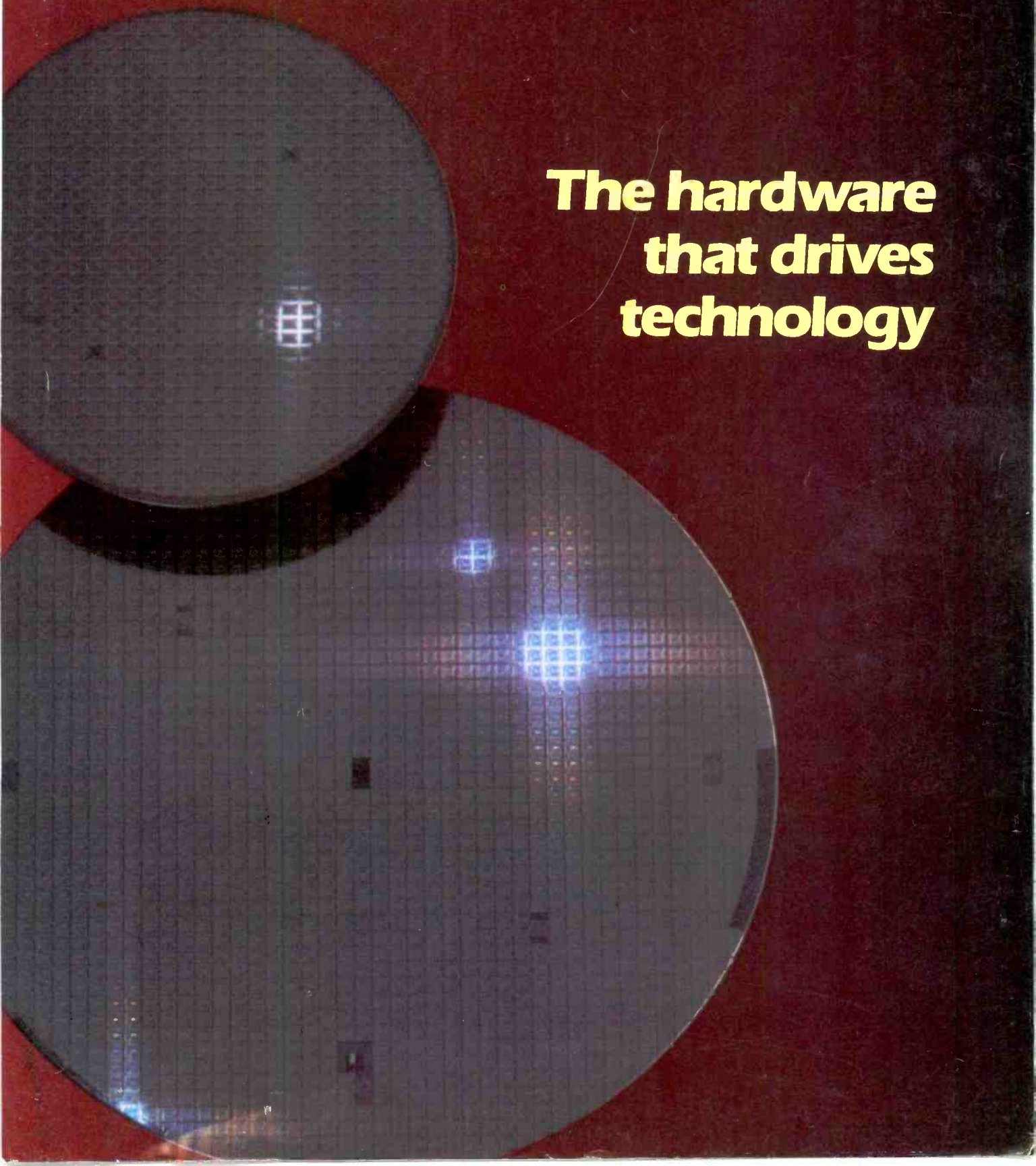
BROADCAST ENGINEERING®

December 1984/$3



The hardware that drives technology

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For Harrison Reliability

Sure, Harrison has waited to enter the U.S. broadcast market. When you're a stickler for precise engineering and a perfectionist when it comes to quality performance – you've got to take your time to get it right. *Get it just right for you.*

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It can be tough getting the right console to match your specifications. About as easy as fitting a square peg in a round hole, right? Harrison Systems has anticipated your need for versatility. A good deal of time and research goes into our consoles in order to bring you the smartest, most efficient technology and service. We've got the system that fits the size and scope of your needs, whether it be:

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- Video Sweetening and Post-Production
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- On-Air Broadcasting
- Broadcast Production
- Live Sound Reinforcement
- Music Recording and Scoring

At Harrison Systems, we give you choices – not excuses or unnecessary fluff. Our systems are designed to bring you long-lasting, clean performance and reliability.

Harrison Puts You In Good Company

Organizations like Swiss Broadcasting and Belgian Radio and Television have believed in the superior quality of Harrison Stereo Broadcast Audio Consoles for years and have chosen Harrison for multiple broadcast installations. Swedish Television has selected 8 TV-3 consoles and has committed to several more. This year's Winter Olympics in Yugoslavia received the main audio feed from a TV-3.

At Last

At Harrison, we take the time to listen to your needs. We design our consoles with the flexibility to fit your operation. And although our standards may be high for our consoles – our prices are very, very reasonable. We think you'll find it's been worth the wait – in golden, Harrison-true performance. Call us for a demonstration and see for yourself.

For Harrison Innovation

Introducing Harrison's TV-3, PRO-7 and TV-4, the broadcast consoles you've been waiting for:

TV-3 For large scale TV audio, remote production, studio production, post-production and sweetening ■ Adapts to wide range of tasks ■ Available in a variety of configurations for customization ■ Plus many options.

Now Available *AIR-7* For on-air stereo radio broadcasting, combining sophisticated technology with simple operation.

PRO-7 Designed for comprehensive use in broadcast, live sound, motion picture teleproduction ■ Two major configurations ■ Simple to operate ■ Cost-effective ■ Independent mix decision capability ■ Long-term performance achieved through thick-film laser-trimmed resistor networks ■ Plus many options.

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Harrison's new VSI Fader Section, which allows for simultaneous interface with automation and video editor/switcher, is available for TV-4 and PRO-7 consoles.

Why wait any longer? Call or write Harrison Systems, Inc., P.O. Box 22964, Nashville, TN 37202; (615) 834-1184, Telex 555133.

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So a DPS-103 gives you more. But at Midwest you get it for less. As one of the largest equipment distributors in the country Midwest deals in volume. So we can charge less per unit. In this case,

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a savings of almost $3000 from the regular price of $7950. And since we maintain an in-depth inventory of DPS-103 TBCs, we can ship your order as soon as we receive it. Quantity discounts are also available. So if you want to get more than you pay for in a TBC, contact Midwest today.

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BROADCAST engineering

The journal of broadcast technology

December 1984 • Volume 26 • No. 12

BROADCAST TECHNOLOGY FORECAST: 1985

Technology is pushing the broadcast industry ahead in ways that would have been considered only science fiction a few years ago. Our Technology Forecast for 1985 examines the road we have taken, and where we are likely to venture in the coming year.

20 **Editorial: Technology: Creating Tomorrow From Today**

22 **The Hardware That Drives Technology**
By Jerry Whitaker, radio editor
A journey into the world of microelectronics: how integrated circuits are made and how they are used in broadcast equipment. Our examination of this topic will also include the following specialized areas:
- **Wafer-Scale Integration: The Problems, the Promises**
- **New Techniques in VLSI Development**
- **In the Chips**
- **Microelectronics Glossary**
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36 **The View From Washington: FCC Actions During 1984**
By Harry C. Martin, legal consultant
Among the commission's actions were major changes in FM allocations, TV stereo and power allocations for Class IV stations.

42 **Whether a Storm?**
By Rhonda L. Wickham, managing editor
Feast or famine? The state of commercial radio and TV and their future is unclear.

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The recommended testing procedures for the **BE** FM audio proof and details of how to participate in our voluntary certification program.

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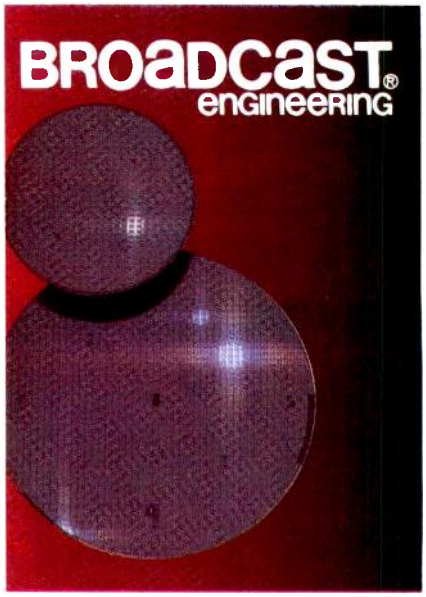

THE COVER this month shows two semiconductor wafers—one that is three inches in diameter and the other five inches—from which integrated circuits will be made. Few industries have affected the equipment that broadcasters use every day more than the semiconductor industry. "The Hardware That Drives Technology," a series of reports, begins on page 22. *(Cover courtesy of National Semiconductor.)*

Coming events
A listing of 1985 shows begins on page 97.

NEXT MONTH
- Remote broadcast/production vans and trucks
- RENG equipment interconnection
- ENG/EFP cameras and recorders

HITACHI INVENTS THE FIRST 1" VTR THAT WATCHES ITSELF SO YOU DON'T HAVE TO.

The revolutionary Hitachi HR-230 1" VTR has the most advanced real-time, self-diagnostic capabilities ever perfected.

In either the record or playback mode, a computer inside the HR-230 monitors 49 different performance parameters second by second. And then stores this information within the memory for recall at a later time—not just with numbers and symbols, but in words.

This means no more errors slip by when your operator is not there. And there's no more need for hit-or-miss spot checking.

The Hitachi HR-230 has a unique quick-threading tape path, incorporating retracting entrance and exit guides, main erase head, as well as a scanner air system that protects tapes.

It recues a 30-second segment in 3.5 seconds. It has a fast/slow motion range that provides real-time reverse and field/frame still motion. Plus programmable time compression up to 20%, with 0.1% accuracy.

A unique, concealed fold-out control panel groups editing functions and separates edit controls from the main control panel.

In short, it's the ultimate 1" for networks, affiliates or teleproduction companies. Don't consider your next 1" purchase without looking into it. Contact Hitachi Denshi America, Ltd., Broadcast and Professional Division. 175 Crossways Park West, Woodbury, NY 11797. (516) 921-7200 or (800) 645-7510. Hitachi Denshi, Ltd. (Canada). 65 Melford Drive, Scarborough, Ontario M1B 2G6. (416) 299-5900.

Hitachi

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business

In the Buyers' Guide of the September issue, Ampex was left out of the suppliers for video production services switchers section. Ampex is recognized for their 4100 series and AVC series switchers, which are used in broadcast, production and post-production facilities.

The Successor Corporation has formed a new division: **Eltrex International Corporation.** Eltrex will produce and sell Comex Systems digital voice and paging products to non-federal government customers.

Fleehart & Sullivan has been appointed representative of the Pacific Northwest region for **nova systems,** Avon, CT. This territory includes Washington, Oregon, Idaho, Montana and Alaska. Representing the California region will be **Lyle Bailey** of **ESP.** This territory includes New Mexico, Nevada, Colorado and California.

Marconi Communications Systems Ltd. announces the appointment of **Comark Communications,** Southwick, MA, and Colmar, PA, as the sole distributor for MCSL broadcasting transmitter products in the United States, Central and South America. According to the agreement, Comark will distribute MCSL UHF exciters, VHF, AM, FM and HF transmitters from low power to 250kW output power. Also included under the agreement is the newly announced 7500 series of highband VHF TV transmitters.

Broadcast Electronics, Quincy, IL, has completed shipment of a 30kW FM broadcast transmission system to **WPLJ,** flagship FM station for ABC Radio, New York. The $200,000 system includes two FM-30s, 1-tube 30kW FM transmitters for main/alternate service and custom-designed output switching equipment for main/standby antenna systems. The new equipment is to be installed in the Empire State Building.

Comsearch, Reston, VA, has announced a new service to protect cable TV systems from interference caused by low power television (LPTV). The service, called CLIP (for CATV/LPTV Interference Protection), uses a computerized data base to identify potential interference cases from among the thousands of LPTV applications being processed by the FCC.

The U.S. Information Agency has awarded a contract to **Shook Electronic Enterprises,** San Antonio, TX, to manufacture a radio van for **Voice of America,** Washington, DC. The facility will serve as a mobile studio and will be touring the United States to cover news events and human interest stories for overseas broadcast.

Calvert Electronics, East Rutherford, NJ, has taken delivery on a transmitter purchased from WCTT in Corbin, KY.

Richardson Electronics, Franklin Park, IL, announces the ability for its customers to call toll free 1-800-323-1770 from all provinces of Canada. This announcement by Ian Stewart, sales manager, corresponds with the corporate expansion of the company's present capabilities to ship all orders the same day they are received. This service gives Canadian customers the ability of direct access to sales personnel for inquiries on pricing, stock position and placing orders.

BROADCAST engineering

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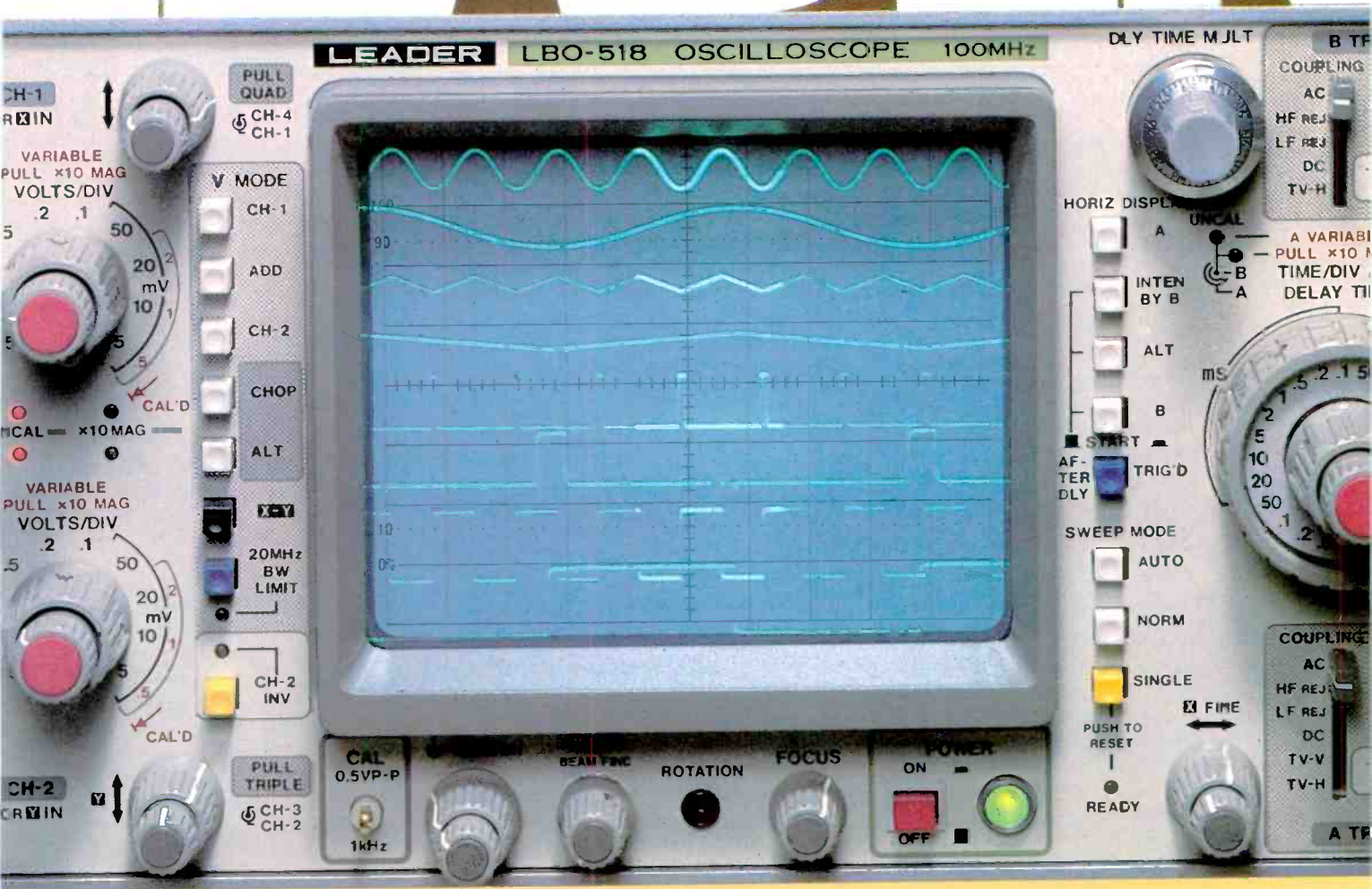

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A year ago, we predicted that the Leader LBO-518 would replace the TEK 465 as the new industry standard. Now, there is no doubt about it. Hundreds of companies have evaluated and purchased the LBO-518, some in very large quantities. And new orders are pouring in.

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Although the LBO-518 costs $1090* less than did the TEK 465, this versatile 4-channel alternate time base scope provides superior performance and features. It has a faster, brighter, higher voltage CRT; ten times greater maximum vertical sensitivity; an extra calibrated input; and it's compact enough to fit under most airline seats. Of course, the LBO-518 beats the TEK 2235, since that's not even in the same league as the 465.

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Try one Leader LBO-518. You'll be impressed with its amazing versatility, performance, accuracy and ease-of-use. Compare this cost-effective, feature-packed oscilloscope to any on the market. Once you do, we're sure the LBO-518 will become your company's new 100-MHz standard.

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*Based on price & specs published in 1983 Tektronix catalog. TEK is a registered trademark of Tektronix.

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FCC update

December 1984

By Harry C. Martin, partner, Reddy, Begley & Martin, Washington, DC

LPTV window processing

To streamline and expedite processing of LPTV and TV translator applications, the FCC has adopted window filing procedures to replace its current filing rules.

With the new rules, a series of filing windows will open at least 30 days after public notice of the window. New applicants will have a limited time after the notice period expires, probably five days, in which to file complete applications.

Applications filed during the window would either be placed on a proposed grant list or grouped for a lottery with other mutually exclusive applications filed during the window period.

Because LPTV allocations are made on an interference basis rather than a predetermined table of community allocations, it will not be possible to open filing windows on a market-by-market basis. It is expected that the first filing window for LPTV applications will involve every frequency still available at any location.

The commission is in the process of reducing its backlog of LPTV applications through lotteries and dismissing defective proposals. By July 1985, the FCC expects to have made substantial progress in clearing its data base, eliminating the preclusive effect of many now-pending but ungrantable proposals. Once the data base is unclogged, the commission plans to open its national LPTV filing window.

Those wishing to file LPTV applications when the window opens may wish to determine now if there is a frequency available for a particular community. While the FCC's data base still is crowded with unacceptable and mutually exclusive applications, a channel available now still would be available when the window opens next year.

In connection with adopting window filing procedures, the commission also has eliminated the requirement for filing financial certifications with LPTV applications but has instituted a new requirement that applicants certify they have reasonable assurance of the availability of their transmitter sites. The commission also refused to create a priority or separate processing class for TV translators.

Issues/programs list retained

The FCC has decided to retain the requirement that commercial radio licensees compile and make available in their public files issues/programs lists. Since July 1, radio stations have had to place such listings in their public files on a quarterly basis.

When the FCC deregulated commercial radio in 1981, it deleted processing guidelines regarding non-entertainment programming and commercial levels and removed ascertainment and program log requirements. However, radio stations still were obligated to provide programming responsive to community issues and to prepare an annual issues/programs list documenting their service.

The U.S. Court of Appeals remanded the FCC's deregulation order, questioning the sufficiency of the annual issues/programs list as a means to gauge service in the public interest. In response to the remand, the commission sought comments on various record-keeping options. At the conclusion of its proceeding the agency modified the list requirement, removing the 10-issue limit established in 1981 and requiring the list to be prepared and made available quarterly rather than annually.

The National Radio Broadcasters Association sought reconsideration of the ruling, arguing that quarterly issues/programs lists are unnecessary. The commission disagreed, saying it had properly balanced the public's need for information against the burdens involved in a quarterly listing requirement.

The FCC's rule, Section 73.3526(a)(10), describes the listing that must be maintained as follows:

> For AM and FM broadcast stations every three months a list of at least five to 10 community issues addressed by the station's programming during the 3-month period. The list is to be filed the first day of each calendar quarter (e.g., July 1, October 1, January 1 and April 1). The list shall include a brief narrative describing how each issue was treated, i.e., public service announcements or programs, giving the description of the program including time, date and duration of each program. These lists are to be retained for the entire license renewal period.

On reconsideration, the FCC granted a 10-day grace period (i.e., to July 10, October 10, January 10 and April 10) for filing of the described listings.

Interference standards for Channel 6/educational FM

The FCC has adopted new rules designed to minimize the interference caused by noncommercial educational FM stations to the reception of Channel 6 TV stations.

The commission decided that the most desirable option is co-location of FM stations with TV-6 transmitting antennas. The commission said it would permit educational FM stations to operate with high power in co-location situations, which it defined as locations within ¼-mile of the Channel 6 transmitter.

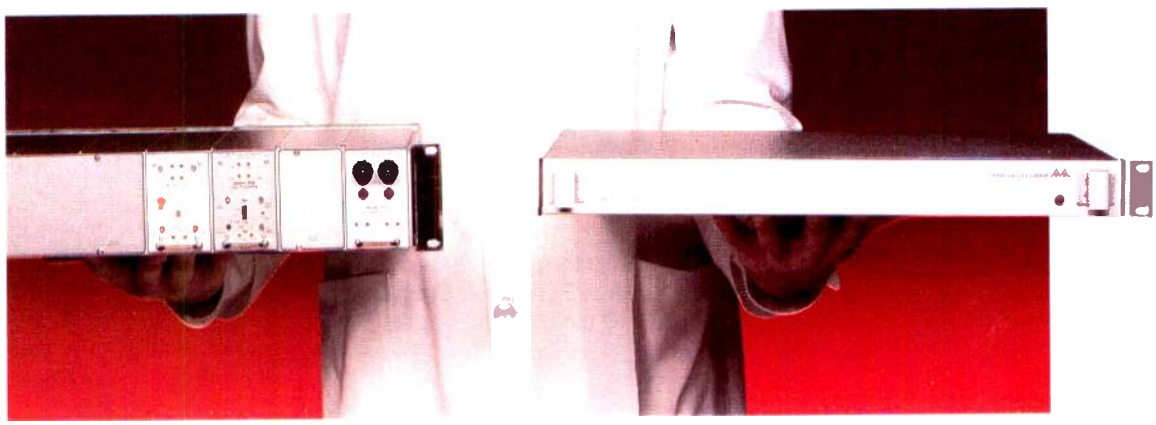
Educational stations not in this zone would be restricted in power based on their frequencies and the Channel 6 station's signal strength. The restriction zone would end 140 miles from the nearest Channel 6 station.

Under the new rules, a noncommercial FM permittee would have a choice between two power levels, a recommended level (level 1) and a maximum level (level 2). The recommended powers are based on three square miles of effective interference within the Grade B contour of the Channel 6 service area. Noncommercial FMs choosing the higher power would assume full financial responsibility for eliminating interference.

Elimination could be accomplished through traps and filters, using of vertical polarization of the FM antenna, installing a TV translator, or by pru-

Continued on page 98

Would You Turn Trader For $500?



If you're among the thousands who have a 900 Series single or dual sync generator system, it could be worth $500 or more.

For a limited time, we'll buy back your single 900 Series system for $500 when you order our 3252A Master sync generator. And if you choose to purchase a 3252A -SG1 or -SG2 dual system, we'll buy back your dual 900 Series system for $1000.

You've never seen an offer like this before. Chances are you won't see one again. And you've only got between now and April 1, 1985 to take advantage of this unusual deal.

Your 900 Series sync generator has already paid for itself several times over. Now make it pay off one more time by stepping up to the best designed, best built and most dependable sync generator made.

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Midwest puts on a great show because it uses the best components

One of the reasons that the Midwest M-40 Series is the most advanced class of large mobile teleproduction units available today is our policy of only using the finest components. This "no compromise" design philosophy ensures a system of superior quality and reliability. Our M-40 units give you up to 47 feet of unparalleled technical and creative capacity. Because we only use the best components . . . from companies like Ikegami.

Ikegami HK-322 automatic color cameras make Midwest picture perfect

In the M-40, we wanted the ability to produce the best possible pictures. So we selected the HK-322 as a basic building block of the system. When the position as the world's most popular field camera passes from the Ikegami HK-357A, it will be to the HK-322. This fully automatic color camera sets the new standard for picture resolution, signal-to-noise ratio and registration accuracy. Standard computer set-up takes much of the hassle out of preparing for remote telecasts. With the Ikegami HK-322, the Midwest M-40 delivers perfect pictures everytime.

Ikegami HL-79E Series plays dual role for Midwest units

The Ikegami HL-79E Series camera was selected for use aboard the Midwest M-40 because it can handle two separate functions with superlative results. Although it's renowned as the perfect hand-held camera, the HL-79E Series can easily be converted into a field camera that produces higher quality images than many other manufacturers' top-of-the-line studio models.

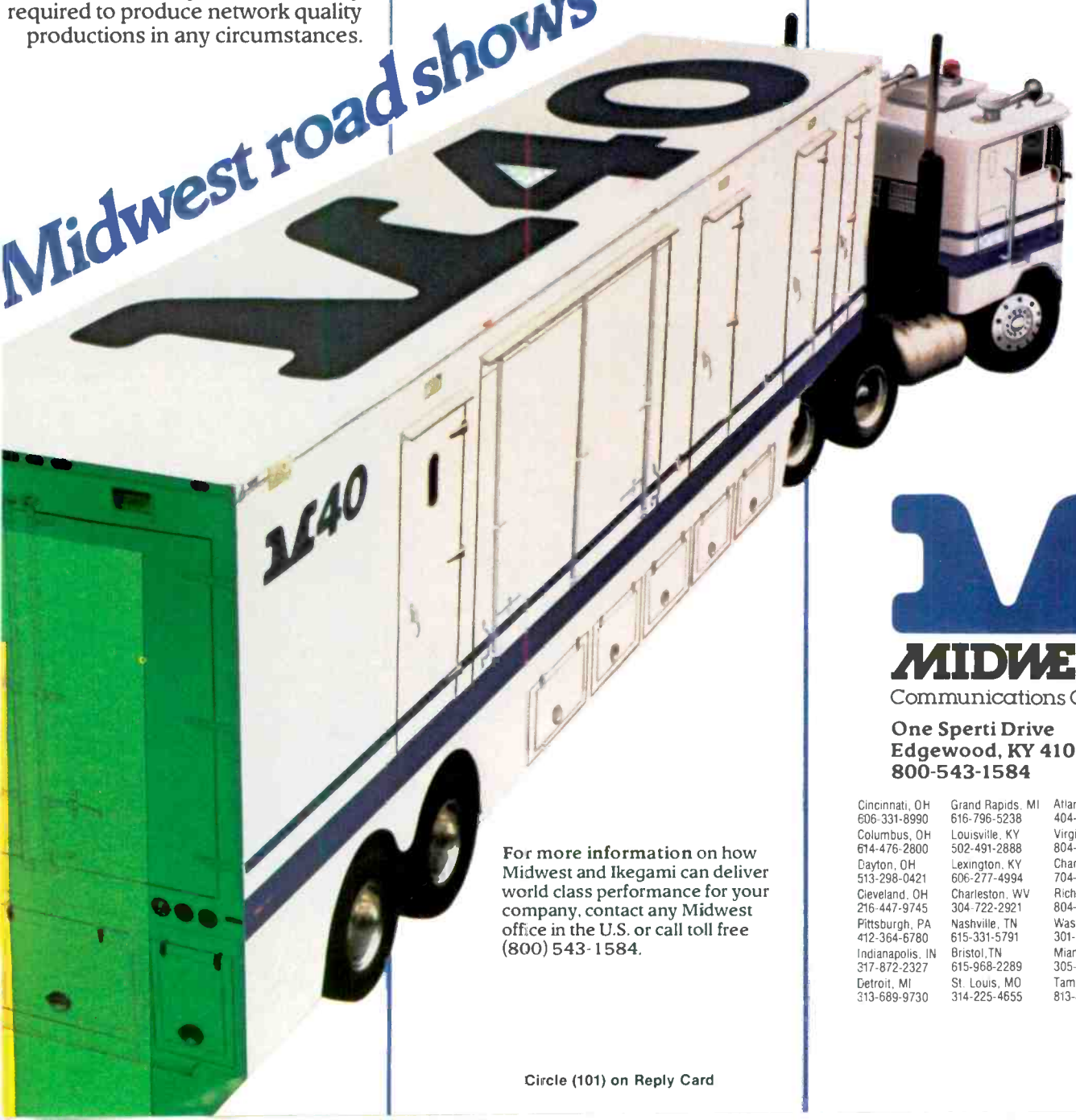
This exceptionally fine performance is due to Ikegami's painstaking attention to detail. Designed to meet the most rigorous performance standards, the HL-79E Series also offers optional automatic set-up, either via its own set-up computer or by interface into the HK-322 set-up computer for total system integration. With the HL-79E Series, Midwest's M-40 offers you the versatility required to produce network quality productions in any circumstances.

Ikegami 9-Series color monitors give Midwest "true to life" pictures

Ikegami 9-Series Color Monitors are standard in the Midwest M-40 mobile unit because of their superb resolution and ability to reproduce colors that are amazingly life-like. This performance is unmatched by any other monitor in the world. Since the 9-Series monitors use In-Line Gun CRTs, they provide more than excellent colorimetry and

fantastic resolution. They also offer high stability, unit interchangeability, low power consumption, and convenient pull-out circuit panels. By using the Ikegami 9-Series, the Midwest M-40 can reproduce colors that are true to life.

Midwest road shows



For more information on how Midwest and Ikegami can deliver world class performance for your company, contact any Midwest office in the U.S. or call toll free (800) 543-1584.

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Strictly TV

by Carl Bentz, television editor

Psychoacoustics and spectral processing for stereo TV

Stereo sound adds a new vocabulary to the world of television. Among the new words, *spectral processing* and *psychoacoustics* need to be explained.

Compatibility with today's monaural TV receivers was a key requirement in the design of a stereo transmission system. In the Zenith approach, the sum of left plus right (L+R) replaces the normal monaural signal. To add stereo, a difference of left minus right (L−R) is transmitted on a subcarrier at 31.468kHz (twice the video H-rate) that FM modulates the main aural carrier.

FM systems characteristically have more noise at higher modulation frequencies. The L+R covers 0 through 15kHz in the TV aural spectrum, but L−R extends from 17kHz to 46kHz. When demodulated, the L−R information will contain a larger measure of noise than a L+R adding to the overall received audio.

Increasing the L−R subcarrier modulation level is one way around the noise problem, but the Zenith approach allows only 6dB more modulation with L−R than with L+R. A greater amount would risk introducing interference. And if a complete Zenith channel is used, i.e., with SAP and engineering channels on top of stereo, the noise becomes an even greater factor.

The best solution is noise reduction, or psychoacoustic masking. By making the program material loud enough and spectrally broad, the ear is captured by the desired signal rather than by system noise (Figures 1 and 2). Most noise reduction systems operate on this principle.

An encoder compresses the audio to mask the noise of the channel during transmission. In the receiver, expansion or decoding recovers the original audio while, it is hoped, eliminating all possible noise and introducing a minimum of distortion.

Working with FM

Noise increases with modulating frequency. In the L−R subcarrier, white noise with a 3dB/octave rising characteristic is found. For the SAP subcarrier, the characteristic is found to be 9dB/octave. To mask out these white noise (hiss) components, the desired signal must contain substantial high frequency content. Normal program material typically lacks the required higher frequencies.

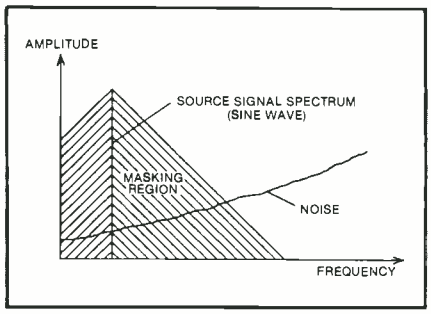

Figure 1. Masking of noise by a low frequency tone.

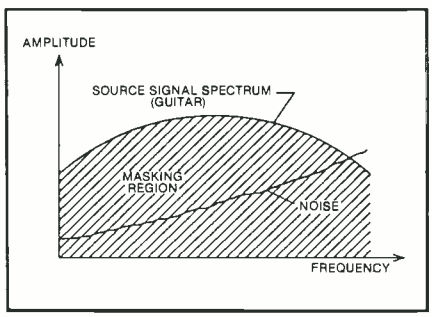

Figure 2. Masking of noise by a broad spectrum signal.

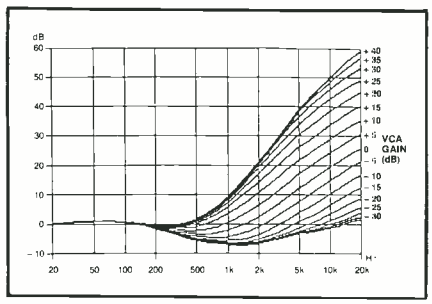

Figure 3. Frequency response range of spectral compressor and fixed pre-emphasis.

