BROADCAST engineering

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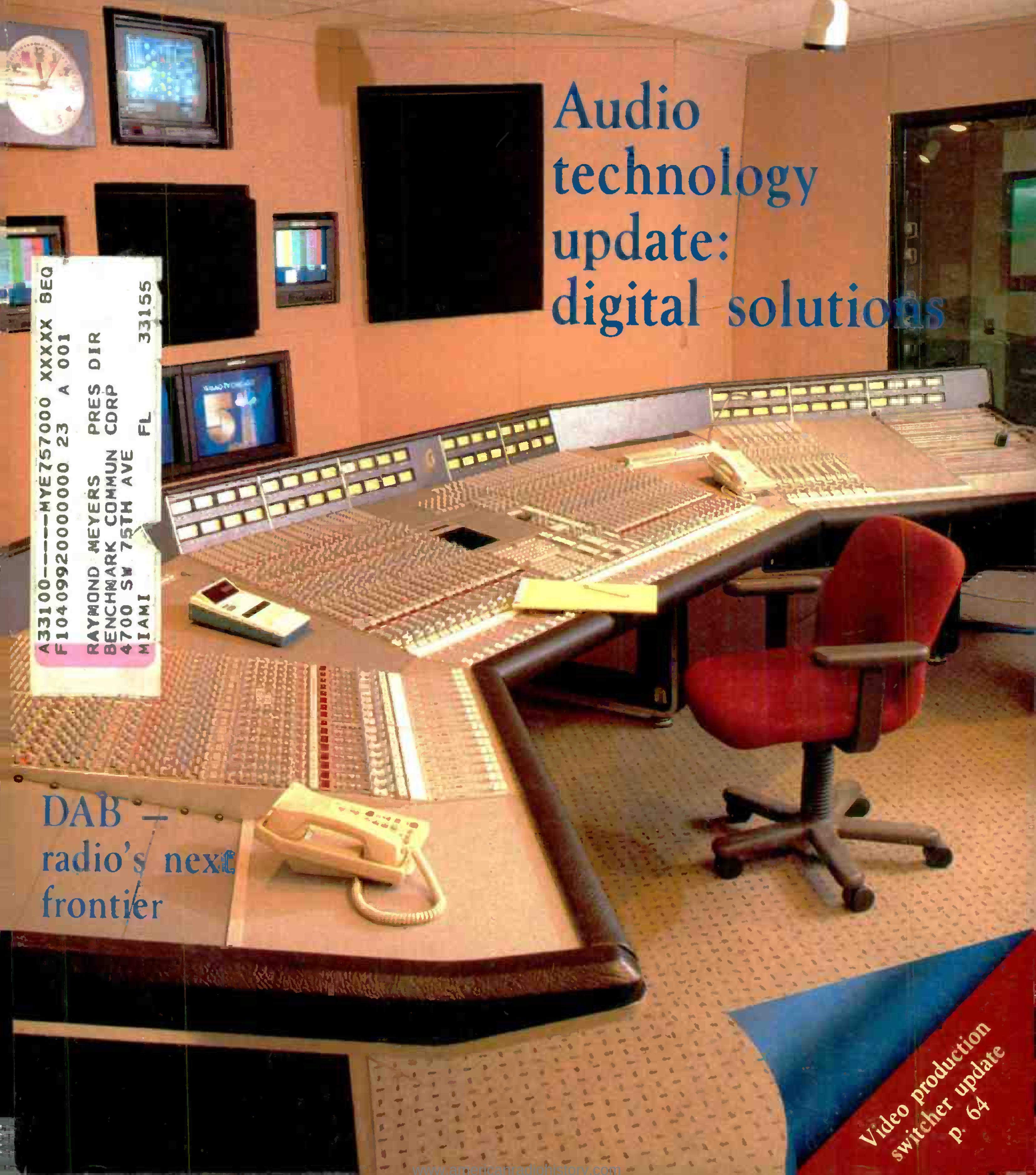

Audio technology update: digital solutions

DAB — radio's next frontier

Video production switcher update p. 64

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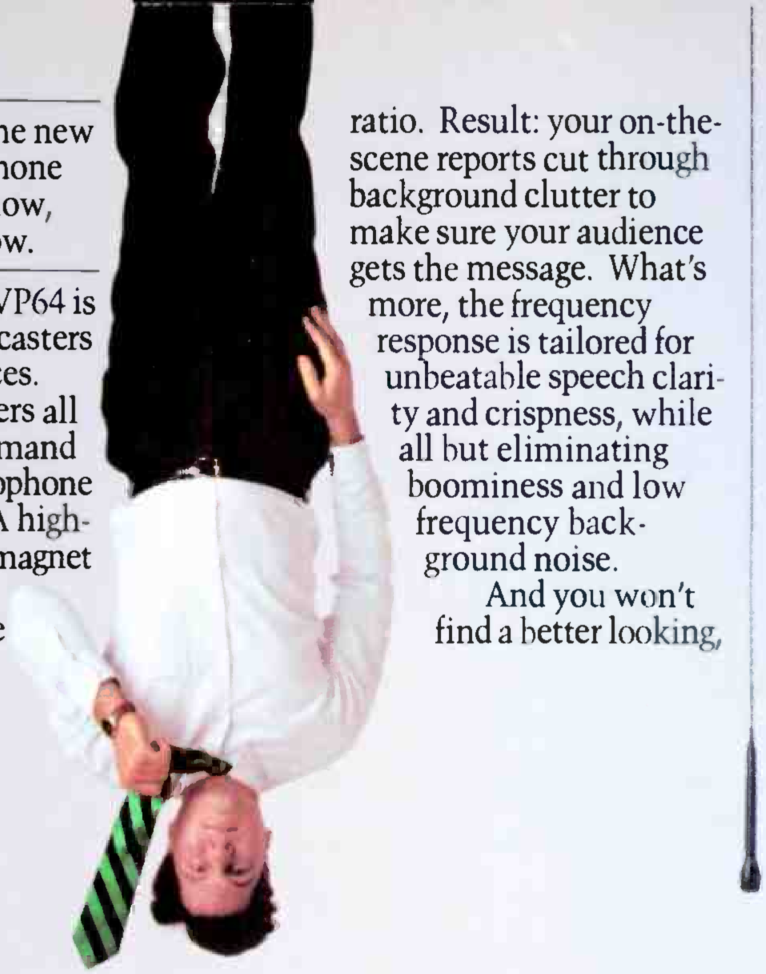

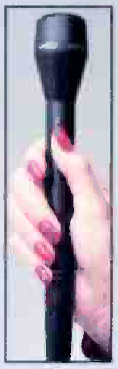

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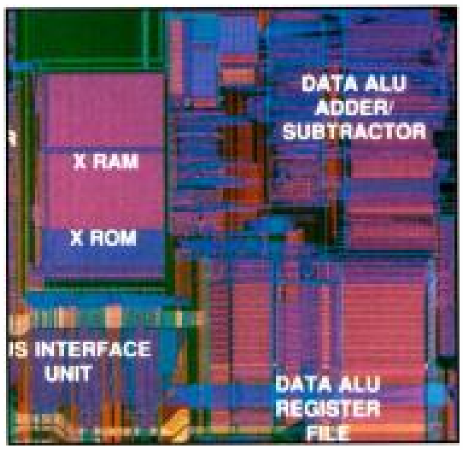

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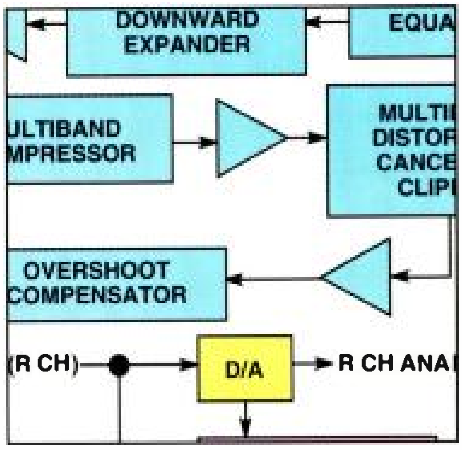

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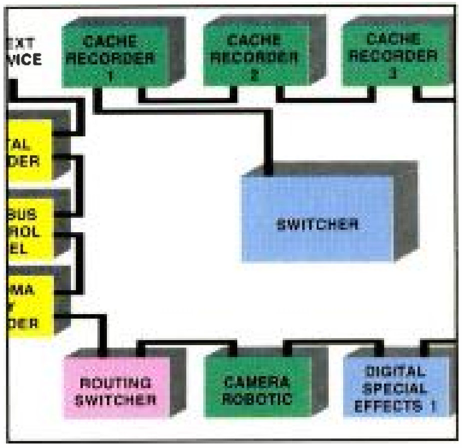

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AUDIO TECHNOLOGY UPDATE: DIGITAL SOLUTIONS

The familiar world of analog audio is being shaken by a number of new digital formats and solutions. Consumers and professionals alike are discovering that new and cost-effective digital products are available. Audio production at radio, TV and production facilities relies more on digital hardware than ever before. Although the quality advantages provided by digital are usually obvious, engineers and producers rely on the technology because it solves problems. This month's issue examines the problem-solving advantages of digital hardware.

FEATURES:

OTHER FEATURES:

DEPARTMENTS:

ON THE COVER

Today's competitive environment requires that stations provide their audiences with the highest-quality audio possible. Although the addition of new hardware may allow a facility to offer its customers or audience unprecedented features or services, it also may result in increased revenues and visibility within the community. (Cover credit: Photography and console — Solid State Logic; facility — WMAQ-TV.)

News

By Dawn Hightower, senior associate editor

TV digital compression delivery in contract phase

Cable Television Laboratories' (CableLabs) process to obtain digital compression and transmission equipment for use by the cable TV industry and public television is moving to the next phase. The first phase has achieved two goals: 1) to accelerate the use of digital compression in the delivery of the current NTSC TV system to the home; and 2) to facilitate the cross-licensing and interoperability of this digital compression technology.

In the next phase, systems will be selected for testing, and individual contracts to buy equipment will be signed. CableLabs announced the digital TV Request for Proposal (RFP) last fall.

CableLabs' RFP partners — Tele-Communications, the Viacom Network unit of Viacom International and the Public Broadcasting Service — foresee testing in mid-1992 and equipment acquisition in late 1992 and early 1993. Certain participants intend to buy digital compression devices that would allow program suppliers to provide multiple program services on one satellite transponder to cable headends, public TV stations and educational institutions, as well as multiple programs in one channel over cable to the home.

The nine parties that responded to that RFP are: 1) AT&T, ComStream Corporation and News Datacom; 2) C. Itoh & Co. of Japan; 3) the Digital Television Consortium, which includes OAK Communications, Leitch Video International and C-Cube Microsystems; 4) General Instrument Corporation's VideoCipher Division; 5) Macrovision; 6) Magnavox CATV Systems/Philips Electronics N.V. and Hughes Network Systems; 7) Scientific-Atlanta/Zenith Electronics; 8) Thomson Consumer Electronics supported by the David Sarnoff Research Center; and 9) Toshiba's Imaging & Information System Division.

Approving licenses should be altered

The National Association of Broadcasters (NAB) feels federal regulators should alter the methods used to approve broadcast licenses. However, it should reject any random selection process, such as lotteries, because these schemes would not properly test the fitness of would-be broadcasters.

Comparative hearings are used by the FCC, using different criteria to measure the fitness of broadcast station applicants. NAB said this process should not be abandoned. One reason is that it requires applicants "to be aware of the needs and interests of their communities and to provide programming and other services that meet those needs..." in accordance with the Communications Act.

However, NAB believes some tinkering is necessary to ensure the license evaluation process evolves with the times. For example, NAB believes the FCC should depend less on outdated criteria and give more weight to preferences that reward station management practices that show a commitment to serving the local community.

License preferences should be granted to station applicants who have identified the need for new services in a community, who commit to long-term operation of a new station, and who demonstrate a realistic proposal to ensure a local market can support the successful operation of a new station.

NAB also suggested that the FCC focus its attention on new standards for comparative renewal hearings for existing broadcasters. NAB called attention to its pending FCC petition asking for changes in the FM allocation policies, and pointed out that these changes might reduce the number of comparative hearings because applicants would have to show the market can support an additional station.

The FCC should continue to provide special preferences to increase minority ownership in broadcasting.

SBE regional convention builds on 20 years of experience

SBE Chapter 22 in central New York, with the cooperation of the Binghamton, Rochester and Albany, NY, SBE chapters, will be holding its 20th regional convention in Syracuse, NY, Sept. 25. The event will be held at the Sheraton Convention Center in Liverpool, NY, from 9 a.m. to 5 p.m. Admission is free.

■

BROADCAST engineering

BROADCAST ENGINEERING is edited for corporate management, engineers/technicians and other station management personnel at commercial and educational radio and TV stations, teleproduction studios, recording studios, CATV and CCTV facilities and government agencies. Qualified persons include consulting engineers and dealer/distributors of broadcast equipment.

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INTERTEC PUBLISHING CORPORATION

Editorial

Glass houses

One of the advantages of being the editor of a magazine is that I have the opportunity to speak my piece in a forum such as this. Since taking this position, I've seldom used it to express my personal opinion on a subject that is so close to home.

I'm talking about the SBE. As a former president of the society, I feel I can view recent problems with a bit more objectivity and long-term viewpoint than can most others. This month, I'd like to offer my perspective.

The last six months have been peppered with accusations, charges and claims by an extremely small faction of dissatisfied SBE members, principally from the West Coast. These people have allowed their emotions (not facts) to launch the second-most public (and most detrimental) debate in the society's history.

After spending almost 10 years an an elected official, I'd like to offer a different and more candid perspective on recent events. Let's look at the first of two issues that have been described by the nay sayers as errors or mistakes made by SBE leadership.

The first issue is the convention. The convention was originally a small source of revenue to the SBE. However, in recent years, economic realities in the broadcast industry have made it increasingly hard to generate the kind of profits that were predicted (and hoped for). A recent diatribe from the complainers wondered how a convention could actually lose money. Let's review some facts.

The broadcast industry has been in the pits. Making money with a convention in this economy has been difficult at best. It is also a fact that the convention's money problems date back to the Denver show, not the Houston show.

The nay sayers didn't look at the realities of running a convention. It's a business, and businesses rely on contracts signed years in advance with penalties for non-performance. Moving the show from Houston anytime after October 1990 could have cost the society tens of thousands of dollars in penalties, not to mention the additional costs of any relocation.

Some have complained because the show has been moved around the country. It's been moved because the 1989 membership survey showed that members *wanted the convention moved to new locations.* SBE leadership was simply following the members' directive.

The second issue centers on hiring SBE professional management. Some, including a few inexperienced board members, think SBE should go back to the old days of having a small SBE office, staffed with one or two clerical people. They suggest that the affairs of a quarter-of-a-million-dollar company can be run by part-time volunteers (themselves) spread across the country.

Give me a break! How in the world are elected officials with full-time jobs, which may require considerable travel, supposed to attend to the daily needs of a 6,000-member organization? The simple truth is they can't. Full-time, professional association management is not an option if SBE is to meet its members' needs.

Finally, it is foolhardy to expect the SBE to work effectively in the real world of association business without a person trained in this area. The standards for training originate from the American Society of Association Executives (ASAE). As SBE members, we promote the value of certification. Yet, some have proposed that the SBE executive director *not* have ASAE certification. SBE members deserve professional management, and that means someone with ASAE certification.

It's time for everyone to pause and take a breath. We shouldn't let emotion dictate the society's future.

Being an elected official forces you to live in a glass house. It's easy for others to throw stones in the form of second-guessing and armchair quarterbacking, none of which we need. To those who are working so hard to destroy what has taken almost 30 years to build, be careful. The house you destroy could be your own.

Brad Dick, editor

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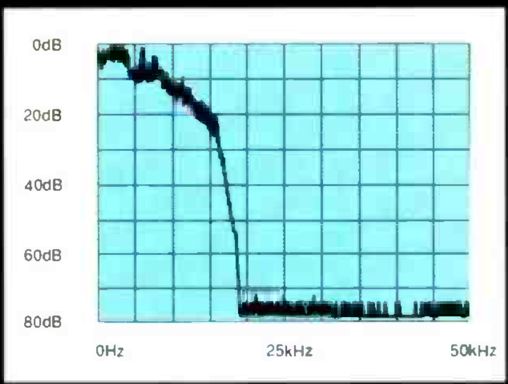

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FCC Update

TV ownership deregulation proposed

By Harry C. Martin

The FCC is seeking comments on the following approaches to relaxing its national and local TV ownership restrictions:

• *National limits.* The agency wants to raise the numerical limit and the national audience "reach" limit. It is offering two proposals: 1) increase the ownership cap from 12 stations and 25% of national TV households to 20 or 24 stations and 35% of TV households; or 2) increase the cap to 18 stations with an audience reach limit of 30%. The agency also is asking for comments on whether the numerical cap should be increased while keeping the current 25% audience cap.

• *Duopoly limits.* The FCC is considering using the Grade A rather than the Grade B contour in determining when prohibited ownership overlap occurs. It also is considering a relaxation that would permit Grade A contour overlap where at least one of the stations involved is UHF, if at least six other independently owned stations exist in the market.

• *One to a market.* The FCC is considering eliminating its radio-TV local cross-ownership prohibition. The commission might allow local ownership of one AM, one FM and one TV station in a market.

• *Network ownership.* The commission is considering eliminating its dual-network rule, which prohibits TV stations from affiliating with a network entity that operates more than one network serving substantially overlapping areas. The agency is considering a plan where multiple network channels could be provided by the same network entity to a single station. Furthermore, the FCC is re-examining its current rules restricting network ownership of small-market TV stations, and the rules requiring networks to offer their programming to independent stations in 2-network markets before offering it to one of the two affiliated stations in the market.

PCS update

Personal communications service (PCS) is expected to be the next wave of advanced telecommunications services. PCS could offer significant economic opportunities for early entrants.

• *What is PCS?* PCS is a digital, low-power mobile technology that may replace much of today's wire and cellular telephone services. According to the FCC, PCS will provide a vast array of advanced voice and data services.

• *Configuration.* A PCS network will have a configuration similar to a cellular network with several electronic transmit and receive devices installed in neighborhoods and business districts. These electronic devices will be linked to the public switched telecommunications network by fiber optics, copper or microwave. High-speed computer systems will be installed in central switching hubs with a capacity to route numerous calls. The outdoor cells and hand-held consumer receivers are expected to be smaller and less expensive to build than cellular equipment.

• *Experimental licenses.* It is believed that the existing cable TV system, with its copper and fiber-optic infrastructures, could form the ideal return system for the PCS cells. Accordingly, several cable system operators have requested experimental PCS licenses from the FCC. Although PCS capability would allow cable operators to provide some types of telephone services, certain cable operators also are considering using PCS to enhance cable system functions.

• *Technical issues.* Unresolved questions include which frequencies should be allocated for PCS use and what transmission standards should be adopted. The equipment, cost and international considerations suggest that a portion of the spectrum to be allocated should come from the 1.8GHz to 2.2GHz band. However, the commission is concerned about the effect on incumbents in this band and intends to allocate the spectrum needed for PCS with minimum disruption to existing users.

• *AMS and PCS.* The FCC is considering expanding the scope of the PCS proceeding to include eight industry petitions concerning the use of advanced message services. AMS refers to paging systems designed to transmit messages to portable computers as well as transmit facsimile messages and operate with digitally compressed voice paging.

• *Status at FCC.* The period for filing comments to the commission's Notice of Inquiry and requests for a pioneer's preference with respect to such services expired earlier this year. Although the commission previously announced that the first allocation phase would occur this year, it is doubtful that any allocations will be made until 1993.

Call signs for broadcast stations are awarded on a first-come, first-serve basis.

Use of relinquished call signs

Under the FCC's rules, call signs for broadcast stations are awarded on a first-come, first-serve basis. When requests to change call signs are pending, the call sign to be relinquished is not available for application by other broadcasters until the effective date of the change. Effective dates for changes are specified in public notices released weekly by the FCC. Agreements between licensees regarding call sign changes are not considered by the FCC in determining the award of any such relinquished call signs.

A fine is assessed

The commission has notified a Georgia FM station that it is liable for a fine of $20,000 for failure to light its antenna tower, and then neglecting to notify the FAA that the tower lights had malfunctioned.

The antenna tower was inspected by the FCC's Atlanta field office in August 1991, and all the lights were out. The inspection further revealed that the FAA had not been notified that the lights were not working. Failure to comply with the commission's antenna rules is an extremely serious matter because of the potential danger it poses to aviators.

Pursuant to the commission's forfeiture standards, the base fine for failure by a licensee to comply with the FCC's tower lighting rules is $20,000. ■

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

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Strictly TV

Unique ENG camera lens accessories

By Douglas E. Howe

Suppose you are a videographer who wants expanded capability for special effects by taking super wide angle and telephoto shots. How could you obtain them?

You could go out and spend big bucks — up to $10,000 — on an additional zoom lens. In fact, until a few years ago, that was all you could do. However, a second alternative is now available in the form of lens-mounting converters, which allow the use of some 35mm still camera lenses on ENG video cameras.

Lens converters are a more cost-effective way to gain increased special effects capability because still lenses are typically less expensive than video lenses.

The advantages

In addition to providing many more lens options, these converters offer users of $^2/_3$-inch ENG/EFP cameras a number of important benefits compared to a dedicated ENG/EFP lens. The first benefit is increased functionality. The videographer now has access to a wider range of lenses. The second advantage is that these lens features are available at a low cost. Even large market stations cannot afford to provide each ENG camera operator with a selection of ENG lenses for every possible shooting task. The cost is simply too great. Lens converters are a more cost-effective way to gain increased special effects capability because still lenses are typically less expensive than video lenses.

Finally, many videographers began their careers as still photographers using 35mm cameras. Some may still own that equipment. If so, some of those lenses might be usable on the ENG cameras with the new series of converters. Once again, the advantage is increased feature options, at a low cost.

Improved camera performance

In addition, the converters also improve optical performance by canceling the aberrations caused by the camera's color separation prism. The converter's superior optical design virtually eliminates color shading by shifting the exit pupil so that it is close to infinity.

One converter has $^1/_{3.98}$ magnification relay, which means the angular field of view remains constant. The unit's maximum aperture remains f2.8, regardless of the lens that is used.

Most lens converters are designed for F-mount-type 35mm lenses. This allows the use of telephoto and micro (more than f:105mm) SLR lenses. The converter helps produce high-resolution images by using the center of the lens' image circle to minimize distortion.

An ENG converter adapter may have relay lenses of 1× magnification. Thus, the lens' effective focal length and aperture does not change. The user merely turns the lens aperture ring manually to adjust the aperture.

Many options available

Videographers will still use basic video lenses to handle most applications. The familiarity and functionality of these lenses makes them primary tools for many shooting assignments. However, when you need special effects or have unique requirements, a standard ENG lens may not do. Or, you may not be able to afford one.

Enter plan B. By using an ENG lens converter on the camera, a new world of special effects and lens features becomes available. Converters may not be the solution to every ENG shooting problem, but they offer a cost-effective and practical solution to the issues faced by videographers. ■

The converters also improve optical performance by canceling the aberrations caused by the camera's color separation prism.

Optical converters extend the capabilities of existing lenses and permit the use of 35mm photographic optics on many TV cameras.

Howe is general manager for Nikon Electronic Imaging, Melville, NY.

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Part 1

re: Radio

Rules and radials

Measuring field strength

By John Battison, P.E.

For reasons I don't understand, it appears that not as many AM directional antenna (DA) systems are having radials run. It seems that engineers aren't running antenna proofs, or station engineers are doing them themselves. In either case, a series dealing with measuring field strength seemed worthwhile.

Although field-strength measurements are an essential part of a DA proof, they are also valuable for other purposes. Every AM station should have at least one set of measurements made when it is first put on the air. These need not be complete radials. However, such information would be useful as years pass and coverage changes — at least according to anecdotal reports.

A full set of readings taken when the station goes on the air will establish a reference. If the field is down, you will know how far it has dropped, and perhaps obtain some hints on why it's low. Even if it is not a new station, it's worth taking readings on radials that cover the major audience areas. However, wait until you have everything running well, and management is pleased with coverage before doing so.

Non-DAs are often in the dark

The only requirement that a non-DA station has to meet is a *theoretical* one in the FCC Form 301, where the required city coverage, the 2mV/m and 0.5mV/m service contours and a few other contours have to be plotted on the proposed coverage map. Unless the commission has some reason for doubting a station's claimed efficiency, the station has no need to run field-strength measurements after going on the air. Therefore, measurements are rarely taken.

It is unfortunate that such measurements are not required, because these stations never confirm their predicted patterns and field strengths. I've been called in by non-DA stations who suspected field-strength problems, and found that although their Form 301 showed 25mV/m over prime listening areas, the measured signal was only 15mV/m or 16mV/m in those locations. So how do you account for this discrepancy?

Checking antenna system performance

First, measure the antenna-base operating impedance. If it is much the same as the original Form 302 showed and the transmitter appears to be operating properly, look for any construction adjacent to the antenna, and between it and the area in question. Be sure to check the ground system.

Many installations are more than 30 years old, and their original ground systems have been sitting quietly corroding away or, in some cases, have been stolen. Check the copper strap from the ground system to the tower base for good connection. Good installations have four straps, one on each side of the pedestal, going down into the expanded copper sheet or radials. Also, try to find some that can be checked with a VOM for continuity out to the end of the ground system. If all else fails and you still suspect the ground system, try to obtain an authorization to plow in at least 120 50-foot radials around the tower. If you can tie these into the remaining system, your efficiency should improve.

Here is a small point worth checking: A surprising number of stations do not have a copper strap from the transmitter out to the tower base. Instead, they rely on the coax's outer conductor to complete the circuit. It may not make any appreciable difference, but installing such a strap if finances permit removes one potential source of trouble.

Try to borrow an in-line bridge and measure the base operating impedance. It should still be extremely close to its original measured value. After all, the characteristic impedance of a tower does not change much unless a lot of items have been hung on it (or if an FM or TV antenna is on it with a ¼-wave matching stub). If the impedance is still fairly close to original value, and I^2R and plate operating efficiency are close to your licensed values, you can be reasonably sure that the RF output is within limits. This excludes the questionable condition and efficiency of the ground system.

In addition, check the base current meter to be sure that its *calibration* has not changed over the years. If you have a delta current transformer, its output should track the meter. If you can't borrow a second standard RF ammeter, you can insert several meters that you have borrowed from nearby stations in the line when checking the calibration. They should all read approximately the same. Be extremely careful not to run the current too high — it's bad enough to burn out your own meter, but don't hit your neighbor's as well.

