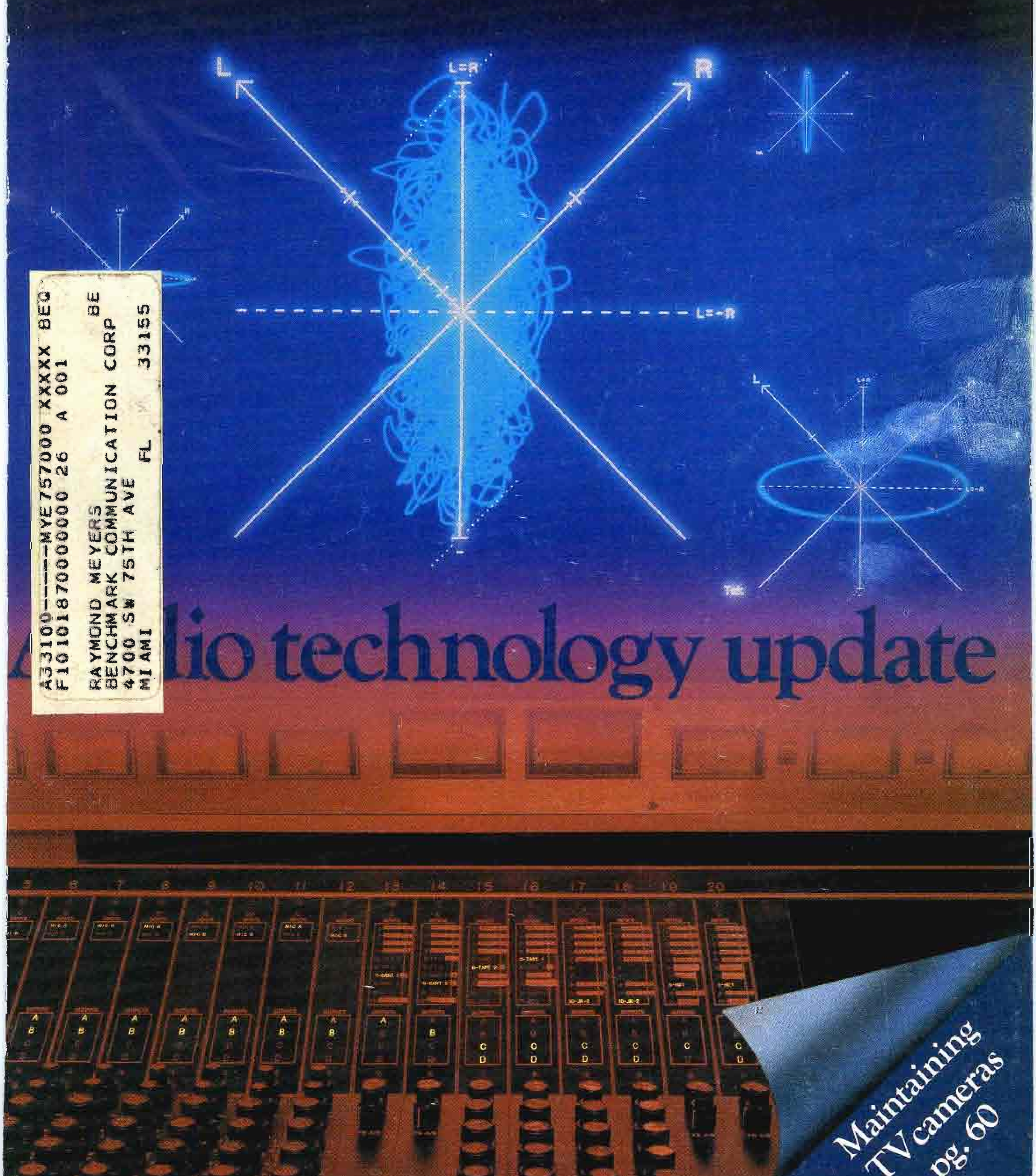
BROADCAST engineering

AN INTERTEC PUBLICATION

July 1987/$3



Audio technology update

Maintaining TV cameras pg. 60

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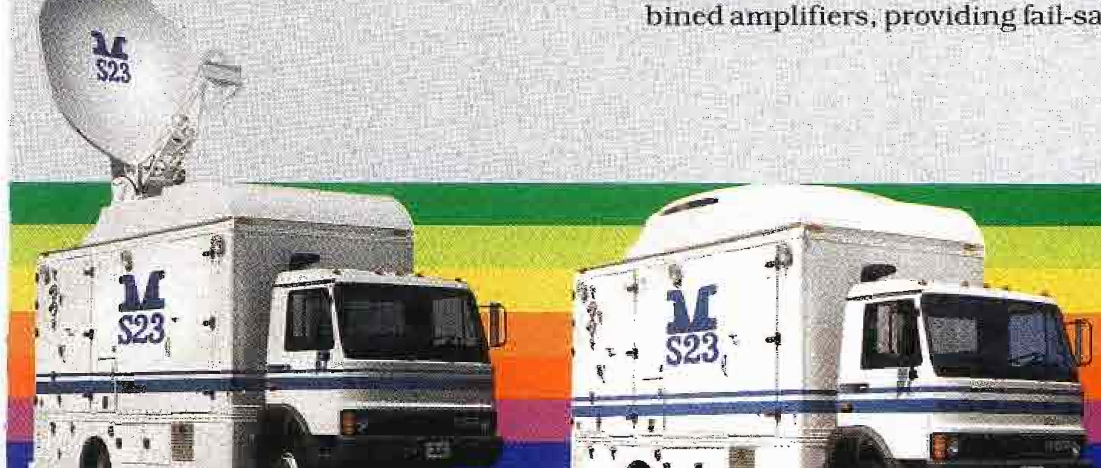

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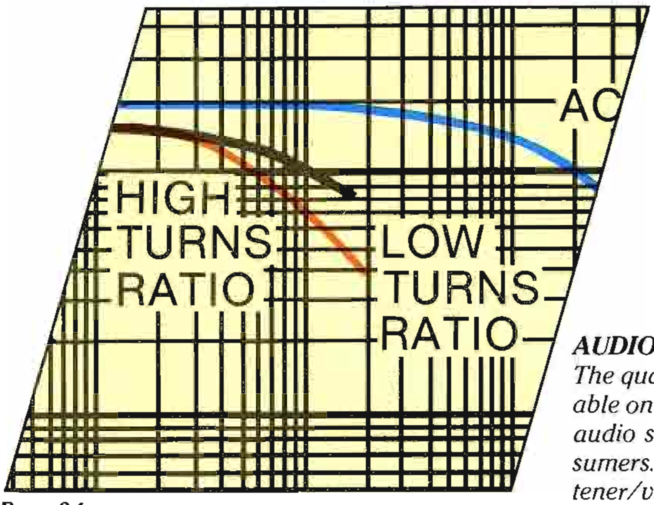

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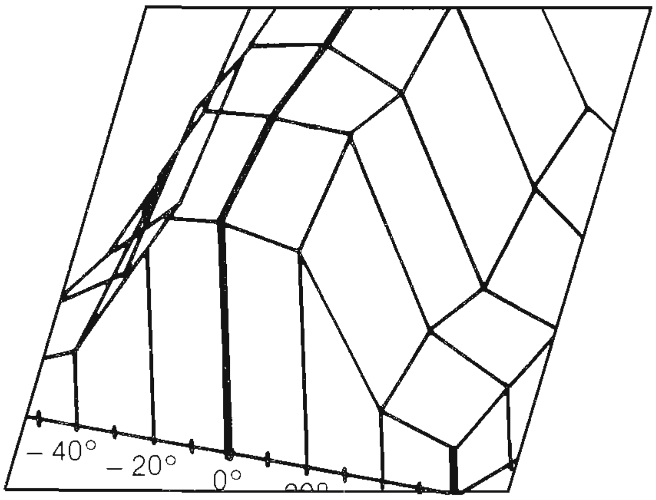

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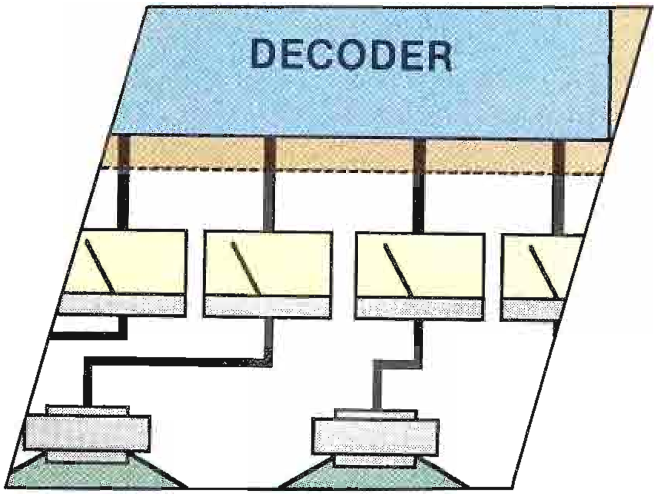

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BROADCAST engineering

AUDIO TECHNOLOGY UPDATE:

The quality of today's audio sources is a far cry from that available only a few years ago. Coupled with these high-performance audio sources is equally superior reception equipment for consumers. Radio and TV engineers need to recognize that the listener/viewer of today expects the same quality from off-air reception that is available from recorded mediums. We will examine some steps broadcast engineers can take to maximize the performance of their station's broadcast audio chain.

OTHER FEATURES:

ON THE COVER

Today's broadcast engineer must continually adapt to new and more accurate ways of measuring equipment performance. Our cover illustrates the various waveforms that might be encountered as an engineer works to maximize the performance of the station's audio chain. (Photo courtesy of Tektronix.)

DEPARTMENTS

SMPTE starts search for conference papers

The search for papers for the 22nd annual Television Conference of the SMPTE program has begun.

The conference, a focal point for discussions and demonstrations on advanced TV technology, will be held Jan. 29-30, 1988, at the Opryland Hotel in Nashville, TN.

J. Wayne Caluger, Caluger & Associates, and Mike Arnold, Scene Three, have been named program chairman and program vice chairman.

Sept. 15 is the deadline for authors to submit technical papers for consideration in the conference program. Subjects to be covered will include: component analog production and post-production, component and composite digital video systems, editing technology and audio and stereo for television.

The SMPTE is seeking technical papers from users, manufacturers and researchers who have applied some of the industry's knowledge, describing their experiences, obstacles and their perspectives on the future of TV technology.

Anyone interested in presenting a paper is urged to send name, address, title of the proposed paper and a 100-word abstract describing the paper to the program coordinator, Dollie Hamlin, SMPTE, 595 W. Hartsdale Ave., White Plains, NY 10607.

The schedule for the conference will include, in addition to the technical papers program, an exhibit of the equipment discussed in the paper sessions, meetings of the SMPTE's engineering, executive and administrative committees, and social activities.

Fall certification examinations

Fall certification examinations for the Society of Broadcast Engineers (SBE) will be held Nov. 13-24. The SBE certification program provides four levels of competency testing for: Broadcast Technologist, Broadcast Engineer, Senior Broadcast Engineer and Professional Broadcast Engineer.

Certification examinations also may be taken at the fall SBE convention in St. Louis. The examination will be given at the convention on Nov. 11. Applications for engineers interested in taking the examinations must be received by the national SBE office no later than Sept. 18. Individuals wishing to take the examination at the convention must indicate so on the application. Further examination information can be obtained from the national SBE office: telephone 317-842-0836.

NAB backs broadcast upgrade

The National Association of Broadcasters reiterated its support of an FCC proposal to allow FM and TV broadcasters to upgrade their service through the use of boosters. The present FM booster service would be improved and a new one would be created for television.

In its reply comments, NAB empha-

Continued on page 115

BROADCAST engineering

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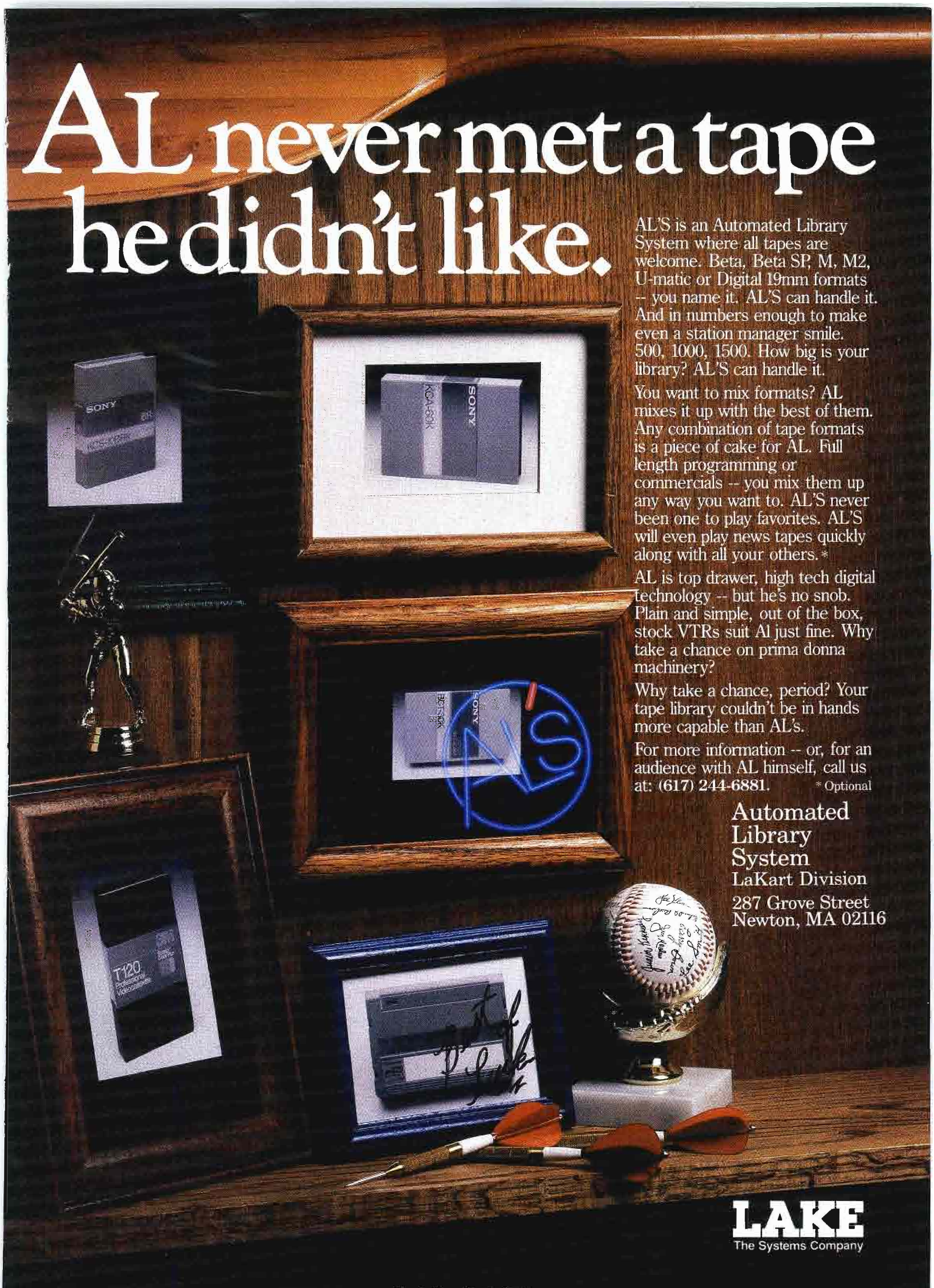

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Follow the crowd

It's Nov. 10—do you know where your engineering staff is? If it seems too quiet around your radio or TV station, it may be because they and other engineers from the United States and several other countries are attending the second SBE national convention and **Broadcast Engineering** conference.

This year's convention will again be held in middle America, in St. Louis. The convention is designed to provide the working engineer an opportunity to see, touch and hear the latest in broadcast technology. Coupled with an outstanding line-up of seminars, the 1987 SBE national convention and **Broadcast Engineering** conference is a must-attend event.

Why have another broadcast convention? It is not difficult to identify several other broadcast-related conventions. But, the NAB and SMPTE conventions notwithstanding, there are no other conventions dedicated to serving the industry's technical decision-makers—engineers.

Gone are the days when a non-technical person could pick and choose boxes of electronics and call the result a broadcast station. In today's marketplace, technology is an integral part of the business, and it's complex and expensive. Stations must purchase equipment that not only serves their needs, but does so on a cost-effective basis. Broadcast engineers, the people who must install and repair the devices, are in the best position to evaluate such hardware.

The sophisticated electronics used today require trained personnel, and manufacturers recognize that fact. They support the SBE convention by staffing their booths with technical experts who can answer technical questions. Oh yes, the sales staff also will be there to take your order. But rest assured, if you want a demonstration or have questions about how a piece of equipment works, someone will be on hand to provide that information.

Perhaps that is one of the elements that makes the SBE national convention so special. The show is not glitz and fluff. Rather, it is specially designed to meet the needs of the working engineer and engineering manager—the people who specify and purchase broadcast equipment. They recognize the difference between a sales pitch and technical information. They appreciate being able to receive the latter, knowing the sales pitch is a part of the package at the appropriate time. The attendees are important to the success of the show and the SBE goes all out to accommodate their needs.

As important as the exhibits are to the show, attendees also want to be updated on the latest technology and techniques. This service is provided by the **Broadcast Engineering** conference.

Through the work of John Battison, an unparalleled roster of industry leaders has been assembled for the conference. These experts will provide instruction on topics ranging from audio to transmitter maintenance to management techniques. Attendees also will have a chance to look into the crystal ball and see what new technologies await them.

This year's convention is shaping up to be even better than last year's. More exhibits are planned, and twice as much floor space has been reserved for equipment compared with last year. Also, more exclusive exhibit time will be provided for attendees to tour the floor. The seminars are scheduled so you can visit the exhibits without missing your favorite presentation.

Finally, attending the SBE convention won't cost you a fortune. The central location, reasonable hotel and airline rates all combine to make convention attendance as inexpensive as possible.

The SBE convention is the only convention developed and presented by broadcast engineers for broadcast engineers. Don't miss the most important broadcast engineering exhibition and engineering conference of the year—the SBE national convention and **Broadcast Engineering** conference. Plan now to attend.

THE NEW OPTIMOD®-AM 9100B

Audio processing for AM improvement.

In the several years since its introduction, OPTIMOD-AM Model 9100A has become one of the most-often used tools for improving AM audio.

Now there is a new opportunity for AM improvement. Over a year ago, the National Radio Systems Committee brought broadcasters, equipment manufacturers, and receiver manufacturers together to talk about a voluntary national transmission standard that would make wideband high-fidelity AM radios practical.

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

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

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

Introducing the *new* Model 9100B:

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

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Night operation for daytime AM stations

By Harry C. Martin

The FCC has proposed to allow all qualified daytime-only AM stations on domestic clear and regional channels to operate at night, with a maximum power of 500W. However, such operation would be permitted only where it complied with interference-protection requirements.

Under this proposal, former AM daytimers would not be required to protect each other against interference at night or to meet city-grade requirements. However, nighttime operating power would have to be reduced below the 500W maximum as necessary, to avoid interference to existing full-time stations.

Those AM stations whose nighttime facilities do not achieve a field strength of at least 141mV/m at 1km from their transmitters would not receive interference protection from subsequently authorized stations, and would not need to comply with minimum operating schedule requirements.

If the proposal is adopted, no applications would be required to obtain this nighttime authority. The commission proposes to do its own calculations and issue authorizations to stations that would benefit from the new rules.

The commission's proposal is designed to benefit listeners, especially those in rural areas where daytime-only stations provide the only local broadcast service. Moreover, the commission hopes its proposal will help daytime-only AM stations to compete more effectively.

The commission also has proposed to permanently discontinue licensing of new daytime-only stations, which it believes will result in the most efficient use of the limited opportunities for new and improved AM service. Furthermore, it proposes to reduce the minimum power for Class III AM stations on regional channels from 0.5kW to 0.25kW, and to reclassify Class IV stations authorized to operate with at least 0.25kW power on regional channels as Class III stations.

This will allow such stations to obtain nighttime protection from subsequently authorized stations. Class III stations, unlike Class IV stations, receive such protection.

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

The commission has asked for public comments on its proposals. The deadline for filing comments had not yet been set as of press time.

New EEO forms and standards adopted

The commission has adopted new equal employment opportunity (EEO) rules and reporting requirements. The requirements are designed to emphasize a licensee's overall EEO performance, not just the numerical composition of its work force.

Each broadcast licensee still will be required to file annual employment reports as well as a more comprehensive report at renewal time. Both forms, however, have been revised.

EEO efforts will be evaluated under a new 2-step approach. First, the commission will consider all information submitted by the station in its annual and renewal reports, any EEO complaints filed against it, and the composition of the local labor force. If the licensee's efforts have not been satisfactory, the commission will request additional information concerning deficiencies.

The revised Broadcast Station Annual Employment Report (FCC Form 395-B) continues to require each licensee with five or more full-time employees, in nine job categories, to report employment statistics by race, national origin and sex. However, the statistical tables have been reformatted to conform to the Equal Employment Opportunity Commission's Form EEO-1.

The new Broadcast EEO Program Report (FCC Form 396), to be filed with the renewal application, replaces the existing form, which required submission of a 10-point EEO program. The new program report requires license renewal applicants with five or more full-time employees to indicate what practices they have undertaken to ensure equal opportunity. Renewal applicants with fewer than five full-time employees will be required to complete only the identification and certification sections of the new form.

The commission has retained a modified version of the employment reports required for headquarters' offices. The reports for headquarters now will require data only for personnel with an operating effect on owned-and-operated stations.

Finally, the commission has retained the requirement that applicants for new broadcast stations or for an assignment of license must submit a 5-point EEO program on FCC Form 396-A.

Inquiry into FM assignments

The commission has initiated an inquiry to consider authorizing directional antenna systems to reduce the distance separations between an FM station's transmitter site and adjacent and cochannel stations and allotments.

The commission tentatively concluded that the limited use of directional antennas for short-spaced transmitter sites may provide more efficient use of FM broadcast spectrum.

The commission pointed out, however, that the use of directional antennas is not under consideration for channel allocations. Rather, this proceeding considers only the extent to which directional antenna systems can be tailored to accommodate short-spaced station transmitter/antenna sites within the framework of the Table of Allotments.

FCC lifts freeze on LPTV filings

In mid-May, the commission announced it would accept applications for new LPTV and TV translator stations, and for major changes (e.g., power increases, increases in height, changes in location) in existing stations, during a filing window of June 22-July 2. This opportunity represented the first major thaw in the LPTV application freeze that was imposed three years ago.

Under new procedures announced earlier this year, an applicant could file no more than five applications, or hold more than a 1% interest in no more than five applications, filed during the window period.

The only Character Generator that can display these kinds of figures.

Dubner's 5-K joins the family of 10-K and 20-K character generators in offering anti-aliased fonts. Designed to meet demanding requirements of broadcast, teleproduction, corporate and industrial video users, the system also features: 16 million colors; full screen help menus; playback effects: tumble, fade, wipes and pushes; sequencer; built-in sync generator/encoder/keyer; 5¼″ floppy disk.

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Part 2

Strictly TV

Format war ends, marketing war begins

By Jerry Whitaker, editorial director

The much-debated question of which way the major networks would move on the two competing small-format recording systems has now been answered. After the NAB convention, ABC announced its commitment to Betacam. And a week later, CBS confirmed what most suspected all along: that the network would move toward Betacam gear for news-gathering applications. NBC on the other hand, continued to express confidence in and success with M-II.

Michael Sherlock, NBC president of operations and technical services, told an NAB convention press conference that additional orders were being placed for M-II equipment. The orders will raise the network's M-II commitment to more than $23 million by the end of the year.

NBC is working with Panasonic Broadcast on some refinements of the M-II product line including a new edit panel as an upgrade on the AU650 studio recorders already in service and a new field-edit package. The field-edit system has long been an objective of the network because such a system will significantly reduce operation and transportation costs. Sherlock said current plans call for roughly 50 systems this year. The field-edit package will weigh 65% less than the present edit system and cut the cost of required equipment by half.

Sherlock also announced that he is continuing to explore the market for an automatic cart machine for spot playback service based on the M-II format. The network has already taken delivery of two M-II computerized videocassette record and playback systems from Odetics. The machines will be used for automated programming for the *Today Show, NBC Nightly News with Tom Brokaw* and other NBC news programs.

NBC entered into a software development program with Odetics to expand the capabilities of the M-II cart machine. Using a DEC Micro Vax computer on the front end enables the network to adapt the machine from a commercial spot player for use by NBC News into other function modes, such as last-minute editing of a news story sequence. The Micro Vax enables the machine to interface with the computer network used by NBC News for communications with its bureaus, owned stations and affiliates.

CBS makes it official

On the heels of the ABC Betacam announcement, CBS reported agreement with Sony, to purchase additional Betacam equipment for network newsgathering use. The purchase includes three cameras, 13 camera/recorder units and 22 portable VTRs. Eight of the cameras use CCD image sensors. Announcement of the agreement was made by Joseph Flaherty, vice president and general manager, engineering and development, CBS Operations and Engineering.

CBS has been using Betacam equipment at its *Hard News Center* with good results. Flaherty said, "We are pleased to (now) begin use of this videotape technology for network news gathering."

CBS has extensive hands-on experience with Betacam products. More on that next month.

Illustration by Tim Lynch

Probably the main unanswered question from NAB was which way ABC would move on the ½-inch tape format issue. The suspense ended about four weeks after the show when the network unveiled plans to begin a gradual move toward Betacam and Beta SP. With that announcement, here's how things stack up along 6th Avenue in New York.

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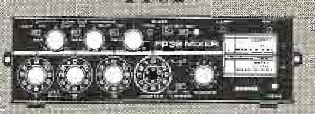

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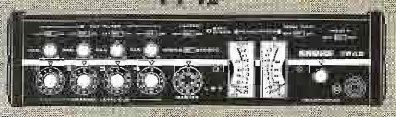


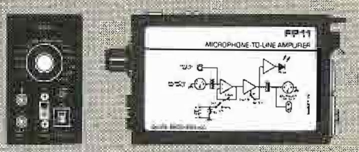
For Stereo Remotes. The FP32 Stereo Mixer is comparable in size and features to our famous FP31. Its stereo capability, light weight, easy-to-use controls and convenient shoulder harness make it the first choice of field crews. Our FP42 Stereo Mixer simplifies mic cueing, so important in situations like sports remotes. Plus it enables you to easily mix down stereo in your post production booth. It offers all the features of the popular M267 plus stereo capability and a stereo headphone amp.

FP31

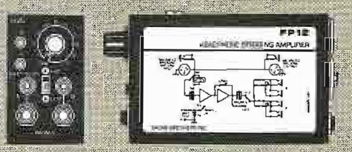
FP16

The Industry Standards. The FP31 is Shure's original field production mixer. Thousands bet their audio on it worldwide. The FP16, a one-by-six distribution amp with transformer balancing and link jacks, outperforms all competition. It's also ideal as a portable press bridge.

FP11



FP12



For Long Yardage Situations. The FP11 Mic-to-Line Amp provides freedom from noise in long line situations, with up to 84 dB of gain in 15 6-dB steps. It converts any mic to line level and includes an invaluable limiter circuit. The FP12 Headphone Bridging Amp is a must for shotgun and boom operators. It keeps them on target without need for a return line. It's ideal for multiple headphone feeds, troubleshooting, and as an intercom.

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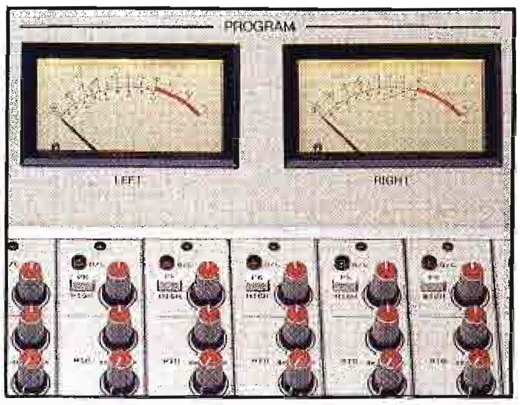

Ground systems for AM stations

By John Battison, P.E.

Last month's column emphasized the importance of low ground-system losses. To continue our discussion on propagation, we will look at the mechanics of ground systems for AM stations.

Ground screens and radials

The FCC rules assume that the performance of a radio station is based on smooth, perfectly conducting ground. To obtain this theoretical condition, a minimum of 120 radials is required. These radials must be equal in length to or longer than the tower height and are usually spaced 3° apart. In those cases where the ground is rocky or sandy, additional radials are interspersed between the standard 120 radials. In this situation, the radials are spaced every 1.5°.

Another solution, and one that the commission often demanded, is the provision of an expanded copper ground screen at the tower base. These screens are 8 feet wide and are then cut to the proper length. The typical copper-screen ground system is about 24'x24' and is centered on the tower base. This area has the highest current density.

Unfortunately, as anyone who has purchased these screens lately can testify, copper is quite expensive. Therefore, many engineers today often try to use the short radials instead of the copper screen, if possible.

Installing the radials

Sometimes a tower site is lopsided or restricted, which means short radials must be used on one side (direction). In severe cases, the resulting ground system may lower the radiation slightly in one direction. Field-intensity measurements can identify this problem. This consideration is primarily applicable to non-DA stations, where the field strength is expected to be the same in all directions.

Although radials may be constructed from copper or aluminum, annealed copper wire is usually used. I prefer to use 8-gauge wire, although in the interest of economy, 10-gauge is often used. For lower power stations, 10-gauge is usually adequate. If aluminum wire is used, it is advisable to add a copper screen at the tower base.

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

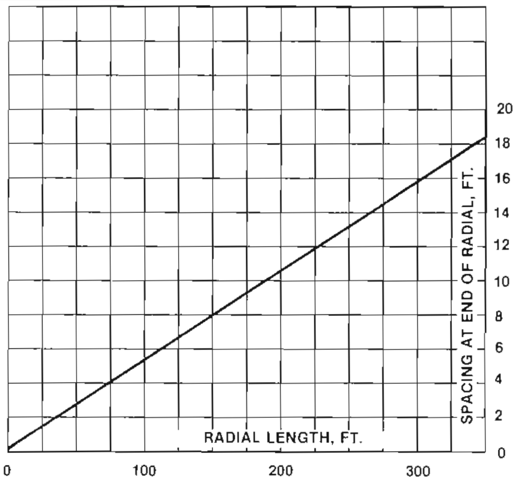

Figure 1. This chart shows the distance between the ends of radials, as measured in a circle around the tower.

It is quite possible to plow in the radials yourself. If you do, be careful to not break the wire as it is placed in the ground. For years, grounding rods were placed at the end of each radial. However, over the years, experience has shown that these rods are not necessary, because the current at the ends of the radials is usually negligible.

Another technique relied on 2-inch or 4-inch copper strap brazed to the ends of the radials, forming a ring around the tower. This practice is not necessary for single towers. However, when there are two or more towers in conditions where radials overlap, it is essential to join all radials to a copper strap, which runs between the towers.

Identifying broken radials

If the condition of the ground system is questionable, first check the continuity of the radials. This simple check can be completed by walking along the radials while observing the field intensity on a field-strength meter. The signal level should be appreciably higher over the radial. If it is not, or if the signal strength suddenly changes partway down a radial, you should suspect a break in the wire.

Another way to check the radials is to connect a VOM to the tower-base ground strap and follow the field-strength meter readings along a radial. If you suspect a problem, you can use a long probe to locate the radial, and then measure its resistance.

If you need to locate the ends of several radials, perhaps for the above resistance measurement, Figure 1 may be helpful. First, locate the end of one radial. Then, locate the adjacent radials by measuring around the tower according to the distance shown on the chart.

Breaks generally seem to occur near the tower base, where traffic is often heavy (usually from making base-current readings). Radials also often break where improper brazing techniques were used. In this case, the radials sometimes drop off from the base strap.

Installation problems

Many years ago, some engineers thought that a criss-cross pattern of wire would form a good ground system. However, as might be expected in today's semiconductor-oriented world, it was found that this sometimes led to the creation of harmonics and spurious signals because of corrosion at welds or brazed points. There are dozens of brazed points in today's radial ground systems, but not half as many as there would be in a criss-cross pattern.

Be careful about building a new system over an old parking lot or other area that may contain many loosely touching metal parts. All reinforcing bars and any other metal should be removed from the ground-system area. The presence of such material is an invitation to spurious radiation problems.

Next month, we'll look at installing the ground system and show the layout of a typical ground system.

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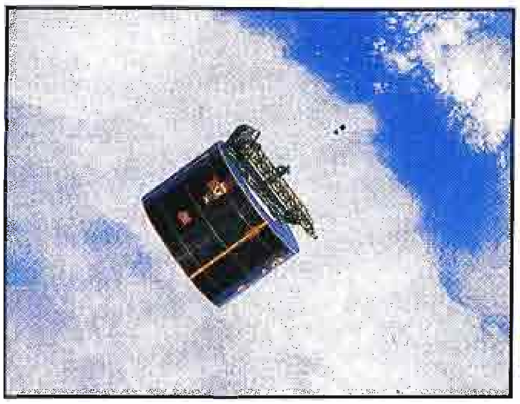

Innovations in microwave circuitry

By Elmer Smalling III

Satellite receivers employ extensive use of two relatively new technologies—*microstrip* and *monolithic* circuitry. These innovations allow for simple radio fabrication and reduce the number of discrete components required for microwave low-noise amplifiers, downconverters and RF amplifiers. This new technology has resulted in manufacturing cost reductions that have made low-cost home and broadcast satellite equipment possible.

Microstrip circuitry

The first of these technologies, microstrip circuitry, consists of a double-sided printed circuit board made of fiberglass. The board is usually 30- to 50-thousandths of an inch thick. One side is coated with a thin tin layer, normally 1- to 2-thousandths of an inch thick, which is uniform over the entire surface and forms an electrical ground plane for the circuit board. This ground plane serves as a return for the electrical fields built up on the circuit side of the board.

The circuitry on the working side of the board is designed so that the shape and length of a trace will dictate its impedence, operating frequency and reactance. Whereas traces on a regular printed circuit board merely serve to connect the devices (such as ICs, resistors and capacitors), traces on a microstrip circuit board not only connect but replace most of the passive devices, such as coils, transformers, resistors and capacitors.

