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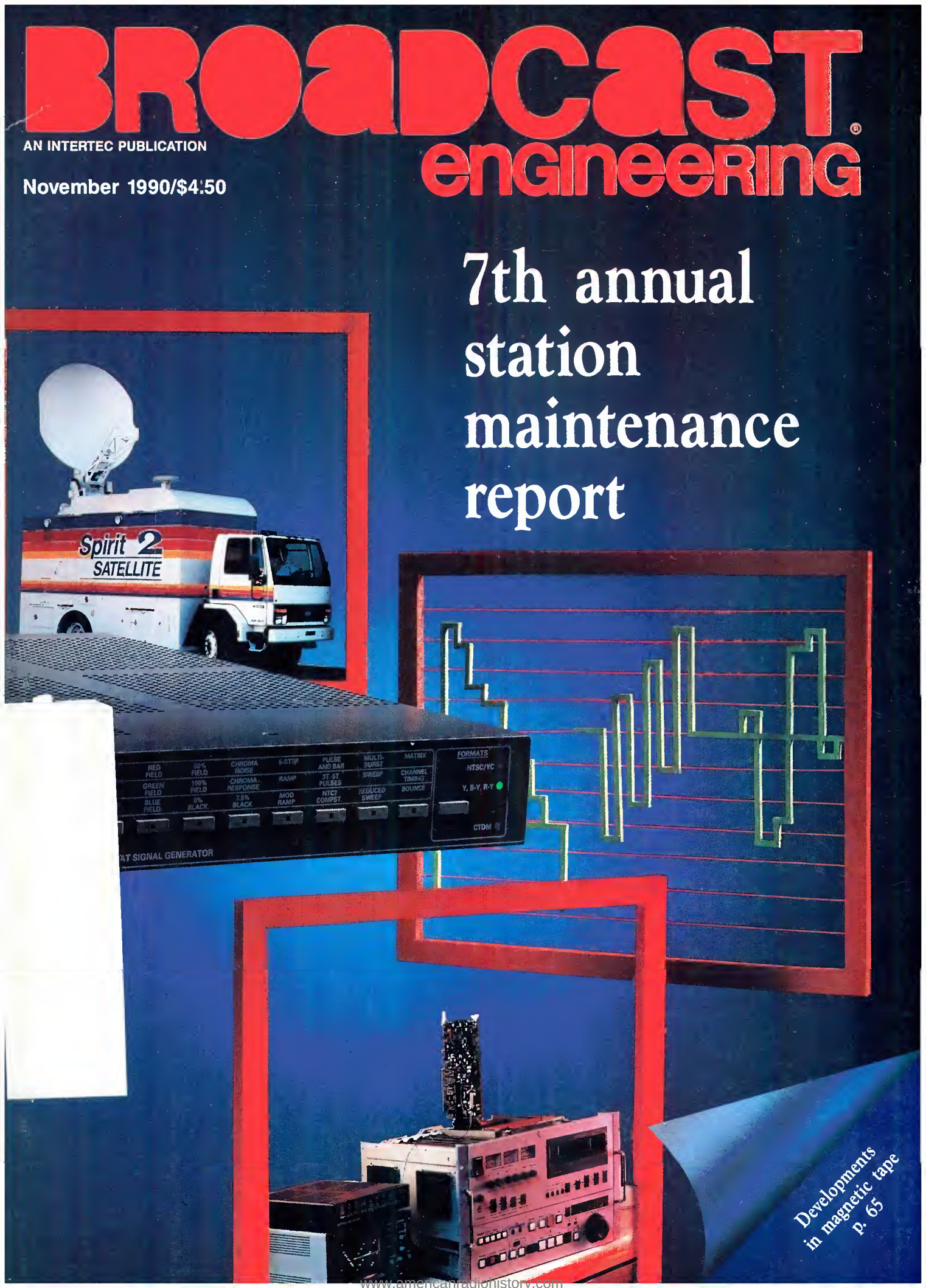
BROADCAST® engineering

7th annual station maintenance report



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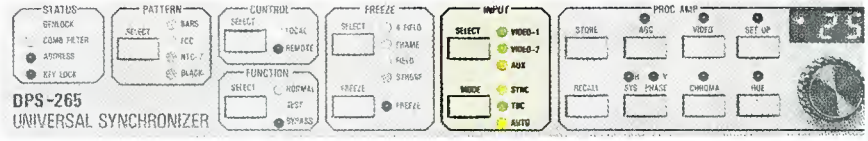

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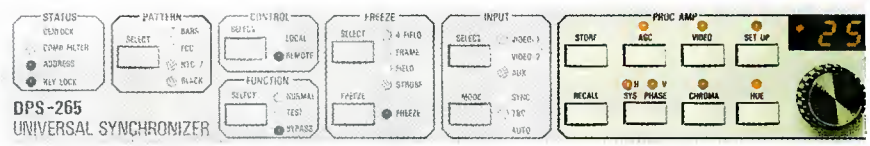

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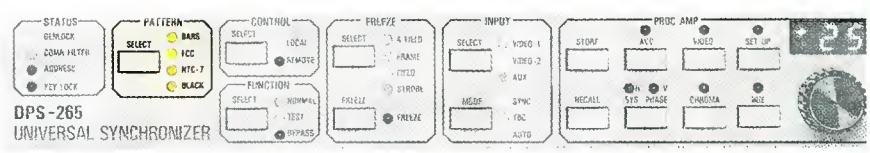

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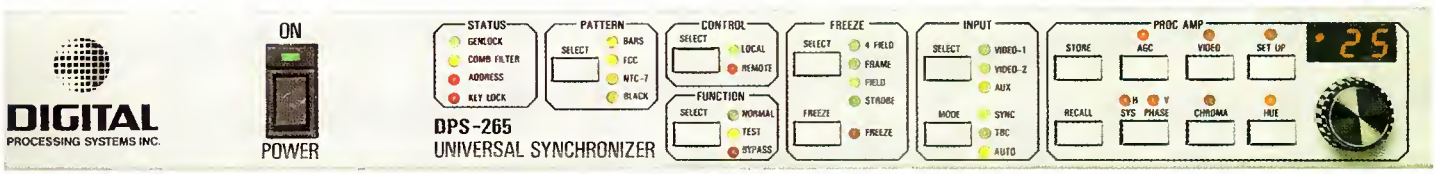

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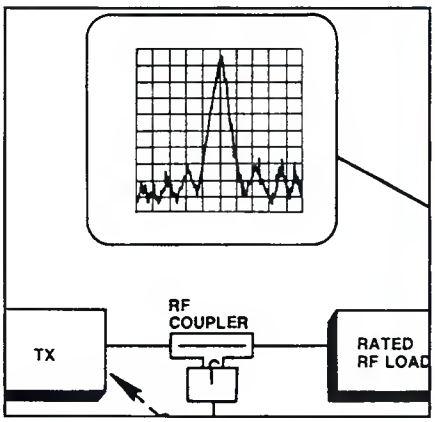

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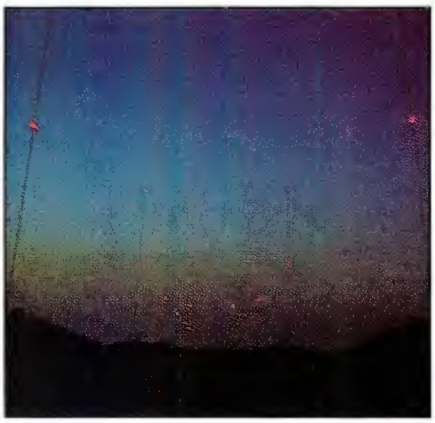

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Page 65

7TH ANNUAL STATION MAINTENANCE REPORT:

As the equipment used by professional audio-video users becomes more complex, the requirements for highly skilled technicians also increases. Maintenance personnel today require advanced test equipment and must think in a "systems mode" to troubleshoot much of the hardware in the field. This month, in our 7th annual Maintenance Report, we will review some of the keys to effective maintenance.

DEPARTMENTS

FEATURES:

OTHER FEATURES:

ON THE COVER

Proper equipment maintenance is the key to long-term profitability of audio and video facilities. And, engineers recognize the importance of keeping the station's investment in hardware operating in peak condition. In today's competitive environment, down time is something no one can afford. (Cover credit: Tektronix.)

The first professional dockable camera with broadcast features. The new Z-one.

Hitachi's new Z-one is the first professional 400,000 pixel IT CCD camera to offer broadcast camera performance—with 750 line resolution and 60 dB S/N. And with many super-smart features, the Z-one is easier to use, and more versatile, than any other camera in its class.

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Dawn Hightower,
senior associate editor

SBE hosted DRB committee at the national convention

In its continuing effort to explore the changing area of broadcasting, the SBE hosted a meeting of the Digital Radio Broadcasting Committee at the SBE National Convention last month in St. Louis. The committee was formed early in 1990, and its purpose is to stimulate and encourage an open exchange of information on design and performance of digital broadcasting systems.

Broadcasters present research on AM antennas

The National Association of Broadcasters (NAB) has issued a report with the results of two experimental AM broadcast transmission antenna projects.

