large blocks and low error rates versus small blocks and high error rates. One of the problems associated with motion vector estimation algorithms is the enormous processing capacity needed to provide the required performance. For example, a block-matching system organized as 8×8 blocks with displacements of ± 16 pixels and ± 16 lines operating at integer pixel accuracy to give integer pixel motion vectors requires approximately 110,000 calculations per block/vector. This represents approximately 30 giga-operations per second. In practice, the real requirement is greater, because a simple block-matching estimator is not adequate for standards conversion. Therefore, the importance of an intelligent algorithm capable of estimating small areas and large displacements can't be overstated.

Such an estimator has been based on spatial correlation, which is a development on the principles of block matching. The estimator is augmented for 3-D motion prediction. Final motion estimation and compensation is jointly optimized for standards conversion. In optimizing hardware for this system, a parallel or bit-slice concept to processing is used. A number of identical processors is placed in a *single instruction multiple data* (SIMD) configuration. Each processor handles a specific spatial picture zone.

Standards conversion of complex or rotational motion is extremely difficult. For example, consider the movement of a human arm, a body and a bicycle wheel. It is easy to see that almost every pixel on the screen has a different speed and direction relative to the scene. Such visual activity generates tens of thousands of vectors in real time. It is this type of condition that vector motion compensation has handled satisfactorily.

New challenges

Standards conversion is moving forward rapidly. Traditional markets will see improvements in feature enhancements that control video quality, as manufacturers find innovative ways to bring high-end motion compensation and estimation techniques into their broad-based product lines. This technology will become more accessible as chip technology and software coding advances along with the ability to optimize development and production. The next frontier lies in the world of HDTV.

Editor's note: Does every situation require a full-blown, broadcast-quality standards converter? Perhaps not. In fact, if you simply need to review a tape recorded by an (S)-VHS recorder, the products discussed earlier represent extensive overkill. For such cases, Instant Replay manufactures several consumer VCR models with standards conversion capability. All major standards, including several different flavors, can be accommodated.

The VCRs can play PAL and SECAM with the output viewed on an NTSC receiver. Although SECAM is reproduced in monochrome only, PAL is in full color. In addition, still-frame and slow-motion features are provided. Recording of all standards also is possible, with NTSC and SECAM reproducible on PAL receivers. The product range includes multiple tuners and modulators for NTSC, PAL (B/G, I, DK) and SECAM for France, Russia, the Middle East and Eastern Europe.

Because Instant Replay represents these VCRs strictly as consumer-level units, they would not meet broadcast standards. Circle Reader Service Number 310. ■

Continued from page 58
should prove imperceptible as far as H timing is concerned, because of the relative scales of subcarrier and horizontal time periods. Changing SC/H phase by adjusting the SC phase control will only result in moving the device out of color time.

It is possible to use a blanking inserter at the output of the production switchers. This provides constant, reliable SC/H phase to any record VTR, regardless of the source.

The goal in SC/H phase adjustments is zero degrees. Although an error as large as ±30° may be tolerated, a ±10° phase error is far better. RS-170A calls for ±40° maximum error, but under some worst-case conditions, this is too wide. If one source (house black) was at +30°, the output of a switcher was at −40° and these signals were recorded adjacently on a 1-inch tape, a 70° variance exists between the two segments.

A 5-step program

It is possible to achieve a correctly SC/H phased and shift-free facility:

1. Use a high-quality RS-170A master sync generator. Any back-up/slave generators must correctly lock to the master source. Be sure that other equipment guarantees a locked RS-170A output.
2. Correctly gen-lock all devices to signals that retain the SC/H relationship of the sync generator. Be aware of devices that require individual sync and subcarrier. Different path lengths can change the relationship.
3. Periodically check and adjust the SC/H phase of any device that produces new sync (for example, the production switcher). Always check SC/H phase when timing a device to the system.
4. Make sure house time-code generators are capable of producing RS-170A color-framed time code.
5. Periodically check and adjust the unity picture position of devices that are capable of changing the H-position of video.

No absolute cure

This article has shown how variations exist between different recording formats relating to SC/H phase and color-framing problems. Timing and phasing continue to be troublesome for almost everyone. Unlike other concerns in video and television, digital systems are not immune.

In addition, these issues exist when using digital VTRs as well. (D-2 behaves like a 1-inch VTR with respect to color framing.)

Perhaps the best solution is to carefully track the SC/H phase and H-position as the studio is initially constructed. When maintenance takes equipment out of the system, ensure that it is checked and adjusted when re-installed. By periodically monitoring the phasing, errors can be kept to a minimum. When the video is placed on air, no surprise H-shifts or significant phase discrepancies should exist.