Running the radials

If you still can't get a satisfactory answer, try running a single radial. Find a direction on the map that is relatively clear of buildings and other obstructions. Draw a line from the transmitter out to approximately a 10-mile distance. Mark at least 15 points along the line, spacing them about ¼-mile to ½-mile apart at first, and gradually increase their spacing to approximately a mile apart as you move toward the distant end. Some engineers warn against plotting your points in advance, because they may not work out when you get there. However, I always like to have a point in mind as I drive along. If the one I chose in advance doesn't work, I pick another.

Be sure to identify carefully every actual measurement point. It's not enough to say "outside red house." When you go back in a year or so, the house may be green or white. Identify by street address, house number and exact location. You should also reference power poles when you have to make a reading near one. Most have an identification number, but these too can change. Beware also of road names that have changed. I recently went looking for a street that had been renamed 15 years earlier. I finally found it from monitor point *photographs* — another good idea.

Next month, we'll consider what to do with field-strength measurement data once it's been collected. ■

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

Part 1

Management for Engineers

Conflict resolution revisited

Problem ownership

By Judith E.A. Perkinson

In January and February, this column featured a 2-part series on conflict resolution. In another 2-part series, we will revisit this issue and focus on two components of conflict resolution: understanding the principles of problem ownership and developing skills in constructive confrontation.

The nature of the beast

Conflict can be the result of unmet expectations. Often, it arises out of the interface between technical and non-technical disciplines, and is the result of a disagreement or misunderstanding of details.

Engineers are technical people. They live and die in a world of detail. Any engineer worth his or her salt has learned to pay attention to the particulars. Conflict is worsened when the person you are dealing with does not understand the significance of the details that are being considered. It is common for engineers to be in conflict over details that are important to them and insignificant to the non-technical person.

When you find yourself in this situation, it is time to closely examine problem ownership. A basic understanding of problem ownership can help you comprehend the resistance you are encountering. Learning basic coping strategies can reduce your stress and frustration.

Understanding problem ownership

Understanding problem ownership begins with the realization that just because an issue is bothering you does not mean it is bothering the other person with whom you are dealing. If you are concerned by the problem, you "own" the problem. You must take the responsibility for resolving it.

If another person's behavior is intolerable, do not assume it is a purposeful slight. Begin by examining your own tolerance, not the other person's motivation.

One common occurrence that demonstrates the difference between understanding and motivation can be exemplified by return phone calls.

A problem arises and you need to get information from another person. You call him, but he is not available. You leave a message to have him return your call as soon as possible. You wait but don't hear back. As more time passes and you still don't have your information, you become annoyed and even angry. Finally, you reach him, and the first question you ask is, "Why didn't you get back to me earlier?" He tells you he didn't know it was important. If he had known, he would have returned your call sooner.

You had the problem, not the person from whom you were seeking information. Because the other person did not see it as a conflict, he did not react as if he was dealing with a problem situation.

Conflict can be the result of unmet expectations.

Many work conflicts arise out of this tolerance differential. When another person is driving you crazy because he is not providing you with information, performing expected tasks, or appears unable or unwilling to meet a schedule, it is likely that the problem is yours, not his.

What to do

Your first reaction might be to find a way to make it the other person's problem. Usually, we do not have the necessary authority or power to enforce our will. Even so, remember that the person who owns the problem must take responsibility for the problem. As a result, you need to look at other methods of diminishing the effect that the tolerance differential has on your ability to perform.

The following three approaches can prove successful in getting the other person to respond:

1. Communicate the importance. In the case of the phone call scenario, the person receiving the message did not understand the importance of an immediate reply. This is one of the most common communication problems.

Before you become upset, be sure you have communicated to the other person the importance of a response. Many problems are eliminated when people understand how their behavior affects another's ability to perform. This is true whether you are dealing with a supervisor, peer or subordinate. If it is important to you, then it is worth the time and effort to communicate the importance to the person who can impact your performance.

At the same time, don't cry wolf. If you constantly tell everyone that everything is critical, then nothing will be considered important. Be honest in your assessment of the problem's significance.

2. Tie lack of response to consequences. Some people will not care about your problems. That is the time to try to link your problem to them. This is usually possible on the station level. The station's operation is affected in one way or another by the engineering department. The trick is to make the other person see that your inability to perform can and will ultimately affect him as well.

This issue is not about blackmail. Blackmail is a bad policy, because it breeds resentment and accomplishes nothing.

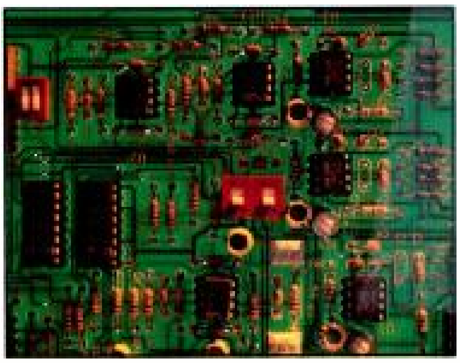
3. Negotiate agreements to obtain what you need. The other person may never consider your issue to be important. This is when you should attempt to negotiate for what you want. One of the best starting points in such a discussion is the simple phrase, "What does it take?" This question avoids the issue of permission and moves immediately into resolving the problem. If you get this far into the problem, be sure to put your agreement in writing. It can be a confirming memo, a thank you note that spells out the terms of the agreement or a formal agreement. Typically, you will not need a formal agreement. The degree of formality will be determined by the situation.

Understanding problem ownership and developing techniques in order to have your needs met can go a long way toward reducing conflict. Next month, we will examine constructive confrontation in conflict resolution. ■

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

Part 3

Circuits



Looking into CCDs

CCDs: Colors without prisms

By Gerry Kaufhold II

In Part 1 of this series, we introduced charge-coupled devices (CCDs) and showed how they can store analog luminance signals. Part 2 explained how the CCD can intake signals from one complete field in parallel, and then act as a "bucket brigade" to output those signals serially in NTSC or PAL formats.

> ***The CCD storage elements underneath the lenses are electrically identical circuits.***

For a broadcast-quality camera, a prism precisely splits incoming light into red, green and blue hues. One CCD is positioned behind each side of the prism to detect the luminance value of each color. A mixing circuit conditions the signals to provide correct color output and proper timing.

This month, in the last part of this series, we'll examine how consumer camcorders can generate color with only one pickup device and without a prism.

Microelectronics makes it possible

There is no inherent reason why the number of charge-coupled analog memory cells in a CCD pickup must exactly equal the number of pixels that the NTSC or PAL standards require. If more than one CCD memory cell can be used per video pixel, signal processing can be performed to obtain color from a single pickup.

Because CCDs are semiconductors, hundreds of thousands of active circuit elements can be placed on each CCD device. The added cost for this overabundance of circuit elements is extremely low, especially when compared to the cost of a precision color prism and the use of three CCDs per camera.

Camcorder CCDs contain approximately eight times the number of photodiodes and analog memory cells as there are video pixels in NTSC or PAL broadcast formats.

To obtain color, manufacturers of CCDs implant microlenses that contain color filters over each row of CCD cells. They then use an interesting technique to mix the outputs from eight adjacent cells to obtain correct color information for each actual pixel of the video picture.

The CCD color mosaic

Figure 1 shows a schematic diagram of the eight photosensitive elements that go into one pixel of color video.

The lens that filters light entering the CCD photodiodes is called a *color mosaic*. Each tile of the mosaic is approximately one square micron in size.

The mosaic contains a detailed pattern that repeats four color combinations. The first two pairs of color lenses are magenta + yellow and green + cyan. These are used to filter out luminance and the red color-difference signal.

The second pair of color lenses are green + yellow and magenta + cyan. These are used to filter out luminance and the blue color-difference signal.

The CCD storage elements underneath the lenses are electrically identical circuits. These CCD circuits still only store the analog luminance value of the colored light that gets through each lens.

The system works because the analog signals stored under each of the eight lens elements represent various mixtures of colored light, which can be reconstructed to create a single correct pixel of color video.

The lenses must provide enough color discrimination to permit a follow-on color separation circuit to decode the matrix and create accurate luminance and color-difference signals.

The color mosaic method is limited by the ability of CCD manufacturers to make these specialized microlenses and position them correctly over the CCD pickup device.

For practical high-volume manufacturing, CCDs using the color mosaic filter method cannot produce true NTSC or PAL video quality.

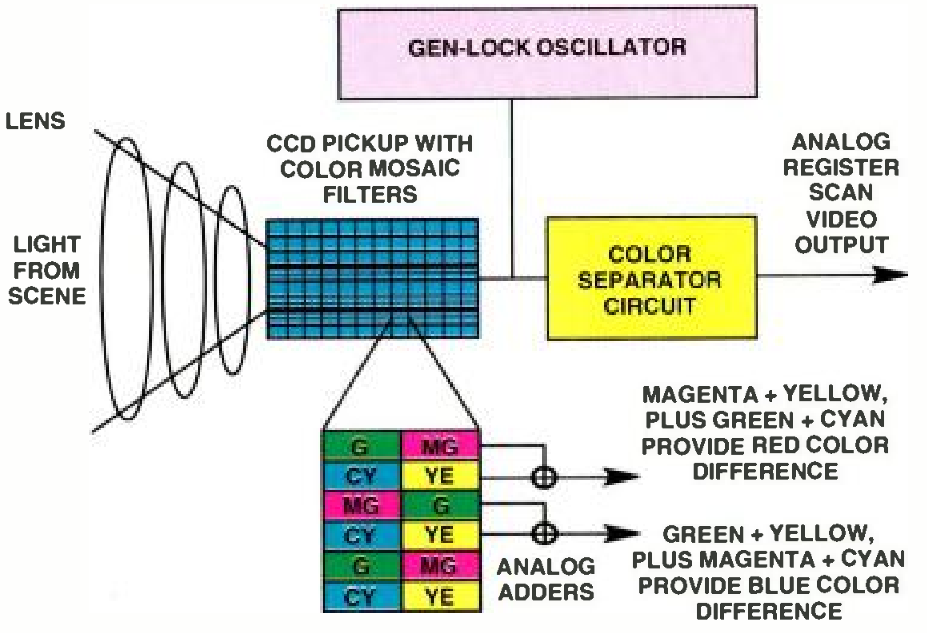
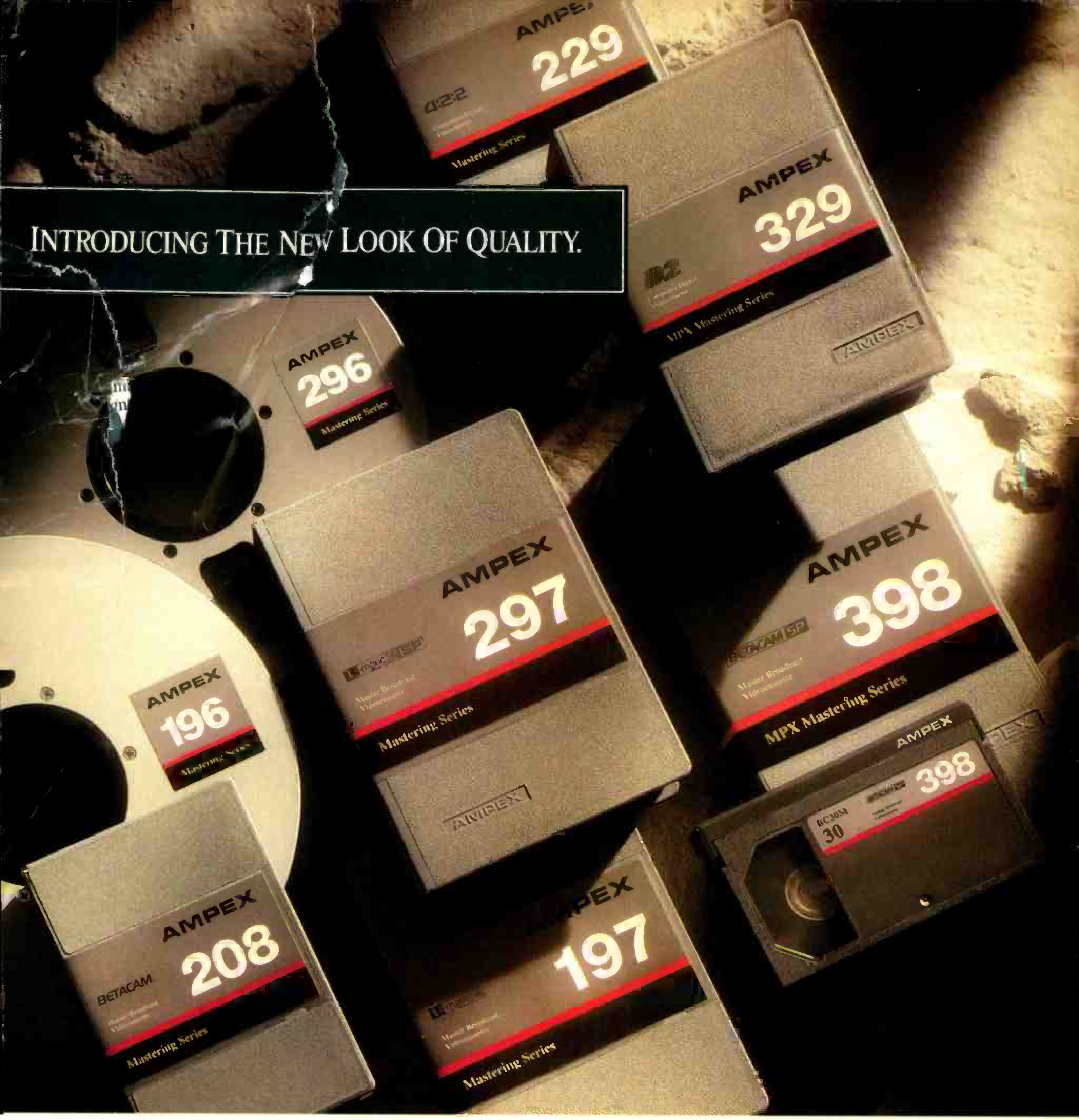


***Figure 1.** The CCD scanning circuits sum two pairs of vertical analog memory cells to obtain each color-difference signal. Luminance (and green) are also provided as part of the color separation processing.* ■

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



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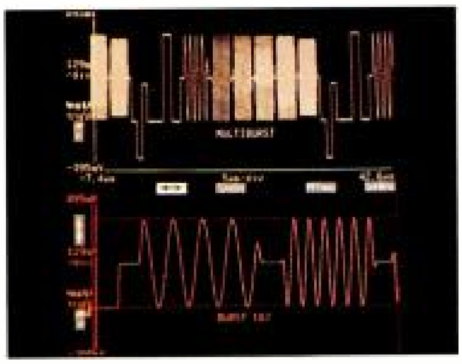
Part 5

Troubleshooting



Maintaining STLs

Routine maintenance

By Chris Durso

Regular low-level maintenance schedules keep engineers aware of their equipments' general condition, and help catch small problems before they become big ones.

Equipment with lots of moving parts (such as VTRs) or hardware that is actively used by station personnel (such as switchers) tends to receive more maintenance than devices that function unattended in the rack (such as STLs). But it is the station engineer's responsibility to ensure that *all* equipment is checked regularly for proper operation.

The perils of redundancy

Many stations have redundant backup STL systems with automatic switchover in case the active system fails. With this kind of arrangement, it is easy to forget about the condition of STL components that are not currently on-line. In the worst case scenario, a main system may have failed days earlier, and the system may have switched undetected to the alternate. The station is now operating without a backup STL, but no one is aware of it. If the alternate system failed for some reason, the station would be off the air. This may be the station's only method of finding out that the main STL has failed.

Therefore, it is good practice to switch between main and alternate systems on a regular basis. This will require some method of remotely switching between STL receivers at the transmitter site. If possible, interface the receivers' status indicators to the remote-control system as well, so the operator is alerted to a change in the on-line STL receiver.

Run a tight ship

As with any electronic equipment, heat buildup can shorten the life of the STL system. Always allow for adequate airflow when rack-mounting STL hardware. Keep all heat sinks, fans and air filters clean and in the clear.

Check audio, video and RF connections at each end of the STL link during the preventive maintenance cycle. Be sure the connectors are still securely fastened to the wire/transmission line and equipment. Cables should make gentle bends and have sufficient service loop. If the cables are not labeled, take the time to clearly mark each wire so that during emergency troubleshooting procedures, you won't become confused if forced to reconfigure the system.

Check all transmission lines' points of building penetration for any evidence of water leaks. For pressurized transmission lines, verify that pressurization equipment is in good working order. Nitrogen systems may require occasional cylinder replacement, while dehydrator desiccant may need drying or replacement.

In an STL maintenance log, track equipment meter readings so that trends can be identified. Typical readings should include power supply voltages, final amplifier current, relative power output, subcarrier levels and receive signal strength. (See Table 1.)

Spare parts for your STL system should be on-hand. The STL manufacturer can recommend a list of spare parts. Although some items may be expensive, their cost must be weighed against the cost of downtime from an inoperative STL. Redundant systems not only reduce downtime, but lessen the burden of stocking a large variety of spare parts.

Be prepared

If the system requires bench maintenance, you should have on hand the equipment discussed in last month's column. (See "Troubleshooting," June 1992.) An understanding of the basic circuits found in your STL is also essential to effective troubleshooting. Take the time to study the technical manual *before* a problem develops. Be sure to use appropriate caution around the high voltages found in many STL transmitters.

Often, the equipment maintenance manual will offer step-by-step troubleshooting procedures designed to isolate specific problems. Most manufacturers also offer technical assistance by telephone. Using this service can accelerate station engineers' learning curves and return the equipment to service quickly.

As in all other areas of station technical operation, a regular maintenance routine will ensure that an STL system is operating at peak performance. ■

TRANSMITTER	RECEIVER
MAIN ALT (Circle one)	MAIN ALT (Circle one)
Final voltage ____	Signal level ____
Final current ____	Mux levels ____
Power output ____	
DC voltage ____	DC voltage ____
Modulation ____	Modulation ____
Audio input ____	Audio output ____
Video input ____	Video output ____
RF connector ____	RF connector ____
RF feedline ____	RF feedline ____
Line press. ____	Line press. ____

Maintenance performed: ____

Comments: ____

Date/Time/Technician: ____

Table 1. A sample form for routine STL system maintenance.

Durso is chief engineer at KPBS-FM, San Diego, CA.

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Circle (12) on Reply Card

Technology News

Using BST on your PCB

By Carl Bentz, special projects editor

The levels of sophistication in electronic products for communications have reached new heights. Product miniaturization and new devices to operate the compact designs have seriously hindered older test procedures for quality control testing and repair troubleshooting. The Boundary-Scan Test concept is a new look at improving test procedures and testing efficiency.

Foreseeing a crisis

Constructing electronic equipment from printed circuit boards (PCBs) used to cause quite a stir among technicians who would eventually be expected to track down malfunctions and failures. The big question was, "How does a person find the fault on a large PCB?" Previously, it was possible to actually follow a conductive trace across a board and check each interconnection. However, more complex circuits produced more densely populated boards with multiple layers and double-sided layouts.

Manufacturers responded with integrated diagnostics and board exchange programs. When a PCB failed, the diagnostics would help a technician locate the faulty board. Once identified, the module was shipped to the manufacturer and a replacement unit was rushed to the customer. "Bad" modules were delivered to the repair technician, who used special test fixtures to sequentially track down the component(s) responsible for the problem.

Laying on a bed of nails

The technician's tasks in board repairs were simplified by a device called a *bed of nails*. Such a test fixture used numerous probes that contacted specified test points on the board.

The program examined circuit paths and, within minutes, produced a report showing those steps that failed. This data led a technician to the section of a PCB with a failure or intermittent condition.

The plot thickens

On IC packages with larger pin counts, component density often made placement of probes on the right connections an awkward proposition. Designs turned to surface-mount technology (SMT), and conditions became extremely difficult. With application-specific integrated circuits (ASIC) on the board, the test procedures became next to impossible.

The conductive traces on today's PCBs are in the 100μm range. The signal and power pins of the devices, becoming more numerous (numbering into the hundreds), exhibit a shrinking of the pitch from 2.5mm to 0.3mm.

Introducing Boundary-Scan Testing

One answer to modern PCB testing is called *Boundary-Scan Testing* (BST), a design-for-testability technique. Instead of probes, a port permits the test system to communicate with the components to determine the status of individual I/O paths. Initially, an additional expense is required to design and manufacture a new generation of ICs that include the test port.

An example of a BST IC is shown in Figure 1. Intercepting the signal paths between each pin and the core function logic are boundary-scan cells (BSCs). These cells form a serial path as a shift-register chain, called the boundary scan register. To access different circuit nodes for tests, appropriate data, clocking and control signals are applied to the test port inputs. An instruction register may contain a choice of tests to be performed. Optional registers may be included for an ID code memory, which might contain IC and manufacturer data.

All internal functions fall under the Test Access Port (TAP) controller, also located in the new generation IC. A minimum of four conductors form a communications path between the test control computer and the individual chips with test data input, test clock, test mode selection and test data outlines. Complete analysis of a circuit device is now possible.

When the boundary-scan ICs are assembled on a PCB, the test lines to individual components can be connected in a serial path around the entire board. Other requirements may specify that each device is individually accessed by its own set of test lines, or several serial paths may be developed.

PCB — heal thyself

Although this technology is only now emerging, test systems using boundary-scan concepts are in use. The big challenge will be to redesign the myriad integrated circuits now in use to contain the special cells. Another challenge will be to incorporate boundary-scan techniques with new equipment designs and devices with redundant gates, thus creating a PCB with the capability of self-healing, based on diagnostic programs offered by the system control computer.

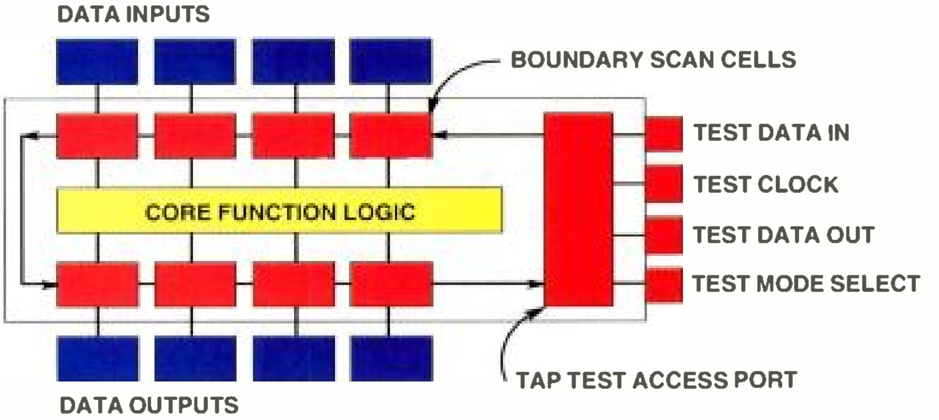


Figure 1. *The shaded series of blocks intercept all lines between I/O pins as an on-chip shift register to access circuit nodes in the IC.*

Editor's note: This information is based on material in "The ABCs of Boundary-Scan Test," published by John Fluke Manufacturing Company and Philips Test & Measuring Equipment. ■

Audio technology update

Digital technology is revolutionizing the way we do business. Are you up to speed?

To those of us who began our engineering careers in the good old days of analog, the changes brought about by digital technology are almost astounding. I remember when tape recorders required constant maintenance just to maintain the factory specification of ±1.5dB record/play frequency response. Wow and flutter was a common issue, as was tape hiss. Often, squeezing that last half decibel of top end performance out of the machine while balancing the low end or upper mid-range bump was akin to magic. The final performance was highly machine dependent, and even the best of engineers couldn't make an old tube-type Magnecord perform miracles.

Technology for audio has come a long way. Nowadays, we expect our audio equipment to operate not within ±2dB ranges, but tenths of decibel tolerances. Noise floors on today's digital audio equipment are as close to theoretical limits as the math predicts.

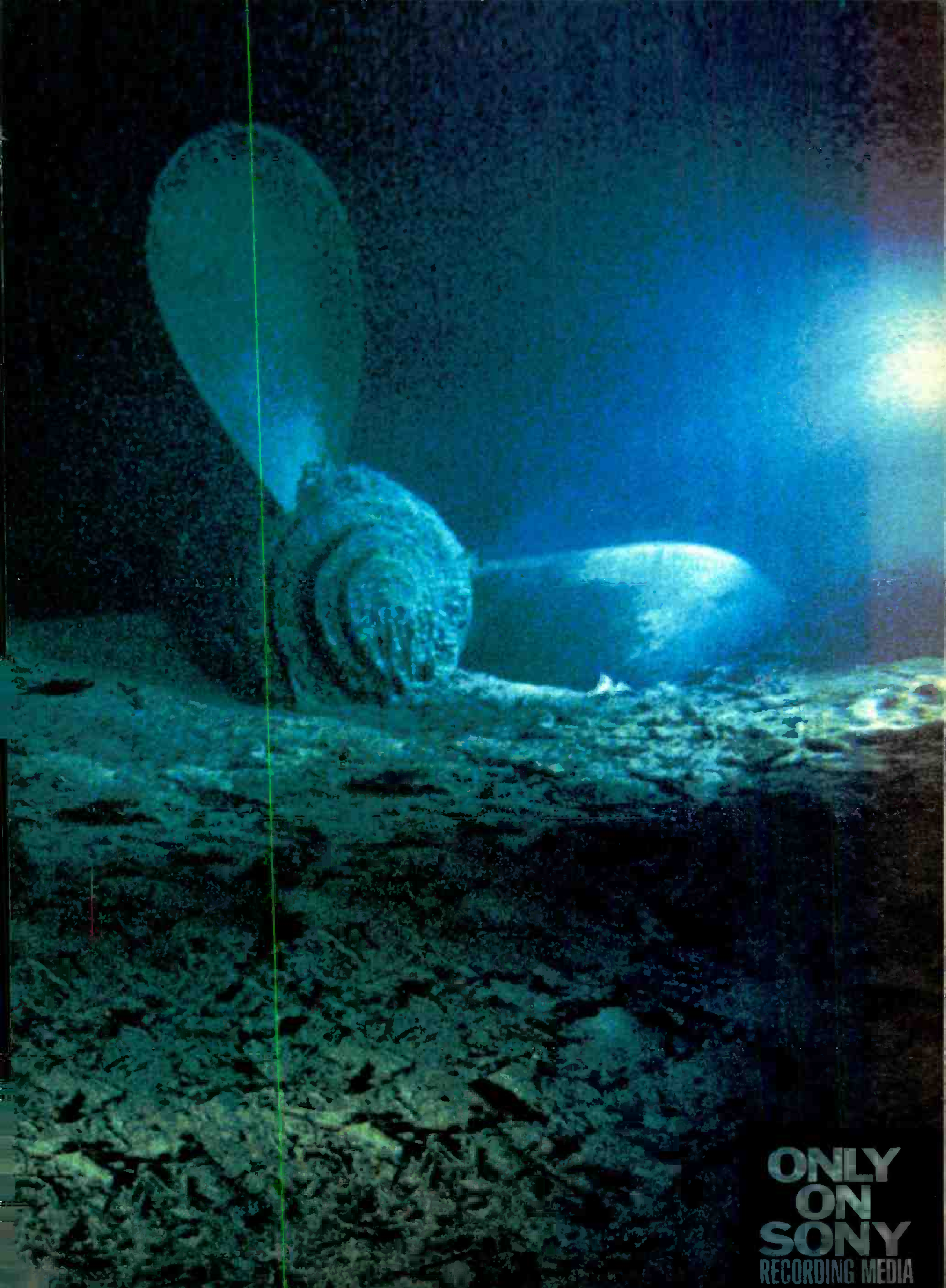
Because we expect almost pristine performance from our DAT and CD recorders, anything less seems unacceptable. We now rely on as much digital technology as we can afford, usually based on the assumption that if it's digital, it must be better.