For one project aimed at reducing nighttime interference on the AM band, researchers built and evaluated a skywave-suppression antenna. The antenna was designed by Ogden Prestholdt of Nokomis, FL, and was created to allow an AM station to reduce its skywave signal without degrading local coverage provided by its groundwave signal.

According to NAB staff engineer Kelly Williams, who coordinated the tests, the skywave antenna did not perform as expected. Although it created the desired null in the skywave pattern at the transmitter site, the hoped-for effect a few hundred miles away was inconsistent. Williams said that when monitored at the receiving end, the null — needed to suppress the skywave signal — was not consistently recognizable. For this reason, the antenna was not considered sufficiently effective.

NAB's second project was a low-profile antenna. As part of this design study, researchers set out to create a standardized mathematical model that could later be used to build a small and affordable AM transmission antenna for low-power use at night. Produced by AGL, the computer models simulated self-supporting towers ranging from 50-170 feet in height.

The computer models of the low-profile antenna met or exceeded performance criteria specified by NAB. Researchers envision that the low-profile antenna could allow daytime stations to improve their AM signal coverage and possibly operate at night by moving their facilities closer to the communities they serve.

The findings from both projects will be submitted to NAB's AM Improvement Committee for further review. Copies of the report (R-890) can be obtained through NAB's Science and Technology Department at 202-429-5346.

Continued on page 130

BROADCAST ENGINEERING

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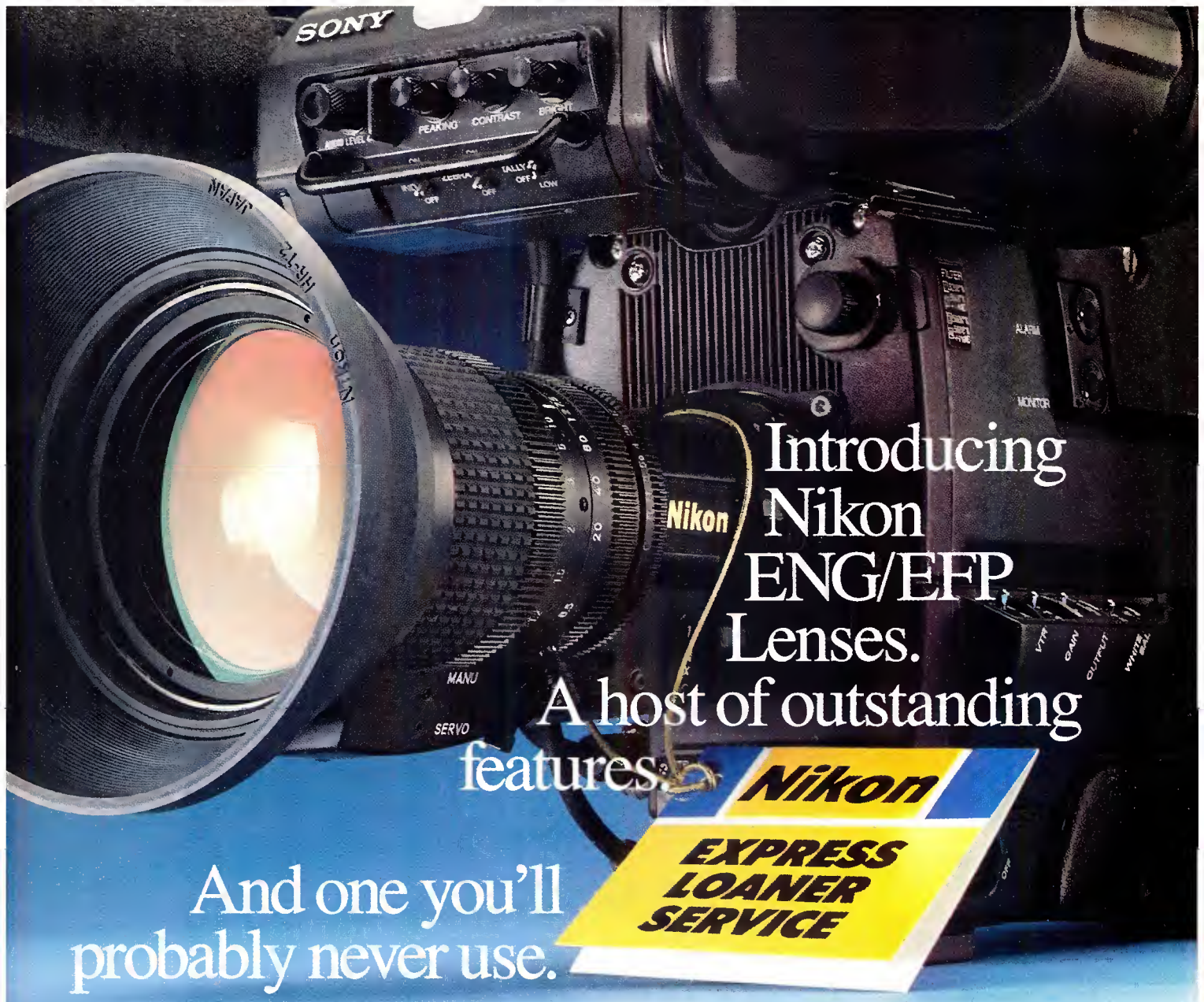

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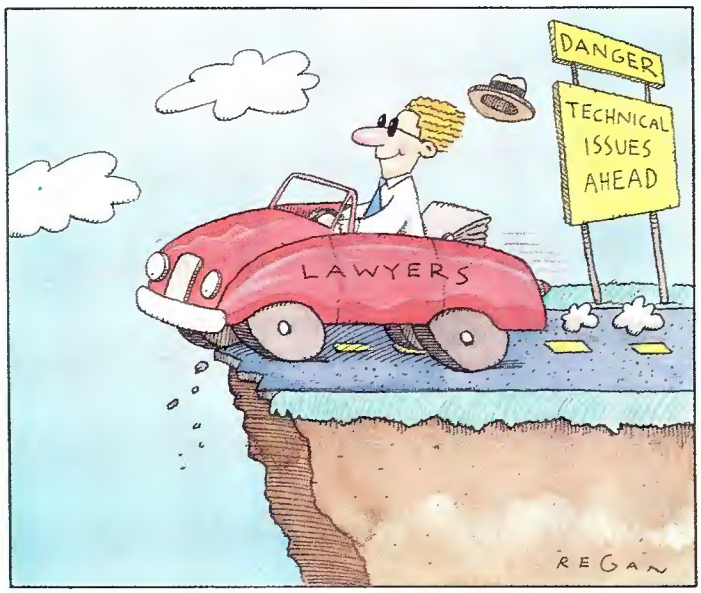
A modest proposal

A guest editorial

When Congress created the Federal Communications Commission (FCC) in 1934, it gave that agency the mandate to regulate the frequency spectrum so as to make available "a rapid, efficient, nationwide and worldwide wire and radio communication service." In the 56 years that have passed since the creation of the FCC, the technical sophistication and complexity of radio spectrum regulatory issues have increased tremendously. Yet, of the 64 past and present FCC commissioners, only eight have been engineers. The last FCC commissioner to have an engineering background was Charles D. Ferris, who served as chairman from 1977 to 1981. He has held positions as a research physicist at Sperry Gyroscope, as chief engineer of the USS Brinkley Bass (DD887) and as an assistant professor for Naval Science-Marine Engineering at Harvard University.

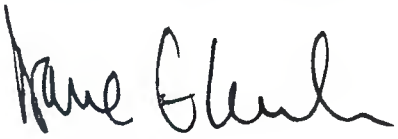


Section 4 of the Communications Act should be amended to require that at least one FCC commissioner be an engineer. An "engineer" could be defined as one holding "Senior" or "Fellow" status in any nationally recognized engineering society, such as the IEEE, SBE, NARTE, SMPTE or SCTE, and at least a 4-year engineering degree from an ECPD-accredited school of engineering, or current registration as a professional engineer in any discipline in any state.

Precedent surely exists for "allocating" commissioner slots. The Communications Act always has placed a limit on the number of commissioners who could be from the same political party. It is common practice to mandate certain qualifications for membership on a regulatory board or committee. For example, the Judicial Performance Commission in California is required to consist of two justices from the Court of Appeals, two judges from the Superior Court, one Municipal Court judge, two practicing attorneys and two public members. Although the Communications Act gives each commissioner the right to appoint three professional assistants, one or more of whom could be engineers, only Commissioner Quello has seen fit to do so. Even if all of the commissioners had engineering assistants, a non-technical commissioner never may fully comprehend technical complexities and tradeoffs.

FCC commissioners must deal with numerous regulatory aspects — economic, legal and, of course, political. Yet, the basic mission of the FCC is as a technical regulatory agency. To require that at least one FCC commissioner be an engineer does not strike me as unreasonably restricting the appointment prerogatives of the president. There are many potential candidates who would meet the proposed definition: James C. McKinney, Wallace E. Johnson and Jules Cohen come immediately to mind. Both the AFCCE and SBE have current and past officers who are not only seasoned engineers, but possess the impartiality and wisdom needed for an effective commissioner.

The SBE has written to members of Congress suggesting such an amendment to the Communications Act. Also approached were all industry groups and associates that the SBE believes have an interest in the amendment and might support it. If widespread and enthusiastic support exists for the SBE proposal, Congress may well decide that an FCC with at least one commissioner as an engineer would foster the regulatory goal of the most efficient use of the radio spectrum. Some lawyers are among the smartest people I know, but even they could use the help of a fellow commissioner with the technical background to understand tomorrow's technology.