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

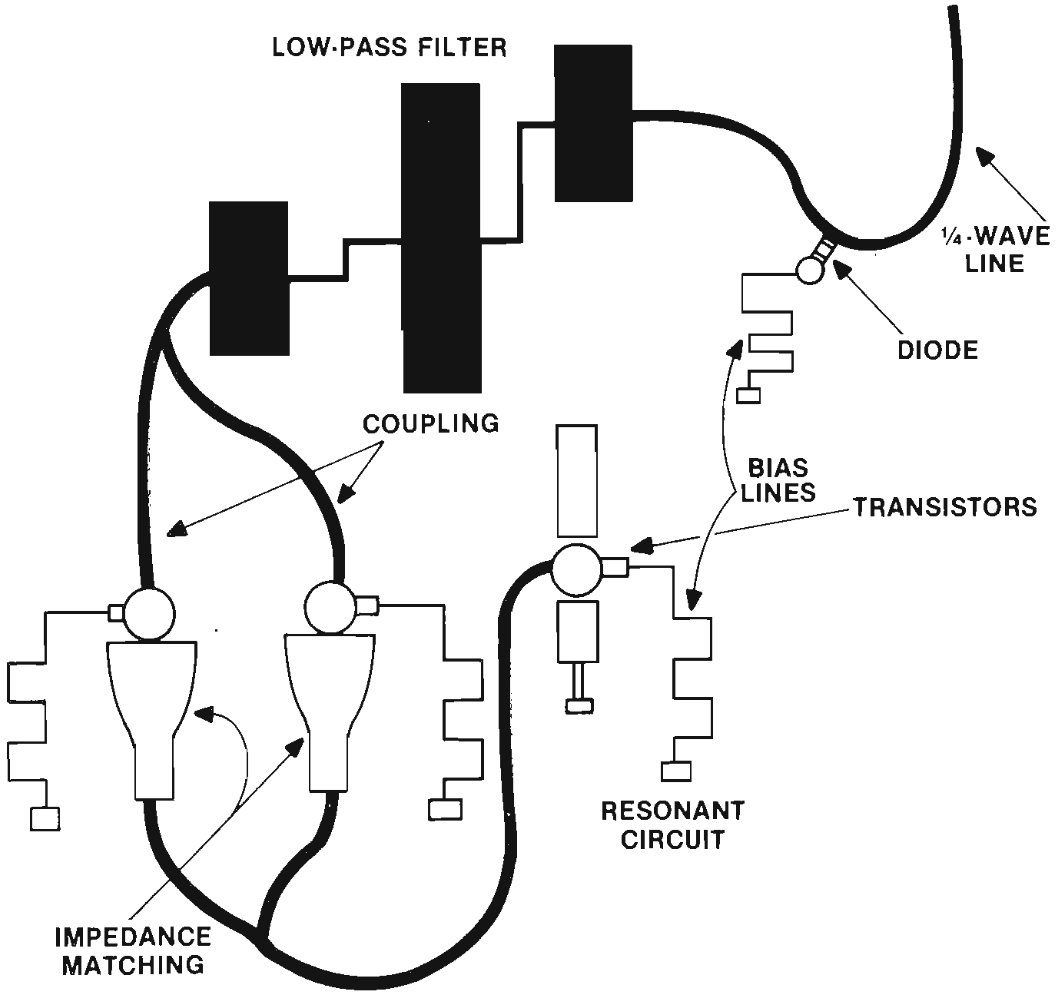

Figure 1. *This typical microstrip circuit shows some of the components commonly used, including a 3-section, low-pass filter; a ¼-wave line used as half of a T/R switch; bias lines to supply +5Vdc; impedance-matching strip segments that convert a high impedance (130Ω) to 50Ω; and coupling lines to connect two circuit sections at one impedance.*

Design factors

One of the most important microstrip design factors is the width of a trace divided by its height above the lower surface ground plane, which, along with the dielectric constant of the glass circuit board material, dictates its impedance.

A second important factor is the length of a trace. At microwave frequencies, a ¼-wavelength can be as short as a half-inch in air. Because all printed circuit boards have a dielectric constant that is greater than the dielectric constant of air, waves are slowed as they travel through the board/line combination.

This effect causes the wavelength on a circuit board to be dependent on the dielectric constant. At board dielectric constants of five to 10 (depending on the material out of which the board is constructed), a wavelength may be up to one-third shorter than in air. This permits the housing of a lot of circuitry in a small area, compared with earlier technologies.

Design considerations

Because most of the elements of microstrip circuitry are combinations of ¼-wave line elements, careful layout is required. The general rule of microstrip design states: *The thicker the trace, the lower the RF impedance.*

Traces that supply bias and require operating or control voltages are made very thin so that they have a high RF impedance while maintaining a low dc resistance. In addition to having a high RF impedance, these thin bias and control traces are usually made to be a multiple of ¼ of a wavelength so that they may be RF-shorted with a capacitor, further ensuring that they won't carry RF.

When discrete components are required on a microstrip circuit board, the type usually used is the second of these new technologies—surface mount, monolithic circuits, which will be covered next month.

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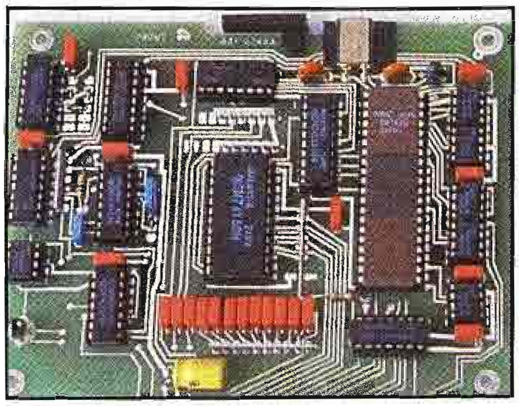
Part 10

Circuits



Inside digital technology

By Gerry Kaufhold II

Since this column started last October, the basic operating principles of digital electronic circuits have been covered.

Several columns were devoted to address decoding circuits. These decoders showed how combinations of various gates could be connected to perform specific functions.

Decoders are important subsystems used to create the elements of digital controllers. Digital controllers are used in broadcast station equipment such as transmitter remote controls, studio cameras or master-control automation systems. Even the telephone PBX system probably contains a digital controller.

Elements of a microcontroller

A typical microcontroller is made up of several digital subsystems combined onto a single integrated circuit. Five bits of address can access 32 memory locations. The four databits provide up to 16 different instructions, and the arithmetic logic unit and the two accumulators allow simple arithmetic such as addition or subtraction.

The master clock and control line circuits manage the timing functions that are required to move data along the address and databuses. Other circuits internal to the IC provide timing and control within the device.

Clock, reset and control lines

The circuit has a master system clock, usually provided from a crystal oscillator. Typical frequency range is from 1MHz to 10MHz. The master system clock is always running. Any clock signal or counting circuit that cannot be reset, but runs all the time, is referred to as *free running*. The master system clock is a free-running signal.

Most digital systems use a RESET line that is active LOW. When the RESET line goes LOW, the CONTROL lines go to a predefined state, the DATA OUTPUT is tri-stated to prevent loading the databus, and the ADDRESS latches are loaded with 00000.

Following RESET, a memory-access cycle fetches the first instruction of the program. Program instructions are called *operating codes* or op-codes. This process of fetching the operating code is termed the *OP-CODE FETCH* memory cycle.

Instruction decoders

Circuits inside the IC create timing and control signals within the chip that feed the data to the instruction decoder circuits.

The instruction decoders in this microcontroller are similar to decoder circuits that already have been discussed. The decoders are made up of AND gates, OR gates and INVERTERS.

There is a separate decoder circuit for each of the 16 possible op-codes. The op-codes are 4-bit nibbles. The manufacturer of the IC has defined what each 4-bit combination means, and has published a user's manual that explains how to use each instruction.

The instructions were arranged into a useful program, and a programmable read-only memory has been programmed and connected to the three buses (data, address and control).

The outputs of each decoder set off a chain reaction that will either fetch fresh data into an accumulator, cause an arithmetic operation to be performed, or modify the address for the next memory-access cycle.

Accumulators

The *A* accumulator is connected to the instruction decoder and the arithmetic logic unit. The contents of the A accumulator can be added to or subtracted from the contents of the *B* accumulator.

Note that the A accumulator contains four bits, so that the A accumulator can read-in or write-out directly to the 4-bit databus.

The B accumulator contains an extra bit, allowing it to hold the carry bit if the result of an addition operation requires five bits.

In addition to the instruction decoder and the arithmetic logic unit, the B accumulator connects to the address modifier circuit. During decoding of the instruction, the B accumulator might be added to or subtracted from the address modifier, which would change the address for the upcoming memory cycle.

Address line drivers

Just after RESET, the address latch is connected to the address bus by the address output circuits. The data stored in the zeroth byte of the PROM memory is READ into the DATA INPUT and latched into the DATA IN latches.

After fetching the first op-code from address 00000, the address modifier automatically increments to 00001, but the address output is tri-stated, so no address appears on the address bus.

Most of the time, the address modifier circuit acts as a counter, sequentially counting up through the available address space. By using the control lines to differentiate between op-codes and data, the same five address bits could access 64 different locations—32 locations to READ from, and 32 locations to WRITE into.

The instruction decoders execute the steps required for the op-code. If the instruction calls for modifying the address of the upcoming memory cycle, then the contents of the address latch get overwritten, and the address for the next valid location is placed into the address latch.

When the control line circuits again become active, the new address is output to the address bus, and the new data or op-code is fetched into the microcontroller.

This process continues until the RESET line is pulled low, and then the process starts all over again.

Microcomputers

Three elements are necessary for a computer—memory, input/output capability and a central processing unit (CPU). Microcontrollers and microprocessors illustrate ways in which several digital subsystems are combined on integrated circuits to provide the elements of the central processing unit. Microprocessors will be featured in later "Circuits" columns.

Kaufhold is an independent consultant located in Tempe, AZ.

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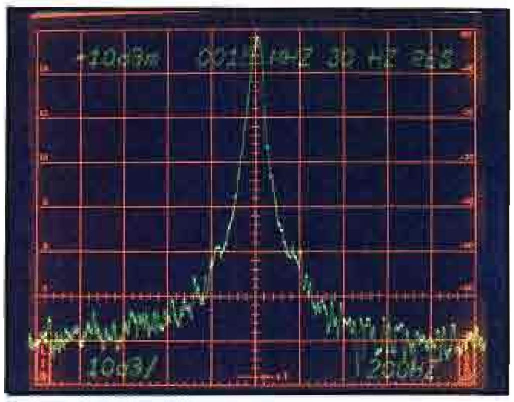

The unexpected citation source

By Mark A. Bunker

Until the advent of TV multichannel sound, the aural side of TV transmitters had changed remarkably little since stations converted to color.

One old problem still exists that may go unnoticed, and can range from viewer complaints to a full citation and fine by the FCC. The problem: aural transmitter spurious carriers.

Audio input and aural spurious carriers

The most common source of aural spurious problems is low-level audio components that infiltrate the audio of a TV station and eventually find their way to the transmitter input. These unwanted audio components produce first-order modulation products.

To a spectrum analyzer, first-order FM-modulation characteristics are identical to an amplitude-modulated, double-sideband, full-carrier signal. As long as an audio sinusoid is low enough in level to produce only first-order products, a 15kHz tone, for example, will produce a minor spectrum lobe 15kHz on either side of the main aural carrier. Amplitude of the minor lobe, compared to the main carrier, will vary with the input level of the audio tone. Low-level, high-frequency components that enter the aural transmitter can, therefore, cause interference with multichannel sound systems. Monaural transmissions may be received distorted or may falsely trip the stereo circuits of stereo TV receivers.

Bunker is an engineering supervisor at KSHB-TV, Kansas City, MO.

FREQ IN	VU IN	Z	$J_1(Z)$	$J_0(Z)$	SL
1.0KHz	-30dB	0.837	0.384	0.8312	-6.7dB
1.0KHz	-50dB	0.0837	0.0397	0.9984	-28dB
8.0KHz	-30dB	0.3934	0.1913	0.9623	-14dB
8.0KHz	-50dB	0.03934	0.02	0.9996	-34dB
15.75KHz	-30dB	0.355	0.1723	0.9696	-15dB
15.75KHz	-50dB	0.0355	0.0175	0.9997	-35dB
15.75KHz	-70dB	0.00355	0.0017	1.00	-55dB
40.0KHz	-30dB	0.1865	0.0945	0.991	-20dB
40.0KHz	-50dB	0.01865	0.01	0.9999	-40dB
40.0KHz	-70dB	0.001865	0.001	1.00	-60dB

Table 1. *This table, based on Bessel functions, reveals first-order aural spurs. Spurs generated by low-level crosstalk at frequencies common to broadcast plants can result in an FCC citation.*

Calculating spurious carrier levels

Susceptibility to potential problems can be illustrated by calculating some common tone levels and the levels they produce on a spectrum analyzer display.

The first-order sideband level can be derived using Bessel function tables, available in any engineering reference manual, and the following relationships:

$$SL = 20 \log \left(\frac{J_1(Z)}{J_0(Z)} \right)$$

Where:
SL = the sideband level below the main carrier in dB;
$J_0(Z)$, $J_1(Z)$ = the Bessel function values for Z; and
Z = the modulation index or: the frequency deviation divided by the modulating frequency.

Several frequencies and modulation levels are charted in Table 1. Note that the calculations allow for a 75μs pre-emphasis curve. Modulating frequencies in excess of 20kHz are calculated at the same pre-emphasis value as the 20kHz value.

Unwanted audio tone levels too low to be seen by a VU meter or modulation meter cause carrier products high enough in amplitude to interfere with multichannel sound reception.

Unwanted audio sources

In a TV station audio system, most unwanted audio components result from crosstalk of video, switching power supplies and digital (computer) sources.

Video crosstalk can occur from an almost unlimited number of sources. Monitoring for components can provide the most meaningful clues in tracking down problem sources. Intermittent occurrences may indicate that the source is not always on the air.

Commerical playback may not immediately show a problem until individual recordings are checked for a bad audio track or stock damage. VTRs and audio cartridge equipment commonly use an 8kHz to 10kHz tone for cuing purposes. Because cue tracks are adjacent to program tracks, minor tape misalignment will cause bleedover of cue tones.

Monitors generate a large 15,750Hz component in their sweep circuits. Tape machines and audio consoles in close proximity to video monitors should be checked.

Much of the equipment in use today uses switching power supplies. These supplies rely on chopping an unregulated dc at a 20kHz to 40kHz rate, passing the result through a transformer and filtering the rectified secondary outputs. These power supplies, because of the higher ripple frequency, produce cleaner outputs with more efficiency and less volume than conventional supplies. The switching, however, exhibits unique problems as components age.

Almost all switching power supplies use the same input circuit. Line ac is passed through a low-pass filter to eliminate switching transients exiting to the line. The ac is then rectified with a voltage doubler (if 120V) or simple rectifier (if 240V) to produce the unregulated dc for the switcher. When used in the 120V doubler configuration, the series electrolytic and filter capacitors typically will dry up and drop in value with age. As the values decrease, larger switching currents are required to maintain power-supply output. At some point, the input line filter will no longer fully suppress the switching transients, allowing the ac line to carry them to other equipment.

Switching power-supply problems are most often observed by nearby equipment exhibiting symptoms synchronous with a 60-cycle line rate.

Such problems can be missed easily by an analyzer on the aural transmitter, unless every source is observed while it is playing on the air, indicating a direct source of the problem.

When high-frequency components are observed at the transmitter input, note whether the level varies. A component that varies may indicate an additive effect caused by editing or dubbing.

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Part 1

Management for engineers

Managing upward

By Brad Dick, radio technical editor

When David came out of Warren's office, it was obvious to the staff that the meeting had not gone well. David was trying to get Warren to approve the purchase of new production equipment for the remote van. David had thought it would be a snap to convince Warren to approve the expenditure. After all, the new equipment would solve many of the problems the station had been having with remote broadcasts.

But, Warren had listened—or seemed to have listened—and then offered some vague reasons why the idea didn't seem feasible. The result was no funding for the project.

"I just don't know how to get through to Warren," said David. "He's on one level, and I'm on another. I can't figure out why he won't approve my projects. There must be a way to get his support for my ideas."

This is a familiar scene faced by many broadcast engineers. Because broadcast engineering is complex and often misunderstood by station managers, they are sometimes unable or unwilling to relate effectively to their technical staffs. Engineers are then frustrated at their inability to obtain the needed support equipment for their stations' technical needs. The resulting frustration can lead to further communication problems and low morale.

Manage your boss

One way to help address this type of problem is by learning to manage your boss. This is something that many managers fail to do. They focus their managerial skills solely on the people who report to them. However, it's just as important for engineers to manage upward.

To many people, the idea of managing their bosses may sound manipulative. However, this process can be restated as a process of consciously working with your superior to obtain the best results for both parties and the organization. For the process to be effective, you need a keen understanding of both yourself and your boss.

Identify career goals

Begin the evaluation process by looking at your responsibilities. How well does your staff support you? Do they need constant supervision, or do they slack off when you're gone? What effect do other departments have on your objectives? Are you a newcomer or an old-timer to the scene? This can make a tremendous difference in the amount of power available to you. Where are the power centers within the company? If you have not yet identified them, it's time to do so.

Take some time to analyze your own work life. What aspirations do you have? Are you happy with the status quo, or do you want to move up the administrative ladder? Would you be willing to relocate? Do you want to relocate?

The key is to develop a plan of what you want from your job. As you begin to look through these and other factors, your own needs should become apparent. Now it's time to look at your supervisor's characteristics.

Status quo

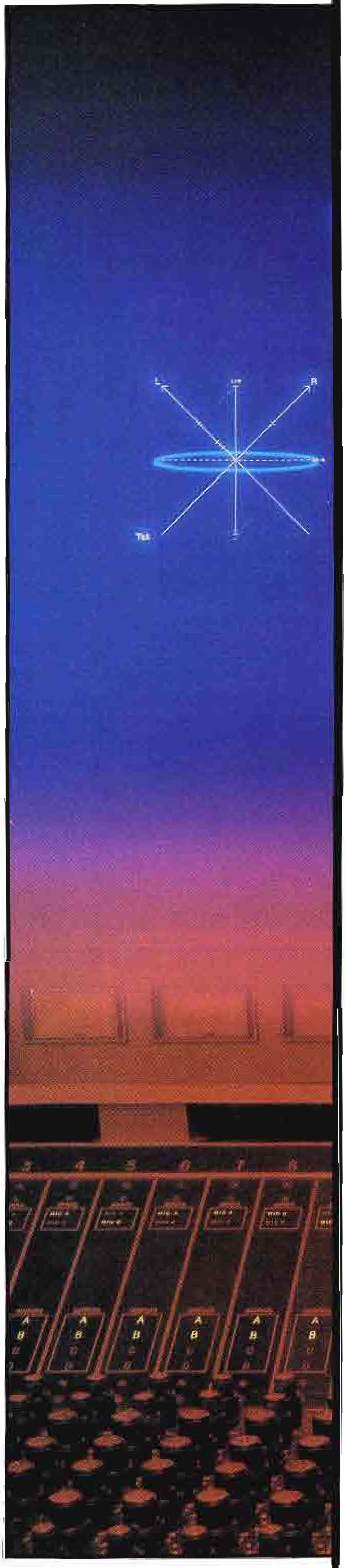
Review, as best as you can, your supervisor's positions with regard to these factors. As you look upward, keep in mind that it is not uncommon for executives to work extremely hard until they reach a certain level. They may then decide to back off and change their work styles. Although they continue to be effective bosses, the desire to advance within the company may not be as great. (This can be a major problem if you have designs on your supervisor's job.)

It's also worthwhile to be sure you understand under what pressures and restrictions your supervisor operates. You may not understand why your boss continually says no to your projects. Closer investigation could indicate that your supervisor does not have the authority to approve them. Even station managers report to someone else, unless they own the station.

PERSONAL AND PREFERENCE FACTORS CHART

TRAIT	YOU	YOUR MANAGER	CONFLICT?
AGE			
RACE			
SEX			
BACKGROUND			
PREFERRED COMMUNICATION METHOD			
REPORT DETAIL LEVEL PREFERRED			
DRESS STYLE			
SENSE OF HUMOR			
RISK TAKER?			
ACCEPTANCE OF CHANGE			
PRESENTATION STYLE			
BEST TIME OF DAY			

Table 1. *Listing your own and your supervisor's personal and preference factors may help identify potential sources of conflict.*



Audio technology update

Broadcasting audio used to be so simple. It didn't require much audio-processing equipment, and seldom used more than four types of audio sources—tape, records, telephone lines and microphones. Not so many years ago, the term "broadcast quality" was the highest tribute that could be paid to a consumer device.

To say that things have changed is an understatement. An audio signal in today's radio or TV station may pass through a dozen or more amplifiers, processors, limiters, equalizers, consoles, distribution amplifiers, STL systems or telephone lines before it reaches the transmitter. Despite the number of "boxes" through which the audio must travel, the quality has improved greatly.

Equipment noise figures in the high 80s, distortion to less than 0.001% and clean output levels up to +24dBu are common. Yes, today's broadcast equipment is far superior to that of the past, but so is the equipment listeners are buying.

Today's consumer equipment provides a degree of performance that may even exceed what comes through the typical broadcast chain. Measure the audio performance of your broadcast system. Then, see how close it comes to the sound from any medium-priced audio or video/TV system. The discrepancy may surprise you.

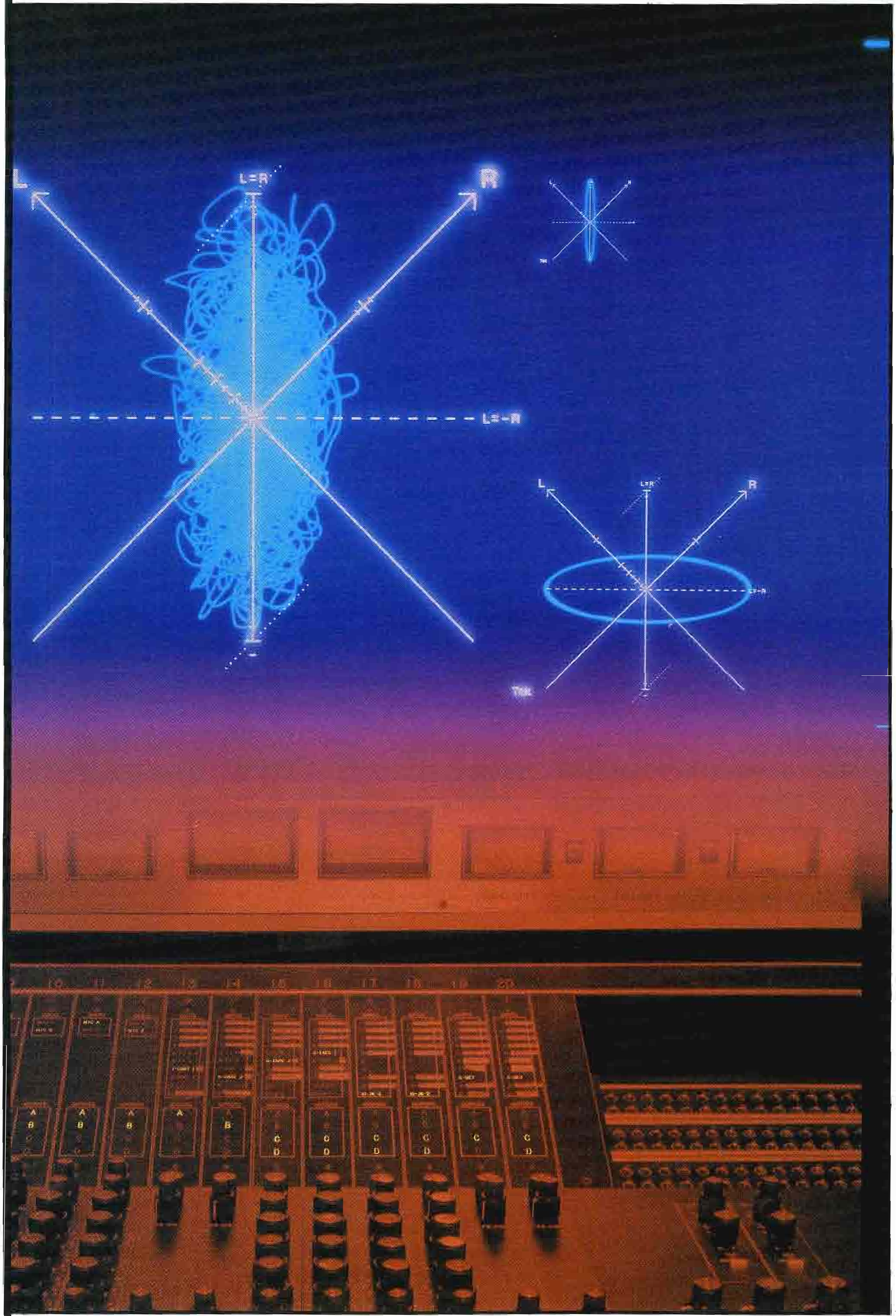
Of course, there are limitations placed on the broadcast system that are not applicable in a closed-circuit environment. But even on a well-engineered station, listeners can hear tape hiss. They often can tell the difference between a CD and an LP. As new technologies become available, stations must make sure their audio broadcast chains are as "transparent" as possible.

To meet the challenge from high-quality CD, satellite and digital sound sources, broadcasters must work continually to "tweak" the last ounce of performance from their systems. The quality-conscious audience can hear it—and expects it. Be honest now. How clean is your audio system? Could it perform better?

The following articles examine techniques to maximize the performance of the broadcast audio chain. Achieving improved performance doesn't always mean replacing equipment. Maybe all you have to do is follow the basics of good engineering practice.

Brad Dick

Brad Dick,
issue editor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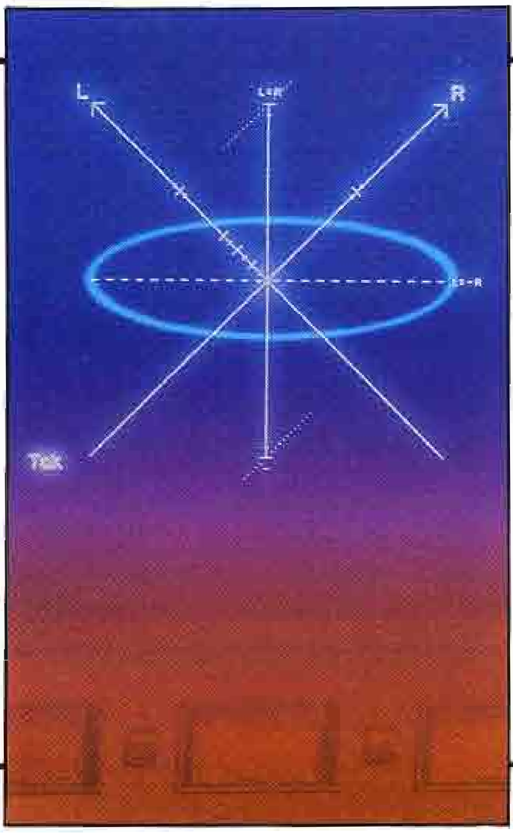


Interconnecting audio equipment

By Cal Perkins

In system interfacing, what works in theory may differ from what works in practice.

If you've never had problems interfacing audio equipment into a system, you've never installed any equipment. When it comes to designing and building today's broadcast studios, theory and practice often go in divergent directions.

A system design may look elegant on paper, yet turn out to be a nightmare when all of the equipment is installed and turned on. That beautifully wired patchbay may contain more hum than a power transformer. The neatly bound cables running along the edge of the rack may look great, but might end up acting like the secondary of a transformer—coupling ac-induced hum into other lines, equipment or even the technical ground. In short, when you're faced with building or remodeling an audio system, theory alone may not help you prevent problems.

Following a signal through the entire system begins with the most commonly used transducer to convert sound to an electrical signal—the microphone—and continues through to the final electrical component—the power amplifier. For purposes of this discussion, disc systems, tape decks, musical instruments and non-mechanical signal-producing components will be considered signal-processing devices.

Any system depends on the following four major elements:

- the components, which include microphones, mixers, signal processors, amplifiers and speakers;
- the component interconnections, cables connectors and wiring methods;
- the physical mounting of the component equipment racks, consoles and road cases; and
- the power company.

Rarely will theoretically correct approaches and cookbook methods yield the desired results, because each group of products has a unique set of interfacing problems by design and by implementation. Products A and B may test perfectly when evaluated on a stand-alone basis; yet when connected to each other, they may hum, buzz, hiss or oscillate.

Perkins is manager of professional audio product engineering, research and development, for Fender Musical Instruments, Brea, CA.

Connecting the microphone

Because the microphone is considered to be a floating source, its shield should be connected to the microphone case and input chassis and nowhere else, unless you want a significant amount of hum and buzz in the system (see Figure 1). However, there are exceptions. Take, for example, the grounded-shell XLR connector, which has an additional shell ground pin that can be connected to the shield. The shell ground provides complete RFI shielding at the connection point where two cables join together. This allows you to serially connect several microphone cables and maintain complete shielding.

The connector shell idea, however, fails when the XLR shells are allowed to come in contact with any grounded metallic fixtures in the building, such as a water pipe or electrical conduit.

Interfacing mic, cable and pre-amp

A microphone's sonic performance is a function of the cable's electrical characteristics and the type of load presented by the pre-amplifier. When you plug microphone A into cable B, which is connected to input C, each component interacts and affects the others.

All microphone cables have stray capacitance between the signal-carrying conductors and between the conductors and shield. The longer the cable, the larger the capacitance. The microphone/cable system formed can have a major influence on the frequency-response performance of the microphone pre-amplifier.

Traditionally, microphone pre-ampli-

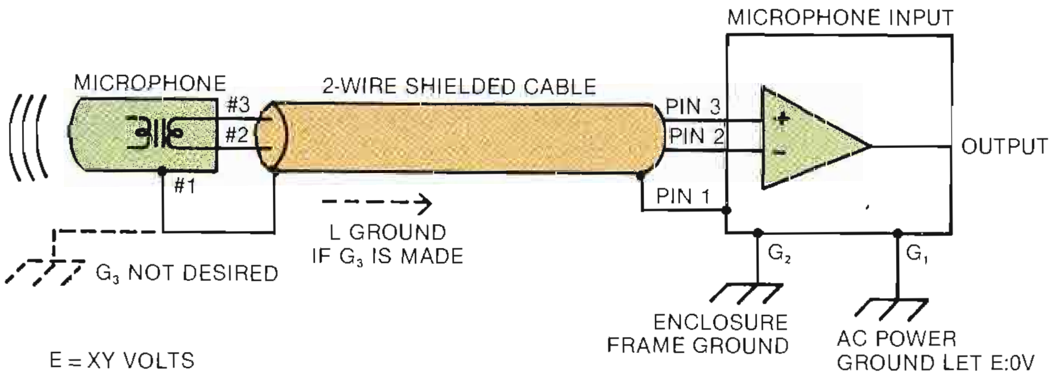
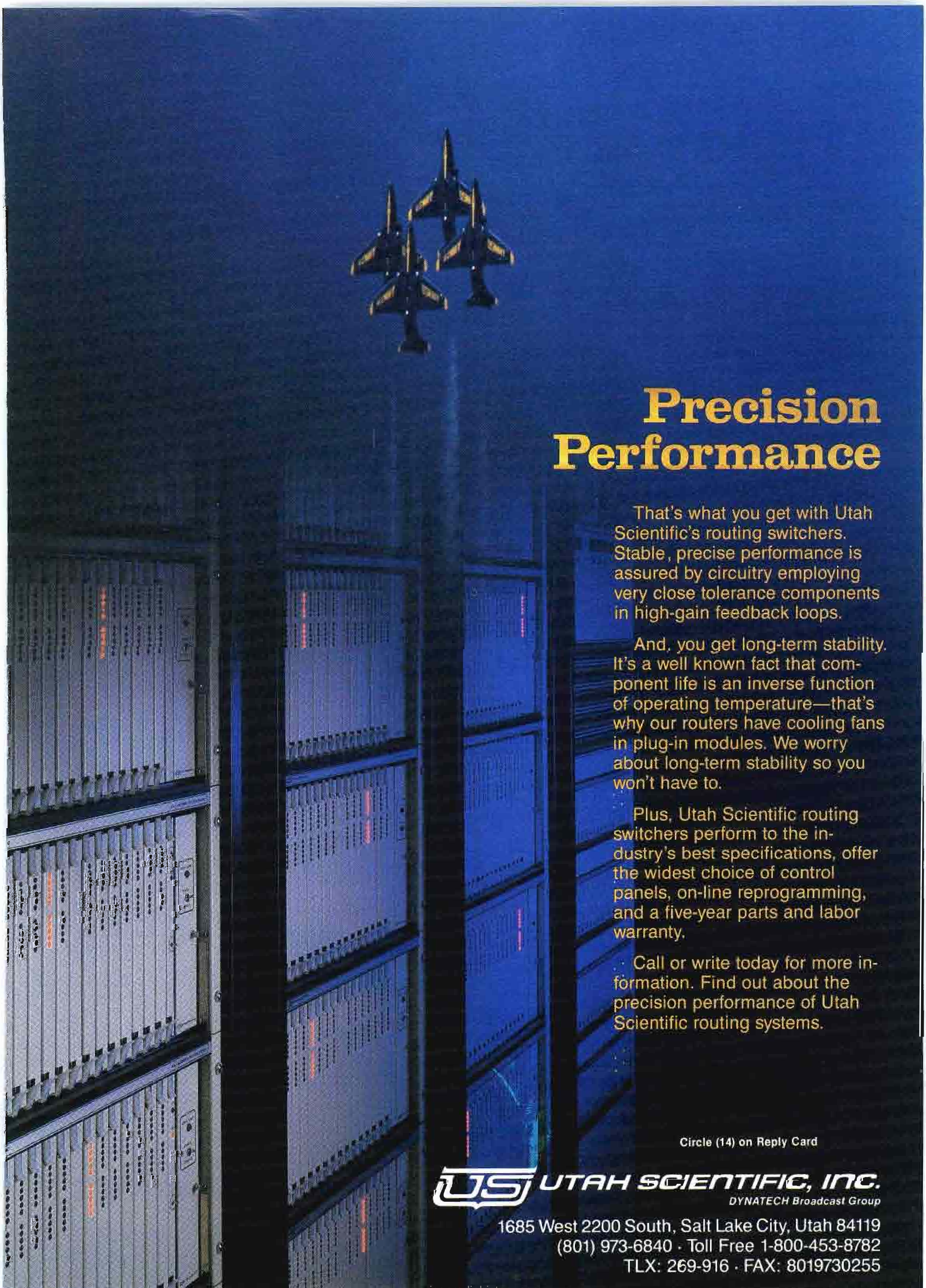


Figure 1. *Interconnections for a floating source such as a microphone. Note that the microphone shield is bonded to the microphone case. It also should be bonded to the microphone input chassis.*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fiers use an input transformer to couple the floating microphone to the amplification stages. Transformerless input stages are becoming popular. (See Figure 2.)

In less expensive equipment, the input transformer generally has a turns ratio of about 1:8 (150Ω to 10kΩ) so that the transformer has voltage gain (18.2dB in this case), and is a better match to the input transistors or ICs for lowest noise performance. When used in the configuration mentioned, the secondary often is not terminated with a 10kΩ load.

Figure 3 shows the effects of three

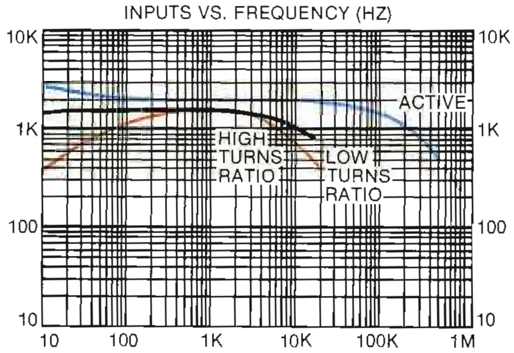

Figure 2. Typical input characteristics of the three most commonly used input-stage circuit realizations.

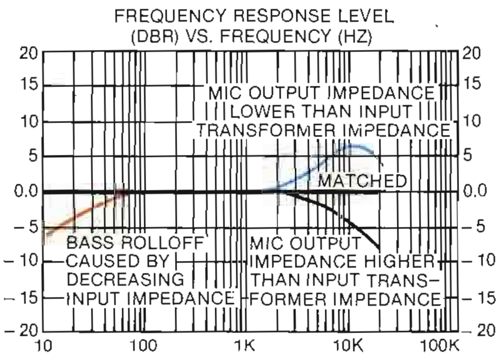

Figure 3. Frequency response of a typical microphone connected to a high turns ratio input transformer as a function of the microphone's output impedance.

source impedances of a microphone on the frequency response of the input transformer. With some microphones, the decreasing input impedance of the transformer at low frequencies also causes a low-frequency rolloff of some microphones. Additionally, the lowered transformer input impedance can cause a considerable increase in distortion, especially with some condenser-type microphones. When the microphone's output impedance is matched to the input transformer specifications, a flatter response often is obtained.

With transformers, you get what you pay for. Cheap transformers create a host of interface problems, most of which are clearly audible. Electronically balanced transformerless circuits eliminate this phenomenon, but they too have performance limitations. Surprisingly, inexpensive electronically balanced transformerless input circuits can show the same increasing distortion at low frequencies, often seen with input transformers. Although active circuits do not exhibit the core saturation problems that transformers do, they are limited in their *common-mode rejection* (CMR) capacity. The CMR is the maximum common-mode signal that can be applied to both inputs.