In FM and TV broadcasting, pre-emphasis increases the content of highs, relative to low frequencies. Essentially, pre-emphasis involves a high-pass filter with a time constant of 75μs. In the receiver, a complementing low-pass filter with a matching time constant of 75μs de-emphasizes the signal, recovering the proper spectral balance.

Stereo TV processing with dbx uses two such pre-/de-emphasis circuits. For the L−R channel, 72.2μs pre-emphasis is used. In the SAP channel, the value is 390μs. The decoder de-emphasizes at the 72.2μs and 390μs values, restoring tonal balance and reducing hiss that originates in the transmission channel.

Adaptive spectral companding

Typical program audio is inconsistent in tonal balance and level. Fixed pre-emphasis ignores the precarious possibility that a signal with predominating high frequencies will cause overmodulation, because of lack of headroom. At other times, insufficient level and reduced highs does not mask channel noise.

Spectral companding helps avoid both problems. Within the encoder, tonal balance of the input is assessed. If large amounts of high frequencies are present, then less pre-emphasis is required.

Conversely, more pre-emphasis is used if the highs content is low. To provide varying control, a VCR element in the frequency selective network of the encoder is gain-controlled

Continued on page 100

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By Bob Streeter,
AM Stereo, Inc., Fort Wayne, IN

Editor's note:
This is the third article of a series on converting an AM station to stereo. This month's article discusses the requirements of the studio-to-transmitter link (STL), using either a radio system or telephone company loops. The information in the article appears courtesy of Continental Electronics.

The STL carries the program audio material from the studio to the transmitter for broadcast, and so the characteristics of the system are critical to an AM station's overall stereophonic performance. The STL may consist of a matched pair of telephone lines, as many FM stereo stations use, or a microwave radio relay system.

The microwave system may use 2 different frequencies, or a single frequency on which a composite (FM stereo) signal is relayed. The composite signal must be encoded at the studio and decoded into the left and right audio channels at the transmitter. There is no such thing as a *composite AM stereo* audio signal, as there is for FM stereo.

Any STL system must be closely matched between left and right audio channels in both amplitude and phase (transmission time delay) for satisfactory crosstalk performance between the sum (L + R) and the difference (L – R) channels. If this crosstalk is high enough, frequency response holes in monophonic and stereophonic programming will occur.

It has been assumed that an AM station would choose to transmit left and right channel audio between the studio and the transmitter. Stations also can relay the sum and difference (matrix) information, however. Using a matrix system would appear to be more technically hazardous, though, in that a serious mismatch between the sum and difference channels will destroy stereophonic separation. Mismatches between left and right audio channels, on the other hand, will cause the center image of the stereophonic sound field to be slightly offset, but will not significantly affect the system's separation.

The primary hazard of separate left and right program audio transmission is the possibility of frequency response holes in the L + R and L – R signals, which would affect the listenability of the station. Generally, however, these problems should be easier to deal with than the difficulties that would be encountered in maintaining accurate L + R and L – R amplitude and phase coherence, necessary for good separation.

Figure 1 shows the phase and amplitude coherence between L + R and L – R that is required for various degrees of stereo separation. The graph is actually a set of parametric curves that may be applied to any matrixing operation, encoding or decoding. It is applicable to the investigation of response and time delay accuracy required in the L + R and L – R signals for a given channel separation, or for the coherence required of the left and right channels for a given amount of crosstalk between L + R and L – R.

How good is good?

Generally, it is possible to control studio equipment performance and STL characteristics so there is no significant stereophonic degredation with a normal installation.

As a check, measure the audio output of the studio and STL system at the transmitter input for distortion, noise, crosstalk, frequency response and phase coherence, through each piece of equipment that may be used for on-air programming.

It might be useful to consider a special set of performance measurements on an overall basis of the studio and STL equipment at the transmitter input. These checks would fall into four general categories: left channel, right channel, combined L + R and combined L – R. The acceptable level of performance for a particular station is a decision that is based upon tradeoffs between performance and expense. Every station will have its own set of performance goals, but some general guidelines are in order.

For the left and right audio chan-

Continued on page 99

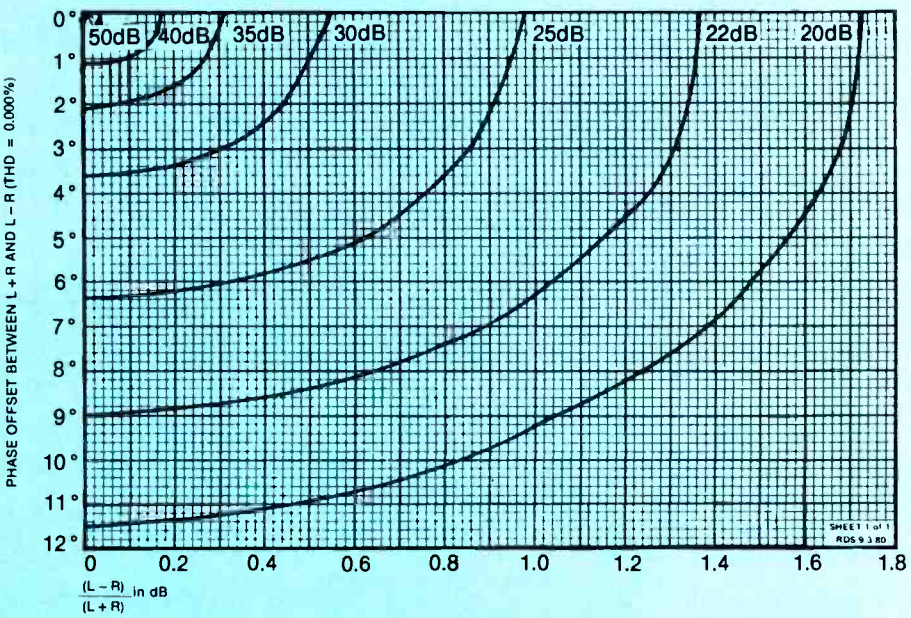

Figure 1. A graphical representation of the influence that amplitude and phase coherence have on stereo separation. The *curves of constant separation* are given for 7 levels of stereo separation (20dB to 50dB).

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Satellite update

By John Kinik, satellite correspondent

2-degree spacing technical parameters

The brave new world of 2-degree spacing is approaching rapidly, with the first phase already in effect. Two pairs of satellites are now assigned by the FCC to operate closely spaced in the C-band:

- Spacenet 1 (120 w.l.) and Westar 5 (122.5 w.l.)
- Satcom 2R (72 w.l.) and Galaxy 2 (74 w.l.)

As satellites with C-band transponders are added to the orbital arc, true 2-degree spacing will gradually become a reality. The key technical parameters involved in interference from adjacent satellite systems spaced 2° apart are summarized in the following tables.

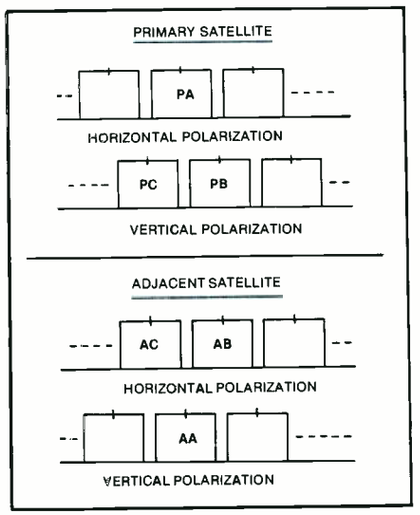

Figure 1. Typical adjacent satellites frequency/polarization plans.

Note: PA is primary satellite transponder with center frequency A. PA receives interfereence from adjacent satellite transponders AA (30dB isolation) and AC + AB (25dB total isolation).

- **Geocentric Spacing – 2° (nominal)**
  – 1.8° (worst-case, with worst-case satellite orbit position errors)
- **Topocentric Spacing – 2.1° (nominal satellite spacing)**
  – 1.9° (worst case satellite spacing)

Note: Geocentric spacing is measured from the center of the earth. Topocentric spacing is measured from the surface of the earth. (Figures for topocentric spacing are for typical worst-case combination of a receive earth station located in the western United States, looking at Satcom 2R or Galaxy 2.)

Table 1. Satellite spacing geometric parameters.

- **Frequency plans – Transponder center frequencies are interleaved to achieve frequency reuse with orthogonal polarizations. This provides approximately 25dB of isolation between TV signals with equal EIRPs in overlapping frequency bands.**
- **Polarization – 30dB (typical) of isolation is provided between TV signals with equal EIRPs because of orthogonal polarization of transponders with identical center frequencies on the adjacent satellite.**
- **Saturating flux density – Transponder SFD can be set over a typical range of up to 9dB by switching attenuators in or out in the satellite receiver by command from the satellite control center. A mismatch of up to ± 9dB can exist between uplink TV signal EIRPs on adjacent satellite systems.**

Table 2. Typical satellite parameters.

- **FCC sidelobe levels = (29 – 25 log Θ) dBi – maximum isotropic gain allowed**
  = 22.0dBi (for Θ = 1.9°)
- **Receive antenna sidelobe isolation* (3m)**
  (from adjacent satellite) = 39.8 – 22.0 = 17.8dB
  (5m) = 44.2 – 22.0 = 22.2dB
- **Interfering transmit antenna sidelobe isolation*(5m)**
  (into adjacent satellite) = 47.6 – 22.0 = 25.6dB
  (10m) = 53.6 – 22.0 = 31.6dB
- **Receive antenna cross-polarization isolation –**
  Two factors can reduce the isolation from orthogonally polarized signals in the desired satellite as well as from adjacent satellites.
  1) Feed polarization setting error – initial setup error.
  2) Pointing error – null of the cross-polarized pattern occurs at center axis of main beam.

***Assuming FCC sidelobe requirements are met and pointing error is zero.**
Note: 3 factors can reduce the isolation in receiving antennas:
1) Initial setup alignment error for 3m antennas.
2) Long term sag – for fiberglass antennas in 5m class.
3) Sidelobe patterns vary with frequency and polarization so that the expected isolation exhibited on a single pattern may be misleading.

Table 3. Typical earth station antenna parameters.

A letter from the President of Ikegami

Ikegami Electronics (U.S.A.), Inc. 37 Brook Avenue Maywood, N.J. 07607 (201) 368-9171

Nick H. Nishi
President

Dear Ikegami HL-79 Camera Customer:

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Through the press I wish to thank all our customers for using over 5,000 sets of the HL-79 series cameras.

Sincerely,

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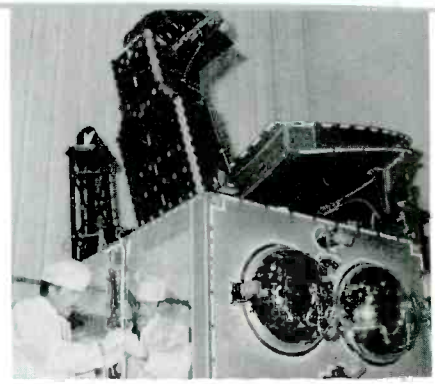
• Adjacent satellite transmit earth station into primary satellite			
Transmit antenna isolation (5m)			25.6dB
Uplink EIRP mismatch (typical)			– 5dB
Net uplink interference isolation			20.6dB
Satellite polarization isolation			30dB
Satellite frequency isolation			25dB
Total isolation-satellite output – Cross polarization			50.6dB
frequency isolation (44.4dB combined)			45.6dB
Total interference isolation – 44.4 – 3 = 41.4dB (two adjacent satellites) (negligible interference)			
• Adjacent satellite into receive antenna		3m	5m
Receive antenna isolation		17.8dB	22.2dB
Second adjacent satellite		– 3dB	– 3dB
Net isolation		14.8dB	19.2dB
Net isolation with EIRP mismatch	0dB	14.8dB	19.2dB
	3dB	17.8dB	22.2dB
	5dB	19.8dB	24.2dB
	– 3dB	11.8dB	16.2dB
	– 5dB	9.8dB	14.2dB

Table 4. Typical system interference parameters.



Joining the Spacenet system in November was the GTE Spacenet 2 satellite by RCA, shown in final testing.

Table 4 illustrates the relative importance of interference received as a result of receive antenna sidelobe isolation compared with other sources in the system. It is imperative in the new 2-degree spacing environment that receive antenna pointing be optimized and that pointing errors caused by weather (wind, ice and snow) be minimized to maximize sidelobe isolation from adjacent satellites in the event that EIRP mismatches between the desired and interfering signals occur in typical operating situations. It is also important to have complete data on sidelobe patterns (all frequencies, both polarizations) to avoid potential problems.

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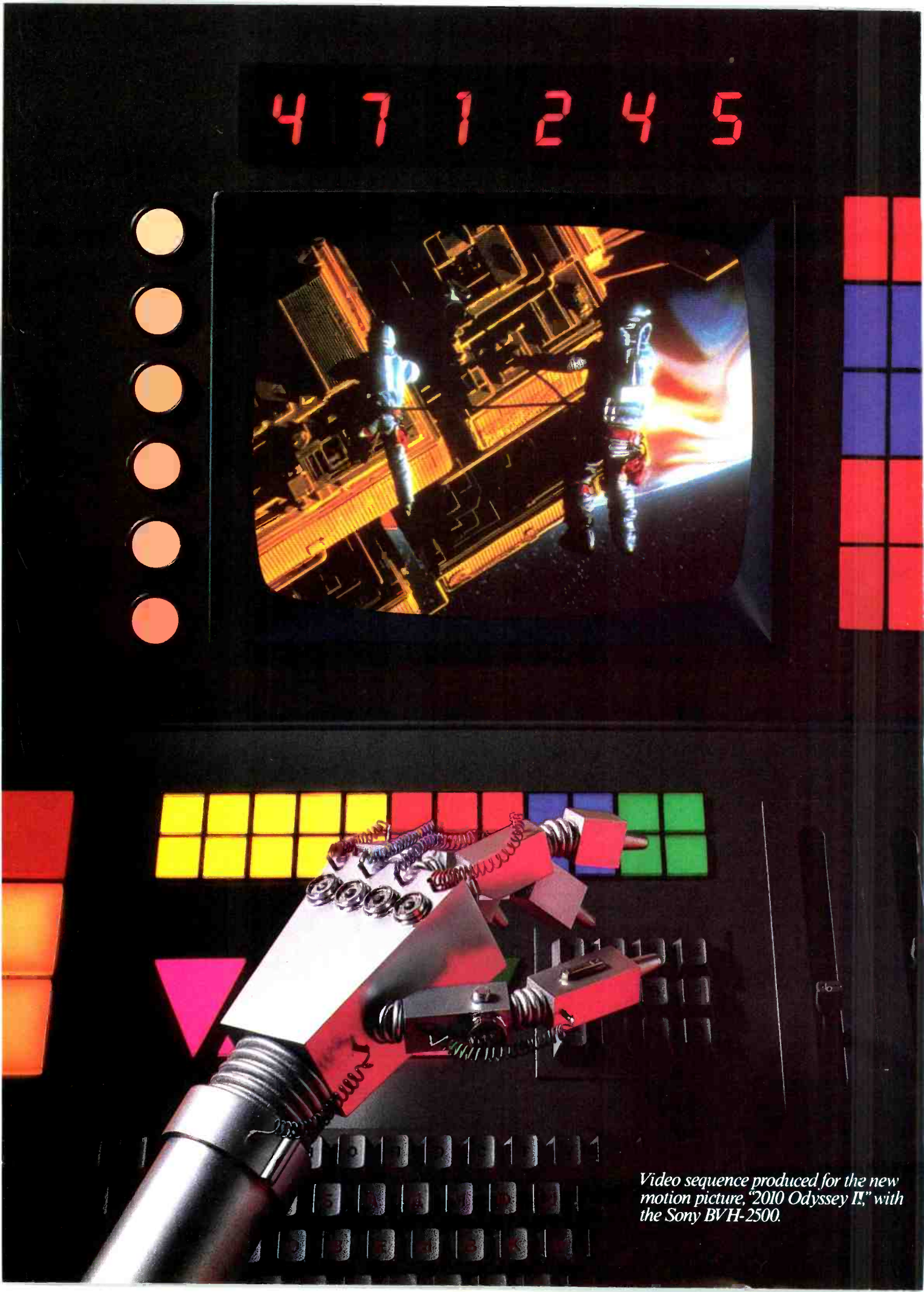

Video sequence produced for the new motion picture, "2010 Odyssey II," with the Sony BVH-2500.

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Even for MGM, the creation of complex, animated action sequences seen simultaneously on 80 video monitors for the film "2010" was a monumental job. Clark Higgins, the production head, was given this seemingly impossible task made even more impossible by a shortened shooting schedule. Sony was the only place to turn.

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Technology: creating tomorrow from today

The world's first digital electronic computer was built with 18,000 vacuum tubes. It occupied an entire room, required 140kW of ac power, weighed 50 tons and cost about $1 million. Today, an entire computer can be built within a single piece of silicon about the size of a child's fingernail. And you can buy one at the local parts house for less than $10.

The progress of technology within our lifetime has produced some dramatic changes in our lives and in our industry. Impressive as the current generation of microprocessor-controlled broadcast equipment is, we have seen only the beginning. This month in **BE**, as the new year approaches, we look at today's technology, and where it will lead us tomorrow.

Few industries have affected the design of broadcast equipment more than the semiconductor industry. Integrated circuits have revolutionized broadcast hardware. They have made it smaller, lighter, quieter and cooler.

Today, it is hard to purchase a piece of equipment that doesn't include at least one IC. These components have given broadcasters equipment with higher performance, greater reliability and lower cost than was ever possible using discrete transistors, let alone those glowing glass envelopes we used to call tubes.

Despite its fascination with electronic gadgets, the broadcast industry as a whole is rather conservative when it comes to implementing new technology. Each advancement, from the transistor to the microprocessor, has had to fight its way into radio and TV stations.

Broadcasters demand a proven track record of performance and reliability from the equipment they use. The transistor, invented in 1947, did not come into its own in the broadcast industry until the mid 1960s. Broadcast engineers accustomed to the vacuum tube viewed this new device with skepticism for a long time. Until 1960, most radio and TV stations built their audio chains upon the 12AX7 and 6V6 tubes. The 6BA6 and 6AU6 were perhaps the backbone of TV video. By 1970, however, virtually all of those familiar links with the past had been replaced with the likes of the 2N2924 and the 40314.

The IC made its entry into the broadcast equipment field in a big way during the 1970s. Invented in 1959, the IC had to prove itself as did the transistor years earlier.

A similar evolution is under way with microprocessor-based equipment. When first developed in 1971, many broadcast engineers unfamiliar with the new technology were skeptical. Some even feared the microprocessor. Implementing this tool was slow at first, but now the latest leap in technology has proved its usefulness in a wide variety of applications.

Everyone in broadcasting expected the microprocessor chip to be used in program automation and business computer systems. But who would have believed that these devices would find their way into virtually every major broadcast system? You can find microprocessors in broadcast transmitters, remote control systems, test instruments, audio processing gear, audio and video control boards and even cart machines.

What is the next big technological leap to come from the semiconductor industry? Many IC engineers feel it will be the 1-month chip, in which the design, fabrication and testing of a specialized IC device would be accomplished in 31 days, instead of the months or years that it now takes.

Others point to the mind-boggling concept of wafer scale integration (WSI). WSI is the next step beyond very large scale integration (VLSI) IC construction. Engineers are talking about building devices that will integrate millions of logic gates into a single package about the size of your hand.

As engineers work to unfold the next generation of semiconductor devices, we must prepare for the technological advances that will filter to our applications as a result of new IC developments. The best way for broadcasters to prepare for tomorrow is through farsighted planning of their technical facilities today.

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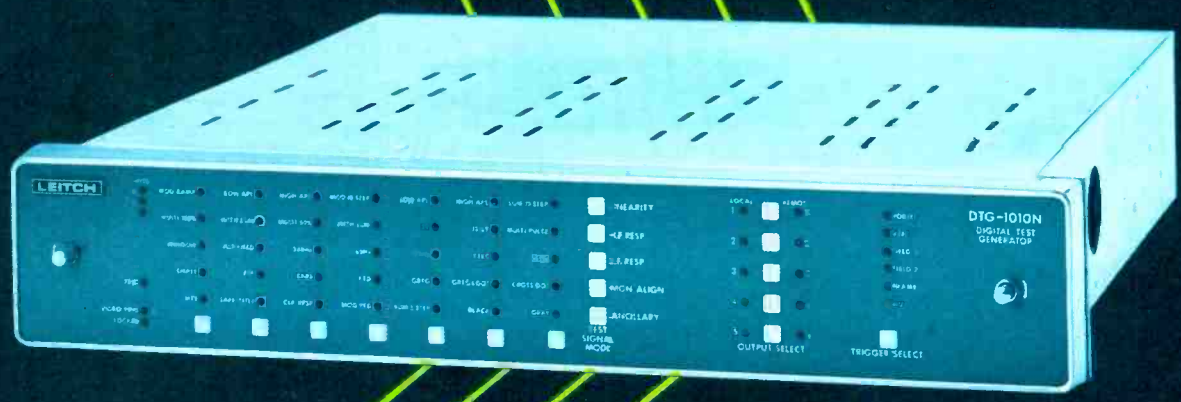

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The IC has been the driving force behind many significant equipment advances and promises to revolutionize the future of the electronics industry in general, and broadcasting in particular.

The hardware th

Courtesy of Zilog.

By Jerry Whitaker, radio editor

It is fascinating to watch the fabrication of integrated circuit chips. ICs are so common today—and inexpensive—that it is easy to forget they are actually built piece-by-piece. Some people may think that they're hatched in a big black box! They are not.

The fabrication process is long, detailed and requires incredible precision. The effort pays off, though, with millions of chips produced every year by each of the major semiconductor manufacturers that have direct application to broadcast transmitting and receiving equipment.

IC fabrication is done in large *clean room* facilities by operators wearing head-to-toe "bunny suits." Anyone entering the clean-room must first pass through an air shower. Everything brought into the facility is carefully checked for contamination. Special paper is even used inside the fabrication plant to limit the contamination that would result if standard notebook or computer printout paper were used. These *advanced-process fabs*—as they are called—are 100 times as clean as a hospital surgery room.

Making the chips

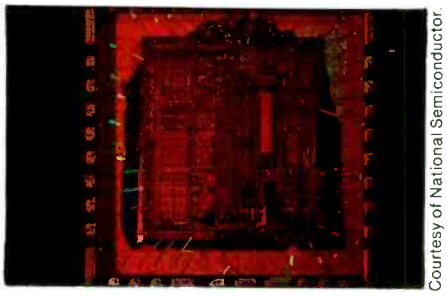
The design of an IC begins with a large-scale drawing of the new device. Called a *composite drawing*, it is 400 times larger than the actual IC. The composite drawing consists of a num-

WSI: the

Wafer-scale integration (WSI) is a technology that holds incredible opportunities for the semiconductor industry. The technology is plagued, however, with several stubborn problems. WSI "superchips" are the next step beyond VLSI integrated circuit development. Instead of using a single wafer to produce hundreds or thousands of individual ICs, the WSI concept calls for the entire wafer to be used for a specific application. This allows the integration of *millions* of logic gates into a single package the size of your hand.

As reported in the October issue of the *IEEE Spectrum*, the superchip concept is not new. Texas Instruments tried using an entire wafer to implement the first large-scale ICs in the mid-1960s. The process, however, required higher technology than was available at the time. Marketplace demands also did not support the sophistication that WSI technology could provide.

Chip fabrication technology today has progressed to the point that it is possible to produce WSI devices. However, several significant problems still remain. The primary difficulty for a WSI designer is removing heat produced by the device. Because the pack-



Courtesy of National Semiconductor.

Integrated circuits are fabricated in an ultra-clean environment (upper left photo) to keep contaminates that might damage wafer dice to an absolute minimum.

As many as 18 different masks are required to produce the needed circuit pattern on the surface of a silicon wafer. These complex masks are generated by an electron beam exposure system (upper right).

Dry etching equipment is used to remove selected areas of oxide during processing (bottom left). Dry etching is designed to eliminate undercutting of the etched surfaces.

The finished product (bottom right). This die is now ready for the installation of connecting wires to the package pins, after which the unit will be encapsulated. The color of the die comes from the various masking stages.

t drives technology

roblems, the promises

age density of the active circuits of a WSI chip is so much greater than in a LSI chip—or even a VLSI chip—the amount of heat produced over the wafer surface is a serious problem. In fact, it would not be uncommon for a large WSI chip to produce 1kW of heat.

Several innovative heat removal systems have been devised to conduct large quantities of heat away from the water surface. Specially constructed wafer mounting forms have been designed to conduct heat from the wafer to a large heat sink area, where it is removed by helium gas or water circulation through the heat sink structure.

The second major problem with WSI fabrication is that of wafer yield. In conventional IC fabrication, several defective dice within a single wafer can be tolerated, as they are simply discarded. Semiconductor manufacturers expect a certain number of fabrication flaws because of contaminants that may be introduced into the processing routine. With WSI devices, however, there can be no flaws, if the finished chip is to function as designed. This requirement places extreme demands on device fabrication procedures and quality controls.

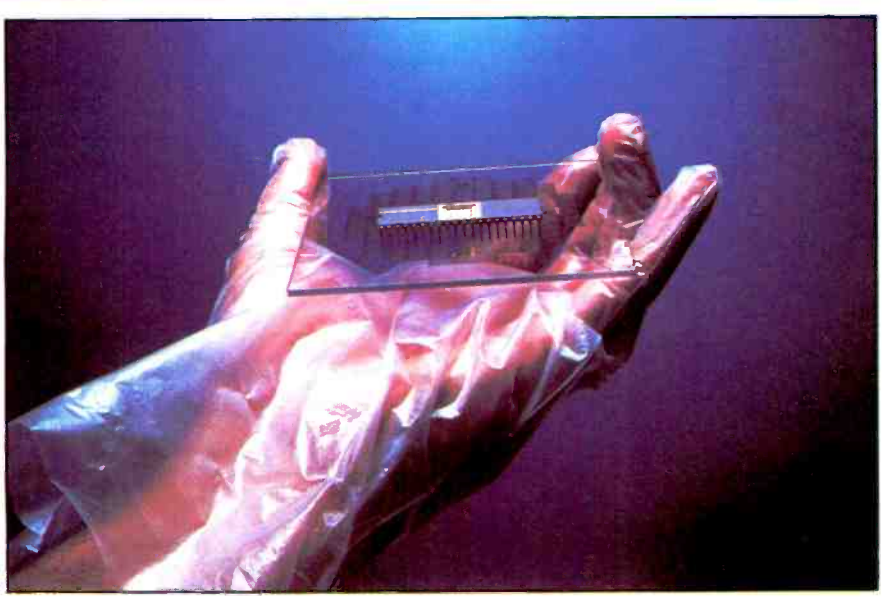
In practical application of WSI technology, manufacturers would use redundant circuitry to overcome the problems of wafer yield. Such "backup" circuits, however, place added limits on the complexity of chip designs, because space must be provided on the IC for the redundant function blocks.

The promises of WSI technology, however, are attractive. Imagine being able to use a single IC to repace an entire card rack of printed circuit boards. It is conceivable that a single 8-inch wafer could hold the equivalent of 100 microprocessors the size of an Intel 8086.

The circuit complexity provided by a WSI chip also requires innovation in the design of interconnecting pins to the "outside world." Semiconductor engineers have talked about chip pinouts in the hundreds, or even thousands.

Although the technological requirements of WSI devices stretch the present fabrication processes to their extremes, work continues—mostly at universities—to find a practical way of making superchips, which could affect the electronics industry like nothing in recent history.

"The Trials of Wafer-Scale Integration," **IEEE Spectrum**, October 1984 pp. 32-39.



ber of interrelated layers.

The semiconductor industry is moving toward a process called CAE (computer aided engineering) to simplify IC product design. Soon, most new circuits will be developed with the aid of a computer, eliminating the manual drawing steps during the composite drawing stage.

Once the circuit details have been finalized, each layer of the composite drawing is digitized and stored in a computer system. This information is used as the database for the generation of the *wafer masks* that are used in IC fabrication.

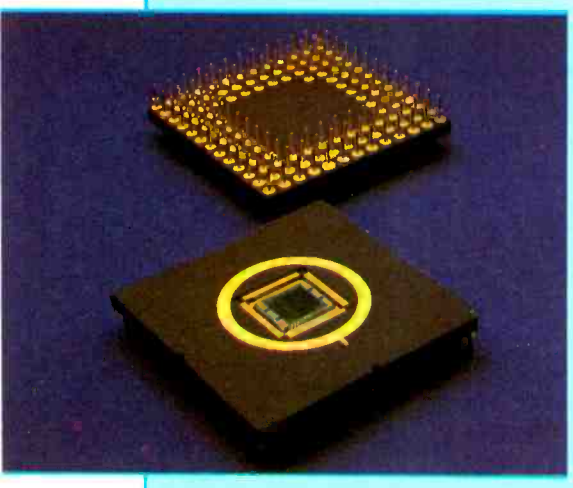
Depending on the complexity of the particular chip, anywhere from five to 18 different glass masks are generated by the computer, using the information contained in the circuit database. When completed, each mask will contain hundreds, or even thousands, of exact replicas of the various circuit layers.

The raw material used most often in

Courtesy of National Semiconductor

Wafers are automatically loaded into diffusion furnaces (above), where gaseous compounds are added to give the required impurity doping of the exposed areas of silicon.

The National NSC800 microprocessor chip (left), shown sitting on one of the glass masks used during its fabrication. The NSC800 is a high speed, low power 8-bit processor.



New techniques in VLSI development

An example of VLSI technology. This National MicroCMOS gate array offers high speed and low power consumption. The chip uses a 120-pin package.

By Barbara Carroll, National Semiconductor, Santa Clara, CA

In the past few decades, the semiconductor industry has progressed from manufacturing single transistors to fabricating entire computers within a single chip of silicon. And change in both product and process technologies continues to accelerate.

The development of very large scale integration (VLSI) technology is being driven both by customers' demands for products designed specifically to meet their needs, and by the complexity of semiconductor technology. As products become increasingly complex and move closer to complete systems on a chip, it becomes virtually impossible to meet the wide variety of needs with any given circuit design. The solution: customer-specific products such as *gate arrays*, in which a customer can take a standard, 1-chip array of logic gates and create a proprietary circuit by customizing the interconnect pattern.

But gate arrays are only the beginning. *Cell arrays* are beginning to appear, in which the customer works with a set of logic functions, rather than gates, and specifies not just the interconnect pattern, but the complete circuit design as well. Following closely on the heels of cell arrays will be *silicon compilers*, which are extremely sophisticated software programs that translate a complete system design into a circuit layout for IC fabrication.

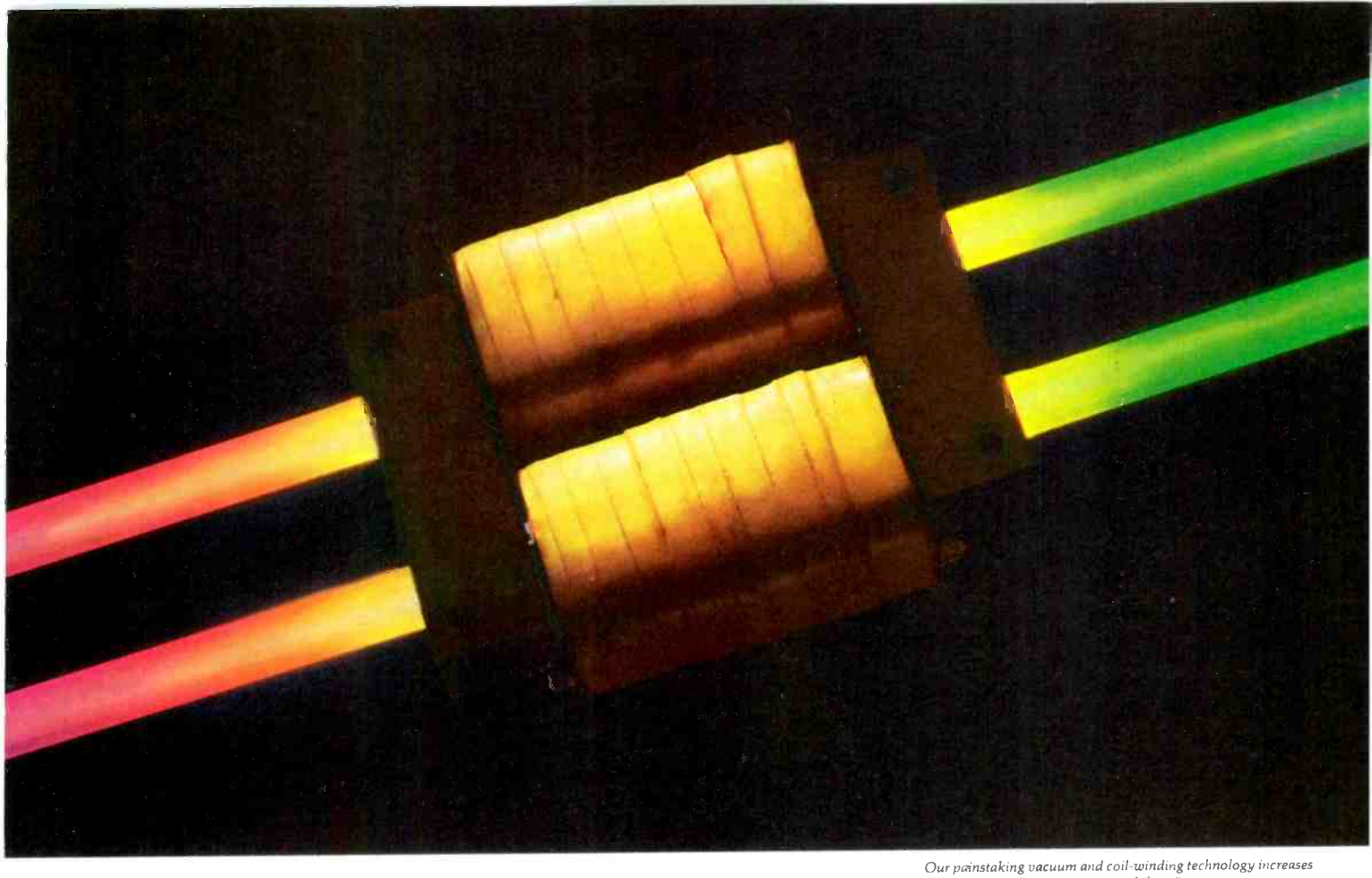
To achieve the circuit density needed to produce a total system within a silicon chip, work is under way to reduce circuit feature sizes. Engineers are now working with line widths near 1 micron—about one-fiftieth the diameter of a human hair.