BIBLIOGRAPHY

The following publications are recommended for further information on SC/H phase and color framing:

1. "NTSC Studio Timing: Principles and Applications." Grass Valley Group.
2. "Model 51 Editing System Installation Guide." Grass Valley Group.
3. "110S Frame Synchronizer Operator's Manual." Tektronix.
4. "The Television Engineering Handbook." K. Blair Benson, McGraw-Hill.

Editor's note: This article has been condensed from its original length.

➡ *For more information on equipment to measure SC/H phase, circle Reader Service Number 304* ■

Continued from page 28
parametric EQ, filters, dynamics and aux sends; 8 aux sends per channel; 24-track random-access digital audio storage; Vision Track random-access video storage allows simultaneous audio and video conforming edits; non-destructive editing; central control of patchbay; central control of VTRs and ATRs.

Circle (364) on Reply Card

Expander/gate

By dbx

- **Model 172 SuperGate:** uses 24dB/octave voltage-controlled filters (VCFs) for selective isolation of signal; parametric filter controls; Transient Capture Mode uses precision linear-phase all-pass filter to insert 0.3ms of delay in main signal path; dedicated expander ratio control; OneShot mode allows creation of consistent note length from irregular drum hits; high-resolution, easy-to-read LED displays.
- **Model 120XP:** synthesizes waveform modeled bass notes exactly one octave below the low bass information found in most musical program material; provides separate level controls for superlow 36Hz to 56Hz and ultralow 26Hz to 36Hz synthesized bass; separate subwoofer signal output subwoofer level control; selectable 80Hz and 120Hz crossover points.

Circle (353) on Reply Card

Portable synthesized receiver

By Sony

- **WRR-810A:** delivers high-quality sound for ENG; offers field producers and broadcasters up to 94 selectable wireless frequencies; PLL operates in TV channels 68 and 69; attaches directly to ENG Betacam equipment; two AA-sized alkaline batteries provide six hours of operation.

Circle (367) on Reply Card

Digital multitrack recording

By Tascam

- **DA-88:** 8-track digital multitrack recording system; features 8mm cassette transport that records on Hi-8 tape; records up to 100 minutes on standard 120 tape; can fit entire CD project, feature film or video project on one tape; 44.1kHz or 48kHz recording with a variable pitch of ±6% at each sampling rate.

Circle (371) on Reply Card

Time-code routing switch

By NVision

- **NV3064-TC:** used for routing time-code signals to videotape recorders, RDATs and other analog/digital devices that conform to the ANSI/SMPTE 12M-1986 time-code standard; features processed outputs and controlled rise time with 2.5V peak-to-peak amplitude independent of time-code rate; 64×64 matrix.

Circle (360) on Reply Card

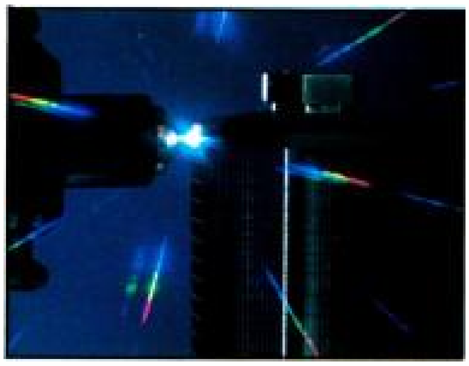
UHF wireless microphone

By Vega

- **662A:** updated version of the 600 series UHF wireless microphone system; implements programmable grounding of the

Continued on page 82

Applied Technology



VM700A with Option 21

By Shu-Ju Wang

Effective performance of video cameras is an important factor in any successful studio. Determining the level of performance, however, can be difficult. Many measurements require cumbersome manual equipment with inherently long setup times. Often, the equipment must be operated by highly technical, expert users. In addition, some camera measurements combine individual tastes and judgments that are often made "on the fly" during a shoot, with disregard for meticulous accuracy. As a result, the process of evaluating a camera becomes challenging and subjective.

So exactly what kind of measurements would produce the most meaningful information in assessing the performance of a modern CCD camera? The most likely parameters include colorimetry, CCD defects, fixed pattern noise, frequency response, aliasing, vertical smear, geometry, registration, gamma, detail and shading. This article examines these topics in camera operation. It may provide insight into design parameters of an instrument, such as the VM700A video measurement set, which is capable of making such measurements on a semi-automated basis by using the Option 21 camera measurement software.

Colorimetry

An important characteristic of any camera is its ability to reproduce colors. Colorimetry measurements tend to be highly subjective. Monitors are closely watched to see the effect of adding or subtracting color. The goal of the adjustment is a specific color condition that is hard to quantify without a familiarity of color science. Because colorimetry measurements are difficult and sometimes tedious, many users have been reluctant to attempt them.

A desirable solution is a semi-automated measuring instrument to quantify colorimetry adjustment. The system should allow measured information to be stored and made available for use. It also should provide a reference to calibrate the color performance of multiple cameras or evaluate cameras for purchase.