Clearly, the common-mode signal plus the input signal cannot exceed the input stage's power-supply capacity. For most IC circuits, the power-supply voltage is from ±15Vdc to ±24Vdc, the lower voltage being the most popular. The maximum common-mode signal handling of an input transformer is limited primarily by the insulation resistance of the transformer's wire and, therefore, is (usually) much greater than ±15V.

Component interconnection

Input stage design and proper system ground techniques inside all signal-processing equipment (even consoles) play major roles in determining the final performance of the equipment when integrated into a total system. (See Figure 4.) The unit's susceptibility to external magnetic fields, line-current leakage to the chassis, input stage characteristics, output stage aberrations under load, system-grounding philosophy and susceptibility to RFI often are not specified by the equipment manufacturer.

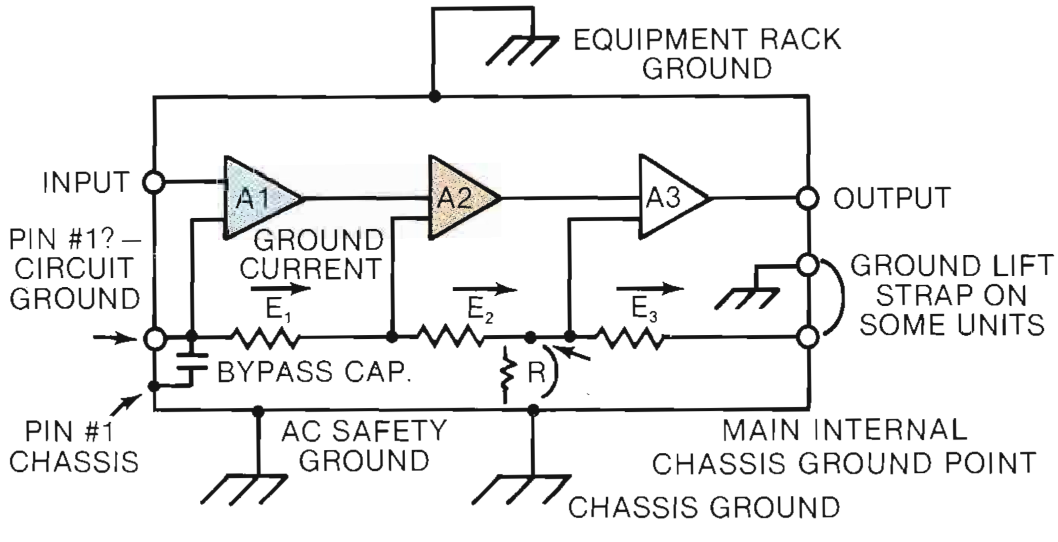

Figure 4. A shield connected to the circuit ground, shield or ground currents (at one end only) will cause the voltage drops e_1, e_2 and e_3, which are amplified by A_2 and A_3. Sometimes a small resistance, R, connects the chassis and the circuit ground, reducing these voltages.

Some products have a mixture of balanced and unbalanced I/O. In some consoles, for example, although the microphone, aux inputs and program outputs might be balanced and/or floating, most of the channel patch points are unbalanced.

Usually, the input device's impedance is greater than 10kΩ. However, what is the input impedance of 10 2-channel units, all connected in parallel, when the manufacturer has shunted the inputs with capacitors of 500pF or more to reduce the RFI problems or to stop the unit from oscillating? These capacitors, totaling 10nF, represent a 795Ω capacitance load at 20kHz connected in parallel with the 1,000Ω combined input impedance. What could this capacitance do to the output performance of the device feeding it? In some cases, plenty.

Output connections

Currently, five generic types of output stages are used:

- the transformer-coupled output (usually floating);
- electronically balanced (circuit-ground center-tap referenced);
- electronic floating;
- single-ended (unbalanced); and
- 3-wire ground current-compensating circuit (which is essentially an unbalanced output).

Each of the various methodologies has its merits in systems operation. Unfortunately, about the only redeeming quality of the simple unbalanced output stage is the lower cost of the unit. The lower component cost often is offset substantially by the inordinate amount of on-site labor costs generated trying to de-hum and de-buzz a system.

One of the least-published specifications is a device's capability to drive the interconnecting cable capacity. Figure 5 demonstrates how an additional 200 feet of standard cable can affect an electronic crossover's performance.

Trace A is the 5kHz square wave response measured at the crossover's output terminal. Trace B is the measured response, again at the output terminal, but with 200 feet of standard broadcast cable attached. In trace C, the response is measured at the end of the unterminated cable. Finally, trace D shows the resulting square wave response at the

Continued on page 30

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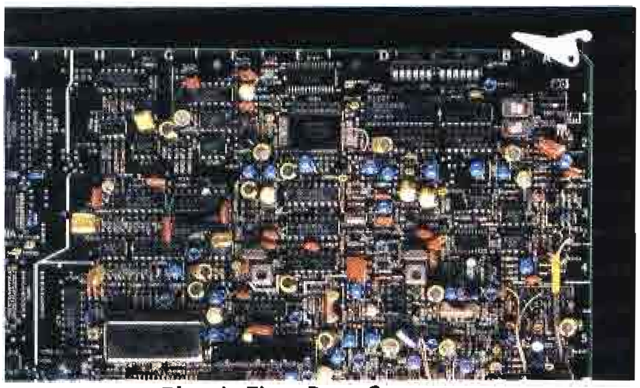
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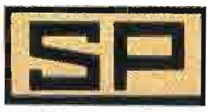

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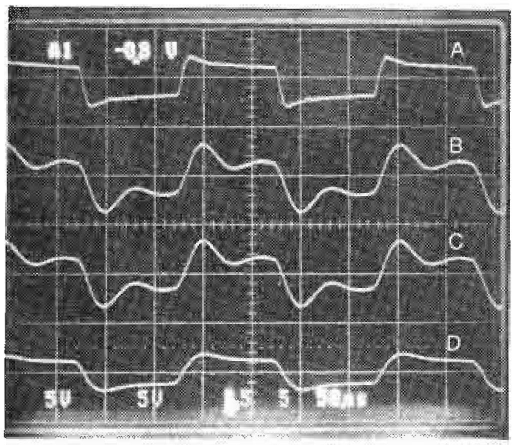

Figure 5. *Square waves showing the effects of cable loading on an electronic crossover.*

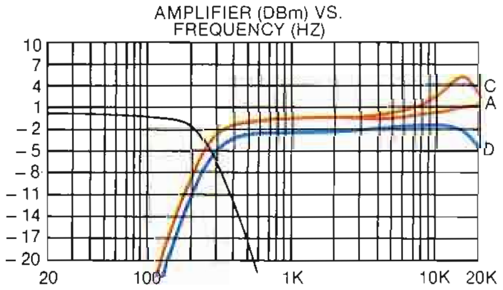

Figure 6. *Swept frequency-response curves showing the effects of cable loading on an electronic crossover. The frequency response in curve C shows that ringing outside the audio band does affect what happens inside the audio band.*

Continued from page 26
end of the cable when terminated in a 600Ω load.

Frequency response also can be affected by the addition of cable to a device's output. In Figure 6, the crossover's frequency response is plotted in the same test conditions listed for Figure 5. Curve A represents the device's response without the cable attached. Curve C represents the response with 200 feet of unterminated cable attached. Curve D shows the crossover's frequency response when connected to 200 feet of cable terminated with a 600Ω load.

This example shows that although a product may have stellar specifications and excellent slew rate when measured on the test bench, the addition of a few hundred feet of cable may seriously degrade its overall performance.

This phenomenon is true especially if the output stage is an integrated circuit. Figure 7 shows what happens when 200 feet of broadcast cable is attached to the IC's output.

Because slew rate is defined as the time rate of change of voltage with respect to time (dv/dt = I/C), if you know both the maximum peak current and the presented capacitance, you can calculate the actual slew rate of the system. The data sheets for a 5532 specify the typical maximum peak output current at 38mA at 25°C. If this theoretical output stage design is required to drive 200 feet of cable with a lumped cable capacitance measured at 0.016μF between the leads for a balanced configuration, the actual calculated slew rate will degenerate from the specified 8Vμ/s to just 2Vμ/s. So much for data sheet numbers when you're working in the real world.

The power company

Common to all of the components used in a system is the ac power line. Regardless of how simple or how complex the system is, attempt to keep all the building machinery motors, appliances, ballasts and lights off the audio-video ac service. When using 3-phase power, try to keep all of the signal-processing equipment connected to the same phase, thus minimizing the amount of 60Hz leakage current flowing among the various pieces of equipment. This clean audio service often is referred to as *technical power*.

Many times, the technical power service is carried to an extreme when a completely separate audio ground-grid earth electrode subsystem is used to ensure that the technical power is clean and has a good RF ground. In most cases, unfortunately, engineers are handed an ac service after the fact and are left to their own devices to sort things out. If you have any influence on the building wiring, insist that all the ac conduit is steel and not plastic, because steel is a good electromagnetic shield, whereas aluminum and plastic are not.

Make sure that at least two feet separate the power and the signal conduits. The last thing you want is a 500-foot conduit run of ac power and mic lines in plastic conduit located two inches from each other. When designing and/or connecting the power-distribution system, try to think of the system as a simple series circuit where any current flowing will cause a voltage drop between two pieces of equipment. Depending on how the system is grounded, the voltage drop can and does appear as an input signal that is amplified by the downstream system gain and is heard ultimately as hum. (See Figure 8.)

A star or unipoint ground system, shown in Figure 9, prevents the ground currents from adding up, as they do in the serial ground system. To function properly, the common ground point should not be excessively long, but rather, be a proper ground bus located in the power-service panel.

Grounding, shielding and safety

Equipment interconnection inevitably brings up the subject of grounding and shielding. The term grounding, when ap-

Pin No. 1, where are you?

Compounding and confounding the grounding issue are the various ways in which equipment manufacturers internally ground their equipment. For a shield to be functional, it should be connected directly to the chassis at the output or input port, depending on the system wiring configuration. Pin No. 1 and the phone jack sleeve in a balanced system, logically, are then tied to the chassis.

But what happens when the equipment uses a 2-wire unbalanced connector in which, unfortunately, the shield is often the signal return? Should the shield (sleeve on a phone plug) be allowed to float from the chassis or be grounded to the chassis?

For unbalanced systems it is best to use a 2-wire scheme in which the ground connection is made via one of the internal wires, and the shield is bonded to the chassis at one end only. Floating the shield from a direct connection to the chassis can eliminate ground loops, but the shield becomes an effective antenna for transmitting RF energy inside the chassis (where, according to Murphy's Law, the RF always is detected at the wrong time).

Floating phone plugs on consoles almost guarantees that the patches will hum and buzz, because the shield currents modulate the console's audio grounds. For example, a 0.063-inch-wide trace of 1-foot-long, 2-ounce copper has a resistance of 0.045Ω. A shield current of only 0.1mA can create a signal of 104.7dBv. A 32-channel console's summing amplifier will increase this signal by 20log (32+1), plus the gain after the summing amplifier (typically, +10dB). What was quiet at −95dB is now degraded to −64dB at the output of the console.

Some equipment manufacturers float the entire circuitry on the enclosure and depend on a chassis ground strap to tie the shields to the chassis. In most cases, however, the PC board resistance between the shield's grounds is quite high; rarely do you find the necessary RF bypass capacitor connected directly at the shield ground to the chassis.

One popular technique commonly used by power amplifier manufacturers, because of the large currents present inside the chassis, is that of raising the ground of the RCA or phone jack connector a few ohms above the chassis. By referencing the unit's small signal internal grounds to this point, ground loop currents are dropped across the resistor and appear as a common-mode input signal. Any fault currents, however, will smoke the resistor—at the wrong time.

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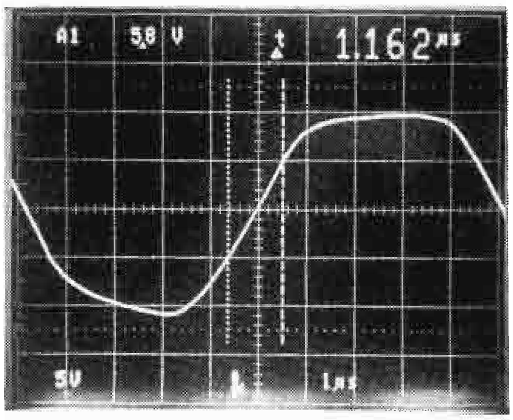

Figure 7. Loading the output of an IC with 200 feet of cable results in a 16.9nF capacitive load. This type of load can drastically affect the IC's actual performance.

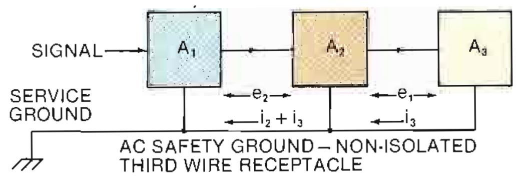

Figure 8. Serial ground implementation. Equipment-leakage currents flowing in the safety ground create small potential differences among the equipment. Amplifier A_2 multiplies the ground current by its gain.

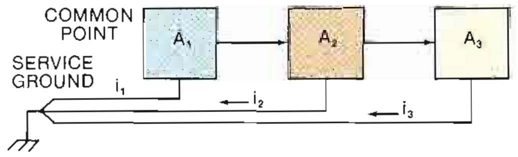

Figure 9. In a star or unipoint ground, with isolated safety ground, the ground currents do not add up because all the grounds are referenced to one point. To function properly, the point cannot be 50 feet long, but should be a proper ground bus in the power-service panel.

plied to audio, often refers loosely to the interconnective wiring and shielding practices used by manufacturers, consultants and contractors. Technically, *ground* is defined as the zero potential point in a system. The trouble is that, in practice, a ground is just as defined: a point with a zero potential that the unfortunate contractor must attempt to find.

A common misconception is that the only way for an audio system to be free from hum and buzz is to secure a good earth ground. Anyone with a portable radio/cassette player knows that this simply is not true. You will have much more success if you view the system's grounds as the signal returns. If you invert the system and call the signal hot outputs/inputs ground, you will quickly observe that the new system hot wire has far more going on than you previously thought.

In the United States and in Europe, a third-wire safety ground wire is commonly employed to connect the chassis to the building or service ground. Any leakage currents from any components in the chassis are, presumably, shunted harmlessly to ground, rather than through you.

It is significant to note that the commonly used 0.01μFd line bypass capacitor can contribute as much as 452μA of leakage current to the chassis in addition to whatever leakage current is caused by the power transformer's winding capacitance leakage to the core. In practice, only a few microamps of leakage current are necessary to cause an audible hum and buzz, as shown in Figure 10.

From a safety standpoint, never lift the third-wire safety ground and depend on the signal wiring for fault protection. You may be in for an expensive surprise. A considerable amount of equipment in the marketplace has pin No. 1 of the XLR connector (shield) and the sleeve of the phone plugs connected to the circuit ground rather than to the chassis. The circuit ground is then often tied to the chassis at the power supply. If a fault occurs in another component that also is improperly safety grounded, then the full 120Vac potential may return to chassis via the internal printed circuit boards, destroying everything in its path. (See the related story, "Pin No. 1, Where Are You?" on page 30.)

The third-wire safety ground plays havoc with any type of rational system interconnection involving any type of unbalanced input/output, because the safety ground is a secondary and/or tertiary signal return. If you want to avoid grief, avoid unbalanced I/O. Regardless of the many claims, there are almost always problems with large multiple-patched unbalanced I/O systems.

This leads us to the concept of the unipotential or single-point *technical ground* in which all the signals are, in theory, referenced to a single low-impedance ground, as shown in Figure 11. In theory, all shields and equipment chassis grounds should be connected to the technical ground, which is supposed to be clean.

If the system is large and complex, then the technical ground should be at a much lower impedance than all the other grounds. However, with typical leakage currents and typical system gains, the technical ground rapidly can approach the dimension of a copper 2'x4', not a piece of No. 4 wire, if the system is to function properly. The inclusion of the technical ground can almost guarantee that you will have ground loops, because now the system has the following ground returns: technical ground, safety ground, physical rack-frame ground and signal

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grounds in the equipment that may or may not be chassis-referenced.

Additionally, if the shields are to be effective near power lines, they need to be terminated at the component chassis, not several feet away at the technical-ground terminal block. For the technical-ground concept to work, all the safety grounds must be returned to the main service via isolated U-ground receptacles, where they join the technical ground. Independent safety-ground isolation should keep some leakage currents from flowing in the technical ground.

For every type of interconnection rule, there is an exception, especially if the system has a large variety of balanced, floating and unbalanced equipment I/O all showing up on patchbays. In the case of an unbalanced output connected to an unbalanced input, a 2-wire plus shield cable should be used, and the shield should be connected to the zero-signal reference potential at the signal output.

If there is a difference in potential between the two pieces of equipment, however, connecting the heavy-gauge shield at both ends actually may reduce the noise; its resistance is now in parallel with the signal return wire, thus lowering the total resistance. As shown in Figure 12, the larger the difference between E_0 and E_p, the worse the problem will be. To help ensure success, make sure that both units are plugged into the same duplex outlet and that both receptacles are fed from the same phase.

Many times, the unbalanced I/O is a normalized send/receive loop from console to patchbay. Incomplete theory can lead you astray. For instance, an in-between patch point further complicates the issue and requires a slightly different approach.

In general, the shields should connect to the signal ground at the chassis tie point of the signal-source end. The shield should be connected at one point only. High RF areas may require that the receive end of the shielded signal cable be bypassed to the chassis with a 0.01μF ceramic disk capacitor.

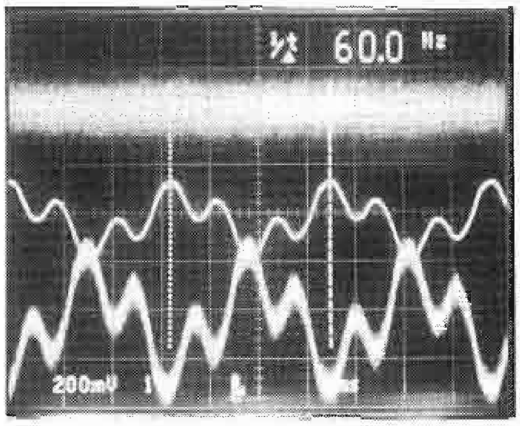


Figure 10. *The top trace is the residual program noise output and measures −88.5dBu. With 1.2mA of ground current flowing (center trace), the output noise floor (bottom trace) rises to −74.5dBu, an increase of 14dB.*

Equipment mounting

The equipment racks sometimes cause interfacing problems. Different amounts of ac line-to-chassis leakage currents in the rack-mounted equipment often can cause a potential of several millivolts from the top to the bottom of the rack. Sometimes, if there are enough line cords all neatly dressed along the length of the rack, the rack can become a good enough transformer core to magnetically couple the ac line into the clean technical ground.

If the equipment has unbalanced I/O, the only way to avoid the rack-induced ground loops may be to totally isolate the equipment from the rack with insulating washers and screws. If you must do this, don't cut the safety ground.

Whatever you do, try not to wire and terminate the entire system at one time. Rather, build the system by terminating equipment progressively and checking the results as you go. As you connect the

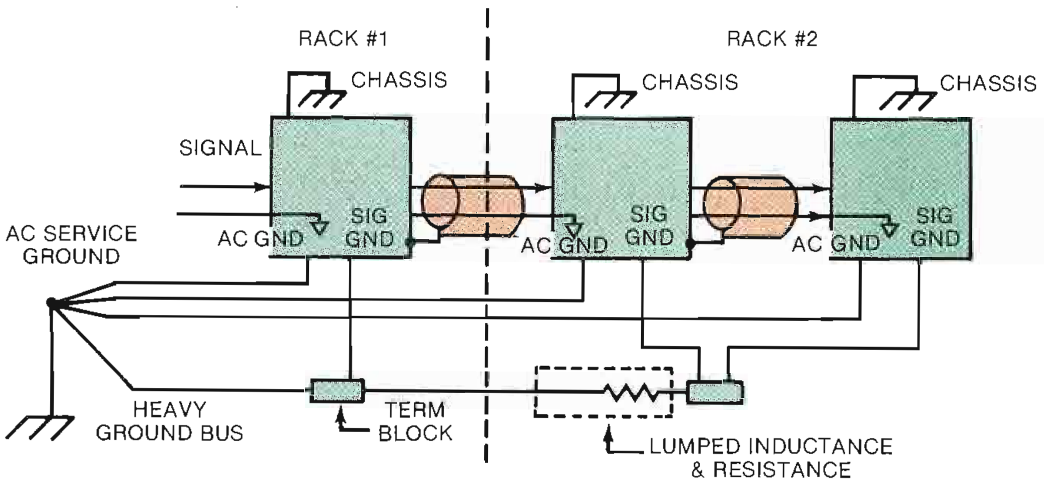
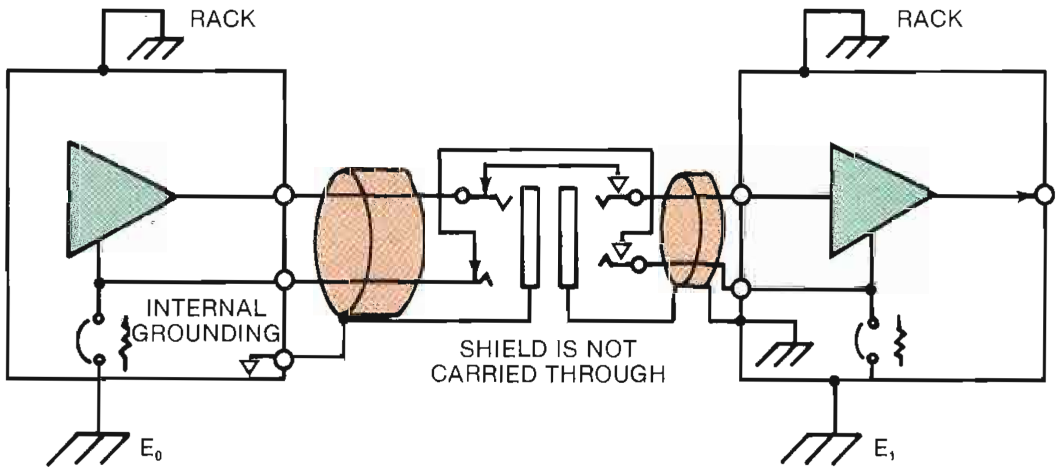


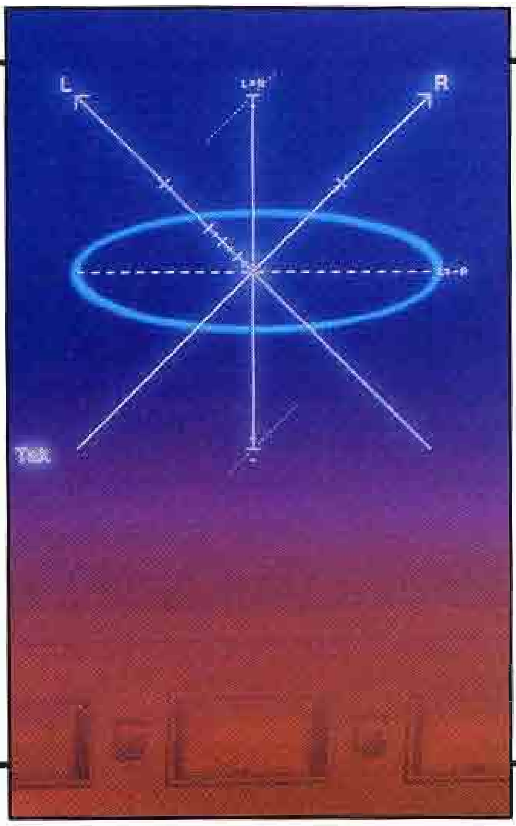
Figure 11. *Concept of a technical ground implemented with a low-impedance ground bus. The theory holds only if the technical ground's actual impedance is considerably below the rest of the signal return paths.*

Figure 12. *Unbalanced I/O through a patchbay. How the grounding is handled inside the units determines the overall result. The larger the difference between* E_1 *and* E_0, *the worse the problem. To ensure success, both units should be plugged into the same duplex outlet, operating from the same phase. Often, the unbalanced I/O is a normalized send/receive loop on a console remote to a patchbay.*



system, all units must be physically installed and turned on. If some of the equipment is off, it is difficult to get an accurate representation of stray equipment fields and power-line perturbations.

Also, test the equipment in as many operational configurations as possible. One test setup may not identify a potential problem. The time to find out that device A will not work properly with device Q is not when you need the combination for the next break or important production work.



Interfacing monitor amplifiers

By Richard C. Cabot, P. E., Ph.D.

A power amplifier's specifications tend to lose importance once the amp is connected to other components.

Amplifier manufacturers would have you believe their units are the ideal black boxes with lots of gain. (This probably explains the basic black cosmetics many of them use.) However, as you know, that isn't true. The equipment that is connected to the amplifiers, and how it is connected, determines the performance of power amplifiers in the real world. This article will explore some of the areas in which system interconnection can affect performance significantly.

If you made a simple model of the black box amplifier, it might look similar to the one shown in Figure 1. The model in the example will produce both linear and non-linear effects, which vary with the devices connected to it. However, it is highly simplified and will include only the effects that will be described here.

The input signal is applied to the terminals on the left. The terminals are shown as if the amplifier is electronically balanced, which is common for professional units. The output signal appears on the right, unbalanced. This is the case except for bridged-mono amplifiers. The power line enters at the top of the box on three leads, including the chassis/safety ground. Let's examine the effects of connecting this model to a real system.

Cabot is vice president and principal engineer at Audio Precision, Beaverton, OR.

Input loading

The input of the amplifier may be viewed as a set of impedances between the input terminals and from each input terminal to ground. With many amplifier designs, the source driving the amplifier sees a different load on each input terminal. This unbalances the lines and creates *common-mode voltage*, the voltage present in phase on each conductor of a balanced line with respect to ground. When many amplifiers are paralleled, the difference could become significant. Because the amplifier responds to the difference between the two voltages, this is not supposed to be a problem.

However, some balanced source circuits misbehave when presented with an unbalanced load. A subtle difference between the behavior of these drivers occurs at large amplitudes. Suppose that the source is delivering 14V peak to the amplifier. Each side of the balanced output would have to produce 7V peak if the load is balanced. However, if the load is unbalanced, one output has to deliver more while the other output delivers less. With a highly unbalanced load, the source clips even though it easily could drive the balanced case.

The amplifier's input capacitance combined with the interconnecting cable causes a rolloff in the high-frequency response by working against the source impedance of the driving device. It also creates an imbalance of the signal on the line at high frequencies if the capacitances are not balanced.

Although most manufacturers specify the performance of amplifiers at rejecting the common-mode voltage (the common-mode rejection ratio, or CMRR), many do not specify the maximum voltage allowed before overload will occur and the amplifier will not be able to reject the signal. This specification is called the *common-mode voltage range*. If this value is exceeded, the input ceases to be linear, even though the signal may be well within the allowable level before

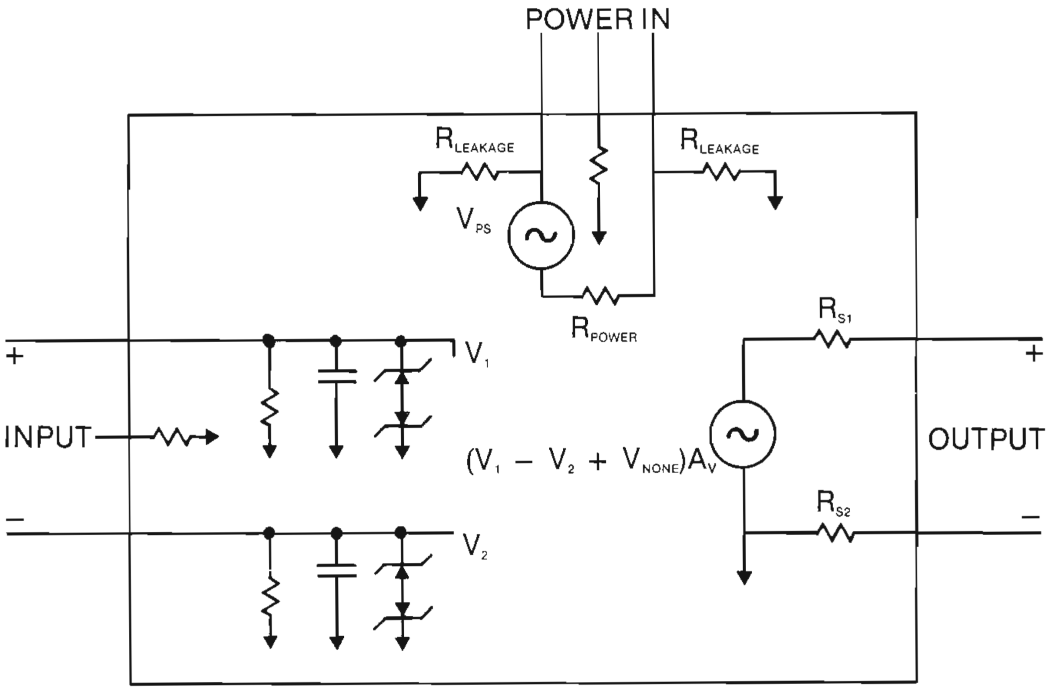


Figure 1. *Inner workings of a basic amplifier that can produce linear and non-linear effects.*

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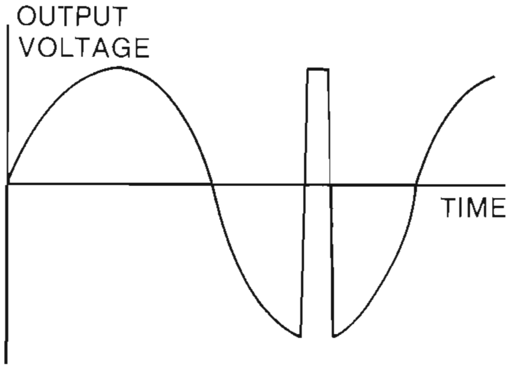


Figure 2. When an amp that uses a Bi-FET op-amp at the input receives too much common-mode voltage, the output reverses itself and swings in the opposite direction.

clipping. If the amplifier and signal source are located far apart or on different power sources, there may be significant common-mode potential between their chassis.

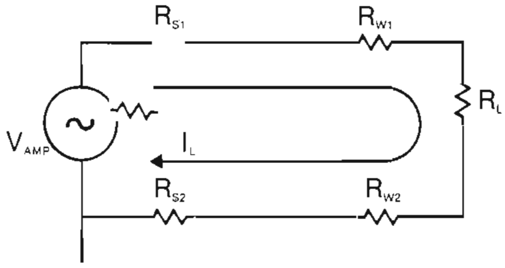
Some amplifiers use an op-amp input buffer circuit to perform a differential to single-ended conversion. The output of this op-amp drives the power-amplifier circuits. Other amplifiers employ a fully differential topology that provides a differential input on the power-amplifier circuit itself. Both approaches can result in a limited common-mode voltage range on the input before the amplifier distorts.

However, the op-amp designs more often exhibit undesirable behavior when this happens. Figure 2 shows the effect of too much common-mode voltage on an amplifier that uses a Bi-FET op-amp at the input. When the signal gets within about 3V of the negative supply, the output reverses itself and swings in the other direction.

Output loading

The output of an ideal amplifier is a voltage source. No matter how much current you draw from it, the voltage should not change. However, because of resistance in the output of the amplifier, the voltage goes down. Figure 3 illustrates this effect. The amplifier output voltage is developed across the internal resistance, the cable resistance and the load. It is a simple matter to calculate the voltage drop in each of these elements by applying Ohm's law (V=IR) to the connection loop. If the load current is known, the voltages are found by multiplying the current and the resistance.

Amplifier output resistance is often specified as a *damping factor* rather than a resistance. Damping factor is the ratio of the load resistance to the amplifier output resistance. This computation assumes a nominal load value and tends to



$$V_L = I_L R_L$$

$$V_{AMP} = I_L(R_{S1} + R_{W1} + R_L + R_{W2} + R_{S2})$$

Figure 3. An example of how the resistance in the output of the amplifier causes a voltage decrease. This voltage drop can be calculated by applying Ohm's law (V=IR) to the connection loop.

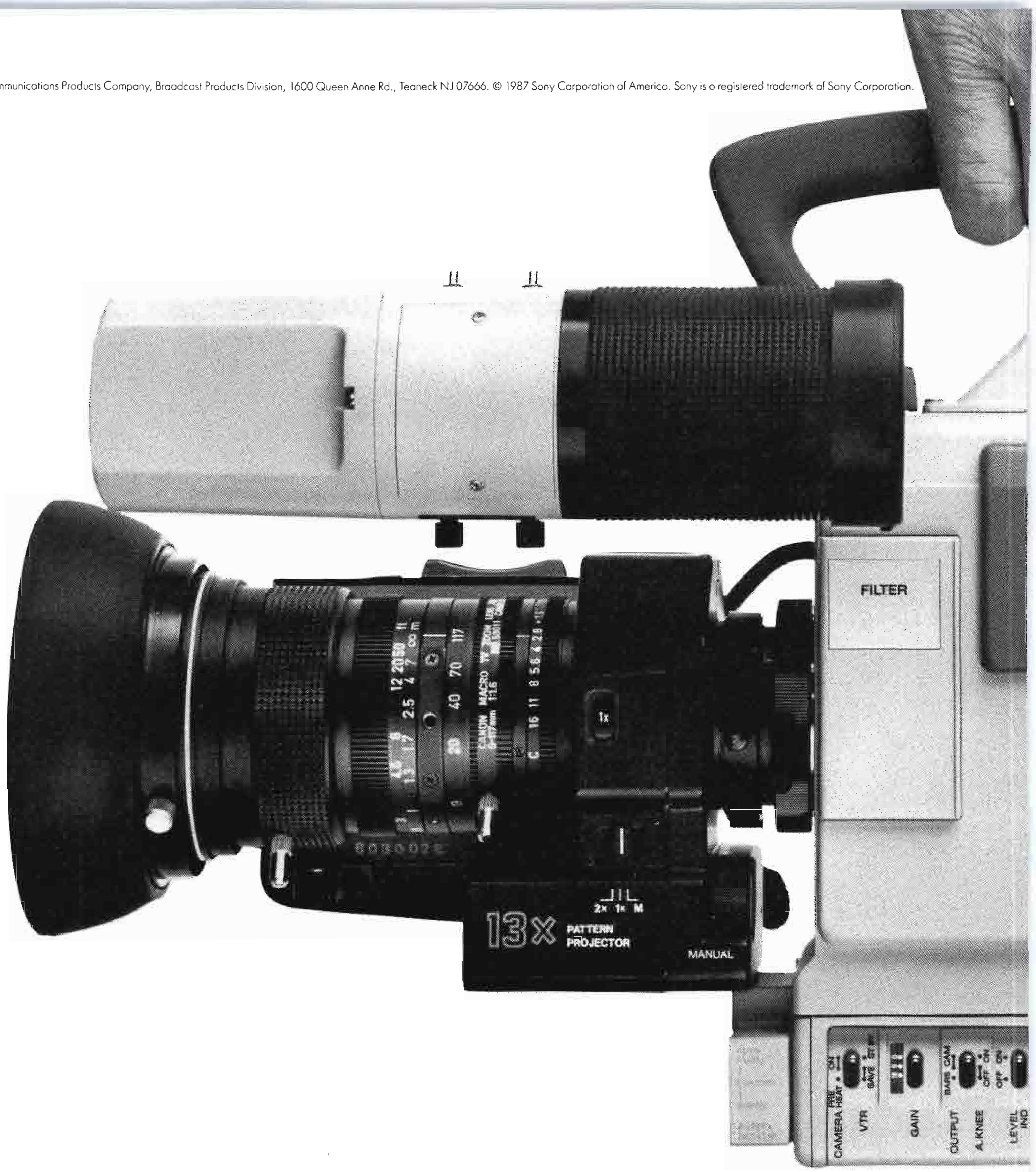
disguise the real information of interest, the output resistance. If you know the damping factor, you can easily recompute the output resistance as:

$$\text{Amplifier output resistance} = \frac{\text{load resistance}}{\text{damping factor}}$$

In typical installations, the amplifier resistance is a negligible part of the power loss before the load. The majority of the power is lost in the wiring.