However, that easy leap in assumption isn't necessarily true. Even so, the advantages provided by today's digital hardware make it easier than ever to improve audio performance or production capability.

In this month's issue, we examine five areas in which digital technology has revolutionized (or soon will revolutionize) how we do business. If you're not up to speed on how digital can improve your operation, keep reading. Some important answers lie within the next few pages.

Brad Dick

Brad Dick,
editor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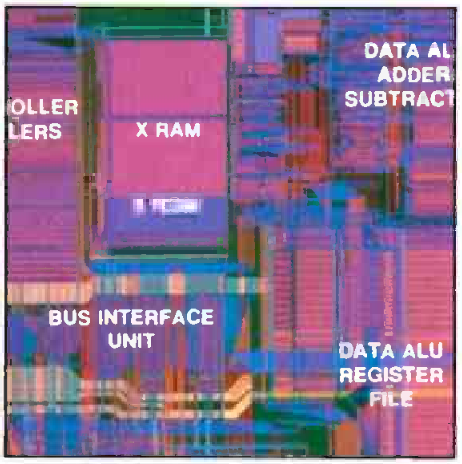


This processor for multimedia applications has 750,000 transistors and performs what previously required multiple chips. It is capable of handling graphics and sound simultaneously, with compact disc-quality sound. (Courtesy of Motorola.)

al, enhance it digitally and play it back in many different ways. In addition, the reverb device can either be source or slave to MIDI events, which ties it to the majority of musical instrument products available today.

On the subject of MIDI and timing, many newer reverbs allow a wide range of control via MIDI or even SMPTE time code. These features become especially useful when the reverb device is used in conjunction with a digital audio workstation, most of which can take either MIDI or SMPTE (or both). Many separate effects can be preset on a single device, and then called up sequentially as needed during the mix by the workstation (or a MIDI controller/sequencer) from embedded automation commands.

Some digital reverbs also provide the sonic benefits of direct digital interface with other digital audio equipment. This has become increasingly useful and important because DVTRs, digital mixing consoles and many other high-end A/V production devices now offer digital audio I/O via an AES/EBU or SPDIF port.

Digital noise eliminators

Even the best reverbs cannot eliminate noise and hum in the signal path. For example, assume that the original program material has inherent background noise and tape hiss along with AC hum. Also assume that the master tape has time-code bleed and the VTR has pickup hum from a ground loop in the rack being injected through the XLR connector, along with SCR noise from a dimmer. It's five minutes to air and the producer is frantic. A decade ago, the engineer would have called it a day. If, by chance, the program was fixed, it probably would have lost much of its sonic punch in the process.

Today, thanks to digital audio processing technology, the engineer has many solutions to choose from in such a situation. The so-called digital *noise eliminators* are the most recent solution. These are available in the form of software packages that operate on PC platforms or digital audio workstations or as dedicated hardware products. Both approaches have their merits.

The computer systems are more sophisticated and versatile, but the dedicated units are portable and simpler to operate. Common to most of these units is multiband downward expansion that attenuates output level when the input signal level falls below a user-defined threshold in each band. If the input signal level is high enough to mask the noise, then the signal passes through unchanged. The multiband approach will generally provide greater noise reduction with fewer artifacts than wideband expansion.

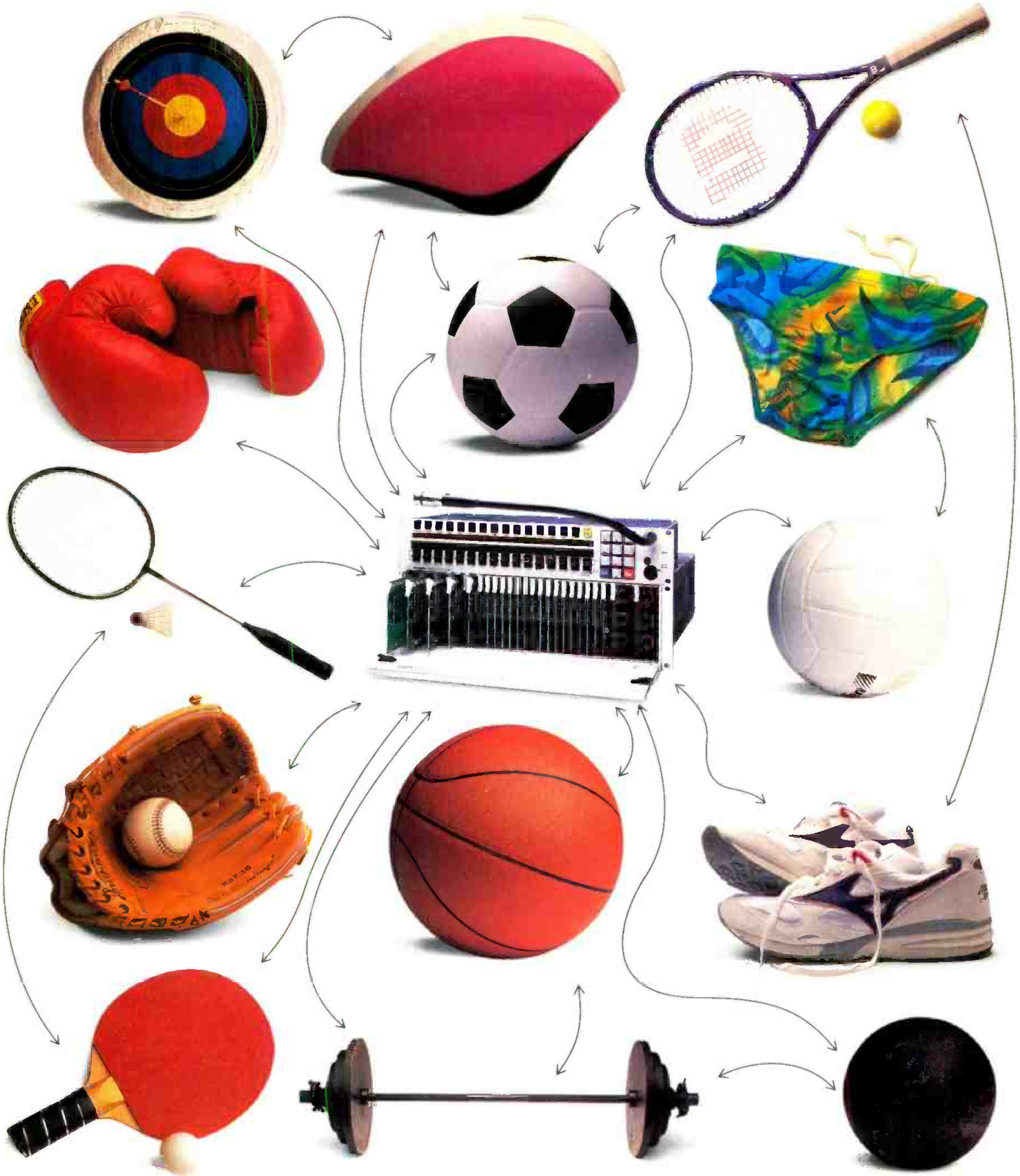
Because each band can have its own attack time, release time, threshold level and separate envelope follower, the natural attack and decay dynamics of a sound are largely retained, along with more of its spectral content. One of these systems can be a useful addition to the broadcaster's production tool kit.

Digital sampling systems

Another breakthrough in digital audio technology is the recent use of digital sampling systems for broadcast production. Although the major market share of samplers is still in the music recording business, more and more are finding homes at stations, audio-for-video and film-post facilities, ADR and Foley rooms, and effects generation and program production studios. What makes the sampler unique is its ability to record a short piece of audio, manipulate it, sequence it, and add polyphony and multitimbral attributes to it, all in one box.

Often, the power of these devices is not realized until the full *variety* of their benefits has been experienced. Imagine having the flexibility to sample and synthesize sounds or create complex sonic passages for program filler or background music beds. Then, add the ability to create dramatic sound effects and fly them into other program material. If that's not enough, add the spectral and dynamic processing that DSP allows, and the pitch-shifting or time compression offered by most samplers. Lastly, the sampler can be used as a slave or master to control other MIDI devices, thereby forming a complete sound production system for sound recording and playback. Sampled libraries are available that perform all of the front-end work.

Many samplers are on the market today, and not all of them are created equal. Again, systems are available in either dedicated hardware units (often disguised as a keyboard instrument) or in the form of a software/hardware package integrated



into a PC. Each system has unique attributes that make it appropriate for its intended market.

Today's better dedicated devices typically use VLSI architecture with expandable RAM memory for stereo sampling and 16-bit to 20-bit resolution. A 24-bit internal bus processing structure is also common. Editing capability and other features are included, along with interface to magnetic or magneto-optical (MO) disk via digital I/O.

So why would a broadcaster or production house use one? Simply, because a digital audio sampler has the ability to extensively and quickly modify sampled sounds to create a multitude of new sonic possibilities for production. For instance, samplers use an assortment of digital waveform generators and low-frequency oscillators to synthesize sound, with sweepable digital time-variant filters for spectral control, and the ability to control amplitude shaping and pitch bending. Some also can perform sample reconstruction synthesis, to completely redefine certain parameters of the original sound.

Furthermore, the sampler can perform editing, auto-looping, crossfades and transition-smoothing functions. When it's time to compile an event list and sound elements, many samplers simplify the process with their extensive data organization utilities. Some of these sophisticated data management tools match the best found in the video world. In addition, most samplers have the ability to read and write to MO and SCSI hard disks, and are compatible with most available CD-ROM systems. Now try to imagine doing your next audio production epic without one of these in your stable.

Conclusion

The world of digital audio has evolved tremendously during the last decade and has touched almost every facet of broadcasters' lives. Looking to the future, digital audio processing technology is likely to merge more harmoniously with video- and computer-based technologies. Similarly, advancements in software design coupled with VLSI development will take the digital audio frontier to new heights. The end result will be added flexibility and performance for the broadcaster, along with a richer feature set, allowing background tasks to be performed more transparently. This will leave the operator with more time to create. Stay tuned.

➡ *For more information on digital audio processors for production use, circle Reader Service Number 300.*

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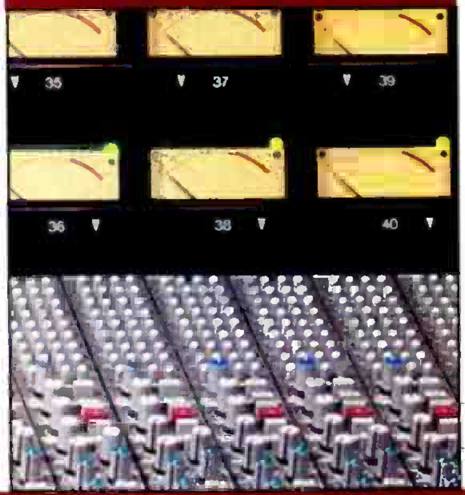

Digital audio processing for transmission

An examination of today's digital audio broadcast processors.

By Dennis R. Ciapura

The Bottom Line

The widespread digital buzzword has recently invaded the land of broadcast air-chain processing in a big way. But sorting out the facts from the hype can sometimes be difficult for the prospective purchaser. All of the current "digital" processors use digital techniques in different ways, and each presents a separate set of issues for the broadcaster to consider. Here is a brief overview to get your comparison-shopping started. **$**

Ciapura, *BE's* consultant on radio technology, is senior vice president at Noble Broadcast Group, San Diego.

Analog audio processing has reached such a high degree of sophistication in the past 20 years of its evolution that further improvement may be considered doubtful. Nevertheless, many have assumed that the powers of digital audio will offer radical new techniques, enabling higher loudness levels with less audible artifacts and vastly improved parametric flexibility. As is often the case, reality lies somewhere between the worst and best of expectations. Now that several new systems incorporating digital elements have debuted, we can begin making assessments of what this new generation of hardware can and cannot do.

Digital is a relative term

Today, the term *digital* is used widely within the broadcast industry. It is important to understand that the word does not have a uniform meaning when applied to systems as complex as today's state-of-the-art audio processors. Different manufacturers apply digital technology in different ways. This can range from those who use digital control for analog processing (such as Aphex, CRL and Cutting Edge Technologies) to those who process audio in the digital domain for most or all of their signal paths (such as Audio Animation, Gentner and Orban).

It is easy to get caught up in the "digital is better" and "how much is really digital" debates when looking at these systems. But for the broadcaster, such analysis is academic, if not frivolous. It may also cloud more important issues, such as the differences in sonic quality, functions, control methods and available options among today's systems, which may also vary considerably.

The new design methodologies that digital audio allows have changed what broadcasters can expect from processing devices. This article will examine the three current systems that use digital signal processing (DSP) to process audio, and will discuss the various philosophies that their

The new designs that digital audio allows have changed what broadcasters can expect from processing devices.

respective designers espouse. This will help the user to best understand and most effectively use the features provided by such new directions.

Peak control methodology

The approach to control of audio peaks is a good place to start. On this issue, today's digital broadcast processors fall into two broad categories: clipping and non-clipping. Although it is possible to totally

Continued on page 36

How to make certain the news always comes from a reliable source.

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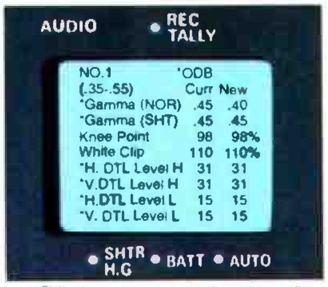
CAMERA SUPPORT EQUIPMENT: *ANALOG.*



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Continued from page 32

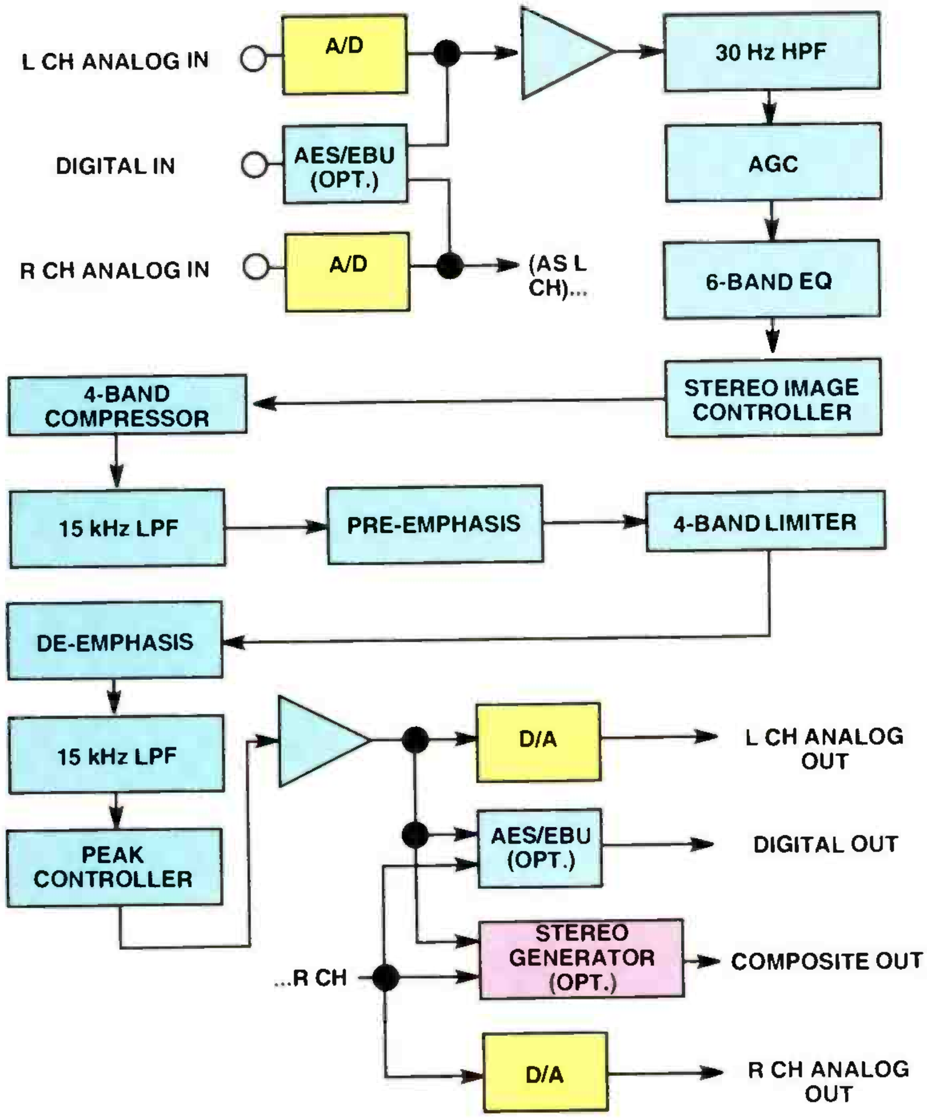

Figure 1. *A block diagram of the Audio Animation Paragon-transmission.*

eliminate clipping in any audio processing system — including analog systems — whether this is *desirable* is the subject of considerable debate.

At the center of the debate is the effect of total waveform gain reduction vs. simply clipping brief program peaks. The output of any limiter with release times slow enough to prevent distortion due to gain reduction on fractional cycles will exhibit peaks to approximately 10dB above the equivalent tone level of the program output. This also is true of multiband limiters with each band as fast as possible. Therefore, a typical limiter without some form of instantaneous attack and release (clipping), or near instantaneous limiting and release, would need to be operated at an average level of approximately 30% to avoid overmodulation by the peaks. This level may be 2dB to 4dB lower than what it takes to produce competitive loudness in most markets today.

Another difficulty with the non-clipping, fast limiter approach involves the long-term level problems it may create: Program content with higher peak-to-average ratios will encounter more gain reduction in such a system. This presents the danger of loudness variation from source to source. Moderate peak clipping, on the other hand, will leave long-term program levels unchanged. However, considerable distortion will be generated unless sophisticated filtered clipper arrangements are employed. Some designers make a compromise solution by teaming a non-clipping multiband limiter and final peak limiter in the audio section with a composite clipper in the stereo generator.

A product for every philosophy

When examining specific units in this light, today's systems exhibit a variety of design methodologies. The Audio Animation *Paragon-transmission* takes the audio purist approach of no clipping anywhere in the system. The AKG/O ban *Optimod 8200* follows in the footsteps of its designer's analog predecessors, using filtered audio clippers but no composite clipping. The Gentner *Lazer* employs no clippers in the audio (although its wideband final limiter can be set to act as a clipper), and includes a composite limiter in the stereo generator output. A more detailed look at each of these designs will provide an extremely useful overview of the state-of-the-art in digital processing at the moment.

Audio Animation designers believe there is a significant market for a totally non-clipping processor, if one could be configured to provide competitive loudness levels. Figure 1 is a block diagram of the *Paragon-transmission*. It resembles a conventional processing chain, but the final peak limiter design is really the key to the system's peak control effectiveness. The fully adjustable attack and release times can be as fast as a *single sample* at 44.1kHz (approximately 23μs), and the limiting ratio can be as high as 500:1. Even when set for release times of approximately 100 samples, the peak limiter gets in and out fast enough to function much like a clipper, but without actually clipping the waveform.

The *Optimod 8200* takes a different approach. It makes use of a multiband clipper distortion-cancellation technique and filter overshoot control technology developed for the analog Optimod, in an attempt to maximize source-to-source loudness uniformity. Audible artifacts of the filtered clipping are minimal until the processing is set aggressively. Its operative strategy assumes that intelligent clipping is the best way to get competitive loudness, as long as clipping artifacts remain inaudible. Peak audio level control is absolute, in keeping with the company's philosophy against composite clipping. (See Figure 2.)

Gentner's *Lazer* uses 3-band limiting followed by a wideband limiter that employs a soft-knee action, allowing the operator

System reconfiguration flexibility is another asset of digital audio processing systems.

to set thresholds at which its limiting begins and ends. The second (higher) level serves as a brick wall maximum output setting. If the two thresholds are set to the same level, the limiter acts as a clipper. Otherwise, the limiter senses the amount of attenuation necessary for any signal it encounters between the two thresholds. A fast composite limiter controls final mod-

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ulation level. Its operation takes place ahead of pilot injection. (See Figure 3.) Additional 4-band compression for users desiring it is available separately with the company's companion device, the *Prizm*. (See Figure 4.)

All three devices (four, including the *Prizm*) use a wideband AGC at the front-end, preceding their limiter sections.

Configuration and control

System reconfiguration flexibility is another asset of digital audio processing systems. Once again, the available products seem to fall into two broad categories. The *Lazer* and *Optimod 8200* are updated via firmware (chip) changes, while the *Paragon-transmission* is a disk-based system. Each approach has its advantages and disadvantages. The firmware-based systems don't have disk drives that can fail and preclude user-programming intervention, but the disk system encourages more frequent updates and allows file import/export.

Another key flexibility issue is the degree of parametric control afforded by the various systems. Again, this is related to vendor design philosophy. The *Optimod 8200* provides a great deal of factory standard setups arranged by programming format. It gives the user some adjustment latitude to alter the factory setups and/or create entirely new ones. The degree of control, however, is somewhat limited. This approach minimizes the possibility of a user accidentally putting something atrocious on the air, and it plays to the comfort zone of the manufacturer's previous customers.

On the other end of the control spectrum, the *Paragon-transmission* provides wide control flexibility, and can put the user in the processing designer's seat (for better or worse). Several generic, fidelity-oriented factory setups are provided, spanning the usable range of the processor's loudness enhancement. In the product's accompanying literature, users are encouraged to experiment with their own designs, employing the factory setups as starting points. Gentner's *Lazer* and *Prizm* provide a level of user control that lies somewhere in between the other two. The *Lazer* offers more access to adjustment of parameters than the *Optimod 8200*, but the structure of the processor is not as reconfigurable. The *Lazer* opts for a fixed 3-band approach in its multiband limiting section (the *Prizm* is a fixed 4-band processor), while the *Optimod 8200* can be configured via software to operate as anything from a single-band to a 4-band processor.

Orban and Audio Animation also chose a single box approach, while Gentner split its processing (and its system price) into two devices, with the thought that some stations may not need the whole package.

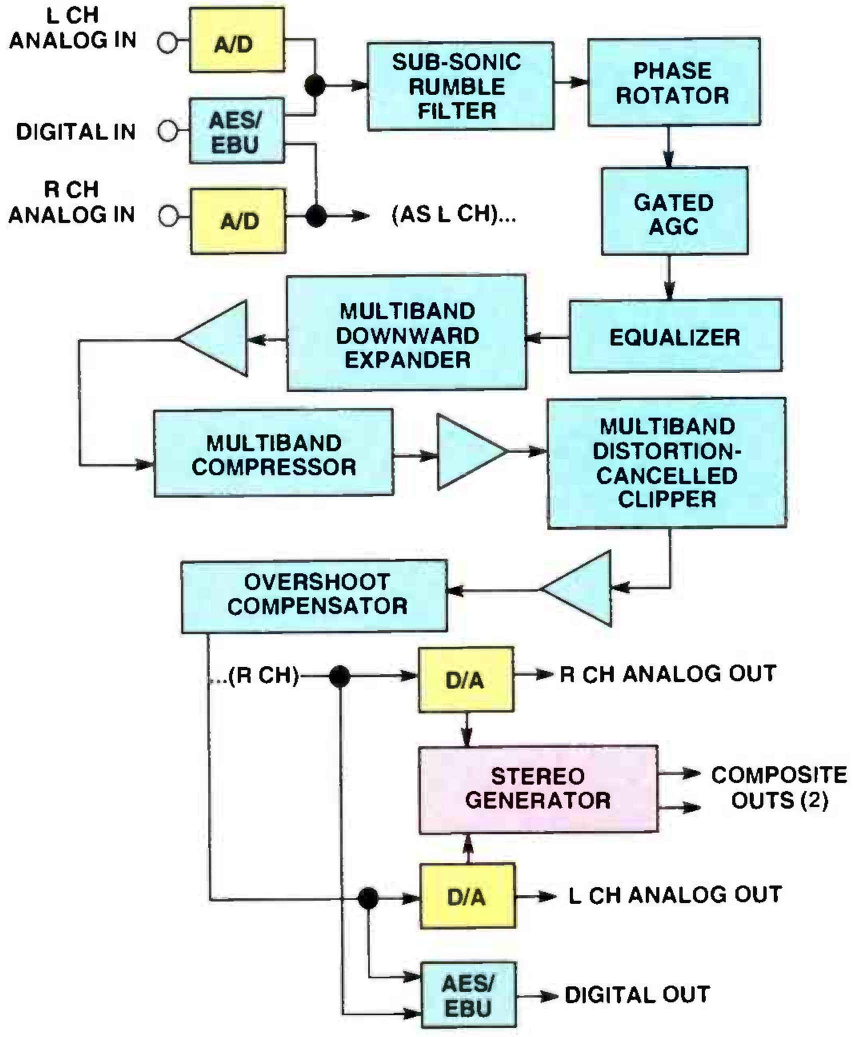

Figure 2. *A block diagram of the Orban Optimod 8200.*

Display and user interface

A variety of control surfaces and displays are used in these systems. The *Paragon-transmission* uses a touchscreen in combination with an assignable rotary control and four dedicated push-buttons (cancel, load, setup and help). The display is a graphic user interface (GUI) running on the internal processor, which can be displayed on the on-board video monitor or an outboard PC monitor. The *Optimod 8200* employs an on-board liquid crystal display (LCD) window with five softkeys and two dedicated push-buttons (escape and help). Four-way cursor arrows and a continuous rotary pot are used for setting parameter values.