Wang is a senior software engineer for Tektronix Television Division, Beaverton, OR.

Colorimetry measurements involve three critical parameters: the color temperature of the light source, the CRT phosphor type the camera was adjusted for and the gamma of the camera. Commission International de l'Eclairage (CIE) color notations can be the basis of measurement. Using several parameters, these notations describe all visible colors within a 3-D cone-shaped space. The CIE system enables one or two overall parameters to quantify the color reproduction capabilities of the camera.

In addition, test charts for colorimetry measurements contain patches of a range of colors. Each patch is assigned a default reference number, based on the Macbeth Colorchecker — a widely used test chart in North America. Because colors change appearance under different lighting conditions, measurement results also must change. Accordingly, reference numbers are needed for light temperatures 3,100K (studio light) and 6,500K (daylight). To extend the test system beyond strict "lab" conditions, users are permitted to design their own color charts and light sources via softkeys and the "configure" mode of the measurement instrument.

External variables for these measurements include the reference number of the chart selected and source color temperature. Primary camera variables that affect performance are the phosphors and the gamma adjustment. The measuring instrument should provide the standard phosphor coordinates (NTSC, EBU and SMPTE) for colorimetry measurements.

Gamma is a correction applied in the camera to compensate for the non-linear response of display monitors to changes in light. In a perfect camera system, a change in light input causes an equal change in light output, and the total gamma is a value of one. The instrument permits a selection of one of three gamma values: linear (1.0), nominal (0.45) or a measured gamma.

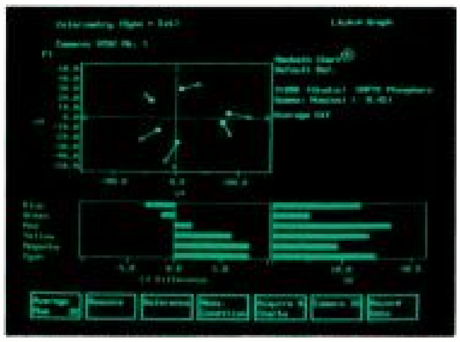


Figure 1. Six color patches from a Macbeth chart are the reference for these displays of luminance, hue and error from a camera under test.

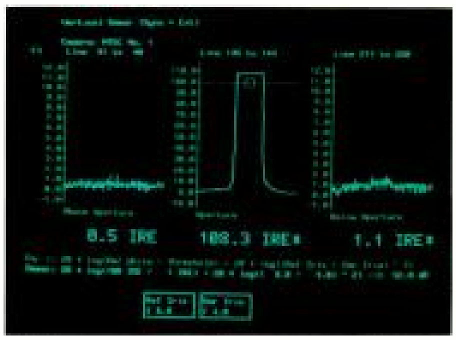


Figure 3. The result of a smear measurement indicates a slight change in video level below the aperture.

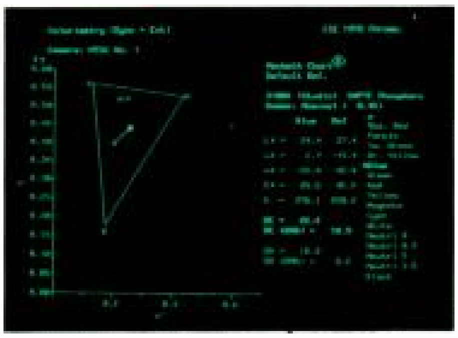


Figure 2. The deviation in output from a single patch of the test chart is shown on a CIE 3-D color space triangle.

Option 21 with the VM700A uses two modes, continuous acquisition and non-continuous, to measure all the colors on the chart once and allow users to examine each color in detail. In continuous acquisition mode, users can monitor up to six colors while making adjustments on the camera. The instrument displays three graphs indicating lightness and hue of the color patch and the amount of error measured in the patch. (See Figure 1.) A graph in the non-continuous acquisition mode indicates the hue of the patch, while text dis-

plays the lightness and any errors in the patch. A front-panel control scrolls through the different color patches. (See Figure 2.)

CCD defects

CCD defects are measured by scanning the CCD target, the array of light-sensitive elements that convert incoming light into electrical charges. The higher the incoming light, the higher the charge. In the ideal array, all pixels will have the same light-to-charge transfer function. Some pixels in a normal CCD array produce a charge lower than other pixels. These pixels can occur individually or in clusters. This discrepancy appears as a "hole" in the camera's output in response to a uniform light. Other defective pixels can create a higher than normal charge, producing a bright spot in the display. Increases in environmental temperature tend to make the errors more pronounced.

Semi-automated CCD defect measurements with Option 21 map defective pixels on a graphic representation of the CCD. This method makes it possible to evaluate each channel within a matter of minutes. By performing the measurement at black (lens capped) and at 50IRE signal levels, both negative and positive deviations in pixel charge can be detected.