As circuit density increases, power dissipation and heat generation also increase. But CMOS technology, noted for its low power requirements, solves these problems. In some cases, CMOS circuits use only one-thousandth the power of a comparable NMOS chip. For this reason, CMOS is seen as the key to high-density VLSI circuits.

IC fabrication is silicon. After an exhaustive purification process, molten silicon is doped to give it specific electrical characteristics. This material is then "grown" as a crystal into a cylindrical ingot. A diamond saw is used to cut the silicon ingot into thin, circular wafers, and the wafers are then polished to a mirror finish.

This silicon-based wafer varies in diameter from 2 to 8 inches. Five-inch wafers are common today. The processing steps taken to produce a finished IC vary from one device type to another, but the general procedures are similar:

- The wafer first goes through an *oxidation stage* to give it a thin, protective coating. This is accomplished by placing the wafer into a 1200°C furnace through which pure oxygen flows, causing an added layer of silicon dioxide to be grown on the surface. Following oxidation, a *photoresist* is applied to the wafer. It is then dried to remove residual solvents and passed on to the *masking stage*.
- The masking step is critical to the success of a wafer, because it establishes the alignment between successive layers of the individual circuit. A computer-controlled laser alignment system is used to ensure proper positioning of the mask on the wafer. Once alignment has been completed, the wafer is exposed to ultraviolet light (UV) for a predetermined length of time. Masking cuts through the photosensitive resist to expose the oxide underneath. A proximity printing method is sometimes used, rather than contact printing, to reduce the possibility of wafer contamination.
- A *solvent rinse* removes the soft resist, but the hard resist stays, having been hardened during UV exposure.
- The wafer is next *etched* to remove the unwanted oxide from the silicon surface. This selective etching forms windows for diffusion in the delineated areas of the surface oxide. Dry or wet etching may be used.
- The *diffusion* of predetermined impurities in the silicon base through the windows created in the etching process takes place in carefully controlled high temperature ovens. These ovens operate from 800°C to 1200°C, and must be regulated with great accuracy. This step is typically computer-controlled, with the IC "recipes" stored in the system memory. When an operator loads a wafer into the oven, certain details—such as the device type and run number—are entered into the supervisory computer system memory. The computer determines the correct sequence of temperatures, gases and timing of the various steps. Depending on the device and the processing stage, 4 or 5 diffusion steps may be performed.
- An *etching bath* removes the remaining oxide, and a new layer of silicon is deposited onto the wafer. With this step, the first layer of the device has been completed.
- The sequence of oxidation, photoresist, masking, resist removal, preddiffusion etching, diffusion and postdiffusion etching is repeated as many as 18 times to form the required circuit configuration. Typically, seven masking steps will be performed. A separate mask is used for each step, completing portions of the IC such as isolation diffusion, collector and resistor diffusion, emitter diffusion, contact window metalization and interconnection path metalization.
- During the last diffusion stage, a layer of oxide is again grown over the wafer. Most of it is left in place to serve as an electrical insulator, and only small openings are etched through the oxide to expose circuit contact areas.
- To interconnect these areas, a thin layer of metal, usually aluminum, is deposited over the entire surface of the wafer. The metal dips down into the circuit contact areas, touching the silicon. Most of the surface metal is then etched away, leaving an interconnection pattern between the circuit elements.
- The final layer applied to the wafer is a glass-like material know as *vapox* (vapor-deposited oxide), which protects the IC from contamination and damage. It is etched away above the bonding pads, which will later be used



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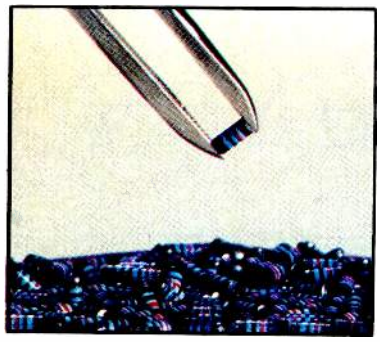
Circle (11) on Reply Card

In the chips

The familiar printed circuit board is getting a new look. This change is coming as a result of the need to pack greater numbers of parts into smaller areas. The requirement is being met with *surface-mounted* devices, *thick-film* fabricated components and advanced PC board processing techniques.

Courtesy of Dupont magazine.

An example of hybrid microcircuit construction. These cards are used in mobile radio equipment manufactured by General Electric.



Color-banded ¼-W chip resistors manufactured by TRW. These components are available in resistances from 3Ω to 1MΩ, with tolerances of ±1%, ±2% and ±5%.

Surface-mounted components, once found only in hybrid circuits, are being used with increasing regularity on standard PC boards. The component selection currently available to manufacturers includes chip resistors, capacitors, potentiometers, RC networks, quartz crystals, ceramic resonators, inductors, discrete transistors and small-outline ICs. These chip components have tolerance ratings equivalent to devices in standard packages.

With the current availability of surface-mounted parts, it is possible to substantially reduce the space requirements of a PC board design. Aside from the savings in circuit board "real estate," performance improvements can be realized, because of the shorter lead lengths and printed wiring runs required. Such conductors on standard PC boards are often a source of unwanted inductance and capacitance in a circuit.

Special packaging arrangements make many of the surface-mounted components suitable for use with automatic PC board assembly equipment.

The face of PC boards is also being changed by thick-film resistors and capacitors built into PC designs. These components are fabricated from paste-like compositions that are silk-screened onto a ceramic substrate and then fired in an 850°C furnace. The conductor tracks are fabricated in a similar manner. Additional components are then soldered onto the substrate to complete the hybrid microcircuit.

Until now, the PC board industry has adapted methods and machinery from photography, metal finishing and laminating. But, with the added requirements being placed on board designers and manufacturers, the PCB industry is developing a technology all its own to accommodate increasingly sophisticated circuits.

According to a study by the research firm of Frost & Sullivan, New York and London, shifts in conventional packaging will continue because of the complexity of new board designs. Higher-density input/output connections are expected, with surface attachment gaining favor, because this method does not consume valuable circuit space.

The firm also reports that new materials are being used to make PCBs, including Teflon and ceramic substrates, aqueous-based photosensitive materials and merchants (developing and etching chemicals) that can be economically disposed of in an environmentally acceptable manner. An increase is also expected in injection molding techniques for PC board construction.

New imaging and plating processes are being developed to allow the production of high density and high-volume PC boards. A new fine-line process developed by Photocircuits, Glen Cove, NY, allows the production of PC cards having close spacing and fine conductor lines. Major user benefits cited by the company of the new process include predictable electrical properties, minimized electromagnetic interference, reduced potential for shorts and solder bridging, improved assembly yields and long-term field reliability.

to connect it to the "outside world."

- Once the processing has been completed, the wafer is cut into hundreds or thousands of *dice* (or chips), each carrying a complete circuit.
- Finally, the leads are attached to the die, and the device is enclosed in a protective package.

The amount of time required to produce an IC depends on the number of wafer masking steps needed to complete the circuit, but it usually takes from 7 to 10 weeks.

The wafer processing sequence is arranged so that there will be a minimum of interaction between successive steps. In some circuits, such interaction can be critical. Stages tend to be arranged so that later steps involve lower temperatures, reducing the possibility of interaction from one processing stage to the next.

Spot checks are made at several points along the process to confirm that the development of the wafer has been satisfactory. A computer system charts the progress of each wafer in its production, thereby allowing failure modes to be identified and analyzed.

As the feature sizes of ICs continue to shrink, the accuracy of processing techniques and the cleanliness of wafer fabrication facilities becomes increasingly important. In fact, the number of airborn contaminates has a direct relationship on the yield of a wafer.

The number of ICs produced from a single wafer varies, depending on the die size, but a common yield from a 5-inch wafer is 4000 units. The failure rate of individual elements within the wafer is affected by wafer contamination, die size and circuit complexity. Generally, the failure rate is less than 30%.

Most ICs are available to the user in a variety of temperature ranges over which specifications will be held (sometimes referred to as *commercial* or *military specs*). These device grades are created in a variety of ways. Some chips are given tighter specs in the actual design stage; others in the fabrication processing stage; and still others in the packaging stage.

Packaging can have a significant effect on the temperature range over which a product may be used, and still maintain its rated specifications. This aspect of IC processing can be of critical importance to broadcast engineers, especially when transmitting or receiving equipment is subjected to the temperature extremes found at many mountain top sites.

Although the methods used to produce different IC families—such as bipolar and CMOS—are similar, there are several fundamental differences in the production of different family

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Circle (12) on Reply Card

groups. For example, bipolar circuits—commonly found in many audio and video amplifiers, video switchers and transmitter logic systems—usually require deeper diffusion than MOS chips. A greater number of high temperature diffusion steps are also required with bipolar ICs than with MOS.

CMOS—a rising star

Although bipolar (TTL) logic ICs have been the mainstay of broadcast equipment manufacturers for years, CMOS (complementary-symetry metal-oxide semiconductor) devices are making significant inroads into logic circuit applications.

Developed in the early 1960s, CMOS was originally conceived as a simple logic device family. The technology now, however, spans the range of digital circuits from microprocessors and memory chips to gate arrays and standard-cell semicustom devices. CMOS chips are also being produced for a growing number of linear applications, including operational amplifiers and digital-to-analog converters. Common applications found today in the broadcast industry include microprocessor-based tape machine control systems, program automation equipment and transmitter remote control hardware.

CMOS ICs give the user four primary benefits: substantially lower power consumption than comparable TTL devices; a wide range of possible operating voltages (some will operate from supplies as high as 20V); switching level stability over wide temperature ranges; and high input line noise immunity.

CMOS components are ideally suited to portable operation applications, a common need in broadcasting. Battery life will be substantially greater in a CMOS-based product than in TTL-based unit.

Dramatic advancements are occurring in the semiconductor industry in CMOS development and application. One of the most far-reaching breakthroughs is the production of a new class of CMOS logic that is capable of high operating speeds. This work has led to new groups of component families, including:

- **QMOS (Quick CMOS):** offers the user operating speeds comparable with LSTTL (low power Schottky TTL), and low power consumption typical of CMOS. Broadcast applications include support logic for microprocessor-based hardware.
- **HCT/CMOS:** allows pin-for-pin and specification-for-specification replacement of many TTL logic chips. Benefits include higher operating speeds, greater noise immunity and lower power consumption. This product line allows conversion of an equipment design from TTL to CMOS, with a reduction in power consumption and increase in equipment performance.
- **HCMOS:** similar to HCT/CMOS but designed primarily for new, all-CMOS circuit applications. HCMOS offers the user a complete line of logic circuits that range from subnanosecond 100K emitter-coupled-logic to 10K ECL ICs. Applications include complex high speed broadcast hardware, such as video time base correctors.
- **CHMOS (complementary high-performance metal oxide silicon):** combines the low power consumption of traditional CMOS with the speed and density of HMOS II devices. This product line includes microcontrollers that can be used to supervise the operation of a broadcast transmitter, VTR or routing switcher.
- **MicroCMOS:** a small geometry, silicon gate, oxide isolated CMOS device with performance that matches NMOS for operating speed and TTL for reliability. MicroCMOS uses about 5% of the power required of a comparable NMOS IC. One feature of this line that makes it especially attractive for use in broadcast equipment is the electro-static discharge protection built into the device structure.

GaAs ICs

A new generation of GaAs ICs, gallium arsenide-based ICs, has recently been developed that boasts operating speeds up to 5 times faster than silicon-based counterparts. The toggle frequency capability of the GaAs devices ranges from dc to more

Microelectronics glossary

assembly—The final step in semiconductor manufacturing, where the device is encased in a plastic or ceramic package.

bipolar—Devices or processes in which current-carrying areas and substrates are of different polarities (n-type and p-type).

bonding—The process of attaching the die (chip) to a package substrate and then connecting the bonding pads of the die to a lead frame using wire bonding or tape automated bonding techniques.

CMOS—Complementary metal-oxide semiconductor. An MOS technology in which both p-channel and n-channel components are fabricated in the same die.

die—A single piece of silicon onto which a semiconductor circuit has been fabricated.

diffusion—A high temperature process in which chemicals, or dropants, enter the semiconductor material and change its electrical characteristics in selected locations.

doping—The introduction of an impurity (dopant) into the crystal structure of a semiconductor to modify its electrical properties. For example, adding boron to silicon makes the material more p-type.

LSI—Large scale integration. Complex devices containing tens of thousands of components, or between 100 and 1000 gate equivalents (a basic unit of measure for digital circuit complexity). Over the years, integration levels have progressed from SSI (small scale), MSI (medium scale) and LSI, to today's VLSI (very large scale).

leadframe—A metal frame, connected to the bonding pads of the die, that provides electrical connection to the outside world.

mask—A patterned screen used to expose selected areas of an IC covered with light-sensitive photoresist.

micrometer—1 millionth of a meter, or about 40 millionths of an inch. Synonymous with micron.

n-type—Semiconductor material containing a small amount of *dopant* atoms that have one extra electron.

p-type—Semiconductor material containing a small amount of *dopant* atoms that have one extra electron. Each dopant atom creates one unoccupied spot, called a "hole," among the electrons. The holes are positively charged.

semiconductor—A material, such as silicon or germanium, whose electrical properties lie between those of conductors and insulators.

substrate—The underlying material on which a microelectronic device is built, normally a silicon wafer.

wafer—A thin slice from an ingot of semiconductor material (usually silicon), typically four to six inches in diameter. Hundreds or even thousands of ICs are fabricated on a single wafer, then cut apart for packaging.

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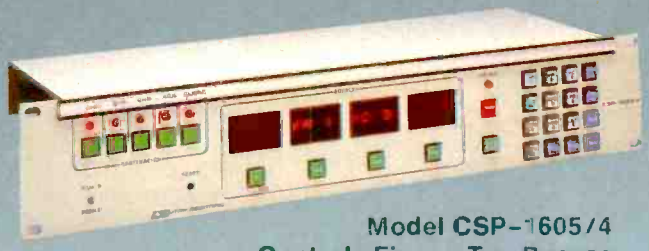

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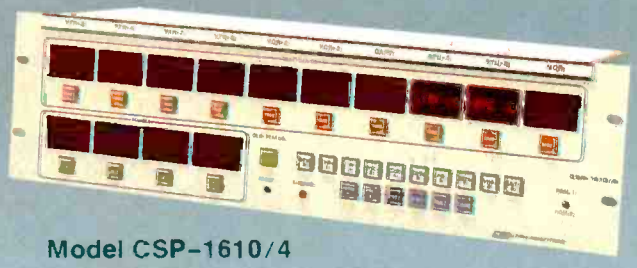

Model CSP-1610/4
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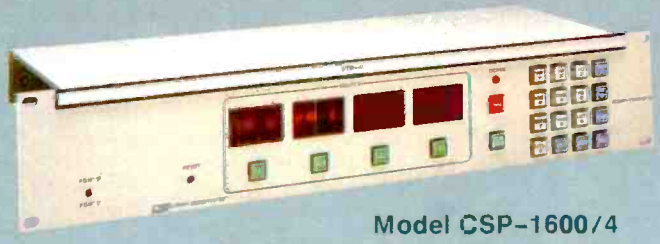

Model CSP-1600/4
Controls One or Two Busses

Model CSP-16160/4
Full Matrix Controller and Diagnostic Panel

This new series of microprocessor-based panels has been designed by Utah Scientific to meet the needs of the broadcast and tele-production industries for individual control of source selection on multiple switching matrices (levels).

Each panel includes four alphanumeric displays to indicate either current *Status* (steady display) or a *Preset* source selection (flashing display) on each switching level. An alternate-action *Clear* button associated with each display plus an *All Clear* button permits toggling the displays between *Preset* and *Status* modes.

The touchpad features sixteen *group name* selections (beware of panels allowing for only ten) which, with either one or two *numeral* keystrokes, accommodates up to 1600 possible source names. Each panel can be provided with a *Program Select* switch that doubles the number of controlled busses at no extra charge.

Multi-bus panels provide instantaneous statusing of all four levels each time a new destination is identified. Instantaneous confirmation of changed status is also provided each time a new Take Command is entered.

The model CSP-16160/4 panel is specially programmed for maintenance/diagnostic duties as well as for full matrix control. It operates in either *alphanumeric* (source and destination names) or *numeric* (matrix input and output numbers) modes and can perform various diagnostic routines to permit rapid isolation of system faults.

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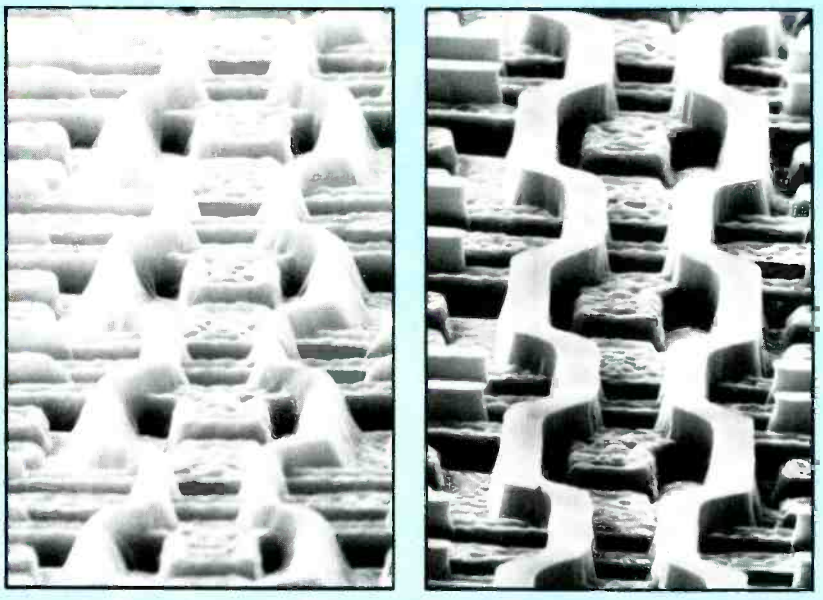
Circle (13) on Reply Card

Smaller ICs?

Scientists at the *General Electric Research and Development Center*, Schenectady, NY, have invented a practical way to make next-generation microelectronic chips with present-generation processing equipment.

Their basic development is a proprietary *contrast-enhancement* material that is applied to semiconductor wafers at the beginning of the fabrication cycle. This coating extends the capability of making microelectronic chips with ultra-small circuits.



Scanning electron micrographs (8000X magnification) of identical microcircuits produced with the conventional process (left) and with General Electric's new contrast-enhancement material (right) dramatize the marked improvement in structure geometry that can be achieved with the new technique.

By using contrast-enhancement material, it will be possible to make next-generation microelectronic chips with present-generation processing equipment. Employing a spin coating apparatus to apply the material is a GE R&D chemist.

Aided by the coating, GE researchers have produced experimental microcircuits with linewidths of only 0.4 micron (a hundredth the thickness of a human hair), employing a commercially available optical projection system called a *stepper aligner*. Without the coating, the stepper is limited to the production of circuit lines twice as wide.

This 50% reduction in circuit widths with the new coating results in improved operating characteristics. When employed in the manufacture of circuits with lines 1 micron wide and larger, it helps to make chips with more precisely defined microsructures.

Basically, the purpose of the coating is to pick up a faint or blurry image from the optical projection system and convert it into a sharp circuit pattern on the semiconductor wafer.

At present, most commercial microchips have circuit lines with widths of 2 to 4 microns although 1.5-micron chips are beginning to appear in the marketplace. As semiconductor manufacturers press toward 1 micron, the projected circuit images tend to be blurry and poorly defined because of lens resolution limitations, making it difficult to produce chips that meet manufacturing specifications.

The new material overcomes this limitation with the aid of a proprietary *photo-bleachable* dye. Normally this dye is opaque, but becomes transparent when exposed to light of a certain wavelength.

When a circuit image from an optical printer is focused onto a wafer coated with the contrast-enhancement material, the areas that see the highest-intensity light bleach through first, becoming transparent.

This creates a window in the material where light can shine onto the underlying photoresist. Thus, the material acts as an in-situ mask on the wafers, providing sharp differentiation in the projected image between light areas (no circuitry) and black areas (with circuitry).

Structures produced with this technique are extremely well formed (uniform line-widths, nearly vertical wall profiles, etc.), even with submicron circuit lines and spaces. The special dye used in the contrast-enhancement material has a combination of characteristics that makes it suitable for this application.

Most important among them is its capability of absorbing light selectively. Also, the dye is compatible with common photoresist films.

Only two steps are required to implement the process. One, to apply a thin (0.3-micron) layer of contrast-enhancement material (this is done with a spin-coating apparatus identical to that employed to apply photoresist), and second, to remove the material after the wafer has been exposed.

The contrast-enhancement material is removed in the same chamber in which the wafer is developed. The chamber is programmed so that one of its extra *dispense heads* can be employed in the first part of the cycle to spray on a stripping solvent. After this is done, the wafer is spun dry and developed in the usual way. The stripping operation adds about 30 seconds to the overall process.

To demonstrate the contrast-enhancement process, the GE researchers have fabricated numerous test structures and circuits with minimum feature sizes ranging from 2 microns to 0.4 micron. In all cases, a significant improvement in the definition of the circuit elements and structures has been demonstrated.

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The mixer also has two separate mic/line outputs for 2-camera shoots and a tape output to feed a cassette. For monitoring, there are two stereo headphone jacks—one ¼-inch and one for miniplugs. The FP31's rugged nylon carrying case allows you easy access to every mixer function and lets you piggyback the mixer on your VCR or other equipment.

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than 1GHz. A key feature of the new IC is signal-level compatibility with the fastest silicon ECL devices available. This allows direct interface to logic circuitry using more traditional devices. This technology has obvious applications in broadcast microwave systems.

Looking ahead

One of the reasons for the large-scale application of ICs in broadcast equipment is the steadily decreasing price of IC components. This price reduction has occurred at the same time more features have been packed into each IC.

The trend toward lower prices may, however, begin to bottom out soon. There are a number of items that affect the cost of an IC, aside from the expense of the silicon and the technology to build the silicon. Packaging is a major portion of the price of any device. Testing of chips is another significant cost for a semiconductor manufacturer.

To combat the cost of device packaging, a number of companies are beginning offer smaller surface-mounted ICs that depart from the traditional DIP package style. Broadcast equipment manufacturers are interested in surface-mounted devices because of the space such components can save on PC boards.

Because the surface-mount style is similar in layout to the more familiar DIP package, PC layout is simplified. These components are also compatible with wave soldering techniques. Surface-mount packaging for ICs is being complemented by the introduction of a number of surface-mounted discrete components. (See the boxed item, "In the Chips," page 26.)

Work is also progressing on a new concept in large pinout packaging, termed the PCC (plastic chip carrier), or *quad* package. This type of device has pins on four sides and offers what some engineers feel will be the best near-term solution to connection needs for medium-to-large count ICs (40-168 pins). Such PCC devices would, however, require special soldering techniques.

Broadcast applications

The semiconductor industry strives constantly to stay on top of what the consumer market will demand one, two or even three years in the future. Because of the long lead time necessary for the design and testing of a new IC product, semiconductor manufacturers constantly study consumer and broadcast industry trends in an effort to determine what the future needs will be.

Application areas that are currently being given special attention by the semiconductor industry are TV multichannel sound, teletext, CATV, digital audio disc players and new AM and FM receivers. Digital signal processing of TV and radio receiver circuits are expected to appear in the future, but the component costs will have to come down substantially before such systems can make significant inroads into the consumer market.

Digital TV receivers—where the received signal is digitized at the IF frequency and demodulated using digital techniques—offer a number of potential user benefits, such as video noise reduction and automatic set-up of all operating parameters.

The numerous developments occurring today in semiconductor technology promise to significantly change the broadcast equipment of tomorrow. Microprocessors and other VLSI chips will increasingly find their way into the equipment that we use every day in radio and TV. This change, while characteristically slow, will occur at an ever-increasing rate, as tomorrow's technology finds solutions to today's problems.

Editor's note:
National Semiconductor, Santa Clara, assisted in preparing this article.

Stereo TV is the one to watch.

Flash. *Stereo TV is the hot topic at the 1984 Consumer Electronics Show in Chicago.*

Flash. *Every major TV set manufacturer plans to put multichannel units on the street by 1985.*

Flash. *NBC announces The Tonight Show and Friday Night Videos will soon be recorded in stereo.*

Flash. *ABC tests bilingual broadcasts of The Fall Guy in Spanish markets; ratings soar.*

Flash. *NEC introduces VHF and UHF transmitters with full stereo sound.*

In 1977.

We signed on seven years ago.

Stereo TV may be hot, but it's nothing new at NEC.

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And since then, we've installed more than 100 stereo TV transmitters in Japan and Australia. With the same proven technology found in more than 1,400 NEC transmitters around the world.

So now, as America moves into stereo, NEC stands ready to offer you this exciting new technology.

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Stereo TV Transmitters. Right now. From NEC.

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Or, you can call NEC toll-free at 1-800-323-6656. We have a full line of multichannel transmitters, with single output powers up to 35 kW, that we'd love to show you.

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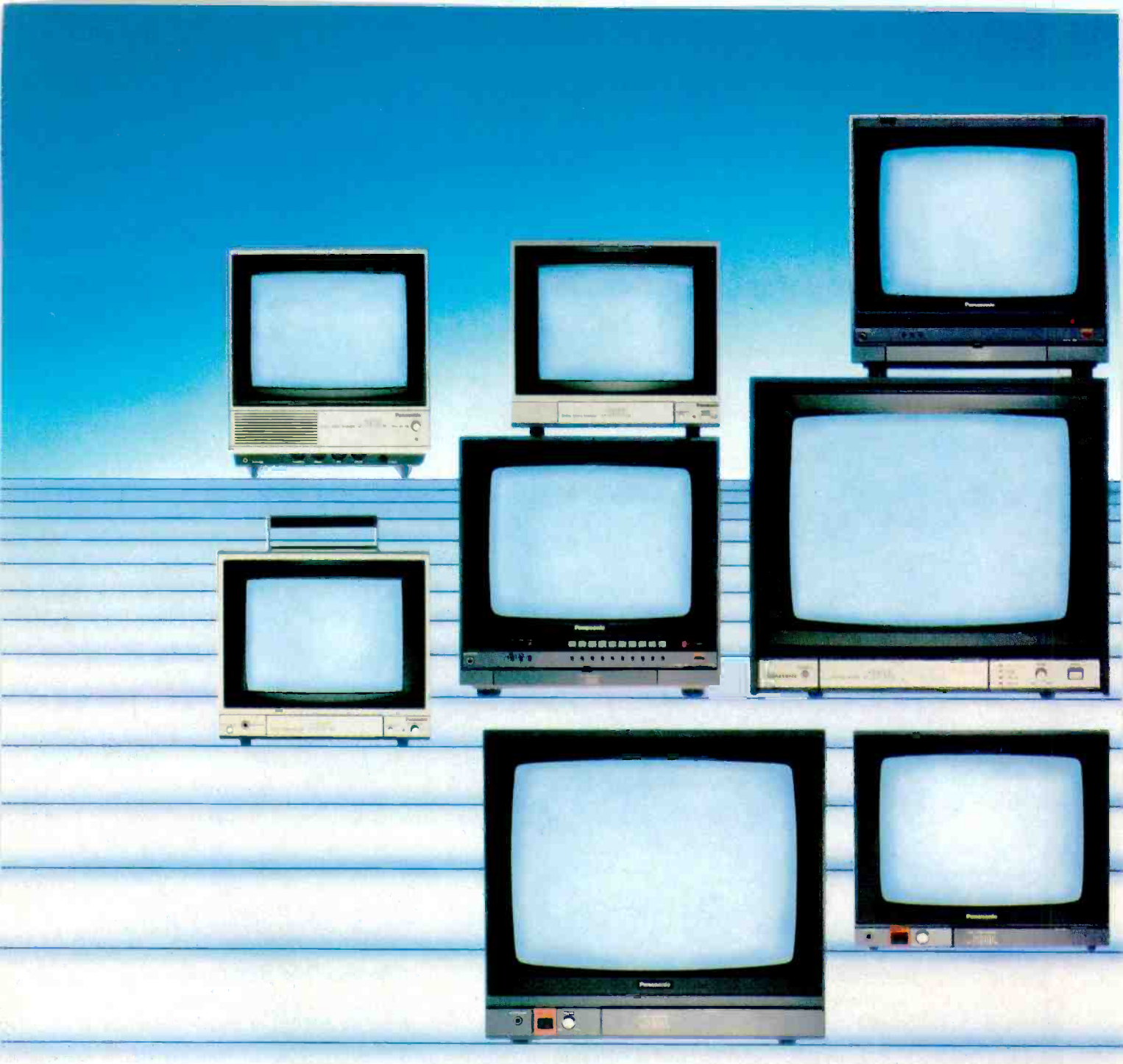

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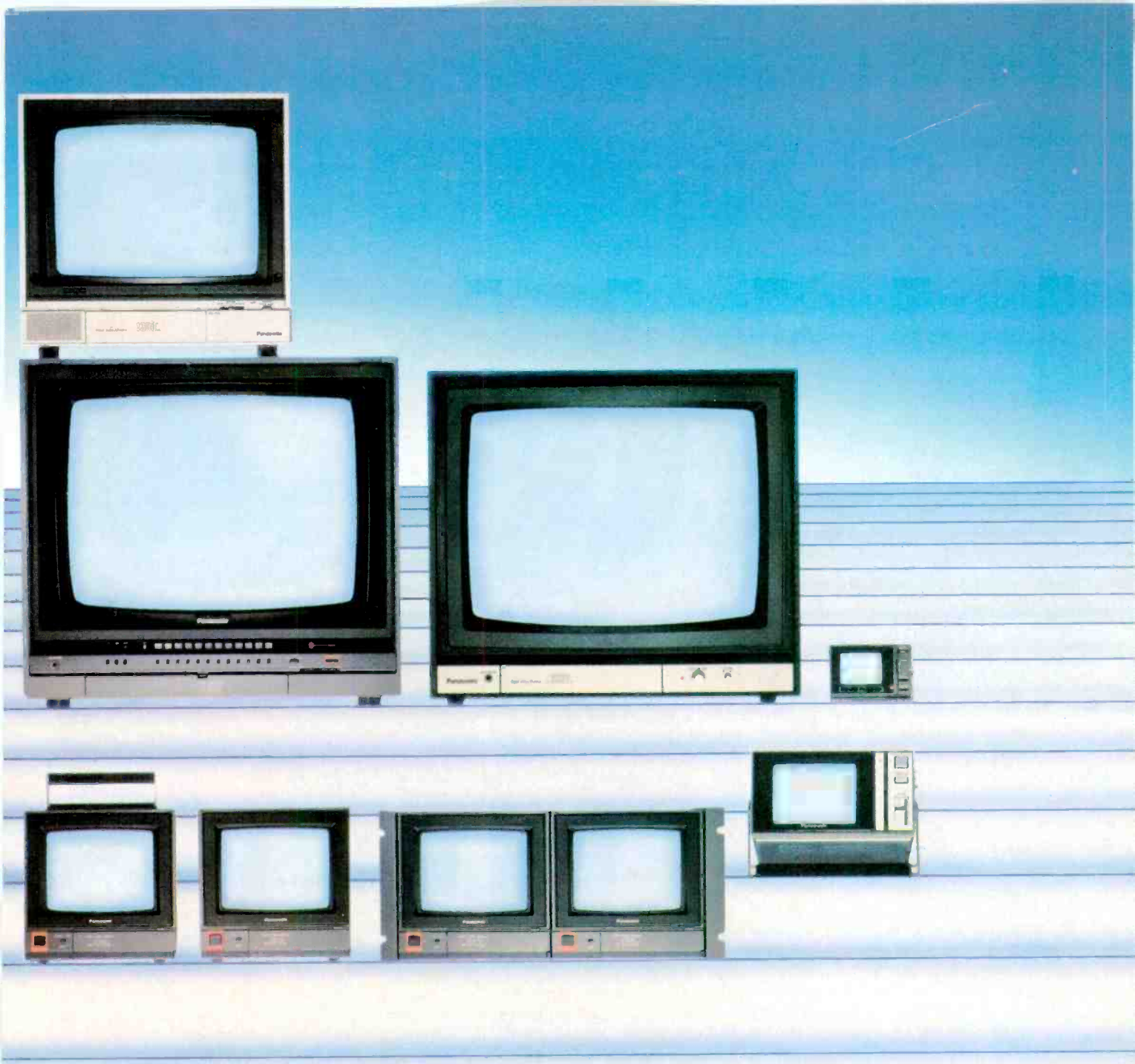
When you look at the BT-S1900N 19" monitor (all screen sizes measured diagonally), you'll see one of our most brilliant and best defined color pictures ever. One reason is our CompuFocus™ picture tube with OverLapping Field Lens gun. Another is a switchable comb filter which increases definition for easy detection of signal flaws. Behind its push-open door lies a full array of operating controls. Like a normal/underscan switch, pulse cross, horizontal/vertical centering controls and blue-only for easy adjustment of chrominance and hue.