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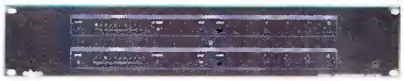

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FCC finds violations of political rules

By Harry Martin

In July, the FCC's Mass Media Bureau audited 30 TV and radio stations to assess the broadcast industry's compliance with the statutes and rules that govern political broadcasting. The stations were located in Cincinnati, Dallas-Fort Worth, Philadelphia, Portland and San Francisco. The audit showed that certain industry practices are not in compliance with law, particularly the "lowest unit charge" provision of Section 315(b) of the Communications Act. The commission found that political candidates had paid higher prices than commercial advertisers at a majority of the stations because sales techniques have encouraged them to buy higher-priced classes of time.

Section 315(b) directs broadcasters to charge candidates for public office the "lowest unit charge" (LUC) of the station for the same class, amount of time, and for the same period during the 45 days preceding a primary election and the 60 days preceding a general or special election. When the candidate purchases time outside these specified pre-election periods, the charges are not to exceed those for comparable use of such stations for other purposes.

After examining the political files, rate cards, and program logs of the various stations, the commission determined that at 16 of the 20 TV stations audited, political candidates paid more for broadcast time than commercial advertisers in virtually every program time period analyzed. In some instances, candidates paid more than every commercial advertiser aired in the same day parts. Although candidates fared better on radio, they still paid more than commercial advertisers at four of the eight stations audited.

The commission believes the primary reason for this disparity is that candidates purchase time at non-pre-emptible "fixed" rates while commercial advertisers generally purchase time at "pre-emptible" rates. Stations report that candidates choose to buy higher-priced fixed time to ensure that their advertising will air exactly as ordered. Therefore, they contend, their time purchases cannot be compared for purposes of LUC calculations. However, the commission found that the stations' sales practices actually encourage candidates to spend more for advertising time by buying the higher-priced non-pre-emptible class of time.

In order to promote compliance with the law and enable candidates to make informed choices regarding broadcasting rates, the commission has set forth the following guidelines:

- Broadcasters should disclose all rates to candidates as well as package options available to commercial advertisers. This disclosure should specify all discount privileges, including every level of pre-emptibility, the approximate clearance potential of the time purchased at current effective selling levels, and special package plans. The disclosure should also indicate the station's customary policies regarding make goods and negotiating for time.
- Broadcasters are prohibited from establishing new classes of time exclusively for candidates which result in higher rates.
- Broadcasters must maintain a political file containing all current requisite information (i.e. requests for time, schedules, rates, and free time granted) in an organized and self-explanatory manner.
- Except for restrictions prohibiting sales to candidates during news programming, broadcasters cannot establish in advance any ban or limitations for the sale of time to federal candidates. Federal candidates have the right to formulate campaign media strategies on an individualized basis and the broadcaster must negotiate each candidate's on an ad hoc basis.

Most AM stations comply

The FCC's Field Operations Bureau, after conducting a nationwide audit of 374 AM stations, found that 87% of them complied with the FCC's new emission limitations designed to reduce adjacent channel interference.

In April 1989, the commission amended its rules to specify the new standard, which is the functional equivalent to the emission standard recommended by the National Radio Systems Committee (NRSC) for AM broadcast stations. The NRSC standard attenuates AM sideband energy beyond 10kHz of the assigned carrier frequency, thereby reducing levels of adjacent channel interference. The commission considers this interference reduction an important part of its ongoing AM improvement effort.

To comply with the new rules, AM stations are permitted to use special NRSC-equipped audio processing equipment or a special NRSC audio filter.

FCC seeks comments

The FCC is examining its rules and policies governing the authorization of TV satellite stations. It is seeking comment on whether it is possible or desirable to define a fixed class of circumstances in which it would be presumptively in the public interest for a TV station to operate as a "satellite" for a distant station.

Currently, satellite stations are authorized based on the economics of a specific market, the gains in diversity that a satellite operation might provide, the extent of overlap between the parent station and the proposed satellite, and the extent to which the proposed satellite would provide service to underserved areas.

In its new initiative, the commission is seeking comment on what constitutes an underserved area, based on the number of signals received. If such a signal-based standard is adopted, the commission wants to know whether its evaluation of underserved areas should include signals provided by non-commercial television and TV translator or LPTV stations.

According to the commission, cable TV penetration might also be considered. The agency is also seeking comment on whether the proposed service area or population of a satellite station must include some minimum underserved service area or population.

Correction

In the item on IF protection rules for FM in August's FCC Update, it was incorrectly reported that the FCC replaced its IF distance separation requirements with a 36mV/m contour overlap standard. The item should have read that the new IF distance separations are based on a 36mV/m protection standard.

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

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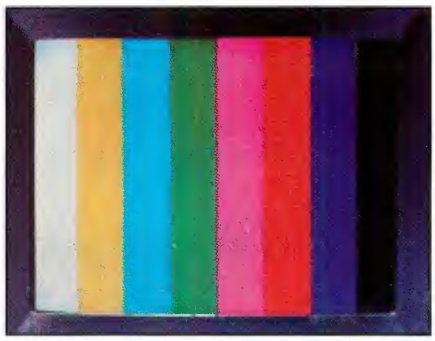


Frequency response monitors system health

By John Horn

Frequency response testing, like taking a person's temperature, is a good indication of overall video system health. Much as a low-grade fever often signals the onset of illness, minor degradations in frequency response can predict larger problems to come.

The value of frequency response as an indicator of general video system health stems from the link of frequency response to so many aspects of video signal and picture quality. Consider, for example, the effects of a reduction in system bandwidth. High-frequency video signal elements are attenuated. This results in a loss in picture sharpness, among other things.

A minor change in system bandwidth will not have as dramatic an impact on picture quality. There may not even be any noticeable impairment. Nevertheless, minor response changes are important because they warn of things that could be going wrong. Possible problems could be a drift in alignment, slow degradation of a capacitor or other component, or a temperature problem.

Horn is the manager of the television division training group for Tektronix, Beaverton, OR.

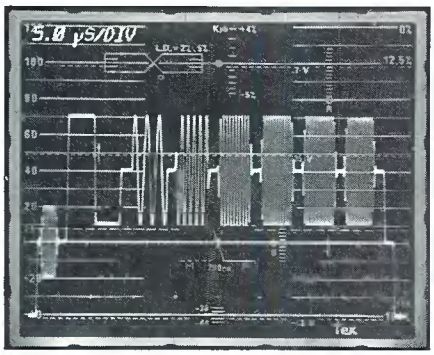


Figure 1a. *Multiburst test signal with 0.5MHz, 1MHz, 2MHz, 3MHz, 3.58MHz and 4.2MHz packet frequencies.*

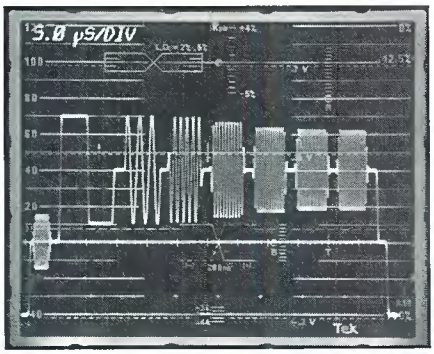


Figure 1b. *Changes in packet amplitudes of video output terminals are a measure of the response to each packet frequency.*

Checking frequency response is relatively simple. A signal of known frequency content and amplitude is applied to the input (or inputs) of the video equipment under test. Changes in signal frequency amplitudes are then observed at the equipment output terminals.

The most common signal of this type for NTSC system check is the multiburst signal. This signal has equal-amplitude bursts, or packets, of sine waves at different frequencies. (See Figure 1a.)

Frequency response is measured by applying the multiburst test signal to the equipment being evaluated. A TV waveform monitor or oscilloscope is then used to observe the multiburst packet amplitudes at the equipment's output terminals. Usually, the white-bar or first-packet peak-to-peak amplitude is measured as a reference. Then the peak-to-peak amplitude of the smallest packet is measured. The ratio of this value to the reference can be converted to decibels to obtain a response value.

For example, let's say the white-bar (or first burst) reference is measured and found to be 60 IRE peak-to-peak. Then the smallest packet is observed to be the 4.2MHz packet, and its peak-to-peak amplitude has a measured value of 45 IRE. (See Figure 1b.)

A dB amplitude ratio calculation shows the loss at 4.2MHz:

$$20 \log10 (45/60) = -2.5\text{dB}$$

Thus, we can say that the amplitude response is down 2.5dB at 4.2MHz.

Sweep check

Sometimes it is desirable to see a continuous frequency response, rather than the response at only the packet frequencies of a multiburst signal. This may be necessary to catch response dipping or peaking that could occur between packet frequencies. Such anomalies can be observed by applying line or field frequency sweeps of a sine wave and viewing the output signal's amplitude envelope.