If long cable runs are required, the cost of wire large enough to keep the power

Continued on page 42



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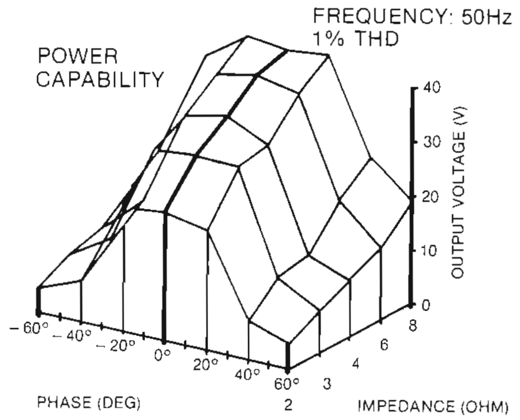

Figure 4. *As the load becomes reactive instead of resistive, the curve tends to drop quickly, generating less output current.*

Continued from page 38

loss down becomes prohibitive. Transformers may then be used to raise the voltage and to lower the current levels in the wire. The lower current levels reduce the voltage drop across the wire.

Most real-life loads that a power amplifier handles (such as a speaker) are reactive as well as resistive. This means that the load looks like a combination of a resistor, an inductor and a capacitor. The impedance changes with frequency, making the current vary with frequency. This also results in a phase shift between the output voltage and the current through the cable.

Two major problems can occur with significant variations in the impedance as a function of frequency. The varying current causes a variation in the voltage drop in the cable. This introduces frequency-response variations that follow the same shape as the impedance curve. At frequencies at which the impedance rises, as happens at resonance, the response rises. When the impedance drops, the response decreases.

For example, if the wire resistance is 10% of the minimum impedance of the speaker, this results in a voltage loss of approximately 10% in the wire. This loss does not occur at resonance or at very high frequencies at which the impedance rises dramatically. There will then be a 1dB variation in response.

The energy storage behavior of inductors and capacitors causes the other effect of a real-life load on an amplifier. When current is developed through an inductor, energy is stored in the magnetic field. When the direction of current flow is changed, which happens every cycle with an ac signal, the stored energy must be removed and the field restored in the opposite direction. For sinusoidal signals, this results in the familiar 90° phase shift between voltage and current through an inductor. Transient signals, such as square waves or pulses, require large current pulses at the same time the polarity reverses because the energy must be withdrawn and replaced fast.

Matti Otala (of TIM fame) has shown that loudspeakers can require current peaks as much as twice those expected from the minimum value of the impedance.[1] In other words, if the speaker impedance dips to 4Ω at some frequency, that current draw on a 40V sine wave at this frequency would be 10A. However, it is possible to devise a pulse waveform that will make the speaker draw 20A at the transitions. This 2-to-1 difference easily can clip an amplifier that was specified into the system based on the 10A value. These worst-case transients aren't likely to happen often, but others that draw substantially more than 10A can be expected.

Worse yet, speaker manufacturers usually quote a nominal impedance value that is sort of the average impedance value over the frequency range of use. Designing a monitoring system with this value can produce even worse overloads than the example cited here.

Most power amplifiers contain limiting

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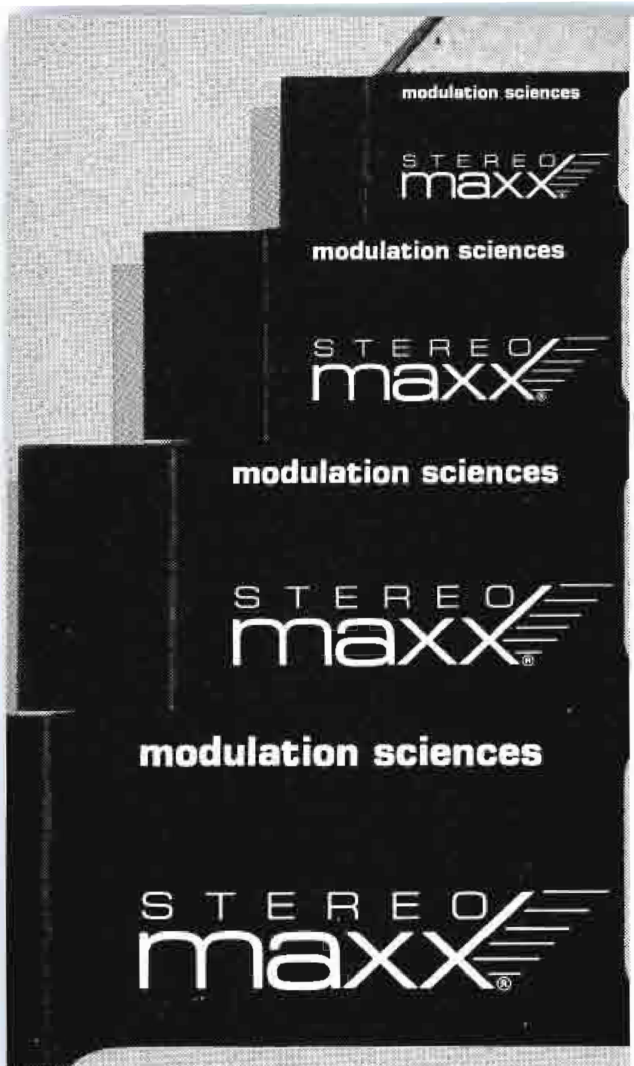

circuits that control the maximum output current. The current limit usually is a function of the phase shift between the current and the output voltage, which limits the output into a reactive load, such as a speaker, to a lower value than can be supplied to a resistor. Because most amplifiers are used to drive speakers, not resistors, this can impact seriously on the system's design.

Figure 4 shows the available output power from a commercial amplifier as a function of the phase angle of the load.[2] The height of the curve down the center indicates the power available into a resistive load. It is quite respectable. However, as the load becomes reactive, the curve drops off quickly. The amplifier can deliver only a fraction of its resistive output current when the load becomes sufficiently reactive.

Power-supply effects

The power feed to an amplifier rack can produce some unusual problems when the system is connected together. The most common problems occur because of leakage currents in the amplifier from power line to ground. These are indicated in the black box models as a pair of capacitors from the power input to chassis. Although current will be returned to ground through the power cord ground lead, the resistance of the ground causes a voltage difference between the chassis and others in the system. If signal ground leads are connected between the amplifier and other devices, some of the current splits and returns through signal grounds. This current can then induce hum in the signal source as it travels through the chassis heading for true ground.

Several amplifiers on the market today have special power supplies called *back-slope regulators, shark-fin regulators* or whatever the marketing department has dreamed up. The basic idea is that a power transformer generates flux in its core based on the voltage applied to the primary. If it is applied only when it is needed to charge the filter capacitor on the secondary, the flux may be reduced and the core can be made smaller. This is accomplished by turning the voltage to the transformer on and off with an SCR at the appropriate time.

The waveform of the applied voltage looks like a shark's fin, hence the name. This design has the side effect of increasing the peak current drawn from the power line. The increased peak current and the menacing-looking voltage waveform can turn a once tame and friendly sine wave power line into a noise generator extraordinaire.

If a rack full of these amplifiers is used in a station, the results can be disastrous. The current peaks will introduce huge voltage drops in the power feed as if something had chewed on the waveform (something did). No matter how carefully filtered the other devices on the power line, they will get jealous and buzz loudly to let everyone know it. A separate power feed for the power amplifiers will be required just to reduce the interference to something manageable.

With shark-fin power-supply amplifiers and conventional designs, the current in the line cord may couple into signal leads through mutual induction. Two wires placed near each other create a small transformer that can couple ac current from one to the other. Although the coupling generally is small, the power-line currents are so large that the result still can be a fairly large hum current.

Attention to proper lead dress can eliminate this problem. Keep power wires away from signal leads, and when they must cross, do so at right angles to each other. Similar problems can occur if the speaker feedlines are routed too close to signal leads. This wiring error can produce crosstalk of one signal into another and, in extreme cases, can cause oscillations by coupling the output of an amplifier back into its input.

Features that can help

Many power amplifiers are now equipped with compressor circuits as standard items. These usually sense clipping in the output stage and reduce the input signal level appropriately. If designed correctly, they can prevent serious clipping of the amplifier. However, most circuits sense only voltage clipping and ignore current limiting, which is merely another form of clipping. Therefore, highly reactive or low-impedance loads still can cause problems. Under no circumstances should the compressor circuit be viewed as overload protection for the speaker driver. Unless the power output of the amplifier is matched exactly to the driver, the compressor circuit will not offer much protection against over-driving the speaker.

In most circumstances, an active differential input on the amplifier is adequate to reject ground noise and induced signals. When this fails, transformers often provide a significant improvement at low frequencies. If the interference is at high frequencies, capacitive imbalance in the transformer windings limits CMRR to the same or worse performance than a high-quality active input.

If line-related interference is suspected, filters can be placed on the power-line inputs of the offending equipment.

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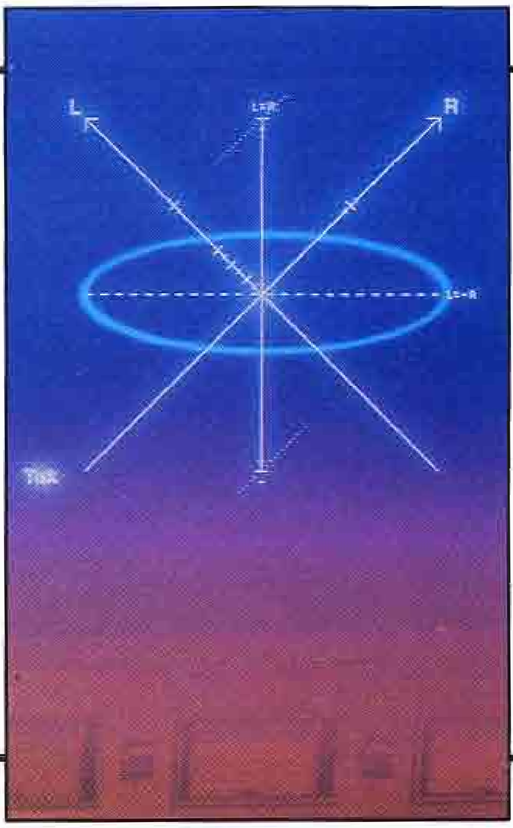

Multidimensional audio for stereo TV

By William Mead

Additional audio channels can enhance the video experience.

In the mid-1970s, a practical, low-cost technique of delivering multidimensional audio was introduced to the theatrical film viewer. The process (known as Dolby Stereo) continues to increase in popularity as motion picture theaters throughout the world convert to the format. Its spatial encoding techniques, used for cinema soundtrack release, have proved to be extremely useful in retaining the multidimensional aspects of soundtracks transferred to consumer distribution mediums such as videotape, optical disc or broadcast. This article will discuss the principles of theatrical stereo and how its techniques can be applied for broadcast stereo television.

Mead is director of special projects, Dolby Laboratories, San Francisco.

For the home video presentation to be enjoyable to both the eye and the ear of the viewer, the sound must relate realistically to its corresponding visual image. The sound and the picture, when properly presented together, bring forth a new and exciting aspect of home entertainment.

Requirements for full-dimensional audio

The quadraphonic systems of the '60s and early '70s were attempts at commercialization of multidimensional audio. Today there is a resurgence of interest in multidimensional audio systems for the home. The difference between yesterday's systems and today's is that the quadraphonic systems were used for music only, but multidimensional audio for video is, by definition, always associated with a visual image. Without the picture, the listener's reference point is lost and the sound mix becomes somewhat arbitrary. The presence of the picture defines in the viewer's mind left and right, and front and back, allowing the sound image to be tailored in a way that adds realism and excitement to the entire presentation. A scene may contain live action that clearly defines a center front, as well as rear—behind the viewer—action. By reproducing the desired soundfield in front of, around and behind the audience, multidimensional audio draws the viewer into the picture.

The number of loudspeakers required varies, depending upon the specific configuration of the playback situation. The goal is to reproduce the soundfield around the viewers in such a way that they are unaware of the number of loudspeakers used and their actual location.

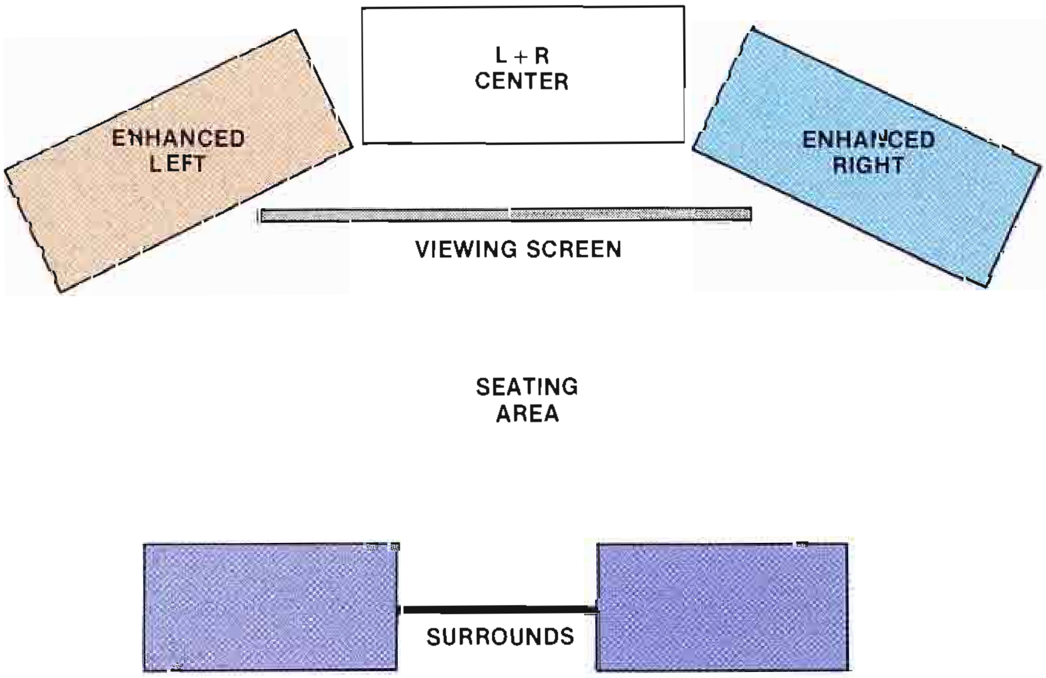

Figure 1. *This typical 4-channel surround-sound environment uses three matched speakers to direct sound across the picture. The center channel allows dialogue to be discretely centered. The fourth channel drives the back speakers (called surrounds) with sound that is not intended to be localized. (Note: not to scale.)*

Practical multidimensional audio systems

Dimensional resolution should be greatest across the front field of view, where the eye can quickly associate point source sounds with specific action on the screen. Less resolution is needed behind the viewer. Depending upon the size of the desired front soundfield and the necessity to localize center-front sounds in the middle of the viewing area, either two or three loudspeakers are required across the front field of view.

The front loudspeakers, when used together, can reproduce point source sounds—dialogue or discrete effects—anywhere across the picture. The loudspeakers at the back, on the other hand, are used to reproduce sounds that are not intended to be localized. Dimensional resolution behind the viewer is

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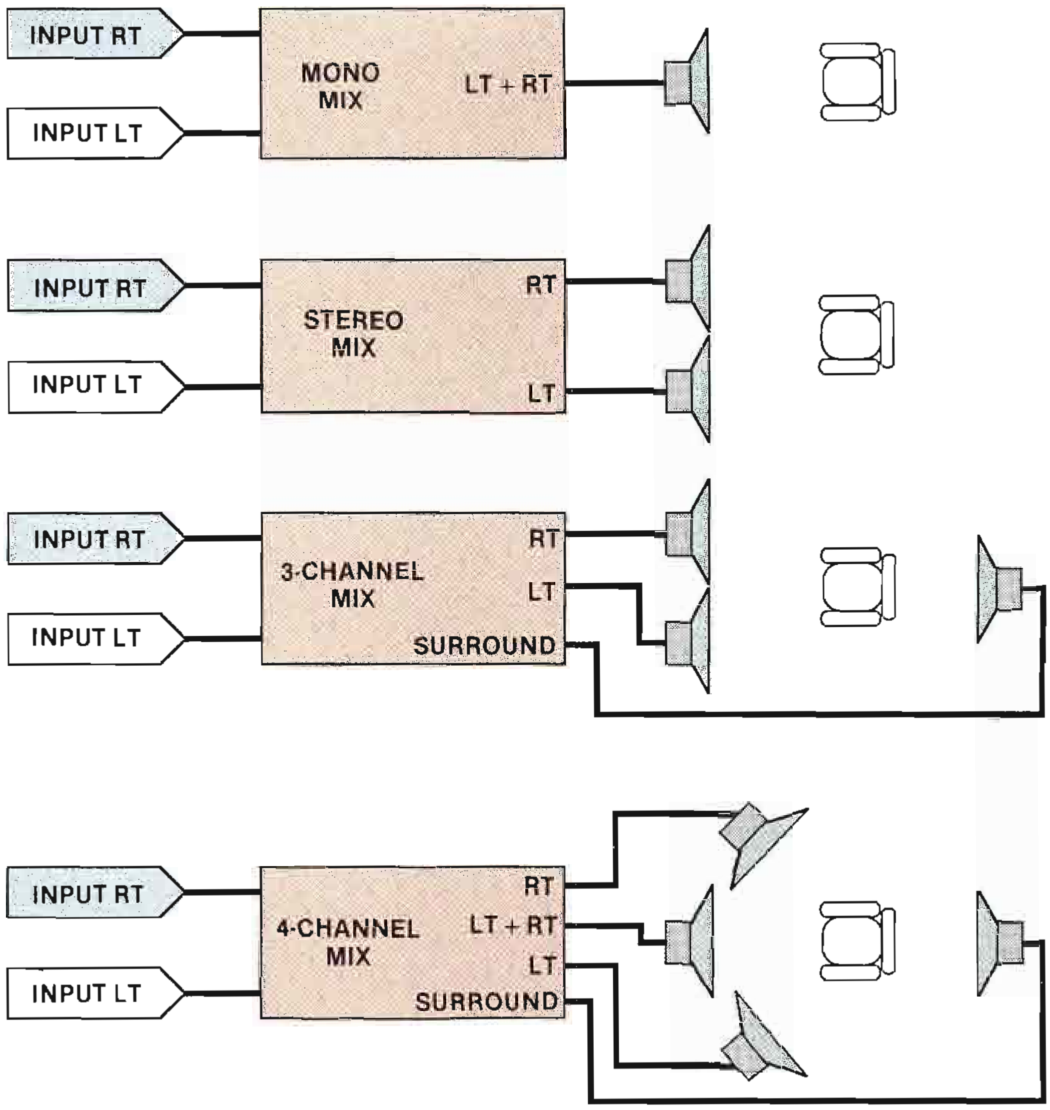

Figure 2. *When stereo audio is mixed for surround-sound effects, it must be monitored carefully for downward compatibility. (Note: not to scale.)*

less critical in creating the feeling of being within the action. A group of spaced loudspeakers called *surrounds* are located around and behind the viewer, as shown in Figure 1. All these speakers reproduce the same information, creating the psychological effect of drawing the viewer into the picture.

It is undesirable to place discrete sounds behind the viewer, because most viewers find point source sounds occurring outside the picture area to be somewhat distracting. However, sounds not intended to localize to a point source—wind, thunder, distant sounds, ambiance, applause and, of course, music—work well to improve the overall presentation when they are used tastefully.

Picture and sound size

How should the size of the sound relate to the size of the picture? In a theatrical presentation, both are more or less fixed, and their relative sizes are roughly matched. In the home, however, the size of the picture is restricted by the viewer's video system and budget. The size of the sound image is determined by how the loudspeakers can be arranged comfortably within the living space. Because the picture may be small when compared with the available sound image, the home viewer is faced with a choice: to reduce the size of the sound image by placing the loudspeakers close to each side of the screen, or to allow the sound to fill the available listening space without regard to picture size. Which choice leads to the most enjoyable presentation?

Although it is easy with today's technology to achieve a high-definition sound image, it is difficult, if not impossible, to deliver a high-definition picture to the viewer's home. Optimizing the size of the sound image within the viewing space can, to some degree, overcome the cramped look of a small picture. The larger-than-life sound image also has the psychological effect of increasing the picture size. For these reasons, it is usually considered unwarranted to compromise the size of the soundfield to match an artificially small picture.

Matrix encoding and decoding

The number of loudspeakers, or reproduced channels, needed for playback vary from system to system depending upon the specific requirements of the playback environment. The num-

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Continued from page 48
ber of distribution channels, on the other hand, are not necessarily a function of any particular listening arrangement.

An important distinction exists between reproduced and distribution channels. Reproduced channels are those heard in the listening room, which are oriented in a fixed and defined directional relationship within the listening area. The number of distribution channels refers to the carrying capacity of the particular delivery system. Most distribution formats, whether for professional or consumer use, have stereo capability. If the stereo channels are treated as intermediate information-carrying channels, full multidimensional audio can be delivered to the viewer through spatial encoding and decoding techniques.

The spatial decoder

The decoding process varies in complexity just as the specific listening environment ranges from the simple to the sophisticated. In general, the decoder can be thought of as a circuit that takes two input channels and produces a number of output signals, each of which is sent to an amplified loudspeaker, or to a group of loudspeakers in the case of the surrounds. The number of input channels is always two, but the number of output channels varies from one to four, depending upon the listener's requirements (see Figure 2).

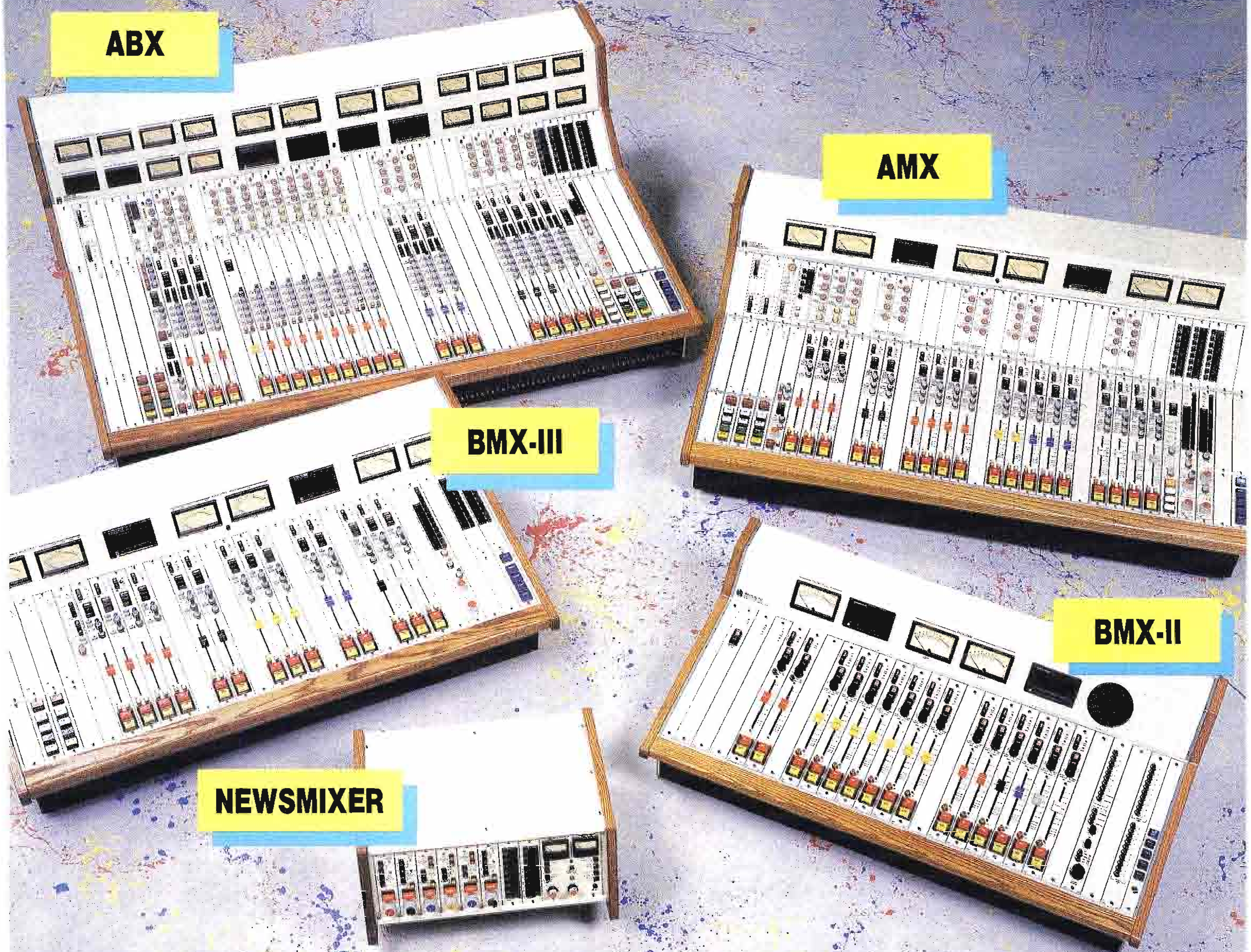
A simple summing network can be thought of as a decoder in its most basic form. The decoder takes the two intermediate channels and produces a single output channel, reproduced ideally in the center of the picture. In monaural, no dimensional information is reproduced, but program content should be retained. By design, the BTSC transmission scheme does not need a mono decoder because the L+R signal is summed in the encoder and transmitted separately.

In its most sophisticated implementation, the spatial decoder generates four output signals that are reproduced in the appropriate areas around the listener. The decoding circuit necessary to reproduce full-dimensional audio is complex, and performs the task known as *directional enhancement*, or steering. The directional-enhancement circuit analyzes the incoming stereo channels, determines their predominant and subdominant directional characteristics, then assigns each in its varying proportion to the output channels. The decoding algorithm relies upon the fact that the playback situation is defined; that is, the directional relationship among the loudspeakers has been established for a particular listening environment. Directional-decoding circuits have evolved to the point at which it is possible, for all practical purposes, to achieve the illusion that the sound is coming from a uniform soundfield surrounding the viewer.

Surround-channel requirements

The processing used on the surround channel requires special consideration because of the physical configurations of cinematic and home listening environments. Usually, the surrounds are physically closer than the front loudspeakers are to the listener, and are located outside the normal viewing area. Their proximity to the listener causes unwanted sounds, particularly dialogue or other on-screen sound effects, to be bothersome if they are reproduced improperly in the back. To counter this, special steps are taken to increase the apparent center-to-back separation. The matrix coefficients are chosen so that center-channel information naturally cancels in the back.

Furthermore, the surround channel is delayed 10ms to 20ms compared with the front channels. This delay is acceptable because of the well-known *Haas ef-*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fect, the principle that the ear tends to disregard the second arrival of an identical sound. Crosstalk information from the back arrives at the ear slightly later than the primary sound from the front and, therefore, is not noticed. An additional noise-reduction circuit is used on the back channel to reduce further any audible interference generated in the transmission or distribution system.

The spatial encoder

The 2-channel distribution material, known as the left total/right total (Lt/Rt) mix, is generated in such a way that the dimensional aspects of the soundfield are retained, but remain compatible with both mono and conventional stereo playback. The encoding coefficients chosen for use with the Lt/Rt distribution format offer the highest degree of decoding compatibility.

The chosen matrix can be considered a natural extension of conventional stereo reproduction and, therefore, leads to optimum results when the two intermediate channels are reproduced without the benefit of the spatial decoder circuit. The encoding coefficients are such that the left and right input channels are carried by the Lt and Rt intermediate channels without alteration. The center input channel is carried, in phase, within both intermediate channels in such a way that a correct phantom center is produced if the two channels are not decoded. Similarly, the surround input is carried in the Lt and Rt channels, but is out of phase, producing a phantom surround if the stereo pair is not decoded.

A precision circuit is used to generate the intermediate Lt/Rt pair from four input channels. This circuit allows the input channels, when decoded, to be more or less assigned as discrete feeds to their respective loudspeakers. In other words, a discrete input can be assigned to the center input and, when the intermediate distribution pair is decoded, reproduced out the center loudspeaker. Similarly, a discrete signal can be assigned to the encoder's surround input and, when decoded, reproduced out of the surround loudspeakers.

Matrix monitoring

The stereo film mix process can be thought of as soundfield synthesis, in which stereo and mono material are combined to form a sound image. The mix is monitored with a full 4-channel matrix decoder and monitor system. The system typically includes three loudspeakers across the picture area and one multiloudspeaker surround channel covering the back listening area.

The 4-2-4 technique, as shown in Figure 3, also is used to monitor the mix. This method requires the use of a processing unit that contains the spatial en-

coder and decoder wired essentially back to back. The unit encodes, or reduces, the four console output channels into the two intermediate Lt/Rt channels, then decodes these back into four output channels that are sent to the monitor loudspeakers. The 2-channel intermediate pair is recorded for distribution or transmission. This 4-2-4 arrangement allows the mixers to hear the results and to make creative judgments about mix content based upon the combined action of the encoder and decoder.

Use of a center loudspeaker puts more directional resolution in front of the viewer, where it is needed, rather than behind the viewer. It is, therefore, impossible to create a sound that moves around in detail behind the viewer. Although this is occasionally a disadvantage to a film, it is not considered to be a practical problem. Furthermore, the matrix process sometimes produces audible side effects from the decoder's dynamic steering process. The sudden occurrence of a dominant signal can cause an audible shift in the placement of subdominant sounds. By monitoring the film mix using the 4-2-4 technique, the rerecording mixer is made aware of any image shifts in real time, and can correct objectionable shifts before the material is released.

Stereo compatibility

In most cases, stereo material that has been mixed and monitored using the 4-2-4 technique sounds better than conventionally produced stereo material when played over two loudspeakers. The multidimensional monitoring system gives the sound engineers an opportunity to build more creative enhancements into the stereo soundtrack than would have been possible with conventional 2-loudspeaker monitoring.

These enhancements, intended for the fully decoded playback, work well in less sophisticated replay situations. For example, with a full multidimensional monitoring system, the sound engineer may use a panpot to move an effect (such as an airplane flying overhead) from center front into the surrounds. When the distribution stereo pair is replayed without the spatial decoder, the front-to-back movements manifest themselves as a phase shift. This takes the sound effect from a phantom center into a diffuse out-of-phase "phantom surround" on the sides, thereby conveying nearly the same feeling of movement. If the same material had been mixed and monitored for conventional 2-speaker playback, the sound engineer probably would not have been able to create the front-to-back movement.

Mono compatibility

Maintaining mono compatibility is an overriding issue for the stereo broadcaster. Mono-summing problems result either from the program material being initially incompatible, or from alteration of normally compatible material during the transmission process. The first problem usually can be solved by using the 4-2-4 technique to monitor the mix at the outset.

The second problem, phase errors in the distribution or transmission process, produces errors just as it does with conventional stereo material. The 4-2-4 process uses phase to carry the directional information; therefore, the 2-channel distribution or transmission system must be phase- and level-stable. This stability is, however, a requirement of any true stereo transmission system because the integrity of the mono, or phantom center image, is likewise affected in any stereo presentation.

Spatial decoders: active and passive

Consumer decoders fall into two general categories. Passive units recover the surround channel by extracting the L – R, or out-of-phase information, from

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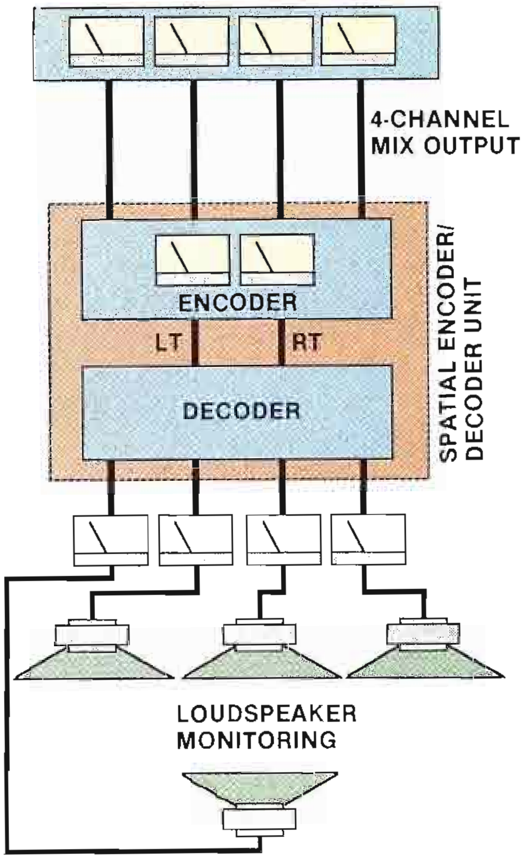

Figure 3. *Surround-sound mixers use the 4-2-4 technique. Instead of directly monitoring the 4-channel output, they encode it to two intermediate channels, then decode it back to four output channels for monitoring the mix.*

the stereo pair. The L – R channel is delayed as necessary for the size of the listening room, then processed with a decoder (modified Dolby B-type), producing the surround output signal. This surround signal, along with the Lt/Rt input signals, is sent to a ganged level control that allows adjustment of the listening level without upsetting the front-to-back balance.

The active decoders contain the same essentials, except that they employ a directional-enhancement circuit to increase the apparent channel-to-channel separation. This circuit produces four output signals (L′ , C′ , R′ , S′) from the input pair (Lt, Rt). These decoders offer a center-channel output; however, most can be used with two front loudspeakers as well. The directional-enhancement circuit is considered essential when a center loudspeaker is used because a simple sum of the stereo pair (Lt + Rt) reproduced as a center channel has a detrimental effect on the apparent width of true stereo material.

Both the active and passive approaches have advantages and disadvantages. The passive decoders are much simpler and, therefore, less expensive. Furthermore, because they contain no processing on the front channels, they produce a stable front soundfield where two front loudspeakers are to be used.

The active decoders, on the other hand, are complex and more expensive. Also, the sophistication of earlier directional-enhancement circuits varied from manufacturer to manufacturer, resulting in audible differences in the stereo image.

Practical applications

A number of limitations with stereo broadcast television can be addressed through the use of multidimensional monitoring. The spatial encoding technique also allows recording engineers to assign specific elements of the sound mix to the back of the listening area. This gives them more creative freedom, resulting in benefits to both stereo and multidimensional systems.

The 4-2-4 technique of monitoring the soundtrack during production also helps the sound engineer know how the mix will sound when it is reproduced in four channels (L, C, R, S), three channels (L, R, S), conventional stereo (Lt, Rt) or mono (Lt + Rt). The versatility of this process is reflected by the compatibility and audio quality of the large number of stereo film titles now available on consumer videotape and optical disc.

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Maintaining TV cameras

By Ned Soseman, TV technical editor

A camera's output reflects the attitudes of staff and management.

How does your station's engineering stack up against the competition's? You can learn a lot by evaluating transmitted video on a good TV set with the sound turned off. If you've ever switched through the TV dial during a Presidential address or PBS auction simulcast that uses a single camera as the source for all video, you've probably observed differences in the pictures from various stations. These discrepancies are a result of different transmission systems, the video- and audio-processing chains and their setup.

Switching among local news broadcasts (when stations are in total control of the live input to the transmitter) also can reveal some interesting differences from station to station. Ignore the on-air personalities, sets, graphics and promotions that define a station's personality, and concentrate on the technical quality of the video pictures themselves. Sure, different camera models and lighting techniques may be used, but most of the noticeable problems, such as bad registration, soft focus and poor color balance, are a direct reflection on the station's engineering maintenance department. Many times, these shortcomings may be the fault of the operator, but in the eyes of management, an engineer should have fixed any problem before it showed up on the air.