The 13" BT-S1300N has the same great picture, controls and inputs. And our 7" BT-S700N is ideal for mobile units and outdoor production because it operates on AC or DC. It also features controls for normal/underscan, pulse cross, blue-only and much more.

The 7" BT-S701N is equipped with switchable line inputs and external sync terminals while the BT-S702 consists of two 701 monitors mounted in



a dual rack adapter.

The Panasonic CT series will also show you a picture that's clear, well-defined and brilliant in color. Because both monitors have either CompuFocus or Quintrix II® picture tubes. And, of course, all models have 8-pin video input and output connectors as well as loop-through capability for easy system adaptation.

When portability and light weight are important, choose from two AC/DC monitor/receivers: the 5" CT-500V, or the CT-300VT with its 2.6" screen—the world's smallest industrial color monitor.

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If you're big on 19" monitors, the CT series keeps you covered in a big way. Both our CT-1930V monitor/receiver and our CT-1920M have comb filters for increased picture definition, while the CT-2000M lets you switch from PAL to SECAM to either NTSC 3.58 or NTSC 4.43.

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AUDIO-VIDEO SYSTEMS DIVISION

The view from Washington: FCC actions during 1984

By Harry C. Martin, legal consultant

FCC actions this year have had a substantial effect on the operation of radio and TV stations.

During 1984 the FCC made significant changes in its technical rules pertaining to broadcasting, and more changes are in the offing.

FM allocations

In mid-March the FCC proposed new FM assignments at 684 locations to implement its rules, adopted in Docket 80-90, establishing new separation requirements for FM stations. The locations are where the commission believes service is needed and where allocations are feasible with the new separation standards.

Counterproposals to the original 684 were accepted, and the commission is now preparing to issue a final list of new allocations. The FCC estimates that applications for the new facilities could be accepted early in 1985.

In connection with its actions in Docket 80-90, the FCC advised all Class B and C stations that they must file applications by March 1, 1987, proposing facilities that would meet or exceed minimum requirements for their classes or be downgraded to lower classes with less separation protection. In this connection, the commission amended its FM allocation rules by establishing a 3-year, 10-mile buffer zone around existing Class C stations operating with antenna heights of less than 300m (984 feet) above average terrain.

The buffer zone will be provided only during the 3-year period ending March 1, 1987, and will enable affected Class C stations to have a sufficient area to relocate, if necessary, or to upgrade facilities.

To ensure the smoothest possible processing of the large number of new FM applications expected, the commission proposed adopting *window processing* to replace its cut-off procedures. With the window procedure, all applications for newly allocated channels would have to be filed within a predetermined window filing period, and no subsequent competing applications would be accepted.

Filing windows are expected to be opened on a region-by-region or channel-by-channel basis. Commission staff members indicate that lotteries will have to be used to decide between competing proposals if the commission is deluged with allocation applications.

TV stereo approved

The FCC adopted rules that allow TV stations to use their aural basebands for stereophonic sound, second-language programming, paging and any other broadcast or nonbroadcast use.

The technical rules permitting TV stereo do not specify a single standard for multichannel TV sound (MTS). Instead, the commission decided to allow marketplace competition in MTS systems and services.

The question of whether cable systems should be required to carry stereophonic TV audio, second audio program channels or other ancillary services is under active consideration in a followup rulemaking.

Class IV power increases

On Jan. 17, the commission signed a new bilateral AM agreement with Canada. The new agreement established the standards and procedures that govern the protection that the United States and Canada provide to each other's AM broadcasting services.

The new agreement opened the way for a general nighttime power increase for Class IV AM stations from 250W to 1000W. A similar agreement recently was reached with Mexico that cleared the way for a nighttime power increase on Dec. 15 for all but 10 stations near the Mexican border.

Last spring the commission adopted changes in its rules to implement these international agreements and, at the same time, developed a *show-cause* procedure to facilitate the transition to 1kW nighttime operation. With the FCC's procedure, the licenses of all but a few Class IV stations will be modified to specify operation at the higher nighttime power. Only the few Class IV's operating with less than 1kW daytime or operating directionally must file applications for increases in power.

Nighttime use of Canadian, Mexican and Bahamian clears

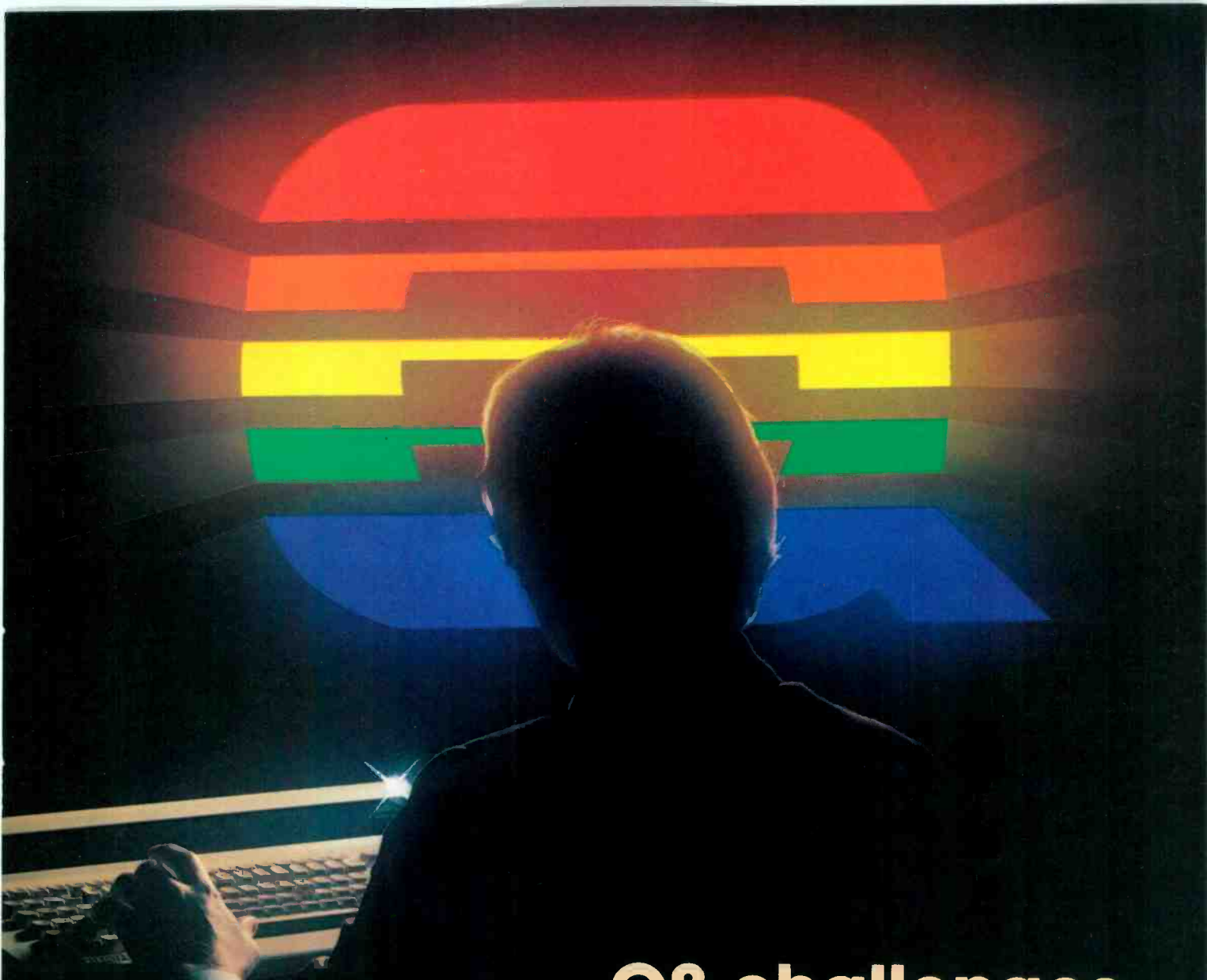
In late March, the FCC proposed amendments to its rules on authorization of unlimited time operation on the Canadian, Mexican and Bahamian Class I-A clear channels. The U.S.-Canadian AM agreement permits nighttime operation on the Canadian clears, at 540, 690, 740, 860, 990, 1110 and 1580 kilohertz, as long as interference protection is given to Canadian stations.

Regarding the Mexican clear channels—at 540, 730, 800, 900, 1050, 1220 and 1570 kilohertz on AM—the United States and Mexico expect to complete a new bilateral AM agreement that would permit nighttime operation on those channels on a basis similar to that agreed to with Canada. In the interim, the FCC has indicated it may accept applications for nighttime use of the Mexican clears, because no interference to Mexican operations is expected.

The single Bahamian clear channel, 1540kHz, will become available upon disengagement of the Bahamas from the North American Regional Broadcasting Agreement, expected soon.

The FCC proposes that daytime AM stations now operating on one of the Canadian, Mexican or Bahamian Class I-A channels, which can meet the requisite interference standards, be eligible to apply for authority to operate at night if they would provide a first- or second-aural service

Martin is a partner in the law firm of Reddy, Begley & Martin, Washington, DC, and the author of **BE**'s "FCC Update" column.



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at night to their communities (or nearby communities). Power would be limited to 1kW at night unless the applicant can demonstrate that with a higher power (to 50kW) it could provide a first primary nighttime aural service to 25% of the area or population within the proposed interference-free contour.

The new or improved stations would be required to protect each other to their 10mV/m contours, which will make possible interference-free service within a 10-mile radius of their transmitters.

Final action on the commission's proposal was expected by the end of this year, with applications accepted starting in early 1985.

Post-sunset authorizations

In April the commission decided to allow Class III daytime-only AM stations to increase post-sunset power to 100W minimum and to use this power until 6 p.m. local time.

In September 1983, the commission relaxed its rules to permit expanded hours of operation for daytime stations. Class III stations were permitted to operate two hours beyond local sunset (to 6 p.m.) with 500W of maximum power, reduced as necessary to avoid interference. Most Class II stations (those on clear channels) also were granted post-sunset authority on a non-interference basis.

The specific powers varied during the 2-hour post-sunset period depending on protection requirements. In some cases, however, post-sunset operation was curtailed and for a few was not possible at all.

At the request of the Daytime Broadcasters Association, these rulings were further relaxed. The commission decided it is possible to allow additional power for some Class III stations. To facilitate this relaxation, the FCC adopted a method for calculating permissible power that uses the *mid-time* for the first hour rather than the end of the 2-hour post-sunset period.

Using this method, many more stations could reach a full 500W or the same maximum daytime power they use, while avoiding excessive interference with full-time stations. Stations still not able to operate at 100W with these standards were permitted to do so anyway if they did not cause interference to foreign stations.

The commission still is reconsidering the post-sunset issue. It is expected to replace the 100W minimum with a new formula that affords greater protection to full-time stations. The new proposal is based upon an agreement reached among competing AM industry groups. Also pending is a possible agreement with Mexico that would permit post-sunset operations past 6 p.m.

Other pending issues

Two major technical issues still are awaiting action:

- Resolution of the issue of interference to Channel 6 reception by non-commercial, educational FM stations. A rulemaking on this subject has been pending for many years and a final, compromise decision is expected shortly.
- Adoption of new technical standards for pre-sunrise operations by daytime AM stations. As a companion to its actions affecting post-sunset operations, the FCC is re-examining the standards under which it grants pre-sunrise authorizations. Pre-sunrise authorizations based on the new diurnal curves developed in connection with the Canadian AM agreement already have been issued to stations operating on the Canadian Class I-A clears. Applying the new curves and standards to daytime stations already operating with PSAs will permit pre-sunrise operations with increased power.

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With speaker and amplifier in one compact, rack-mountable package, this monitor system solves problems like limited rack space, equipment transport on remotes or cramped spaces in video editing booths.

Also, by requiring less hardware—fewer cables and connectors—the 100EL keeps setup simple and reduces potential interconnect problems. And there's no possibility of power loss caused by resistance from a lengthy speaker cable.

The on-board amplifier in the 100EL makes it ideal for single-channel monitoring. Why buy one speaker and an extra amplifier channel, when the Sentry 100EL does the job all by itself? And because amplifier power is perfectly matched to the speaker system, there's no chance of damage from inadvertent signal overload.

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With an ABX, each input module (up to 34 on our largest mainframe) has two inputs with separate machine control for each input on the line modules and separate control tallying, muting and intercom on the mic modules. All modules feature panning and four "send" buses. The send buses feed echo and special effects devices as well as provide a separate mix for studio talent. The output of each module can be routed to Program, Audition, Utility, 2-Mix special multitrack buses, all in full stereo. Each input may also be sent to one or more tracks of a multitrack tape machine. Submastering is easily accomplished by assigning input modules to the specific multitrack channels, which, in turn, can then be used as a grouping masters.

The ABX has both cue and solo buses, in stereo. Slating and talkback are provided from both operator's and producer's mics.

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A telephone mix module provides mix-minus returns for up to four lines. The ABX provides comprehensive metering instead of confusing, and inconvenient meter switching. Timers and clocks are available on the meter panel too. There's plenty of room on the console surface for full-function remote control panels for tape recorders and cart machines.

Three band stereo equalizers as well as mono three band equalizers with tunable high and low pass filters are available. A multi-frequency test oscillator is included on the slate-talkback module to help with system set-up and performance checks. All logic control is CMOS for the highest immunity to electrical noise and RF fields. Audio switching is performed by miniature gold contact relays. The faders are reliable, long-life Penny & Giles conductive plastic.

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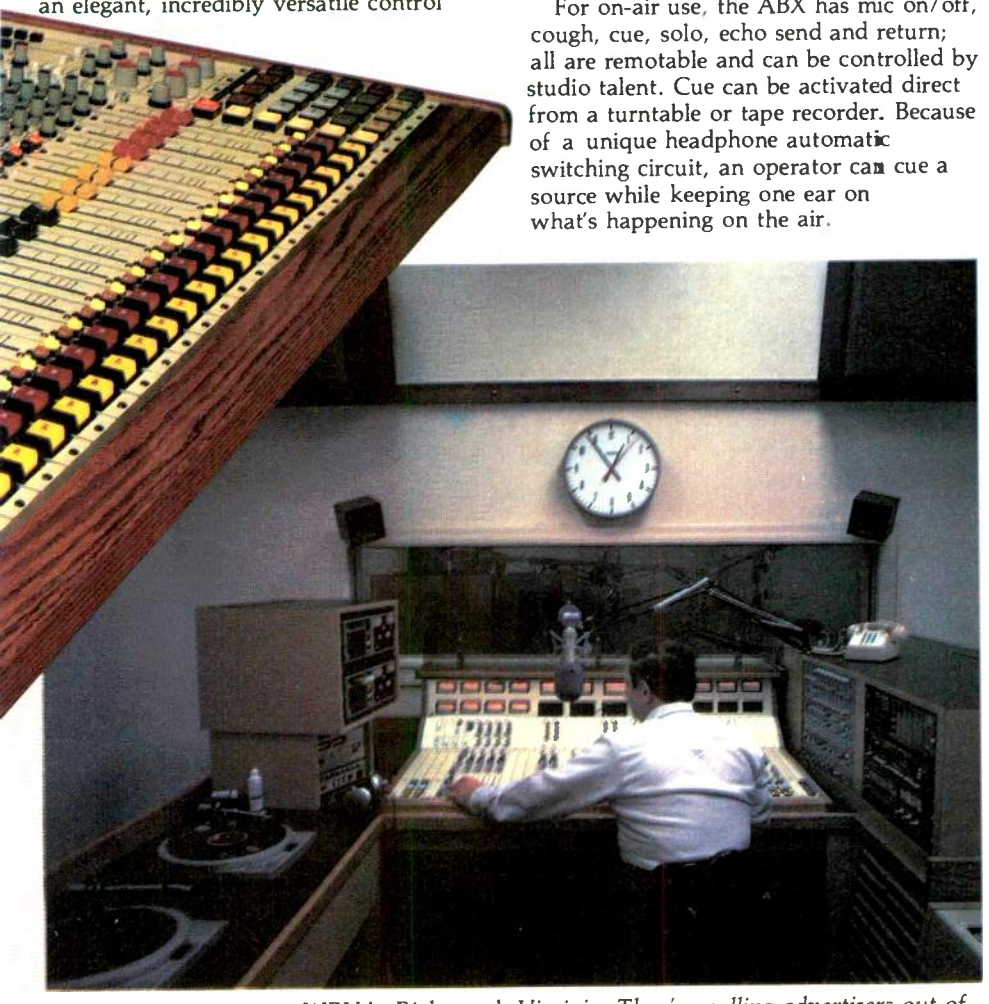

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The *Choice* for More #1 Stations.

Whether a storm?

The state of the industry remains a cloudy issue.

By Rhonda L. Wickham, managing editor

Gauging the barometer of the broadcast industry's health is as precarious as attempting to predict a station's next technical failure.

Because of close observation and regular maintenance, you know the condition of your equipment and the quality of your signal. However, you have no real guarantee that you will be able to stave off unpredictable outside influences for the next day, month or even year, before you have to make adjustments or a complete overhaul. You keep plugging along, watching and inspecting, and hope that you can continue to maintain a crisp, clean signal.

Of course, the state of the broadcast industry is not quite as simple as a transmitter, antenna and the related broadcast paraphernalia of your station. "The Industry" is shaped by a wide range of major and lesser contingent factors that effectually contribute to the success or failure of the industry daily, weekly and annually.

However, it is safe to say that radio and TV communications are here to stay. They have become the lifelines of effective interhuman relations. Statistics bear this out: This year the average TV household had their TV set on more than 7 hours every day, up about 30 minutes from 1983 estimates. The average radio listener tuned in at least 3 hours a day.

On the sending end, there were 11,061 radio and TV stations in the United States as of Sept. 30: 9577 for radio and 1484 for television. Close to 100% of families in the United States own radios and 98% own at least one television.

This pervasive penetration assures us that the demand for our services will not likely cease in our lifetimes. At best, the demand will make the industry grow and prosper. At worst, the demand will channel into peripheral areas related to broadcasting such as interactive services.

All that is gold may not glitter

This viewpoint might be too much of a rose-colored-glass evaluation of our industry. Providing some income figures gives a more realistic view of what is actually taking place. In a survey conducted by Ted Bolten Associates and published by McGavern Guild Radio, the income increases for radio for 1970-1980 were compared with the expenses for the same 10-year period.

Results of the study indicated that on the radio side, income increases had not offset increased competition and higher operating expenses. The survey cited operating expense increases of 191% vs. income increases of 70% for the decade (Table 1).

Audience fragmentation was cited as the most critical issue, according to the 53 radio executive (presidents, vice presidents and general managers) who were interviewed for the study. Overall radio listening has not decreased, it has simply been fragmented to more outlets, as evidenced by the 20% increase in AM/FM outlets.

The fragmentation noted for radio has not been as pronounced for TV broadcasting, however. The total TV outlets increased only approximately 6% in the 10-year time frame, representing few takers of the profits. In this same period, the TV income was reported to have increased 264% compared with a 203% increase in operating expenses.

The fragmentation comes from increased media alternatives, both within and between media forms, which has more than doubled the entertainment options for the average consumer. The effect of the audience fragmentation has been a redirection in share of audience, which in turn generates smaller advertising revenues for the individual stations.

Coming around

The 1970s and even the early 1980s were a difficult period for the industry because of a dubiously fluctuating economy, a certain on-hold pattern in developing technologies and a reliance on major networks for programming. However, the past couple of years seem to show a broadcast economy coming around: beginning an upward curve after a relatively flat period.

Last year, in our survey of the state of the industry (December **BE**), we discovered that many broadcasters reported increased sales, especially in larger markets, and most broadcasters were anticipating, if not planning, upgrade programs for their facilities. According to our survey this year, broadcasters are still reporting increased sales and most of the facilities, which chose to comment, are planning further upgrades through

	1970	1980	1970-1980 % Increase
Total AM/FM outlets	4898	5878	20%
Total TV outlets	686	725	6%
Radio expenses	$1044[a]	$3047	191%
TV expenses	$2354	$7154	203%
Radio income[b]	$ 93	$ 159	70%
TV Income	$454	$1654	264%

a Millions of dollars
b Before federal taxes

Table 1. Radio and TV trends: 1970-1980.

Microwave Analysis Made Simple

The Anritsu Microwave System Analyzer

Time was, keeping microwave communications in tip-top, distortion-free shape was almost an act of necromancy. You could try to deduce complex signal and phase relationships from a handful of relatively simple instruments. Or you could spend big money on a link analyzer — and then lock yourself into a long apprenticeship learning how to use it.

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Just press a key, and the measurement results you need to know — such as group delay, modulator linearity and sensitivity, differential gain and phase — appear on the CRT and the digital readouts. Ranging and attenuation are automatic, too. So FM deviation, peak-to-peak signal value, IF/BB return loss — and more — all appear automatically labelled and formatted. There's no need to analyze or render data from the CRT — and no mistaking the results.

Extras are standard

The Anritsu MSA comes in two models: the ME453 for systems with a 70MHz IF, and the ME538 for those with an IF of 140MHz. No matter which model you choose, you get the same great features — including pushbutton baseband frequency selection, auto sweep reduction, and a built-in normalizer for signal averaging and subtraction at no extra cost. And opting for GPIB in the receiver allows automatic control of acquisition and analysis of measurement data.

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equipment purchases and facilities renovations.

Although the figures for the 1970s might have looked rather bleak, it appears that a similar survey of 1980 to 1990 might tell a completely different story. For example, in 1983, more than 100 million radios were sold in the United States alone.

In accord with this, Edward Fritts, NAB president, said, "We anticipate another 600 to 700 FM stations will be allocated within the next year."

Although AM and TV stations will not predict as large an increase, the growth factor is very much alive in those areas. NRBA president Tom McCoy claims that this robust growth is due to a more realistic approach by broadcasters. "The stations have been able to find a niche. They are able to focus on a specific audience and appeal to them." He added that although more people are splitting up the pie, the pie is still growing.

A sizable slice

A dominant area that will measurably increase the size of the radio pie is AM stereo. Although, at times, it seems as though AM stereo is floundering or stagnating because of the various systems and the lack of receivers, the manufacturers persist. Motorola, for one, seems to be making great strides with acceptance by Pioneer, Chrysler, Concord, Sherwood, Delco/GM and Marantz. NAB and NRBA projections see AM stereo in full bloom sometime in 1985 (at least for receiver manufacturers).

The extra filling for the TV pie looks as though it might come from stereo television in 1985. (The surrogate for stereo television – simulcasting – has permitted a rather ambivalent comradery between radio and TV, at least for the short run. Until stereo TV technology takes hold, the joining of the panoramic sights of TV and stereo sounds of radio both covering live concerts will bring the two factions additional income.)

If the number of manufacturers offering stereo TV units at current trade shows is any indicator, it appears that the technology will flourish in 1985. On those coattails, the improving technology and economic affordability will no doubt make stereo television a standard in American homes during this decade.

Down the road

Research and development in new areas is blossoming. To track this, the Radio-Television News Directors Association decided to discern the shape that the broadcasting industry would take in the next 10 years. Its

Deregulation fallout

In the 1983 "State of the Industry report," December **BE**, we asked readers if the FCC deregulation had any impact on them and on budgets. The overwhelming majority of respondents indicated that there had been no effect on the budgeting.

A small percentage, however, voiced reticence about the wisdom of the technical move. Despite their concern, they still agreed that there had been no profound budgeting influence.

This year, however, more ballots were cast and the vote seems to be swaying the other direction. Although there is still a clear majority who indicated that the deregulation had not affected their budgeting, more readers indicated that there had been some budgeting reconsiderations. They also had more than just mild reservations about the implications of the action.

Across all markets, the written comments that we have received seem to express the same concern about the technical deregulation and elimination of the FCC first-class license: Technical integrity of the stations and the engineering positions is being compromised; overall salary structures are on the slide and less than professional workmanship is being encouraged.

We have provided some of the comments that we received this month on the FCC deregulation:

"Deregulation has given management an excuse to reduce or eliminate equipment performance measurements and other formerly routine preventative maintenance work. There is a trend to farm out some formerly in-house engineering duties. Contract engineers may have a bright future, but overall, engineering quality is deteriorating."

"One of the big problems in the broadcasting industry has been the way the FCC has gone about deregulation as it pertains to the broadcast engineer; for example, the virtual elimination of the first-class licenses has, and will, cause problems, particularly in small markets."

"As companies attempt to maximize profits and the FCC deregulates the industry, I see the trend developing where owners ignore technical standards (excellence) more all the time. Concurrently, they tend to overlook the importance of competent and hard-working engineers and their contributions to their business."

"I do not feel that much of the FCC's deregulation efforts are beneficial to the technical end of the broadcast industry. It is also more and more difficult to find technically qualified and motivated broadcast technicians."

"I do not see a great many technically oriented people choosing broadcasting as a first-choice career. Deregulation has taken much of the integrity and pride of performance away from the professional broadcast technician."

"Deregulation is really re-regulation; what was clear is now blurry. It is red tape to red confetti with deregulation. It is a good thing the FCC has not pressed station inspections."

"Since the end of the first-class license, the trend has been downward in pay."

"Too much deregulation is bad...technical standards of engineers, decency in both television and radio. Some deregulation has been good...advertising and logging requirements.

"Since the elimination of the first-class requirement, engineering personnel must be willing to enter other areas of the broadcast industry, such as programming or even air work in order to improve or even maintain their present status."

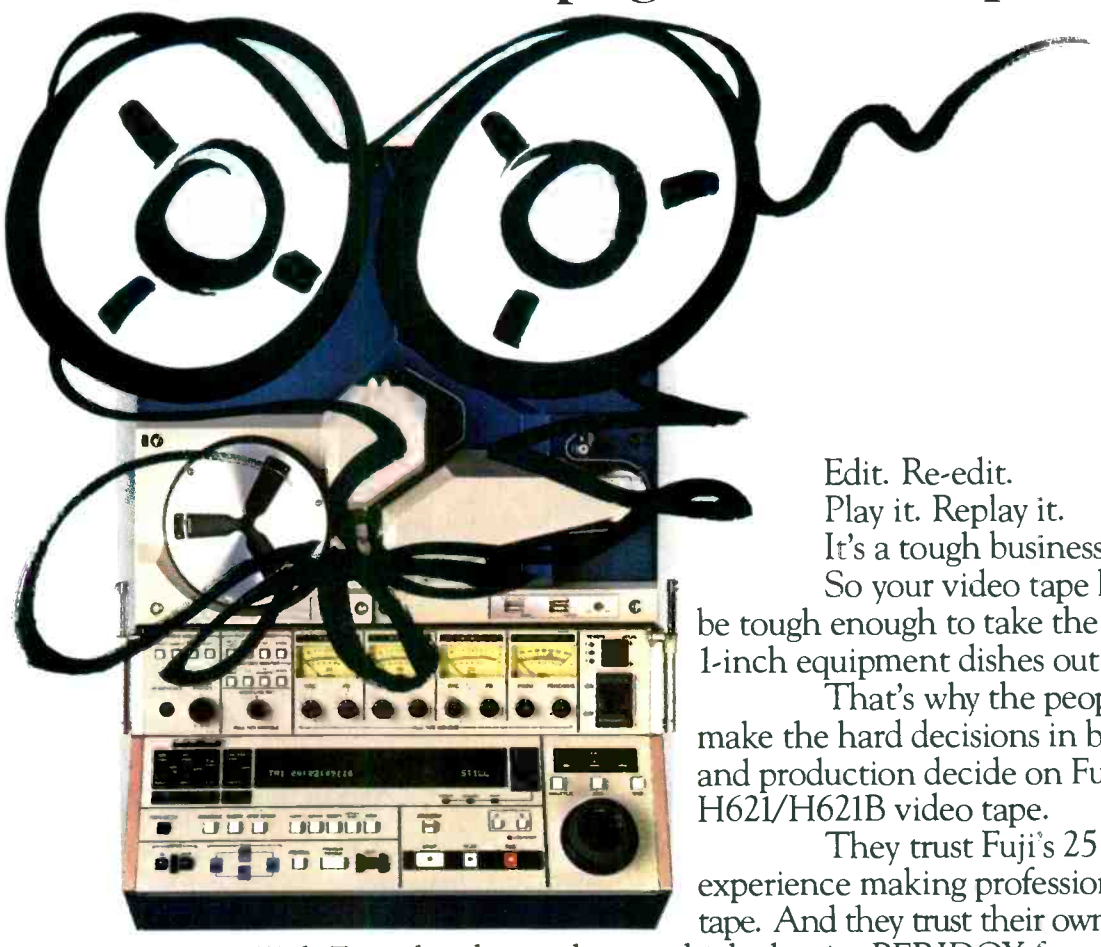
"There should be more respect directed to the qualified broadcast engineer from the FCC and broadcasters. A good way to show this is through higher salaries."

"Deregulation is causing the industry to be less concerned with professionalism. Just got the bucks attitude."

"The FCC decision to downgrade the 'first' to a general-class ticket is really causing problems. Most stations in small markets have the local radio TV repairman doing the work and then wondering why they sound bad. Doesn't make sense."

"I believe the FCC deregulation has hurt the radio engineers, but companies worth working for realize the necessity of qualified people, so that compensation to a proper level remains."

What good is a $75,000 video recorder when the video tape gives a two-bit performance?



Edit. Re-edit.
Play it. Replay it.
It's a tough business.
So your video tape has got to be tough enough to take the beating your 1-inch equipment dishes out.

That's why the people who make the hard decisions in broadcasting and production decide on Fuji 1-inch H621/H621B video tape.

They trust Fuji's 25 years of experience making professional video tape. And they trust their own experience.

With Fuji, they know that our high-density BERIDOX formula and special back-coating deliver picture quality that's consistently vivid, even after multiple generations. They know that dropouts drop down to a minimum. And that valuable video heads are protected to a maximum.

If you want to know more about what makes Fuji's extraordinary video tape the first choice of professionals, just do a very ordinary thing.

Run to your phone and call Fuji.

And we'll show you a tape you can run and run and run and run and run and run.

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Nobody gives you better performance.

Circle (22) on Reply Card

recently completed study posed such questions as: what new technologies are likely to change the present communications systems; what types of programming will become more important; and where and how will today's electronic journalist be employed.

Interviews were conducted with several groups associated with the broadcasting industry: 100 TV station managers and 100 TV news directors representing a cross-section of market sizes and areas of the country. A similar number of radio station managers and radio news directors—17 top-level executives representing the networks, cable companies, broadcast ownership groups, satellite services and advertising agencies—were interviewed, as were 21 professors representing university departments of broadcasting and journalism.

In radio, respondents commented that music would continue to play the major role in FM radio and take on increased importance, with the growth of AM stereo the major role in AM programming. They also indicated a growing demand for syndicated and specialty network programming.

When asked to project which specific elements will have the greatest impact on the radio industry in the next decade, the following topped the list: satellite delivery systems; specialization; locally produced news and information programs; FM stations; program syndicators and low-power FM stations. As for the news jobs, the study reports that growth appears to be in the outside program supplier level rather than on the local front.

In television, the respondents expect the next decade to bring an increase in the amount of locally produced programming. Local news programs are the single most frequently pointed to type of local program on the rise. TV broadcasters see a decline in local stations' use of and dependence on syndicated and network programming.