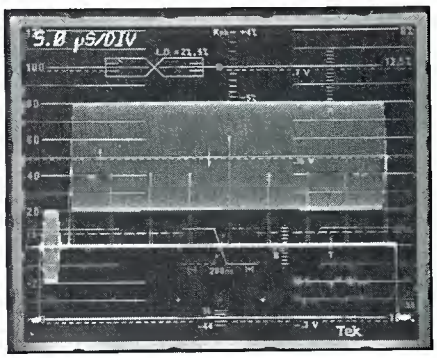


Figure 2a. *Y/C system chroma response test signal (2.58MHz-4.58MHz sweep).*

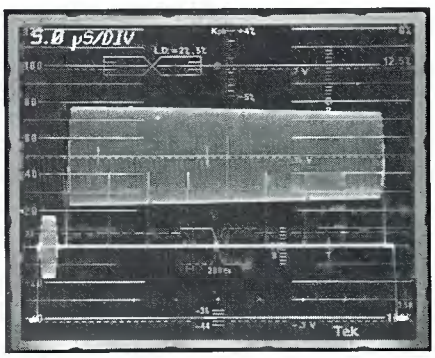
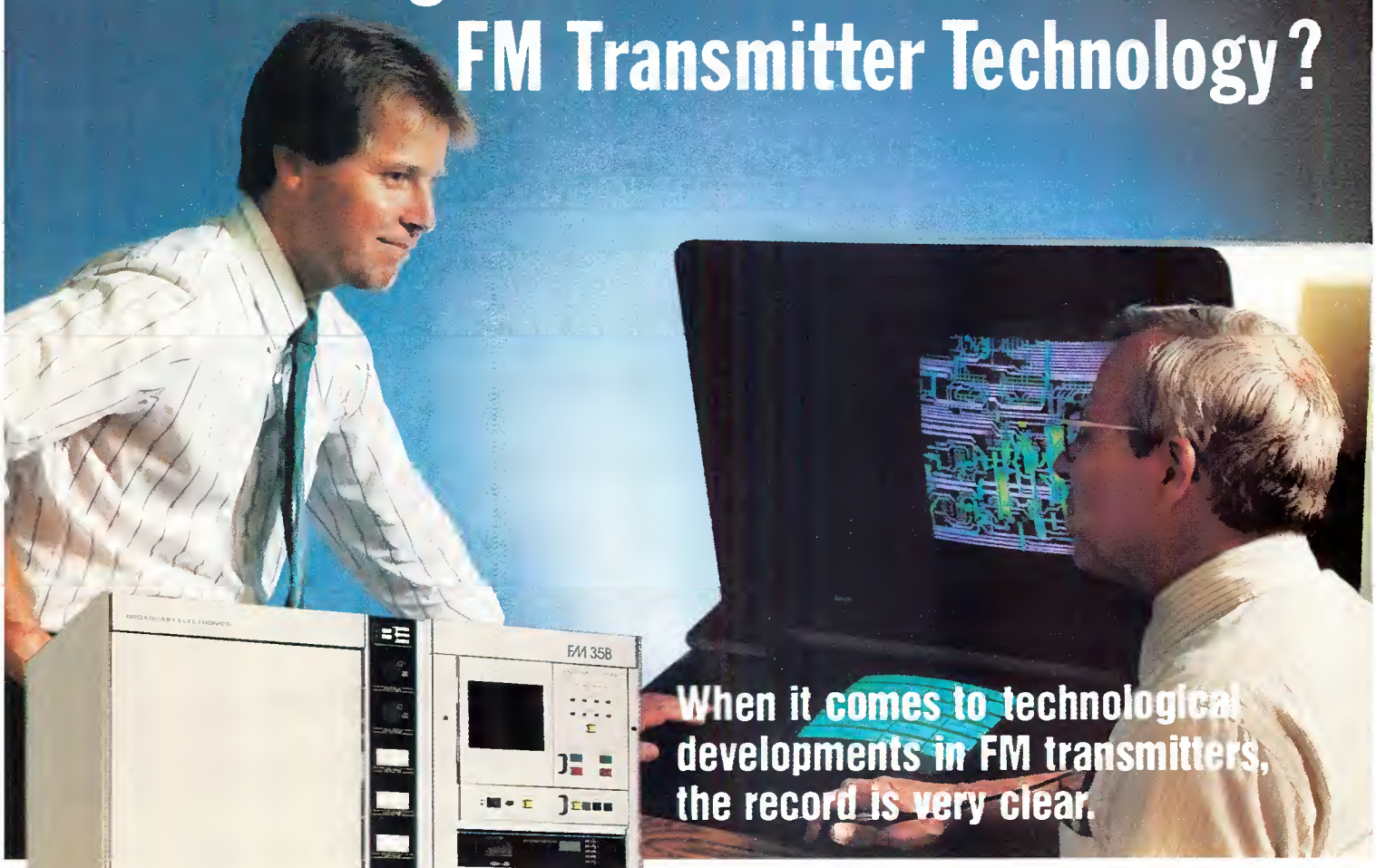


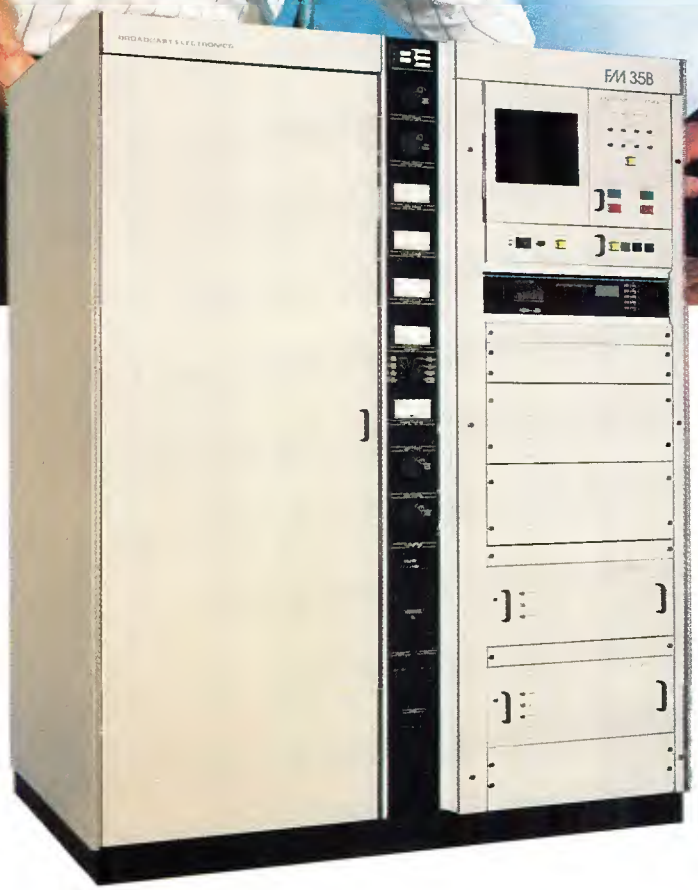
Figure 2b. *Chroma channel response to the frequency sweep.*

Sweep signals are also used in testing the responses of Y/C and component (Y, B-Y, R-Y) systems. For example, the chroma response of Y/C format equipment can be tested with a 2.58MHz to 4.58MHz sweep. (See Figure 2a.) Results are interpreted in similar fashion to the above. (See Figure 2b.) The frequency of interest is determined by counting the markers on the sweep signal. For 3-wire component equipment, line sweeps of 200kHz to 5.5MHz are used for the Y signal and 100kHz to 2.75MHz sweeps for the B-Y and R-Y channels.

Who's Setting The Pace For FM Transmitter Technology?



When it comes to technological developments in FM transmitters, the record is very clear.



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First to introduce "PWM Automatic Power Control" with "Soft Start".

First to offer a built-in synchronous AM test port.

First to design a single tube high power 30kW FM Transmitter.

First to introduce a single tube 10kW FM Transmitter with a 4CX7500A tube.

First to introduce a single tube 3.5kW FM Transmitter with a 4CX3500A tube.

First to introduce a Microprocessor Video Diagnostic System.

First to offer built-in, PC based, transmitter remote control.

First to offer a standard synchronous FM booster option.

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  Internal Second Harmonic Suppressor, patented 1982.
- Broadband Input Impedance Matching Circuit, patented 1985.

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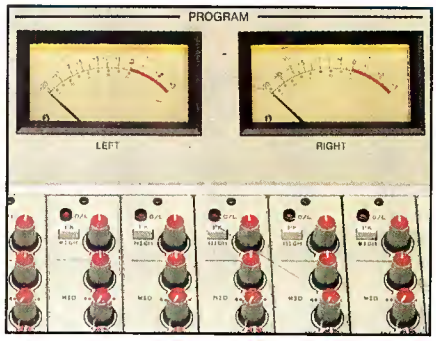
More on modulation



By John Battison, P.E.

Last month we talked about modulation systems and tubes. One of the earliest systems, which is still often used, was invented by an engineer named R.A. Heising. He described it in the *Proceedings of the I.R.E.* in August 1921. It is also known as the constant-current system because the modulator tube and modulated RF amplifier are connected to the same high-voltage supply.

Heising's system is known to most of us as "choke modulation" because it depends on a common, iron-cored choke for its operation.

The basic theory assumes the RF stage to be a pure resistance in parallel with the plate resistance of the modulator tube(s). High-voltage is supplied through an LF choke of (theoretically) infinite impedance. The sum of all the currents in the two stages is assumed to be a constant, hence the term "constant current."