A variety of control surfaces and displays are used in these systems.

Using optional software, an outboard PC can provide a larger, higher-resolution color display. The *Lazer* and *Prizm* use perhaps the simplest approach. Each device employs a single, 4-line alphanumeric LCD window and five push-buttons. Two of the buttons are up/down arrows for stepping through parameter values and moving the screen cursor. The other three buttons select, enter and escape the device's various functions.

Metering philosophy also differs among these systems. Audio Animation and Orban use their display screens to show meters, while Gentner uses horizontal LED displays. Some of these LED meters are dedicated to a particular parameter, and others are assignable.

All systems allow (or plan to allow) remote control via RS-232 or a similar interface. This means that a standard dial-up modem can be used to control these devices remotely via PC. All of these devices also offer password protection to prevent unauthorized access to active and stored settings.

Digital interface considerations

Another issue foremost in the minds of

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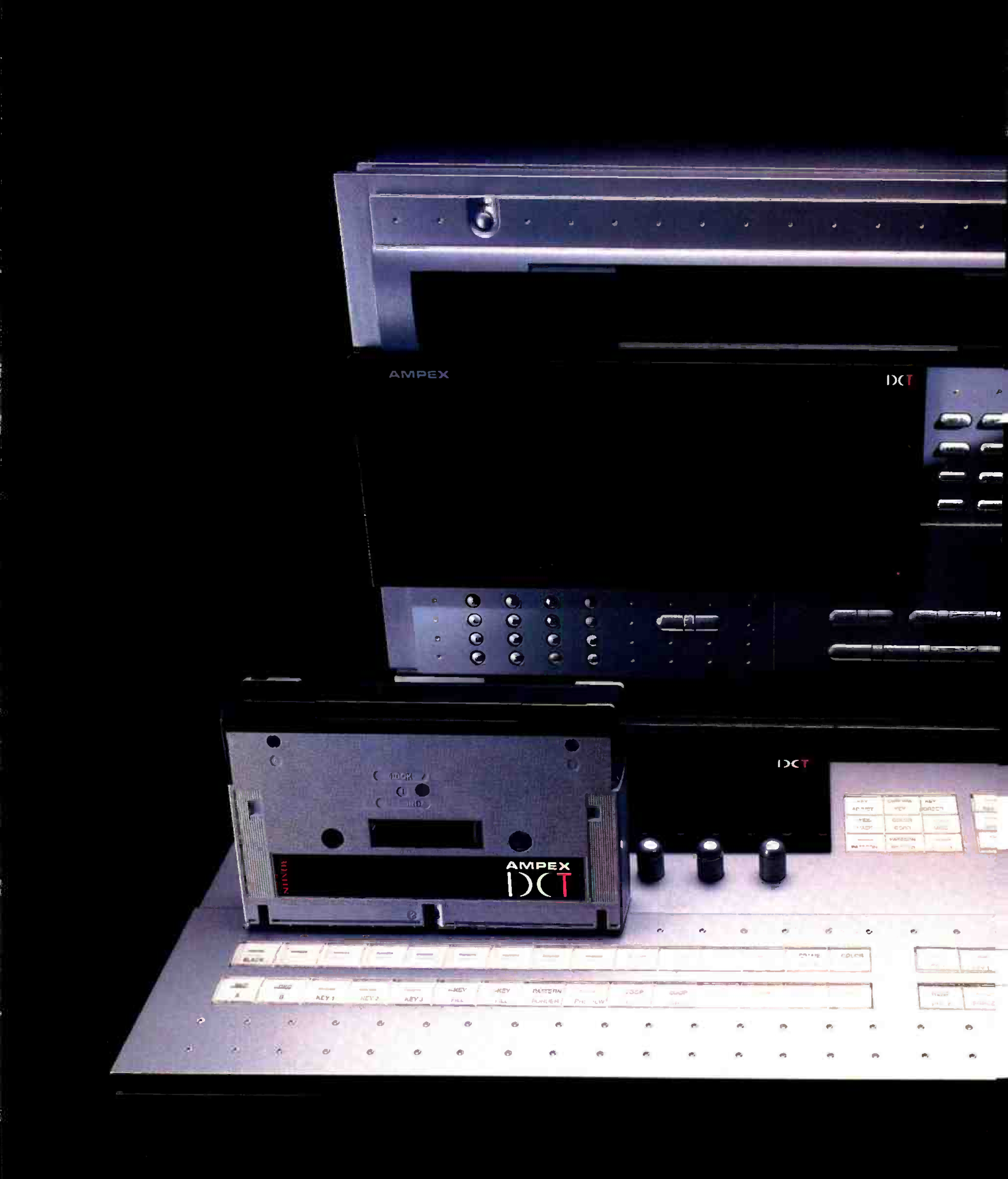
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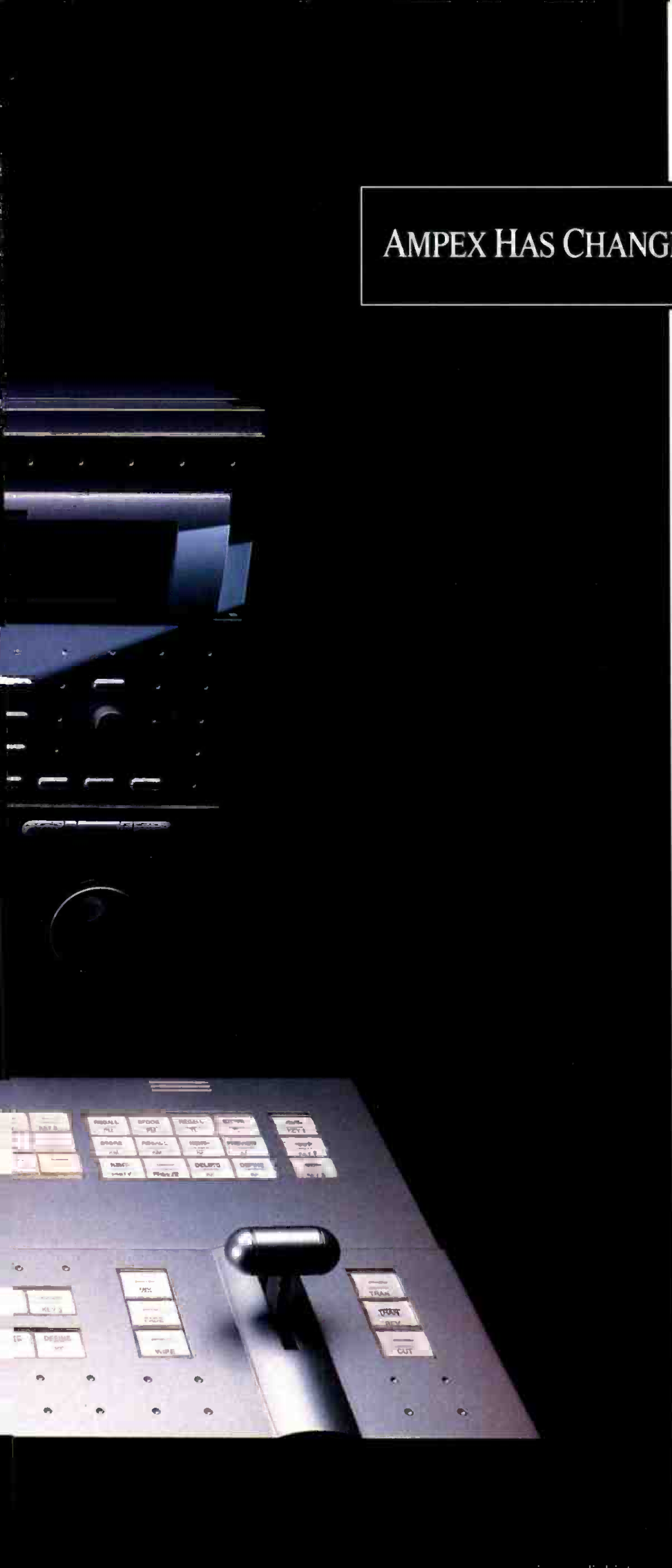

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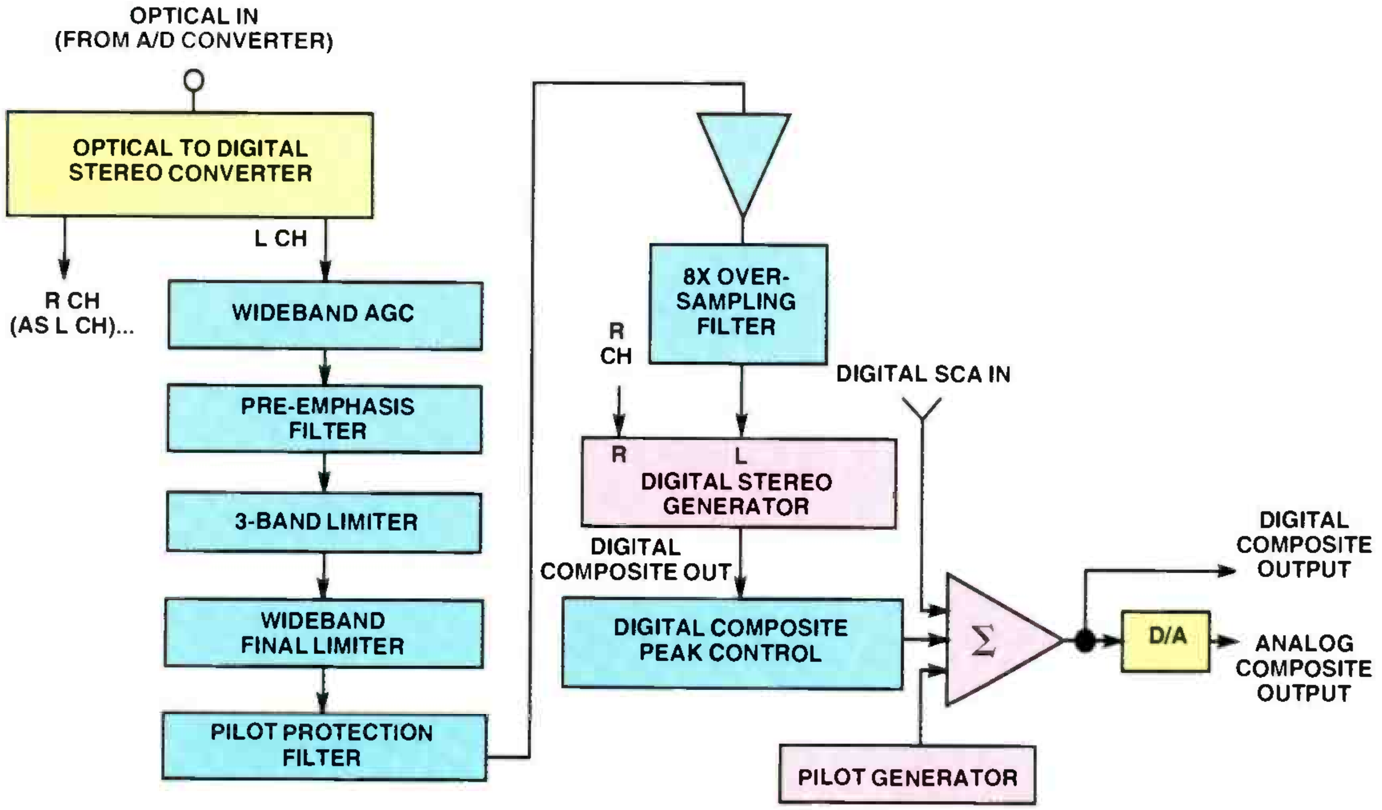

Figure 3. A block diagram of the Gentner Lazer. Analog-to-digital conversion is handled by a preceding device, whose fiber-optic output feeds the Lazer's optical input.

many broadcasters is the fully digital system of the future. This implies some compatibility and standardization for interconnection of digital devices, including the audio processor. Unfortunately, progress in this area has been slow. Decisions there will greatly affect some important audio processor design issues, including sampling rates for systems with integrated stereo generators, and time base accuracy for carrier frequency generation in exciters. Manufacturers have different opinions on optimum sampling rate (32kHz, 38kHz and 44.1kHz all have merit for obvious reasons), and a number of efforts have been launched to sort out a standard. All of the currently available digital audio processing systems include provisions for eventual direct digital audio input and output, but at this point, these remain largely unused.

Beyond the sampling rate question is the issue of *where* the broadcast system's time base should be located. For example, CD tolerances have been shown to be insufficient for translation to FM carrier frequency. Should the station time base be in the console? Should it be at the transmitter and referenced back to the studio? What about digital STL delays? Some interesting debates lie ahead.

Just where in the processing chain the signal enters and leaves the digital domain is an important issue for interface reasons, at least in the short term (while the digital audio processor still exists as an island

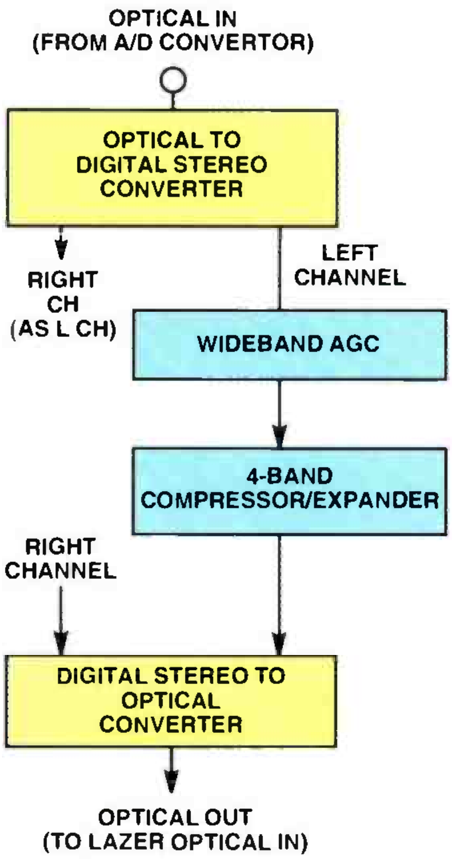

Figure 4. A block diagram of the Gentner Prizm. Designed for use as an optional preprocessor to the Lazer, the Prizm is inserted between the analog-to-digital-to-optical converter (described in Figure 3) and the Lazer, accounting for its exclusively optical I/O.

in the otherwise analog audio chain). Here, too, differences between the systems apply.

The *Paragon-transmission* takes audio straight from the source (typically the on-air console or switcher) and immediately converts it to the digital domain. After processing, it provides either analog or digital audio output to an outboard stereo generator. The release of an on-board stereo generator upgrade for the system

Which processing philosophy is best? What level of user control is optimum?

(of hybrid analog/digital design) was impending at this writing. This would allow provision of an analog composite output as well. The *Optimod 8200* also converts analog inputs immediately to digital audio for processing, and includes an analog stereo generator. As a result, the unit offers analog or digital audio outputs, and a pair of (identical) analog composite outputs. Gentner's *Lazer* and *Prizm* are fully digital devices, to the extent that they do not include onboard analog-to-digital converters. A separate conversion device is

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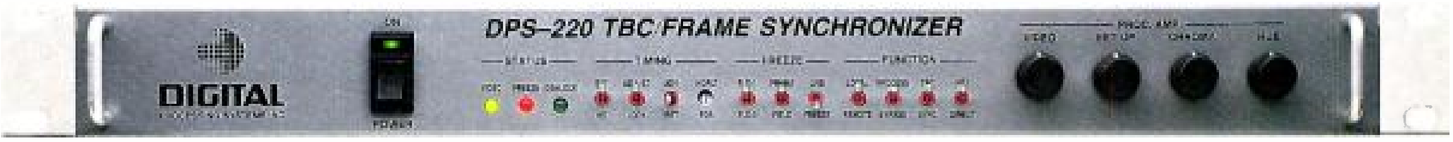

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used, which applies phase rotation in the analog domain and then converts the signal to digital audio. The converter's output is sent to the *Lazer* or *Prizm* via a fiber-optic interface. Therefore, both the *Lazer* and *Prizm* have optical inputs only. The *Prizm* also has an optical output only, while the *Lazer* includes a digital stereo generator, so it offers composite outputs in analog and digital form (the latter is designed for use with exciters offering a compatible digital input).

Which is best?

Choosing a digital audio processor is a matter of individual station culture and personal preference. All of the systems mentioned here are well-designed and constructed, and each will likely find its following in the marketplace. Which processing philosophy is best and what level of user control is optimum are the two primary questions that anyone considering digital audio processing will confront.

Digital audio processing does not offer a loudness bonanza, and all of these manufacturers candidly point out that the methods developed for analog have already pushed the loudness quest to its practical limit. What digital systems do offer is the opportunity for the user to participate in the processing *design* to a greater extent than is possible in the analog domain. For those who have amassed racks full of repeatedly modified analog gear in the never-ending quest for a unique sound in today's ultracompetitive radio markets, this can be a compelling incentive. Greater uniformity and repeatability in performance, full remote control (using optional PC display/interface software in some cases) and the ability to vary settings by daypart (or some other criteria) are among the other advantages presented by this new technology.

These manufacturers have also begun discussing the possibilities offered by open-architecture and third-party software for their systems. Perhaps the authoring of such software will be the role of tomorrow's audio consultants and radio gurus.

Digital systems allow the user to participate in the processing design to a greater extent.

Finally, although movement toward a fully digital audio chain has been long in coming, most agree that its eventual arrival is inevitable. A sensible approach to this transition is to take it incrementally, concentrating on where a digital replacement will provide the greatest benefit at the current time. Broadcast audio processing is certainly one of those replacement points. As the products described here clearly demonstrate, it's not too soon to start looking seriously at digital alternatives for this important part of the air chain. ■

Editor's note: The block diagrams shown in this article are simplified versions of documentation supplied by the manufacturers.

➠ *For more information on digital audio broadcast processors, circle Reader Service Number 301.*

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Replacing the analog cart machine

In the new world of broadcast audio recording, life imitates cart.

By Skip Pizzi, technical editor

The Bottom Line

Manufacturers have long been taking aim at the broadcast audio cartridge format, but without great success. As much as users decry the cart's many flaws, its inherent reliability, familiarity and standardization make it difficult to relinquish. Nevertheless, digital systems are mounting an increasingly serious challenge to the workhorse cart. Broadcasters' growing comfort with computer hardware has opened the door to such replacement technologies, causing many stations to rethink their use of cartridge-based systems.

Someone once called the audio cartridge "the format that broadcasters love to hate." Yet, rumors of its demise have been greatly exaggerated. Some of this longevity has come from cart machine manufacturers' resourcefulness in providing incremental improvements over the years. Retrofitted audio upgrades, mechanical rebuilds, wholesale recorder redesigns, new tape formulations and cartridge designs, new tape speeds and track widths, noise-reduction systems, matrixed stereo and other stereo phase-compensation, bar code identification and more — the format has experienced significant evolution.

Today, audio cartridge systems are still widely prevalent. Almost all radio stations use them in some capacity, and many use them as a predominant on-air audio source. In some cases, if it's not live or from the network, it's on cart. But the trend away from carts has already been established. Purchase of new cartridge hardware dropped by 30% in 1991.[1]

Most likely, carts' reliability and familiarity have kept them in use. But as computers and digital audio equipment migrate into more areas of the broadcast operation, carts' perceived advantages in these respects have diminished. On one hand, audio quality of the facility is improving beyond what carts can deliver. On the other hand, broadcasters are now more conceptually trusting of computerized audio operations. Sensing this opportunity, manufacturers have approached the cart machine replacement market from a number of different directions.

Variations on a scheme

Cart replacement technologies can be divided into three general categories. (See Table 1.) First are the direct machine-for-machine replacements, where in an operational sense, only the media changes. Instead of a cart, audio is stored on some sort of digital carrier, typically disc-based. Hardware looks and acts like a cart machine, with similar size and control features.

A second type of system uses a bank of RAM to store a brief and/or bandlimited message. These are especially useful in lieu of carts for call-in announcement lines, for which purpose they often incorporate telco hookup and auto-answer functions.

The final group of replacement devices

> ***The trend away from carts has already been established.***

are a different breed altogether, replacing all of the cart machines in the facility with a single computer system. This global approach is implemented either on a PC platform or in proprietary hardware. In most cases, this kind of device is really a station automation system that incorporates hard disk recording, rather than a cart machine replacement per se.

Cart for cart's sake

Although difficult to explain, most broadcasters still find it reassuring to be able to hold that car dealer's spot or contest promo in their hand and physically load it into its playback device. Perhaps it stems from a basic human need for tactile feedback (or maybe just for the satisfaction of flinging it across the room when it jams). In any case, this "warm and fuzzy" factor argues for a replacement system that uses the same physical carrier approach.

Some of these products come from new companies, but several are made by traditional cart machine manufacturers. Available systems use a variety of media, spanning a range of optical and magnetic systems. Although the use of removable media is a key design element, some of these digital cart machines offer additional storage on internal hard disk drives. Some simple editing capabilities also are included.

Media choices are typically from the standard computer storage inventory. For example, high density (1.4Mbyte) and extra-high density (4Mbyte) 3.5-inch floppy disks are used by some systems, employing data compression to allow several minutes of high-quality stereo on each disk. (See "Digital Audio Data Compression," February 1992.)

One philosophical step removed from exact cart-for-cart replacement is a system that uses removable media, but on a *multiple message-per-carrier* basis. This category includes Bernoulli disks (removable hard disks), recordable CDs (CD-R) and magneto-optical (MO) systems. Although not a random-access format, the fast winding and accurate ID-point marking of DAT makes it another player.

Among the magnetic drives using removable (floppy or Bernoulli) media, some also offer an internal hard disk option for additional storage. Most of the random-access systems (magnetic and optical disk formats) include some simple editing capabilities as well.

Your choice of format hinges on several criteria, foremost of which is the facility's intended application. Some operations use carts only for short, occasional announcements or drop-ins, while others use them as their primary media. In the latter case, long-form storage offered by DAT, optical and Bernoulli disks may be more appropriate. Other criteria of choice include hardware cost, media cost and capacity, user-friendliness, the importance of rewritability (all formats except CD-R are erasable) and the likelihood of long-term format support by the manufacturer.

Purchase of new cartridge hardware dropped by 30% in 1991.

Most of these devices also include an RS-232 and/or other type of control port, allowing their integration into an automation system. Don't overlook this important element when assessing the appropriateness of various systems to your facility and its applications.

No moving parts

For a few specific applications traditionally handled by carts (primarily for their automatic recuing capacity), RAM recorders are offered by a few manufacturers. These are designed for repeated play of the same message(s), typically via telephone. Not only do these systems automatically recue, but they also can do so *instantaneously*.

Digital audio allows the trade off of bandwidth for record time, so these systems typically offer longer storage times at lower audio fidelity, and vice versa. Therefore, a range of audio quality levels is available. Other features offered by different products include multiple message storage, multiple simultaneous outputs, auto-answer capability and DTMF (telephone touch-tone) sensing.

Station on a screen

Other manufacturers support a different transition philosophy in their cart replacement systems. Rather than simply replac-

MANUFACTURER	DIGITAL CART MACHINE					RAM RE-CORD-ER	HARD DISK W/AUTO-MATION		RDR SVC NO.
	FD	B	CDR	DAT	MO		PC	Prop	
Acutron Electroacustica (PORT)							X		395
AEQ (SPN)						X			396
Agap (FR)							X		397
Arrakis (USA)							X		398
Asaca Shibasoku (JPN)					X				399
ASC (UK)	X								400
Barco/EMT (GER)					X				401
Basys/D-CART (USA/AUSTRAL)							X	X	402
Broadcast Electronics (USA)	X						X		403
Cipher Digital (USA)								X	404
Computer Concepts (USA)							X		405
Dalet Digital Media Systems (FR)							X		406
Denon (JPN)			X						407
Enco Systems (USA)							X		408
Ferrograph (UK)		X							409
Fidelipac (USA)	X								410
FOR-A (JPN)								X	411
Fostex (JPN)				X					412
Fougerolle Audio (FR)								X	413
Gentner Communications (USA)							X		414
Giese Electronic (GER)			X						415
Gotham Audio (USA)			X						416
Henry Engineering (USA)						X			417
IMC/Akai (JPN)					X				418
Marantz (JPN)			X						419
MediaTouch Systems (USA)							X		420
Otari (JPN)				X					421
Panasonic (JPN)				X					422
PKE International (AUSTRAL)							X	X	423
R.G. Barth (GER)							X		424
Racom Broadcast (UK)								X	425
Radio Systems (USA)				X					426
Ranson Audio (UK)								X	427
Rodman/Brown Associates (USA)							X		428
Smarts Broadcast Systems (USA)							X		429
Sonifex (UK)	X								430
Sony (JPN)				X					431
Studer Digitec/Numisys (SWIT/FR)								X	432
Studer Revox (SWIT)			X	X					433
Tascam (JPN)				X					434
TBS (FR)					X				435
The Management (USA)							X		436
360 Systems (USA)		X							437
Wheatstone (USA)								X	438
XIS (FR)							X		439
Yamaha (JPN)			X						440

Table 1. A listing of manufacturers of cart machine replacement systems and the general nature of their products. The "Digital Cart Machine" heading covers any appropriate digital audio recording format using removable media, including floppy disk (FD), Bernoulli (B), CD-R, DAT or MO systems. (FD and Bernoulli systems may also include internal hard drives.) The "Hard disk with Automation" heading includes PC-based and proprietary/stand-alone systems, some of which can incorporate optical drives.

ing the analog decks and cartridges with digital ones, these companies take a more integrated approach, centered on the automation controller. They leap-frog the digital cart machine transition and move into a more fully computerized environment.

In this context, carts are replaced by hard disk (or optical disk) storage. An automation controller accesses the hard disk drive(s), calling up audio spots from disk as required by the automation's programming instructions. Typically, the automation system and hard disk recorder are part of the same software, and run on the same PC (although external hard disk drives may also be involved, typically interfaced via SCSI ports).

The level of integration among these systems is another variable. Some put only short-form programs (for example, spots, PSAs, jingles/drop-ins and announcer breaks) on the hard disk, keeping longer program elements on other outboard devices, such as reel-to-reel, DAT, CD or other formats. Control of these devices is handled by the automation system (generally via RS-232 interface), but these devices must still be properly loaded and otherwise regulated. Such a system can be used in live-assist and full automation applications.

More advanced systems place *all* recorded audio on hard disk, and originate their entire local programming from the automation computer. In this case, more than just the cart machine has been replaced. The most sophisticated concepts integrate the entire station (i.e. master control, production studio, newsroom) into a common file server system interconnected by LAN. This allows spots to be produced in the production studio and aired in master control with no recording media changing hands. Traffic assumes a new meaning at such a facility. (See "Increasing Your Audience Through Technology: Integrating Digital Workstations," June 1992.)