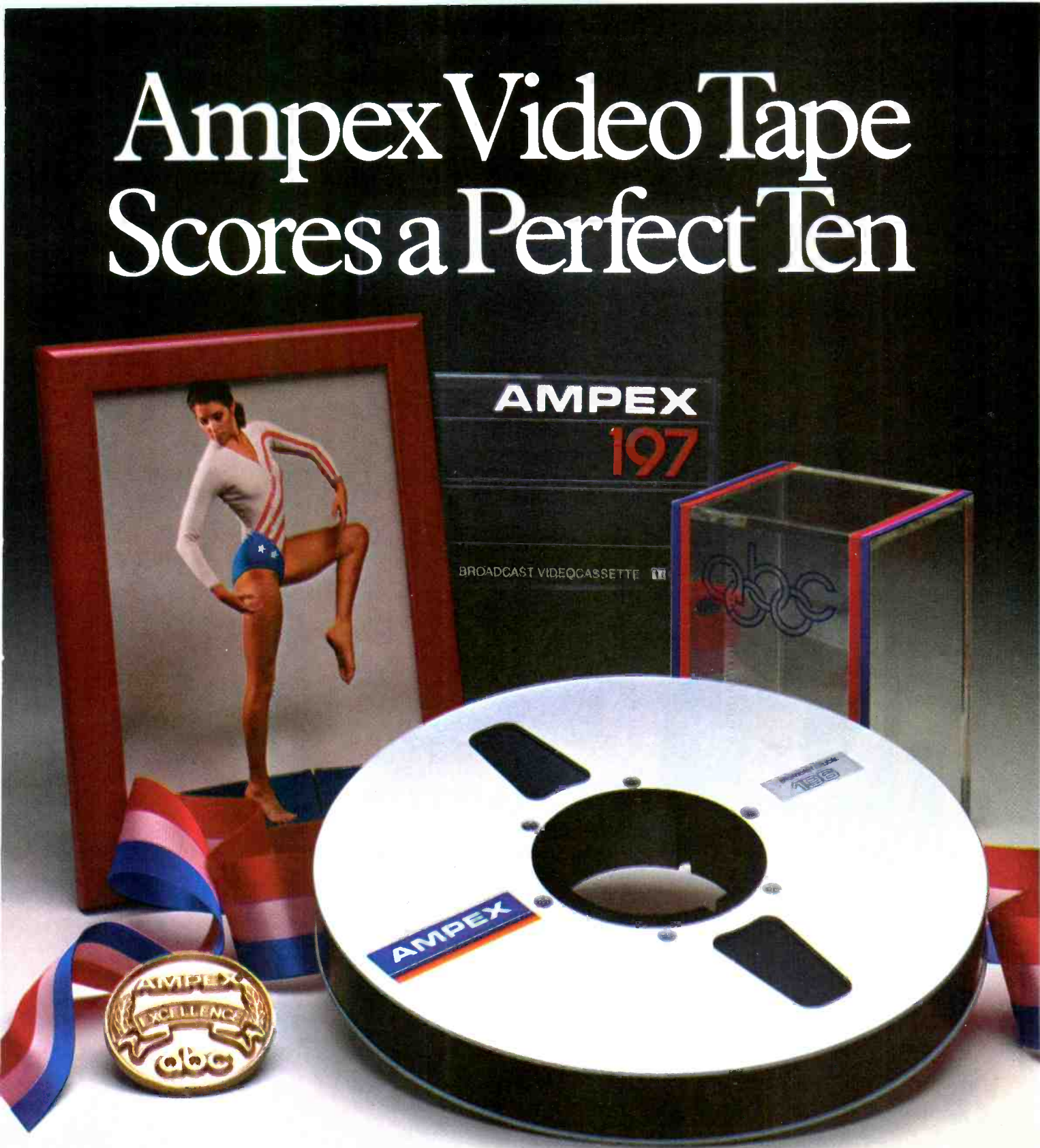
When respondents were asked to project which specific elements will have the greatest impact on the TV industry in the next decade, the following topped the list: locally produced news and information programs; the use of television for consumer information; direct broadcast satellite; state and regional networks; local independent stations; local UHF stations and narrowcasting. In TV news, a subject of particular interest indicated that jobs at the local level would appear to be on the increase during the next 10 years.

Radio and television have maintained during perhaps one of the roughest economic periods in its young history. It looks as though the 1980s might be the clearing after the storm. Research and development of new products is permitting the introduction of new technologies at relatively affordable prices as well as the upgrading of old technologies to mesh with the new.

The backbone of the industry, the manufacturers, continues to quench the unsatiable desires of the broadcasters to present the best communications package that technology will permit. Stations and facilities are upgrading and renovating. And most importantly, the industry is getting its fingers into other media technology pies.

All added up, this could be the pot at the end of the rainbow for broadcasters—a deluge of growth after a long dry spell.

Ampex Video Tape Scores a Perfect Ten



To capture the excitement of 8,000 hours of the Summer Games, ABC knew they'd need a video tape that was picture perfect.

That's why ABC chose Ampex 196 1" helical video tape and 197 ¾" videocassettes as the exclusive tapes to record the biggest events in the history of sports. It was an incredible honor for Ampex. One earned through years of consistently cr sp, clean perfor nance. Reel after reel. Generation after generation. Even under the pressures of heavy editing and multiple generation dubbing.

So if you're looking for a video tape with a track record for reliability and quality, look to Ampex 196 and 197. ABC did. And their perfect performance made them the biggest winners of all.

AMPEX

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Circle (24) on Reply Card

BE proof, Part 5: Making th

With the conclusion of the **BE** proof of performance program for FM stations, we are pleased to announce the beginning of a voluntary certification program for outstanding technical facilities.

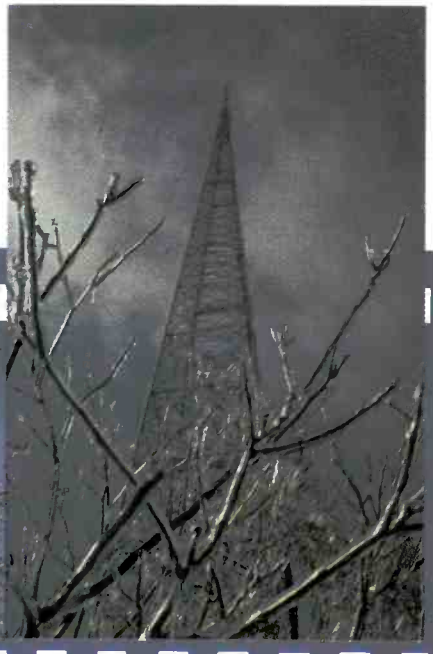
By Jerry Whitaker, radio editor

The **BE** audio proof of performance program has been structured to simulate as closely as possible the normal operating conditions at an FM station. The recommended test procedures reflect this.

The signal generator output is applied to one of the commonly used audio console line inputs. Operating level is defined as 0VU or equivalent at the console. All processing and equalizaion, if used, is left in the program line and adjusted as usual. The output is sampled and demodulated at the transmitter antenna output.

Ideally, a high quality off-air demodulator is used for the system output sample, if available. An off-air demoduator has the advantage of taking transmitter and antenna bandpass irregularities into account. The demod must, however, be very flat to avoid invalid results.

For stations with a modern wideband antenna and near-zero VSWR under static and dynamic conditions, an output line tap probably makes the most sense. We recommend using an actual line tap, not a PA cavity pickup loop, so that any irregularities in the harmonic filter or combiner equipment may be observed.



Test equipment

For the test measurements to be of value, the test equipment used must be carefully selected and accurately calibrated. The following instruments will be required to correctly run the **BE** proof:

- A low distortion audio signal generator with a metered output and calibrated attenuator.
- A distortion analyzer capable of measuring THD and SMPTE IMD.
- An audio voltmeter capable of accurately measuring signals to at least -65dBm. This function is usually provided on distortion analyzers.
- An oscilloscope with response to at least 1MHz.
- A properly calibrated FM stereo modulation monitor. Because measurements will be made with de-emphasis, the accuracy of the built-in de-emphasis circuits should be verified.

These test instruments are common and any well-equipped engineering shop should have them. Stations that do not have such gear in their inventory can usually borrow the missing items from another station in town, perhaps for a nominal fee.

Test equipment can also be rented from a rental/leasing company. This option often gives the station the opportunity to use the latest high-tech test instruments. The purchase price of such gear is often well beyond the budget of most radio stations; rental allows even small-market broadcasters to fine-tune their systems on the best test equipment available.

e measurements

Since we launched the **BE** proof of performance program in the August issue, the reader response has been extremely positive. Support has come not only for the concept of the effort, but also for a voluntary program of certification. For this reason, we are now accepting applications for **BE** proof certificates.

There are 2 levels of certification available under the program, *superior* and *excellent:*

- The *superior* classification requires a high degree of equipment performance and represents the maximum capability of a state-of-the-art FM stereo facility. Although relatively few stations will be able to provide this level of performance, the targets are achievable and are challenging goals for those in quest of all-out fidelity.
- The *excellent* classification includes performance objectives that are considerably tighter than the FCC's equipment performance measurement specifications, but still within the reach of almost any properly engineered FM station with typical equipment.

Our performance objectives (outlined in the November **BE,** page 48 may look tough, and they do describe superlative FM fidelity. They are, however, achievable. Although the performance targets suggested may be tighter than the manufacturer's specifications on some of the individual links in the system, it is possible for the overall system performance to be better in some respects than the manufacturer's specs for one of the component parts for two reasons.

First, the factory specs are usually conservative enough to accommodate production variations, so *typical performance* is generally better than the published specifications.

Second, distortion figures in a complex system are not usually additive, although they can be, and the weakest link generally sets the overall system performance limit. Also, frequency response errors can be manipulated to cancel each other for a flat audio bandpass through the transmission chain.

Stations interested in applying for **BE** proof of performance certification should study the test measurement procedures outlined in the accompanying article. The measurements must be submitted on the form shown on page 52. Sign, date and notorize the data sheet. You may copy the data sheet as necessary to document the results. Please include with the completed test forms a note on your station's letterhead stating that all procedures outlined by **BE** have been met.

Mail the information to: **BE** Proof Program, **Broadcast Engineering,** P.O. Box 12901, Overland Park, KS 66212.

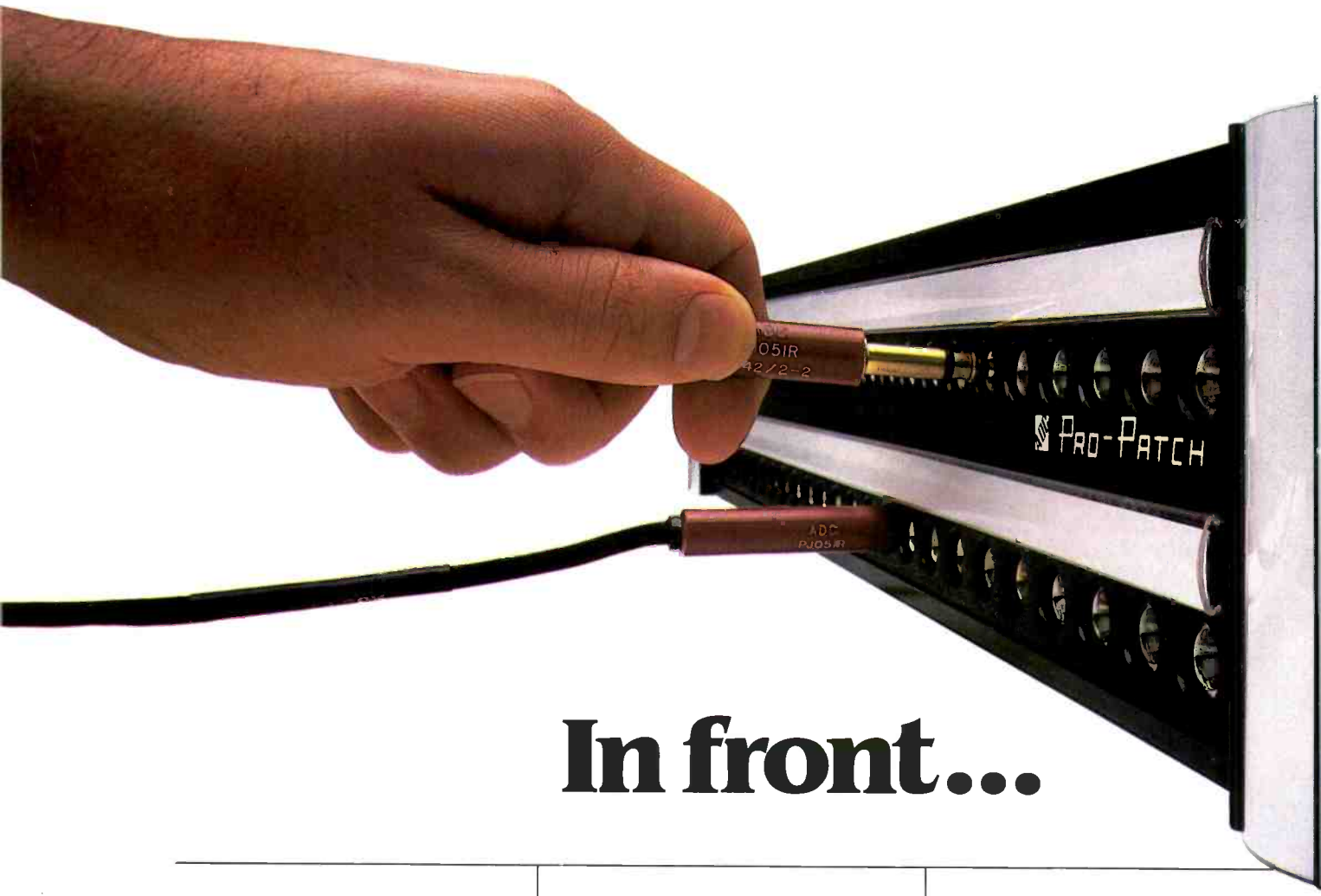
Allow 3 weeks for processing of the certificate.

Engineers interested in a booklet describing the program and outlining the test measurements should circle (500) on the Reader Service Card in the back of this issue.

Because of the interest generated by the introduction of the **BE** proof program for FM radio, we have decided to also offer audio proofs for AM and TV stations. These programs will be presented in future issues of **BE.**

The broadcast industry is faced with unprecedented competition from alternative programming sources and new technologies. Stations can only compete with these services by delivering to their audiences top-quality programs through top-quality transmission systems. The **BE** proof is a realistic, meaningful and economically sound way of maintaining peak performance.

PRE-WIRED JACKFIELDS



In front...

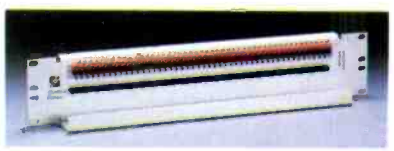
Your engineering staff has more important things to do than soldering patch panels. That's why you'll find a big advantage in ADC's 100% pre-wired Pro-Patch™ jackfields and Ultra-Patch™ panels. Featuring ADC's new split cylinder contacts, these units allow for fast, reliable, hassle-free installation.

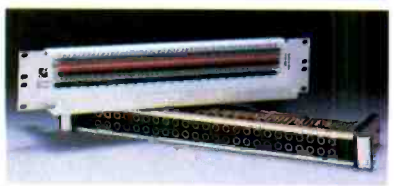
Fully assembled, computer tested and ready to hook up, Pro-Patch and Ultra-Patch completely eliminate labor intensive soldering or crimping operations.

In fact, hooking up to the back of a Pro-Patch unit is almost as easy as plugging into the front. Just a push on a special hand tool bares a wire, locks it into a split-cylinder contact inside an insulated housing and trims off excess length.

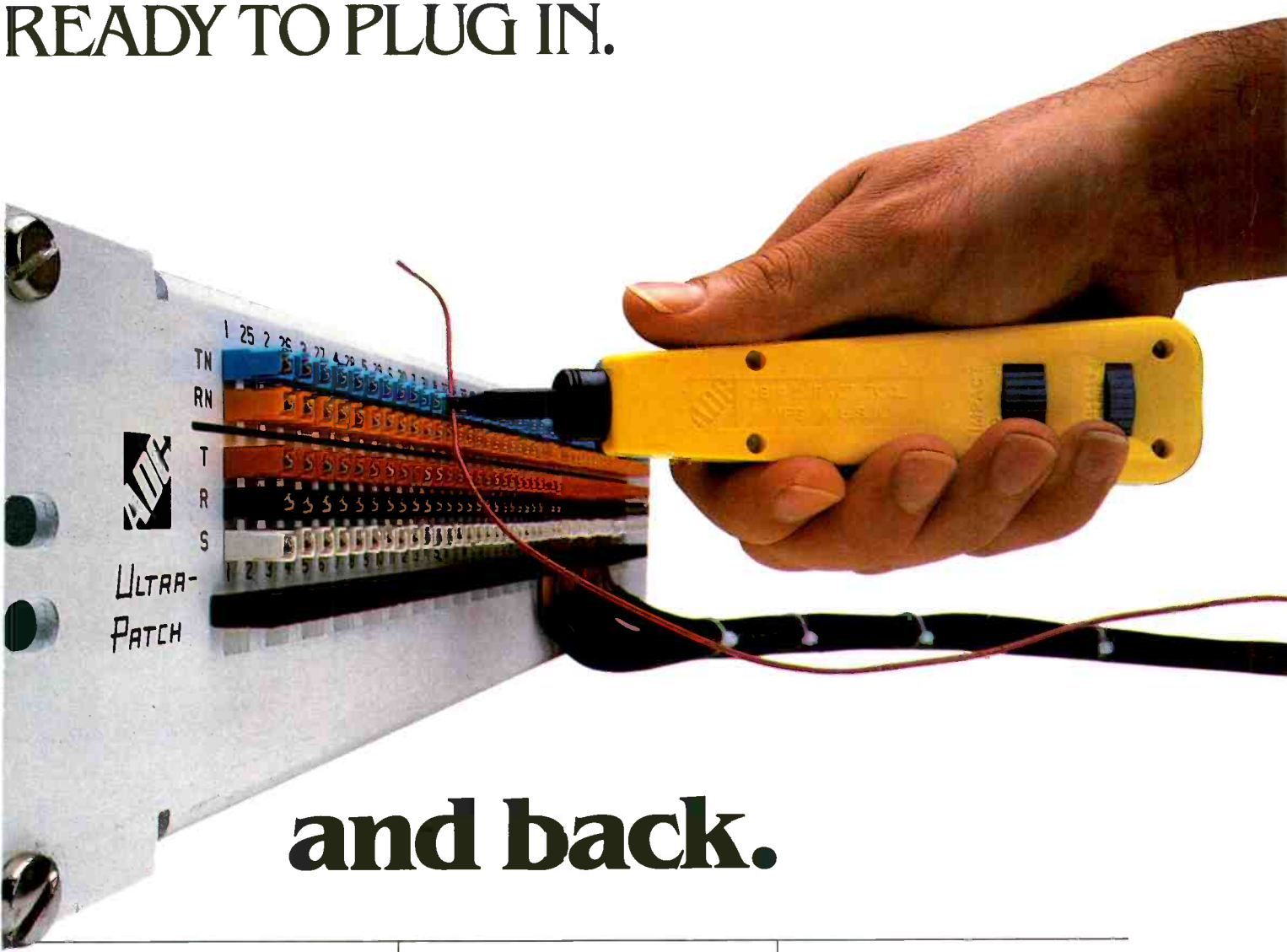
Pro-Patch jackfields and Ultra-Patch panels cut installation time from hours to minutes and allow circuit or normalling configuration changes in seconds.

Since their introduction last April at NAB, Pro-Patch jackfields and Ultra-Patch panels have appeared in virtually every segment of the Broadcast industry.

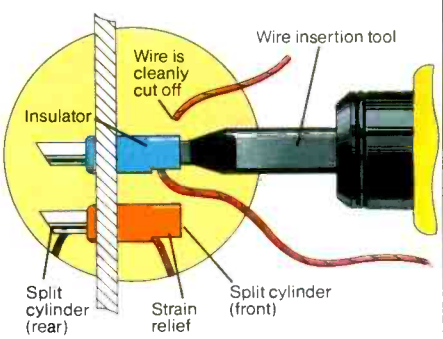




READY TO PLUG IN.



and back.



ADC's unique split-cylinder system features contacts that will accept 22,24 or 26 AWG solid or stranded wires. The cylinders are housed in plastic insulating modules and are recessed to virtually eliminate shorting at the contacts. Both sides of the contact have two-wire capability providing for four gas-tight terminations per contact. The cylinders are also rated for a minimum 100 cycles and are easily replaceable. Triple strain reliefing is provided on all units.

Pro-Patch and Ultra-Patch—as well as many custom configurations incorporating the split-cylinder contacts—are fast setting the stage for a new industry standard of wire termination.

For more information on these truly state-of-the-art audio patching systems—or the name of your nearest ADC distributor—write or call ADC Magnetic Controls Co., 4900 West 78th Street, Minneapolis, MN 55435, (612) 893-3000.

ADC®

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BROADCAST ENGINEERING
OFFICIAL PROOF FORM

DATA SUMMARY SHEET
STATION _____ FM

LEFT CHANNEL ☐ RIGHT CHANNEL ☐

NOISE TEST _____dB	SMPTE IMD _____%	SEPARATION AT 15kHz _____dB

FREQ.	75μs CURVE FACTOR*	RESPONSE DEVIATION dB	SEPARATION dB	DISTORTION %
30Hz	– 0.2dB			
40Hz	– 0.2dB			
50Hz	– 0.2dB			
63Hz	– 0.2dB			
80Hz	– 0.2dB			
100Hz	– 0.2dB			
125Hz	– 0.2dB			
160Hz	– 0.2dB			
200Hz	– 0.2dB			
250Hz	– 0.15dB			
315Hz	– 0.1dB			
400Hz	0dB Reference			
500Hz	+ 0.05dB			
630Hz	+ 0.2dB			

FREQ.	75μs CURVE FACTOR*	RESPONSE DEVIATION dB	SEPARATION dB	DISTORTION %
800Hz	+ 0.4dB			
1kHz	+ 0.7dB			
1.25kHz	+ 1.05dB			
1.6kHz	+ 1.8dB			
2kHz	+ 2.55dB			
2.5kHz	+ 3.6dB			
3.15kHz	+ 4.85dB			
4kHz	+ 6.3dB			
5kHz	+ 8.05dB			
6.3kHz	+ 9.9dB			
7.5kHz	+ 11.35dB			
10kHz	+ 13.55dB			
12.5kHz	+ 15.35dB			
15kHz	+ 16.7dB			

*The correction factor that should be applied to the *response deviation* calculation. The 75μs *curve offset* value applies to the frequency response characteristics of the standard 75μs pre-emphasis curve, referenced to 400Hz. The data are taken from Section 73.333 (Figure 4) of the commission's rules.

CHECK COMPLIANCE WITH THE FOLLOWING:

AUDIO CLIPPING LEVEL	
COMPOSITE "A" TEST	
COMPOSITE "B" TEST	
AUDIO PROCESSING LEVEL	

GENERAL TEST CONDITIONS

- System in stereo mode
- Input signals applied to console line input(s) used for most program sources.
- System output sampled and demodulated at transmitter antenna output.
- All processing and EQ left in line and adjusted as usual.
- Operating level defined as 0VU or equivalent at console.

Note: Separation refers to the amount of residual signal in the other channel that is caused by modulation of this channel.

IMPORTANT: The BE proof is not a substitute for the annual equipment performance measurements required by the FCC.

ALL TESTS PERFORMED BY: _____

DATE: _____

THE NEW NAME IN VIDEO WON'T DISTORT THE NEWS.

The new three-quarter-inch EASTMAN Professional Video Tape gives your news crews the reliability needed to deliver the story accurately every time. With high signal-to-noise ratio and the lowest of dropouts. With consistency, cassette after cassette.

This broadcast-quality video tape is designed to work with today's state-of-the-art recording and editing equipment. It's available in all popular sizes of standard and mini cassettes.

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Washington, D.C.: 703/558-9220 • Montreal: 514/761-3481 • Toronto: 416/766-8233 • Vancouver: 604/926-7411.

Kodak

Circle (26) on Reply Card

Before attempting to run the proof, check the audio generator and distortion analyzer frequency response and residual distortion at all frequencies of interest. Response should be flat to within at least 0.1dB from 30Hz to 15kHz. Distortion should be below 0.1% for all frequencies to be measured. The noise floor of the distortion analyzer and audio voltmeter should be at least −65dBm. If adjustments or repairs are indicated in these closed-loop checks, make them before attempting to run the proof.

The residual test equipment distortion values determined during pre-proof compliance tests *may not* be subtracted from the total system distortion figures obtained when running the actual proof. Subtracting test instrument residual distortion is not a valid procedure because distortion components do not necessarily add.

In fact, the only time they will add is when all of the harmonics are in phase—a near impossibility when you consider that this would have to be true for every modulating frequency used during the proof.

How many frequencies?

To accurately evaluate a broadcast transmission system, the performance of the equipment must be checked at a sufficiently large number of discrete frequencies, or points. The traditional FCC equipment performance measurements (EPMs) require modulating frequencies of 50Hz, 100Hz, 400Hz, 1kHz, 5kHz, 10kHz and 15kHz.

Although these points give the engineer a basic idea of how well the system is performing, they fall short of our goal, which is to push the equipment to its maximum performance limits. The frequency spaces in the traditional EPM tests—as much as 5kHz—are far too wide to accurately predict the performance of the transmission system across the audio band.

For this reason, the **BE** proof testing procedures specify a substantially greater number of points than the standard EPMs. We specify checking 28 separate frequencies between 30Hz and 15kHz. These points are based on 1/3-octave ISO (International Standards Organization) center frequencies, with three minor modifications. The measurement frequencies are shown in the accompanying test form.

The lowest frequency measured is 30Hz. The actual ISO frequency is 31Hz. All other frequencies are standard ISO centers, except 7.5kHz (standard ISO is 8kHz) and 15kHz (16kHz).

These modifications of the ISO standard 1/3-octave frequencies provide compatability with the frequencies specified in our performance objectives and compatability with the standard FCC EPM test frequencies. In recognition of the bandpass limits of an FM transmission system, no attempt is made to measure frequencies below 30Hz or above 15kHz.

The EPM requires measurement of seven discrete frequencies. The **BE** proof requires measurement of 28 discrete frequencies. Although a substantially greater number of frequencies are checked with the **BE** proof, all measurements are made at a single modulating level. Running the **BE** proof should take no longer than running the FCC's EPMs.

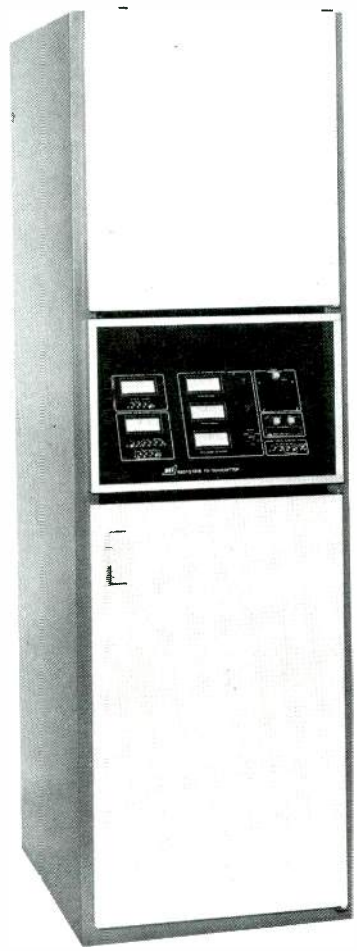
Making the measurements

The **BE** proof of performance reporting form lists all measurements needed to meet our certification requirements. The form should be photocopied to provide a data summary sheet for the left channel and the right channel. No measurements are taken in the monophonic mode, unless the station regulary operates in mono.

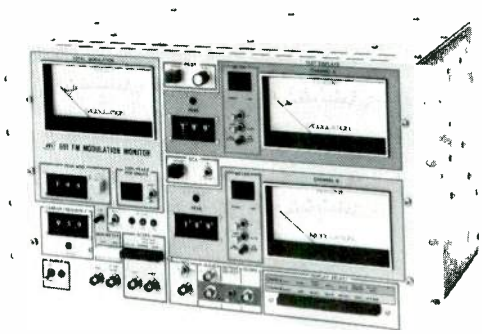
The tests are arranged in the order that the proof should be conducted. The first step is to check the noise floor, SMPTE intermodulation distor-

High Technology Or Low Price

Do you want a fully remote controlled FM transmitter with features for total automation and satellite feed? Must you have microprocessor logic, digital diagnostics, each with a back-up system? Do you demand a super-low distortion exciter and total solid-state for your new one kilowatt transmitter ...or a 3.5KW with only one tube?
Is it imperative that your transmitter talk to the factory's computer.
Perhaps low price is most important? Look at the deal you can make with companies assembling those 25 years old look alikes.
And maybe you can find a good used remote control unit... cheap.
Prepare for the future, or hold-the-line?
Price or Technology?



The New 695T3.5KW



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call John Tiedeck at QEI, 609-728-2020. He will tell you how. Remember, we are the FM people. Monitors, ATS and transmitters from 20W. to 5KW.

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THE FIRST 3-CHIP CCD CAMERA IS ON THE STREET.

And we just made it better.

Introducing the new SP-3A. NEC's second generation in CCD cameras. With a dramatic 30% increase in light sensitivity. And 100 time improvement in high-light handling.

And no pick-up tubes inside. So you can forget about burn-ins, retubing, sticking, comet tails, and re-registration. Forever.

Because now, NEC gives you locked-in image quality to match any conventional ENG camera. Cranking out more than 450 lines of beautiful color resolution, for any VTR format.

And it's all neatly packaged into 5.9 lbs. (head only) of solid state power. So rugged, so reliable, you can probably drop it on a sidewalk and still get the picture.

To find out more, including a very newsworthy price, just call NEC toll-free at 1-800-323-6656. And see why this CCD is making ENG video better than ever.

NEC

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Introduced at SMPTE to the most demanding audience in the world.

"Give me one good reason why my next camera should be a CCD."

"SP-3A... it's new from NEC."

After 3-chip CCD cameras were introduced at NAB, NEC did extensive research to learn what you thought about CCD camera technology.

And quite frankly, you liked what you saw. But you weren't exactly ready to throw all your old ENG cameras down the tubes.

So our engineers went back and made a few major advances in CCD camera technology. Advances like a 30% increase in light sensitivity. And a signal-to-noise ratio of 58 DB. Advances which make this NEC 3-chip the match of any ENG camera on the market.

We call it the SP-3A. And we think you'll call it a dream. Because it has all the features of the SP-3, such as no burn-ins, no retubing, no re-registration, and no comet tails.

No geometric distortion, no microphonics, and no light overloads. No magnetic disturbance, no sticking, no gray scale degradation, and no pick-up tubes. And no blooming. Plus a signal-to-noise ratio and light sensitivity to meet even the most critical professional ENG requirements.

Oh yes, we did all of this and kept the price extremely attractive. So see the new SP-3A. We think you'll agree it's one of the most valuable and reliable ENG cameras on the street. For more than one good reason.

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Circle (31) on Reply Card

tion and separation at 15kHz. A station that can meet the **BE** proof requirements for these parameters should be able to pass the rest of the proof with little difficulty. The object of conducting the noise, IMD and 15kHz separation tests first is to determine whether the transmission system is operating properly or requires adjustments, before substantial time is spent making the measurements.

The next step is to check channel separation, response deviation and harmonic distortion at the 28 test frequencies. These measurements should be made with the signal generator fed into one audio input at the control console, and the other input terminated with a 600Ω wirewound resistor (or other appropriate resistance value).

The test procedures and performance objectives are shown on page 48 of the November issue of **BE.** A more detailed examination of the test procedures is contained in the September **BE,** page 22. Study this material before beginning the tests. A booklet is available from **BE** that outlines the entire FM proof program. (See the sidebar for details.)

To meet the **BE** certification requirements, it is not necessary to plot the frequency response or distortion levels on graph paper. We advise, however, that such graphs be kept on hand for reference. (The necessary graph paper is in the proof booklet.)

The 75μs pre-emphasis correction factor for calculation of the response deviation figures is given on the data summary sheet. A reference value of 400Hz is assumed. Distortion and separation measurements are performed using common techniques. Audio and composite clipping levels should be measured using the recommended procedures. (See the September or November issues.) After adherence to the performance objectives is verified, the appropriate boxes should be checked.

The **BE** proof program does not specify audio processing parameters, except to recommend certain levels below the threshold of limiting. In recognition of the competitive nature of FM broadcasting, adherence to our recommended limits is not a requirement for certification under the program. Stations that do comply, however, should check the appropriate box on the data reporting form.

The recommended operating level below the threshold of limiting for a 400Hz tone input to one channel is broken down into various formats:

- Classical/Fine Arts — -6 to -10dB.
- Beautiful Music/Jazz — -3 to -5dB.
- AOR/Adult Contemporary — -2 to -4dB.
- Rock — 0 to -2dB.

Final thoughts

The **BE** proof is not a substitute for the FCC's EPM tests. While outdated, the FCC measurements are still required annually.

It is not our intention to replace the commission's proof of performance, which fulfill an important function by setting minimum levels of acceptable performance for FM stations. Instead, the **BE** proof is geared to maximum performance in recognition of today's competitive marketplace.

Achieving the fidelity objectives of the **BE** proof means more than simply providing outstanding FM audio. It means that participating stations are back in the high-fidelity business and are ready to meet the challenges of the digital audio world creeping up on us. FM broadcasters will find improved source signals widening the gap between FM quality and home system quality, unless FM can once again establish itself as a high-fidelity medium.