Recalling that an important property of an inductance is to resist change in current by developing a voltage across its windings, we see that this voltage is given by:

$$E = L\ di/dt$$

If the plate current of the modulator stage changes because of audio in a given direction, the choke's inductance tends to prevent a change in the total current. However, this requires a current change in the RF tube in the opposite direction. The resulting change of current in the RF stage produces the desired amplitude modulation by varying the power generated in this stage in accordance with the modulation level.

It is normal to use similar tubes in the modulator and RF amplifier stages. When using older transmitters, a larger tube is sometimes used in the modulator stage rather than in the RF amplifier, or a pair of tubes in parallel is used to provide the required power. This is necessary to cope with a plate dissipation of 120% of the RF stage.

Although this system is very popular in older transmitters, it is relatively inefficient because it's basically a linear amplifier with a typical linear efficiency of approximately 33%. It is difficult to achieve 100% modulation without encountering a positive grid condition in the modulator, and the plate cannot go lower than the grid. Therefore, the anode of the RF stage will not go down to zero volts without adding a few components to the circuit. (See Figure 1.) This makes it necessary to place a resistor R in the B+ lead to the final in order to reduce the final's B+. To provide an audio path, we place capacitor C across the resistor. This increases the ratio of audio voltage to DC to the final, making it possible to reach 100% modulation.

However, this approach is lower in efficiency. For a typical 1kW transmitter there is a loss of approximately one-fifth of the DC input to the final (about 260W). This loss is included in the overall efficiency figure of approximately 33%.

I've seen older transmitters that have been butchered and had this R-C network in the modulator stage removed by someone who did not realize its purpose. This could be the reason for the inability to achieve 100% modulation. Look for this at a station with an old transmitter that won't modulate properly.

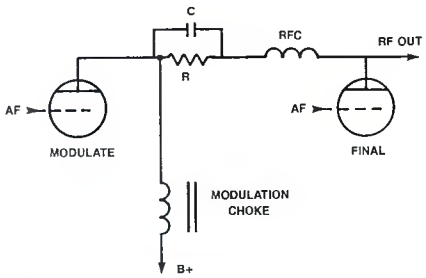


Figure 1. Typical Heising circuit.

Another point sometimes overlooked in recent years, as the trend toward solid-state continues, is the care needed in the treatment of modulator tubes in this modulation system. Some of you may have wondered why modulator tubes in old, 33% efficiency transmitters seem to run with red hot plates and often have an "electrode image" on the plate in terms of even redder lines.

When the stage is in pure Class A conditions without input, the grid wires often work to form electrons into narrow "hot" streams. These will cause excessive plate heating and often create a presentation of the grid's image on the plate. Class A tube ratings are normally lower than those for Classes B or C in order to provide headroom for this effect.

Positive vs. negative modulation

Tube type transmitters often have a problem with negative modulation running higher than positive. Assuming that no fancy inversion amplifiers are used to reverse polarity, we normally expect to run 125% positive and not to exceed 100% negative. I've seen stations with approximately 80% positive and 90% negative, which is all they can get.

The mechanical modulation meter in the modulation monitor has ballistics that prevent it from reading instantaneous values. Therefore, we use the 125% positive flasher and the 100% negative flasher. By setting the flash level, it is easy to get an idea of modulation levels. A good graphic way is to watch the needle swing on positive and negative settings. Visual integration gives you a good idea of modulation conditions. Of course nothing beats a scope, but how many of us have scopes at small stations?

The problem condition mentioned above is normally easy to remedy. You simply change the tubes. Check their date of going into service. If it is a short time and new tubes cure the trouble, an investigation is necessary. Go into the transmitter to measure and record operating voltages and currents. Sometimes a screen grid B+ value is too high, causing excessive current.

At the time of tube change, filament voltage should always be measured. Also, if necessary and possible, it should be adjusted for optimum tube burn-in and longest life.

One advantage of a transistor is that it rarely loses emission!

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

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KEY PERFORMANCE SPECS	AUDIO PRECISION SYSTEM ONE	H-P 8903B	S-T 3000B	TEK AA5001/SG5010
Flatness 20-20kHz, gen/analyzer	0.03/0.03 dB	0.06/0.2 dB[1]	0.1/0.1 dB	0.05/0.1 dB
Amplitude accuracy, gen/analyzer	0.1/0.1 dB	0.2/0.2 dB	0.2 dB/no spec	0.2/0.3 dB
Generator amplitude range	+30 to −90 dBm	+17 to −68 dBm	+30.6 to −90 dBm	+28 to −72 dBm
System THD + N 20-20kHz, 80 k BW	0.0015%	0.01%	0.0018%[2]	0.0032%
Min. amplitude for THD + N function	25 microvolts	50 millivolts	30 millivolts	60 millivolts
Residual noise (80 kHz BW)	3.0 μV	15 μV	4.0 μV	3.0 μV
Analyzer stereo separation @ 20 kHz	140 dB	function not avail.	100 dB	function not avail.
Common mode rejection ratio	70 dB, 50-20kHz	60 dB, 20-1kHz	100 dB @ 50 Hz	50 dB, @ 50/60 Hz
Speed, THD function (autorange)	10 sec 16-pt sweep	1.5 sec to 1st rdng	2.5 sec to 1st rdng	2.5 sec to 1st rdng
Speed, amplitude function (autorange)	10 sec 30-pt sweep (2 chan simultaneous)	1.5 sec to 1st rdng (1 channel)	1.3 sec to 1st rdng (per channel)	2.0 sec to 1st rdng (1 channel)
PRICE (U.S. DOMESTIC)				
Computer-interfaceable instrument	$7350	$6250	$10280	$9795-$10205
Software package	included	none available	$595-$2580	none available
Typical controller	$600-$3000[3]	$6080[4]	$1000-$3430[5]	$1000-$3400[5]

[1] Analyzer flatness not specified separately, analyzer accuracy 0.2 dB 20 Hz-20 kHz
[2] Total system THD + N not specified; generator THD plus analyzer distortion specs added together equal 0.0018%
[3] Personal computer. Interface card included in instrument price.
[4] H-P Model 332MMA IEEE-488 compatible
[5] Personal computer plus IEEE-488 interface card
Competitive data compiled from H-P 1990 catalog, S-T data sheet 3000A 1987, price list 1989, Tektronix 1990 catalog.

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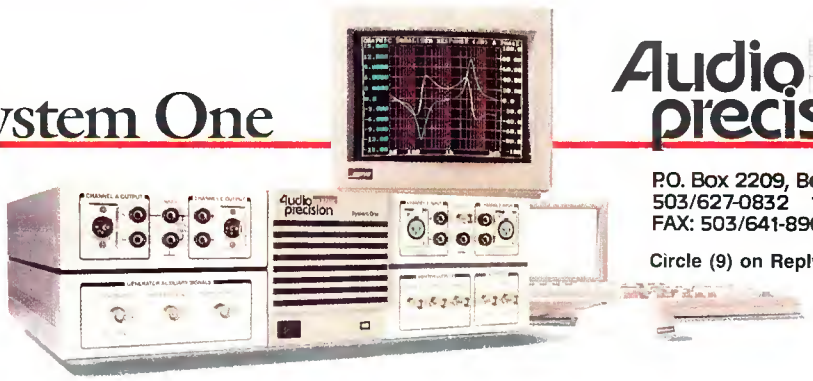

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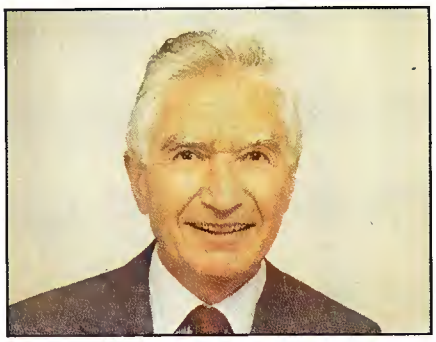

By Elmer Smalling III

Irv Rosner, a consultant's consultant, was born in the borough of Brooklyn, NY. After serving in the Navy, where he received electronics training, Rosner attended Cooper Union University. He graduated with a B.S. in electrical engineering in 1949. Later, he attended Columbia University, where he received a Master of Engineering Management degree. Rosner says he decided on a career in TV engineering because he enjoys working with people and being part of a team. After a summer stint as radar operator on a merchant Marine ship, he joined CBS and worked for seven years in the TV operations department, which was involved in production, maintenance and construction of new facilities.

It was during this period that CBS designed and constructed the majority of its TV facilities in New York. For the next three years, Rosner worked in the CBS-TV engineering department, which designed new facilities and much of the broadcast equipment and systems for CBS during this important period in network television's growth. While working in the engineering department, Rosner designed video switchers and amplifiers and worked with project teams that designed custom video components. In those days, you did not buy most TV support equipment. You designed and built it yourself. Rosner left CBS in the early '60s to join the RCA Broadcast Systems Group in Camden, NJ. There, he worked on the design and construction of color video switchers, terminal equipment and mobile TV trucks.

In 1960, with 12 years of design and construction work under his belt, Rosner felt he was ready to start his own TV consulting firm. Rosner Television Systems was founded in 1961, and it is still going strong after 30 years.