How does your station tackle camera maintenance? When a camera breaks, it undoubtedly gets fixed, but who decides when it's time to perform more than a white and black balance? Ideally, a specialized maintenance team follows a regimented weekly maintenance routine for all field cameras, and thoroughly and regularly evaluates the performance of studio cameras. The criteria often used to determine the *need* for camera maintenance, unfortunately, may be how a camera looks on the general manager's TV set, or that a written complaint was made by the news director or operations manager—with copies, of course, to everybody.

There's no question that, pound for pound, broadcast TV cameras are some of the most expensive hardware investments a station can make. They also are the most delicate. They require precision electronics, mechanics and optics to work in unison. Each of these areas is highly vulnerable to environmental influences, from vibration to contamination to heat. Although studio cameras are in a fairly stable environment, field cameras are subjected to environments and contaminants that are usually beyond the control of the user.

This article is not about how to troubleshoot a camera that is down, but rather, how to maintain optimum performance from working cameras and extend the mean time between failures (MTBF). Its scope is not limited to hand-held cameras. However, because they encounter the most rugged use, and outnumber studio cameras at most stations, many of their potential problems are addressed. Most of the information applies to all TV cameras and is generic by design. Refer to manufacturers' service manuals for troubleshooting procedures and details pertaining to specific cameras.

Statistically, 3-tube camera users (including non-broadcast users) should expect a major failure requiring component-level troubleshooting in no more than one out of 20 cameras each year. In the studio, most negative physical influences that affect the MTBF and performance of cameras—such as heat, contamination, humidity and vibration—can be carefully monitored and controlled. In the field, however, station policy might have a greater effect than the environment on the MTBF and performance of a camera.

The responsibility to protect the station's investment in cameras typically is passed by way of the chief engineer directly to a few, specialized maintenance engineers. Unfortunately, maintenance engineers seldom are involved in the determination of station policy.

Exclusive assignment of each photographer (or operator) to the same camera each day is the most effective approach to maintaining control of the operating environment. It instills pride, and typically provides plenty of feedback loaded with clues to help with early discovery of problems and imminent failures.

Some stations use an equipment-pool approach. Although the up-front costs of equipment pooling may be lower, in the final analysis, the overall cost to the station can be higher. The pool system is not effective for maintaining control, and it doesn't generate the sense of pride and respect for equipment that comes with exclusive assignment. Also, it leaves the maintenance engineer with unreliable feedback, and necessitates intensive and thorough routine maintenance procedures and schedules.

Main story continues on page 64

Testing, one, two, three

If you're a camera operator, take this multiple-choice test to evaluate your knowledge.

1.) Cameras are immune to image burn-in when:
a.) the power is off.
b.) the camera is capped.
c.) the camera is not pointed at bright objects.
d.) the auto-iris is working properly.

2.) When changing batteries:
a.) switch the camera to standby.
b.) always cap the lens.
c.) switch the camera power off.
d.) swap as quickly as possible with power on.

3.) When the lens is dirty you should:
a.) breathe on the lens and wipe with a clean facial tissue.
b.) use window cleaner and wipe gently with a soft cotton cloth.
c.) use eyeglass cleaner and tissue.
d.) use an untreated lens tissue with a mixture of alcohol and Freon.

4.) You notice the lens is loose. Tighten by:
a.) using a special tool.
b.) using the posts on the ring for the best grip.
c.) using only the knurled ring until it is finger-tight.
d.) gripping the knurled ring by hand, tightening as much as possible.

5.) Camera lenses with the same lens mount:
a.) may not be interchanged without electronic alignment.
b.) may be interchanged if the f/stop is the same.
c.) may be interchanged only with similar cameras.
d. may be interchanged only if they are the same brand.

6.) If a camera is advertised as rainproof it:
a.) is OK to use in a light rain.
b.) can be used in a downpour.
c.) is impervious to moisture.
d.) should be kept dry because the lens and power source may not be rainproof.

7.) A camera must be left on a tripod in the sun. You should:
a.) turn camera power off when not in use.
b.) keep camera capped when not in use.
c.) wait until the last minute to set up camera.
d.) shade the camera with an umbrella, whether on or off.

8.) Color bars are designed to be used for:
a.) setting up a television for viewing.
b.) marking the beginning of a shot.
c.) engineering evaluation and setup.
d.) recalibrating white balance on playback.

9.) Heat affects:
a.) camera registration.
b.) electronic component life.
c.) pickup device life.
d.) all of the above.

10.) White balance should be performed:
a.) daily, using the filter wheel to set for different lighting conditions.
b.) before each shot, using the predominant source of light on the subject.
c.) each time the camera is powered up.
d.) before leaving the station.

Answers: 1-B, 2-C, 3-D, 4-C, 5-A, 6-D, 7-D, 8-C, 9-D, 10-B

OPERATOR SCORECARD

CORRECT ANSWERS	RATING
10	PROFESSIONAL
9	NEEDS REVIEW
6-8	NEEDS PERSONAL TRAINING
<6	DANGEROUS

Continued from page 60

Protect yourself

Whether in the studio or the field, the experience of photographers, videographers and camera operators must extend beyond simply knowing the location of switches, levers and connectors and which end to look into. Camera users must always respect the cost and fragility of the device, and they must be trained and educated to develop proper care, operation and cleaning habits. It is the engineer's responsibility to ensure that this occurs (see the related stories, "Testing, One, Two, Three" and "Powering Up a Camera").

Ideally, only the maintenance engineer should ever remove a side panel; any operator found using a diddlestick inside a camera should be publicly admonished, if not fired. However, the reality of live TV broadcasting sometimes requires that an operator remove a camera's side panel in the field to replace fuses or to balance multiple cameras without CCUs. Many operators feel the need to carry a few tools for such occasions regardless of station policy or union jurisdictions.

Typically, operators don't understand service manuals, yet some think they are camera experts. A maintenance engineer's nightmare is that these so-called experts will find themselves alone with a camera, a screwdriver set and the idea that they can improve the camera's performance.

It is the engineer's responsibility to identify and defuse potential disaster. When a new camera arrives at your station, first record the serial number and check its operation; then remove the side panels and carefully mark the position of each internal pot. Use a substance such as fingernail polish or coil dope that will shear when adjusted, so the break line can be matched to recall the exact factory setting. A camera has two natural enemies: the environment and the diddlestick.

The main reason 3-tube cameras are sent back to the factory for service is misalignment by users. The No. 2 reason broken cameras are returned is closely related: component failure due to overcurrent conditions (from screwdriver shorts or reverse polarity of the dc power input). Engineers must discourage potential tweakers through effective training and high-profile, routine maintenance.

Operator maintenance

Operators have plenty of opportunities to unwittingly create problems without a screwdriver.

Removal of fingerprints on the lens and viewfinder optics is probably the most common field maintenance task performed by operators. The acid contained in a fingerprint can permanently etch the glass of a lens or reflective surface of a front-coated viewfinder mirror, and should be removed immediately. Use only an *untreated* soft tissue and a mixture of Freon and pure alcohol to clean optical surfaces. Since plastic eyeglasses and lenses have become popular, many suppliers now sell lens-cleaning products that contain silicon. For cleaning the optical surfaces of a camera, do not allow the use of any product that contains silicon.

Teach users some basics regarding the effect of heat on video cameras. The life of electronic components, both solid-state devices and pickup tubes, is inversely proportional to the cumulative amount of heat to which they are exposed. If, for example, a camera must be stored for several hours in the trunk of a car parked in the hot summer sun, it should be packed in its shipping case, which offers a fair amount of thermal insulation. In any event, users must know

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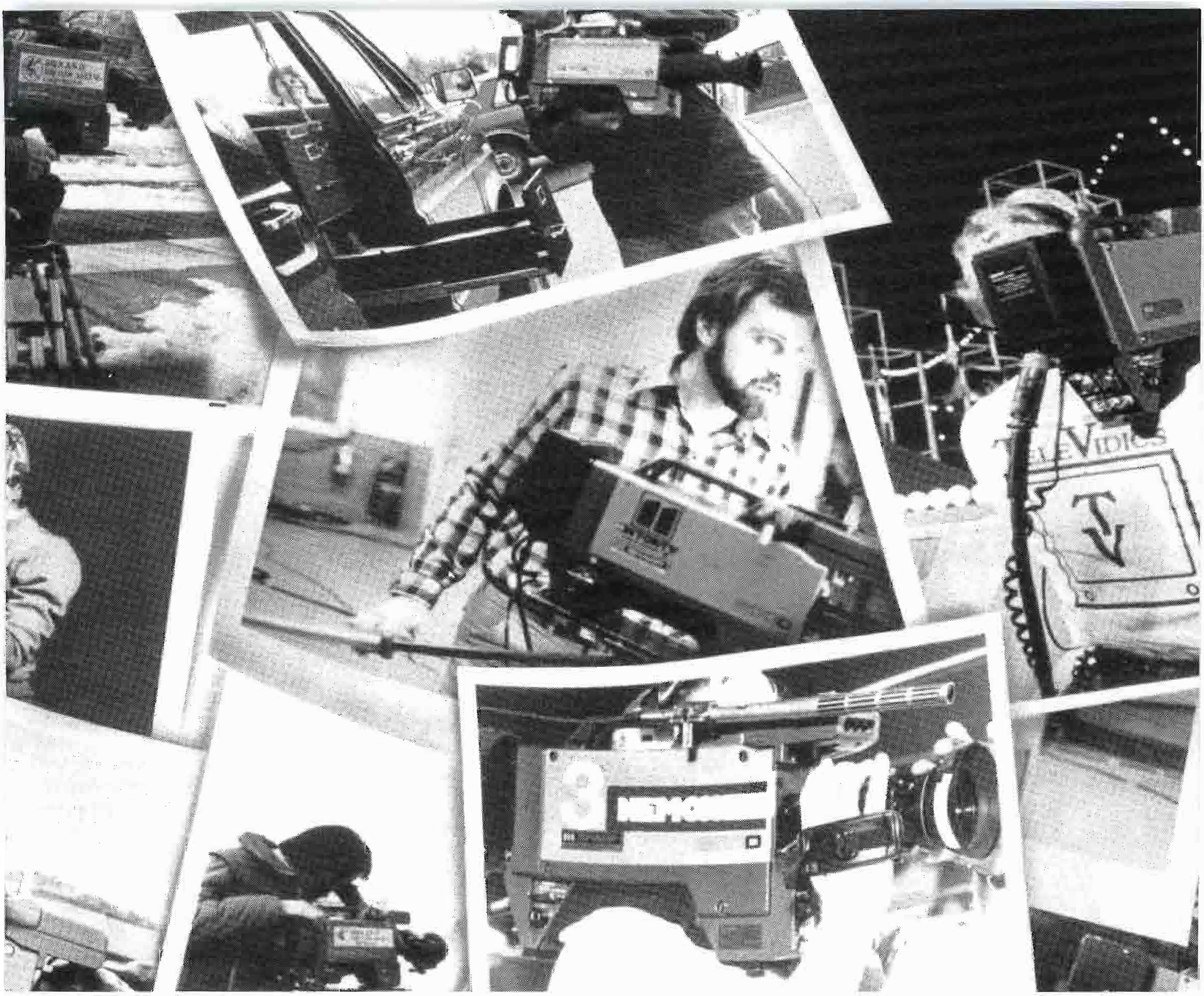

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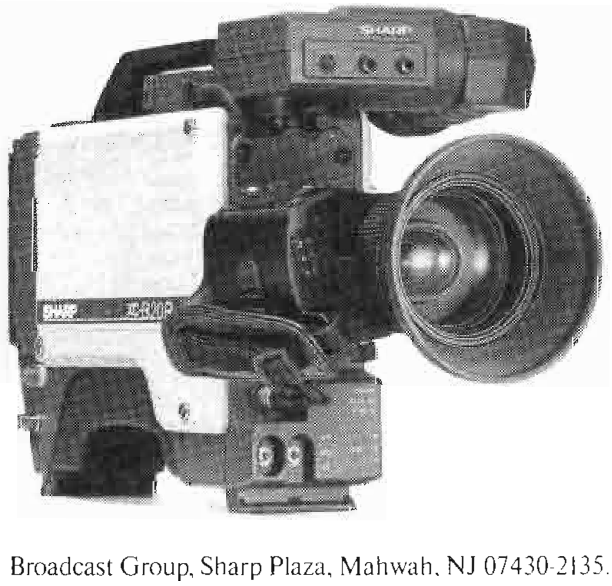

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Continued from page 64

that heat reduces the useful lives of cameras and other electronic devices, whether powered up or down.

Plumbicons, for example, will permanently and cumulatively lose sensitivity due to scan burn-in, which occurs when they are operated at warm temperatures. Invest in an umbrella with a clamp to shade the camera from prolonged exposure to the sun. Because most ENG cameras often are used in low-light situations, maintaining pickup tube sensivity is an important part of their designed function. Keep the camera cool!

Setting up a test bench

The first step in the successful maintenance of cameras is to make available adequate facilities for testing. Mechanical, electronic and optical test devices and fixtures are necessary.

Mechanically, a tripod adapter and a heavy, stable tripod are musts. You also may need extender boards and, possibly, a board extractor. Be sure you have a set of tools, including a set of cross-point (not Phillips) screwdrivers. A true Phillips screwdriver is too pointed and may strip the heads of the soft fasteners used in most cameras. Occasionally you will also hear the cross-point screwdriver called a *plus* screwdriver, as opposed to the *minus* (flat blade) screwdriver.

For electronic and electrical measurements, use a calibrated waveform monitor, vectorscope and dual-trace oscilloscope. For visual observations, use a good high-resolution black-and-white video monitor capable of at least 100 lines more resolution than the camera. Most color video monitors are not useful for making technical measurements, and should be used only for flesh-tone checks. Use a calibrated voltmeter for component-level repairs and troubleshooting.

Optical tests use a resolution chart, ball-pattern chart, registration chart, multiburst chart and Siemens star chart. A gray-scale chart also is required, but not all gray-scale charts are created equal.

The standard EIA logarithmic reflectance *chip chart* is a 9-step carry-over from the image-orthocon days. Most broadcasters still use them. The 9-step chart provides a 20:1 contrast ratio, with 60% reflectance. Most modern cameras and test procedures do not properly track the 9-step log chart, because modern pickup tubes do not respond to its logarithmic progression.

Camera manufacturers use the newer 11-step gray scale with modern cameras. You should too. The 11-step chart contains a 40:1 gray scale with 89% reflectance. Most service manuals specify the 11-step chart for waveforms, test procedures and performance specs.

Besides 29% less reflectance, the EIA chart does not inversely match the gamma curve of cameras as the 11-step chart does. The 11-step chart will provide a true "X" on the output waveform of a properly tuned (and lit) camera. The 9-step chart requires interpolation. Camera sensitivity typically is measured using a calibrated 11-step chart (89% reflectance) lit evenly with 186 footcandles (fc) (2,000 lux) ±4fc of pure 3,200°K light.

Test charts must be lit evenly. A light box with transparent patterns will fulfill the requirement, or you can carefully light reflective charts. Use a spotlight meter to light charts evenly to exactly 186fc (2,000 lux) ±4fc incident uniformity. Obviously, this will require more than one floodlight. To ensure the accuracy of measurements, charts must be shielded from light sources that might affect pure 3,200°K uniformity.

Consistent lighting from setup to setup is equally important. Any lighting irregularity will mislead an engineer who is evaluating performance and/or making electronic adjustments to the camera. It may be difficult to secure the space and budget for a permanent camera maintenance test area, but it is virtually impossible to align cameras accurately or similarly if lighting and charts must be set up each time.

Routine maintenance inspection

How often is often enough? Studio cameras should be checked out thoroughly at least once a month. The frequency of required maintenance increases as a function of the camera's exposure to environments that vary from the benign, vaultlike atmosphere of the studio. When used heavily (field use for more than six hours daily), cameras should be inspected weekly.

Start with a methodical physical inspection of the camera. Beginning with the lens, check for dirt, smudges and scratches on the optics. Inspect the mechanical condition of the focus, zoom and iris rings, and observe the operating condition of the power zoom. Check the auto iris for stickiness. Snug the lens mount, using your fingers on the knurled surface. Do not overtighten. Use the posts for lens removal only. Verify that the lens still has a cap. If you have questions about the lens, ask the lens (not the camera) manufacturer.

Feel the camera body for loose switches, jacks and parts, particularly around the viewfinder. Wipe the body with a mild solution of soap and water, if necessary, and wipe dry with a soft towel.

Remove the side panels and check for loose circuit boards, wires and parts.

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Powering up a camera

This is the recommended power-up sequence for many video cameras. Operators should follow this procedure each time the camera is powered up.

1.) Make sure power switch is off.
2.) Attach power source (battery or ac), mics and VCR.
3.) Check positions of user switches (gain, etc.).
4.) Flip power switch to standby, and wait a few moments.
5.) Flip power switch to bars, and record bars on VCR for 30 seconds.
6.) Point camera away from bright lights and reflections.
7.) Remove cap, and set filter wheel to the proper position for light source.
8.) Inspect lens for dirt, and clean if necessary.
9.) Flip camera switch to operate.
10.) Aim at a clean white card, lit with the light source for the subject; then white/black balance.
11.) Check registration if possible.

Teaching each user about a camera and its correct power-up procedures will extend the operational life of the equipment. A camera should give many years of service if it is operated sensibly and maintained on a routine schedule.

Clean or dust if necessary. Look for any clues indicating that someone has tampered with adjustments.

Turn on the power

Check the master optical backfocus using the Siemens star chart. The star chart does not need to be lit as flatly as those used for electronic measurements and should be about 30 feet from the camera. Adjust master backfocus by zooming in as tightly as possible, then focus, using the focus ring. Then zoom wide and carefully optimize wide-angle focus, using the master backfocus adjustment on the lens. Repeat several times.

Switch the camera's output to color bars, and observe the signal on a waveform monitor and a vectorscope. All vectors should fall within the 2% boxes. Check for I/Q null. Confirm that sync and blanking levels and timing meet FCC specs. If any of these measurements are not within tolerance, refer to the service manual for the adjustment procedure.

Perform a white-and-black balance using a clean, pure-white chart. Frame the resolution chart so the arrows just meet the edges of the underscanned picture. Measure the camera's performance by observing the resolution wedges on an overscanned, high-resolution black-and-white monitor. If the camera meets 90% of its specified resolution, it passes. Check the resolution on each channel for possible tube/pre-amp deficiencies.

Use the 11-step chip chart to check for gamma and shading irregularities. If the output is flat within 5%, it passes. Check clipping, smearing and streaking with the window chart.

Assuming that the 89% reflectance 11-step chip chart is lit at exactly 2,000 lux, observe the iris f/stop setting on the camera. Saticon cameras should iris to f/4.0. Plumbicons should iris at f/4.5. If a full volt of video is not produced at these settings, check the condition of the pickup tubes by capping the camera, switching to the highest gain and observ-

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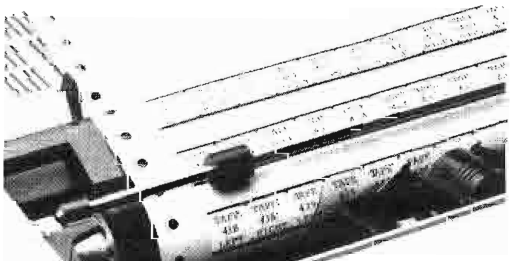

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ing noise on each channel, beginning with red.

Just how much noise is acceptable and at what point tubes need replacement are decisions the station must make. Keep in mind that if your station uses ¾-inch recorders, the best possible recorded signal-to-noise ratio is approximately 49dB. A camera that should produce a 57dB S/N, for example, still would be quite usable at 50dB, unless high gain often is employed.

To check registration, allow the camera to warm up for at least 10 minutes. The prism and optics will change their characteristics slightly during this warm-up period, and can influence the registration measurements. Some cameras provide a special circuit to detect and compensate for temperature changes. Check the operation of this circuit by observing registration from a cold start, after performing a complete registration at operating temperature. When manually registering, switch off detail enhancement circuits before proceeding.

Caveat tweaker

Camera technology has changed rapidly over the past few years. The use of microprocessors has dramatically stabilized camera electronics and eliminated the need for tweaking. Typically, as the tubes age, beam, focus, target, shading, gamma and related circuits need recalibration after approximately 500 hours. In cameras that are not microprocessor-based, more adjustments are needed more often.

Most microprocessor-based broadcast cameras are not simply "brought up to spec" during the manufacturing process. Broadcast cameras are hand-tweaked by engineers at the factory, and again before shipment to the end-user. Because each lens exhibits unique characteristics, cameras ordered with a specific lens usually are hand-tweaked to match the electronics of that particular lens before shipment. Even the best lenses contain slight shading and flare irregularities, which are easily compensated by electronic alignment. When a camera's lens is changed, its alignment becomes invalid. A camera and a lens make up a system, and must be aligned as a system.

Regardless of the type of camera, most circuit-board-mounted trim pots are designed to withstand approximately 200 adjustments. This number is lower if the pot is often returned to its original position after movement.

Inside the camera, pots fall into two categories: edge-mounted controls and board-mounted trim pots. Edge-mounted controls are placed on the outer edge of each board for convenient access. Board-mounted pots are more difficult to access by design. Mark and document the original position of each pot before making any adjustment. Be aware that many camera circuits interact. Adjustment of any pot probably will require adjustments of other circuits downstream. Therefore, don't adjust any pots without a good reason.

Do not adjust any board-mounted trim pots (except for shading and deflection) unless a component has been replaced. Never adjust power-supply voltages unless they are grossly out of tolerance. Tweaking power-supply voltages upsets the balance of almost every electronic adjustment inside the camera.

Service manuals

Service manuals are not training manuals. There are three ways to learn about broadcast video cameras: trial and error, factory service schools and thorough one-on-one training by someone who has attended a factory service school. All manufacturers offer factory service training on their camera products. Typically, service manuals are a supplement to formal training, not a sub-

stitute for it. Using the service manual as the only source of information for camera alignment invites trouble and usually results in misalignment. Although a camera may be tweaked to look better under a certain set of circumstances, uneducated tweaking probably will degrade overall camera performance.

Many manuals are difficult to follow and need occasional translation. They are written with certain assumptions about the reader that vary from camera to camera. Procedures that may appear to be step by step may be based on the assumption that you know how to set up conditions to perform the test. A particular test switch that was changed two pages earlier might still be assumed changed. In many instances, detailed instructions are provided for circumstances that are unique to the particular camera, but other vital information might be omitted if the writer considered that information to be common knowledge.

Some procedures may have been written for the manufacturing process and should be considered carefully before you follow them. Ignore phrases such as "center all pots" or "turn pots counterclockwise" unless major components have been replaced.

When using the service manual, never assume it is 100% step by step or 100% correct. Maintenance engineers must apply their own experience and knowledge of cameras to the information provided by the manual. Blindly following a service manual does not guarantee success.

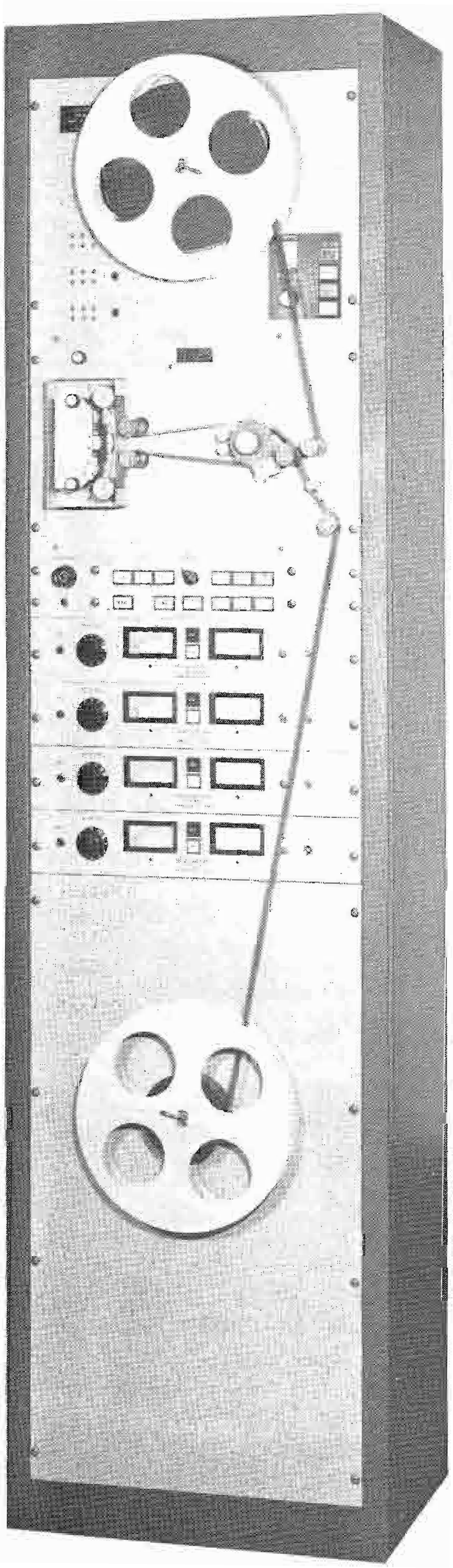
Management's job

It is the maintenance engineer's job to maintain cameras. It is management's job to ensure a good return on investments. Management should realize that there is much more to maintaining cameras than simply relying on an engineer's electronic prowess.

Management must take three steps to ensure a good return on their camera investments. First, operators must be carefully screened, trained and continually retrained under the supervision of maintenance engineers. Second, maintenance engineers must be formally trained and properly equipped. Formal factory training should be included as an integral part of the purchase agreement for each new camera model that is brought into the station. Third, management must support maintenance engineers through open communications, station policy and discipline.

In the final analysis, the MTBF and performance of cameras usually has little to do with the technical skill of the maintenance engineers. It is controlled by station management.

M T E



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Installing acoustic materials

By Peter D'Antonio and John H. Konnert

The introduction of stereo to television and AM radio, the recent advances in 3-D stereo processing and digital master recording, and the emphasis on quality audio-for-video have placed new importance on the acoustic design of recording and broadcast facilities. Of particular interest are the concepts of a reflection-free zone (RFZ) and a diffuse sound field, and how they can be applied to the design of broadcast control rooms, recording studios and announce booths.

It is important to distinguish between noise control and sound control. In noise control, you want to decrease the level of interfering sound. Mass and isolation are the most important techniques in minimizing sound transmission in and out of the studio. To reduce the noise level in a room, broadband and frequency-selective absorption are useful. In sound control or interior acoustic design, you should be concerned with manipulating the room's reflections to enhance music or speech. This material will concentrate on sound control.

Control of reflected sound is important in acoustic design. Three ingredients, absorption, reflection and diffusion, form the basis of a fixed- or variable-acoustic environment. Figure 1 compares temporal and spatial characteristics of the three components, using energy-time curves (ETC) and 2kHz polar patterns, determined with time-delay spectrometry (TDS) methods.

D'Antonio and Konnert are president and vice president, respectively, of RPG Diffusor Systems, Largo, MD.

Of the three acoustic surfaces, absorptive types are the most widely known and used. The terms *acoustical ceiling* and *absorptive ceiling* have become synonymous. Although absorptive surfaces are important, they are only one of three possible acoustic components in a balanced design.

Regarding absorption

An ideal absorptive surface reflects none of the sound incident upon it, regardless of the audio frequency or the angle of incidence (that angle at which sound from a source strikes the surface). Because the reflected energy is negligible, only the incident sound appears in the ETC and no reflected polar pattern is illustrated. (See Figure 1.)

The effectiveness of absorptive material is characterized by its absorption coefficient, or the percentage of incident sound absorbed as a function of frequency. A coefficient of 0.95 at 4kHz indicates a 95% absorption of randomly incident sound at that frequency for a specific material.

For a room to reproduce all frequencies equally, acoustic surface treatments must have broad bandwidth properties. Unless absorption is effective over a broad range of frequencies, acoustic anomalies can color the sound in the room. Thin surface treatments (two inches or less) of porous absorbers, such as fiberglass, sculptured foam and rockwool, are effective down to 500Hz. Below that point their absorption coefficients drop substantially. It is possible to increase low-frequency absorption by increasing the thickness and moving the material away from a boundary surface. Generally, good broadband absorption can be achieved with four inches or more of thickness.

Random incidence absorption coefficients are useful in decay-time calculations, but it also is necessary to determine absorption properties for non-random incidence. In an acoustic design you need to know the absorption coefficients

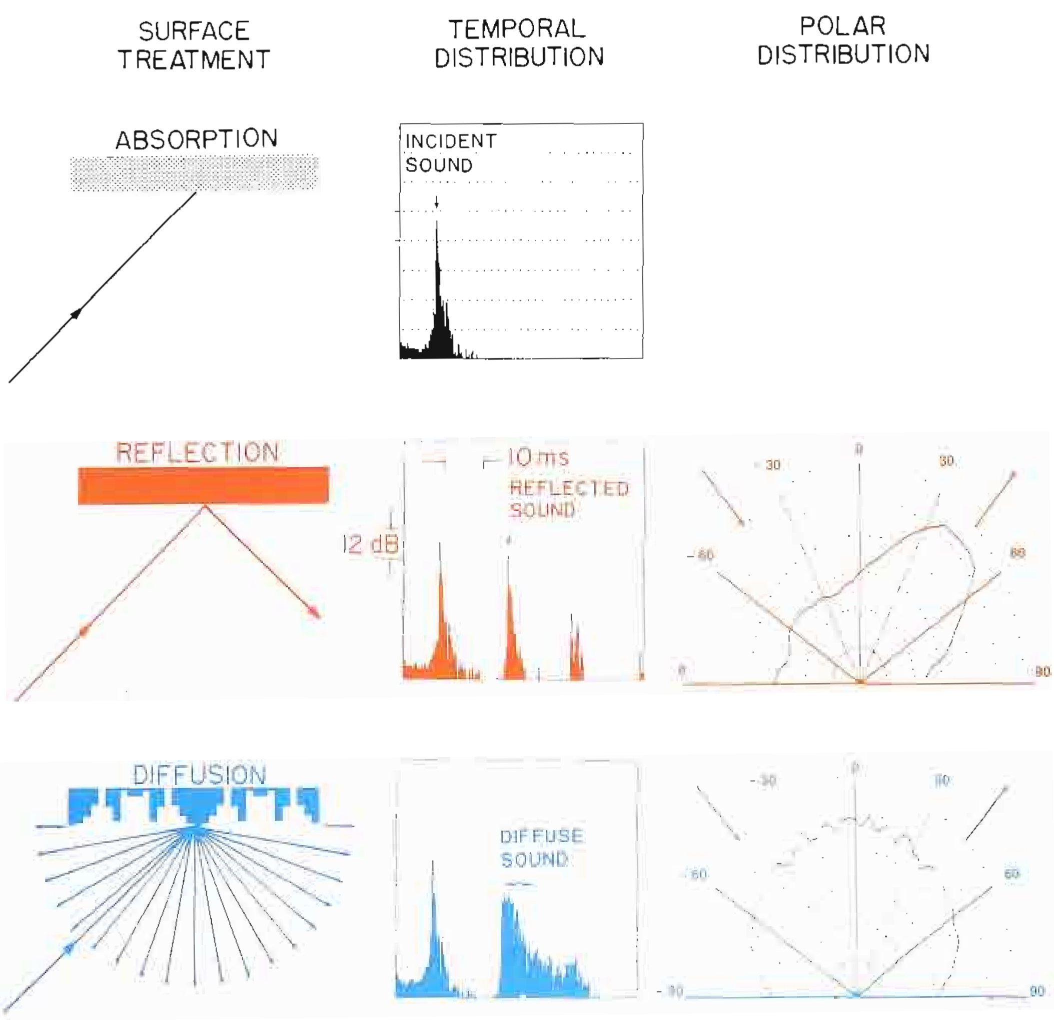

Figure 1. *Comparison of the spatio-temporal properties of absorptive, reflective and diffusive surfaces.*

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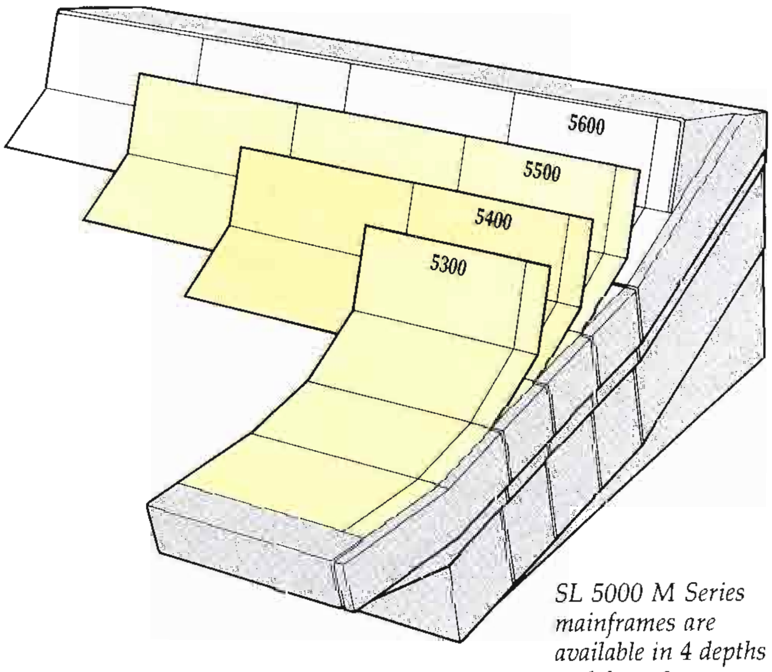

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for particular angles of incidence. At glancing incidence, for example, some absorbers become reflective at certain frequencies. Such information is not readily available, but can be obtained by qualified acoustic consultants using TDS measurements.

Regarding reflection

An ideal reflective surface scatters all incident sound in a specular direction, where the angle of incidence equals the angle of reflection, over a broad frequency bandwidth. A reflective scattering polar pattern is shown in the center row of Figure 1. The angle of incidence (−45°) and reflection (+45°) are indicated by arrows.

The temporal distribution of the incident and reflected sound, separated by 18ms, is illustrated in the ETC. If a reflective surface contains no surface variation, it introduces minimal time spread. Also in Figure 1, the direct and reflected sound are essentially equal in time spread and differ by only 3dB in amplitude.

Because the reflected energy is comparable to that of the incident sound, constructive (additive) and destructive (subtractive) interference occurs when the two combine. This causes frequency coloration called *comb filtering*. The problem can be lessened by decreasing the reflected energy through absorption or diffusion.

Intense specular reflections can degrade stereo images, cause acoustic feedback and produce intelligibility loss. A specular surface, like a flat or curved wall, reflects only those frequencies with wavelengths smaller than the dimensions of the reflecting surface. For example, a 50Hz frequency has a wavelength of 22.6 feet. Broad bandwidth reflection control for low frequencies requires large surfaces.