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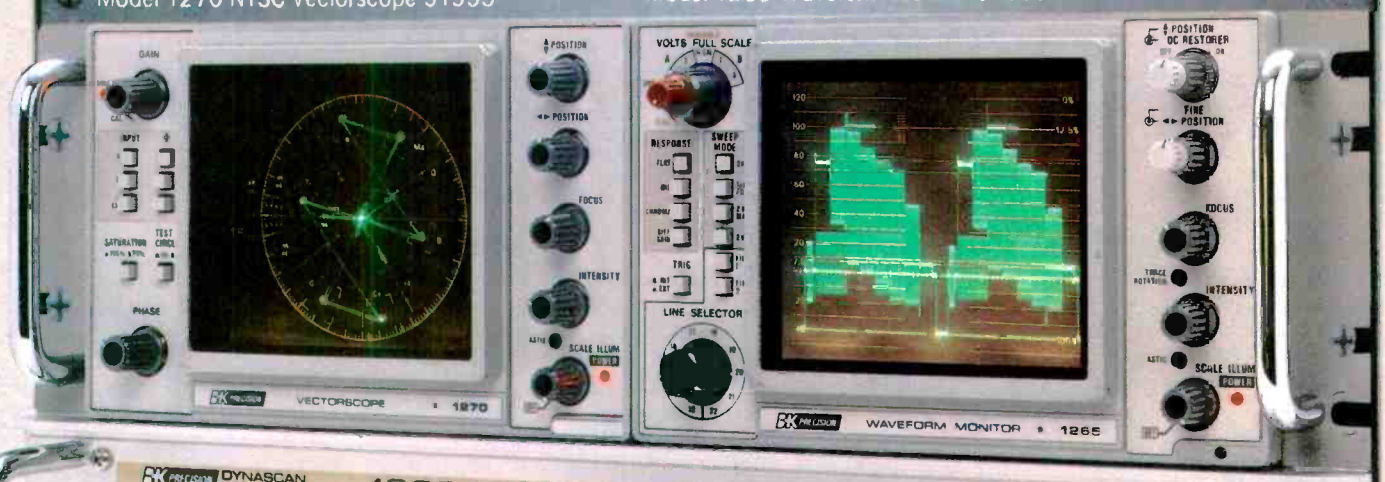

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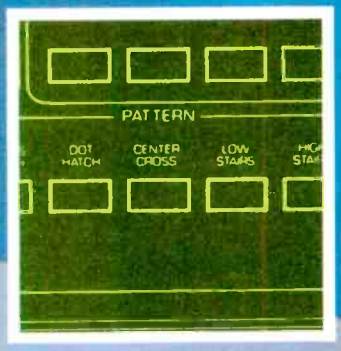

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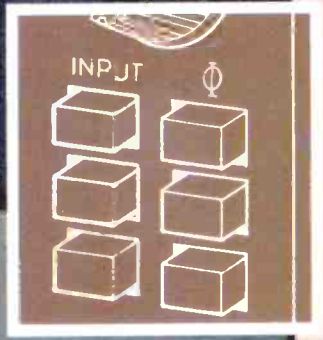

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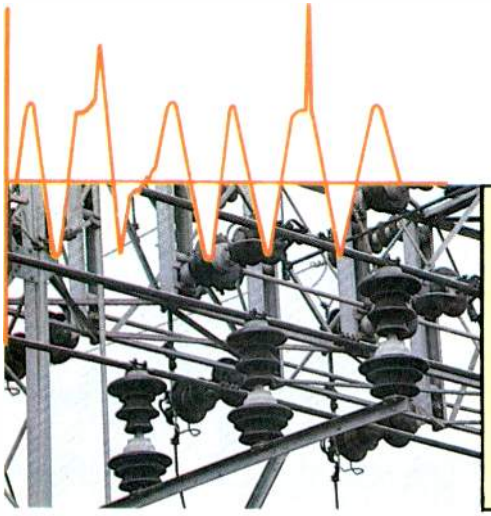


The effects of ac line disturbances

Part 4

By Jerry Whitaker, radio editor

We take the utility company power system for granted. To get ac service, just call the local office and order a power drop. We expect the utility company lines to operate all day, every day. But how is this intricate ac system designed, and how is it interfaced to user equipment?

The details of power distribution in the United States vary from one utility company to another, but the basics are the same (Figure 1). Power from a generating station or distribution grid comes into an area substation at 115kV or higher. The substation consists of switching systems, step-down transformers, fuses, circuit breakers, reclosers, monitors and control equipment. The substation will deliver output voltages of about 60kV to subtransmission circuits, which feed distribution substations.

These substations convert the energy to approximately 12kV and provide voltage regulation and switching arrangements that permit *patching around* a problem. The 12kV lines power the pole- and surface-mounted transformers, which supply various voltages (generally 208V to 240V 3 phase) to the individual loads.

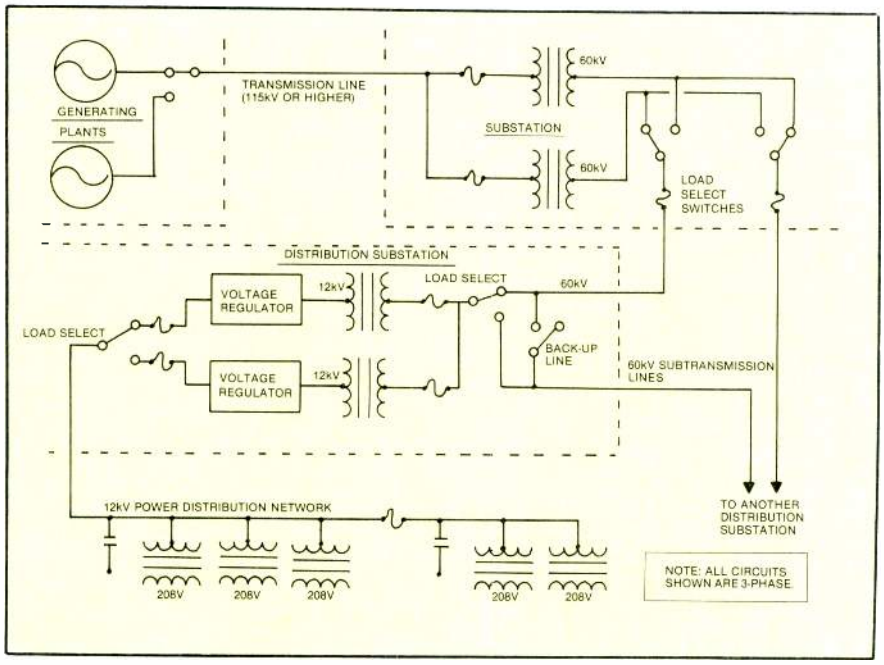
Fuses and circuit breakers are included at a number of points in the 12kV distribution system to minimize fault-caused interruptions of service. Ground-fault interrupters are also included at various points in the 12kV system to open the circuit if excessive ground currents begin to flow on the monitored line.

Reclosers may be included as part of overcurrent protection of the 12kV lines. They will open the circuit if excessive currents are detected, and reclose after a preset length of time. The recloser will perform this trip off-reset action several times before being locked out.

In some areas, the actions of circuit breakers, pole-mounted switches and reclosers are controlled by 2-way radio systems that allow status interrogation and switching of the remotely located devices from a control center. Some utilities use this method sparingly, but others make extensive use of it.

Depending on the geographic location, varying levels of lightning protection are included as part of the ac power system design. Most service drop transformers (12kV to 208V) have integral lightning arresters. In areas of severe lighting, a ground wire will be strung between the top insulators of each pole, attracting lightning to the ground wire, and not the hot leads.

Figure 1. A simplified block diagram of a basic utility company power distribution system. The devices shown as fuses could be circuit breakers or reclosers, which function as automatic-resetting circuit breakers. All circuits shown are 3-phase. The capacitors perform power factor correction duty.



Power factor

Capacitor banks are placed at various locations in the 12kV distribution system. Their number and location are determined by the load distribution and *power factor* of the circuit. The capacitors will improve the short-term line voltage regulation (in the millisecond range) and reduce transient activity on the line.

Surges are reduced because the capacitor will present a high impedance to the 60Hz line voltage frequency and a low impedance to a high frequency transient. The capacitors are placed on the line in order to keep the power factor as close to unity as possible. Transient suppression is simply a by-product.

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Power factor (PF) is defined as the ratio of *true power* to *apparent power*, generally expressed as a percentage. Reactive loads (inductive or capacitive) act on power systems to shift the current out of phase with the voltage. The cosine of the resulting angle between the current and voltage is the power factor.

A utility line that is looking into an inductive load (which is most often the case) is said to have a *lagging* power factor, while a line feeding a capacitive load has a *leading* power factor (Figure 2).

A poor power factor will result in excessive losses along utility company feeder lines because more current is required to supply a particular load with a low power factor than if the load had a power factor close to unity (100%).

For example, a motor requiring 5kW from the line is connected to the utility service entrance. If it has a power factor of 86%, the actual amount of power demanded by the load will be 5kW divided by 86%, or more than 5800W. The apparent power is 5kW, and the true power is 5.8kW. The same amount of work is being done by the motor, but the closer the power factor is to unity, the more efficient the system will be.

To keep the power factor as close as possible to 100%, utility companies place capacitor banks at various locations in the 12kV distribution system, offsetting the inductive loading (lagging power factor) of most user equipment. The idea is to create an equal amount of leading PF in the system to match the load's lagging PF. When balanced, the power factor is 100%.

In practice, this is seldom attainable, because loads are switched on and off at random times, but utilities routinely (through much effort) maintain a power factor of approximately 99%. To accomplish this, capacitor banks are switched automatically to compensate for changing load conditions. The actual power factor of a particular system is determined by a complicated series of steps that involves measuring line para-

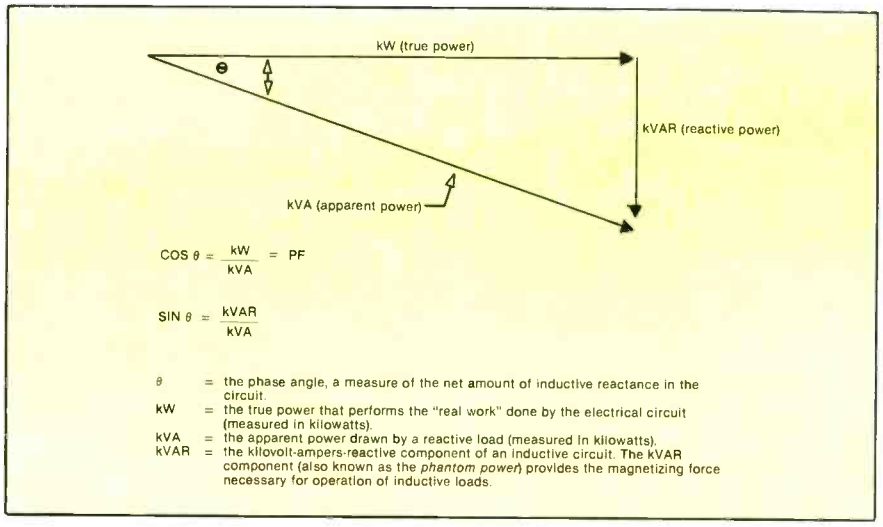

Figure 2. The mathematical relationships of an inductive circuit as they apply to power factor (PF) measurements. Reducing the kVAR component of the circuit causes Θ to diminish, improving the PF. When kW is equal to kVA the phase angle is zero and the power factor is unity (100%).

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meters and correlating them with various charts and look-up tables.

Utility company interfacing

Most utility company connections are the standard Delta-Wye type (Figure 3). This transformer arrangement is usually connected with the Delta side facing the high voltage and the Wye side facing the load. This type of arrangement provides good isolation of the load from the utility and somewhat retards the transmission of transients from the primary to the secondary. The individual 3-phase loads are denoted by Z-1, Z-2 and Z-3. They carry load currents as shown.

Some utility connections, however, use the Open-Delta arrangement shown in Figure 4. Customers often encounter problems when operating a sensitive 3-phase load from such a connection because of the system's poor voltage regulation characteristics during varying load conditions. The Open-Delta configuration is also subject to high third harmonic content and transient propagation. The three loads and their respective load currents are shown in the diagram.

Other primary power connection arrangements are possible, such as Wye-to-Wye or Delta-to-Delta. Like the Delta-to-Wye configuration, they are not susceptible to the problems that can be experienced with the Open-Delta (or V-V) service.

The Open-Delta system can develop a considerable imbalance between the individual phases in either voltage or phase or both. Such an occurrence can introduce a strong 120Hz ripple frequency in 3-phase power supplies, which are designed to filter out a 360Hz ripple. The effects of this 120Hz ripple can be increased noise in the supply and possible damage to

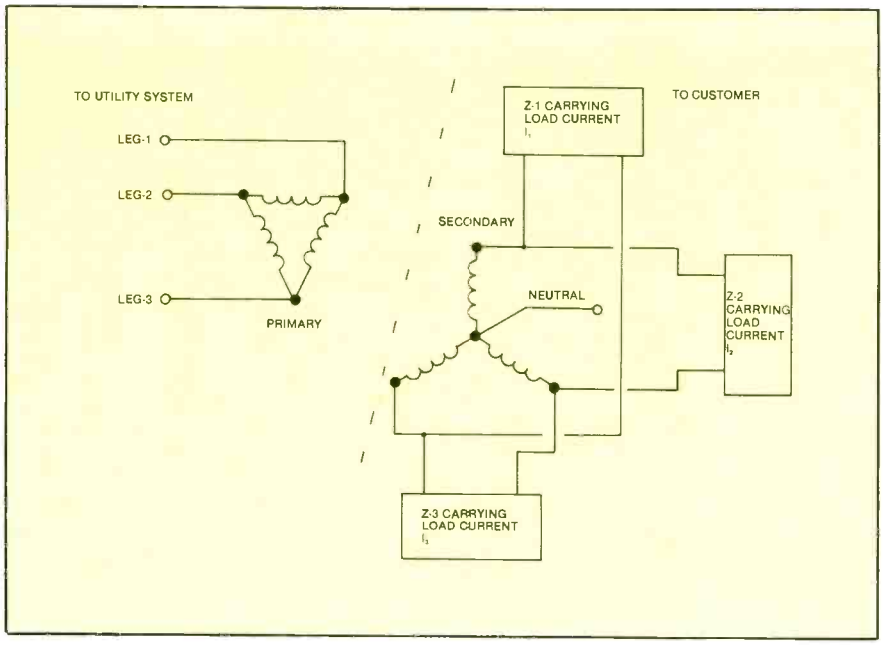
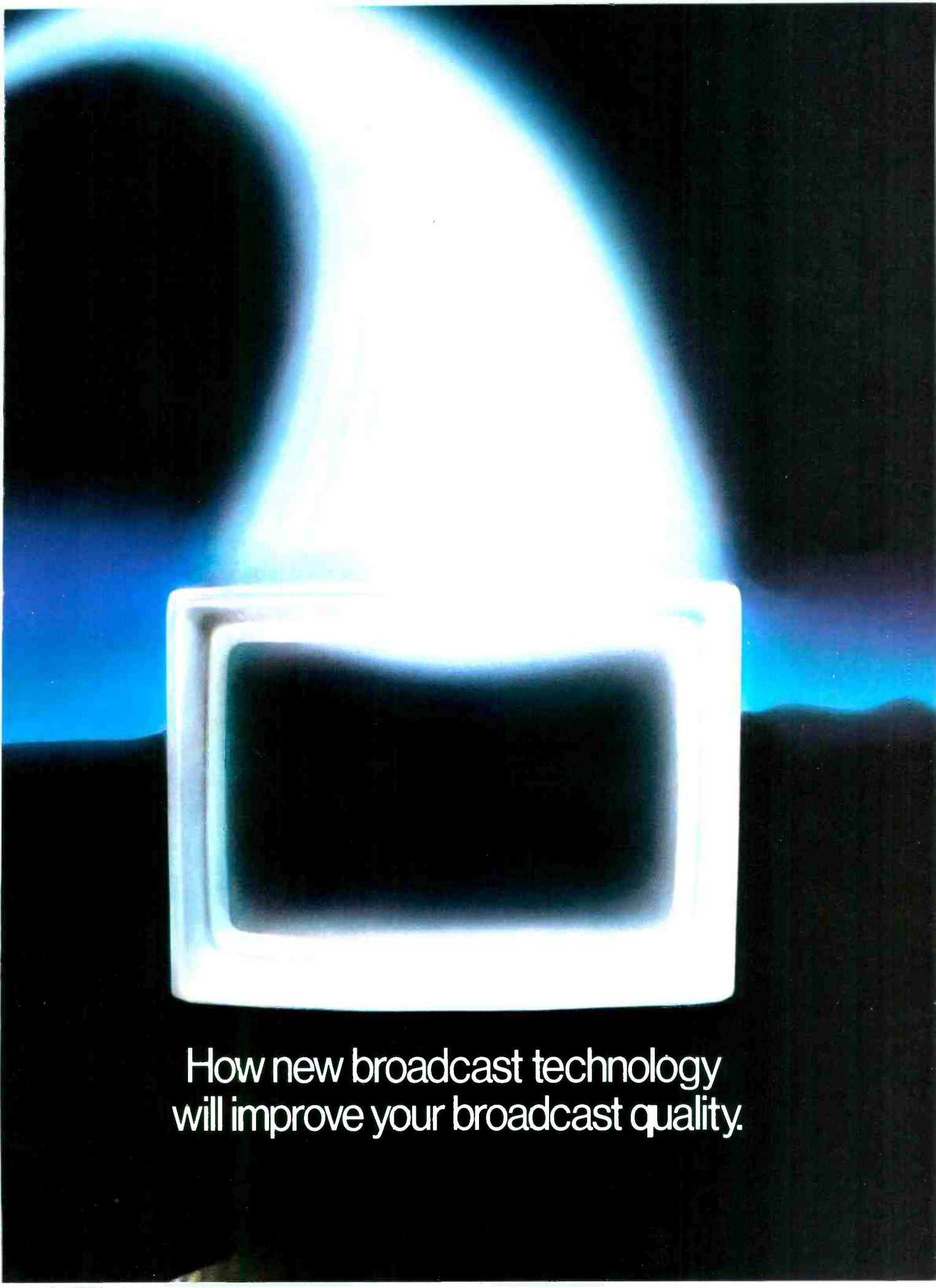


Figure 3. The Delta-Wye transformer configuration for utility company power distribution. This common type of service connection transformer provides good isolation of the load from the 12kV distribution system line.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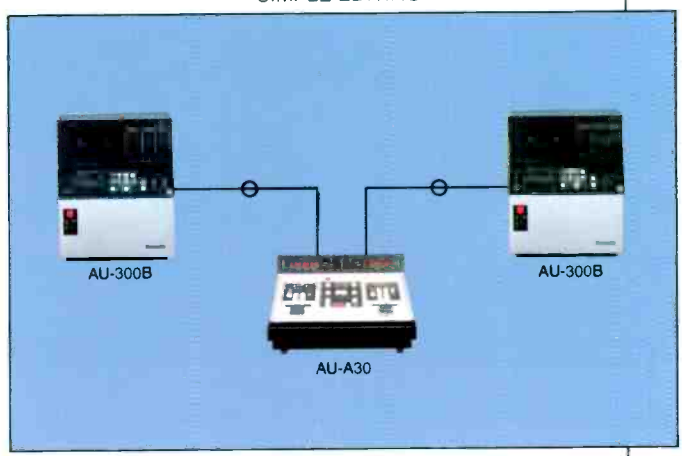

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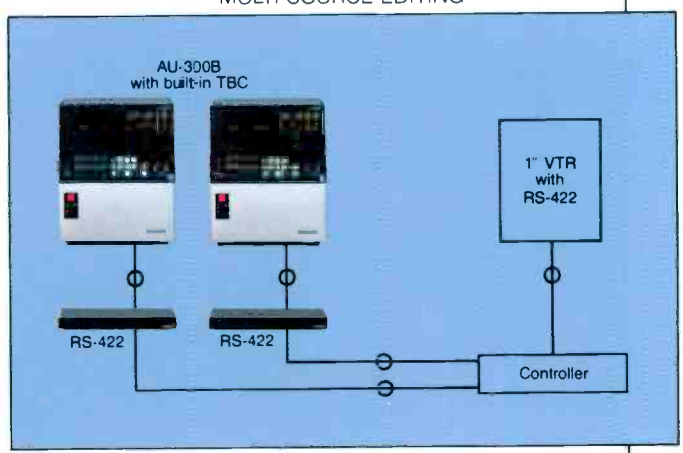

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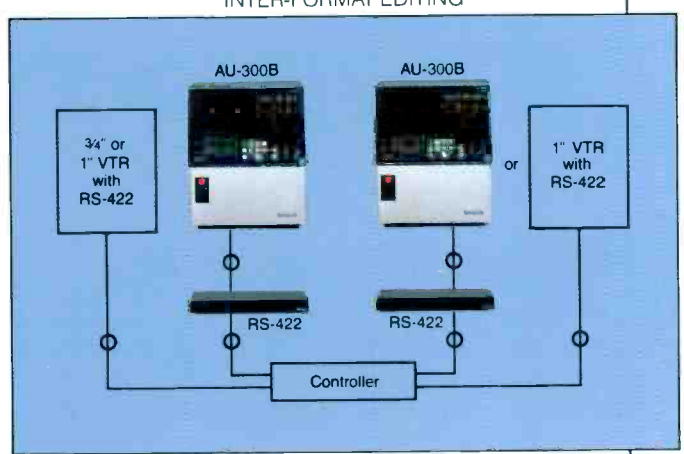

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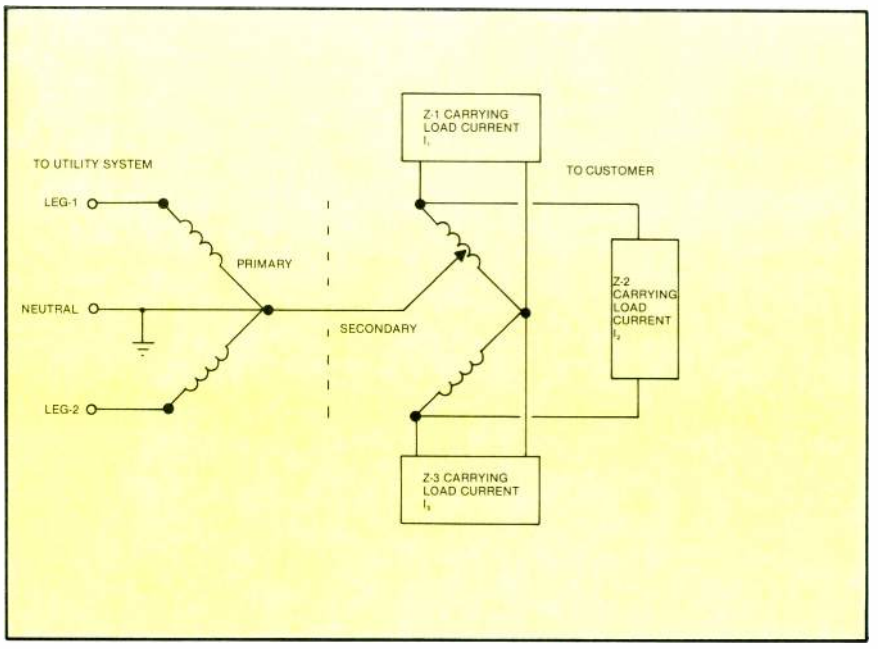


Figure 4. The Open-Delta (or V-V) utility company service connection transformer. Use of this configuration is not recommended because of the tendency of the arrangement to provide poor voltage regulation, high third harmonic content and transient disturbance propagation.

protection devices across the power supply chokes.

Depending on the loading of an Open-Delta transformer arrangement, high third harmonic energy can be transferred to the load, producing transients of up to 300% of the normal voltage, which severely strain rectifiers, capacitors and inductors in the power supply as well as adding to the supply's output noise.

The phase-to-phase voltage balance of a utility company line is important to a broadcast facility, not only because of the increased power supply ripple it may cause, but also because of the heating effects that may result. Even simple 3-phase devices such as motors should be operated from a power line that is well balanced (preferably within 1%).

Studies have shown that a line imbalance of only 3.5% can produce a 25% increase in the heat generated by a 3-phase motor. A 5% imbalance can cause a 50% increase, which is potentially destructive. Similar heating can also occur in the windings of 3-phase power transformers used in broadcast equipment.

Phase-to-phase voltage balance can be accurately measured over several days with a slow-speed chart recorder. The causes of imbalanced operation are generally large single-phase power users on the 12kV distribution line. Uneven currents through the utility company power distribution system will result in uneven line-to-line voltages at the customer's service drop entrance.

When using a Wye-connected system, it is important that the building's neutral lead be connected to the midpoint of the transformer windings, as shown in Figure 3. The neutral line provides a path for the removal of any harmonic currents that may be generated in the system because of rectification of the secondary voltages.

Sensitive broadcast equipment can be protected against disturbances on the ac line in several ways. Three common methods include motor-generator units, uninterruptible power systems and high-performance isolation transformers.

Motor-generator units

As the name implies, a motor-generator unit (MGU) consists of a motor powered by the ac utility supply that is mechanically tied to a generator, which feeds the load. Transients on the utility line will have no effect on the load when this arrangement is used. Adding a flywheel to the motor-to-generator shaft will protect against brief power dips (up to ½s on many models). Figure 5 shows the construction of a typical MGU.

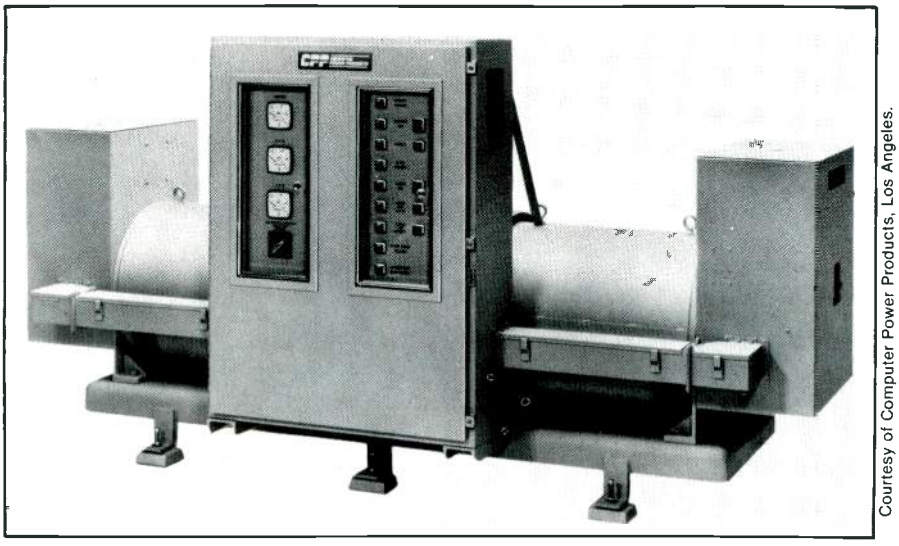
Other features available from a motor-generator unit include output voltage and frequency regulation, ideal sine wave output, elimination of common-mode and transverse-mode noise, elimination of utility company power factor correction problems and true 120° phase shift for 3-phase models. The efficiency of a typical MGU ranges from 65% to 89%, depending on the size of the unit and the load.

Uninterruptible power systems

Another method guaranteed to eliminate spikes on utility company power lines is the rectifier-inverter combination, used in many uninterruptible power systems (UPS). As shown in Figure 6, ac from the utility is rectified to a given voltage, say 120V dc, across which floats a bank of batteries connected in series to yield slightly less than 120V. This dc power drives a closed-loop inverter, regulating voltage and frequency.

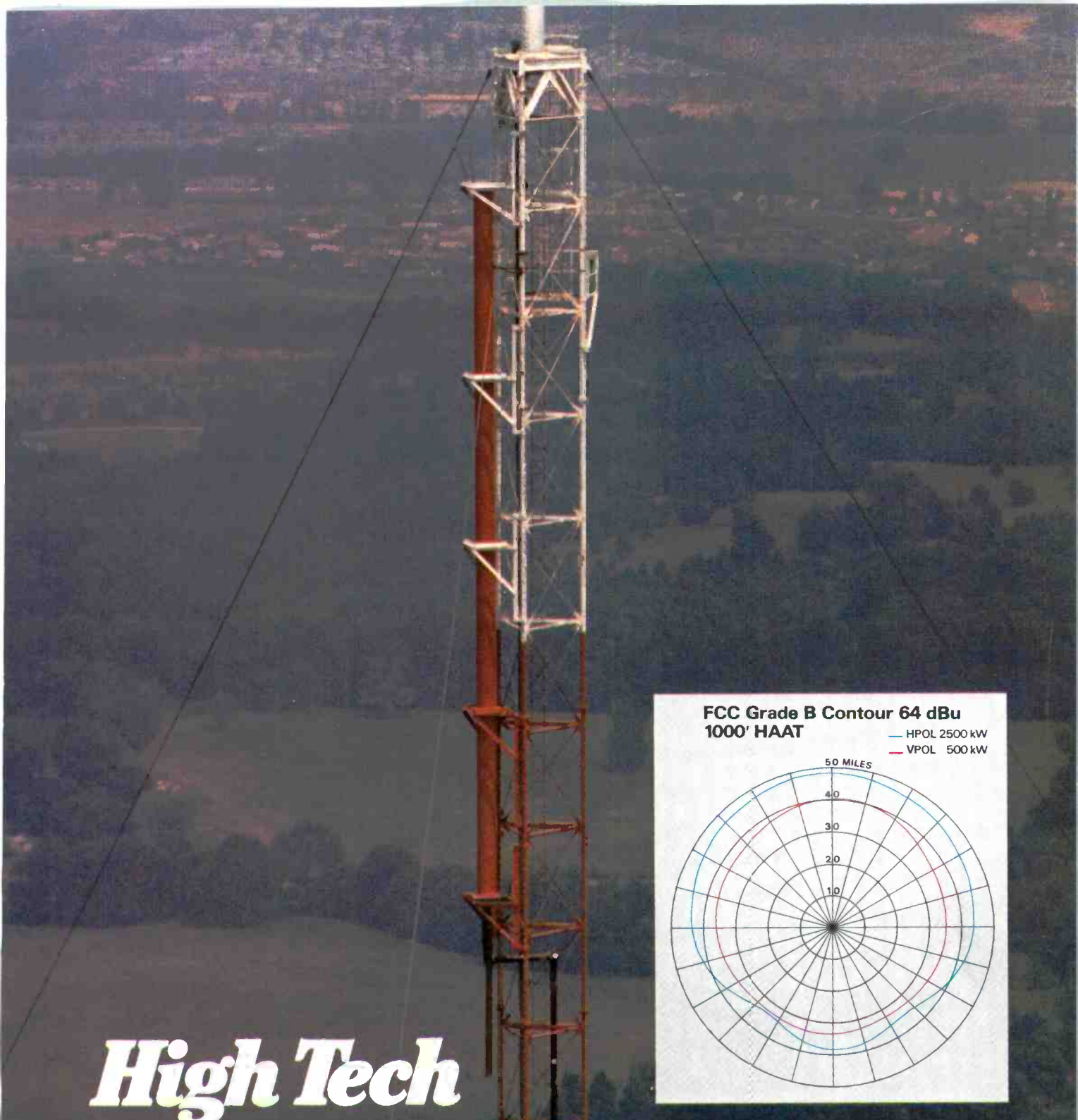
The output of the inverter is generally a sine wave, or pseudo sine wave (really a stepped square wave). If the utility voltage should drop or disappear, current is drawn from the batteries. When ac power is restored, the batteries are recharged.

Many UPS systems incorporate a standby diesel generator that starts as soon as the utility company feed is interrupted. With this arrangement, the batteries are called upon to supply the operating current for only 30 seconds or so, until the generator gets up to speed.



Courtesy of Computer Power Products, Los Angeles.

Figure 5. The design layout of a typical motor-generator unit (MGU).



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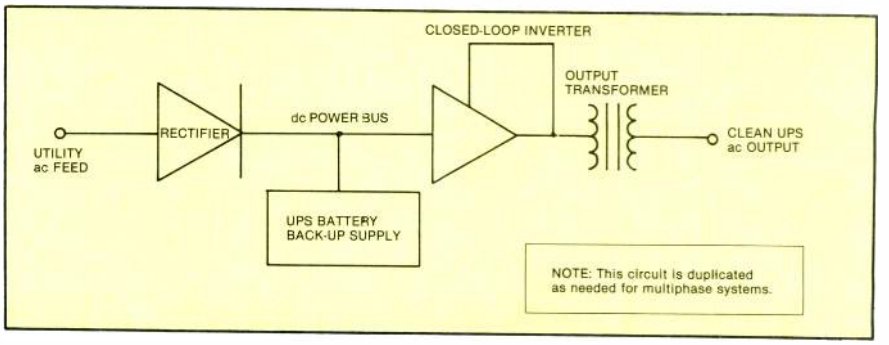
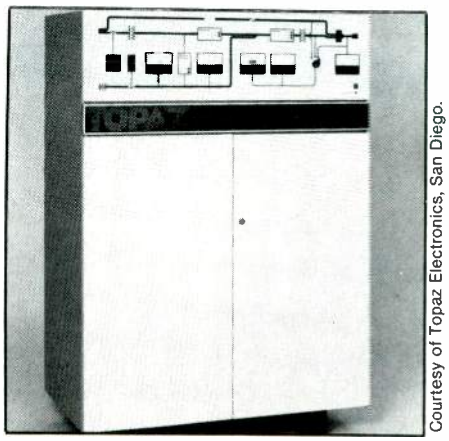


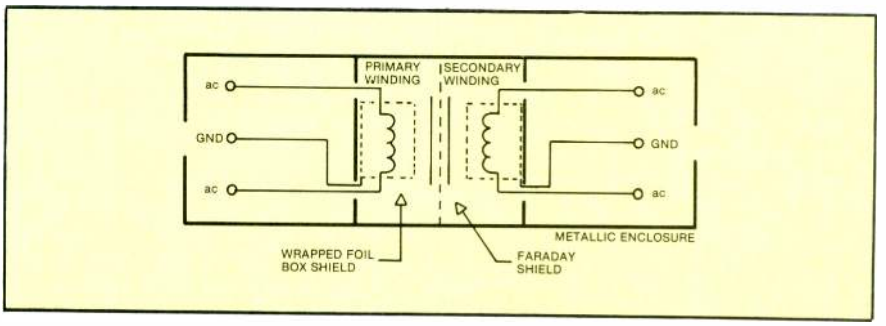
Figure 6. A block diagram of a typical uninterruptable power system (UPS) using ac rectification to float the battery supply. A closed-loop inverter draws on this supply and delivers clean ac power to the protected load.



Courtesy of Topaz Electronics, San Diego.

Figure 7. A typical UPS using externally located batteries. The control panel on the front of the chassis is used to check the performance of the equipment and to monitor the quality of the incoming ac power.