One of Rosner's first projects for his new company was his work with the CBS design engineering group at KNXT in Los Angeles. He worked on many aspects of design of this facility, which included early computer-automated video switching and state-of-the-art pulse and video distribution systems. During the year-long project, he commuted between Los Angeles and New York.

Rosner was married in 1962 and immediately received more work from CBS in Los Angeles—this time at Television City, the extensive production center that is still at the heart of CBS's West Coast programming.

His next project brought him back to the East Coast and Washington, DC, where he was part of the design team for the CBS Television New Bureau, the district's first network facility. He designed aspects of the monochrome TV system and, in 1966, the complete system for colorization. As with many of his projects, these were long-term, so he commuted between New York and Washington, DC.

During the mid-'60s, he designed what were then called closed-circuit TV systems for corporate clients, such as IBM, and institutions, such as the Ford Foundation. He also designed them for schools, including the State University of New York.

In the early '70s, he performed feasibility studies for public television. His research took him to London, Rome and Tokyo to examine public television in these countries with the idea of designing the new PBS system in the United States. Rosner designed the first PBS facility that was to be located in New York. However, public TV officials decided that because PBS was to be national and different from the existing three commercial networks (not needing close proximity to Madison Avenue), it should be located in Washington, DC.

Next, Rosner was appointed to the position of FCC technical adviser. He was responsible for developing cable TV standards. He was also a member of Mayor John Lindsay's New York Cable Commission, which was responsible for shaping the regulations and structure of the cable TV industry.

The mid-'70s were very busy for Rosner Television Systems. Rosner redesigned WWL-TV, WWL-FM and moved the WWL-AM broadcast facilities from the shores of Lake Pontchartrain to an alligator-filled floating prairie in the southern part of Jefferson Parrish, LA. This project included designing a hurricane-proof, self-sufficient facility with 100% system redundancy.

Soon after this project, Rosner designed the TV facilities for the New Orleans Superdome, including broadcast television and the on-field playback system, which used four huge Eidophor video projectors. Another facility design project Rosner worked on during this period was WBTV in Charlotte, NC, and its post- production facility.

One of the biggest projects for Rosner Television Systems during the mid-'70s was the relocation of the U.S. Information Agency's TV facilities from the old Post Office at 12th and Pennsylvania Avenue to the new Patrick Henry Building at 6th and D streets. This operation consisted of many multiple-standard film and tape systems that were designed to serve most of the countries of the world, with provisions for production and post-production in many languages. This project required documenting and relocating all facilities from the retired old Post Office building without downtime, using much of the existing gear. This had to be carefully orchestrated and executed. The studios in the new USIA facility are big enough to record and mix a symphony orchestra.

In the late '70s, Rosner conducted studies for the House of Representatives to determine the best type of low-light cameras and TV system design to be used to record House proceedings. In the 1980s, he was asked by the U.S. Senate to advise and design its TV system, select color cameras and robotic systems.

Today, Irv Rosner is busy with projects involving HDTV and interactive TV systems. He says, "Television engineering has changed over the last 40 years from being technology driven to being financially driven. Today's engineers must work within the economic constraints of their environment. Systems must justify themselves with return on investment because broadcasters are less likely to design facilities for prestige reasons alone, as was done in the past. They look for facilities to generate an economic return."

Irv Rosner is a leader in the field of broadcast engineering and design. For over 30 years, he has striven for excellence, and he has passed this desire for excellence on to those with whom he has worked. |:(:)))|

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

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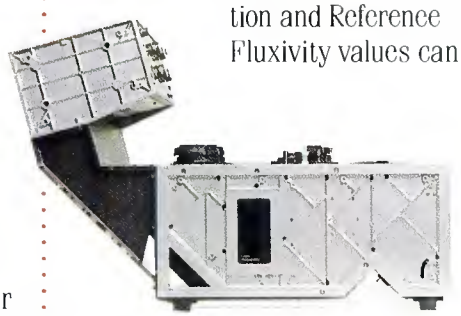

A 1.5" cast alloy deckplate, plus cast side frames give the MX-55NM the rigidity and ruggedness you've come to expect from Otari. (Do our competitors show you the inside of their machines?)

he changed with a flip of a switch. And as you put the deck through its paces, notice that the vari-speed control provides 0.01% step resolution. This means you can make precise changes, and perhaps more importantly, you can repeat a change *exactly* when necessary.

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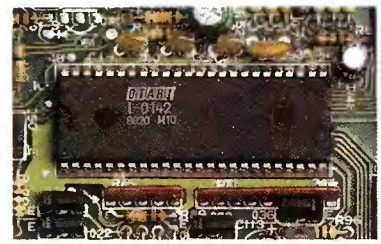

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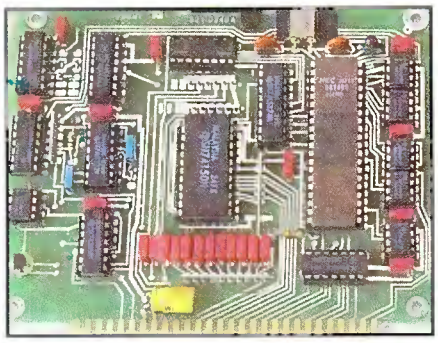

Building with microcontrollers

By Gerry Kaufhold II

Unlike the microprocessors used in personal computers, single chip microcontrollers do not require external clock chips. A crystal oscillator function, designed into the microcontroller, produces all of the timing signals required.

Selecting the crystal frequency requires some care. To make it easy to interface to the serial port of a personal computer, the crystal for a Z-8 should be 7.372800MHz. From this frequency, the microcontroller can create bit-rate clocks of 300-baud, 1,200-baud, 2,400-baud and 9,600-baud by successive division by two. These frequencies are fed as clock pulses directly to the serial bit-shift registers of the microcontroller's UART.

However, choosing a clock frequency that is convenient for serial communications may create difficulty in interfacing to other external equipment. For example, if we are connecting this microcontroller to a frequency counter whose base frequency is 10.0MHz, the microcontroller won't be able to catch each pulse without some help from other circuitry. The nature of embedded control requires close attention to all of these details.

Installing the crystal

When the circuit is constructed, a 22pF capacitor is connected between each lead of the crystal and ground. This is to provide proper loading for the Z-8's onboard oscillator circuit. (See Figure 1.)

Be liberal with decoupling capacitors. The microcontroller is a digital circuit and generates momentary current and voltage spikes when inputs and outputs switch. Clock signal lines are especially susceptible to "ground bounce," a common cause of faulty operation.

The Z-8 data sheet recommends installation of a 2.2MF capacitor as close as possible to the device's Vcc and ground pins. This is to reduce power supply spikes. In addition, several 0.1MF disk capacitors should be used to filter very fast transients. At these frequencies, the wire leads of capacitors act as inductors, so keep the leads as short as possible. Several companies make special sockets for microcontroller ICs that have the capacitors already molded into the plastic body of the socket.

Thanks for the memories

Figure 2 illustrates the four types of information storage areas available on a Z-8. The internal program memory is only used in high-volume applications. These use the on-board ROM to store the controller program. For our work with the Z-8681, internal program memory is ignored.

The internal registers provide a variety of important functions. The I/O ports are mapped into the register space. In addition, other registers provide read/write space (RAM) for program functions, such as the program counter, working registers, and the stack. These terms will be explained in an upcoming column.

There are two types of external memory available. External Read-Only Memory (ROM), such as EPROM, stores the operating program for projects. External read/write memory (RAM) can be used to provide data buffering and scratchpad space for applications that exceed the Z-8's 124 bytes of on-board RAM.

The Z-8681 can work with up to 64k of ROM and another 64k of RAM. A hardware signal on the Z-8, called DM, selects between data memory (RAM) and program memory (ROM). This splits the memory into two 64kbyte banks, providing up to 128kbytes of total external memory space. For our applications, we will be content with using only the 124 on-board general registers as RAM, and only 4kbytes of external ROM for program storage.

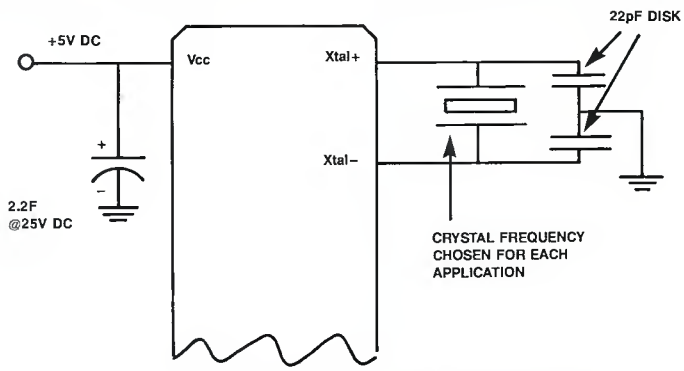

Figure 1. A capacitor between each leg of the crystal and ground provides proper loading for the oscillator circuit.