Regarding diffusion

An ideal diffusive surface distributes incident sound over an appreciable time

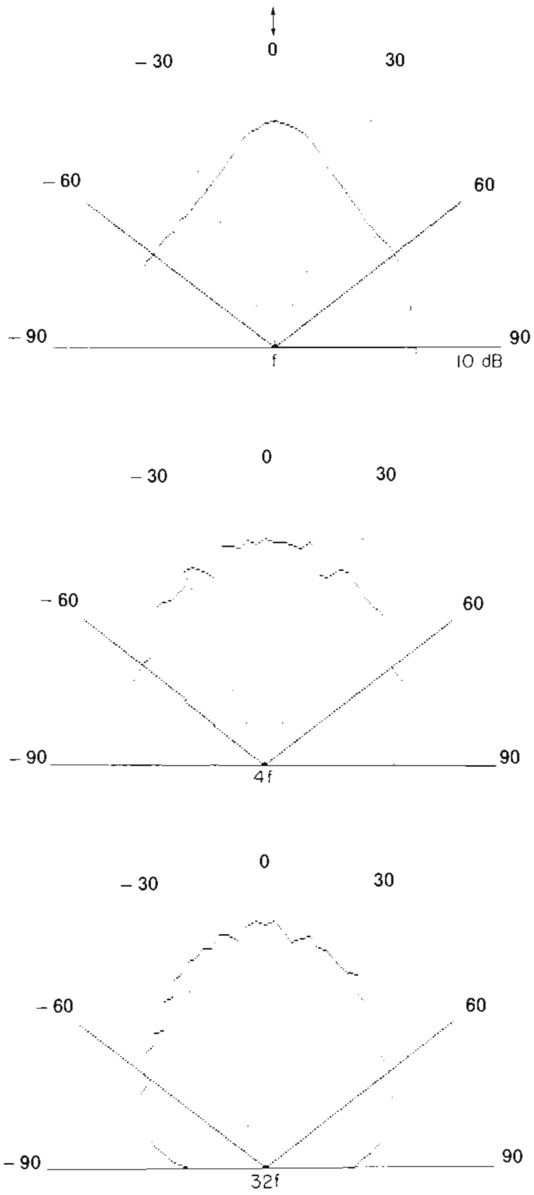

Figure 2. *Octave-averaged polar energy response of a QRD surface shows uniform wide-angle diffusion. The polar patterns at f=250Hz, 4f=1,000Hz and 32f=8,000Hz cover five musical octaves. The black trace indicates 0° incidence; the color trace represents 45°.*

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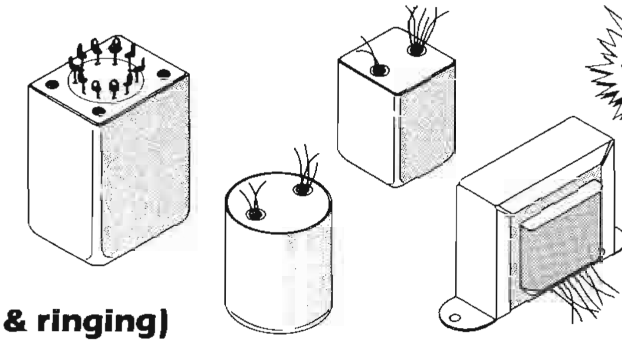

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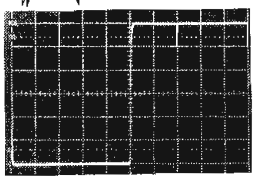

JE-16A
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INPUT TRANSFORMERS AND SPECIAL TYPES

Model	Application	Impedance Ratio Pri-Sec	Turns Ratio Pri:Sec	20Hz Max Input Level[1]	Typical THD Below Saturation (%) 20 Hz / 1 kHz	Frequency Response (dB ref. 1 kHz) 20 Hz / 20 kHz	Band-Width[2] –3 dB @(kHz)	20 kHz Phase Response (degrees)	Over-Shoot (%)	Noise Figure (dB)	Magnetic Shield[4] (dB)	Number of Faraday[4] Shields	Package[5]	PRICES 1-19	PRICES 100-249	PRICES 1000
MICROPHONE INPUT																
JE-16-A JE-16-B	Mic in for 990 opamp	150-600	1:2	+8	0.036/0.003	–0.08/–0.05	230	–8	<1	1.7	–30	1	A=1 B=2	75.42 82.89	49.87 54.81	34.40 37.81
JE-13K7-A JE-13K7-B	Mic in for 990 or I.C.	150-3750	1:5	+8	0.036/0.003	–0.09/–0.21	85	–19	<2	2.3	–30	1	A=1 B=2	75.42 82.89	49.87 54.81	34.40 37.81
* JE-115K-E	Mic in for I.C. opamp	150-15K	1:10	–6	0.170/0.010	–0.50/+0.10	100	–16	<7	1.5	–30	1	3	54.81	36.24	28.39
LINE INPUT																
JE-11P-9	Line in	15K-15K	1:1	+26	0.025/0.003	–0.03/–0.30	52	–28	<3		–30	1	1	122.22	80.82	55.75
JE-11P-1	Line in	15K-15K	1:1	+17	0.045/0.003	–0.03/–0.25	85	–23	<1		–30	1	3	52.32	34.59	27.10
JE-6110K-B JE-6110K-BB	Line in bridging	36K-2200 (10K-600)	4:1	+24	0.005/0.002	–0.02/–0.09	125	–12	<1		–30	1	B=1 BB=2	73.95 85.59	48.90 56.59	35.88 39.04
JE-10KB-C	Line in bridging	30K-1800 (10K-600)	4:1	+19	0.033/0.003	–0.11/–0.08	160	–9	<2		–30	1	3	53.17	35.16	24.53
JE-11SSP-8M	Line in/ repeat coil	600/150-600/150	1:1 split	+22	0.035/0.003	–0.03/–0.00	120	–9	<3.5		–30	1	4	194.63	128.69	88.78
JE-11SSP-6M	Line in/ repeat coil	600/150-600/150	1:1 split	+17	0.035/0.003	–0.25/–0.00	160	–5	<3		–30	1	5	98.39	65.06	44.88
SPECIAL TYPES																
JE-MB-C	2-way[3] mic split	150-150	1:1	+1	0.050/0.003	–0.16/–0.13	100	–12	<1		–30	2	3	44.85	29.65	23.24
JE-MB-D	3-way[3] mic split	150-150-150	1:1:1	+2	0.044/0.003	–0.14/–0.16	100	–12	<1		–30	3	3	76.19	50.37	39.42
JE-MB-E	4-way[3] mic split	150-150-150-150	1:1:1:1	+10	0.050/0.002	–0.10/–1.00	40	–18	<1		–30	4	1	114.40	75.64	52.18
JE-DB-E	Direct box for guitar	20K-150	12:1	+19	0.096/0.005	–0.20/–0.20	80	–18	<1		–30	2	6	54.56	36.07	28.23

1. (dBu) Max input level = 1% THD; dBu = dBv ref. 0.775 V
2. With recommended secondary termination
3. Specifications shown are for max. number of secondaries terminated in 1000 ohm (typical mic preamp)
4. Separate lead supplied for case and for each faraday shield
5. Except as noted, above transformers are cased in 80% nickel mu-metal cans with wire leads.

PACKAGE DIMENSIONS:

	W	L	H
1 =	1 5/16" Diam.		× 1 9/16"
2 =	1 3/16"	× 1 3/16"	× 1 5/8"
3 =	1 1/8" Diam.		× 1 1/16"
4 =	1 1/2"	× 1 3/4"	2 1/2" w/solder terminals
5 =	1 5/8" Diam.		× 1 3/4"
6 =	1 1/8" Diam.		× 15/16"

NICKEL CORE OUTPUT TRANSFORMERS[6]

Model	Construction	Nominal Impedance Ratio Pri-Sec	Turns Ratio Pri:Sec	20 Hz Max Output Level[7] (dBu)	across (n) windings	600 Ω Load Loss (dB)	DC Resistance per Winding	Typical THD Below Saturation (%) 20 Hz / 1 kHz	Frequency Response (dB ref. 1 kHz) 20 Hz / 20 kHz	Band-Width –3 dB @ (kHz)	20 kHz Phase Response (degrees)	Over-Shoot (%)	Package	PRICES 1-19	PRICES 100-249	PRICES 1000
JE-11-BMCF	Bifilar 80% nickel	600-600	1:1	+26	1	–1.1	40 Ω	0.002/0.002	–0.02/–0.00	>10MHz	–0.0	<1[9]	7	81.55	53.92	37.76
JE-11-DMCF	Bifilar 80% nickel	600-600	1:1	+21	1	–1.0	38 Ω	0.004/0.002	–0.02/–0.00	>10MHz	–0.0	<1[9]	8	56.32	37.24	25.69
JE-123-BLCF	Quadfilar	600-600 150-600	1:1 1:2	+32	2	–1.1	20 Ω	0.041/0.003	–0.02/–0.01	>450 170	–1.9 –4.0	<1[8]	7	73.85	43.14	29.76
JE-11SS-DLCF	Bifilar split/split	600-600 150-600	1:1 1:2	+27	2	–1.0	19 Ω	0.065/0.003	–0.02/–0.01	>10MHz 245	–0.0 –2.5	<1[8]	8	53.62	35.45	24.46
JE-11-ELCF	Bifilar	600-600	1:1	+23.5	1	–1.1	40 Ω	0.088/0.003	–0.03/–0.00	>10MHz	–0.0	<1[9]	9	36.36	24.04	16.59
JE-11-FLCF	Bifilar	600-600	1:1	+20.4	1	–1.6	58 Ω	0.114/0.003	–0.03/–0.00	>10MHz	–0.0	<1[9]	10	27.36	18.09	12.48
JE-112-LCF	Quadfilar	600-600 150-600	1:1 1:2	+20.4	2	–1.6	29 Ω	0.114/0.003	–0.03/–0.01	>450 205	–1.2 –3.2	<1[8]	10	32.80	21.69	14.96
JE-123-ALCF	Quadfilar	66.7-600	1:3	+26.5	3	–1.3	8 Ω	0.125/0.003	–0.04/+0.06	190	–4.6	<6[8]	8	50.96	33.69	23.24
JE-11S-LCF	Bifilar w/ split pri.	600-600 150-600	1:1 1:2	+30	1 (sec)	–1.7	63 Ω	0.058/0.002	–0.02/+0.01 –0.02/–0.05	>10MHz 155	+1.1 –4.1	<1[8]	8	50.96	33.69	23.24

6. Multifilar construction has no faraday shield: cannot be used as input transformer. All specifications are for 0 Ω source, 600 Ω load.
7. Max output level = 1% THD; dBu = dBv ref. 0.775 V
8. Source amplifier –3 dB @ 100 kHz
9. Source amplifier –3 dB @ 200 kHz
10. Output transformers are horizontal channel frame type with wire leads, vertical channel frames available. PC types available.

PACKAGE DIMENSIONS:

	W	L	H	Mounting Centers
7 =	1 1/2"	× 2 5/16"	× 1 15/16"	2 13/16"
8 =	1 5/16"	× 1 15/16"	× 1 5/8"	2 3/8"
9 =	1 1/8"	× 1 11/16"	× 1 3/8"	2"
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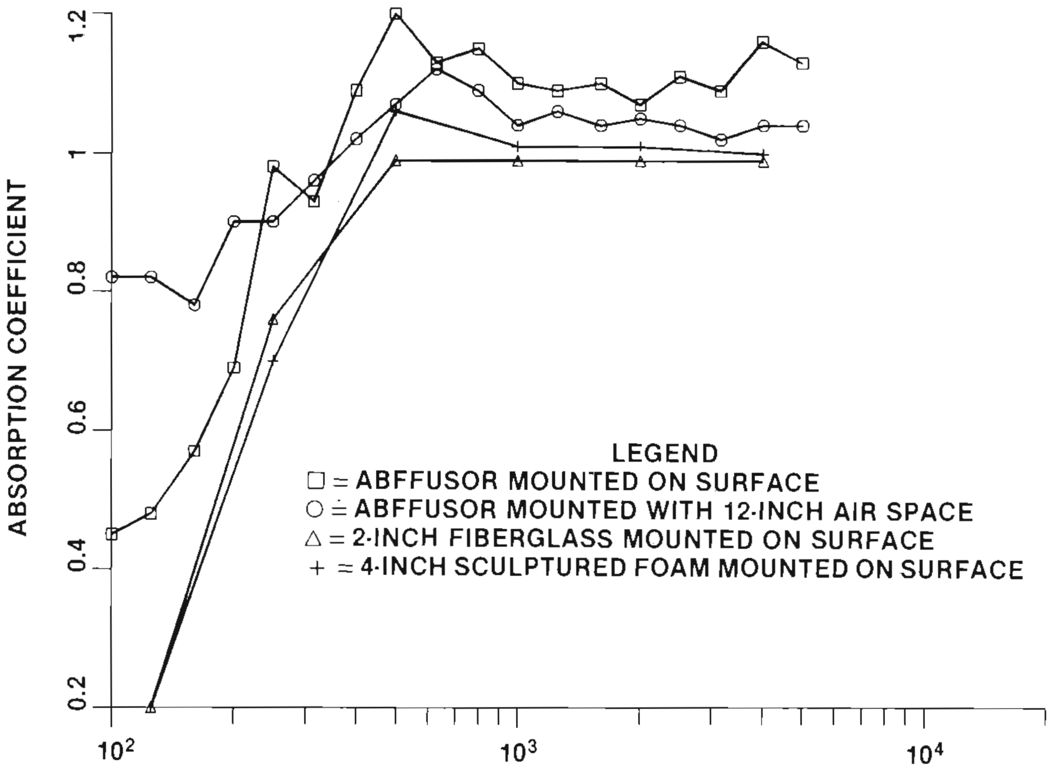


Figure 3. *A comparison of absorptive properties of the ABFFUSOR, two inches of fiberglass and four inches of sculptured foam.*

period and scatters sound arriving from any direction uniformly in all directions over a broad frequency range. The ETC in Figure 1 depicts the temporal distribution of scattered sound, while the polar plot illustrates the uniform wide-angle scattering of nearly 180° for an incidence angle of −45°.

The temporal and spatial distribution properties of a diffusive surface cause a decrease in the back-scattered energy, which reduces the interference when directly and indirectly reflected diffuse sounds combine. The evaluation of a diffusive surface must include the time distribution of reflected energy, the spatial coverage from all angles of incidence and the range of frequencies over which the energy is uniformly scattered.

Miming the ideal

An optimum surface variation that provides ideal diffusion is *reflection phase grating* (RPG). The 1-dimensional RPG consists of a periodic grouping of an array of wells, each separated by thin dividers. They all have equal width, but exhibit a different depth. The depths, determined by number-theory sequences, cause sound arriving from any direction to be scattered in all directions for any desired frequency bandwidth. *Quadratic residue sequences*, attributed to Karl Friedrich Gauss, the 18th century mathematician, are used to design a form of diffusor referred to as a QRD. Diffraction directions for each frequency are determined by the dimension of the repeat unit, with the intensity in any direction depending upon the depth sequence within a period.

An RPG is the acoustic analog of the optical diffraction grating that has been used in optics for more than 100 years. However, surfaces of this nature were not used in architectural acoustics prior to the discovery of the link between number theory to acoustics by Manfred R. Schroeder. The RPG uniformly diffuses reflected sound in much the same manner that frosted glass diffuses transmitted light. In addition to increasing the spatial impression in large rooms and eliminating common acoustic problems, such as flutter and slap echo, resonances and frequency coloration, the uniform distribution of sound improves smaller dead-sounding rooms by psychoacoustically creating an open impression with the natural ambiance of a large room.

Along directional lines

Time distribution of reflected energy is often overlooked. For example, a cylindrical column or an irregular geometric shape provide useful scattering, but they may also produce inappropriately spaced reflections that cause severe frequency-domain anomalies. The RPG provides an optimum temporal distribution, yielding dense, uniformly distributed, irregularly spaced frequency notches characteristic of a truly diffuse sound field.

A vertical, cylindrical surface provides uniform spatial coverage in the horizontal plane, but only at normal (90°) incidence (broadside) and for a restricted frequency range. Vertical wells uniformly diffuse sound into a horizontal hemidisk for any angle of incidence in the horizontal plane. The diffusive surface is capable of uniform wide-angle scattering over five musical octaves. Experimental polar patterns for 0° and 45° angles of incidence are shown in Figure 2. These measurements arose from a systematic study measuring the time, frequency and directivity energy response of sound-diffusing surfaces using a boundary measurement technique based on TDS.

Consider what happens when you combine the number-theory surface variations of the RPG with porous absorption and diaphragmatic panel resonance. The result is a broad audio bandwidth absorber, with NRC=1, for an average absorbing thickness of two inches. The surface variation enables broad bandwidth absorption even when the incident sound arrives at glancing incidence, where absorptive flat panels may show a reflective character at high frequencies.

A plot of the absorption coefficients in Figure 3 for random incidence compares this absorptive/resonant material with fiberglass and sculptured foam. The material improves low-frequency properties of an equivalent thickness of porous material. Note the near-ideal absorptive properties with an absorption coefficient of 0.82 even at 125Hz.

Flexibility of acoustic environments becomes more important when space restrictions and the varied program activities of a facility are considered. In order to achieve a controllable variable acoustic environment, a rotatable triangular column containing diffusive, absorptive and reflective sides is a practical possibility. Such modules can be mounted side-by-side in a linear array. Varied environments are created by selecting appropriate surfaces. These concepts are being put to practical use in a number of installations around the world.

Broadcast facility design

Room dimensions are the first item to be considered for optimum modal frequency distribution. Boundary surfaces are then angled, if possible, for appropriate reflection control, and diffusive surfaces are positioned to create a diffuse sound field. Absorptive surfaces should be added last to control primary boundary reflections and to adjust the decay time. Because absorption has traditionally been the primary acoustic treatment, it sometimes has been overused.

Some acoustic problems, for which absorption has been customarily specified, also can be treated as effectively with diffusion. One example is the control of a flutter or intense specular reflection (slap echo). Absorption minimizes the problem, but energy is removed, with the po-

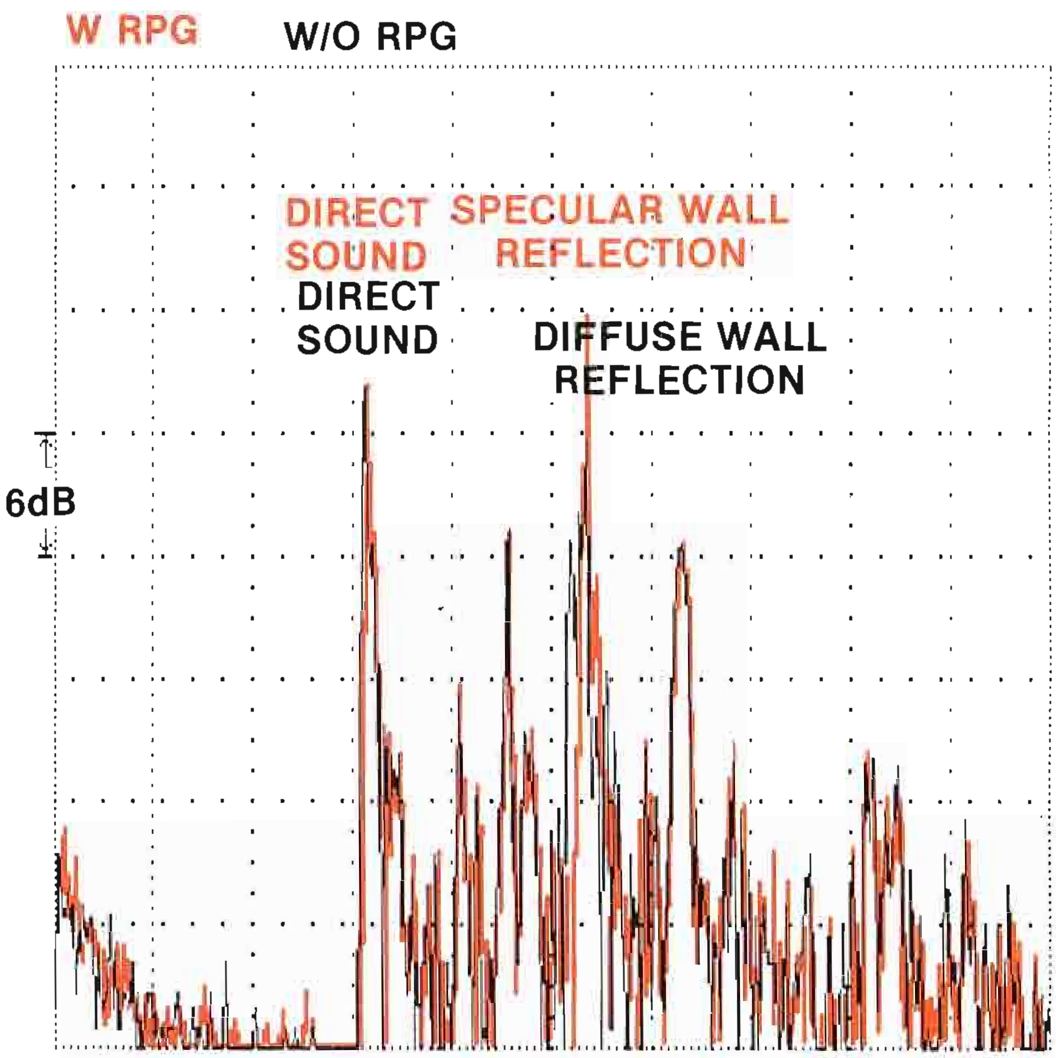


Figure 4. *ETCs illustrate how diffusion can redistribute the energy of an intense specular reflection. The measurements were made with and without RPG diffusors present at a listening position 15 feet from the wall. The energy of the diffuse wall reflections decreases about 6dB because the energy is diffused uniformly into the sound field.*

tential acoustic side effect of a dead space. The broadcast studio credo, *No acoustics are better than bad acoustics,* should not be accepted.

Diffusion can control intense specular reflections without absorption by uniformly scattering the sound so that energy is not concentrated in a single direction. In Figure 4, a 16-square-foot, 8-inch-thick diffusive panel redistributes the energy of an intense echo, removing the problem and maintaining a more natural ambiance.

In the control room

Research has suggested that both live-end, dead-end (LEDE) and conventional designs for broadcast and recording control rooms can be optimized by implementing an RFZ over a wide area surrounding the mix position and creating a dense diffuse sound field having significant lateral components in the room.

The RFZ is achieved by splaying massive speaker boundary surfaces, which can contain distributed broad bandwidth absorption, minimizing boundary reflections at the mix position. The RFZ permits accurate binaural perception of pre-encoded spatial textures over a wide area, while reducing the speaker boundary interference frequency coloration caused by very early reflections. In addition, this design allows the formation of an initial time delay (ITD) gap before the onset of indirect reflected energy.

The diffuse sound field is created with diffusors on the back walls. The creation of an ITD with the RFZ allows indirect energy reflection patterns to be sequenced at any arrival time and directionalized with significant lateral components derived by RPG orientation.

Coupling between specular surfaces on the walls, floor and ceiling and diffusive surfaces is critical in providing a uniformly dense reflection pattern over the decay time of the room. Low-frequency modal response is optimized with low-frequency diffusion and/or absorption.

Figure 5 shows an ETC of a typical small broadcast control room before and after treatment. Reflections in the untreated room (top) are numbered. Reflection 1 is from the floor and 2 is from the ceiling between the speaker and listening position. Reflections 3 through 10 occur from side and back surfaces. After acoustic treatment, the room has near-ideal characteristics.

The RFZ establishes a clean ITD gap 24dB below the direct sound, while the RPGs establish a dense, diffuse exponentially decaying sound field, without any of the late, interfering reflections present before treatment.

Combo production rooms

Properly designed broadcast control rooms also may be useful for open-mic production rooms or talk-show formats, because the diffuse sound field reduces the electroacoustic interference of intense specular reflections. In some instances, a recording control room also serves as a production room, with several live microphones, extending the studio into the control area.

It is important to keep reflections from the console, auxiliary desks or racks and near-field speakers from combining at the mix position. This can be evaluated by examining the ETC at the mix position using TDS. One effective production desk arrangement is to position a lowboy rack containing signal-processing equipment behind the mix position. The desktop can become a work area and synthesizer station. If the RFZ is made larger to encompass this location, it also may be used to critically monitor the program. With diffusors, the indirect reflected energy allows effective use of the entire room.

In a talk-show format, with several open mics, potential interference arises from table, wall and ceiling specular reflections. Reflections from ceiling and walls are reduced by the use of diffusion, while an absorptive table covering attenuates table reflections. Problems are lessened with appropriate use of figure-eight and cardioid microphone patterns.

In contrast to absorptive treatment, which also will reduce specular reflections, diffusion does not deaden the space. In fact, diffusion typically provides a pleasing ambiance to the talent, while reducing reflected energy coloration and feedback.

Planning for recording

In a recording studio, diffusion can be used in various ways. One application is to provide a uniformly diffuse sound field throughout the room, with an exponentially decaying sound field devoid of flutter, late slap echos and other discontinuities. This is achieved with diffusors mounted on the walls and/or in standard ceiling T-bar suspended systems. This arrangement provides a spacious sound and the sweetening of a concert hall.

The RPG, when ceiling mounted, can provide an integrated ceiling system of diffusion, absorption, lighting and HVAC. In addition, much of the necessary electrical, plumbing and HVAC supply lines can be hidden by this cost-effective technique, leaving them accessible for maintenance.

Another approach is to provide fixed or variable acoustics in a particular area of a room. Ceiling clouds or localized

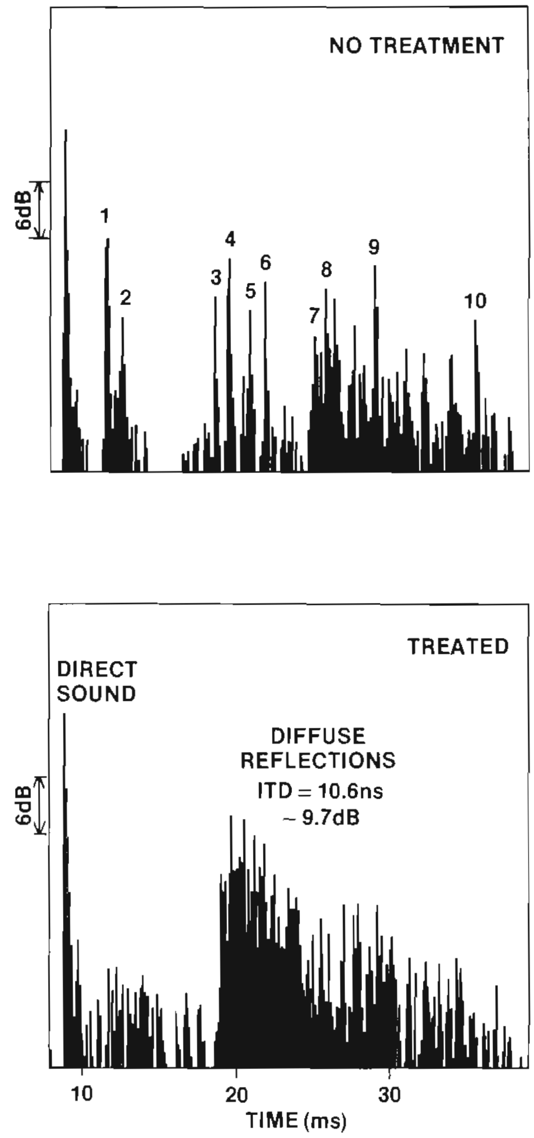


Figure 5. *An ETC of a typical small broadcast studio before acoustic treatment. Note the interfering reflections in ITD (1,2), the sparse reflection pattern (3 through 10) and intense late reflections (8 through 10).*

An ETC after a typical RFZ/RPG treatment indicates a clean ITD between the direct sound and the exponentially decaying dense diffuse reflections. (Courtesy of C. Bilello)

wall systems are examples of fixed acoustical treatments. Variable localized acoustics can be achieved with rotatable modules of diffusive, reflective and absorptive sides. A linear array of these modules can be mounted into a wall element or movable variable acoustics panels. An effective recording technique is to position a figure-eight or omnidirectional microphone between the sound source and the variable RPG cluster. The mic picks up direct sound followed by whatever sound is returned from the variable acoustics panel.

When musical groups are involved, an acoustical shell can provide broad bandwidth diffuse reflections to heighten the sense of ensemble, enabling them to hear themselves and other performers. The ensemble acoustical shell provides an optimum temporal pattern of broad bandwidth reflections that contain a blend of contributions from all participants in the group. The arrival time and directionality of diffuse reflections may be adjusted for different musical motifs.

Lively spots

The announce booth is an important part of commercial broadcasts, but because of space considerations, voice-overs are usually carried out in restricted spaces. These acoustic environments translate, unfortunately, into dull recordings that lack ambiance. In small rooms, the ITD is very short. Minimal diffuse energy and modal effects cause position-dependent intensity variations (hot spots and voids). With the principles of an RFZ and diffusion, the small room can become a larger room through psychoacoustics.

The talent should speak into the longest dimension. Permanent reflective items, such as windows and doors, should be situated along the side walls. They can be used as delayed sound sources to the diffusors located on the wall opposite the talent. Strategically placed absorption creates an RFZ around the microphone to establish an ITD.

In an optimized voice-over booth, the RFZ, created with broad bandwidth absorption behind and to the sides of the microphone, reduces the early reflections that would normally provide the auditory system with clues as to the size of the room. Broad bandwidth absorption is stressed so as not to accentuate the low-frequency modal problems in small rooms. The farthest wall, treated with diffusion, returns a spatially and temporally diffuse sound to the microphone. The ceiling and side walls, splayed slightly at 1 inch per foot, cut flutter echoes and reflect the sound to and from the diffusing surface, to increase the reflection density.

Many geometries can be made to work for a variety of purposes, when appropriate criteria are established. Whether the need is to create an impression of space or to confine a larger room in an acoustically small one, the concepts of the RFZ and the sequenced diffuse sound fields become important acoustic design tools.

Editor's note: This material was prepared from papers presented at the 1986 and 1987 NAB technical sessions.

DIFFUSOR, ABFUSSOR, TRIFFUSOR, RPG, QRD, RFZ and LFD are trademarks of RPG Diffusor Systems. LEDE is a trademark of Synergetic Audio Concepts.

Rank Cintel ADS 1 telecine

By Andy Murphy and Erv Vanags

When our independent TV station, WMSN-TV, signed on last June, our slogan was *Look At The Difference*. To support that theme, we wanted a high-quality telecine for our air and production work. After looking at the various options available, we selected the Rank Cintel ADS 1.

This report is based on an extensive product workout over an 8-month period. The operating tests actually started with some practical, as opposed to technological, considerations. Our station needed a transfer machine that, besides providing high visual quality, could run reliably 24 hours a day. In our station, the telecine is often attended by an operator, rather than an engineer.

This operational capability is worth considering. Because of the unit's stability and ease of operation, we have been able to store much of our syndicated programming. This has resulted in a significant savings in our billing and shipping costs.

CCD technology

Although our engineering team recognized that a flying spot telecine still provides the optimum film-to-tape transfer image quality, these machines are expensive, sophisticated, and may not be well suited to the average TV broadcast studio. The flying spot telecine provides heightened creative control. However, the equipment is as expensive as it is beneficial, because highly skilled (and probably higher paid) technicians are needed for its operation.

Murphy is chief engineer and Vanags is maintenance engineer at WMSN-TV, Madison, WI.

Performance at a glance

- *Superior picture quality*
- *Automatic color correction*
- *Jitter-free time compression*
- *Electronic multiplexing allows reliable film broqdcasts*
- *Auto black, white, color-level operation*
- *Joystick, gamma and gain control*

The CCD is making inroads in many areas of TV broadcast and production. CCDs also are being used as the latest link in the film chain to fill the cost/technological gap between photoconductive and flying spot scanners.

The ADS 1 telecine is an example of how new digital-image storage technology can be adapted to address the specific needs of the broadcaster. A total of four dedicated CCD sensors are used in the telecine. There are three sensors, one each for the red, green and blue channels and a fourth to detect the infrared signal. This infrared signal is used in the electronic dirt and scratch concealment circuitry, which will be described later.

Although this type of CCD imaging is technologically advanced, it contributes to an overall simple design. The telecine, shown in Figure 1, is designed with a straightforward control block, providing dependable operation without the need for constant supervision.

Sprocketless capstan drive

Much of the unit's reliability lies in the unique transport assembly. The telecine uses a tension (sprocketless) capstan drive to feed the film. In fact, the only sprocket in the entire assembly is the frame counter. The telecine works much like a videotape machine—except it uses film instead of tape. Annoying jitters are effectively eliminated as well as the problem of film broken by the sprocket drive. Film with torn sprocket holes will pass through the telecine with little picture quality degradation.

The improvement in our broadcast picture quality is only one of the machine's advantages. There also have been several operational advantages. The machine allows the operator to fast forward or reverse the film with extreme accuracy. All film editing is performed during the transfer process, by simply pausing and prerolling the film to make the needed cuts directly onto tape. This process eliminates the need to cut and resplice films before returning them to the syndicator.

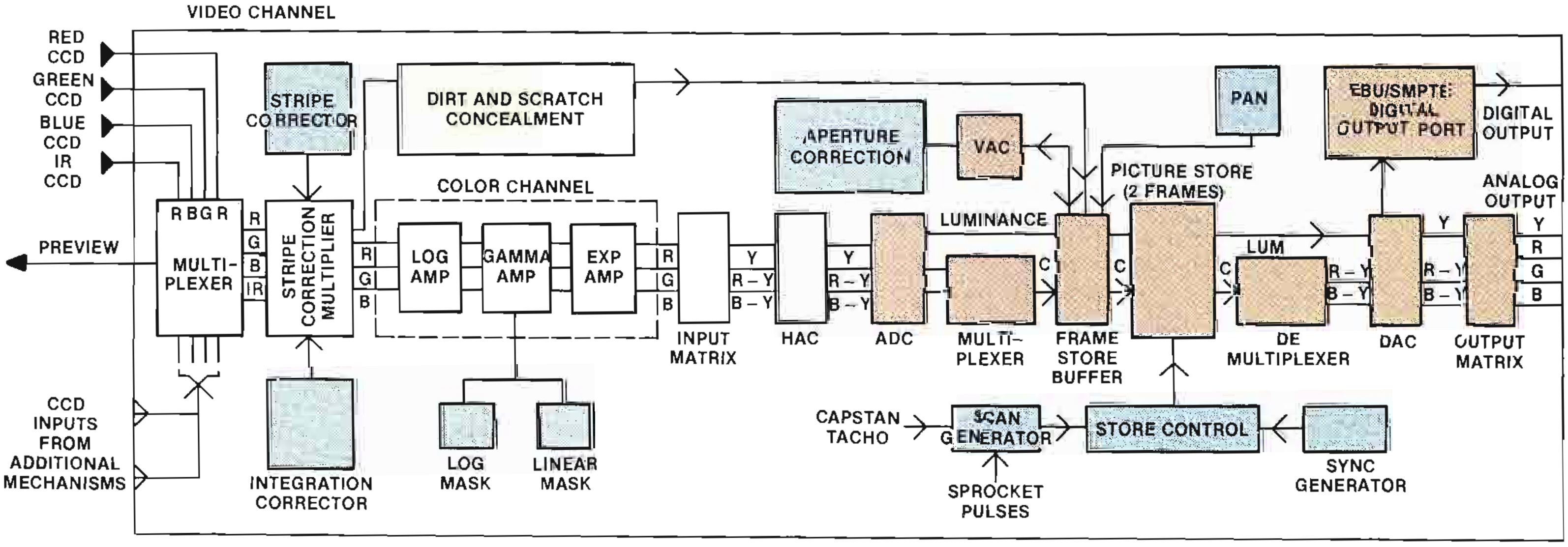


Figure 1. *Block diagram of the ADS 1 telecine.*

Other features

The telecine optical system consists of a lamphouse, lens assembly and beam splitter to separate the RGB and infrared signals (see Figure 2). Constant film illumination is ensured by a 2-lamp automatic changeover system, even in the event of a lamp failure.

The telecine's 4-port beam-splitter assembly block has proved to be more than adept at ensuring optimum RGB signal separation. These four sensors are mounted on the beam-splitter block in such a way that focus and registration can be preset with surprising accuracy.

The telecine cubicle comes equipped with built-in waveform and monochrome monitors. An RGB monitor has been added to let us view the transfer process. A switch-selection bank lets the operator select any of the video signals, as well as strobe, coded output or program input. Differential inspection of the video signals also is possible. When the film is loaded and the transport still, the picture monitor displays the signal from the built-in frame store, together with a 1-line scan of the film obtained directly from the CCD sensor.