Fixed pattern noise

Fixed pattern noise (FPN) refers to unwanted signal non-uniformities correlated to the CCD pixels. The visual appearance is a persistent pattern superimposed on the camera image and on random noise that may be present.

There are foreground and background types of FPN. The primary source of foreground FPN results from aperture variations in individual photo sensors or from structural defects within the CCD device. Foreground FPN is measured with the camera directed at an evenly illuminated white field, while background FPN is measured at extremely low luminance (or capped) black. Its primary source is the variation in dark current among individual pixels. Background FPN increases as the environmental temperature rises.

A certain amount of noise is always present in a CCD. In fact, the greatest difficulty in measuring FPN is in distinguishing random noise, which can mask persistent noise that may be present. This difficulty is countered in a semi-automated system by averaging 64 frames of the incoming image. The averaging reduces random noise by approximately 18dB without affecting persistent noise. The FPN can then be quantified as an rms noise level (calculated by the instrument) and displayed graphically, showing any pixel that exceeds a defined threshold. It is performed at black and at 50IRE signal levels, and indicates the overall FPN level with a single result.

Five graphs of fixed pattern noise — a histogram, waveform, screen plot, expanded screen plot and noise spectrum — give the operator visual feedback. It is important to note that these graphs are visual aids and are not guides for making visual measurements.

Vertical smear

Vertical smear, seen as vertical streaks in a TV monitor, are particularly noticeable in shots with a dark background. Their origin stems from the structure of interline transfer CCD devices, which consist of photosensitive cells interlaced with transfer cells. During vertical blanking, the charge in the photosensitive cells is shifted into transfer cells, then clocked out. As the charge is shifted, excess charge from the photosensitive cells can leak into the transfer cells.

A semi-automated approach provides a standard to evaluate the smear value. See Figure 3 for a display relevant to this measurement.

The VM700A measurement technique consists of overdriving the light-sensitive elements of the CCD to test the ability to handle excess charges. The test method uses a black window chart with a small aperture that allows light to enter. The camera iris is moved while making the measurement. A display allows the operator to monitor three different areas in the active video, and the video level at the window is used as a reference while monitoring the black areas above and below the opening.

Both vertical and horizontal detail are measured and reported as a percentage of the bar amplitude.

Geometry/registration

Geometry measurements quantify geometric distortions existing in imaging elements, and are measured on the green channel. Tube cameras exhibit the problem as a "pin cushion" effect, usually caused by the deflection circuits. In CCD cameras, it results entirely from lens distortion. The measurement uses a Ball chart and a grid pattern generator, with the error determined from a TV monitor.

Registration measures how well the blue and red channels track green. In CCD cameras, because the CCD chips are permanently bonded to the prism, tracking is constant over the life of the CCD device. Therefore, errors found in this measurement are caused by the lens.

Automated methods eliminate the Ball chart and grid pattern generator, using only a chart with black vertical and horizontal lines on a white background for registration and geometry. Suggested default charts include the Porta-Pattern registration chart and the EBU chart. In addition, custom charts can be defined, provided their lines are evenly spaced. The procedure uses numerous test points as the source of its determination.

To make the measurement, the luminance level must be at least 100mV with the lens focused on the test chart. For the measurement to be valid, the chart must be properly framed with the camera input from the chart superimposed over a generated grid. The goal of the measurement is to quantify the difference between the actual display and an ideal reference grid generated by the instrument.

Results are shown in a monitor-like display, with the worst errors in each of the four quadrants (for example, upper right or upper left) reported. The location of the errors is indicated on the graph and text readout, with the location expressed relative to the center as a percentage of screen height.

Gamma

Gamma is the input-to-output light transfer characteristic of an imaging or display device. Although CCD cameras are inherently linear, the gamma adjustment is necessary to maintain the integrity of the entire video system, including the TV receiver. Gamma has been quite a subjective measurement, with contrast added or subtracted as necessary. With Option 21 and the VM700A, a quantified measurement of gamma is now possible.

Because the instrument quantifies this adjustment, calibration of multiple cameras is simplified by using a single camera as a standard. The quantified value usually makes the measurement more accurate; averaging capability further increases the accuracy. (See Figure 4.)

Detail

Detail is an artificial sharpening of transitions added to the video in horizontal and vertical directions. The amount of added detail is measured as a percentage of the transition amplitude. The measurement uses any chart that contains a white patch (either a window chart or a gray scale chart with a white chip).

Two displays graph the horizontal and vertical waveforms. Both vertical and horizontal detail are measured and reported as a percentage of the bar amplitude. A bar graph is visible where the white patch is present on the chart. (See Figure 5.)

Shading

Shading refers to the variation in luminance level of the camera output when light input is constant. Note that a luminance variation can be caused by the lens, the camera circuitry or the bias lighting in tube cameras.