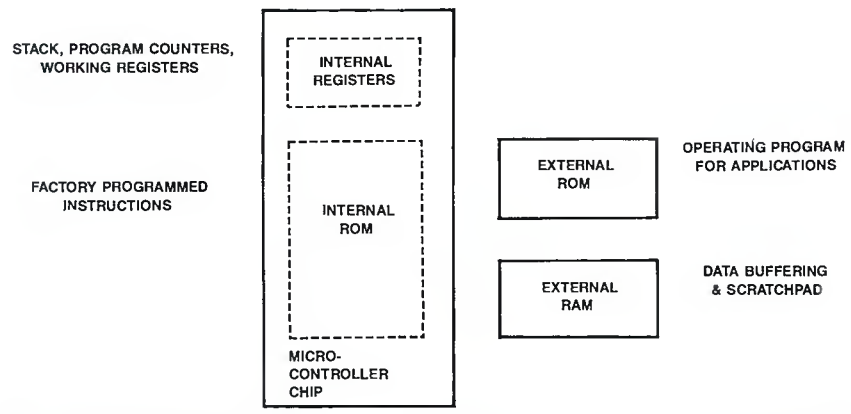

Figure 2. Four types of memory are available to the Z-8 microcontroller on-board ROM, internal registers, external ROM and external RAM.

Kaufhold is a market development engineer for SGS-Thomson Microelectronics, Phoenix, AZ.

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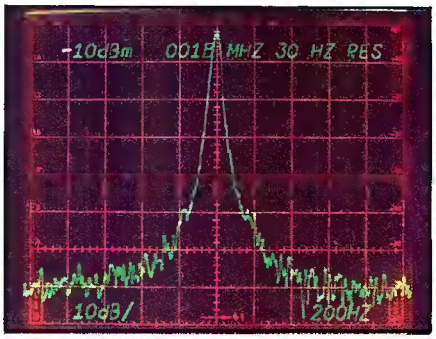
Part 2

Troubleshooting



Cleaning and flushing klystron water and vapor cooling systems

By Colin Erridge

Klystrons are expected to be long-life, reliable tubes—and in most cases they are. However, inadequate or improper cooling, because of scale or corrosion, may curtail the tube life of klystron amplifiers. There are some simple steps you can take to avoid the early demise of your transmitter's klystron.

Corrosion frequently occurs in the cooling channels of the klystron body, on the surface of the water/vapor-cooled collector, and in the cooling channels of the electromagnet. The corrosion is caused by chemical reaction between free oxygen-laden coolant and the hot copper channel wall. Scale can be caused by the use of other than clean distilled water or as the by-product of electrolysis between dissimilar metals in the heat-exchange system.

The following procedures are suggested for cleaning the cooling passages of water/vapor-cooled klystrons and associated transmitter equipment. The procedures should be performed before installing klystrons into a new system and repeated on a scheduled periodic maintenance program while the tubes are in service.

Transmitter flushing

New transmitter water lines frequently contain contaminants. When the water lines are first installed, these contaminants must be flushed and cleaned from the system before the klystron and magnet are connected. Also, follow the cleaning procedures in the transmitter manufacturer's manual.

Before cleaning the transmitter closed circulating water system, disconnect tube and magnet.

- Add jumper hoses between input and output of the klystron and electromagnet water lines.
- Disconnect or bypass pump motor.
- Fill system with hot tap water, if available. Open drain in transmitter cabinet and flush for 15 minutes or until clean.
- Flush water lines between tank and pump separately with hot tap water until clean.
- Connect all water lines and fill system with hot tap water, if available, and one (1) cup of non-sudsing detergent. Trisodium phosphate is recommended.
- Operate water system with hot tap water for 30 minutes.
- Drain and flush system with hot tap water for 30 minutes.
- Remove and clean filter element.
- Refill water system with tap water (ambient).
- Operate water system. Maintain water level while draining and flushing system until no detergent, foam, or foreign objects or particles are visible in drained or filtered element.
- Drain and refill system with distilled water when tube and transmitter water lines are both clean.
- Remove, clean and replace filter before using.

Flushing klystron and magnet water lines

Tubes with contaminated water lines, corrosion, scale or blocked passages should be flushed. Magnet water lines may be flushed in the same manner.

Back flush klystron body water lines.

- Remove input water fitting (Hansen type) and add a straight pipe extension to tube.
- Attach hose to this fitting, using "hose-clamp" to secure hose. This is the drain line and should be drained into a convenient outlet.
- On some models, the normal body-cooling output line is fed to the base of the Vapotron boiler. Remove the hose at base of Vapotron boiler. Do not damage this fitting as it must be reused.
- Attach a 2- to 3-inch extension pipe with fittings for the small hose at one end and a garden hose at the other. Secure with clamps.
- Connect a garden hose to the tape water faucet (preferably hot).
- Back flush klystron cooling passages for 10-15 minutes at full pressure until clean.
- Reconnect input and output water lines to klystron.
- If scale is present on the Vapotron collector, a solution of trisodium phosphate should be used for the first cleaning. This should be done with a clean transmitter water system.
- Connect klystron to transmitter water lines and fill system with tap water and one cup of non-sudsing detergent.
- Operate water system for 15 minutes, making sure water level covers collector core completely.
- Drain and flush system for 30 minutes, or until no detergent foam is present.
- Remove and clean filter element.
- Fill system with distilled water.
- Drain system water and refill with distilled water.

Cleaning klystron and magnet water lines

Magnet and klystron water lines may be cleaned in the same manner. If there is heavy scaling on the Vapotron collector and/or blocked water passages, they may be cleaned by using a stronger cleaning agent.

- Clean transmitter water system first.
- Connect tube to transmitter water system.
- Fill system with hot tap water and add two gallons of cleaning solution for every 50 gallons of water.
- Operate water system for 15 minutes or until scales have been removed and collector has a clean copper color.
- Make sure water level covers top of collector during cleaning.
- Drain and flush system with tap water.
- Remove and clean filter element and replace.
- Refill system with distilled water and flush for 30 minutes to one hour.
- Check for detergent foam and pH factor at end of flushing. Continue flushing with distilled water until foam is gone and pH factor is within specified range.
- Refill system with clean, distilled water.

A thorough flushing with distilled water will remove harmful chlorine traces from tap water.

General cleaning

Two remaining items must be clean to achieve efficient operation: the sight glass and the floats in the water-flow indicators. The water-flow indicators usually become contaminated during use. This contamination collects on the sight glass and on the float, making flow-reading difficult.

Erridge is product manager, Varian Associates, Inc., Palo Alto, CA.

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Part 2

Management for engineers

Project management for engineers

By Judith E.A. Perkinson

Planning a project and managing a project are two different disciplines. Planning uses your ability to think and organize. Managing calls on your ability to think, organize and respond— usually on your feet.

A major part of effective project management is being able to keep a handle on what is going on and to recognize when the project is in trouble.

The plan and time lines

The plan is your road map. If put together with care, it can also be the best assistant you've ever had. When developing your plan, secure the input of the people who will be involved in making it work. In plan development, it really is true that two heads are better than one.

How you set your time lines can greatly affect the workability of your plan. Most inexperienced project managers underestimate the time requirement for a project. Be realistic and allow for problems. All projects have time line dependencies. For instance, you can't install a piece of equipment that has not been delivered. Watch your project dependencies. Build in flexibility when dependencies are not essential. Don't make the management of your project impossible by creating time lines that cannot be met.

Organizational structure

Because project management is anything but routine, you cannot depend upon your memory. If you are accustomed to managing with piles of paper all over your office, you may find this system fails you in project management.

You will save yourself a great deal of grief and duplication of work if you have an organizational tool that helps you manage your management. It can be a notebook, a 3-ring binder, a series of files or any tangible means of organizing the paper generated by a project.

This notebook should include your plan, correspondence, notes, tracking system material, vendor information and any other relative information.

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

Tracking system

Every project needs a tracking system. No one should be expected to be everywhere and know everything. A good tracking system will be that extra 12 hours a day you need to do a good job. The tracking system should provide essential information to you and others.

Armed with the proper system, you'll be able to know:

- When things are supposed to happen.
- What tasks and activities have been completed.
- When the system has broken down.

Communication

If we consider the plan to be the road map, then your communication system is the vehicle. Do not assume that communication will take place. You must plan the method you will use to ensure that timely and effective communication is the hallmark of your project.

In general, there are four areas of communication for which a project manager is responsible:

- Communication with superiors.
- Communication with the project team.
- Communication with the people directly affected by the project.
- Communication with the outside people who directly affect the project.

The section of the plan that defines who needs to know what should be your starting point. This will define your primary communication responsibilities. There are many tools that a project manager can use. Some of the tools that can prove effective include meetings, memos, oral and written reports, phone conversations and walk-around management.

Project team

No one has to be Superman and no one has to do it alone. Save your sanity by putting together a project team. This team can be made up of your regular staff, temporary staff, vendors and other department members.

Your team should be used from the beginning. Your team can be helpful from the time you start to plan your project until you evaluate the results.

When using a team, you must learn to delegate. A team should relieve you of responsibility, not add to it. The real value of a team can only be obtained when the team is managed properly.

Pride of authorship

I once knew a manager who took great pride in the quality of the plans he developed. However, he took so much pride in his plans that he would turn the project upside down and drive everyone crazy, rather than modify one element of his plan.