As with removable-media formats, some systems include provisions for data compression, thereby expanding hard disk capacity. Basic editing features are also included on most systems.

Automation systems include a switching or mixing function as well, allowing incorporation of network audio feeds. Routing and recording of incoming spots and programs to be aired later can also be handled automatically.

Furthermore, hybrid systems can be created, using elements of all of the aforementioned methodologies. For example, a computer-based automation system might employ internal hard disk storage for spots, while it controls external removable-media drives for music programming, DAT for time-shifting of satellite-delivered, long-form programs and a RAM recorder for listener call-in lines.

Assessing your needs

To help in your planning, ask yourself and your vendors the following questions concerning cart replacement:

- *What kinds of programming do you use carts for now?*

Do you use them for spots and breaks only, or all of your music? Consider news applications, too.

- *What kind of automation are you currently running (if any) or do you envision?*

Can/will the system easily support internal hard disk storage, or will you need to use outboard devices? In the latter case, what machine control protocols are supported by the automation system?

- *How fast is the turnover of the material you use carts for now?*

Are carts re-recorded quickly or do they stay on the shelf after recording for many months? (This addresses the applicability of multiple message-per-carrier systems, and the issue of erasable vs. write-once media.)

- *What is the typical length of program segment you usually put on cart?*

(Some removable-media systems have limited record times.)

- *How big are your download/time-shift requirements for satellite-fed programming?*

(These are best handled by the more sophisticated integrated automation/hard disk recording systems.)

- *Are you a multiple operation in which the same audio material may be needed by two studios at or near the same time?*

(If so, you're a good candidate for the integrated LAN/file server-type of system.)

- *How trainable are your operators?*

Can they handle the full-blown changeover to station-on-a-screen overnight, or should you take a more gradual approach?

- *What are your call-in announcement line needs? How frequently are they updated? How many calls must be handled at once?*

Your final decision will probably involve a philosophical element: Can you eliminate the tangible carrier used by familiar cart systems and replace it with unseen data from an austere hard disk? Is an intermediate step preferable? Or are you content with audio carts as they are? Any of these are a viable choice, although the industry's direction is clearly moving away from analog toward integrated digital systems.

Transition planning also should include some ramp-up time. Carts and their replacement systems should be operated in tandem for the first month or so. If all goes well, then the trusty (or is it rusty?) carts can be retired.

Moving beyond the "if" and on to the "when" and "how" is your first challenge regarding cart replacement. Then the serious research and shopping can begin. The choices are numerous and diverse. Know what you want, and find the system that meets your requirements. Chances are it's already out there. ■

➡ *For more information on analog cart machines, circle Reader Service Number 302.*

Footnote:

1. *1991 Radio Market Profile*. Intertec Corporate Market Research. August 1991. (Don't blame the recession for the drop in cartridge equipment purchases — this same survey shows that overall equipment spending was up slightly for 1991.)

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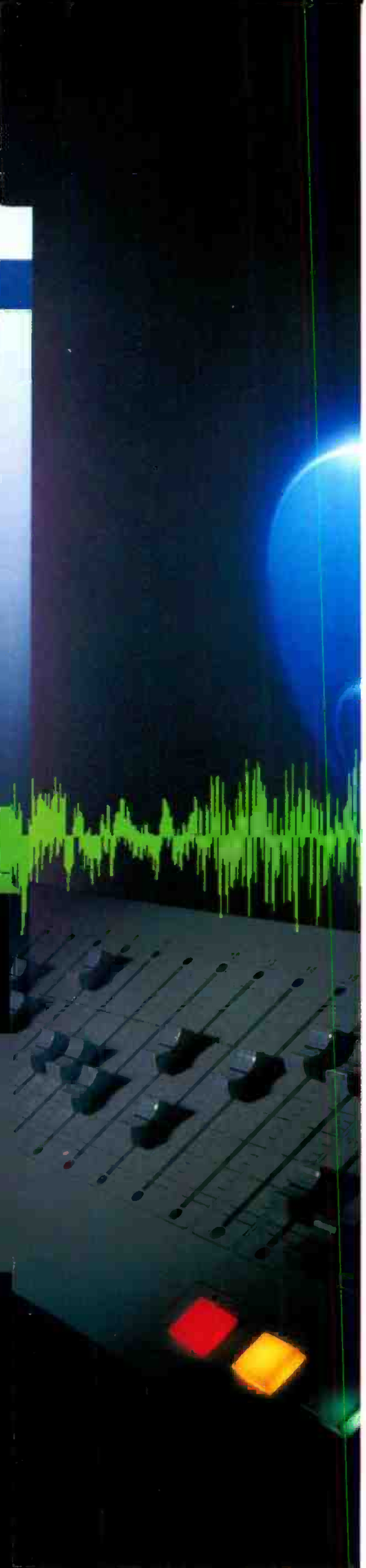

There are a lot of multitrack digital audio workstations out there, but only one with Otari's name on it.

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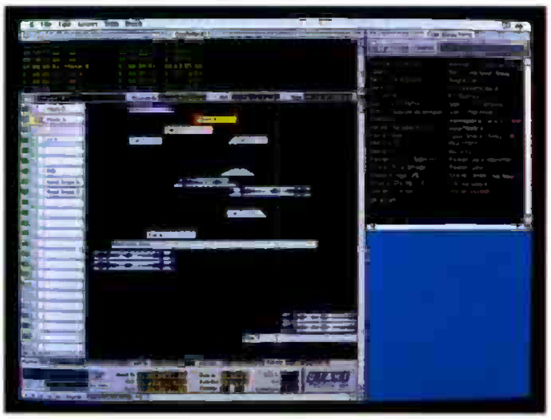

ProDisk's new Graphical User Interface for Digital Editing (guide™) combines several windows into an intuitive, easy-to-use display. Far from just an EDL list, the relationship between all tracks is shown.

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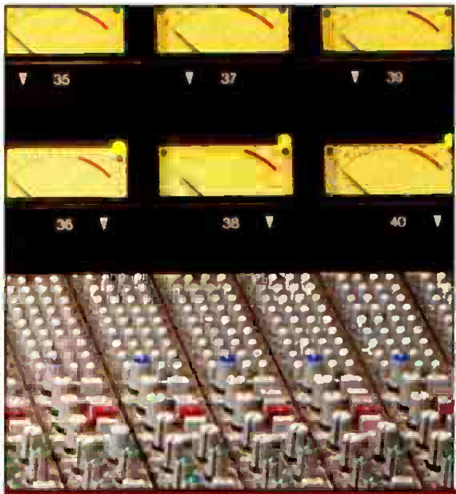


Using DAT in the field

DAT makes a great acquisition format — but choose your hardware carefully.

By Flawn Williams

The Bottom Line

Ever since this little cassette started creeping into the broadcast world about five years ago, it's been making cleaner field recordings possible, while improving portability and cost-effectiveness. But with every new format comes inevitable early difficulties, and pioneering users have learned a lot the hard way. This article details some of the features that make field use of DAT a pleasure, and tells how to avoid some of the pain.

Williams is a technical producer and trainer for National Public Radio, based in Chicago.

If you look at the current crop of recorders using the digital audiotape (DAT) format, you will see indications of its growing acceptance among users and manufacturers. From bare-bones units to full-blown production systems, DAT has found its niche as a long form, small size and low-cost option for digital audio recording.

Its small size and long recording time make DAT particularly attractive for *portable* recorders, either for stand-alone audio recording or for high-quality post-synched audio-for-video and film.

DAT stats

DAT uses a 4mm tape loaded in a self-enclosed housing, similar to a videocassette. Commercially prepackaged tapes are available in lengths up to two hours, but the cassette shell can actually accommodate two hours and 20 minutes of tape. If that extra 20 minutes of uninterrupted recording is important to your recording needs, contact a custom loading company to buy 140-minute DAT tapes.

All of the tapes currently marketed for audio applications use the same thickness of tape stock, so no ruggedness or fidelity is traded off for longer recording times, unlike analog recording media. On a cost-per-minute basis, the 2-hour tapes are cheapest. But if you're doing a lot of short recordings, you may find it less confusing and time consuming in post-production to use separate cassettes of shorter lengths.

Some recorders offer a half-speed record/play option, which doubles the amount of time on a tape, but uses a reduced sampling rate (32kHz instead of 44.1kHz or 48kHz) and lower resolution (12 bit instead of 16 bit). This translates into reduced high-frequency response and a lower signal-to-noise ratio. If you're getting into DAT for high audio quality, this is not the best way to economize. However, if size and uninterrupted record time are primary concerns, and analog audiocassettes provide adequate audio quality, extended-play DAT may be for you.

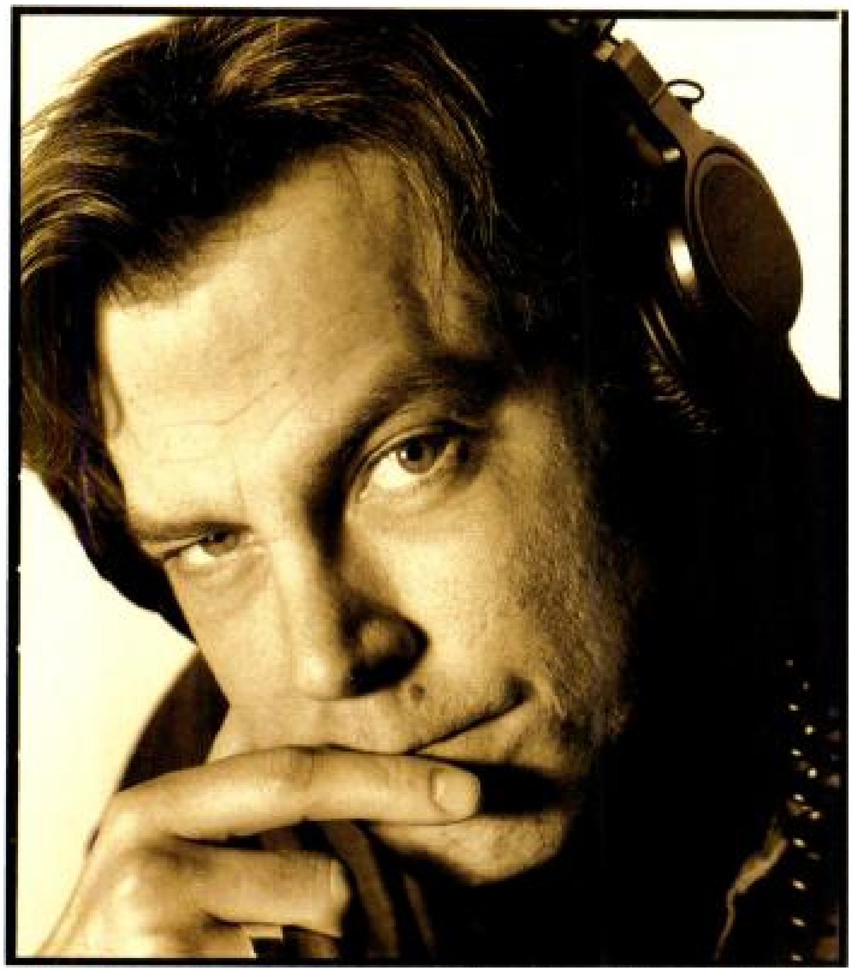
DAT has also been adopted by the computer industry for data storage. Sixty-meter length data tapes that are sold in the computer stores are the same as 120-minute audio DATs. These data DATs use a slightly higher-quality tape and cassette shell than the typical audio DAT, and are reportedly subjected to tighter quality control, in deference to the lower error rates required by computer data. Computer DATs of 90-meter length are also available (using thinner tape), which theoretically could hold three hours of audio information. To date, no manufacturer of audio DAT recorders has recommended the use of this non-standard tape stock for audio purposes.

Some recorders offer a half-speed record/play option, which doubles the amount of time on a tape.

Getting audio onto DAT

Like videotape, the DAT cassette is opened after insertion in the recorder and a loop of tape is pulled into contact with the heads. A helical-scan head drum writes or reads diagonal lines of magnetic data on the tape. (See "DAT in the Professional Environment," August 1990.)

Most of this information is digital *audio* data, but some of the tape is set aside for



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the so-called *subcodes*, where location markers and other descriptive messages about the audio can be stored. More important, subcode data can be erased or rewritten separately from the audio data by most recorders.

The audio data for the original DAT standard is sampled at 48kHz, but many professional DAT decks (and some recent consumer models) can record at either 44.1kHz or 48kHz sampling, from either digital or analog sources. Your application will determine which rate is more suitable. If no direct digital transfers to or from CD are anticipated, 48kHz is usually the better choice.

Microphone input options

Most DAT decks intended for in-studio use do not have microphone inputs, because they are expected to be installed in an analog line-level or digital I/O environment. On the other hand, all *portable* DAT decks — from the smallest pocket-size models to the briefcase-size, full-featured machines — include microphone inputs. Beyond that, however, other decisions must be made regarding your needs. (See Table 1.)

• *Balanced or unbalanced.* Lower-cost machines often use unbalanced microphone inputs, either on separate 1/4-inch phone jacks or a single tip-ring-sleeve mini-jack. These leave you more vulnerable to RF interference and hum or accidental unplugging. The mini-plugs are not rugged enough to withstand the rigors of long-term field use. Other recorders offer a pair of 3-pin XLR input jacks or a single 5-pin XLR input for stereo-balanced microphone inputs.

• *Microphone powering.* Many of the best microphones for field work are condenser types that need phantom or T-power. Only a few of the most expensive DAT decks offer this as a built-in feature. With the others, you'll need an outboard power supply, which increases the complexity of the cabling and requires another battery. If you're feeding an unbalanced mic input with an outboard-powered condenser microphone, the mic power supply must have blocking capacitors on its signal outputs. If not, the unbalanced input will short out the supply voltage, and the microphone will not be powered.

• *Sensitivity.* Your DAT's excellent dynamic range may be wasted if your microphones don't have enough output power to drive the inputs, or if the signal is strong enough to drive the microphone pre-amps into clipping.

If you're recording distant, quiet sounds with dynamic microphones, then the pre-amps of the DAT may add significant noise to the signal. In this case, buying higher-output microphones, buying a top-of-the-line DAT deck with the cleanest input gain structure, or switching to an outboard microphone pre-amplifier of higher quality would be best.

If you anticipate having hot signals from close microphone placement, or you are working with extremely loud sounds and/or high-output microphones, then some type of attenuation may be needed before the signal reaches the DAT's pre-amps. Most DAT portables offer some sort of switchable pad for the microphone inputs, usually 20dB or 30dB.

DAT's ability to provide index marking and time coding of tapes may be an advantage.

Because many of these machines lack state-of-the-art pre-amps, you may be faced with a tough choice. With the pad *out*, you run the risk of occasional distortion. But with the pad *in* and gain brought up to compensate, the pre-amplifier noise may rise to intolerable levels. If you want to compromise with more moderate attenuation, for example 10dB or 15dB, you'll have to buy microphones that have pads of this value built-in, or buy in-line XLR attenuator barrels. Some outboard microphone power supplies also include switchable attenuation.

• *Mono or stereo.* All DAT recorders are stereo. Unlike their open-reel competitors, they cannot be configured to double their recording time by using only one channel at a time. A few models are easy to use as mono recorders. On these, flipping a switch can route the signal from one microphone jack to both recording channels, and allow monitoring in both ears on stereo headphones.

Some machines include a more ingenious mono mode. The input from one microphone is routed to one channel at normal level, and simultaneously to the other channel at a level 15dB lower. This allows levels to be run less conservatively. If you distort the louder channel, then you have another independently encoded mono channel 15dB quieter as a backup. (This sort of split configuration can be accomplished on other DAT decks by using a Y-adapter and an in-line attenuator on one side of the Y's output.)

Handling other inputs and outputs

DAT recorders also may be required to handle line-level analog inputs in the field, typically from a wireless-microphone receiver, mixer, outboard microphone pre-amp or another recorder. Less-expensive decks offer unbalanced line inputs on RCA jacks or a stereo mini-jack. Higher-priced machines will accept balanced line-level inputs, often sharing the microphone inputs' jacks and using a line/mic input switch.

Most DAT decks select line or mic level for *both* left and right inputs with one switch. On these decks, if you need to record a microphone on one channel and a line-level signal on the other, you'll need some external means of padding the line-level signal down to mic level.

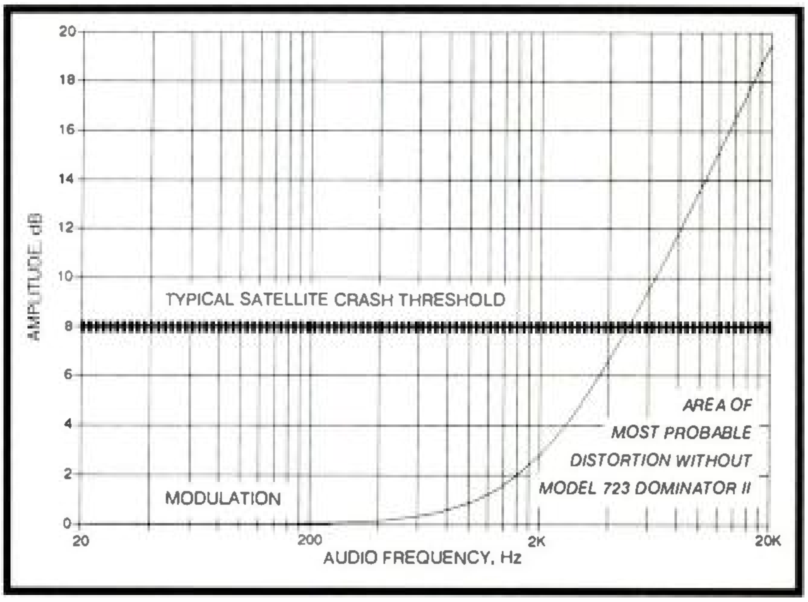
In order to keep portable decks' size and cost down, analog line outputs are often unbalanced only, on RCA or mini-jacks. Manufacturers assume that critical playback will occur in the studio environment on another deck. Similarly, D-to-A conversion is not of ultimate fidelity on some

INPUT	DISPLAY/CONTROL	OUTPUT	POWERING
Mic/line Balanced/unbalanced Mic powering Mic attenuation Mono/stero Dig. input, type	Start IDs PNOs Skip IDs Erase/Write/Renumber Error IDs Absolute time Program time SMPTE time code Metering	Balanced/unbalanced Dig. output, type Monitor speaker Confidence replay Monitor selection (L/R/St/Mono/M-S)	Alkaline/rechargeable NiCad/lead-acid "Bridge" battery Charge in/out of deck Ext. AC supply Ext. DC conv Ext. battery pack

Table 1. *Issues worth exploring when choosing portable DAT equipment.*

Satellite Splatter

The Cause: Over Modulation from Pre-Emphasis



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portable decks.

Connecting to the outside world digitally

The shortcomings of the analog outputs can be bypassed by using the digital output that most DAT portables offer. This allows the signal to be decoded through a higher-quality outboard D/A converter, or to make a direct digital interconnection or transfer to another device. Some portables offer digital *outputs* only, but most of them also have some option for digital inputs.

You may be aware of the bitter history of differing digital interconnect standards, copy-protection schemes and other sources of incompatibility. So if you're planning on making direct digital connections to or from a DAT recorder, check the details of its digital ports carefully. The two most commonly found digital ports are AES/EBU (on XLR-3) and S/PDIF (on RCA jacks). In both cases, a single connector serves both stereo channels.

If you can get a pair of decks that work properly together, the S/PDIF link may be more useful than the AES/EBU. Some machines can transmit and receive subcode markers, such as start IDs and program numbers along with the audio data on S/PDIF, but only the audio data can be passed through the AES/EBU links.

Powering DAT in the field

The best equipment in the business won't be any good if you don't have the power to run it. This is one of DAT's major weaknesses compared to other audio recording formats.

The helical-scan head drum, multiple tape drive motors and high-speed digital circuitry add up, making the DAT power-hungry. Although all portable DATs offer some option other than mains powering, their practicality and cost vary widely. If your needs involve a lot of self-powered recording, then read on and plan carefully.

- *Batteries.* A few DAT portables can run off large numbers of alkaline C or even AA cells, but they will exhaust these batteries quickly. Most rely on some kind of proprietary, removable NiCad or lead-acid rechargeable batteries. Depending on the machine and the battery, these can last from 40 minutes to two hours in reasonable weather, and less in cold weather. You'll probably need to change batteries more often than you change tapes.

Multiple rechargeable batteries can be used to accomplish longer field-recording assignments. In most cases, however, this means interrupting the recording while you change batteries.

Some of the decks that have an alkaline-battery option can do long *uninterrupted* recordings on battery power, because they allow you to switch from NiCad to alkaline power for a few moments, change NiCad packs, then switch back to the NiCad source. The alkaline "bridge" batteries can handle many changeovers before being depleted.

Although some portable DAT batteries can be recharged on external chargers, others must be inserted in the DAT deck for recharging. The least practical decks will not recharge their internal battery while operating on line power — the decks must be turned *off* in order to recharge the batteries inside.

External power supplies

If your work requires long hours of battery-powered operation, then a power belt or some other type of external DC source will be a better solution. The power pack may weigh more than the deck it's powering, but the grief saved is worth the weight.

Make sure you select a DAT recorder that has some provision for accepting external DC power, and then pull together the necessary charger and cells to make a power system. To date, few DAT manufacturers are marketing dedicated powering accessories for their machines, so some hunting will be necessary.

The most practical common denominator will be a DAT deck that accepts 12VDC from the outside world, perhaps through some sort of proprietary DC-DC adapter. Then you can choose from a wide range of generic external power options developed for video, film and lighting gear, which offer 12V outputs on car cigarette-lighter-style sockets.

Location markers and other subcode options

When the DAT standard was established, an important feature was its ability to put extra data in *subcode* form. At the time, many possible (but unspecified) uses were foreseen for subcode in the expected consumer incarnation of DAT — locating songs, lyrics and other graphic displays, timing data, and so on (similar to the CD format and its offshoots). Therefore, a margin of undesignated flexibility was built into the DAT standards for subcodes.

Since then, consumer DAT has metamorphosed into professional DAT. Each manufacturer has taken that range of subcode flexibility and branched off in a different direction. Some features have become standardized in an ad-hoc manner, but some shocking inconsistencies still exist from maker to maker, and even from model to model from the same maker.

The following is a rundown of some of the subcode features offered by current DAT decks:

- *Start IDs*. This is the most basic subcode feature. This electronic marker can be located in fast-wind mode. Most DAT recorders will write a start ID each time the deck is placed into record. Some also offer an audio level-sensing trigger to write a start ID each time a few seconds of silence is followed by a loud signal during recording. An unlimited number of start IDs can be placed on a DAT tape, although each ID takes about nine seconds to write, so two successive start IDs cannot be placed closer together than that. Many DAT decks have trouble reading start IDs (in fast wind) that are less than 30 seconds apart on the tape.

- *Program numbers*. Commonly abbreviated as *PNOs*, these are similar to start IDs but also encode a discrete identifying *number*. Up to 99 such numbers can be put on a single tape. Just as track/index numbers on a CD, they can be used to mark and locate passages on the tape by number. Here, at least 30-second spacing is required for reliable locating.

- *Skip IDs*. This subcode marker tells the deck to fast-wind to the next start ID or PNO. It is useful for programming selective dubbing or listening after a tape has been recorded.

- *Erase, write and renumber*. The earliest generation of DAT portables lacked the ability to change the subcode contents after recording. Manufacturers assumed these functions would be performed on studio machines, not out in the field. However, most newer portables offer a full range of subcode marker editing options.

Erase allows you to remove a previously written start ID, skip ID or PNO. *Write* lets you add a new ID to a previously recorded tape. *Renumber* starts at the beginning of the tape and assigns (or reassigns) consecutive PNOs each time it finds a start ID (or existing PNO), up to 99 per tape.

If you think you'll be renumbering PNOs often, determine how long a particular model takes to perform this task. Although it's a fully automatic process requiring no user intervention beyond pushing the renumber button, some machines do it much faster than others.

- *Error IDs*. Many of the more expensive

DAT decks have four heads rather than the usual two. This allows off-tape monitoring during the recording process (read after write). By adding a data comparator, some 4-head decks can detect occasions where the data coming back from the tape differs from what was entered. The deck can then write an error ID marker at those points.

After recording, you can search to each error ID, and playback to see if the error was significant enough to cause audible problems. This is an extremely useful feature, but for now it is only available on the more expensive machines.

Time code

DAT is inherently stable when it comes to record/playback timing. However, many users need a particular unique time code locked to their audio recording for synchronizing it with video, film or other audio decks.

Time code has been a long time coming to DAT decks, but it has finally arrived. A few top-of-the-line portable decks can now record SMPTE time code of any necessary rate and format, using a recently accepted, retrofitted standard that emulates SMPTE data in DAT subcode. These decks can accept external code or generate their own, and sync to external word clocks (digital house sync) or supply their own to the outside world. At present, the universe of portable DAT decks offering SMPTE time code is still small and expensive.

For users who need to locate and time particular sections of a tape precisely, but don't need the actual chase/lock or other synchronization possibilities afforded by SMPTE, there is a subcode feature called *Absolute time* (or A-time). This records in the subcode the elapsed time from the beginning of the cassette. A companion feature offered on some decks is *program time*, which shows the elapsed Absolute time since the last PNO number.

A-time is touted by some as "the poor man's time code," and the features available on some mid-priced studio decks make that description apt. You can search to a particular point on the tape by punching in the A-time location on a keypad. More synching and editing features using A-time are promised for the future. Few portables on the market have A-time *search* features built in, but many of them — including some of the cheaper consumer decks — now *write* A-time on their recordings. This makes those tapes easier to use in post-production with studio machines.

Beware of the visual tape-timing displays on DAT decks that are *not* using A-time or SMPTE time code. Those displays are often just estimations of timing, based on counting revolutions of the feed and take-up spools and calculating time from that. These displays can be grossly inaccurate, particularly when rewind or fast-forward is used, even though the time stability of the audio on the tape is almost perfectly accurate.

Environmental factors

Like all recorders using rotary head technology, DAT portables have an interesting physiology that includes three potential areas of weakness. They are affected by *temperature, humidity* and *contamination* from dust or other foreign matter.

Temperatures below freezing can cause DAT batteries to emit less power, and have a much shorter useful running time. Extreme cold can cause increased shedding of particles from the tape, which can cause head blockages. But the most common problem in cold weather involves condensation on the head drum when a DAT recorder is brought in from the cold to a warmer, more humid indoor environment. Moisture on the head drum can cause the tape to stick to the drum. The most expensive portables compensate for this with heaters in the head drums. Others simply shut down. Some decks issue a "moisture" message under these conditions.