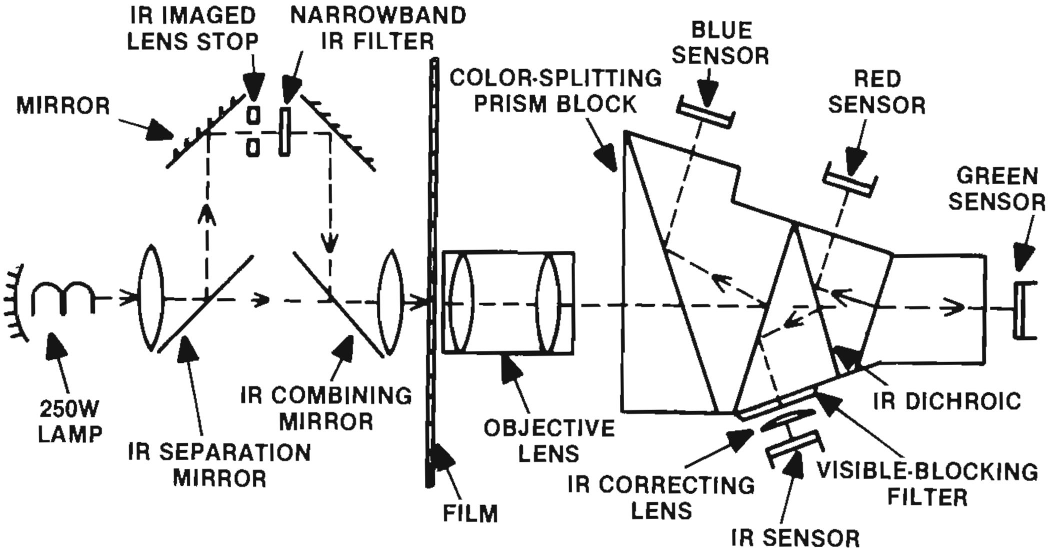


Figure 2. *The ADS 1 relies on infrared light to detect and correct for dirt and scratches. A 250W lamp and optical path provides the required amount of infrared signal to the fourth CCD sensor. This sensor then produces the needed detection signals for the appropriate degree of dirt and scratch concealment.*

Operator controls

The control panel provides easy access to the unit's operational features. These controls include: transmit, sync, ¼-frame and shuttle. Transmit selects the film transport, sync synchronizes the unit with another transport or sound-follower device. The ¼-frame feature instantly corrects ¼-frame errors when using 35mm film. The shuttle feature is a great convenience. It moves 35mm film at variable speeds up to 10 times normal speed and 16mm film at up to 20 times normal speed.

The variable speed feature also allows stations to time compress programming, which is something our station does not do. Stations can use this feature in conjunction with audio time compressors to create extra billable time during regular programming. Although videotape time compression may result in objectionable jitter on the screen, we did not have these problems with tapes time compressed on the ADS 1. The machine's capability to digitally store every frame for compression helps prevent any jitter problems.

Other operator controls include mask select, gamma lift and gain. The mask feature digitally activates one of eight different masking equations, which can help improve the image quality. The gamma controls are directed through a joystick. A dense control removes the neutral density filter from the light path, which results in a marked improvement in the transfer of dark film footage. Color saturation also can be controlled as needed by a front-panel knob.

System interface

Although these types of operator controls are important, the machine must also interface with the rest of the station. The telecine provides a full array of facility controls including: auto black, white and color and a 2-dimensional variable-optical focus control. There is a special switch to select either a preset focus or a continuously variable focus mode. Other remote interconnects control the dirt concealment and freeze frame features.

The vertical film path makes the telecine compatible with standard rack-mounted equipment, making it easy to interface the unit with existing facilities. Loading the film spools and cores is quick and simple. The mechanism cubicles are fitted with doors to keep out grime and protect the moving components from damage.

Dirt concealment

The telecine's electronic dirt and scratch concealment feature has been a major factor in making our programming cleaner and clearer. Of course, if you use a badly marred film, you are not going to get perfect tape copies. However, for repairing vertical scratches, the telecine infrared repair system is tremendous. It should be noted that the infrared error detection works only with color film. The machine's electronically generated color patch is good enough that we can now run programming once thought to be unairable.

The telecine does not repair horizontal scratches as effectively as it does vertical scratches. Processed film sometimes shows slight traces of some sort of digital touch-up work, when faced with large horizontal scratches.

The concealment system works in much the same way as a VTR dropout compensator. The circuit relies on infrared separating and combining mirrors, narrowband infrared and dichroic filters and a correcting lens. A dedicated CCD senses the scratch and deduces the appropriate likeness to be filled in. Despite the technical complexity, the optical design does not need regular alignment.

Color correction

The automatic color corrector works in tandem with the dirt-concealment feature. The combination allows the telecine to maintain consistent color balance throughout an entire reel. Generally, color errors are more noticeable in the dark areas of a picture. The telecine color corrector ensures that the black level is always set to black. The white level is adjusted in much the same way as other color systems. For overall chromatic balance, the red and blue signals are matched to the green. In addition, low-luminance fade out is corrected with a dynamic black corrector, which eliminates colored shadows. The scheme does not affect the overall hue, individual color vectors or picture luminance.

The first photo shows the green tint, which was on the original film. In the middle photo, the excess green has been removed by the automatic color-correction circuitry. However, the scratches still remain. The last photo shows how the dirt and scratch elimination system completely eliminated all traces of scratches from the image. The result of the two circuits is a greatly improved video image.

The automatic color-correction circuitry can be overridden at any time. In our operation, this is seldom necessary. In one case, during the transfer of the Elvis Presley film "Clambake," in a scene with considerable soft pastels the automatic color-correction circuit did not reproduce the correct skin tone. We simply switched to manual operation, performed a slight adjustment and continued the transfer process. For the most part, the automatic color-correction feature allows our operators to perform other jobs while the transfer process continues virtually unattended.

The telecine does not rely on a filter wheel to adjust the video levels. Rather, the video level is electronically adjusted. The system makes these adjustments quite rapidly, with level changes taking place within a single frame.

Live on film

Although photoconductive telecine systems generally offer lower picture quality, they have the capability to optically multiplex several film transport mechanisms into one common camera channel, saving a great deal of time. This machine takes that idea one step further with electronic multiplexing. Up to three 16mm or 35mm mechanisms can be interfaced to the same master electronics cubicle. The greatest advantage here is the flexibility and ease of operation. The design also provides the capability for high-quality on-air operation.

In the electronic multiplexing system, each mechanism is equipped with its own control panel, allowing independent operation. The individual mechanisms are selected by depressing the transmit button, which completes the transport changeover. No manual gate changes are needed to switch from 35mm to

16mm film. One switch moves the objective lens, condenser lens and skidplate mountings into position for the selected format.

Electronic multiplexing is designed for jockeying short film segments, thus providing independent transport operation. For example, one transport can be on-air while another is being prepared for transmission and a third engaged in other tasks. The output of each transport is monitored easily with preview and on-air output options. Although our machine is not used in the multiplexed mode, it is nice to know that the feature can be added later if needed.

Another feature, unused by us at this point, is the digital 4:2:2 output. This permits the machine to be directly interfaced to other digital studio products for the highest quality transfers.

Maintenance and performance

Routine maintenance is simple and easy. All we do is clean the optical block and capstan. The manufacturer has performed other maintenance when needed. Company support also has been good. When the original machine arrived in damaged condition, the manufacturer replaced it free of charge.

We have sometimes found it necessary to pull out and clean the PC cards. Once, we started to notice dropouts and lines in the video. In another case, the black balance shifted slightly. As soon as the cards were cleaned and alignment checked, the problems disappeared.

Our staff also has found that the telecine alignment circuit provides excellent performance, with no telltale CCD indications. If the black level is allowed to vary in other machines, especially during low-light scenes, a racklike effect can be produced. This telecine produces no such effects, and provides clean video outputs.

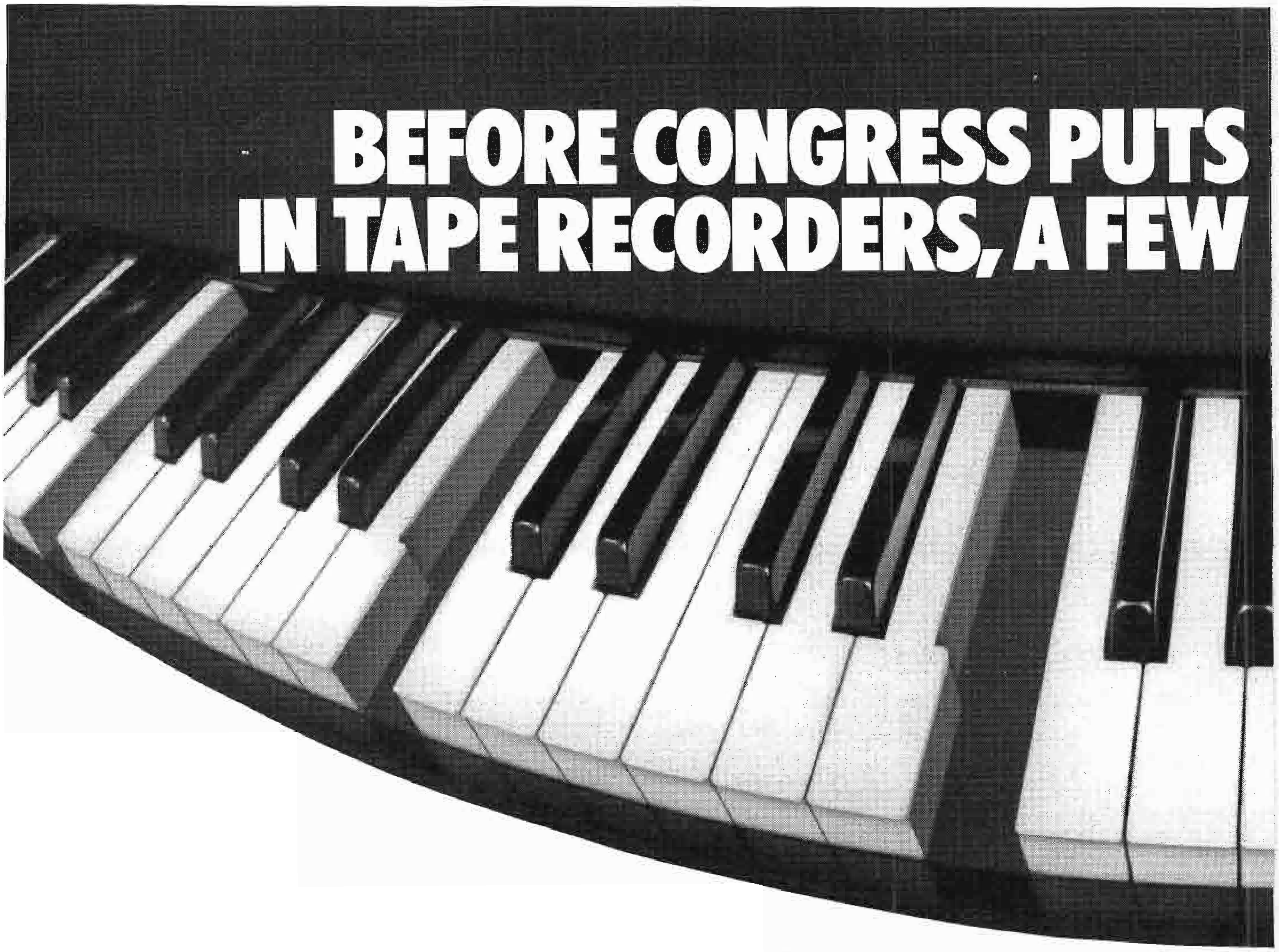
In the eight months the machine has been in operation, no registration problems have occurred. This tells me that once it has been registered, you can leave it alone.

The Rank Cintel ADS 1 provides all the technology and convenience needed to produce top-quality images for our audience. Coupled with its reliable and low-maintenance operation, it has proved to be an excellent choice for our station.

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

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

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

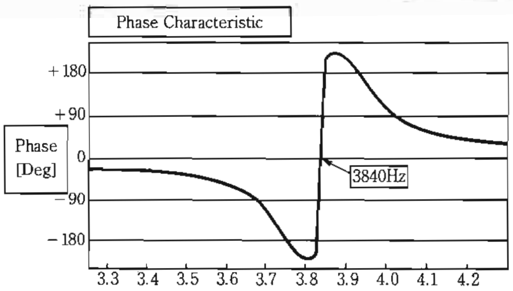


B, G, E, B-flat, F-sharp and D-sharp to name just a few.

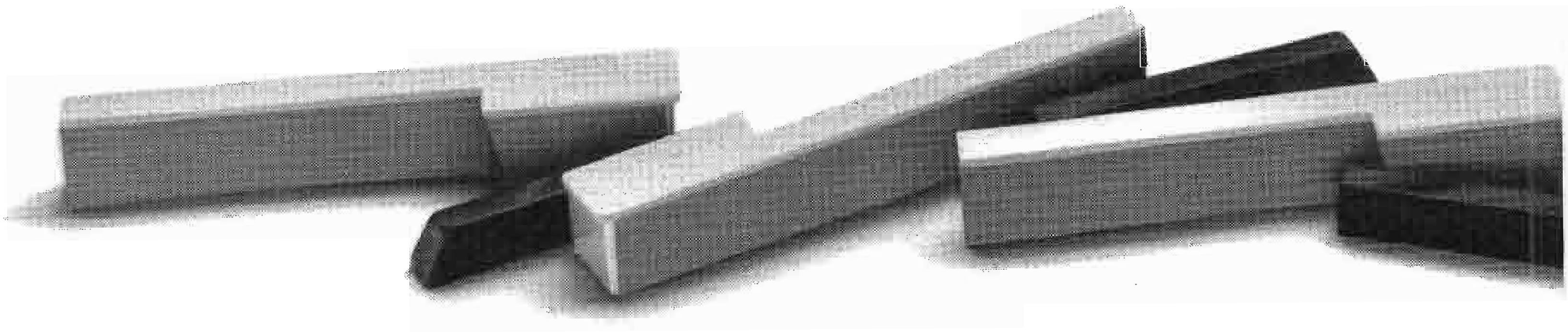
Powerful new evidence suggests that the anti-taping system that Congress might require in the new digital recorders (DATS) will severely affect notes up and down the scale.

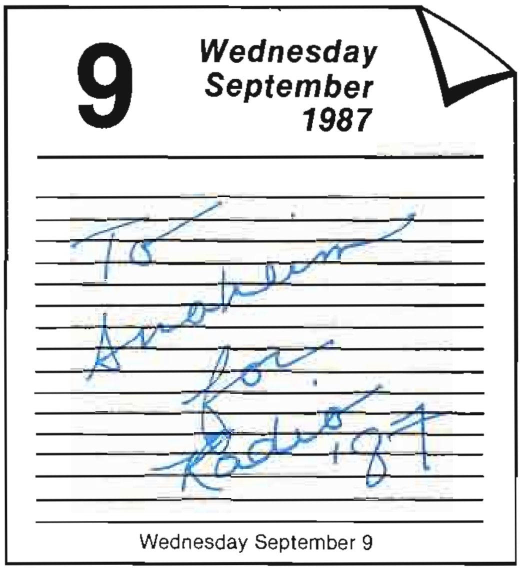
For these scanner devices to do their job—stopping consumers from using their DATs to record—the machines will respond to encoding that will literally "suck out" some of the beautiful sounds that artists and engineers have tried so hard to create. The result? Ringing, phase shift and corruption of sound quality on *playback* of records, tapes and discs.

And these aren't sounds out in some supersonic region where they won't be missed. They're smack dab in the middle of the audio spectrum.



The effect of anti-copy chip encoder upon stereo imaging and accuracy. Source: Congressional Testimony by Leonard Feldman, April 2, 1987.





Radio '87 to showcase technical innovations

By Brad Dick, radio technical editor

Radio '87 is scheduled for Sept. 9-12, in Anaheim, CA. Continuing the practice begun last year, the NAB will offer optional (extra cost) seminars on engineering topics.

This year's seminar topics will include: AM directional antenna systems, the National Radio Stereophonic Committee (NRSC) standards and an update on last year's RF seminar.

In addition to the optional seminars, 10 regular engineering sessions will be held at the convention. Admittance to these engineering sessions is included in the standard registration fee. Topics for the engineering sessions will include: audio processing, RF maintenance, speaking and writing skills, telephones, tower maintenance, electrical interference, AM synchronous transmitters and new FM technology.

The engineering sessions generally will take place during the afternoons and will not conflict with the optional seminars. An open meeting with the FCC's chief of the Mass Media Bureau and an engineering reception also are planned.

Seminars

The most extensive seminar will center on AM directional antennas. Although the NAB has regularly coordinated a directional antenna seminar, this year is the first time the seminar will be held as part of the radio convention.

The seminar will begin one day prior to the convention on Tuesday, Sept. 8, at 5 p.m. The training will continue through Wednesday and half of Thursday.

The seminar will cover such topics as broadbanding antenna systems, measuring tower impedance and detuning structures within antenna fields. Carl Smith, Smith Electronics, will lead the course.

The NRSC seminar will begin at 7:30 a.m. Friday and will continue until noon. Topics to be discussed will include: RF mask technology, history of the NRSC standard and an update on NRSC implementation for receivers.

The RF seminar will begin at 7:30 a.m. Saturday and will end at 2 p.m. The RF seminar will cover topics such as: FCC procedures and policy, certification of compliance, ANSI exposure guidelines, measurement techniques, occupational exposure and FM antenna pattern design and modification. The seminar will provide the engineer with the necessary technical understanding to conduct a thorough and accurate evaluation of a station.

The presentations at the RF seminar will be conducted by six speakers experienced in the FCC regulations, facility design and modifications, RF radiation measurements and the legal aspects of compliance. Plenty of time will be allowed for questions.

Registration

Registration fees for the 4-day convention are $150 for NAB members and $395 for non-NAB members. The cost after Aug. 7 will increase to $345 for NAB members and $495 for non-NAB members.

If you wish to attend the directional antenna seminar, the cost before Aug. 7 is $150. After Aug. 7, the cost will be $200 (for NAB members). The NRSC and RF radiation seminars each cost $65 or $150 (depending on NAB membership), if you register prior to Aug. 7. You also must register for the Radio '87 convention if you want to attend any of the seminars. Registration for the seminars alone is not permitted.

Engineering sessions

- Audio Processing for AM Improvement
- RF Maintenance for AM and FM
- New Cart Machine Technology
- Workshop on Speaking and Writing Skills
- How to Wring Hi-Fi from Ma's Bell
- Maintaining Towers
- FCC Town Meeting with FCC Officials
- Removing Electrical Interference
- Using AM Synchronous Transmitters
- New FM Technology

Table 1. *Radio '87 engineering sessions will cover a wide range of topics, from new technology to personal communication skills.*

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SBE Update

SBE pushes for frequency coordination

By Bob Van Buhler

The Society of Broadcast Engineers recently filed comments on FCC Docket 86-405, Flexible Operational Licensing Procedures for the Broadcast Auxiliary Services (BAS), and the Cable Television Relay Service. The comments were filed in response to the commission's Notice of Inquiry (NOI) on Nov. 4. The inquiry concerns the implementation of blanket licensing for mobile and portable operations under Parts 74 and 78. The licensed facilities would be co-equal, but secondary in status to fixed links, such as STL, TSL and intercity relays.

The thrust of the SBE's comments is to urge the commission to make frequency coordination a requirement. This would give teeth to the commission's recognition of coordination as essential to the effective use of the BAS frequencies. An effective coordination system is especially important in congested areas where stations must share channels.

The SBE points to the recent successful efforts by the industry-backed National Frequency Coordinating Committee (NFCC). This group, comprised of broadcast, network and cable companies, is attempting to develop a universal coordination process for the BAS frequencies.

The SBE filing took issue with the commission's ambiguity regarding the consequences of causing interference. In one section, the NOI states that stations *"repeatedly found to be causing interference and which do not make timely notifications and show proper regard for other operations would be subject to appropriate sanctions..."*

The SBE believes this statement provides little information to the potential reader about the rules and the consequences of failing to follow them. The SBE feels it is important to define what constitutes a repeated cause of interference, what is timely notification and what is proper regard for other operations.

The SBE filing points out that the notice itself is not relevant to the avoidance of interference. For instance, blanket licensing itself does nothing to prevent interference. The non-local, itinerant users and non-broadcast licensees also appear to have less incentive to participate in the coordination process than do the local broadcasters. The local user follows the rules because it is a means of self-preservation. The SBE believes that simply encouraging coordination is not enough. Coordination must be required for all users in order to be effective.

The SBE's comments were followed by a filing from the NAB, which agreed with much of the SBE filing. The NAB position did, however, more closely follow that of the NFCC.

Board appointment

The SBE executive committee met via conference call on May 12. In the minutes, which were distributed to all SBE board members, the executive committee noted the results of a telephone election held to replace Warren Pritchard, board member. Pritchard left the board with a year of his term remaining.

The board approved the election of Ed Roos to fill the unexpired term of Pritchard. Roos is a charter senior member of the SBE and is engineering manager of WPTV-TV, Palm Beach, FL. He served as Chapter 88 chairman in 1982 and 1983, and as vice chairman in 1984. In 1985, he served as certification chairman of Chapter 88.

Ennes Foundation

The Ennes Foundation was created to provide an umbrella organization for all of the SBE's national-level educational efforts. This effort includes all national scholarships and other society vocational projects. Within a few months, SBE certification will become a part of the Ennes Foundation as well. Foundation board members include: Roger Johnson, Jack McKain, Mary Beth Leidman, Jim Wulliman, Brad Dick and Richard Rudman.

SBE fights for hams

In support of amateur radio operators across the country, the SBE also filed comments in opposition to reallocating part of the 220MHz to 225MHz band to land mobile industry. Calling the commission's proposal "a gross misallocation of resources," the SBE pointed to the land mobile industry's lack of serious efforts to develop or employ spectrum-efficient technology until spectrum management policies force it to do so.

The SBE took issue with the land mobile industry's claims of inadequacies in the amplitude-companded sideband (ACSB) technology as a means of spectrum conservation. The SBE feels any inadequacy is due to the land mobile industry's failure to improve the ACSB technology on its own. The SBE noted that amateurs had been successful in using a centered pilot and digital modulation techniques. The SBE believes there is little reason the land mobile industry also could not develop effective techniques.

Ennes Fund scholarships

The Ennes Scholarship was increased to provide a total of $3,000 to five applicants. Steven Brown, Ohio University, and Denise Darling, a WAVY-TV operations engineer and E.E.T. candidate, Tidewater Community College, each received $750 to continue their educations. Rob Kasper and Helga Paap, University of Wisconsin students, and Daniel Tarum, Wichita State University, each received $500.

All of these students represent high-quality applicants and currently are working in broadcast engineering. Brown, Kasper and Paap also are members of the broadcast society, Alpha Epsilon Rho.

Call for papers

If you would like to see your work published in the SBE *Journal*, you must act quickly. In conjunction with the SBE National Convention and **Broadcast Engineering** Conference, technical papers will be printed in the *Journal*. It is not necessary to give a speech or presentation at the convention for your paper to be included.

A 1-page abstract should be submitted to John Battison, in care of the SBE national office. A camera-ready copy of the complete paper must be received by Aug. 31.

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

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1. Please check the ONE type of facility or operation that best describes your business classification:

- Low power TV station ☐ 19
- TV station ☐ 20
- AM station ☐ 21
- FM station ☐ 22
- AM & FM station ☐ 23
- TV & AM station ☐ 24
- TV & FM station ☐ 25
- TV, AM & FM station ☐ 26
- CATV facility ☐ 27
- Non-broadcast TV including closed circuit TV (CCTV) ☐ 28
- Recording studio ☐ 29
- Teleproduction facility ☐ 30
- Microwave, relay station or satellite company ☐ 31
- Government ☐ 32
- Consultant (engineering or management) ☐ 33
- Dealer, distributor or manufacturer ☐ 34
- Other: Specify ☐ ______ Other (please specify)

2. If you checked 20 through 26 above, which of the following best describes your over-the-air station: (Check only one.)

- Commercial ☐ A
- Educational ☐ B
- Religious ☐ C
- Campus low frequency ☐ D
- Community ☐ E
- Municipally owned ☐ F

3. Check the category that best describes your title: (Check only one.)

Company management—chairman of the board, president, owner, partner, director, vice president, general manager (other than in charge of engineering or station operation management) and other corporate and financial officials ☐ A

Technical management & engineering—technical director or manager, chief engineer, other engineering or technical titles ☐ B

Operations & station management/production & programming—VP operations, operation manager/director, station manager, production manager, program manager, news director and other operations titles ☐ C

Other: Specify ☐ D Other: Specify ______

4. IMPORTANT: Check the statement that best describes your role in the purchase of major communication equipment components and accessories.

- Make final decision to buy a specific make or model ☐
- Recommend make or model to be purchased ☐
- Have no part in specifying or buying ☐

5. If none of the foregoing businesses or occupational categories fits your situations, please describe specifically your occupation or interest in BROADCAST ENGINEERING magazine ☐ ______

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the journal of broadcast technology

P.O. Box 12937, Overland Park, KS 66212

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Title ______

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P.O. BOX 12937
OVERLAND PARK, KANSAS 66212-0937

Circulation Department

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   - 33 ☐ Consultant (Engineering or Management)
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Your signature is required Date

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Advertiser's Name ________________ Circle No. ______

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BROADCAST engineering

P.O. Box 12902
Overland Park, KS 66212-0902

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BROADCAST engineering

P.O. Box 12902
Overland Park, KS 66212-0902

Agile Omni, the industry's most advanced receiver designed by the most relied upon name in the business . . . Standard.

With the new Agile Omni, you need no other Satellite TV Receiver. Standard designed it for Broadcasters, Cable TV operators, and Business and Special Teleconferencing Networks now and in the future.

An on board microprocessor permits selection of most frequency formats available from the INTELSAT series to various DOMSAT frequencies in the C and Ku-band formats worldwide. 32 position channel tuning provides direct reading of the transponder—assigned channel number and format control permits selection of up to six satellite frequency formats. With the selection of channel and format, the microprocessor will control center frequency, channel spacing, transponder bandwidth, audio frequency and the three subcarrier bandwidths—Wide, Medium and Narrow—along with the antenna and video polarity, all automatically from the front panel.

The Omni's flexible design can handle up to three separate subcarriers including stereo programming or data. This type of flexibility was unheard of in the past.

True multi-format receiver operations require multiple IF bandwidths. The Agile Omni was designed for this from the start with a low DG/DPLC filter that comes standard as a 30 or 36 MHz bandwidth. A second internal optional filter can be installed in 16, 18, 22, or 26 MHz bandwidth and controlled by the microprocessor, or manually switched.

Standard's proven RF loop-thru circuitry and block downconversion technology combined with better image rejection and lower differential gain and phase produce state of the art video and audio performance. C/N threshold is an impressive 7.0 db at the wide broadcast style 30 MHz bandwidth.

All of these design features and flexibility add up to a new "Standard of the Industry" in cost effective, commercial quality satellite reception equipment; something Standard Communications is committed to providing now and in the future.

For further information and technical assistance, contact:

Standard Communications

SATCOM DIVISION
P.O. Box 92151
Los Angeles, CA 90009-2151
Corporate Office Shipping Address:
108 West Victoria Street
Carson, CA 90746
(213) 532-5300 Telex 67-7173
Cable STACOM—Fax (213) 515-7197

Engineered to a new Standard

Circle (71) on Reply Card

Operating functions including MGC, AGC, AFC, level sets, normal/invert video, clamp/unclamp video, skew, subcarrier frequency selection, video and IF test points are conveniently located on the front panel. Meter reads C/N ratio, signal strength or center-tune.

Format control enables selections of desired satellite system. Direct-reading channel selector displays transponder-assigned channel. Second selectable, subcarrier and space for optional third subcarrier or descrambler modules.

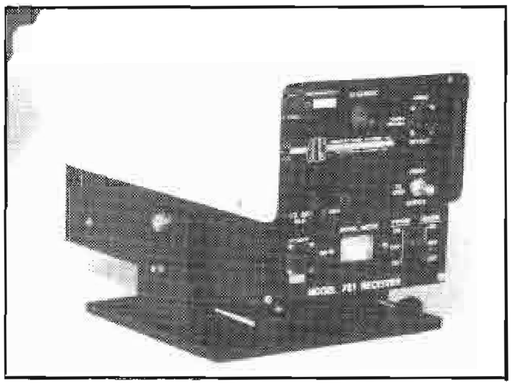
Monitoring systems

Apogee Electronics has introduced the following products:

- The H405 near-field reference monitor features external crossover, 4"x5" bass drivers and a 1"x1" tweeter per cabinet. The driver arrangement is symmetrical on both axes allowing the monitor to be used either horizontally or vertically, with precise stereo imaging. It also features four portliners.
- The 405P near-field reference monitor features internal crossover with 4"x5" bass drivers and a 1"x1" tweeter per cabinet.
- The Q range of studio monitors are triamped and have soft dome mid- and high-frequency drivers. The midband is handled by a 3-inch soft dome unit. The monitors feature an edge-wound short voice coil that operates in a long magnetic gap. Other features include electronically balanced inputs and outputs on XLR connectors; 24dB/octave slope; crossover frequencies determined by plug-in modules; and 0° phase adjustment.

Circle (350) on Reply Card

Atmospheric link

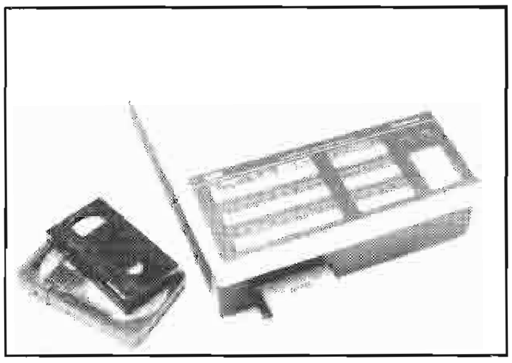


American Laser Systems has introduced the model 761 video transmission system. It has a signal-to-noise ratio of 56dB at 3,400 feet and 52dB at one mile. One channel of baseband video and audio is transmitted through the air, point to point on an invisible beam of light at 8,800A. A signal meter on the back panel of the receiver eliminates the need for test equipment to align the system.

Circle (351) on Reply Card

Still-store

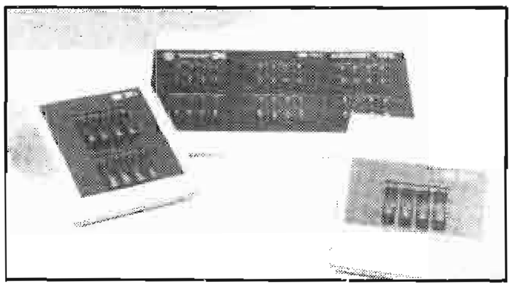
The ALTA Group has introduced its Centaurus broadcast-quality digital still-store and retrieval system that offers special effects, A/B roll video switching, stereo audio mixing and dual infinite-window time-base correction/frame synchronization. The system stores up to 50 pictures, logos, slides and titles, which can be stored using a removable Winchester hard disk. An additional 2,500 pictures can be stored in an external 500-megabyte disk drive. Stills can be programmed to replay in any sequence with effects. Other features include an internal downstream keyer, wipes and dual-channel, fully independent digital frame/field freeze. The A/B roll video switcher includes nine wipes, dissolve, fade-to-black and fade-to-color, plus nine digital effects. A 4x2 routing switcher and a 4x2 mixer provide full and independent source selection for both channels.



Circle (352) on Reply Card

Chargers

Alexander has introduced five 9V and N-cell battery chargers. The CR0908 and CR0904 chargers will accommodate eight and four 9V batteries, respectively. The SM2400-2, SM2408-2 and the SM2404-2 chargers accommodate 24, eight and four H6965 N-size cells, respectively. Each of the charging stations work independently, allowing the units to start charging a battery at any time without interrupting the other charge cycles. The units have a charge rate of 15mAh and a 6-foot, 3-prong grounded cord.



Circle (353) on Reply Card

Mechanical splice and continuity checker kit

AMP has introduced these products:

- The OPTIMATE mechanical splice can be used for multimode and single-mode optical fibers. The design and crimping method of the splice compensates for fiber diameter variations, ensuring center axis alignment without tuning procedures. The uniform crimp avoids microbends and other loss-producing fiber deformations. Splice performance is rated at less than 0.25dB loss average.
- The OPTIMATE continuity checker kit gives instant readout of end-to-end attenuation within a 20dB range. A graphic LED display indicates signal strength, and a variable pitch, audible indicator can be activated when visibility is limited. The units are fitted with OPTIMATE connectors; adapters supplied allow use with a wide variety of connectors for fibers with core diameters from 50 microns to 1,000 microns.

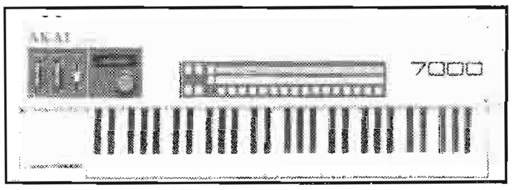
Circle (354) on Reply Card

Cassette recorder

AMR has introduced the MCR 4/S, a synchronization-capable 4-track cassette recorder. A 25-pin synchronization/control port provides full remote speed and transport control, tachometer and tally outputs, and enables the recorder to act as a full-function slave or master when used with the SyncController. A back-panel noise-reduction defeat switch for track 4 enables performance with a wide range of synchronization signals without sacrificing the Dolby B/C noise reduction on the remaining tracks. Other features include zero stop, zero play, peak-reading LED arrays for each track, variable pitch and an LED counter/timer.

Circle (355) on Reply Card

Sampler



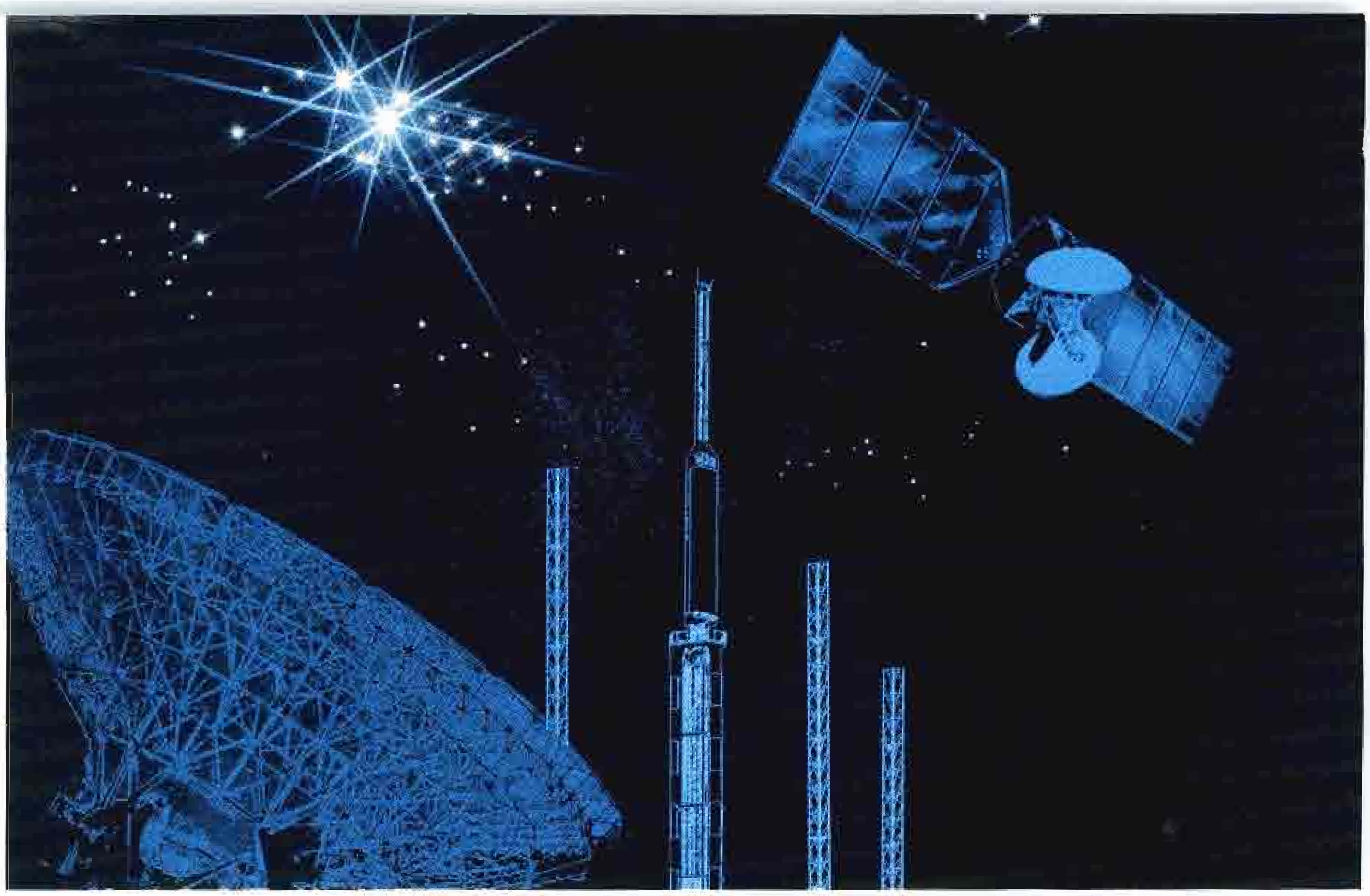
AKAI has introduced the X-7000 sampler. It offers selection of a library of sounds through 12-bit sampling. The unit is a linear, 6-voice sampler with a variable sampling rate of 40kHz to 4kHz and can load in six different samples. The samples can be assigned to play over the whole keyboard in splits or layers, with 32 different programs available.