A semi-automated measurement offers two modes. In continuous mode, one entire frame of video is acquired, processed and displayed, and the user adjusts the camera circuitry while observing the shad-

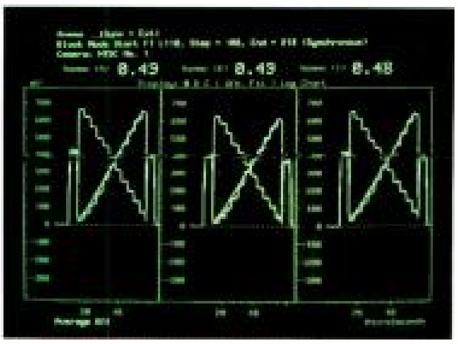


Figure 4. A display of gamma measurement results.

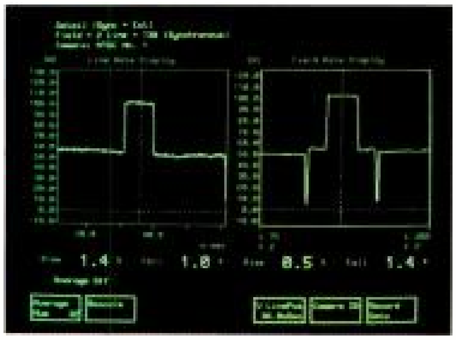


Figure 5. Detail measurements show the amount of overshoot or rounding of fast transitions between black to white.

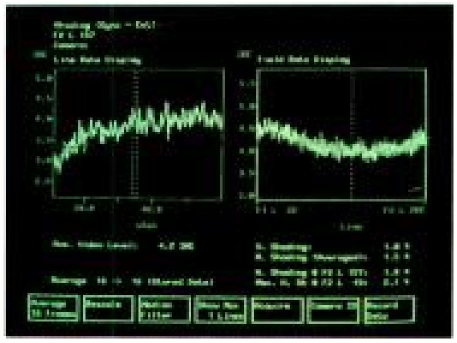


Figure 6. Field- and line-rate shading measurements indicate any tendency toward undesirable coloration in the images.

Figure 7. Frequency response tests of red, green and blue channels also show aliasing.

ing effect. In the second mode, up to 32 frames of data can be averaged. (Averaging is a better method for precision measurements, but it should not be used if the camera is being adjusted.)

When the measurement is complete, the horizontal and vertical shading values are graphically displayed and presented as text readout, including vertical shading, maximum horizontal shading, average horizontal shading and horizontal shading on the line selected. The results are reported as percent error of peak white. (See Figure 6.)

Frequency response and aliasing

Frequency response assesses the degradation of waveform amplitude as the frequency of modulation increases. Typically, this test is performed using a chart that contains packets of square wave or sine wave bursts at various frequencies.

Aliasing is a direct result of the image sampling process. A sine wave chart is recommended for aliasing measurements. Images input at frequencies above one-half the sampling rate of the camera will be seen at the frequency of the aliased components. The camera will still present an image that appears complete to the human eye, but it is not a true representation of the input.

In the past, depth of modulation measurement has been difficult because the degradation of the amplitude had to be observed on a waveform monitor. Because the monitor could not average the deviation, this task also had to be performed visually. The semi-automated measurement uses an averaged result for greater accuracy.

The frequency response measurement evaluates this camera characteristic with a multiburst or sine chart showing six to 12 frequency packets. The measurement displays the level of each packet relative to the value of the selected reference packet. Frequency packets outside the frequency response of the instrument are dimmed. Results are displayed as decibels or percentages.