> ***DAT is inherently stable when it comes to record/playback timing.***

A DAT recorder's digital circuitry radiates a good deal of heat. This is an advantage in cold weather, but in hot environments, if the recorder is kept wrapped in an insulating case or bag while running, temperatures can reach dangerous levels. Above approximately 140°F, the base film of the tape can deform, and the shell may warp.

Any foreign matter, such as dust, moisture, salt spray at the beach or coffee spilled on the machine, can wreak havoc on a DAT. A format with this high of data density must have consistently good tape-to-head contact, and any foreign matter or crinkling of the tape will lead to dropouts or tape transport shutdown.

Look for recorders that offer *double enclosure* (two sets of doors over the tape insertion point), to minimize the chance of dirt reaching the head drum inside. Or plan on keeping your portable DAT in a shoulder bag or other insulating case when using it outdoors.

Most of these precautions are the same ones you should use with open-reel or cassette recorders in the field. In general, DAT should be considered slightly more sensitive than earlier formats.

Monitoring

Some DAT portables offer a built-in monitor speaker (typically of low fidelity), but all of them include reasonably high-quality headphone outputs.

However, there is a wide variation in what can be monitored through headphones. Most decks offer only straight stereo monitoring: left channel to the left ear and right channel to the right one. But other options can be helpful in the field, such as the ability to sum stereo to mono or listen to just one channel through both ears.

On decks that don't offer confidence (off-tape) monitoring, it is wise to perform a trial recording and playback after every loading of a DAT tape. Occasionally, loading will not be properly accomplished, yet the recorder will seem to be operating normally. Upon playback, the recordist may be horrified to find nothing on the tape. If improper loading is detected during a test recording, reloading the same tape in the same deck may clear the problem. But if another tape is handy, use it instead. After returning to home base, check the suspect tape and the deck's loading mechanism — either one could be the culprit. (See "Troubleshooting: DAT Maintenance," Parts 1-6, March-August 1991.)

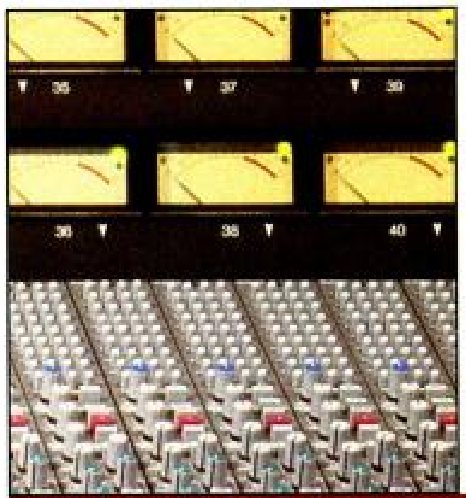
Hit the road

Any portable DAT deck can make excellent field recordings with the right accessories. The first portables to reach the market cost approximately $2,500. Today, the bottom end of the range has dropped 75% below that, and the top end has gone up about 400%.

The less-expensive machines offer simpler controls and therefore fewer possible errors in a basic recording situation. What the more expensive decks offer is greater flexibility, confidence (through off-tape monitoring), ruggedness, dependability in climatic extremes and time-code synchronization. They also offer high-quality analog and digital performance in a variety of recording scenarios, without having to resort to endless chains of outboard gizmos.

On balance, DAT offers a cost-effective and extremely high-quality field acquisition format that is appropriate for many applications. If it turns out to be right for you, you'll wonder how you ever got along without it.

➡ *For more information on portable DAT equipment, circle Reader Service Number 303.* ■



Digital radio update

Tomorrow's radio is taking shape today, but much still hangs in the balance.

By Skip Pizzi, technical editor

The Bottom Line

The clouds in the crystal ball are breaking up as radio's future begins to form. Around the world, broadcasters wait with expectation — and some trepidation — at what lies ahead. Tomorrow's possibilities for today's broadcasters could fall anywhere between massive windfall and abject ruin. Keeping up-to-the-minute with where technologies stand is the only way broadcasters can remain in advantageous positions during the coming transitional times.

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Like a growing child, digital radio seems to be developing in fits and starts, and moving in many different directions at once. Like that child's parents, broadcasters are worried. During the last year, enough progress has been made by various players to cause considerable concern about future worldwide (and perhaps even intracontinental) compatibility, and about the viability of today's broadcasters in the digital age.

In terms of formats, the pioneering *Eureka 147/DAB* system continues to find favor in Europe and Canada, while in-band systems from *USA Digital* and *Strother/LinCom* lead the pack in the United States. The divergence doesn't stop with formats, but also includes frequency bands. (See Figure 1.) Although in-band systems by definition use existing AM and FM bands, Eureka 147 will be implemented in new spectrum. And even though the World Administrative Radio Conference (WARC-92) held in Torremolinos, Spain, last February and March defined a worldwide standard at L-band (1,452-1,492MHz) for digital radio use, deviation from this standard has been declared by the United States, the former Soviet Union, Japan and other nations. (See "re: Radio," June 1992.) These countries have opted for higher-frequency allocations in the S-band (2GHz) region.

Further confusion exists in Europe, where plans call for an interim VHF terrestrial application of Eureka 147 in existing TV broadcast spectrum. This would be followed after 2007 by direct satellite and terrestrial use of Eureka 147 at L-band.

In the Western Hemisphere, Canada has jumped out in front with a simpler approach: L-band terrestrial broadcasts will begin this fall, using Eureka 147. Direct satellite broadcasting will begin after 2000, using the same format and spectrum.

Complicating this is the U.S. government's prohibition of L-band application of digital radio, citing that spectrum's continued use for aeronautical testing by military and other users. How Canadian L-band allocations will be dealt with by U.S. authorities remains an open question.

Although previous debate on the power requirements for L-band applications was settled by definitive Canadian tests during 1991, the actual power needed for S-band digital radio remains untested. This is now an important issue for those countries that have adopted S-band as their preferred allocation. Theoretical extrapolations indicate that four times the power required for equivalent FM coverage would be needed for terrestrial S-band application of digital radio, but this has not been empirically confirmed.

In-band developments

At present, all eyes are upon American in-band digital radio developers. Their work shows tantalizing progress, but more testing is required before these systems can be said to work reliably and comprehensively. FM and AM in-band developments continue, although FM is further along. On-channel (AM and FM) and adjacent-channel (FM only) systems are under study.

If in-band development should bear fruit, the impact will be significant, but not only in the United States. The planned transition methodologies for digital radio abroad are not without their critics in those countries, and an in-band solution might prove advantageous there as well.

Presently, laboratory tests of the two in-band systems mentioned previously have

Circle (31) on Reply Card

been successful. USA Digital has reached the Beta stage in receiver development with a VLSI decoder chip prototype for its FM system. Both proponents made impressive demonstrations of their systems at NAB '92. These companies also plan over-the-air testing with fixed and mobile receivers as their next developmental milestone, perhaps by this fall.

The satellite situation

The greatest concern to existing broadcasters regarding digital radio has always been the possibility of its direct broadcast satellite (DBS) application. Although this potential still exists, it appears certain to be a second-wave implementation, lagging behind terrestrial applications by as much as a decade. Under many plans, satellite systems will require a different receiver from the one used for terrestrial digital radio (or at least some additional converter hardware). Canada is a clear exception, with a plan that implements a single receiver for terrestrial and satellite digital radio from the outset.

In the United States, satellite systems have taken a back seat in development for domestic application, but *Satellite CD Radio* (SCDR) and *Radio Satellite Corporation* (RSC) are still officially on the books as DBS digital radio proponents. (SCDR has taken a wait-and-see approach while terrestrial developments unfold, and RSC has been involved in a regulatory and legal entanglement.) On the international front, however, *USIA/VOA* and *Afrispace* are steadily moving forward with their plans for DBS audio services to markets outside the United States.

Concern over the potential impact of DBS services has not subsided among U.S. broadcasters, especially since the introduction of digital cable audio services. The surprisingly positive results reported in some test markets by these services and their customers (even as a *wired* delivery method) have given the radio industry an inkling of what impact DBS audio services might have.

Standard-setting activities

The industry's best hope of successful digital radio implementation lies with the timely establishment of standards. As with any such enterprise, timing is critical, so that the standards are set neither too soon nor too late. To this end, two bodies are currently at work on standardizing digital radio formats: the Electronic Industries Association (EIA) and the International Consultative Committee on Radio (CCIR).

The EIA, a trade association of electronics manufacturers, has established a Digital Audio Radio (DAR) subcommittee to undertake standard-setting for that industry. The subcommittee includes broadcast representation, and has set an ambitious schedule. Nevertheless, the active digital radio proponents in the United States have all agreed to abide by it. The CCIR has an only slightly more conservative approach, running about six months behind EIA's.

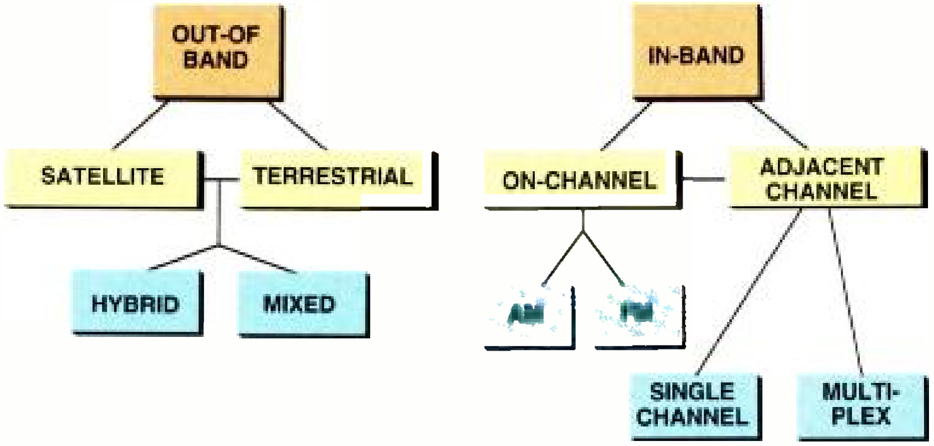

***Figure 1.** A tree of the different format types proposed for digital radio. Out-of-band requires new spectrum, while in-band uses existing broadcast frequencies. Hybrid satellite-terrestrial systems include low-power, ground-based gap-filler transmitters for satellite signals. Mixed systems include satellite and terrestrially originated channels in the same band.*

The actions of these groups will have tremendous impact on the industry, which currently contemplates a worst-case scenario of a half-dozen or more different receiver types worldwide. If EIA and CCIR narrow this down to one or two formats, digital radio could become a mainstream reality before the decade's end.

On another front, the bit-rate reduction algorithms proposed for *source coder* use in digital radio broadcast systems continue to undergo testing by various entities worldwide, even as new systems and refinements are introduced. No clear consensus has emerged on a unified format of choice, but one is certain to be defined as part of any broadcast standard.

On the business side

Problems of AM/FM parity, shared-carrier dislocation and control, licensing procedures and cost/benefit ratios still exist (see "Digital Radio: The First Five Years," July 1991), but these must all be considered secondary to the choice of standard format. Because some of these issues are format-dependent, some will be decided de facto upon format selection. Other remaining issues can then (and only then) be worked out in the standard's detail.

Meanwhile, broadcasters are beginning to sense the new opportunities that digital radio service might provide. Besides improved audio fidelity to help compete with recorded and cable-delivered formats, digital radio might offer an increased number of channels to better accommodate the niche programming trends that may lie ahead. (Channel ownership regulations and broadcast rights fee structures will require amendment before that scenario can become viable, however.) The most untapped potential may lie in *datacasting*, the transmission of multiple channels of data in the excess capacity of the digital radio broadcast channel. (See the related article, "Datacasting — Profit Center of Tomorrow?" below.)

As all this detail transpires within the industry, interest is starting to grow among the world's general public for what digital radio may have to offer. Right now, the stakes are high and the pace is quick. Much that is currently undecided will be cast in stone soon. Let the faint of heart be forewarned: The next two to three years will define the future of radio for generations to come. ■

Datacasting — profit center of tomorrow?

By Robert D. Culver

Since the earliest days of digital radio discussions, every proposed format has included a specification for *auxiliary data*. However, only vague ideas of how this could be used have been presented, with the majority of interest naturally being focused on the main audio channel's performance.

Auxiliary data capacity is available on most systems because of the difference between the peak and average data bandwidths required by bit-rate reduced digital audio signals. The actual data rate required for audio programming will

Continued on page 85

Culver is a consulting engineer for Lohnes & Culver, Washington, DC.

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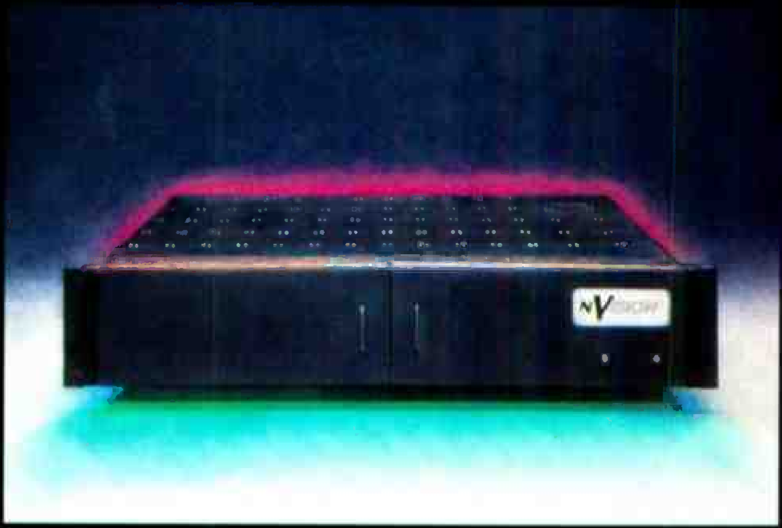

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Video producti
switcher u

Switchers lead the way in integrated contr

By Andy Sheldon

The Bottom Line

Efficiency in the workplace can translate into a more profitable operation. Many production facilities today have equipment configurations that are not as efficient as they could be. Integrated control systems that allow the entire production environment to be simply and logically controlled from one location can offer more rewarding solutions.

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Sheldon is product manager for Abekas Video Systems, Redwood City, CA.

The broadcast and teleproduction market is constantly bombarded with products designed to make life simpler for the operator. With a few exceptions, these systems perform a single function. Each has its own separate control system—with its own operating system and interface. Meanwhile, editors and producers have tried to gain more control over the myriad devices of the editing or production environment, but no systems could control all of the variety of equipment from different manufacturers.

Today, that is beginning to change. A new generation of digital disk-based switchers exists that can provide integrated control over a complete editing or production environment. Such switchers may oversee more than 30 peripheral devices, including routers, frame buffers, time base correctors, camera robotics, VTRs and audio recorders.

The need for integrated control

Although a separate control system may be the "optimum" for some devices, each has a unique operating system the operator must learn. Each user interface has its own control anomalies and visual feedback methods. Obviously, a good deal of time and expense can be involved in operator learning curves and control system design.

Many systems use separate CRT monitors to display all of the information needed to operate the device. In a modern facility, edit bay or production environment, a monitor wall is almost essential to display control system feedback for the devices in the room. Coupled to these are dedicated control panels, each occupying a piece of real estate on the console. It is not uncommon to find sprawling edit bays with every inch of counter spa with control panels and displays.

Dealing with all of these devices comes quite cumbersome and inefficie and it poses a problem for the operators — they must trolley back and forth to operate each piece of equipment. Continual switching of operations from one control panel to another wastes time.

Apart from the obvious physical liabilities of numerous separate systems, related drawbacks crop up when storing effects, configurations or other data. Many manufacturers use inexpensive floppy disks for data storage archiving. Many jobs end up with four or five floppies each. Without appropriate labeling, numerous disks become inefficient.

> ***Switchers can provide integrated control over a complete environment.***

Video and audio standards provide program interconnection between system pieces, but a similar standard does not yet exist for the control interface. Recommended SMPTE practices may connect the video switcher controls to a computerized editing system, VTR controls to editing systems or digital special effects systems to video switchers. However, few of these systems provide control over the whole environment. Many systems specializing in control, such as videotape editor controllers or station automation packages, probably control only a small subset of a controlled device's functions.

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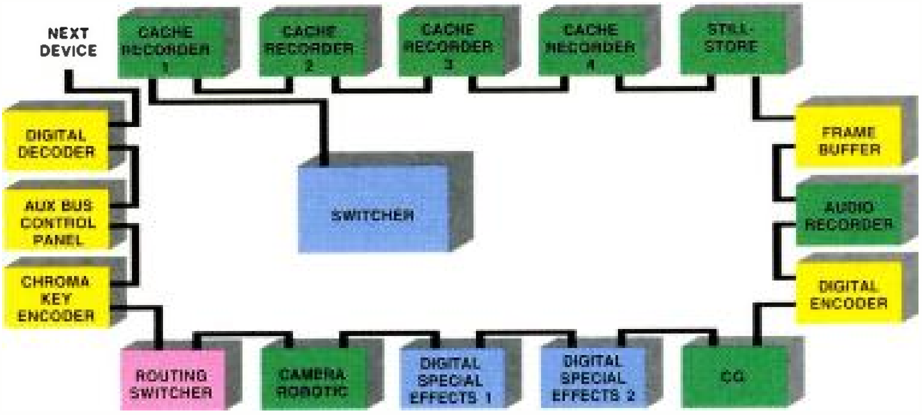

Figure 1. *Integrating control of the entire edit suite is possible with some of today's new digital switchers. A switcher with control protocol ties external device time lines to the switcher's reference for recalling, previewing and running effects, and delegates functions on the switcher control panel to the peripheral so its control may be partially or completely integrated into the switcher control system.*

Obviously, more than consolidation of control panels is needed. Reducing the time and expense involved in operator training on multiple control systems is also essential. But most important, there's a need to give the operator all the information and systems required to do the job as efficiently as possible.

Configuring an integrated control system

Because most systems now include computers, the technology exists to provide integration. For any form of integrated control to be useful, it must meet two basic constraints: 1) It must have an interface that is flexible in type and number of controlled devices; and 2) It should have an interface that is easy to implement from the standpoint of other manufacturers.

It's difficult to interconnect products from several manufacturers or existing station devices unless such equipment follows standard recommendations. Many manufacturers now incorporate an RS-422 interface in their equipment; RS-422 has replaced the RS-232 interface in newer equipment, and complies with the SMPTE standard interface.

The newest digital switchers feature easily implemented protocols and incorporate the RS-422 standard interface, allowing third-party systems to be controlled from the switcher panel and required control information to be stored as part of a switcher effect.

Switchers need to control two types of devices: field-based devices (systems that can be run) and devices that provide static recall. An interface function must enable peripheral devices, which can be run, to be coupled to the switcher time line and to provide a display and means to control the peripheral device.

- *Field-based devices*

These devices require time-code updates on a field-by-field basis to execute an effect or replay an element previously recorded. Such devices include digital special effects systems, digital disk recorders, VTRs, camera robotics, character generators, audio recorders and mixers and lighting controllers.

• *Static devices*

These devices store a setup or configuration and, in some cases, permit parameters to be dynamically adjusted. Constant time-code updates are not required to replay or restore selected parameters. Such equipment includes still-store systems, encoders, decoders, noise reducers, routing switchers and time base correctors. Static devices' settings can be recalled as part of a switcher effect, and with access from the switcher's menu system to display setup parameters and adjustments.

To communicate with field-based and static devices, serial communications ports on the switcher serve as a "multidrop" master controller. Baud rate is 38,400 even parity with one stop bit. A standard 9-pin to 9-pin cable looped from one device to the next connects each to the network.

More than 30 devices can be connected to the network in this way. In practice, the network is restricted to 12 different field-based devices, with the remainder being static devices. Each device has a unique network address in the range 0 to 31.

The switcher polls each field-based device and one static device once per TV field. Each device informs the switcher of:

1. its availability (operational, power on);
2. its identity (what type of device);
3. its current position (a tape, disk source); and
4. its functional status (stopped, running forward, running backward or recording).

Two types of communication are used: private and multicast messages. Private messages are directed from the switcher panel (master) to a specific device (slave).

Switchers need to control two types of devices: field-based devices (systems that can be run) and devices that provide static recall.

This data is unique to each slave and must be sent prior to sending multicast messages. A multicast message is a global command from the switcher to several devices.

Return communication from slave devices takes the form of either a constant update of position and state or menu display.

The switcher gathers current position information from one device per field until all are polled, at which time the process is repeated. If 10 field-based devices are on the network, it takes 10 fields to update each device's time-code values for their current positions. When the device is stopped, a field-accurate time-code value appears on the switcher.

A display of slave device menus on the switcher shows communication. By selecting the device's menu, it saturates the network for up to four fields and writes its screens into the switcher displays. Menus reside in the processor at the slave device end.

Once the menu is written, only differential data is sent over the network. This data is easily accommodated by each field and reverts to a real time parameter update.

Benefits of integrated control systems

Integrated control of peripherals is a powerful production tool, but the real potential is not appreciated until peripheral devices are attached to the switcher's time line effects system.

When a switcher creates an effect with two or more key frames (a switcher snapshot), the effect appears on the time line menu as a block along a time axis. The time line is calibrated in seconds and is an hour long. It indicates graphically the effect on each M/E and peripheral device. A cursor tracks the current position along the time line. Time line controls adjust effect start, effect end, effect offset and effect duration parameters.

A unique feature of such an effects system is the dynamically interactive relation between the controls and the actual effect. An effect with a wipe pattern move responds dynamically to an offset adjustment. This removes the guesswork from effects creation and editing, providing faster and more accurate editing.

Another important feature is the system's interaction with existing computerized editing systems. The switcher time line appears to the editor/controller as a VTR transport by emulating a SMPTE or Sony-type tape transport with the edit decision list (EDL), providing transport control over the switcher time line and, in turn, the peripherals attached to the time line. Most important, the editor can "gang jog" the switcher time line and a VTR, and elements on videotape can be previewed in non-real time together with switcher effects. This increases the accuracy and speed of effects previewing.

Integrated control of peripherals is a powerful production tool.

The other pieces of the production puzzle

Today's edit suite contains a mixture of analog and digital, component and composite products and various interface products to bridge the gap between different formats. These interface systems form part of the integration package and can be controlled under a multidrop protocol.

Routing switchers

Routine day-to-day recording, monitoring and maintenance for most teleproduction facilities presupposes an ability to select from any number of available sources. It is the function of the router to provide a method of switching signals and directing them to the correct destination.

When a router is integrated into the switcher, three advantages are realized. First, it eliminates the cost of installed, fixed control panels. Second, the switcher front-end may require less operator training than a conventional panel because the interface can effectively disguise the router from the user. Third, the working of the facility can be handled effectively by a small staff.

One manufacturer recently announced a serial router that works with all different standards. The router not only interfaces with the new digital switchers, but also listens to other router control systems, effects machines and 3-D rendering systems.

Time base correctors and frame buffers

Basic to the teleproduction or broadcast facility is the time base corrector (TBC). The TBC provides control of video levels and timing, allowing the editor to adjust VTR outputs as needed.

An interface between the TBC and a digital switcher permits the operator to access memory functions of the TBC directly from the switcher control panel. TBC settings — video and chroma levels, setup, hue and registration transition rate — are saved directly into the EDL, along with common edit parameters, such as in/out points, duration and edit type. No matter how large the facility or how distant the tape room, full control is achieved from the edit bay — no running back and forth to set levels and timing.

The benefits of integration materialize in projects involving large amounts of raw footage. In this case, TBC memory registers contain a TBC setup for each reel or group of similar scenes. As the switcher triggers the memory registers directly, the need to adjust a VTR for every reel change is eliminated.

Combining frame buffers with the production switcher not only saves on control panels, but significantly extends the effects power of the production system. With integrated dual frame buffers, both stores are available as inputs to the switcher, serving as video or key signals. Graphic elements composited to the switcher output are captured in the buffer and returned as inputs to the switcher for further layering. By using two buffers — one to playback the previous layer, the other to capture the next pass — several passes through the buffer-switcher system can double, triple or quadruple what a less-sophisticated switcher can do in a single pass.

Additionally, analog inputs of the buffer can be used to perform analog-to-digital conversion of NTSC signals for use in the switcher. The buffer will function as a frame synchronizer and pass real time signals to the switcher.

Camera robotics

Computer control of cameras has emerged as an integral part of the broadcast world, because it reduces the labor required to physically place the camera and frame the shot. Integrating camera robotics into a switcher takes the technology of simplification one step further by putting the power of camera positioning into one central tool.

With camera robotics control available at the switcher, a technical director (TD) who may know little about cameras has the ability to work cameras without a dedicated camera crew. In a news station situation this feature permits a smaller news production facility to handle late-breaking stories with only a TD.

Integrating computer-controlled camera positioning into a switcher allows the user to access a selection of pre-orchestrated camera moves, which may include camera walks, twists, turns, angles and height changes. This leaves the switcher operator only the job of framing the subject, a task that can be accomplished from the switcher.

Audio recorders

A growing number of tasks within post-production facilities involve coordination of audio and video functions with one another. For instance, consider a complex video editing session with a series of complimentary audio-follow-video level fades and pans.

In addition to video capabilities, some new switcher designs feature interfaces to audio recorder systems. The recorder is directly controlled from the switcher control panel.

Audio recorders have an independent time line in the effects system. Audio segments can be learned as part of a switcher effect or edit. When coupled to the switcher time line, the audio recorder can be used as a "scratch track" to facilitate scripting of animation and effects.

Editing with the integrated control system

Substantial benefits can accrue when editing with this type of system. Most editors know roughly how an edit session will go, and most clients have an idea how their job should be put together. Therefore, a good deal of session time is spent fine-tuning the edit to achieve just the right timing. Thanks to cache recorders, a switcher time line effects system eliminates waiting for VTRs to preroll and lock-up. This also takes guesswork out of the editing process and allows operators to pursue "what-if" scenarios.

Another advantage is control over a single VTR to upload and download elements to and from cache recorders. Using a protocol control, the system interface protocol must be translated into SMPTE or Sony protocol for controlling the VTR. Standard transport controls are provided for the VTR, and search algorithms make loading the required elements fast and easy.

The VTR transport, as a device in the switcher edit menu, also has a dedicated time line in the effects system. Now, effects

can be generated that encompass the switcher, DVE, still-store, character generator and cache recorder elements, in addition to VTR elements off tape.

A finished composite can be layed-off for archiving. A periodic automatic lay-off function can be preset into the editing system with the switcher keeping track of recorded elements. This is particularly useful when assembling an edit, because composited elements can be recalled rather than starting from scratch.