Figure 8. The shielding arrangement used in the Ultra-Isolator transformer (manufactured by Topaz Electronics). The design goal of this type of unit is high common-mode and transverse-mode noise attenuation.



High-performance isolation transformers

Transients, as well as noise (RF and low-level spikes) can pass through transformers, not only by way of the magnetic lines of flux between the primary and the secondary, but through resistive and capacitive paths between the windings as well. Increasing the physical separation of the primary and secondary windings will reduce the resistive and capacitive couplings. However, it will also reduce the inductive coupling and decrease the power transfer.

A better solution is to shield the primary and secondary windings from each other and divert much of the primary noise current to ground, leaving the inductive coupling basically unchanged. This idea can be carried a step further by placing the primary winding in a shielding box that shunts noise current to ground and reduces the capacitive coupling between the windings.

One application of this technology is shown in Figure 8, in which transformer noise decoupling is taken a step further by placing the primary and secondary windings in their own wrapped foil box shields. The windings are separated physically as much as possible for the particular power rating, and placed between special Faraday shields.

This gives the transformer high noise attenuation from the primary to the secondary, as well as from secondary to the primary. The interwinding capacitance of a typical transformer using this technology is 0.005pF. Common mode noise attentuation is typically greater than 120dB and transverse mode noise attenuation is typically in excess of 60dB.

Part 5 of this series on ac line disturbances will examine ways to protect broadcast facilities using discrete transient suppression devices.

Bibliography

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Harris Coorporation. **The Susceptability of the Open Delta Connection to Third Harmonic Disturbances. Defense Civil Preparedness Agency, EMP and Electric Power Systems.** Publication TR-61-D, July 1973.

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IBC '84 in Review

By John Battison,
antennas/radiation consultant,
and Carl Bentz, television editor

At the 10th International Broadcasting Convention at Brighton, England, the exhibit areas proved a tight fit for almost 150 manufacturers' exhibits and 7000 people from around the world who came to look at new and established products and talk technical matters at the Hotel Metropol.

As a result, IBC management suggested that space will again be expanded for the exhibition for 1986.

A highlight of the convention, held Sept. 21-25, was the presentation of the first IBC Award to Dr. Geoffrey Phillips, head of the Radio Frequency Group, BBC Research Department, during the IBC Champagne Reception hosted by John Tucker, chairman of the IBC Management Committee. The award design, suggesting the marriage of technology and artistic creation in broadcasting, recognized Philips' 30-year effort on efficient use of RF spectrum.

The products in the exhibit areas showed a proliferation of analog audio, digital control and component and digital video. Among them were no major surprises of new technology, but rather building on previous products. About 90% were TV-oriented.

A listing of all of the innovative products shown at IBC is not possible. However, here are some of the outstanding items:

A post-production console by Ampex Systems Group for Fountain Television, a production company in Richmond, England.

Elektroimpex, Hungary, Hungarian Foreign Trading Company.

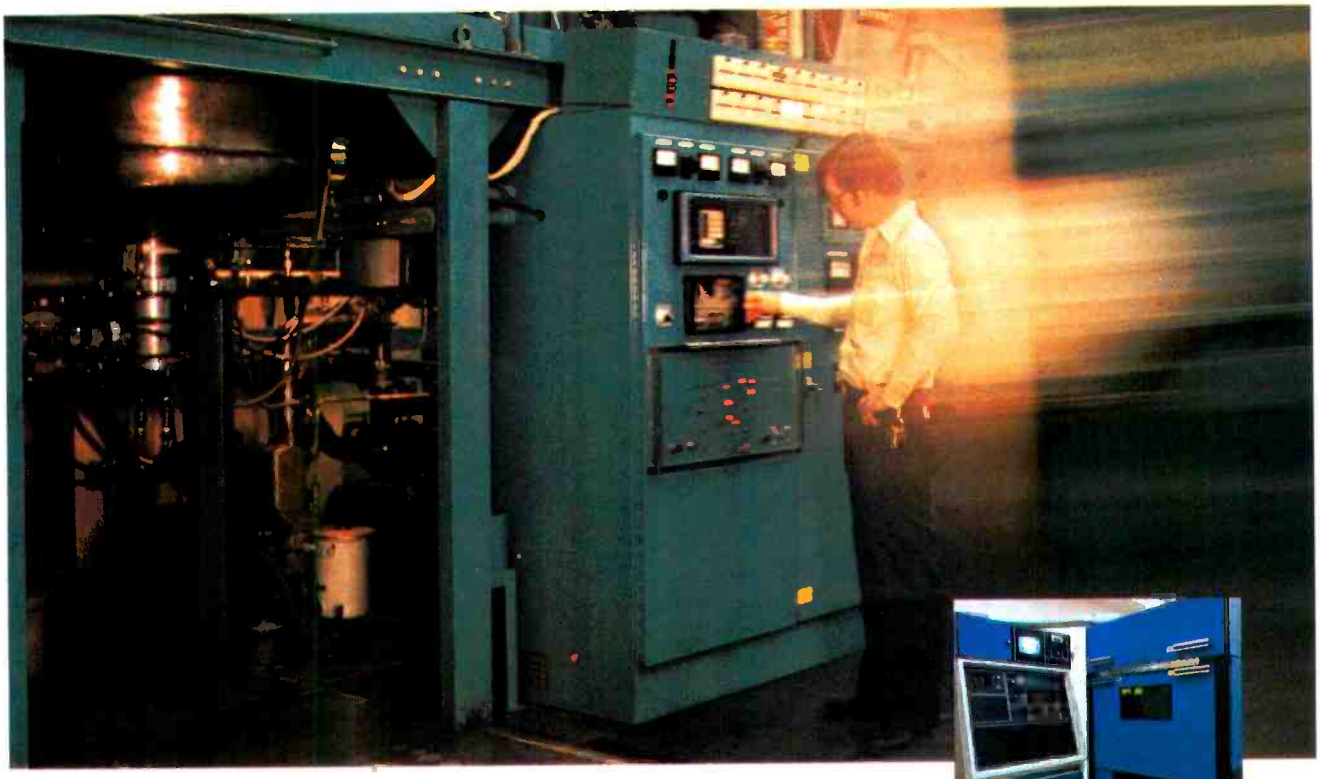
Audio/radio

- An assignable studio audio mixing desk by Audix Ltd. uses highly flexible digital control to reconfigure the analog audio system.
- The Necam 96 Neve mix-down and post-production system includes a color display CRT of system status with advanced software for faster and simplier use than previous Necam units.
- The Soundcraft Electronics SAC-2 on-air mixer provides autosequencing of cart machines, enhanced profanity editing and the capability to control tape or disk machines via keypad from a remote location.
- Pitch correction of the audio as a result of variable speed film or VTR equipment and time-compressed or expanded audio is possible in stereo with the 2-channel Advanced Music Systems' Timeflex.
- Dolby DP-80 digital audio baseband coding system is tolerant of transmission noise errors and does not break up as quickly as other PCM systems.
- Digital techniques for audio mixing show wide dynamic range and low noise qualities in the Neve DSP digital mixer.
- Philips LHH-2000 CD system is a 3-player configuration for professional audio reproduction and editing.
- A newly designed Solid State Logic SL5000 M series audio desk includes digital control of analog audio with special consideration given to stereo TV production.
- The Sony CDK-7000 multi-CD storage and player unit has sequential access to a maximum of 120 discs, playing individual selections or complete disc sides.

Video/TV

- The Ampex VPR-6 places intelligence within the video recorder for improved tape handling, editing functions and diagnostics.
- The Aston 3 video character generator can combine Arabic and Latin characters and allows time code controlled subtitling and animation.
- An Audio Kinetics TimeLink system acts as a time code gearbox in converting from one time code standard to another, allowing restriping of incorrect code tapes in real time.
- A Cinemagraphic editing work station for the EECO EMME editor includes a mouse controller for the operator selection of editing and machine functions from the CRT menu. The system is compatible with the EMME video editing workstation.

Battison is director of engineering at WOSU/AM-FM-TV, Columbus, OH.



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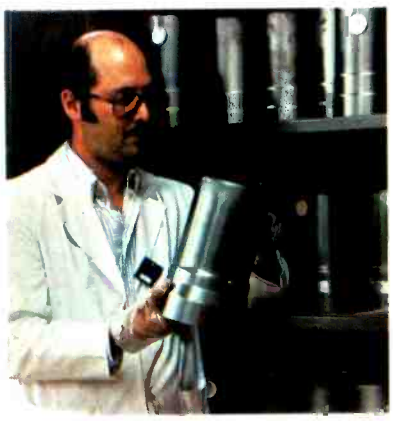

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"OUR NEWS IMAGE HAS NEVER BEEN BETTER."

–David Choate, News Director WSVN-TV, Miami

"Ranked as a competitive activity, TV news would probably fall somewhere between rugby and wild boar wrestling in terms of fierceness. Which is why we're constantly on the lookout for anything that might give us an edge.

"Our 6 Betacam camera-recorder systems are a good example. Their image quality is spectacular, so we look great on-air.

"But even better, the mobility Betacam offers is a real incentive to our photographers to go for that really dramatic, unusual shot. The kind you won't see on every channel at 6 and 11. Because at least for the time being every station doesn't have Betacam."

"THE ABILITY TO SEND OUT MORE CREWS ON MORE STORIES IS WHAT I CALL GOOD NEWS."

–Tom Kirby, VP/News WTCN-TV, Minneapolis

"Before coming here, I was with Gannett's Denver station, KUSA, which was the winner of the NPPA's 1983 'Station of the Year' award. And frankly, my goal here is to get to the finals again. A not unrealistic objective when you consider the talent we have, and the fact that we recently purchased 23 Betacams.

"After all, it seems obvious, the more people you have on the street, the better your chances are of coming up with a winner. Providing, of course, you give those people equipment that's as performance-minded as they are."

"WITH SO MUCH LESS EQUIPMENT TO LUG AROUND, WE'RE SEEING A LOT MORE EXCITING TAPE."

–James Delmonico, President/General Manager WRGB-TV, Schenectady

"I don't care how inspired or dedicated a photographer is, eight hours of hauling sixty-plus pounds of camera, recorder, lights, and cable all over hell and gone is bound to have a stifling effect on someone's creativity.

"That's what initially got us interested in Betacam, and ultimately, why we made the decision to invest in it. The simple fact that you don't have to be a gorilla to use it. The maneuverability of this system is tremendous. So naturally we're seeing shots you just couldn't get before. And, of course, the image quality itself is magnificent.

"In fact, I'd have to say from the looks of things, we'll be adding more Betacam systems

HOW THE PEOPLE WHO LIVE AND DIE BY THE RATINGS RATE THE SONY BETACAM.™

before long. If for no other reason than to stop our crews from fighting over who gets to use the ones we currently have."

"THIS IS CLEARLY A SYSTEM BUILT FOR THE REAL WORLD."

–Allan Howard, VP/General Manager KXTV-TV, Sacramento

"You rarely find news under ideal conditions. More likely you're getting jostled around by a huge crowd, buffeted by gale winds or caught in a very tense, fast-moving situation. All of which tend to play havoc with equipment life spans.

"Betacam, however, seems to have been designed especially for this environment. It's an extremely well-built, exceptionally rugged system, particularly for its weight. And the net result is that in the year we've had them, downtime has been virtually nil.

"Equally important, because Betacam is totally compatible with ¾" systems, you can move into this technology at your own pace. Which is another part of adapting to the real world, the world of equipment budgets."

These are just a few examples of the reports we're getting from stations that have made the move to Betacam. To hear more, or, better yet, to get a look at the system behind them, just give us a call. In the New York/New Jersey area (201) 833-5350; in the Northeast/Mid-Atlantic (201) 833-5375; in the Midwest (312) 773-6045; in the Southeast (404) 451-7671; in the Southwest (214) 659-3600; in the West (213) 841-8711.

SONY® Broadcast

Michael Cox Electronics, a United Kingdom company, displaying video switching, routing and color correction.

• Zeno, from IVCC, uses 8-bit processing for zoom and manipulation effects in PAL and SECAM productions, with multi-event memory, prompting, rehearsal mode and external floppy disc storage for preprogrammed events.

• Merlin Effects, from Gunnerfield Marketing, uses two full-frame stores to perform production effects between any two PAL or SECAM 3/4-inch or 1/2-inch VTR.

• A compatible control system allows the NEC-100 ENG/EFP camera from Link Electronics to be used with the Model 130 studio camera in multicamera production.

• Philips LDM-3005 CVE (component video effects) uses Y/U/V components, an integral visual switcher and dual channels for clean processing of visual effects.

• Auto scene identifiction with a shot-change detector simplifies programming color or video corrections in telecine operation on a Rank Cintel Mk IIIc/Amigo system.

• An RGB, Y/I/Q or Y/R-Y/B-Y component signal as an input to the Shintron MC-1 Component Intermatrix Converter is converted to any of the 3 component formats.

• Thomson-CSF Genese digital effects allows easy access to sophisticated production effects. Computer control of the TTV-1525C automatic camera handles nearly every setup adjustment required.

• The developmental 50kW UHF tetrode by Thomson-CSF Tube Division indicates an in-circuit 74% efficiency from a small 8" x 6", 13-pound tube.

• Selection of appropriate components for DBS transmissions includes factors of dish sizes, rain factor, satellite power and location, from British Aerospace.

• The Independent Broadcast Authority C-MAC analog component transmission system avoids the degradation of imaging from a color subcarrier. Planned for use in the United Kingdom and Europe, the system includes digital audio capabilities.

• A developmental Philips/PyeTVT CVG component video graphics unit provides dual frame storage for instant on-air picture swap, simplified image creation and 4:4:4 13.5MHz digital processing with 720x576 pixel resolution.

• Scientific-Atlanta & Digital Systems B-MAC analog component transmission system allows secure digital encoding of video and audio, multiple

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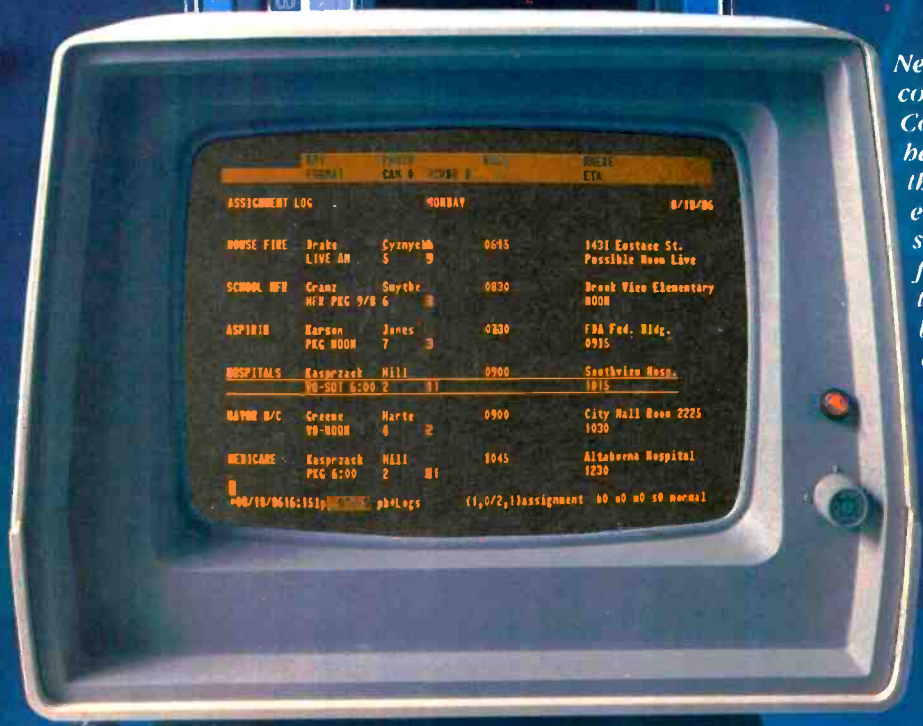

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KPRC-TV, *Houston*
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digital audio channels with Dolby processing and data transmission capabilities.

- Sony Broadcast Super Motion video system uses a 525-line, 180-field format in the BVP-3000 series camera to produce a high resolution image for recording on the BVH-2700 VTR. The recorder includes full compatibility with Type C units in playback mode.
- Thomson-CSF TTV-2710 slide scanner is based on CCD image sensing. A 2x expansion of any portion of the image is possible through a special lens system.
- The GEC-McMichael/Marconi SNG satellite ENG system is designed around a transportable terminal and special codec unit. The entire system, including a reduced size antenna, fits easily into many small private or commercial aircraft.

In the lecture halls

The 14 sessions, some held concurrently, covered almost every discipline of broadcasting. Eight dealt specifically with TV, one with radio transmitters and one with evolving technology, including economics, education and DBS. Digital signal distribution and links, sound signal origination and satellites filled the remaining sessions.

Satellite broadcasting in the form of DBS and TV standards of necessity bound to satellite systems were the subjects attracting the most interest. Although CATV appeared to offer unlimited riches and future for entrepreneurs several years ago, cable TV has become passé in the United Kingdom, with DBS suggested to be the coming thing.

One of the few papers from a U.S. company was presented by C.P. Sidell, Midwest Corporation, titled, "Design Consideration for Small Outside Broadcast Television Vehicles, Specifically for Low Budget Productions for Cable Television." Applicable to broadcast as well, it was well received and generated many questions.

Only three papers looked at AM radio transmitters:

- "Further Developments and Applications of Pulse Modulation," by Dr. W. Schminke; Brown, Boveri and Company; Switzerland.
- "Trends in High Power Broadcast Transmitter," by R.H. Bradbrook and J.D. Watson; Marconi Communications Systems.
- "Design of High Power Transmitters Operating in the Long Wave Sound Broadcast Band," J.A. Brisbane and K.W. Boon; Marconi.

Great interest was shown for the presentation by C. Gandy, BBC, on DBS receiving antennas. Rather than the dish, a flat antenna, based on the phased-array principle for radar, may

The wraps are off, and the newest Community Antenna system is now available for multi-station use. It's a thoroughly engineered panel antenna. Wider than the entire FM band. In fact, wider than CH-7 through CH-13, so it's made for TV also.

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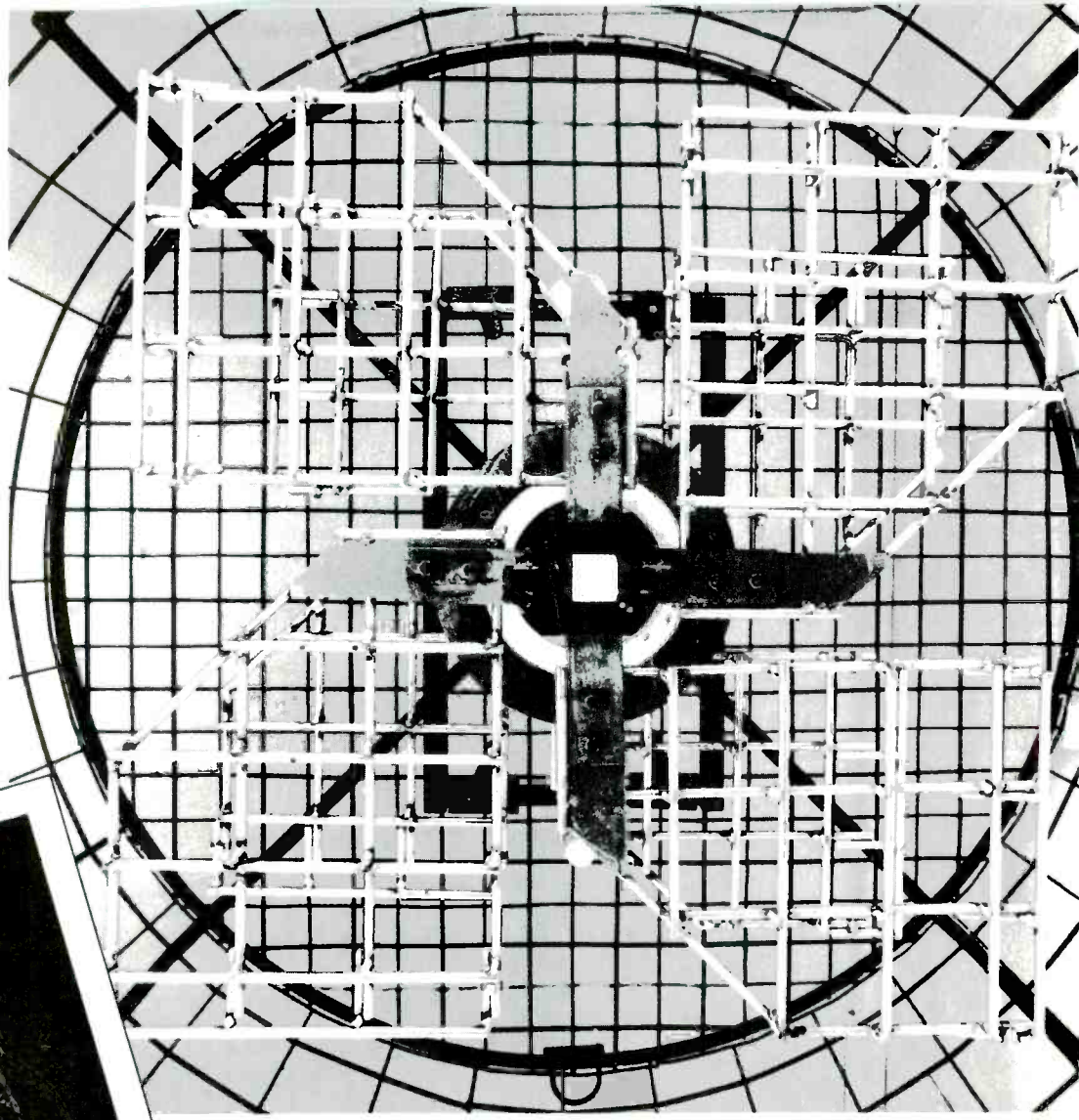

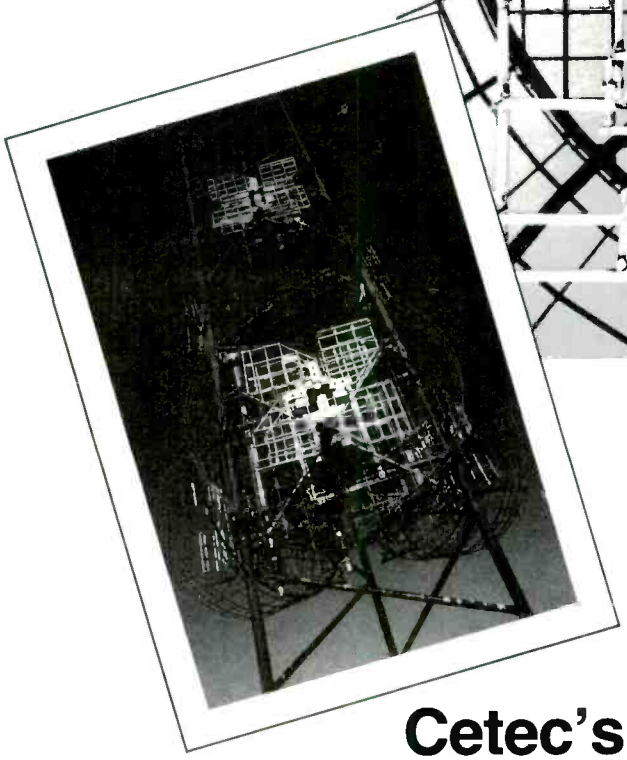

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be a viable alternative to Parabolic types. Changing azimuth, changing elevation and polarization changes built into the antenna specifications makes the design difficult.

Y. Makamura, Japanese Broadcasting Company (NHK), presented an interesting paper on the operational satellite broadcasting system in Japan. Much of Japan receives high quality video with PCM audio using a 75cm dish antenna.

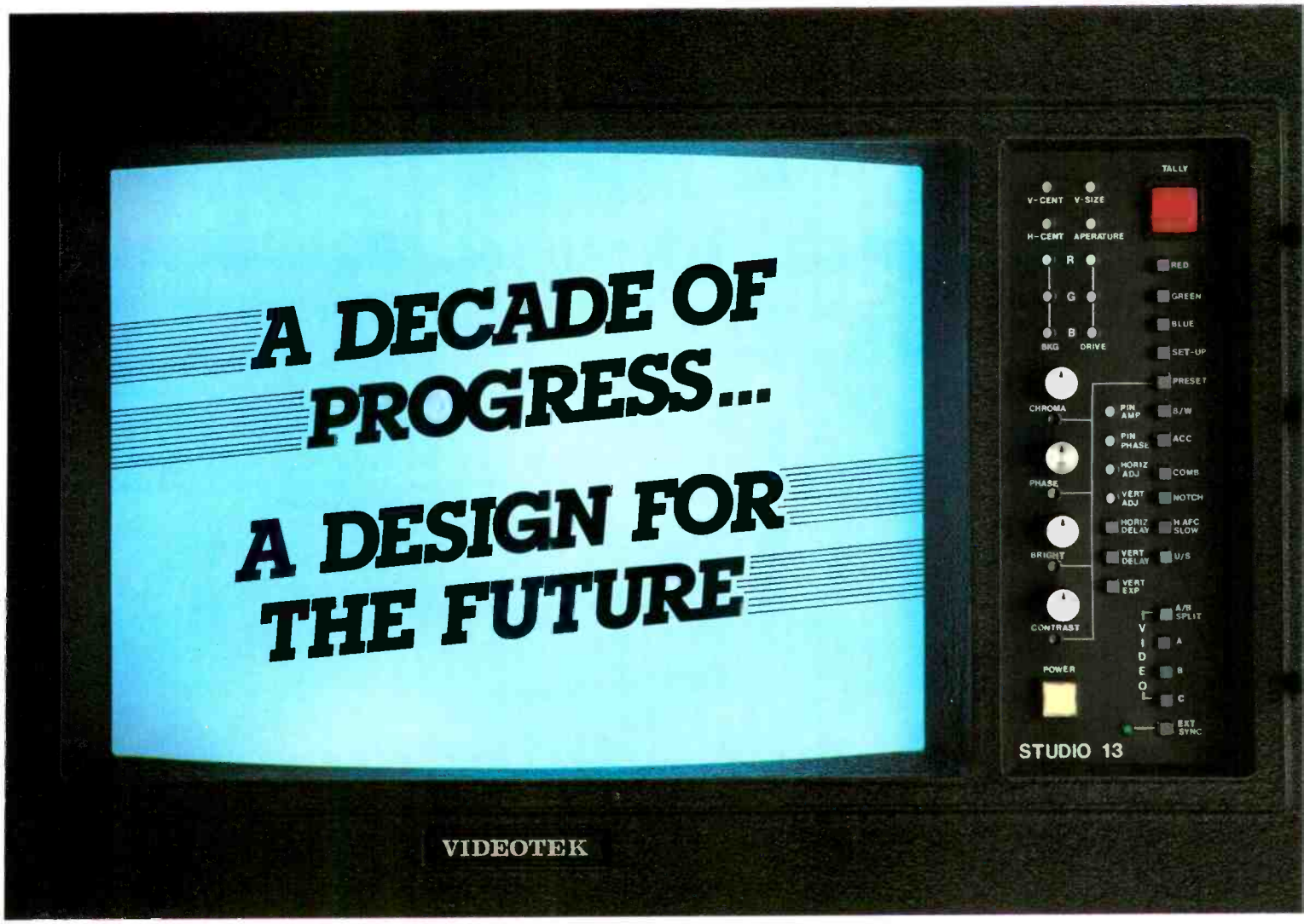
Dr. Geoffrey Phillips, Radio Frequency Group, BBC Research, recipient of the first IBC Award.

Richard A. O'Connor, CBS Broadcasting Group, presented "High Power Direct Broadcast Satellite Planning in the United States," surveying problems encountered in providing a footprint of the United States.

G. Sampath, Bharat Electronics, India, described the broadcast satellite system that employs an integrated network of terrestrial transmitters fed via DBS. "A Television Service Plan Through a MultiPurpose Satellite—a Cost-Effective Indian Model for Developing Countries" dealt with the various political and ethnic influences to be considered in serving more than 500 million people living in the rural areas of India.

The session on TV transmitter systems evoked considerable interest, but nothing startling for UHF TV operation was presented. Klystrode development was reviewed by D. H. Preist and M. B. Shrader of Varian-Eimac. If the early promise of the Klystrode is borne out, it should become a useful part of UHF TV transmission.

Efficiency in TV transmission stressed improved klystron and amplifier design. Of interest were



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Almost a half-mile of mobile production systems lined the Brighton Promenade. Some were small units for downlinking from a single satellite, but others were complete facilities with 8 cameras and self-contained power.

Kodak stressed film as well as tape.

"The Changing Concepts of TV Klystron Operation" by L. F. Howard, Marconi, and "A 50kW Tetrode for UHF TV Broadcasting" by Piere Gerlach and Charles Kalfon, Thomson-CSF Electron Tube Division.

Digital audio played an important role in sessions involving new broadcast services and sound signal origination. Although digital sound has found its way into processing, mixing, recording and some transmission systems, the technology has yet to see widespread use.

An interesting facet of IBC is the differing broadcast philosophies of North America, the United Kingdom and Europe. For example, the small amount of attention given to AM radio was exceeded by a greater lack of interest in FM. Relatively few AM and FM operations exist in Europe, with the BBC and IBA operating the U.K. transmitters and governments heading radio in most of the European countries.

One of the problems for U.S. manufacturers, exhibiting at IBC and other international trade shows, is the need to offer equipment in NTSC as well as PAL and SECAM. If, and when, digital TV becomes the norm, the lot of the equipment supplier should be considerably simplified with the compliance to only one standard.

New modes of transmission and signal distribution have been discussed for many years. At IBC '84, many of the products shown apply almost directly to tomorrow's systems. That these products also fit today's requirements shows an interest toward the logical growth of broadcasting technology.

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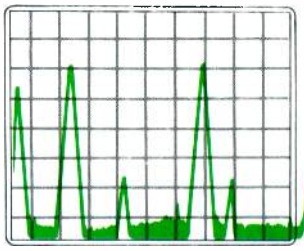

Troubleshooting

The 1/4-wavelength PA cavity

By Jerry Whitaker, radio editor,
and Clarence Daugherty,
senior broadcast technology instructor,
Harris Broadcast Group

The ¼-wavelength PA cavity is common in FM transmitting equipment today. The design is simple and straightforward. A number of variations can be found in different transmitters, but the underlying theory of operation is the same.

A typical ¼-wave cavity is shown in Figure 1. The plate of the tube connects directly to the inner section (tube) of the plate blocking capacitor. The blocking capacitor can be formed in one of several ways. In the FM-25K, it is made by wrapping the outside surface of the inner tube conductor with five layers of 8-inch-wide and 0.005-inch-thick polymide (kapton) film. The exhaust chimney/inner conductor forms the other half of the blocking capacitor. The cavity walls form the outer conductor of the ¼-wave *transmission line* circuit. The dc plate voltage is applied to the PA tube by a cable routed inside the exhaust chimney and inner tube conductor.

The screen contact fingerstock ring mounts on a metal plate that is insulated from the grounded cavity deck by a kapton blocker. This hardware makes up the screen blocker assembly. The dc screen voltage feeds to the fingerstock ring from underneath the cavity deck through an insulated feed-through assembly.

Some transmitters employing the ¼-wave cavity design use a grounded screen configuration in which the screen contact fingerstock ring is connected directly to the grounded cavity deck. The PA cathode then operates at below ground potential (in other words, at a negative voltage), establishing the required screen voltage to the tube.

The cavity design shown in Figure 1 is set up to be slightly shorter than a full ¼-wavelength at the operating frequency. This makes the load inductive and resonates the tube's output capacity. Thus, the physically foreshortened shorted transmission line is

Editor's note:
The background discussion in this column is based on a paper by Daugherty, describing the design of the FM-25K transmitter.

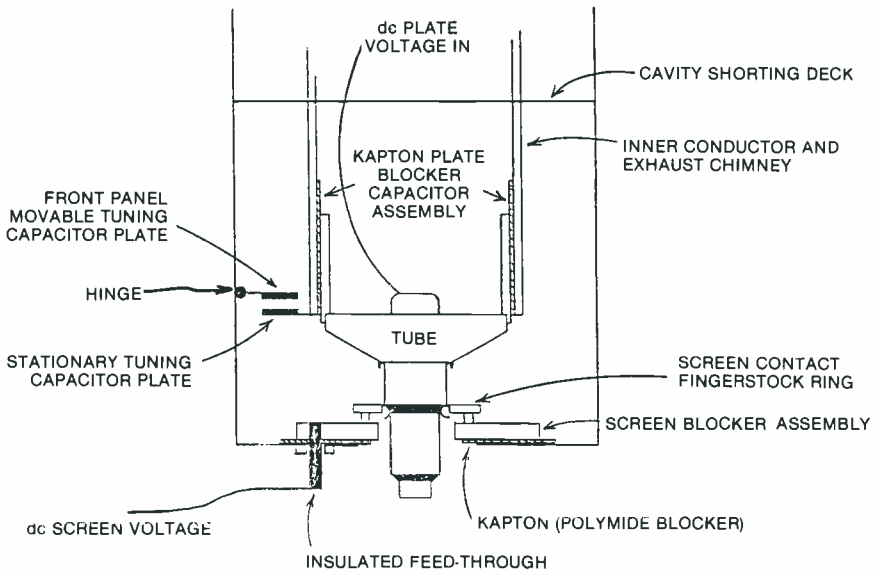

Figure 1. The layout of the FM-25K transmitter ¼-wavelength PA cavity.