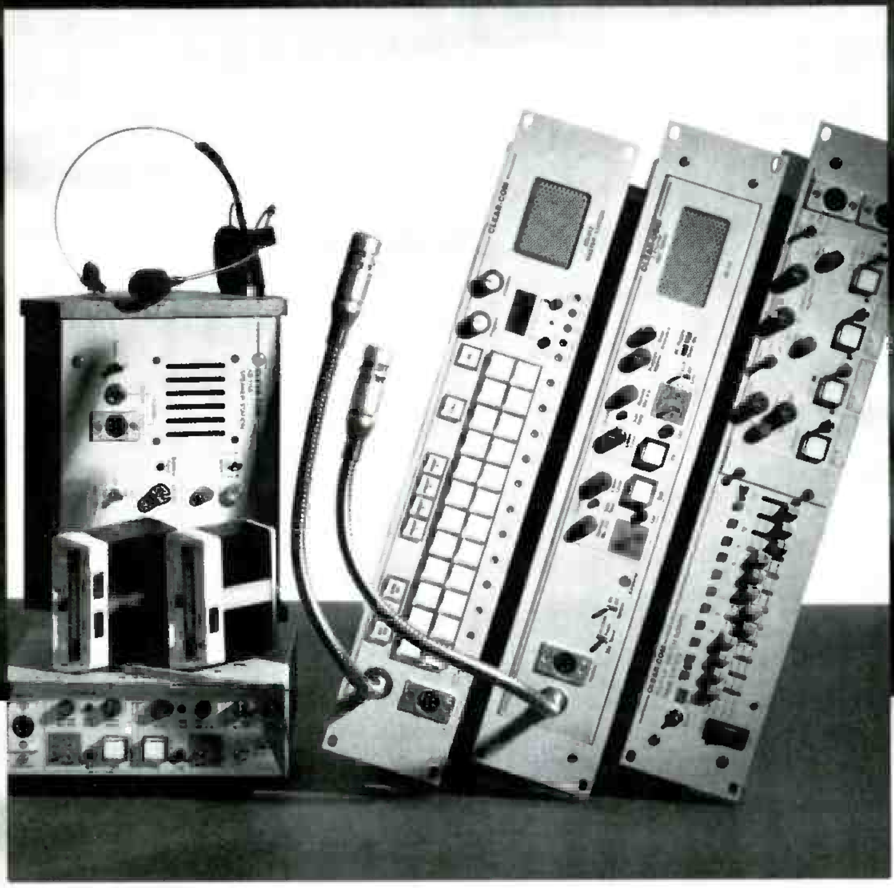
Packets beyond the bandwidth range of the instrument are used for the aliasing measurement. The aliased components are measured, and their frequencies and amplitudes are reported. The amplitude is then referenced to the selected reference packet. (See Figure 7.)

As with other semi-automated measurements, frequency response and aliasing can be averaged to obtain a more stable display. In addition, measurements can be made against a stored reference to allow comparison of a camera over time.

Conclusion

Eleven measurements form a comprehensive system to evaluate camera performance. Now, a semi-automated approach can be used to determine these measurements, adding speed, ease-of-use and accuracy to the evaluation process. Such information is useful throughout the life of the camera — during the purchase process, for service and for ongoing maintenance. Together, these measurements represent a marked advancement in evaluation capability, providing data that can significantly enhance camera performance.

Editor's note: All illustrations show displays of the VM700A video measurement set using Option 21 camera measurement software. Courtesy of Tektronix. ■



Continued from page 77

receiver's audio transformer center, making it more accommodating to a wide variety of mixing consoles; upgraded audio gain potentiometer offers increased reliability; decreases hum with the addition of an MU-metal shield around the audio transformer; features interface connector for external monitoring of audio RF and squelch.

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Professional R-DAT recorder

By Otari

• **DTR-90T:** 4-head machine offers tape monitoring and insert editing capability; punch-in/punch-out done on individual tracks; standard features are time-code read/generate and synchronizer capabilities as well as AES/EBU and SPDIF digital interface; removable front panel can be laid flat or mounted on work surface.

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Wireless mic

By Sennheiser

• **SK 250 UHF transmitter:** 250mW; 16 switchable channels available within 24MHz range covering the entire UHF spectrum; HiDyn Plus compander with pre-emphasis provides optimum attack and decay of compander circuit; long-distance transmission, compact size; alkaline or special rechargeable batteries used in conjunction with L 50 charger guarantee against overcharging.

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Consoles/automation systems

By Solid State Logic

• **Dream Machine G series console:** designed to meet the needs of a particular facility; customers may specify consoles with frame sizes from 32 to 96 channels with L- or U-shaped console wings; two styles of equalization (E or G series); Ultimation or VCA automation; oxygen-free cable; other customized features available.

• **SL 8000 G series console:** multiformat production system designed for all TV, motion picture and music recording formats; allows mix for Dolby Surround; Dolby SR-D, Kodak CDS, HDTV and new 3-D music recording processes; also provides left, center, right and surround planning on every channel.

• **Ultimation moving fader automation system:** for G series consoles; can work as either a dedicated VCA system, a dedicated moving fader system or can combine the best features of both systems; available as a standard option on all new G series consoles or as a retrofit.