For each edit, a conventional list is generated. Unlike most editing system EDLs, however, an integrated system tracks significantly more data — the entire switcher setup can be saved as part of the edit. The switcher learns the current effect from the effects system, current page from the character generator and still-store, all related time-code values for each cache recorder and the VTR — and any other connected device.

Recalling the list restores data to all peripheral devices, the switcher and cache recorders. This increases the speed and accuracy of auto-assembly and reduces the number of notes that must be taken in a complex layering session.

Hard copy can be produced, or the list can be stored on a floppy disk. Edits appear as a grammatical edit description when the effect is recalled on a DOS-based PC. Thus, editors and clients can produce simple cut lists off-line without tying up an expensive edit suite, and can modify edits off-line and then reassemble them in the edit suite.

Several manufacturers are investigating ways to import other EDL formats. One possible method would enable a CMX-compatible EDL to be re-created on a switcher with cache recorders. Re-creating Mac or PC-based off-line edits in an on-line edit bay with cache recorders will be a big step forward to fully integrated, full broadcast-quality, disk-based on-line systems.

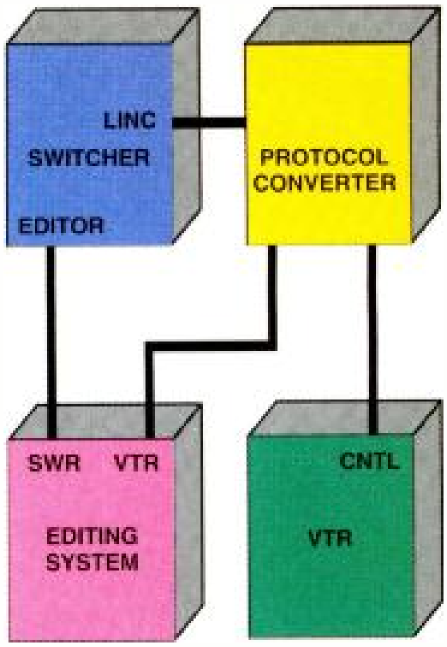

Figure 2. Centralizing control over the numerous video sources and designations is an effective and efficient way to improve production. The newest digital switchers feature easily implemented protocols, which allow a variety of devices to be controlled from the switcher panel. Such features also allow control information to be stored as a part of a switcher effect.

A glimpse at the future

The most noticeable feature of the broadcast facility with an integrated control system is what's missing. There are no banks upon banks of control panels and monitors — no separate panels for each piece of equipment. When operators want to switch a new source into their machines, they call up a menu on the switcher control panel screen.

The future production workstation where everything is integrated into one box, and perhaps the digital special effects system is on a floppy disk, is still some years away. However, the new generation of digital disk-based switchers with control interfaces provide a stepping stone to the ultimate integrated control production environment.

➡ *For more information on video production switchers, circle Reader Service Number 305.* ■

Preview

August...

VIDEO TECHNOLOGY UPDATE

- **HDTV: Who's On First?**

Part 1. An update on the HDTV standard selection process. Emphasis will be placed on those systems under test (or finished) by the ATTC. The industry issues on timing, cost and market factors will be examined.

- **HDTV Transmitter Requirements**

Part 2. A discussion of the demands to be placed on UHF transmitters when required to transmit a digital HDTV signal. In many cases, the specifications and techniques used effectively for years for NTSC will have no meaning in the digital world. Knowing what to look for in a new HDTV transmitter will be important in meeting the needs of the audience and challenging the competition.

- **The HDTV Antenna System**

Part 3. A cost/feasibility analysis approach to installing the UHF HDTV antenna. The focus is in finding ways to place the new HDTV antenna on a station's current tower. The article reviews a survey conducted by MCI to determine station needs and options in converting to the HDTV world. This is a *BE* exclusive.

- **HDTV Routing Switchers**

Part 4. As stations begin buying HDTV-compatible equipment, routing switchers are foremost on many minds. The article reviews a current product developed by TRW, which is capable of handling full HDTV bandwidth signals.

- **Selecting and Servicing Video Effects Systems**

This will be a 2-part article. The first part will look at the options available. Part 2 will examine modern servicing techniques for this equipment. Equipment discussions will emphasize 2-D and 3-D effects hardware.

- **Digital Videotape Recorders**

An examination of digital videotape recorder technology. The coverage will examine D-1, D-2 and D-3 systems. This means that component and composite systems will be examined.

September...

AUDIO AND VIDEO PRODUCTION SYSTEMS

- **Desktop Video**

A look at PC-based video editing, production and effects systems. The article will emphasize the use of small, non-proprietary platform-based hardware.

- **Audio Console Technology Update**

A review of modern audio consoles. The article will consider the various features available in audio consoles, including automation and digital control and processing.

- **Inside Video Graphics Systems**

A look at the technology used in modern video effects hardware. The article will not concentrate on the outside of this technology, but rather on what makes it work. Integrated circuit-level technology will be the basis for the article.

- **Production Suite Technology**

A review of the hardware used in modern production suites. This may include recorders (D-1, D-2), production switchers, graphics systems and sophisticated routing switchers that allow suites to "share" expensive hardware.

Multitone audio testing

Modern DSP techniques make implementation of this old idea a reality.

By Bill Thompson

The Bottom Line

Today, audiences are more aware of audio quality. Many consumers own high-quality receiver/tuners, amplifiers and speakers, and they are more critical of what they hear. Previously, stations that tried to get the best results from their equipment meant all-night system audio test sessions. Now, with multitone testing, this approach can reveal much more about your audio chain in a matter of seconds — without sacrificing air time.

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Thompson is marketing manager for the TV Audio Measurements Group, Tektronix, Beaverton, OR.

The sophistication and technical quality of today's broadcast audio, in conjunction with better home entertainment equipment, has created an audience that is more critical of the audio portion of programming than ever before. One logical response for broadcasters would be to perform rigorous audio tests more often while minimizing (or, if possible, eliminating) downtime.

Another option is to develop tests more relevant to perceived audio quality. Making measurements that were not previously possible also might help appease this demanding audience.

Once broadcasters have settled on an approach, they still have to face the issue of taking gear off-line for testing. Engineers need time to perform tests and make adjustments or repairs; the rest of the staff needs the equipment on-line to produce, edit and broadcast the programming. Automated digital signal processing (DSP) techniques offer a better solution, and multitone testing is up to the challenge.

What is multitone?

For those unfamiliar with the term or the technology, *multitone testing* uses the premise that audio equipment can be stimulated to the same extent by a simultaneous combination of sine waves as it can by a series of discrete tones occurring one at a time. The advantage of multitone analysis is clear: It provides complete system evaluation in one step, eliminating the time-consuming process of applying a series of individual tones, allowing a settling time after each, making adjustments after each, and then repeating the process to check for interactions.

If multitone testing is such a great idea, why has it only recently emerged from the laboratory? The history of multitone dates back several decades. Early attempts to implement multitone testing encountered problems not at the stimulus end, but rather with the bulk, expense and performance of the analysis equipment.

Analog filtering of multitone stimulus was a staggering venture. Recent advances in digital signal processing equipment and techniques have reduced multitone signal acquisition and analysis to a manageable, affordable task. Multitone equipment is currently available from a small but increasing number of vendors.

Multitone test techniques use carefully designed mixtures of tones applied simultaneously to the device under test (DUT). The individual tone elements have well-defined frequency, phase and amplitude relationships. The frequencies of multitone components are selected to avoid mathematically predictable harmonic and intermodulation products that would fall on or extremely near any of the fundamentals. The phase of each tone is fixed, but randomly selected relative to each of the other tones. Amplitude relationships may vary, depending on the device under test.

Multitone signals may be created with an inverse fast Fourier transform (FFT) for highly accurate and stable signal parameters. Figure 1 shows a spectral display of a multitone signal designed for testing wideband audio recording equipment.

Because the frequency, phase and amplitude relationships of the elements of a multitone signal are well defined, DSP techniques allow easy detection of changes in these relationships. Thus, frequencies not present in the original multitone are due to distortion and noise. Similarly, changes in phase relationships of the multitone elements can be used to derive phase response information. It follows that deviation from the known amplitude relationships will provide frequency response information.

Simply stated, multitone signal analysis consists of analyzing the level, frequency and phase characteristics of the fundamental frequencies at the DUT's output, and conversely, looking for noise and distortion at frequencies where no signal is expected.

A more detailed explanation of multitone analysis techniques is in the related article, "Analysis by FFT," on page 77.

Typical results/displays available

Although implementations of multitone analysis vary from vendor to vendor, most provide plots of level vs. frequency, level difference between channels, phase difference between channels vs. frequency, and noise and/or distortion vs. frequency. Figures 2 and 3 show two other types of

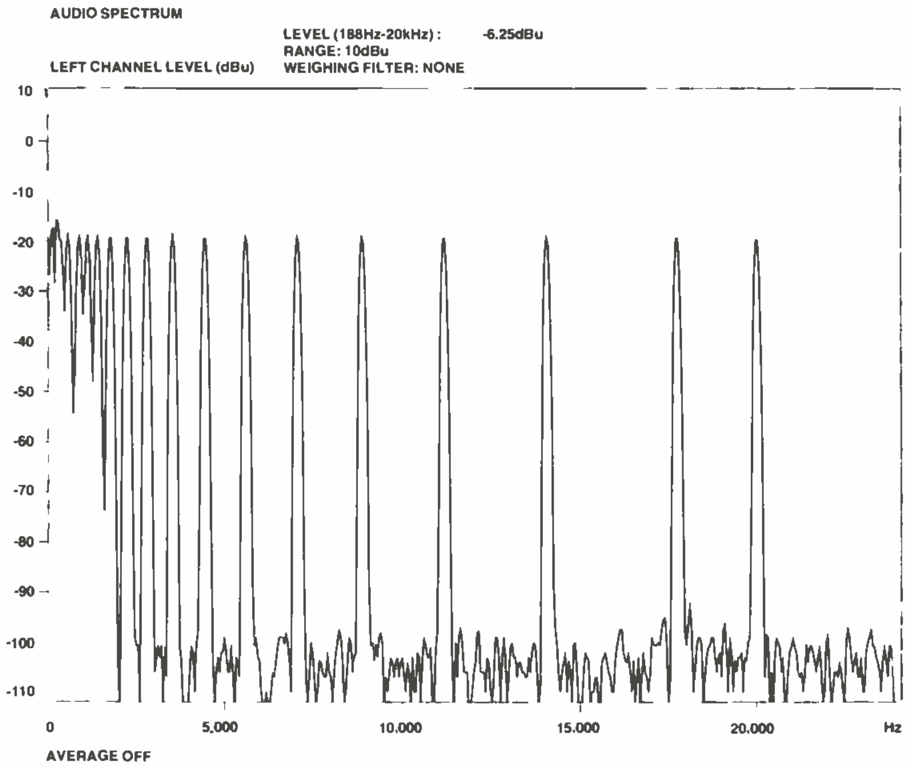


Figure 1. An audio spectrum display shows the spectral distribution of the numerous fundamental frequencies in a multitone signal.

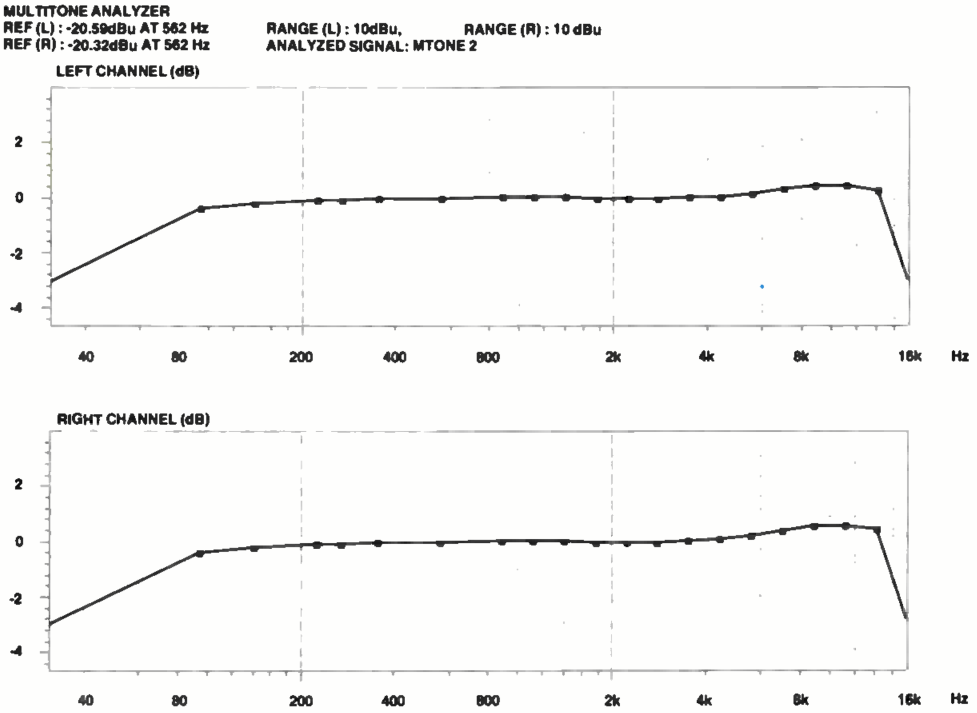


Figure 2. Level vs. frequency plots are one of several typical multitone displays.

multitone displays available, the levels vs. frequency display (frequency response) and the level/phase differences between channels plotted against frequency. An audio spectrum display, such as the one shown in Figure 1, is also a valuable tool when combined with the multitone signal.

Multitone vs. discrete tones

Multitone testing differs from traditional single-tone testing in several ways. As previously mentioned, multitone analysis reduces testing and calibration times. This speed advantage stems from several properties:

- All tones are applied at once.
- Entire spectrum is measured/adjusted at once.
- Only one settling time is needed for the generator, DUT and measurement device, because a single signal acquisition is made.
- Level, phase and noise and distortion calculations are made from one FFT record.

Not only does multitone eliminate the step-and-repeat process, but it also can provide immediate feedback on equipment adjustments. Watching the entire audio spectrum respond to interactive adjustments with no annoying time lag further simplifies audio equipment calibration.

When compared to a single sine wave tone, looking at a multitone signal in the time domain (see Figure 4) illustrates how closely a multitone signal resembles program audio. Two factors contribute to this resemblance. First, multitones fill more of the spectrum than single sine wave tones. Second, the crest factor of multitone is similar to that of music or voice signals.

With multitone's similarity to program material, it can be argued that the adjustments performed and measurement results obtained through multitone give more realistic noise and distortion values than discrete tone testing. (In this case, "more realistic" means a value better representing the noise and distortion present with program material.) In the past, noise measurements were made on audio equipment while no input signal was present. Therefore, the quantization noise and other level-related anomalies were not a part of the noise measurement result. Furthermore, signal processors often operate at different gain ranges, depending on the input signal level. So, a no-input noise measurement would be even less representative of actual operating conditions.

The different type of stimulation provided by multitone can, however, lead to measurement results that do not exactly match results obtained with conventional tones or tone sequences. With this in mind, multitone testing should not be used interchangeably with tests made on single-tone input signals. The strengths of multitone testing are speed and convenience, so it excels in the roles of calibration, production line testing and equipment performance tracking.

When compared with conventional discrete tone sequence testing, multitone wins again. Standardized tone sequence tests require settling, acquisition and measurement times for each tone in the sequence. All of the advantages of multitone previously mentioned apply here as well. And because multitone is a DSP-based technology, it is always backed up with the computing power necessary for automation. To fully mimic standard tone sequences, a "multitone sequence" of two or three different levels of multitone can be performed in one-tenth the time of conventional sequences.

Multitones for maintenance

Multitone analysis can be implemented with display update rates of at least eight times per second. Combine this near real time analysis capability with a level vs. fre-

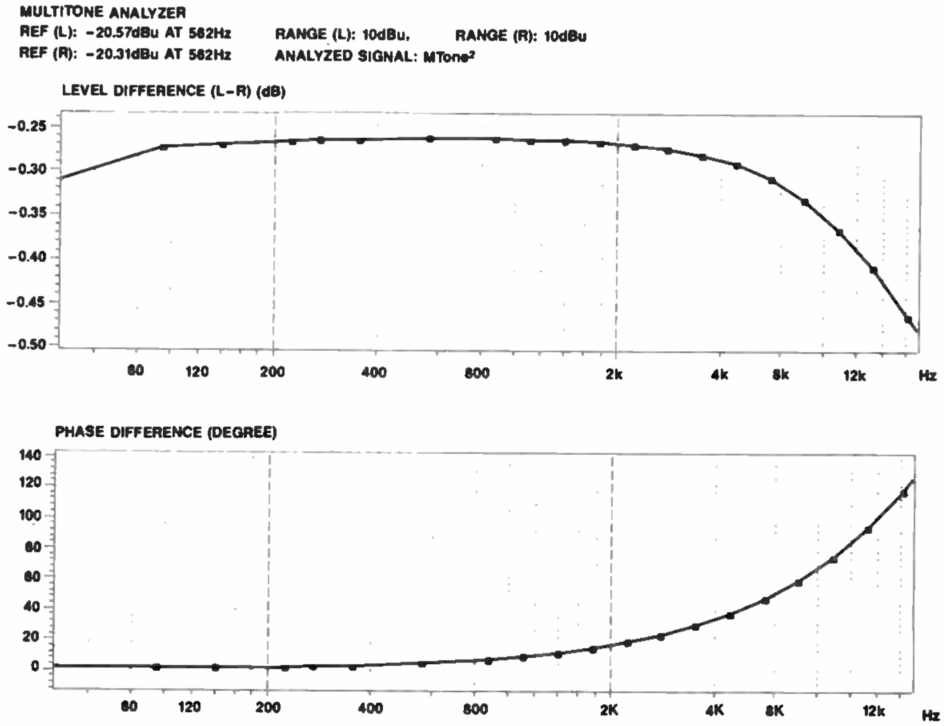
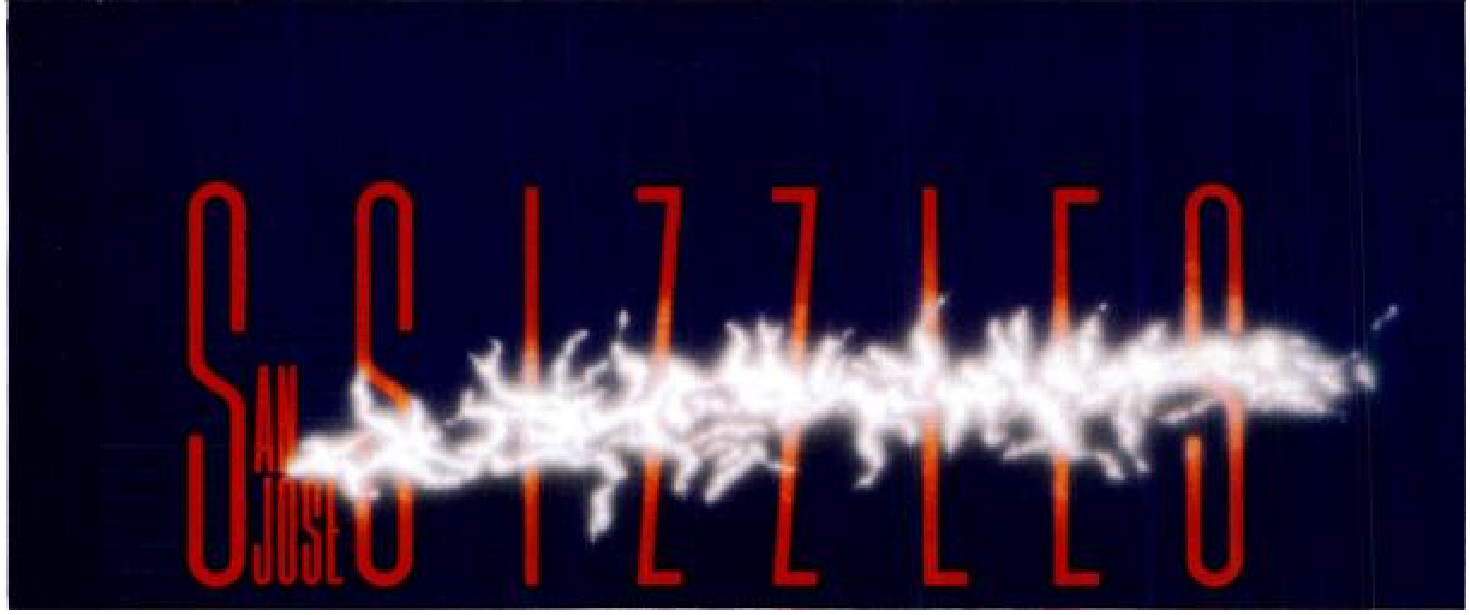


Figure 3. Matching phase and levels between two channels or pieces of equipment is simplified with level and phase differences between channels vs. frequency display.



WITH

TECHNOLOGY

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quency graph, and frequency response adjustments are easier and faster.

Some calibration procedures in VTR service manuals specify a single tone for minimizing crosstalk in playback circuits. Using the single tone specified by the manufacturer makes the adjustment simple. With multitone tools and techniques, the adjustment is just as easy, and the additional means to optimize crosstalk across the entire spectrum is provided. The multitone version of the adjustment is made while viewing level vs. frequency plot of the undriven channel. Multitone fundamentals feeding through from the driven channel sneak up from the noise floor as the adjustment is made, with the correct adjustment being the best compromise across the spectrum.

Preliminary experimentation using multitone for azimuth adjustments shows considerable promise. Viewing the phase difference between the channel display, the adjustment can be made. Because this display shows the entire audio spectrum, it eliminates the standard practice of maximizing a low-frequency tone amplitude, then switching to a mid-range tone, and finally a high frequency tone. This type of display immediately shows the effect of the adjustment throughout the spectrum. Additionally, a phase-difference display provides resolution not previously available for this type of adjustment.

Even without a multitone analyzer, the multitone signal could simplify this adjustment when used with an X–Y audio monitor (Lissajous display). With azimuth properly adjusted, the Lissajous pattern made by a multitone will be a straight line, just like a single sine wave tone. But instead of the ellipsoidal opening of the sine wave tone, multitone spreads into a complex pattern that resembles stereo program material when azimuth is misadjusted.

Remember that standard alignment tapes don't (yet) contain multitones. Until they do, making a pseudo-alignment tape containing multitone on the reference deck in a facility is the only way to use multitone for azimuth adjustments.

Split-site testing

Multitone is a strong candidate for rapid performance tests of common carrier and broadcast audio transmission links — while on the air. A short burst of multitone, typically about one second, is all that is needed for analyzers to do a complete audio path characterization.

Although most multitones don't sound particularly symphonic, they aren't abrasive either, especially in the short bursts necessary for measurement. Multitones can be transmitted during local insertion of station IDs or during an occasional fade-to-black prior to a commercial — without annoying the audience.

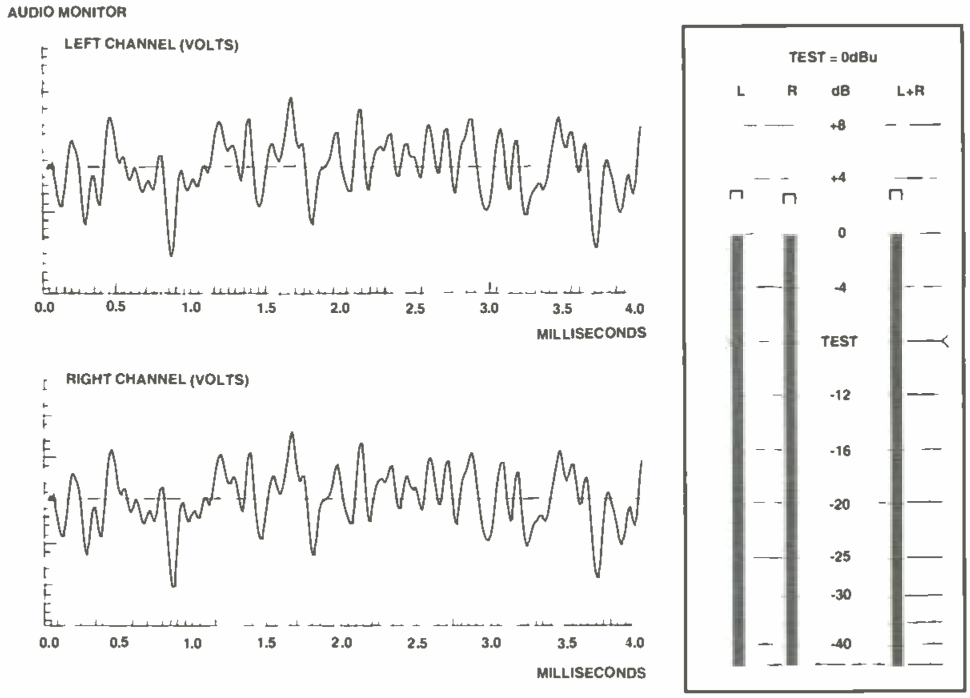


***Figure 4.** In the time domain, multitone bears a much stronger resemblance to program material than a single sine wave tone.*

Given the distance between ends of the system during split-site testing (i.e., transmitter and studio), it is not practical to lock the sampling clocks of the generator and analyzer, resulting in slight frequency shifts in the multitone elements. Split-site testing is one application where frequency shifts in the multitone can occur, and windowing prior to the FFT analysis should be employed to ensure accurate measurement results. (See the related article, "Analysis by FFT," on this page for a discussion on windowing.)

Summary

The power of digital signal processing can be brought to bear on the challenges of audio measurements and adjustments through multitone testing. The inherent strengths of multitone testing — speed, repeatability, flexibility and convenience — can be enhanced by integrating these measurements into a facility's automation system.

Use of multitone equipment is spreading throughout the broadcast industry. Although still in its infancy, many applications for multitone testing have been discovered, and it is likely that more will surface. As more facilities come on-line with multitone, and as industry support grows, standards committees will want to consider endorsing this technology by including it in standards and alignment tapes.

➡ *For additional information on multitone audio test systems, circle Reader Service Number 306.*

Analysis by FFT

A closer look at multitone analysis shows the need for caution when processing the signal. Figures 1 and 2 illustrate how different processing techniques produce drastically different results, only some of which are meaningful. Both figures are based on a simulated 8192-point (8K) FFT with a 48kHz sampling frequency and a 588.87Hz tone. FFT bin numbers (e.g., bin 100 out of 4,096 bins) label the horizontal axes of each graph. The fundamental frequency of 588.87Hz falls halfway between bin numbers 100 (585.94Hz) and 101 (591.80Hz).