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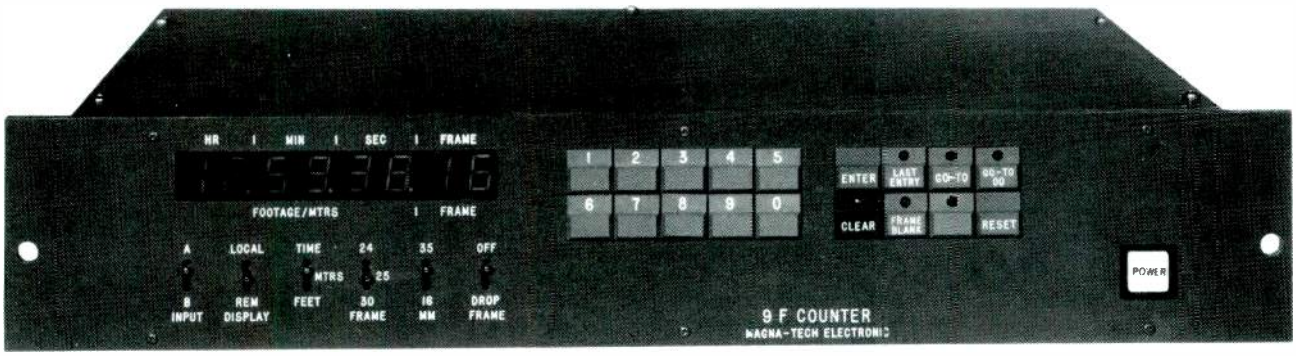

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resonated and electrically lengthened to ¼-wavelength.

Figure 2 illustrates the paths taken by the RF circulating currents in the circuit. RF energy flows from the plate, through the plate blocking capacitor, along the inside surface of the chimney/inner conductor (because of the skin effect), across the top of the cavity, down the inside surface of the cavity box, across the cavity desk, through the screen blocking capacitor, over the screen contact fingerstock and into the screen grid.

Figure 3 shows a graph of RF current, voltage and impedance for a shortened ¼-wavelength coaxial transmission line. It shows that infinite impedance, zero RF current and maximum RF voltage occur at the feed point. This would not be suitable for a practical PA circuit, because arcing and poor efficiency would occur from the mismatch resulting between the tube and the load.

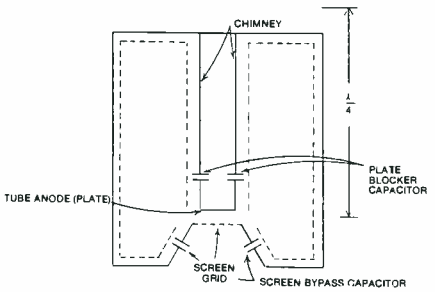

Figure 2. The RF circulating current paths for the ¼-wavelength cavity shown in Figure 1.

Notice, however, the point on the graph marked at slightly less than ¼-wavelength. This length yields an impedance of 600Ω to 800Ω, and would be ideal for the PA plate circuit.

The output capacity of the tube shunts the transmission line that forms the cavity and electrically lengthens it. In view of the information presented in Figure 3, however, it is now necessary to physically foreshorten the shorted coaxial transmission line (the cavity) to slightly less than ¼-wavelength so that the load will present the required impedance to the plate of the PA tube.

Figure 4 shows a graph of the RF current, voltage and impedance presented to the plate of the tube as a result of the physically foreshortened line. This plate impedance is now closer to the ideal 600Ω to 800Ω value required by the tube's anode.

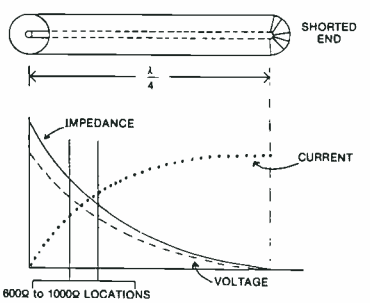

Figure 3. A graph of the RF current (....), RF voltage (----) and RF impedance (—) for a ¼-wavelength shorted transmission line. Note that at the feed point, RF current is zero, RF voltage is maximum and RF impedance is infinite.

Tuning the cavity

Coarse tuning of the cavity is accomplished by adjusting the cavity length. The top of the cavity (the cavity shorting deck) is fastened by screws or clamps and can be raised or lowered to set the length of the cavity for the particular operating frequency.

Fine tuning is accomplished by the variable capacity *plate tuning* control that is built into the cavity. In the example shown in Figure 1, one plate of this capacitor, the stationary plate, is fastened to the inner conductor just above the plate blocking capacitor. The movable tuning plate is fastened to the cavity box, the outer conductor, and mechanically linked to the front

panel tuning control. This capacity shunts the inner conductor to the outer conductor and can vary the electrical length and resonant frequency of the cavity.

The ¼-wavelength cavity is inductively coupled to the output port. This coupling is usually on the side opposite the cavity access door. The inductive pickup loop can take several forms.

In the FM-25K, it consists of a half-loop of flat copper bar stock that terminates in the loading capacitor at one end and feeds the output transmission line inner conductor at the other end. The inductive pickup is positioned at a maximum current point in the cavity. It is lightly coupled so that changes in the loading will have a minimum effect when the plate is tuned.

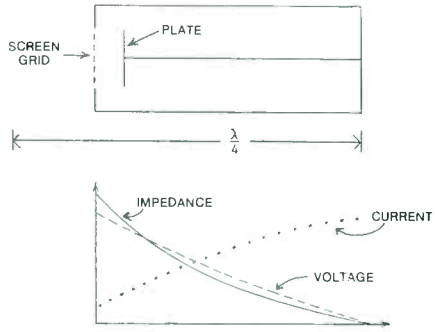

Figure 4. A graph of the RF current (....), RF voltage (----) and RF impedance (—) produced by the physically foreshortened coaxial transmission line cavity.

Adjustment of the loading capacitor matches the 50Ω transmission line impedance to the impedance of the cavity. Heavy loading lowers the plate impedance presented to the tube by the cavity. Light loading reflects a much higher load impedance to the amplifier's plate.

Troubleshooting suggestions

For any transmitter—particularly in the high power RF stages—the best troubleshooting measures really are preventive maintenance. Many problems in the PA input stage can be prevented by regularly inspecting the cavity and PA compartment. There is no section of the transmitter where it is more important to keep connections tight and insulators clean than in the PA stage.

Loose connections can result in arcing between components and conductors that will not only put you off the air, but also destroy an expensive component. It might appear to the casual observer that the PA cavity is mechanically "overbuilt," that individual sections or components are secured with an unusually large number of screws and nuts.

However, the manufacturer puts every component—even down to the smallest screw—there for a reason. It is not enough for *most* of the hardware to be tight. Everything must be tight.

The cavity access door is also a part of the outer conductor of the coaxial transmission line circuit. High RF circulating currents flow along the inner surface of the door, and it must be fastened securely to prevent arcing.

Cleaning insulators is important to the proper operation of a final amplifier stage because of the high voltages present. Pay particular attention to the insulators used in the PA tube socket. Because the supply of cooling air is passed through the socket, airborn contaminants can be deposited on the various sections of the socket. These can create a high voltage arc path across one of the insulators in the assembly.

A word of caution is in order. Although it is important to keep all components in the PA circuit tight, do not overtighten. An engineer who goes overboard on preventative maintenance can cause problems.

Along these lines, the PA tube should never be removed from its socket without good reason. Ac-

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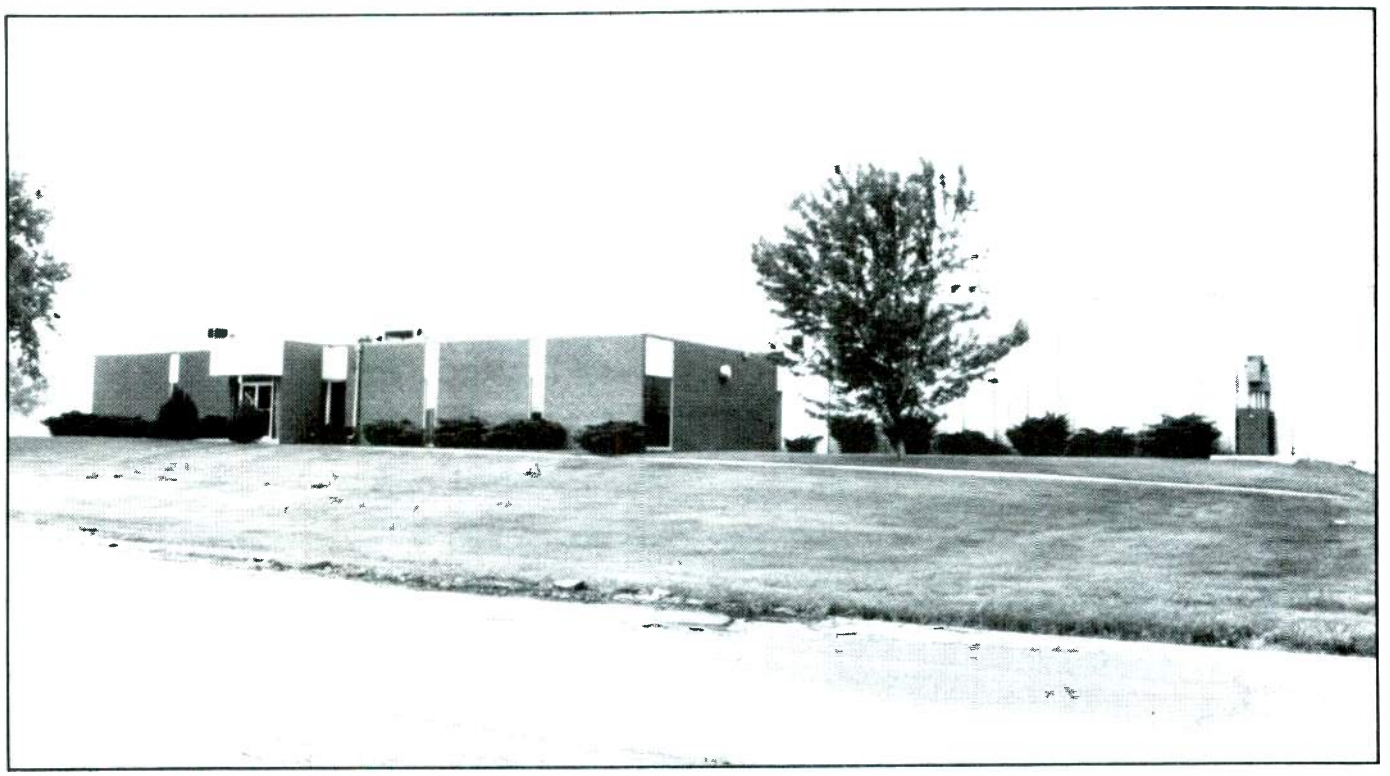

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SATELLITE TECHNOLOGY DIVISION – Satellite Earth Terminal Systems and Transmission Systems

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cidents when removing or inserting the PA tube can so damage the fingerstock that a contract ring must be replaced.

A number of problems that can occur in the PA stage require immediate troubleshooting to get the transmitter back on the air. Perhaps the most frequent is the plate supply overload fault condition.

The first step in any transmitter troubleshooting procedure is to switch the transmitter to *local control* so that you, not the studio operator, have control of the unit. The second step is to switch off the transmitter's automatic recycle circuit. When troubleshooting, you do not want the transmitter to cycle through an overload several times. This only increases the possibility of additional component damage.

When a transmitter will not stay on the air because of plate supply (high voltage) overloads, check several basic items:

- Determine the fault condition. When you get to the transmitter building, the unit will probably be down. The carrier will be off, but the filaments will still be on. Check all of the multimeter readings on the transmitter and exciter. If they indicate a problem in a low voltage stage, troubleshoot that problem before bringing the high voltage up.
- Assuming that all low voltage systems are operating normally, switch the filaments off and make a quick visual check inside the transmitter cabinet. Determine whether there is any obvious problem. Pay particular attention to the condition of power transformers and high voltage capacitors. Check for signs of arcing in the PA compartment. Look on the floor of the transmitter and in the RF compartments to see if there are any pieces of components. Sniff inside the cabinet for hints of smoke. Check the circuit breakers and fuses to see what failures might be indicated.
- After running through these preliminary steps, restart the filaments. Then, take a deep breath and bring up the high voltage. Watch the front panel meters to see how they react. Observe what happens and listen for any sound of arcing. If the transmitter will come up, quickly run through all the PA and IPA meter readings. Check the VSWR meter for excessive reflected power.
- Once you compile a list of the operating parameters, turn off the high voltage, pull out the manufacturer's instruction book and try to figure out what's going on.

Next month's column will continue our examination of plate supply overload problems.

1985 calendar

Jan. 5-8
Association of Independent Television Stations, Los Angeles

Jan. 10-14
National Association of Television Program Executives, Hilton, San Francisco

Jan. 13-16
PTC '85, Honolulu

Feb. 3-6
National Religious Broadcasters Convention, Sheraton Washington, Washington, DC

Feb. 11-15
Video Expo/San Francisco, Civic Auditorium, San Francisco

Feb. 15-16
SMPTE, St. Francis Hotel, San Francisco

March 5-8
AES, Hamburg, West Germany

April 14-17
NAB '85, Convention Center, Las Vegas, NV

May 7-11
American Women in Radio & Television, Hilton, New York

May 12-15
Broadcast Financial Management, Chicago

May 14-15
LPTV, Western Bonaventure, Los Angeles

May 15-18
Public Broadcasting Service/National Association of Public Television Stations, St. Francis Hotel, San Francisco

May 19-23
National Public Radio, Mariott City Center, Denver

May 29-June 1
ITVA Conference, Marriott, New Orleans

June 2-5
National Cable Television Association, Convention Center, Las Vegas, NV

June 5-9
Broadcast Promotion Association/ Broadcast Designers Association, Hyatt Regency, Chicago

June 6-12
14th International Television Symposium and Technical Exhibition, Montreaux, Switzerland

June 27-29
Third Seoul International Broadcasting & Communications Equipment Exhibition, Kosami Exhibition Hall (Yeoi-Do), Seoul, South Korea

July 23-25
WOSU-Broadcast Engineering Conference, Fawcett Center For Tomorrow, Columbus, OH

Aug. 8-Sept. 14
World Administrative Radio Conference, Geneva, Switzerland

Sept. 11-14
Radio Convention and Programming Conference, Loew's Anatole Hotel, Dallas

Sept. 12-14
RTNDA Fall, Opryland Hotel, Nashville, TN

Sept. 30-Oct. 4
Video Expo/New York, New York

Oct. 8-11
AES, New York

Oct. 27-Nov. 1
SMPTE, Conference Center, Los Angeles

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FCC Update

Continued from page 6

dent location of the FM transmitter. If an FM permittee is unable to resolve interference problems, it might be required to reduce power to level 1 or below.

Licensing policies for noncommercial FM stations operating under the new rules will be as follows:

- A conditional construction permit will be issued alerting the permittee to its interference responsibilities.
- The permittee must notify the FCC's Field Operation Bureau of the steps taken to alert the local community of possible interference.
- Before a license is granted, the permittee must supplement its license application with a discussion of its actions to supply information to all complainants and its attempts to remedy all cases of interference.
- Before the license is granted, the permittee must submit an affidavit stating that at least two months of program testing has occurred and all nonexempt complaints have been satisfied (this condition would apply only to those stations operating with greater than level 1 facilities).

Remote pickup frequency assignment procedures changed

The FCC has adopted new rules permitting the optional use of narrowband technologies in the broadcast remote pickup service. The new rules, which affect remote pickup units at 153mHz, 161mHz and 450mHz, do the following:

- Permit licensees the option of splitting channel operation using either very narrowband FM or Amplitude Compandored Sideband.
- Incorporate new emission limitations for single sideband type systems.
- Continue the practice of informal, rather than mandatory, frequency coordination.
- Allow narrowband repeaters (using 5kHz bandwidths) on VHF.
- Eliminate usage restrictions on certain frequencies.
- Eliminate the requirement for a guard receiver on repeaters.

Because the new rules will require changes to the FCC's computer program for updating its frequency master file, it will be necessary to delay their implementation. The staff estimates that the delay will be from three months to as much as a year.

Continued from page 12

nels, a response deviation of less than ±0.5dB (referenced to 1kHz) is a reasonable goal. THD and intermodulation distortion should be well below 1%, even at the maximum level to be transmitted on the line. The noise floor should be at least 60dB below normal program level. Crosstalk between the left and right channels should be at least 40dB below normal program levels, and preferably closer to 60dB.

These measurements should apply within the audio band of interest to the station. That is, if the station would like to maintain good performance to 10kHz, the measurements should be made within the limits suggested out to at least 10kHz.

The L+R and L−R signals are not directly available in the normal broadcast audio system. They are usually accessible, however, from auxiliary outputs on the AM stereo exciter, and occasionally from the AM stereo processor. Feeding a mono (L=R) signal to the studio equipment will form a L+R test signal. Reversing the polarity of the right channel at the studio (to give L=−R) will give a L−R test signal. The performance of the L+R and L−R channels should be checked at the same time the previously outlined tests on the discrete left and right channels are conducted.

The L+R and L−R frequency response should be within 1dB across the measured band (referenced to 1kHz). Harmonic and intermodulation distortion should be less than 1%. The noise floor should be at least 50dB below the normal program level, and preferably closer to 60dB.

More significantly, a L=R source at the studio should result in crosstalk in the L−R channel that is down at least 30dB, and preferably closer to 50dB. Similar crosstalk figures should be achieved in the L+R channel when a reversed phase (L=−R) signal is applied at the studio. These measurements should be made, as mentioned, within the entire audio band of interest to the station.

Because of the difficulties that may be encountered with passing an AM stereo signal through the transmitter and a narrowband antenna, it is important to provide the cleanest possible input to the transmission chain. Actually, the better the performance of the studio and STL system, and more variation in performance that can be accepted after the AM stereo exciter input.

Strictly TV

Continued from page 10

by an rms-level detector and spectral content monitor. Spectral compression and fixed pre-emphasis are combined in the dbx processor, producing a general frequency response as shown in Figure 3.

At the receiver, a mirror-image de-emphasis network expands the energy content of the signal to match the original. The variable pre-emphasis and de-emphasis system is controlled by a similar rms-level detection circuit. Control polarity, however, is reversed. High levels of high frequencies introduce greater pre-emphasis and low levels result in de-emphasis.

Wideband considerations

Very low-level, high-frequency signals are difficult to handle with spectral companding or fixed pre-/de-emphasis. To counteract these conditions, a stage of wideband companding adjusts levels of all frequencies simultaneously to maintain a high level to the transmission channel.

For wideband control, a second rms-level detector is driven through a bandpass filter with a response from 35Hz to about 2.1kHz. This region contains the majority of energy that dominates typical program material. Logically, high-level signals are compressed, while low dynamic range inputs are expanded for a more consistent output.

Protection of the pilot carrier is required for proper operation. In the FCC approval of the stereo TV mode, the major restriction was avoiding energy at or near the 15.734kHz pilot frequency. This requires that information must be restricted below 15kHz through bandwidth limiting circuitry.

At the receiving decoder, another mirror-image system with reversed control polarity is used. When the input to the receiving expander is high, gain of a VCA element is large, causing greater expansion. If low levels are sensed in the transmission channel, expansion in the VCA is reduced.

The overall result is to recreate the dynamics of the original signal with a high degree of accuracy, while bandwidth control continues to protect the pilot carrier. The system effect of wideband compression and expansion is illustrated in Figure 4.

Handling transients

Large level transitions or transients in programming to any system risk overmodulation. Peak excursion of the compressor output for the Zenith/dbx system is just as important. Controlling the excursions is handled through an intelligent clipping system.

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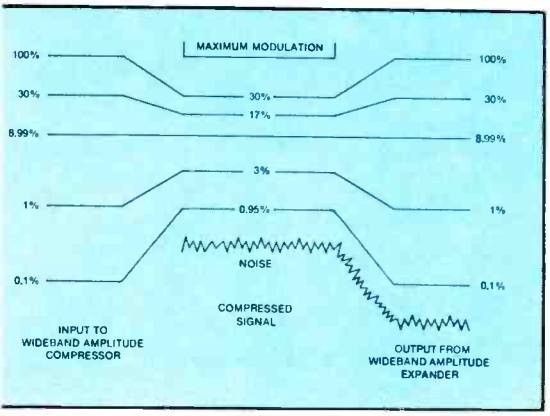

Figure 4. Wideband amplitude compressor/expander response.

may only clip transients of limited (fewer than a few milliseconds) duration. Several factors are included in the dbx processor to allow inaudible clipping. First, the compressor system output is maintained at about 17dB below the level that would cause 100% modulation, providing some transient headroom.

Second, time constants of the wideband and spectral compressor systems are short enough that only brief transients or overloads are allowed to pass.

Finally, fixed pre-emphasis precedes the clipper, further reducing any overload-causing transients.

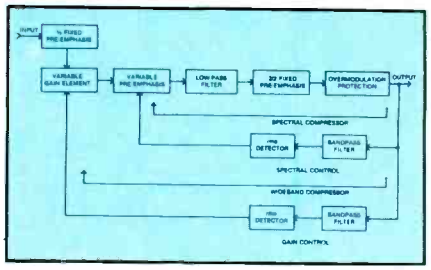

Figure 5. Compressor (encoder).

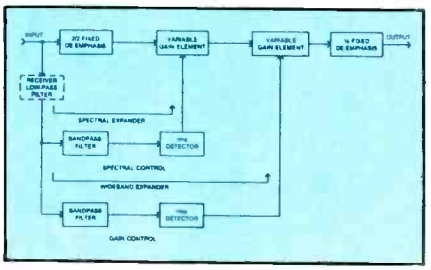

Figure 6. Expander (decoder).

Block diagrams of the encoder and decoder circuits of the dbx audio system for stereo aural TV are shown in Figures 5 and 6.

At the modulator input

Once the special processing of the L – R channel is completed, the signal level for the stereo subcarrier tends to have an amplitude distribution that will average 10% to 30% modulation. In the Zenith system, it is important that modulation of the mono-plus-stereo carriers do not exceed modulation limits.

Because the stereo subcarrier will typically average less than 30%, the mono carrier may be deviated to a 70% level, which is close to present-day broadcast practices. A high degree of compatibility with today's receivers is achieved.

Producing realistic stereo

Caution is in order for those that would plan quick stereo productions. A stereo soundtrack that is poorly done will drive an audience away.

Consider the scene in Figure 7. We would expect audio from actor A to come from the left speaker and be louder than that from actor B. As the camera angle is changed to that of Figure 8, the situation should change. Psychoacoustically, we will expect that the level of A decreases, the level of B increases and the position of B changes from center to screen right.

Going to Figure 9, we now expect that actor B is much louder from screen right, while the actor A level is much reduced at screen center.

An automated audio desk, capable of holding a large number of preset conditions that are available at the press of a button, might allow a reasonably realistic live production.

Continued on page 106

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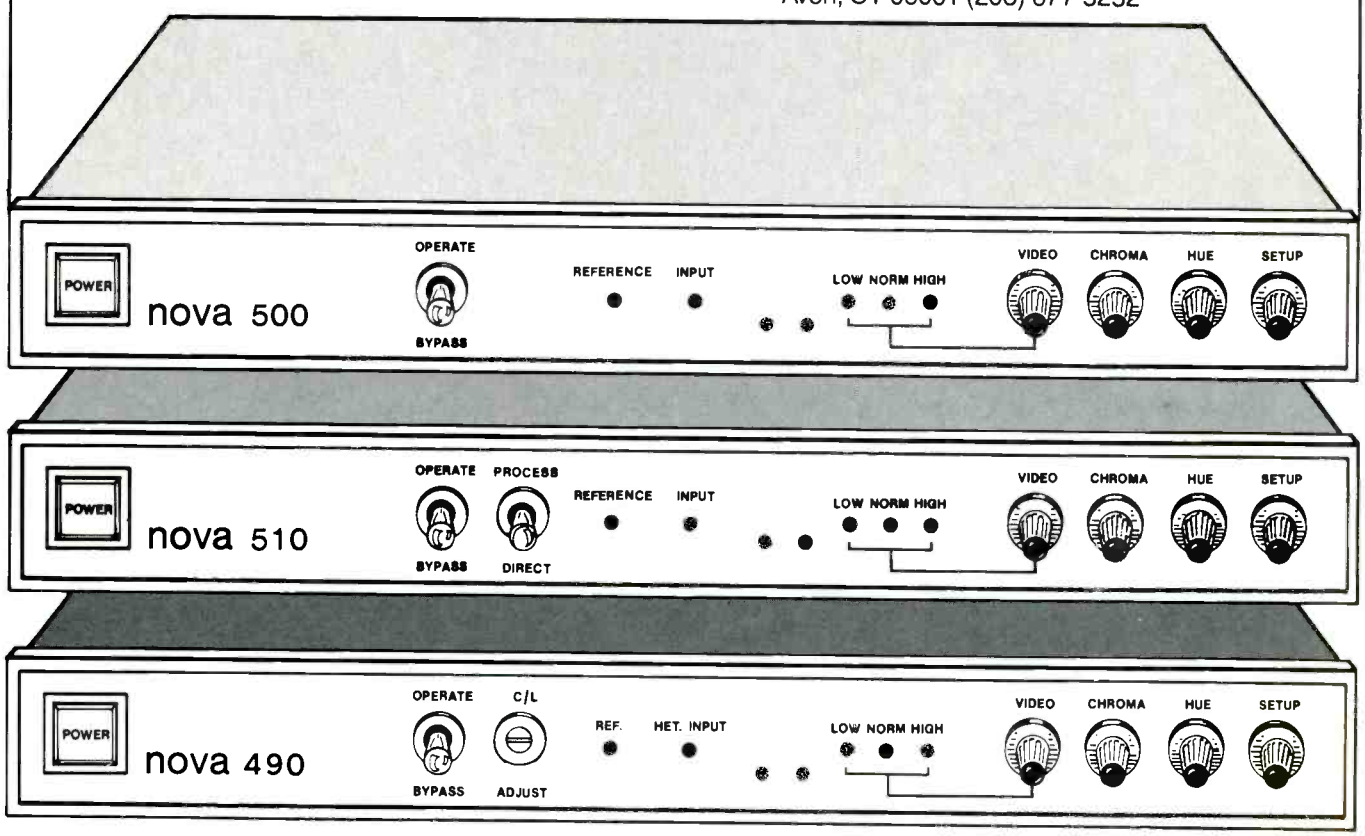

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new products

FM transmitters

Fully solid-state, state-of-the-art FM transmitters from *Thomson-LGT*, division of *Thomson-CSF Broadcast*, are now available in the United States. Models range from 10W to 2500W power output. Featured are optional built-in stereo generators with adjustable modulation limiting; synthesized frequency control; two standard and two optional SCA inputs: low-noise/high-performance modulators; and built-in modulation monitor circuitry. Multiple VSWR-protected power amplifiers assure minimum downtime.

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Carbon intercom amplifiers

Durcom has introduced the Booster One carbon intercom amplifier. A small, portable plug-in unit, which stays with each headset, clipped to a belt or mounted, the Booster One gives the user the capability of increasing the incoming headset volume up to 800%. Booster One also allows the headset microphone to be shut off without cutting off communications; no batteries or additional power supplies are needed. These units are compatible with the 2- and 3-wire carbon systems used across the United States, providing an alternative to total replacement of the carbon intercom system.

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Mixing console

The TAC Scorpion, from *Amek Consoles*, is a versatile, low-cost mixing console derived from the TAC 16/8/2 system. Principle features include fully modular construction, 16 routing buses plus a separate stereo bus, 4-band EQ with swept mids and selectable turnover points, four auxiliary sends, two assignable auxiliary returns, fader reverse function metering with switchable peak/VU ballistics and stepped chassis with horizontal fader section, 10-degree module angle and penthouse meter hood. The Scorpion is available in 27- and 43-position frame sizes.

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Mini-UPS

UL-listing has been approved for a new 750VA Mini-UPS (uninterruptible power system) available from *Sola Electric*, a unit of *General Signal*. Offering automatic inverter restart and an alarm circuit for signaling battery operation in addition to Sola's standard UPS features, the new unit incorporates all the design features formerly available on Sola's discontinued 750VA standard and deluxe models. The portable, plug-in Mini-UPS is designed to protect small electronics equipment from all potential ac power line problems, including blackouts, brownouts, voltage transients and noise.

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New component TBC

Fortel has introduced the CCD Y/C Time Base Corrector, which uses the same circuit techniques found in the CCDHP TBC, but the CCD Y/C also processes separate luma and chroma (Y/DC) dub component video. The CCD Y/C incorporates some performance characteristics of the Y-688 into its Y/C processing technique, making the CCD Y/C suitable for use with Sony 5800 series VTRs.

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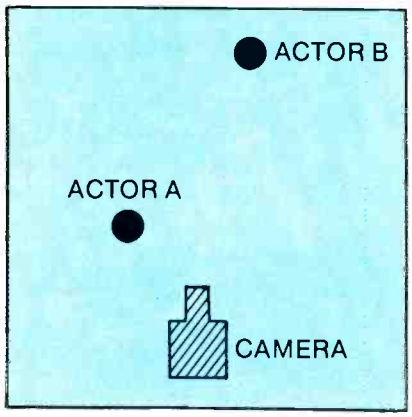

Figure 7. Stereo production where Actor A is louder than Actor B.

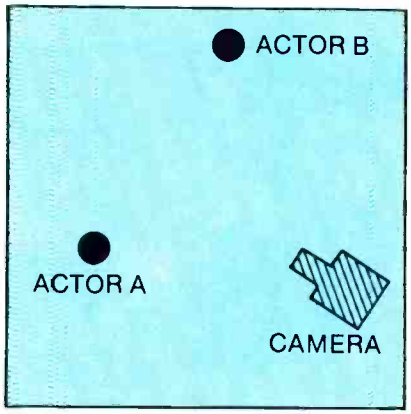

Figure 8. Stereo production where Actor B is louder than Actor A.

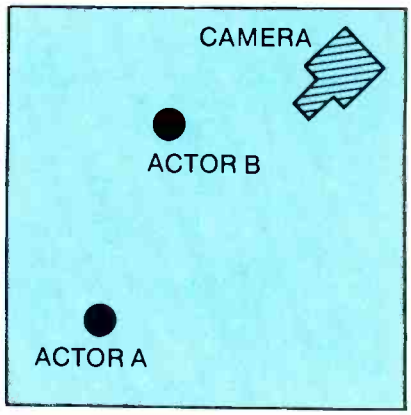

Figure 9. Stereo production where Actor B is much louder than Actor A.

Continued from page 102

Rehearsal for audio will be more critical than ever before. In a studio without the assistance of automation, the live dramatic production could easily produce some rather comic, yet undesired, effects.

Dramatic productions are seldom live anymore. Even the soaps are taped today, taking advantage of the obvious advantages of videotape. The post-production process will allow time to work out the logistical problems of a psychoacoustically correct presentation.

Another type of program, the music show, offers a logistics question as well. Music groups, whether country or rock or symphony orchestras, work very hard to achieve a proper balance from right to left. Soloists, particularly in symphonic or choral performances, must balance properly with the ensemble. If the aesthetics of the performance are to be preserved, what is the function of the stereo mix?

Realistic stereo is obviously going to take a good deal of thought. Although being realistic should be a problem for the production people, engineering will undoubtedly be called upon to help make it work. Care will be required, as every program will offer new and different challenges. Even the talk show, if stereo effects are to be wasted on such programming, will have its problems.

To those initiating local stereo program production soon, we wish you the best of luck. We also invite you to tell us some of the horror stories and solutions to your beginning problems.

Editor's note:
Figures 1 through 6 are courtesy of dbx inc.

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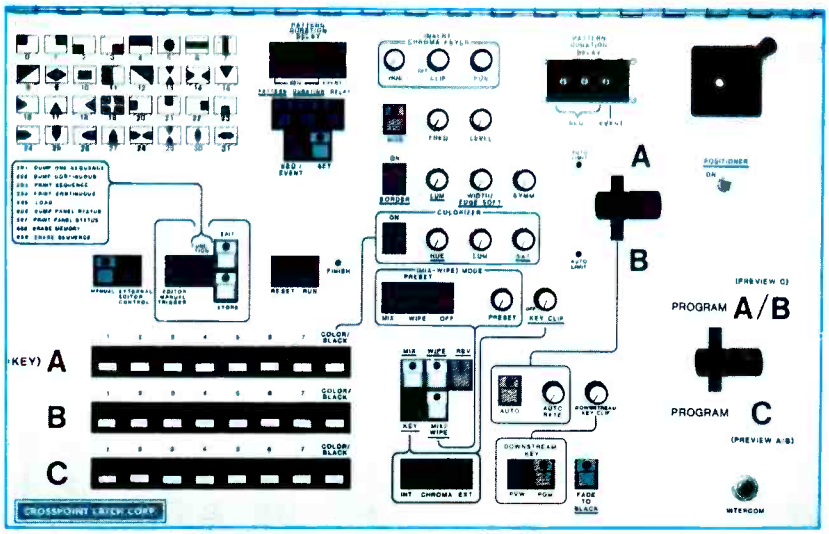

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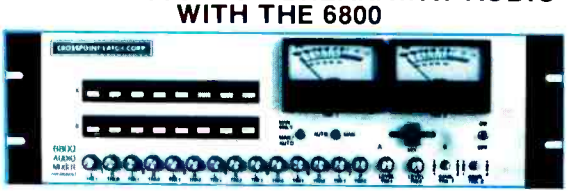

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