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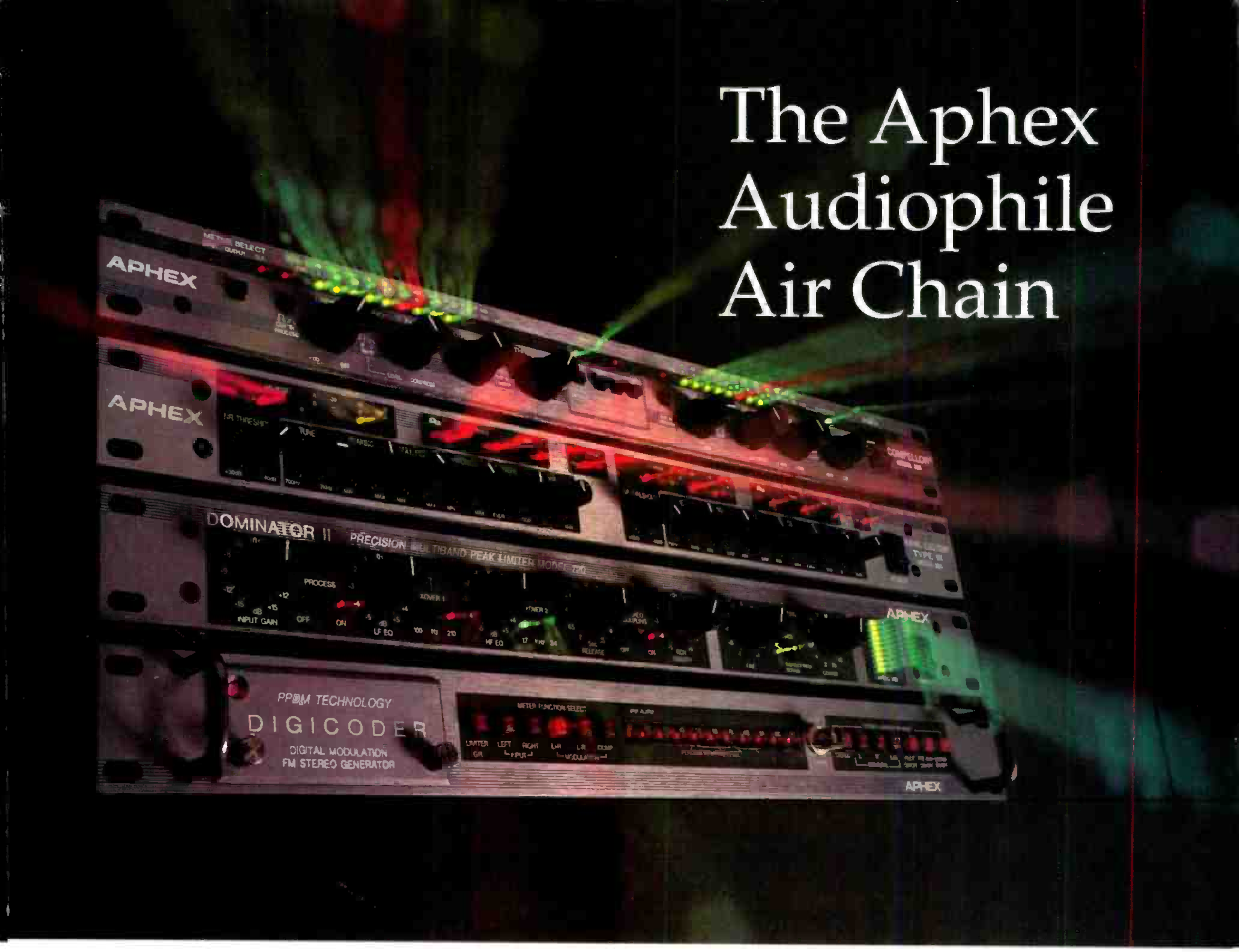

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TV MAINTENANCE ENGINEER: Needed for Central New York NBC Affiliate. Must have both studio and transmitter experience. Prefer someone familiar wiht low band transmitters to work on RCA TTFL-30 and associated equipment. Experience with ACR-25's, MII, 1" and ¾" equipment a real plus. SBE Certification or FCC General Class License and an ASEE or equivalent required. Send resume to LISA BEYRAU, WSTM-TV, 1030 JAMES STREET, SYRACUSE, NY 13203 (NO PHONE CALLS). WSTM-TV is an equal opportunity employer. 11-92-1t

CHIEF ENGINEER PRODUCTION MANAGER Performs a wide range of supervisory, operational and technical functions in the production of TV and radio projects. Responsible for ensuring that all equipment and productions meet applicable technical standards. Ability to maintain microprocessor based production equipment, including DVE, video switcher, VCR, editor and other equipment. Requires a bachelor's degree or an equivalent combination of education and/or experience. Must have at least five years experience in TV and radio maintenance and engineering to include several years in a management position. Also requires FCC General Class License/Microwave Endorsement. Must have working knowledge of computers and experience with scheduling and related software. Excellent communication and problem solving skills are essential. Familiarity with scheduling and traffic of television operations for a large production facility desirable. Rutgers. New Brunswick campus is 30 miles south of New York City. State salary requirements. Excellent benefit package includes tuition remission for employees and children. Send resume to P.O. Box 496, New Brunswick, NJ 08903-0496. THE STATE UNIVERSITY of NEW JERSEY RUTGERS. Employment Eligibility Verification Required Affirmative Action 11-92-1t