Transforming time domain information into the frequency domain with an FFT requires that the period of the time domain signal be an integer multiple of the period of the FFT. When such a periodic relationship occurs, a fundamental frequency will fall into a single FFT bin.

The graph in Figure 1 shows the effects of leakage. If the fundamental was at 585.94Hz, a single line at bin 100 with no energy in adjacent bins would result. A rectangular window, which is equivalent to no window, was used here.

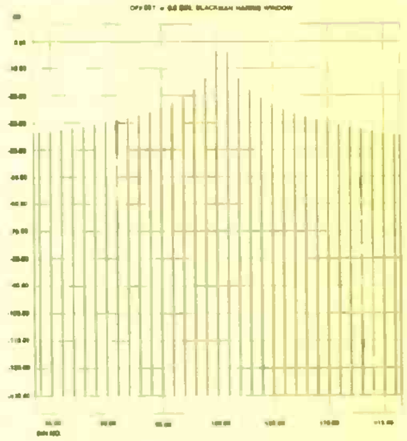


Figure 1. *The 588.87Hz fundamental frequency in this computer model does not correspond exactly to an FFT bin. The result is leakage that provides a misleading noise floor display.*

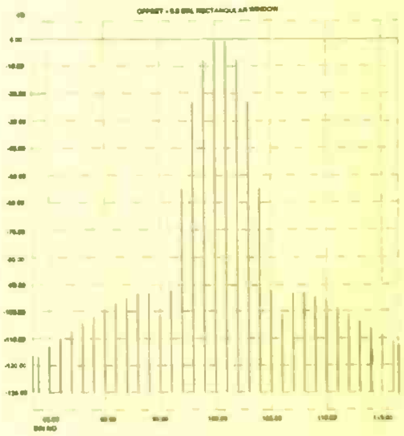


Figure 2. *Application of windowing prior to the FFT drastically reduces the effects of leakage. Within 23.44Hz either side of the fundamental, leakage is more than 90dB down.*

The graph in Figure 2 shows the effect of applying a Blackman-Harris window to the same data. After only four bins either side of the fundamental, the leakage is down more than 90dB. In actual application, an algorithm can determine the exact frequency and amplitude of the fundamental. To compensate for significant shifts in pitch, the spectra surrounding each expected multitone fundamental may be searched ± 5% of the frequency of each fundamental.

For noise and distortion measurements, the eight bins surrounding each fundamental in a multitone are set to zero. The remaining bins are plotted to represent the noise (and distortion) floor of the device under test. ■

Field Report

Sierra Automated Systems' routing switcher

By Margaret Bryant

When WMAQ-AM decided to move to a new studio/office facility, the station also decided to expand its existing Media Touch control system. To do so, an audio routing switcher was needed that could perform functions the existing switcher could not. WMAQ wanted a routing switcher that had the ability to sum several inputs to one output. Other considerations included customer support, flexibility, ease of operation, reliability and cost. With these requirements in mind, the station began shopping for a switcher. After much searching before and at the NAB Convention, only three routers were found that met WMAQ's requirements. One system was immediately eliminated because of cost. Demos of the two remaining products were scheduled. Of them, only the Sierra Automated Systems (SAS) routing switcher met and exceeded the station's expectations.

Meeting the needs

At WMAQ-AM All News Radio, many needs must be met by a routing switcher. Not only are there three on-air studios, four edit booths, a production studio and a tape dubbing room, but the station also has a massive newsroom. Each room has a different need for signal routing, depending on the function of the room. Some router outputs must be controlled by the Media Touch system. Other rooms must have outputs that are controlled manually and by computer. The SAS switcher fulfills those needs, and does it with style. The designers appear to have put much thought into all aspects of the unit. From a dependability standpoint, they thought of all the worst-case problems and found ways to make the switcher exceptionally reliable. They also took into consideration the environments in which the switcher would be used, and again planned for worst-case use (and abuse).

The cutting edge

The SAS switcher has a modular design with many possible combinations of inputs and outputs produced by assembling groups of modular frames. In addition, the system can be configured for a combination of stereo and mono inputs rather than all stereo or all mono. When a mono input is selected, the input is split by the switcher and fed to the two channels of a stereo output. In its present configuration, WMAQ's switcher fills six frames, consisting of 32 stereo inputs, 64 mono inputs and 48 stereo outputs.

Each modular frame contains input cards, crosspoint/output cards, power supply modules and a controller card. Any of the cards can be removed with the power on and not cause damage. You might think most switchers designed for broadcast would include this feature. However, this is not always the case. With the routing switcher, the heart of the operation — being able to remove the cards without disrupting the operation of the rest of the switcher — is extremely important. The cards are keyed, so if a card is inserted into an incorrect slot, no damage will occur. This is just one of many details to which the designers paid attention.

Furthermore, there are dual-redundant power supplies with separate AC cords for each frame — another feature that is not necessarily included in every switcher.

This modular design is not only expandable, but also extremely compact. Although this is a tremendous advantage in saving space, the frames tend to run a little hotter than desired. Fan trays were built

Performance at a glance:

- *Summing capability*
- *High-density matrix*
- *Multimicroprocessor design*
- *Dual-redundant power supplies*
- *Alphanumeric control heads*

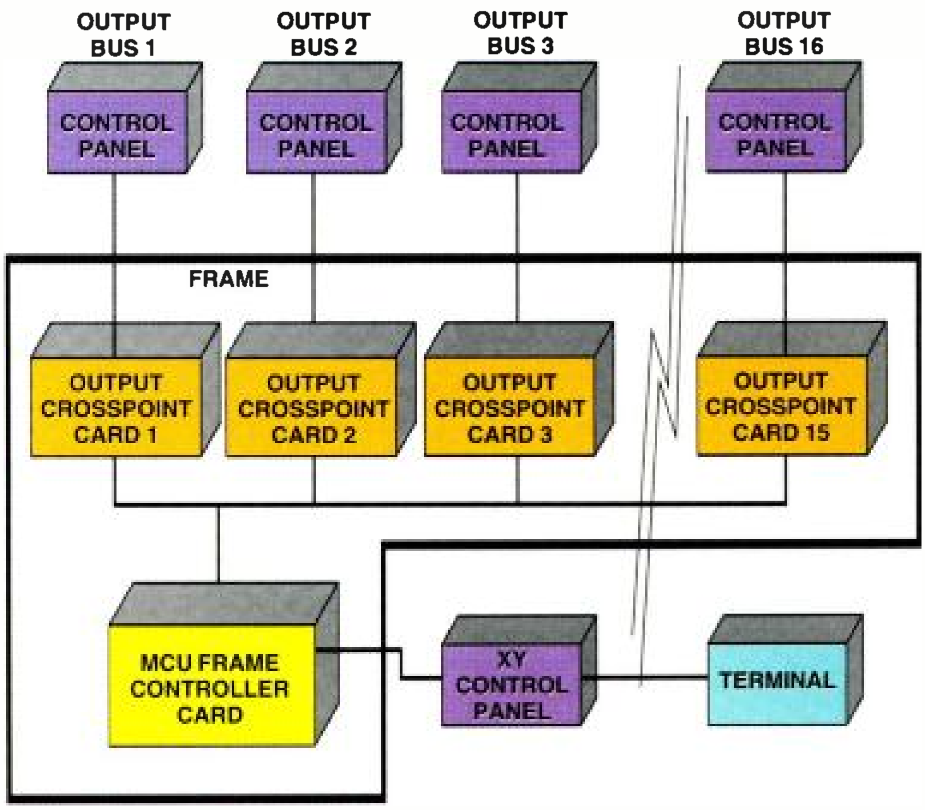


***Figure 1.** A block diagram of the Sierra Automated Systems routing switcher.*

Bryant is engineering manager, WMAQ-AM, Chicago.

to help solve this problem. The compact design extends to the input and output connectors on the rear of each frame. The package uses euroconnectors, which work quite well when you get the hang of the crimp tool. Although the actual connection is easy to make, the density of the wiring can make wire dressing difficult.

The designers appear to have put much thought into all aspects of the unit. From a dependability standpoint, they thought of all the worst-case problems and found ways to make the switcher exceptionally reliable.

Perhaps one of the switcher's best features is its use of multiple microprocessors. Because each crosspoint/output card has a microprocessor, communication occurs directly with the output control panel. There are no intermediate steps to slow operations or intermediate components to fail. This makes switching faster and easier. The reliability is enhanced because the entire switcher is not dependent on only a few processors.

Specifications

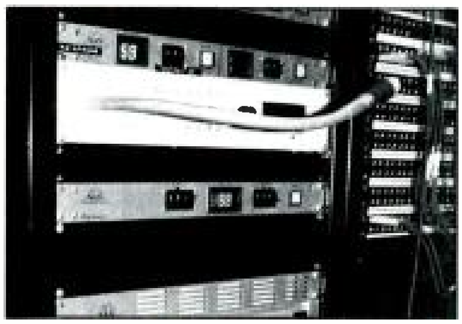
When it comes to specifications, the switcher met or exceeded all of the published information. With the high-density central matrix in the switcher, crosstalk and noise performance were primary concerns. They were tested with various configurations of inputs and outputs, and the results were better than expected. The crosstalk measurements were limited by our test equipment. However, the −80dB measurement we obtained was quite respectable (and better than the claim in the spec sheet). As expected, the frequency response was flat and the THD extremely low.

The documentation on the switcher is extensive and thorough. Although all of the necessary information is present, occasionally it took some searching to find what we needed. Apparently the company is working on improvements to the manual.

Summing was an important criteria in selecting this router. At WMAQ, the switcher is used for many purposes. The first use is in conjunction with the Media Touch in the on-air chain. Virtually all program elements, except the microphone and actuality carts, pass through the routing switcher. This means that a variety of stereo and mono sources, such as equalized phone lines for weather and traffic, 2-way radio, cellular phone, radio networks, regular phone hybrids and Instacarts, are selected and/or summed by the routing switcher. Through the computer serial interface, the inputs are selected and switched or summed to the on-air output.

Second, routing switcher outputs appear in all the studios (eight studios in all) and in various locations in the newsroom and taping room. These outputs are for news and spot production and dubbing. All outputs on the switcher can be addressed by the computer serial interface and the manual thumbwheel controller, which is another unique feature of the switcher.

Presently, we use the thumbwheel control heads in each of the studios and an XY thumbwheel controller that selects input and outputs right at the switcher. The XY controller is also where the connection is made for a computer to control the system. An LED display on the XY control shows the input(s) assigned as each output is dialed up. Should the output have several summed inputs, the LED display scrolls through the input numbers being summed. The display is helpful in keeping track of what is going on the air — especially when you aren't sure if it's an operator problem or an equipment problem. The disadvantage of the thumbwheel controllers is the need for an outboard list of available inputs. Although this is not a significant drawback, SAS has since developed an alphanumeric controller.



The alphanumeric controller is rack-mounted, taking up one rack unit in height. The input selector uses a shaft encoder. As the knob is rotated, source names are displayed in alphabetic order (even if that isn't how the inputs are wired to the switcher). An 8-character LED display is enough to spell most input names. Two buttons allow either the "active input" or the "selections available" to be displayed. The box is a creative solution to viewing the available inputs.

Two other controller options are available, which were tested during the demo before our purchase. One is a 1-rack unit push-button panel to select inputs. It features a "sum" button to combine various inputs to one output.

The second is an interface to connect a computer terminal directly into the XY controller. This option produces a crosspoint map on the terminal, showing the I/O configuration of the switcher at a quick glance.

Serving the needs

Factory help is outstanding. A mysterious problem developed in the communications between the switcher and Media Touch, which was immediately corrected with a software modification. From the start, the company was clearly customer-oriented. The company eagerly seeks input from customers on how to improve its product. Moreover, it uses an innovative approach to finding solutions to customers' needs, taking any suggestions several steps further. You might expect this to increase the price, but the switcher is affordable. WMAQ's experience with the Sierra Automated Systems switcher has been favorable, and we look forward to seeing the product in other installations. ■

When it comes to specifications, the switcher met or exceeded all of the published information.

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

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

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

SBE Day at NAB a success

By Jerry Whitaker

The society moved into a new era of visibility and respect this year at the annual NAB Convention in Las Vegas. The SBE prepared and presented a full day of engineering sessions targeting future trends and current hands-on technical needs. The sessions were packaged as "SBE Day at NAB '92."

Concurrent radio and TV sessions were presented, along with a combined regulatory session on technical issues.

Papers on a wide variety of subjects also were presented. The papers relating to FCC enforcement efforts seemed to attract the greatest attention. Richard Smith, a member of the FCC Field Operations Bureau, discussed the enforcement activities of the commission, and the effects that increased fines are having on stations. He also addressed the budget problems facing the agency, and the potential negative effects that such shortfalls could have on enforcement efforts.

Jim Zoulek, of the FCC Los Angeles office, outlined the self-inspection program for broadcast stations that his office has instituted. A number of questions were raised regarding the scope of the program and the likelihood of it being expanded to other areas of the country.

Additional papers presented on the topic of regulation included a detailed background report on tower construction and safety standards presented by John Windle of Stainless Inc. Significant changes are contained in ANSI/TIA/EIA standards, and Windle discussed how these will affect the typical broadcast station.

Richard Rudman, chair of the SBE frequency coordination task force, discussed the current status of the 2GHz frequencies. He cautioned the audience that "we have won the battle, but not the war...yet." The upcoming political conventions, proposed spectrum reassignments and the looming issue of HDTV simulcast channels have made frequency coordination more critical than ever.

Membership meeting

An important part of SBE Day was the annual SBE chapter chairs meeting and the annual membership meeting. The two events, which merged into one large gathering, provided an opportunity for chapter chairs and members to express their views on any subjects they wished.

Richard Farquhar, SBE president, opened the gathering by stating that in the past the national organization had not effectively communicated important information to its members. He assured those present that communication was a high priority.

The SBE board adopted three resolutions to ensure an informed membership and open meetings.

Board actions

At its April meeting, the SBE board adopted three resolutions to ensure an informed membership and open meetings. The first resolution establishes that the SBE will annually publish in its house organ a financial statement, with narrative, explaining any significant profits or losses. Although such a publication is currently called for in the existing bylaws, the actual implementation is not specified. Furthermore, the resolution requires that any request by a member in good standing for a line-item profit and loss statement, and a copy of any recent audit shall be honored.

The second resolution establishes that the SBE publish a summary of proposals and actions taken in the first practical national newsletter following a board meeting.

The third resolution affirms, as a matter of written policy, that board meetings are open to any member. Closed sessions are to be used sparingly, and only in the most unusual circumstances.

Although these resolutions do not have the force of formal bylaws changes, they do establish in writing national level protocols that heretofore have been subject to the style of individual SBE governing officers.

Bylaws changes

The board also unanimously agreed to add a procedure to the bylaws that allows any five chapter chairs, representing a majority of the membership, to place a bylaws change before the board of directors. More importantly, if the board fails to ratify the change, it will automatically go to a full vote of the membership.

The last set of bylaws changes (fall of '91) that removed the member vote did have a practical purpose. Full membership votes are expensive. Typically, the first class mailing to each member costs approximately $3,500. Likewise, if done correctly, they are slow, requiring time to publish the intended changes and allow for discussion. Furthermore, most bylaws changes are technical or address an issue that already has full membership approval, and a full membership vote would be unjustified.

An example of this was the board's decision to back board member Paul Montoya, and the membership committee's request to permit recently unemployed members continued access to the society's resources while they seek reemployment. Few, if any, of the membership would disagree with this bylaw change, and the need is immediate.

The bylaw addition passed at NAB does not prevent the board from making rapid and technical adjustments to the bylaws. It does, however, allow the membership to overturn those decisions or initiate its own changes.

Another avenue of change remains unaltered. Under the bylaws, any 25 members in good standing can place a resolution before the board. Although this places an issue on the agenda, it does not force the board to act. In practical terms, the board frequently discusses and often adopts these kinds of resolutions.

The result is that the membership has a larger voice. In the past, the membership merely voted on what the board (or more practically, a committee) proposed. Now the SBE membership can initiate change. ■

Whitaker, a technical writer in Beaverton, OR, is vice president of the Society of Broadcast Engineers.

Industry Briefs

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Panasonic Broadcast & Television Systems Company, Secaucus, NJ, delivered three AJ-D350 studio VTRs to KCPT-TV, Kansas City, MO. KCPT is the first public TV station in the United States to purchase D-3 ½-inch composite digital VTRs.

Additionally, WOAY-TV, Oak Hill, WV, has purchased a M.A.R.C.II-100 MII automated recording/playback cassette system to air commercial spots and some of its programming.

Vyvx, Tulsa, OK, and **CBS**, New York, signed an agreement that calls for the network to increase its use of fiber optics over the next year for various occasional TV transmission requirements.

The agreement guarantees Vyvx a minimum number of hours in occasional service as specified by CBS from points across the United States.

Broadcast Video Systems, Richmond Hill, Ontario, Canada, delivered eight MASTERKEY 4 linear downstream keyers to NBC for use at the '92 Summer Olympics in Barcelona, Spain.

Harris Allied Systems, Quincy, IL, received an order by KBHK-TV to coordinate a turnkey relocation of the station to new facilities. The project is expected to be completed by Nov. 1, 1992.

Canon, Irvine, CA, sold a J33ax 11B IAS internal focus telephoto zoom lens to Modular Video Services, Seattle.

Winged Vision, Crofton, MD, has also acquired a J33ax 11B IAS lens.

The ALTA Group/Calaway Editing, San Jose, CA, has been awarded a general service administration contract effective March 16, 1992 through March 31, 1994.

Sony Broadcast & Communications, Basingstoke, England, received an order from Scottish broadcaster Grampian Television for two digital library management systems. Central Television, another U.K.-based company, also has purchased a Sony BZC-2100 software system.

Pinnacle, Santa Clara, CA, delivered nine video workstations to various broadcast, corporate and governmental TV producers in the western United States.

Quantel, Darien, CT, sold its first Hal digital compositing system to 4:2:2 Video-graphics, Bristol, England.

Television Technology Corporation (TTC), Louisville, CO, has teamed up with Zenith and AT&T to broadcast the first long-distance over-the-air field test of an all-digital HDTV signal. The signal was broadcast from WMVT-TV in Milwaukee 75 miles to Zenith's technical center in Glenview, IL, on May 29.

JVC, Elmwood Park, NJ, and **Fox Broadcasting Company** reached an agreement whereby JVC will supply Fox affiliates and Fox-owned stations with professional S-VHS-C camcorders and S-VHS editing systems for electronic news gathering.

Kline Towers, Columbia, SC, and **Dielectric Communications**, Raymond, ME, have agreed to a joint venture. The venture will allow the two companies to offer turnkey packages in the design, fabrication, construction and installation of towers, transmission equipment and antennas; complete inspection and maintenance services; HDTV feasibility studies; and structural design analysis and reinforcement requirements of existing towers for future broadcast capability.

Harris Allied Broadcast Division, Quincy, IL, has established Harris Allied Europe, a radio distribution company based in Cambridge, England.

In addition, Harris will open two offices to serve the Latin American radio and TV broadcast market. The first office and headquarters was opened in Miami on July 1. A branch office, Harris Mexico S.A. de C.V., will open in Mexico City shortly thereafter.

PEOPLE

Schoichi Takada was promoted to president for Fujinon, Wayne, NJ.

Mark L. Dziekan has been named national sales and marketing manager of the Professional Video System Group for Toshiba, Tokyo.

Jack Fenster was promoted to manager, operations and programs, for Scientific Atlanta's Broadcast Radio and Data Systems unit, Atlanta.

Marin H
New York of
ist/designer.

Doug DiGiac
Midwest regional s
Graphics and Quan

Quentin R. Nelson
ed national sales mana
poration, Natick, MA.

Joe Mack has joined Ha
tems, Highland Heights, KY,
ellite sales and product spec

Glen Curry has been appointe
regional sales manager for Digi
Mountain View, CA.

David Kerstin is the newly appoi
president of Broadcasters General Sto
Ocala, FL.

Patricia Seeley has been named marketing communications manager for the ALTA Group/Calaway Editing, San Jose, CA. ■

New Products

Advanced FM technology

By Continental Electronics

• **Model 802B exciter:** broadband FM unit operates at 5W to 50W output; PLL-controlled frequency in 10kHz steps; inputs for composite, monaural audio, three SCA sources; comprehensive LED, digital front panel indicators; rear panel includes access to remote control and monitors as well as all inputs; integral harmonic filter.

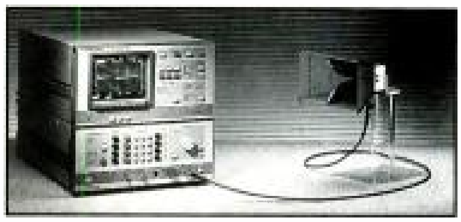
Circle (362) on Reply Card

Frequency analysis

By Rohde & Schwarz

• **ESBI test receiver:** extends upper frequency limit of EMI test series to 5GHz; covers fundamentals to 1GHz; for investigation and measurement of unintended spurious emissions produced by computer-related equipment.

• **ESS test receiver:** covers 5Hz-1GHz range for EMI measurements; compact unit with auto test system, manual tuning; battery operation.



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Captioning enhancement

By Image Logic

• **Autocaption placements:** closed-caption system offers automatic centering, zone features; inserts sequential list of captions into line 21 of the video signal based on time codes; zone commands place caption under the appropriate speaker; permits caption text to be prepared by staff member in-house.

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Audio interfacing

By Sonitech International

• **SAIB:** stereo audio/telephone interface box; stereo audio A/D, D/A converter; 16-bit, with dynamic range to 80dB; integrated anti-aliasing and smoothing filters; I/O connections for line, mic, telephone; speaker output.

• **DAI:** digital audio interface for CD player or DAT deck through SPDIF or AES/EBU specifications; 32, 44.1, 48ksamples/s with 16- to 24-bit word sizes; C-, U-bit access.

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Circle (45) Send Literature

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Multitrack optical recorder

By A/Z Associates

• **Augan 408 OMX:** digital audio workstation; records on removable, rewritable magneto-optical disk; stores audio and session information; stand-alone system with separate control/edit panel, track-sheet display; by Augan Instruments from The Netherlands.

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Facility control

By ABB Infocom

• **BROADMASTER:** automatic control system for broadcast centers; monitors and displays status of complete broadcast center with analog, digital values on color CRT; handles switching between transmitters, antennas, program lines.

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Powered speakers

By Audix

• **Power House speaker series:** for studio monitoring or use with computers and workstations; four 2-way models; PH3 18W, PH4 22W, PH5 25W, PH6 25W; integrated power amplifier uses high-gain, low-voltage hybrid design.

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Digital cart system

By Barco-EMT GmbH

• **BEDAS 466:** removable magneto-optical disk system; stores 3.2 hours of stereo in ISO Musicam format; system expansion to eight drives extends time to 25.6 hours; Jukebox configurations possible; external control and monitor unit.

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Audio measurements

By Gold Line

• **Model DSP-30:** real time analyzer includes digital 1/4-octave spectrum analysis; filters adjust by keypad to triple-tuned or sharper notching modes; 0.25-5dB scales check studio machines with test tapes, equalize rooms, adjust PA systems; user-programmable curves; LED display; auto sum and average function; operates from eight AA cells.

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Product literature

By Motorola Semiconductor Products

• **RF products selector guide:** data and cross-reference to more than 50,000 semiconductor devices for RF applications.

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Microwave equipment

By N Systems Inc.

• **Spectrum Series:** center-fed parabolic antennas for terrestrial microwave; models for 17.7GHz-19.7GHz and 21.2GHz-23.6GHz; reflectors from 27- to 72-inch diameters; single and dual linear polarization; modular design permits easier transporting of the units.

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Reference material

By Lester Laboratories

• **DAS-2000 brochure:** 8-page publication describing digital fiber transmission system.

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Continued from page 62

vary between those two amounts, but the actual system output must remain at a constant data rate. The remaining bandwidth can be filled with data that allows its transmission on a space-available basis.

Such auxiliary data does not have the real time requirements of digital audio signals, but rather can be sent in bits and pieces as the excess bandwidth allows, and collected by buffers on the receiving end.

Plugging in some numbers

Various digital radio formats have proposed auxiliary data rates ranging anywhere from 8kbit/s to 80kbit/s on average (instantaneous auxiliary data rates will vary, as mentioned). Let's pick a round number in the middle of this range — for example, 50kbit/s — and examine what it could mean in real terms.

The average double-spaced page of text represents approximately 2,000 characters. Each character might require 10 bits for its transmission. Therefore, the 50kbit/s auxiliary data channel can transmit 5,000 characters, or approximately 2.5 pages of text each second. A bit-mapped graphic image (such as a data-compressed photograph) of reasonable size might take 50kbits to 500kbits of data, requiring up to 10 seconds to transmit. A little math shows that a large newspaper could be transmitted on this channel in a few hours (for example, 1 a.m. to 5 a.m.).

Across a full day (86,400 seconds) the 4.3Gbits of throughput on this channel represents a lot of auxiliary data. If it were 100% used and charged at a penny per second, gross revenues would amount to $315,360 per year. That $0.01/s rate schedule is just a shot in the dark — the market might bear much higher rates.

Consider it from the customer's perspective. Suppose a real-estate agency wants to distribute its listings on a daily basis to its clients. Auxiliary data transmission provides the 1-way, point-to-multipoint service that it needs, and with a delivery speed and flexibility that serves its purpose. Color and resolution surpasses fax transmission quality. But more important, one transmission is received by all the clients at once, instead of requiring many sequential calls. Assume the clients' digital radios are hooked up to their home computers for display and selective printout. Even if the transmission takes an hour, the $360 cost is probably a bargain, given the quality, distribution coverage and timeliness of service. In this respect, a higher rate could easily be considered feasible.

Addressability

Addressability is another issue. Even without requiring radios to have unique addresses (such as cellular phones or pagers), a number of *pseudo-addressabilities* could be implemented. For example, *label acceptance* methodologies might allow news service data to be coded by subject (a Dewey Decimal System of the air). Listeners could collect data only on desired subjects by setting their receivers to the appropriate codes. Position or time data could also be used to filter messages, or any combination of the above. Mass messaging ("R-mail?") could be developed as a cross between advertising and direct mail.

Meanwhile, on the receiving end, smart radios incorporating adaptive information management techniques will be deemed critical by tomorrow's consumers who are likely to be inundated by continually increasing amounts of junk data.

Program-associated data (PAD) can also be offered, whereby supplemental information relating to main-channel programming can be received. Overall, datacasting may well become the largest part of the business of broadcasting in the not-too-distant future. ■

➡ *For more information on digital radio broadcasting, circle Reader Service Number 304.*

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