Circle (356) on Reply Card

Animation software

Alias Research has announced the second-generation release of its ALIAS/1 3-D video animation system, which includes version 2 of its software, the Pixar Image computer and the Silicon Graphics super workstation. The software includes an animation control system that gives the user visual control over all separate attributes in time and in motion for every

THOMSON-CSF



THE FURTHER WE GO, THE FURTHER YOU GO.

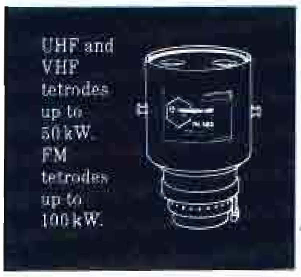
At Thomson-CSF we've been pioneers in developing the use of high-power tetrodes in transmitters for more than 70 years.

Over the years we've stayed ahead with such developments as Pyrobloc® grids and the Hypervapotron® cooling system.

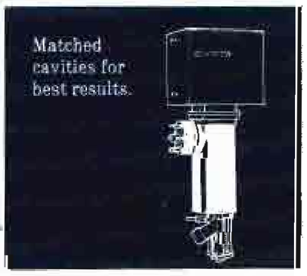
We offer: A complete line of tubes for radio broadcasting applications from FM to the most powerful SW and LW transmitters – the quality of our 500-600 kW tubes has been amply demonstrated in 15 years of service in over forty transmitters worldwide.

High power radio broadcasting tetrodes up to 1.2 MW.

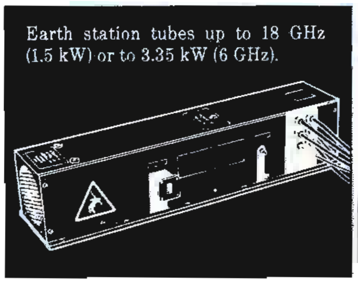
A complete line of power grid tubes and their associated cavities for UHF/VHF TV transmitters. Thanks to their efficiency, reliability and tight tolerances, systems makers can offer their customers substantially more cost-effective products.



UHF and VHF tetrodes up to 50 kW. FM tetrodes up to 100 kW.



Matched cavities for best results.



Earth station tubes up to 18 GHz (1.5 kW) or to 3.35 kW (6 GHz).

High efficiency space TWTs (including 50 W and 100 W Ku-band for next generation DBS Satellites).

A complete line of klystrons and TWTs for ground stations and space TWTs for direct broadcasting satellites (DBS) designed to last for at least a decade.

And we also produce high-resolution image pick-up tubes and devices (CCDs), and high-luminosity CRTs for top range professional applications.

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scene, including objects, surfaces, lights, backgrounds and multiple camera positions. A rendering system also is included. The system is equipped with first-generation special effects rendering software that allows numerous environments to be created and animated interactively.

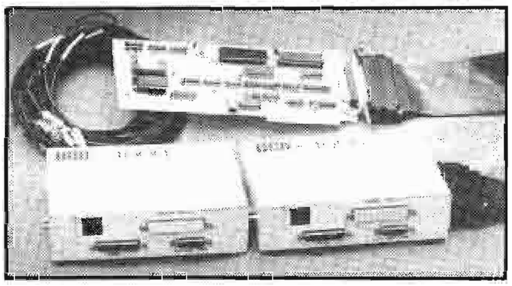
Circle (357) on Reply Card

Coax cables

Belden Wire and Cable has introduced two 50Ω, low-loss VHF/UHF coaxial cables. The 9913 cable has an air-dielectric construction, a single 9½ AWG (solid) bare copper conductor, polyethylene insulation, a nominal capacitance of 24pF/ft and a velocity of propagation of 84%. The 9914 cable has a 10AWG (solid) bare copper conductor, cellular polyethylene insulation, a nominal capacitance of 26pF/ft and a velocity of propagation of 78%. Both cables have a black PVC jacket and a Duobond II foil shield and tinned copper braid design that provides 100% shield coverage. Both cables operate at 600Vac, are temperature rated at −40°C to 80°C, and have a minimum bend radius of eight inches.

Circle (358) on Reply Card

Video controller



BCD Associates has introduced the BCD-4000 controller for slot-compatible IBM PC-type computers. The unit can control two industrial and broadcast videotape or videodisc machines of different models in nearly any combination. The microprocessor-based controller can be equipped with dual independent SMPTE time-code generators and readers (drop and non-drop frame) for compatibility with existing systems.

Circle (359) on Reply Card

Enclosure accessories

Equipto Electronics has introduced 12 standard colors for its Challenger line of modular electronic enclosures. The enclosures offer 19-inch and 24-inch panel space. Free engineering services are available along with an assortment of accessories.

Circle (360) on Reply Card

GYROZOOM® USER'S PROFILE

"The Gyrozoom solved one problem in covering the Pittsburgh Marathon– unfortunately it couldn't improve the weather."

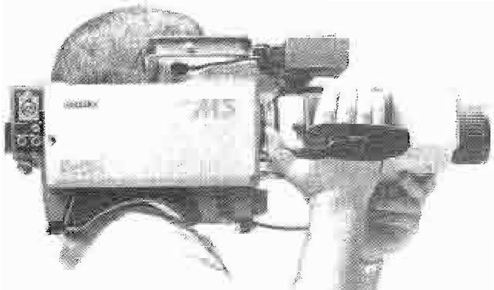
Charlie Fagan
KDKA-TV, Pittsburgh, PA

PITTSBURGH, PA, MAY 3— "The worst weather conditions for a remote broadcast I've seen in 30 years," was the way one KDKA staffer put it. The scene was the annual Pittsburgh Marathon and heavy rain fell from the very dark skies.

"We'd planned our coverage," said KDKA's Charlie Fagan, "using cameras on a golf cart, a truck and in a helicopter. Because all three cameras were subject to severe vibration we decided to equip them with Gyrozoom 60/300's to stabilize the images."

"The camera and Gyrozooms were covered with plastic and we did our best to keep the crews dry with umbrellas," Fagan continued. "The helicopter flew for awhile, but conditions were too bad. Between the rain and mud we were losing mikes, cables and connectors faster than we could replace them. The Gyrozooms did a great job—the footage was excellent."

For more information on the Schwem Gyrozoom lenses, call or write Schwem Technology today.



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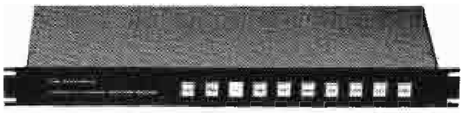


Linear video keyer

Broadcast Video Systems has introduced MASTERKEY, a stand-alone composite keyer that can be operated in a controlled linear mode to produce seamless inlays of DVEs, paint boxes and anti-aliased character generators into program video. For keying situations requiring separation of foreground and background, the keyer may be switched to fast mode, allowing its sliding window to differentiate down to a 5IRE level difference anywhere in the gray scale. The remote panel contains the fader lever and operating controls.

Circle (361) on Reply Card

Wireless microphone receiver

Cetec Vega has introduced the model R-33 PRO PLUS portable wireless microphone receiver. It runs at least eight hours on a 9V battery if the RF/AF/battery display is turned off. The receiver has DYNEX II audio processing and a GaAsFET pre-amp transistor. Typical system signal-to-noise ratio is 104dB, A-weighted. Typical dynamic range is 104dB, A-weighted. A miniaturized true helical resonator filter and 10 poles of IF filtering provide high selectivity.

Circle (362) on Reply Card

Monitor switcher, ad insertion system and switcher

Channelmatic has introduced the following products:

• The 8-BALL instrument-grade monitor switcher uses only integrated circuits and features unity gain on both audio and video sections. It is transparent to the signal sources and the destination monitor to which the signal is directed. The unit offers electronically controlled vertical interval switching, stereo audio capability and a 1F capacitor for memory backup to restore switching configuration after a power outage.

- The ADCART 2+2 automated random access ad insertion system offers fully automatic 2-channel stereo ad insertion switching. Commands are entered with single keystrokes, and a single screen displays summary system status information 12 channels at a time. System status also appears on the front panels of the CCU, which controls all ad insertion switching functions on two channels. The CCU is implemented almost entirely using CMOS logic.
- The NSS-4A network share switcher enables a cable system to insert advertising or program material into four CATV satellite networks from one source. It will interface with character generators, computer graphic generators or sequential ad insertion equipment. The unit contains four DTMF decoders and four preroll delay timers, one for each network, along with a composite sync output and vertical interval switching. A relay bypass will automatically switch back to the network if power is lost.

Circle (363) on Reply Card

Miniature unidirectional mic

Telex Communications has introduced the compact LM-300 unidirectional microphone system. The system combines the miniature WLM-60 lapel mic and the PS-10 in-line phantom power supply. The lapel mic weighs only 15g. The unidirectional pickup pattern controls background noise and feedback. Because of the mic's frequency response, low-frequency chest tones are almost non-existent. The system also features three styles of mounting clips for use on clothing or instruments. The mic and power supply are finished in a non-glare black matte.

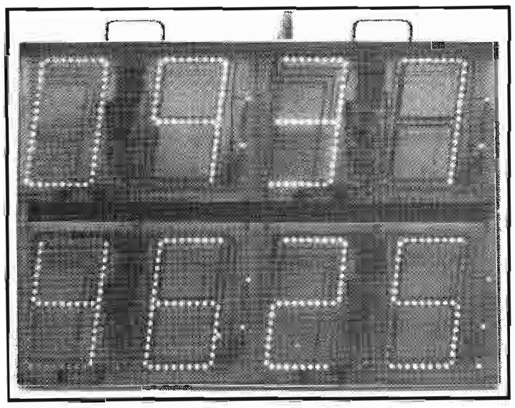
Circle (364) on Reply Card

Soldering station

Davle Tech has introduced the SUPERTEMP XY7 soldering station, which offers five fixed temperatures (320°C, 350°C, 380°C, 410°C and 440°C) and an insulated nichrome wire-heating element compressed between two layers of stainless steel. An electronic control circuit maintains tip temperature to within ±3°C. Zero voltage switching protects voltage and current-sensitive devices against transient voltage spikes. The soldering tip is grounded through the power unit to ensure the tip leakage to less than 0.4mV or 0.03μA.

Circle (365) on Reply Card

Time-code concert slate



Denecke has introduced the DCODE TS-6.5 time-code concert slate that reads and displays SMPTE/EBU time code and drop-frame status on a 6½-inch LED readout. The unit features variable intensity LEDs that are readable in sunlight. The unit has a 2A power consumption at full intensity and is 12V battery- or ac-powered. Connection is by 4-pin Cannon connector and ¼-inch phone jack.

Circle (366) on Reply Card

Portable motion control

Elicon has introduced the portable camera control system (PCCS), a real-time, live-action motion control system. The system records movements on a frame-by-frame basis at live-action speeds. The record and playback speeds are continuously adjustable from 0.01 samples per second to 60 samples per second allowing camera speeds from time-lapse to 120fps while retaining frame-for-frame repeatability. Prerecorded moves are stored on floppy disks. One or more of the axes involved in any move can be modified. The system operates off of a 110V, 60-cycle source.

Circle (367) on Reply Card

Line driver and line-level interface

FM Acoustics has introduced the FM 214 precision-balanced line driver and the FM 216 precision line-level interface. The units are complete stereo systems that resolve level and impedance mismatches that might exist among consumer, semi-professional and professional equipment working at +4dBV, +6dBV and +8dBV levels. The systems have short-circuit-proof outputs. Delayed turn-on circuitry, combined with mains power monitoring and instant switch-off, avoids thumps. Input impedance is 50kΩ (the FM 214) or 40kΩ (the FM 216). Recessed gain controls on the front panel of the FM 214 allow level adjustment from −70dBV to +14dBV. The FM 216 is set for a fixed attenuation of 14dB, which can be varied internally between −7dB and −20dB. A separate power supply is used for hum and noise rejection.

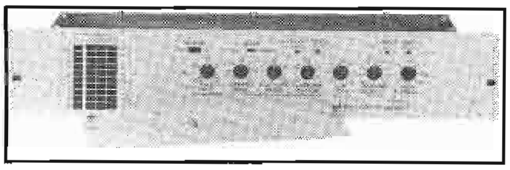
Circle (368) on Reply Card

Current probe

The *John Fluke Manufacturing Company* has introduced its 80i-1010 clamp-on current probe. The probe measures ac current to 700A and dc current up to 1,000A. The probe clamps around a conductor and uses dual Hall-effect sensors to sense the magnetic field produced by current flow, allowing measurements without breaking the circuit. A thumbwheel zero control allows the user to compensate for residual core magnetism in the clamp and improves the accuracy of dc measurements down to 1A. An amplifier circuit generates an output signal of 1mV per amp for correct decimal placement when using the DMM's mV range. Frequency range is from dc to 440Hz, with frequency response to 6kHz.

Circle (369) on Reply Card

Audio processor



Inovonics has announced the model 255 triband/PWM audio processor, which incorporates the triple function of gated, gain-riding AGC, 3-band dynamic compression and program peak limiting. Range control over subjective results is afforded by a variety of calibrated user adjustments with emphasis on assignment of program spectral distribution and density. The unit uses pulse-width modulation in a system of soft-knee feed-forward gain reduction. The upper crossover frequency is selectable to accommodate 50µs or 75µs or flat transmission characteristics.

Circle (370) on Reply Card

Audio generator booster

Leader Instruments has introduced the LBA-1835, a 10Vrms audio generator booster. The amplifier delivers up to 10Vrms into a 600Ω load when used in conjunction with sine wave generators. Features include a wide-band frequency response and low-distortion specifications. The unit can be used as a 20dB in-line amplifier if signal gain is needed.

Circle (371) on Reply Card

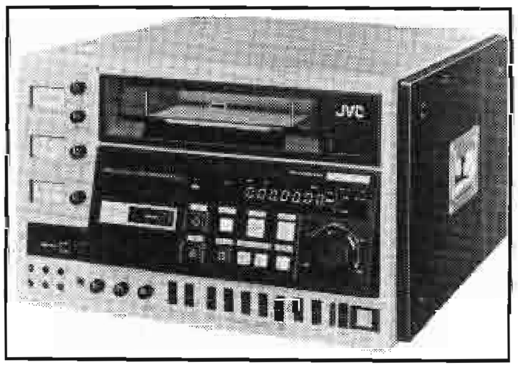
Distribution amplifier

Lenco has introduced the PVA-352 utility video distribution amplifier. A power-status LED remains lit when the PVA-352 is correctly powered. Gain control provides adjustments of each distribution amplifier. Front-mounted video test points allow system analysis without removing the module from the frame.

Circle (372) on Reply Card

¾-inch VCR

The Professional Video Communications Division of *JVC* has introduced the CR-600U, a microprocessor-controlled ¾-inch VCR with SMPTE time-code capabilities. The VCR is front-loading for mounting in a standard 19-inch EIA rack, and features full direct-drive tape transport. A diagnostic warning system with double-digit codes enables the operator to detect and troubleshoot potential problems. The signal-to-noise ratio is 49dB luminance. The head-switching line is in the vertical interval so it is never visible in the picture. The VCR has a visible picture search from 1/30 to 10 times normal speed, and searches up to 15X forward and 20X in reverse. Other features include: separate audio/video tracking meters with level controls, independent audio limiters, balanced audio with XLR connectors, external sync and subcarrier inputs. The 7-digit digital tape counter has a lap mode capable of reading individual frames and indicating time from the last edit point.



Circle (373) on Reply Card

Lightning prevention system

Lightning Prevention Systems has introduced the ALS-3000 lightning prevention system, which prevents lightning from striking any structure on which it is mounted. The system uses stainless steel and anodized aluminum arrays with more than 40,000 dissipating points to accelerate ion dissipation, thereby neutralizing lightning-receptive structures over a 30,000-square-foot ground area.

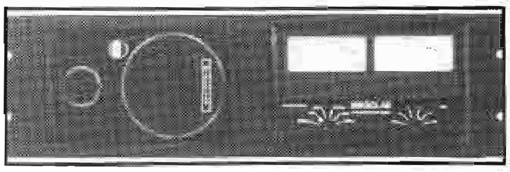
Circle (374) on Reply Card

Prompter display

Listec Video has introduced the A-5000 prompter display device that stores in RAM plain ASCII text files sent from the serial port of any host computer running standard word processing. The device automatically formats its video output into the prompting mode. The host computer can be a newsroom computer or a personal computer. The device is programmed in ROM to accept imbedded commands and recognizes a choice of four fonts and associated characters per line from 16 to 24. The output of the device can be controlled from the host computer or by means of an optional intelligent control box. Standard features include an infinitely variable scroll without jitter, reordering of story rundown, story interrupt, pause and run.

Circle (375) on Reply Card

Stereo-buffered meter system



Mikrolab Video has announced the VU-III stereo-buffered meter system to operate with dual or single monitor feeds. The system is configured with a monaural amplified speaker system for monitoring levels and program content of a stereo audio line. Each of the two balanced, HI-Z input XLR connectors may be compensated by a front-panel gain adjustment in 4dB steps from −12dBm to +8dBm. One of the three output connectors is a mixed mono feed from the two inputs. The two remaining output connectors can be selected as stereo, mono, left only, right only and off. All three outputs are differential driven and have a nominal 0dBm output into 600Ω. Output levels can be internally modified for alternate output levels.

Circle (376) on Reply Card

UHF trap

The *Microwave Filter Company* has introduced the model 5891 UHF viewer trap, which reduces viewer pre-amp overload from a strong UHF TV station. This allows the strong station to be viewed without strong interference to other UHF receptions. The trap can be supplied tuned to any UHF channel video frequency with about 20dB attenuation and a bandwidth of 40MHz. Connectors are type F.

Circle (377) on Reply Card

Audio switcher

Mitsubishi has introduced the ACS series audio switcher, a digitally controlled electronic crosspoint routing and/or mixing switcher. The switcher incorporates low-resistance FET-based cross-point switches and uses ultrashort signal paths to allow for virtually noise-free and distortion-free operation. Ground loops are eliminated through opto-isolation of the digital controls. The system consists of an IBM XT compatible computer with a digital interface card and a 19-inch-wide electronics cabinet that houses a digital control card and input/switching and output/summing cards that control up to 16 input lines and 16 output lines. RS-232 and RS-422 communications ports are available for interfacing the switcher to other systems. The modular system can be expanded to 96 inputs by 64 outputs with additional input/switching, output/summing cards.

Circle (378) on Reply Card

TBC

Nova Systems has announced the NOVA 700, a digital time-base corrector with a 32-line digital video memory. The TBC will work with almost all ½-inch and ¾-inch videotape recorders that accept an advanced sync signal. The TBC operates in the heterodyne mode and uses 8-bit, 4X subcarrier sampling.

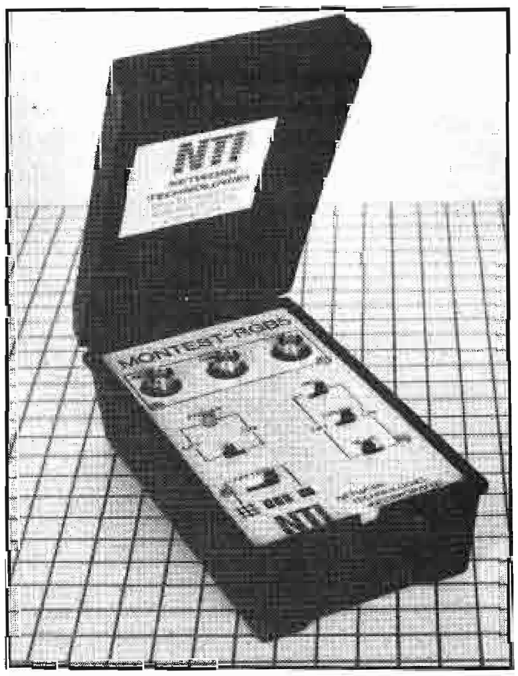
Circle (379) on Reply Card

Uninterruptible power system

Nova Electric has introduced the Galaxy 5000, an on-line 5kVa uninterruptible power system. The UPS module is 8¾-inches high and includes a complementary 7-inch battery pack that provides up to 10 minutes of operation at full load. The UPS uses transistor technology and provides low MTTR because only two printed circuit areas are used to provide signal processing and control to the system's battery charger, inverter and solid-state transfer switch.

Circle (380) on Reply Card

Video generator



Network Technologies has introduced the MONTEST-RGB5, a portable video generator for high-resolution CRT monitors. The tester is designed for use with monitors implementing scan rates of 50kHz with 798 lines of resolution. Its battery-powered design allows it to be attached directly to the monitor. The tester generates three patterns—cross hatch, color bars and full rasters with eight different color combinations. The unit drives the monitors directly using RS-170 output connectors.

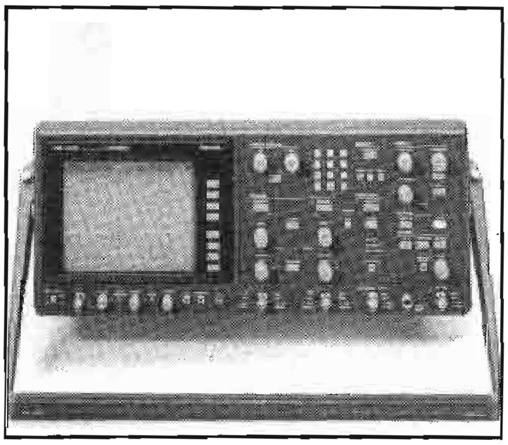
Circle (381) on Reply Card

23GHz systems

Nurad has introduced a line of 23GHz systems for STL/ICR applications. The systems meet or exceed EIA RS-250B short-haul standards and are modular in design. Configurations include a variety of single/dual channel, simplex/duplex and non-protected/hot standby versions. Features include 3-segment LED displays for receiver signal strength, full diagnostics and up to four synthesized audio subcarriers.

Circle (382) on Reply Card

Storage scope



Philips Test & Measuring Instruments has introduced the PM3320, a digital storage oscilloscope that offers a 200MHz analog bandwidth with 10-bit vertical resolution. The scope provides a 250 megasample/s maximum sample rate for a 4ns resolution; glitch-catching circuitry ensures capture of details as small as 3ns, even at the lowest timebase settings. Functions include dc offset, roll mode and mathematical operations such as multiply, peak to peak, rise time and mean value. Trigger facilities include dual slope, positive and negative delay, event and multiple shot. Memory length is 4,096 x 10 bits for single-channel or 2,048 x 10 bits per channel in dual-channel operation. At least 512 x 10 bits can be stored in the single-shot mode. Random sampling allows both pre- and post-trigger display over the full 200MHz bandwidth.

Circle (383) on Reply Card

People

Al Salci has been appointed to a position with RTS Systems, Burbank, CA. He is an analog/digital/system designer with a specialty in digital hardware/software design. Salci is responsible for new product designs.

Tom Smock has been named Western regional sales manager for Sharp Electronics Professional Products Division, Mahwah, NJ. He will oversee 13 western states, including Hawaii, Alaska and western Canada, servicing the broadcast, production, post-production and audio/visual markets.

Susan Seidenglanz and **Robert Crachy** have been appointed to positions with Shoreline Professional Video Systems, Hollywood, CA. Seidenglanz is a sales account executive. Crachy is a sales account executive for broadcast production systems, industrial and corporate video facilities.

Ed Form has been appointed director of engineering for Tannoy, England. He is responsible for loudspeaker development and production engineering.

Bernard M. VanBenthem and **Daniel F. Antonellis** have been appointed to positions with Utah Scientific, Salt Lake City. VanBenthem is vice president of engineering. He is responsible for administration of engineering activities in both current and new product development. Antonellis is Northeastern regional sales manager. He will handle the product line in New England, New York, New Jersey and Pennsylvania.

Vern A. Pearson has been appointed to central regional manager for Dynair Electronics, San Diego, CA. He is responsible for sales and service supervision.

Richard Lunniss has been promoted from director of sales to vice president of sales for A.F. Associates, Northvale, NJ.

Chip Miller has been named product manager, videotape products at Ampex Magnetic Tape Division, Redwood City, CA. He will assume marketing responsibility for the 196 1-inch videotape and the 175 quad format videotape lines.

Robin Stelling and **Phillip J. Smith** have been appointed to positions with Aurora Systems, San Francisco. Stelling is a 3-D specialist. She will handle training responsibilities for the 3-D modeling package. Smith is central regional sales manager. He is responsible for marketing operations throughout the central United States, and will be located in Dallas.

F. Kurt Shafer has been appointed director of sales and marketing for the industrial and government product line at Christie Electric, Torrance, CA.

Dawn Ford has been named product manager for the CASS-1 computer-aided sound sweetening system at CMX, Santa Clara, CA.

News
Continued from page 4
sized that stations should be free to feed programming material to boosters by any means broadcasters deem appropriate.

NAB also said that:

- Only primary stations should be booster licensees;
- The FM booster service should be separated from the translator rules and that an entirely new rule section for FM boosters be created;
- The language on interference is too vague and restrictive, but that some flexibility with respect to power and interference levels should be afforded to operators when designing and installing the booster facilities; and
- Adequate restrictions and safeguards should be included to prevent interference by non-commercial FM boosters to TV channel 6.

Hopkins is U.S. rep to CCIR IWP 11/6

Robert Hopkins, executive director of the U.S. Advanced Television Systems Committee (ATSC), has been named by the U.S. Department of State as the U.S. representative to the CCIR Interim Working Party (IWP) 11/6.

The CCIR (International Radio Consultative Committee) is a permanent part of the International Telecommunication Union (ITU). The ITU is the specialized agency of the United Nations for the planning, coordination, regulation and standardization of telecommunications worldwide. The role of the CCIR is to study and issue recommendations on technical and operating questions relating to radio communications.

The IWP 11/6 was established to define the parameters for a single worldwide high-definition TV standard for program production and for the international exchange of programs. The ATSC was established to coordinate and to develop voluntary national technical standards in the United States for advanced TV systems.

A-V fair to focus on new developments

The International Audio and Video Fair, the world fair for consumer electronics, is scheduled for Aug. 28 through Sept. 6, at the Berlin Radio Tower. The plans for the fair center on informing the attendees of the new developments in the audio and video industries.

The fair will include exhibits of the advancements made in televisions, compact disc players, video recorders, car radios and portable radios.

As part of the technical and scientific program, information will be provided on the subject of *Broadcasting Technology,* and will focus on the Radio Data System and its possibilities. Direct reception of satellite broadcasts, the future D2-MAC TV standard, the broadband information system from Cable Communication Project Company and the use of teletext to program video recorders are other aspects that will be covered in the program. Details will be available on the future developments in 3-D television, technical improvements to high-definition television and on-radio broadcasting services.

A new display, MediaCom, will supply information about the technical, scientific and commercial uses of communication technology.

More than 300 exhibitors from Europe, Asia and America will attend. There will be a 75,000m display area at the ICC Berlin Centre.

SBE Chapter 22 plans regional convention

The Society of Broadcast Engineers, Chapter 22, Central New York, will be holding its 15th regional convention Sept. 25 in Liverpool, NY. For booth reservations and further information, vendors and other interested parties should contact John Soergel, convention chairman, 25 Cotty Dr., E. Syracuse, NY 13057.

Planning under way for Broadcast '87

High-definition television and an overview of the latest developments in the field of CCD cameras are a few of the special programs and workshops planned for the Frankfurt Broadcast '87 Fair, Oct. 14-17. Other program topics will include graphic animation, special radio shows with digital audio studios and hardware.

Visitors will be able to follow computer animation and motion-graphic video animation as it goes from the concept stage to its completion in the TV graphic live studio. The HDTV studio and the radio talk show also will be open for visitor participation.

A course for camera operators and programs on digital recording and editing and time-code dubbing coupling are planned for the convention as well.

For more information contact Messe Frankfurt, Dept. 1202, P.O. Box 970126, D-6000 Frankfurt 1; telephone 069-7575-292.

AMEK

BCII

AMEK BCII – Compact Audio Engineering for Broadcast Production

Preferred for Film and Video Post · Audio Post for Radio · Stereo Television · Foley · ADR · Transfer · ENG · On-Location Recording · Corporate Video Production.

AMEK's BCII System responds to the needs of the contemporary Broadcast Production environment for a higher standard of performance and flexibility in compact audio production consoles.

Our in-depth understanding of operational and creative requirements has lead to the inclusion of many new and valid design ideas. Our innovative approach has created an audio-mixing system which is truly compatible with almost any operating environment; whilst its competitive pricing makes the BCII extremely budget-efficient.

A range of interchangeable modules in both Mono and Stereo formats utilising plug-in subassemblies, combined with comprehensive control facilities, allow many tasks to be accomplished in a number of ways. Customization of signal flow paths using internal links, optional Dynamics modules and several chassis variations, further serve to increase the capabilities of the system.

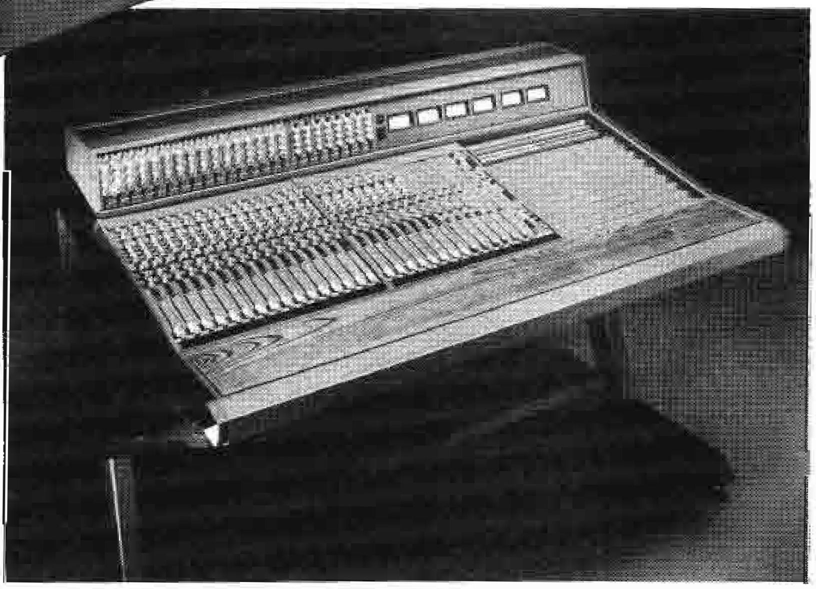
The robust, all-metal chassis design fully screens the electronics from stray electromagnetic fields; ultra-low-noise circuitry, balanced outputs, and the use of balanced bussing provide exceptional performance characteristics. The AMEK equalizer has a very wide operating range, suited to any application from delicate track sweetening sweetening to severe, corrective equalization.

The monitoring system allows comprehensive handling of gallery/control room requirements. Various metering arrangements are available.

Furthermore, the BCII has ports for AFV (Audio Follows Video) which can be configured for either Remote Muting in the standard version or for remote DC control of fader levels in the VCA version.

In essence, an outstanding product specified worldwide by a diverse range of clients, from owner-operators to major, multi-installation broadcasters such as the BBC and NBC.

AMEK BCII IN 8/4/2 VERSION



AMEK BCII IN 24/4/2 STUDIO CHASSIS VERSION

Head Office, Factory and Sales: AMEK Systems and Controls Ltd, Islington Mill, James Street, Salford M3 5HW, England. Tel: 061-834 6747. Telex: 668127 AMEK G E-MAIL: AMEK-UK. Fax: 061-834 0593.

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Circle (98) on Reply Card

Barco signs agreement with Ampex

At the NAB convention, *Barco-Industries*, Dallas, announced the signing of a 1-year agreement to supply 9-inch and 14-inch professional TV color monitors to Ampex. Barco also will be supplying 14-inch monitors for the Ampex VPR-3 and VPR-6 recorders. The contract includes both BI CTVM 4 and CVS monitors. The company also will supply 20-inch CVS monitors for the AVA and ESS graphics systems, and 20-inch CD-351 computer graphic displays for the PictureMaker 3-D modeling and animation system.

Acrodyne supplies transmitter

Xhrio-TV, Matamoros, Mexico, has installed the TT-252VL, a 20kW transmitter from *Acrodyne Industries*, Blue Bell, PA. The station has extended its coverage following the installation of the transmitter. The system was bought and installed by Amerimex International Media, El Paso, TX.

Canadian government selects Motorola system

The Canadian Department of Communications has selected the C-QUAM AM stereo system from *Motorola*, Schaumburg, IL, to be the technical standard for the transmission of stereophonic sound by Canadian AM radio broadcasters. The C-QUAM AM stereo system is one of several systems that has been used in Canada under a temporary experimental authority. The adoption of a single AM stereo technical standard is expected to accelerate the production and marketing of AM stereo receivers and the conversion to AM stereo by broadcasters in Canada.

Aurora Systems opens sales and training center

Aurora Systems, San Francisco, has announced the opening of a sales and training center in New York. It is at 165 W. 46th St., Suite 603, New York; telephone 212-575-3115. The facility services systems sales and client training for the Northeastern United States.

RTE accepts Dynatech NEWSTAR system

Dynatech NEWSTAR, Madison, WI, has announced that Radio Telefis Eireann (RTE) has released its final acceptance of the NEWSTAR system installed at its Dublin, Ireland, facility. The system, which comprises about 100 terminals and other devices, was installed and became operational in October. All of RTE's offices and remote bureaus in Ireland and abroad are linked to the Dublin system. For the past six months, the NEWSTAR operation has been subjected to a testing specification, encompassing continuous uptime and device performance.

Ikegami equipment to be used at '88 Olympics

When CTV hosts the 1988 Winter Olympics in Alberta, Canada, Feb. 13-28, it will be using at least 60 HK-323 and 323P automatic color cameras from *Ikegami,* Maywood, NJ.

Lexicon moves into new quarters

Lexicon, Waltham, MA, has moved to a 30,000-square-foot facility at 100 Beaver St., Waltham, MA. Engineering, marketing and sales, product development, manufacturing and customer service operations are at the new facility.

Microtime and PVK form agreement

Microtime, Bloomfield, CT, and *PVK*, Munich, West Germany, have completed the negotiation of a product/technology licensing agreement. PVK has granted Microtime exclusive manufacturing and marketing rights for its digital disk recording systems as well as certain technology for the NTSC areas of the United States.

CNN orders Midwest's uplink

CNN, Atlanta, has placed an order for its first portable satellite uplink for use in its news-gathering operations. The unit is manufactured by *Midwest Communications*, Edgewood, KY, and was delivered to the Atlanta headquarters at the end of March.

Midwest Communications, Birmingham, UK, has been awarded a contract for two satellite communications vehicles for use in Italy by Radiotelevisione Italiana (RAI). Construction is taking place in the Edgewood factory because the company is gearing up for European production in Birmingham later this year.

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