TECHNICAL Northeast major market television station seeks a television technician with a minimum of 10 years experience in all phases of television broadcasting operations. Must possess a "General Class" F.C.C. license, and have a formal technical education. All inquiries should be addressed (no calls) to Irwin Ross, Director of Engineering, WPVI-TV, 4100 City Avenue, Suite 800, Philadelphia, PA 19131. EOE. 11-92-1t

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HELP WANTED

STAFF ENGINEER

Salary Limit: $35K. **Education:** 2 Year electronics school graduate. **Experience:** 2 years work experience at an AM or FM broadcast station. **Duties and responsibilities:** Supplying technical support for any of the station's diverse activities within the Los Angeles/Orange county areas. Send resume to:

Bob Moore, Chief Engineer

KLVE/KTNQ, 1645 N. Vine St., Hollywood, CA 90028

TV/AV MAINTENANCE ENGINEER Engineering Support Incorporated is seeking qualified individuals with a minimum 10 years experience in broadcast grade, video/audio maintenance and/or videotape machine repair. Potential candidates should have worked in one of the following positions: —Senior Maintenance Technician —Engineering Supervisor —Assistant Chief Engineer. Engineering Support Incorporated offers a comprehensive benefits package that includes medical/dental, retirement, holidays, vacation, education assisatance and 401K plan. Please send resume in complete confidence to AAI Engineering Support Inc., P.O. Box 1108, Hunt VAlley, MD 21030-1108, Attn: Personnel. AAI/ESI An Equal Opportunity Employer U.S. Citizenship Required. 11-92-1t

CHIEF VIDEO ENGINEER $35,069-$49,837 Responsible for the video production facility of the City's Cablecast Television System to include: 3/4 inch maintenance/preventive maintenance, systems design and timing, ENG/SNG production, studio/master control and off-line production. Will aslo supervise technical staff and interns. Requires five years of television broadcast maintenance experience, including two years of supervisory experience and a bachelor's degree in Electronic or Communications ENgineering, or equivalent military experience plus SBE or FCC certification. Applications available beginning 9/28/92 until a selection is made. Applications for Maricopa County residents are available at 135 N. 2nd Ave., Phoenix, AZ 85003. Outside Maricopa County call (602) 262-6277 or write for an application. Subject to closing without notice. City of Phoenix, AA/EEO/D Employer 11-92-1t

CHIEF ENGINEER For UHF station WEHT in Evansville, Indiana. Must have thorough background n analog and digital electronics; five years experience in television broadcast equipment; knowledge of all formats of video recording, switching, digital effects and storage, ENG equipment, and editing. This is a "hands-on" position requiring troubleshooting ability to the component level. High power TV RF system experience is required. Some administrative ability and FCC general class license necessary. SBE Certification a plus. Resume and salary requirements to: Elmer Chancellor, WEHT-TV, P.O. Box 25, Evansville, IN 47701. Fax 502-826-6823 EOE, M/F. 11-92-1t

Classified

HELP WANTED

TELEVISION MAINTENANCE ENGINEER Maintenance Engineer needed to install, service and maintain all technicai equipment related to the television production studio including, but not limited to, television equipment field setup, audo and/or video recording, playback equipment television maintenance and any new devices that may be added to the television operation. Requires: Associate degree in electronics or HS diploma or GED and equivalent experience as a broadcast television technician. Through understanding of television equipment to include one inch, beta, and D2 formats, fiber optic transmissions, Sony camera, Grass Valley switchers, ampex ADAFT, ADO and Alex systems. Ability to troubleshoot all of the above to component level. Familiarity with FCC standard broadcast rules and regulations. Ability to use sign language or the willingness to learn. Competitive salary and excellent benefits package. To apply, send cover letter and resume to: Ms. Trudy Lewis, Gallaudet University, Personnel Office, College Hall, Rm. 106, 800 Florida Avenue, NE, Washington, DC 20002-3695 EOE. 11-92-1t

MAINTENANCE ENGINEER FCC General Class license required. Must have 3 years expeience trouble-shooting to component level in RF, video and audio TV equipment. Experience in maintaining digital and microporcessor based equipment required. SBE certification desirable. Resume and salary requirements to: Elmer CHancellor, WEHT-TV, P. O. Box 25, Evansville, IN 47701. Fax 502-826-6823 EOE, M/F. 11-92-1t

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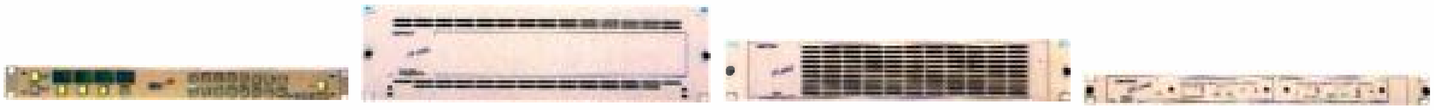

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