Project management is not an exact science. Any project involves so many variables that modifications are unavoidable. The most important thing you can understand is that *adjustments are not failures, they are supposed to be improvements.*

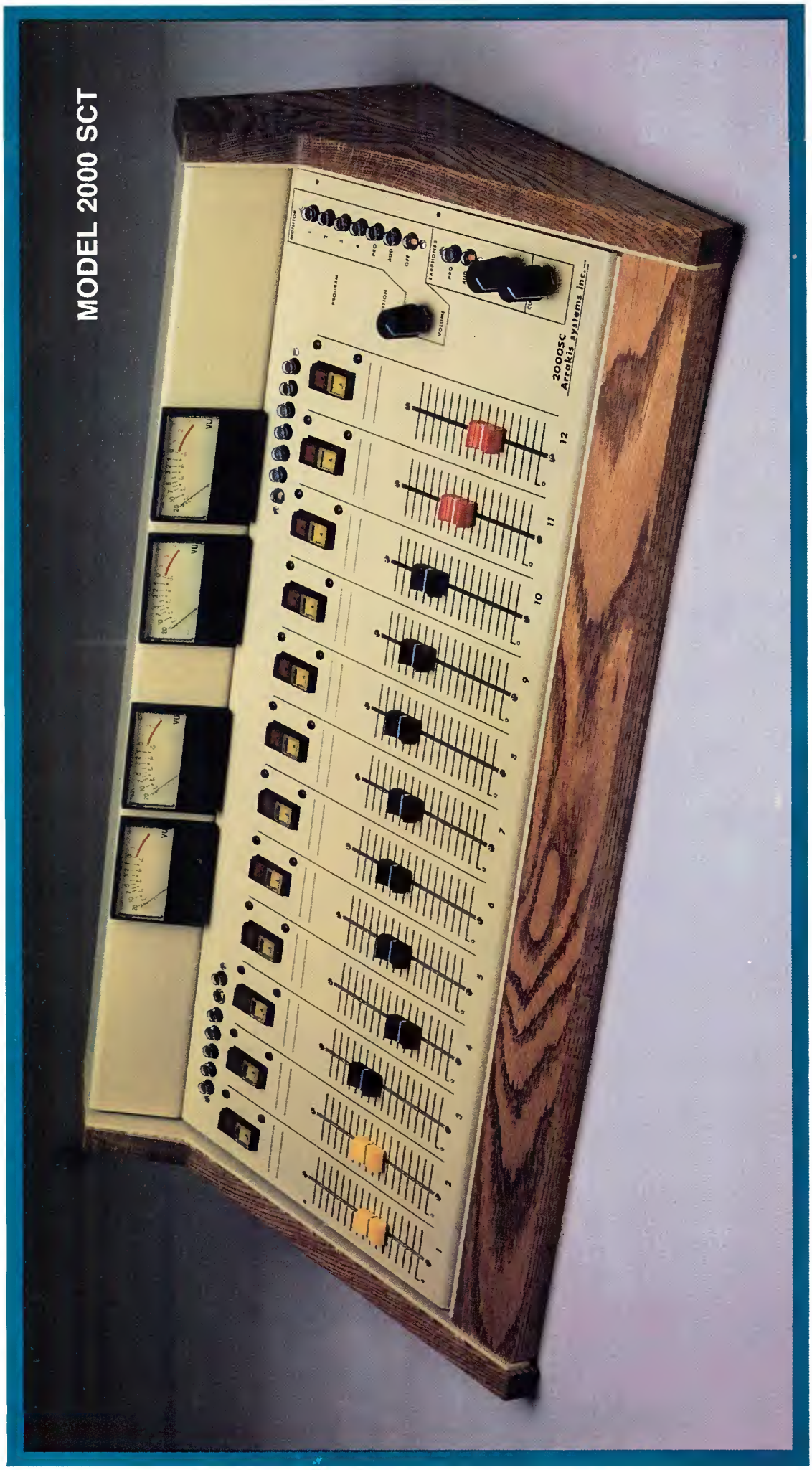
There is, however, a balance. Just as it is true that plans should not be tyrants, it is equally true that plans are not made to be ignored. Somewhere in between is sound project management. Modifications are made because they are necessary. Before they are made, the good project manager should:

- Have the data necessary to make the decision.
- Understand the impact of the modification on the rest of the elements of the project.
- Modify the project plan to accommodate the modification.
- Communicate the modification to everyone who may be affected by the change.

No one has to be an expert

Every project is different. When you begin to use a new piece of equipment, you depend upon the instruction manual. The most effective project managers lean heavily on the tools of successful project management — the plan, time lines, an organizational tool, tracking systems, communication and a project team.

We don't manage projects every day. Before you begin that next project, take a few moments to review the fundamentals. A solid understanding of the tools of project management can actually help you appear to be in two places at once. They call it good management.



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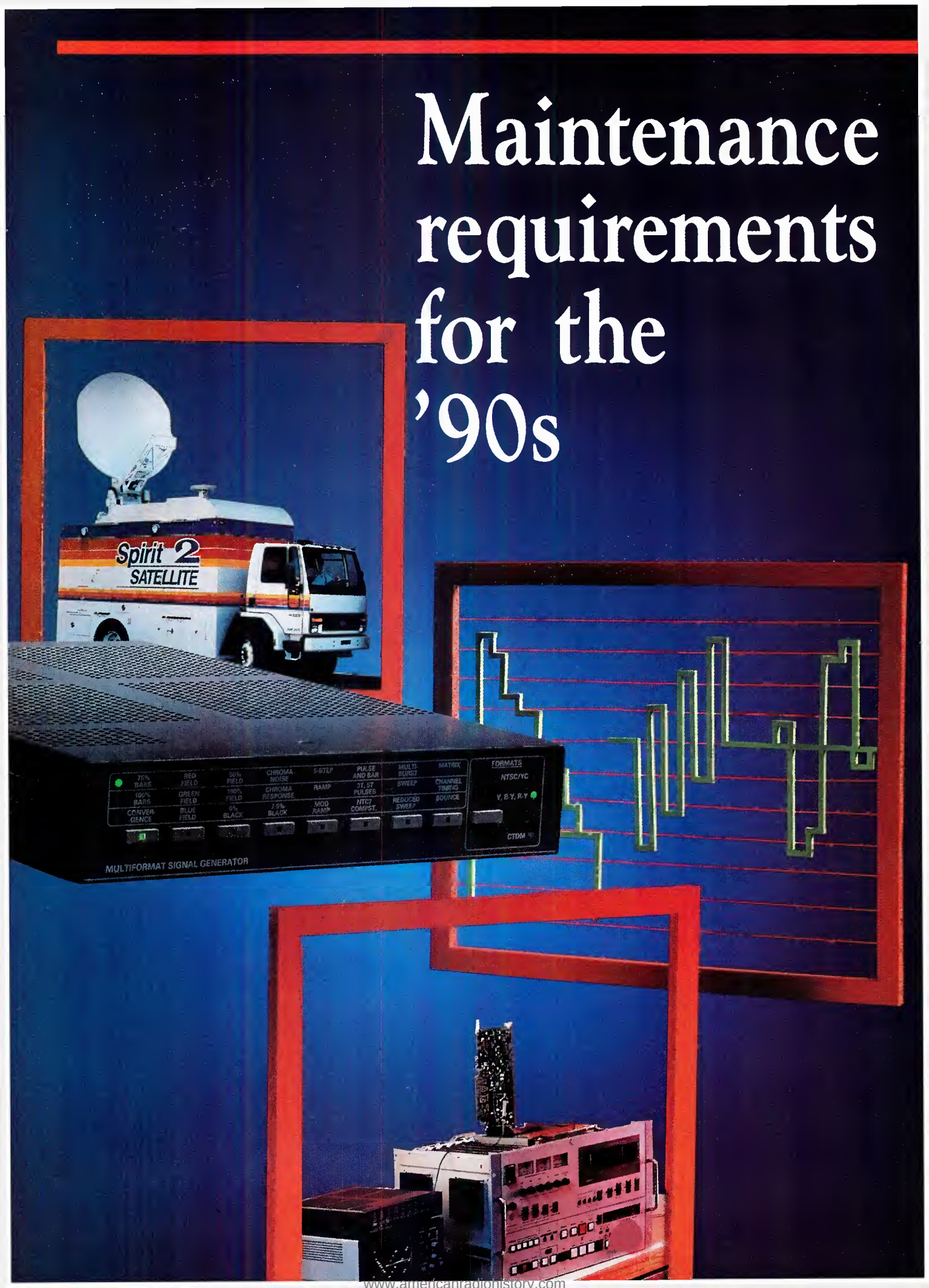
Maintenance requirements for the '90s



Equipment maintenance isn't what it used to be. And that's probably a good thing.

During the past 10 years, all types of electronic equipment have undergone immense changes. For starters, most hardware now contains tens or hundreds of ICs, and many of them are surface-mounted devices. The progress of technology has given the industry and consumers products that are more versatile and more reliable than systems built of discrete components.

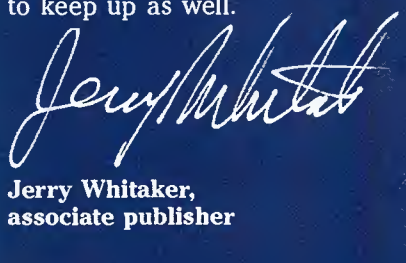
People responsible for maintenance of new technology equipment, however, are not necessarily pleased with many of the trends in equipment design. The days of troubleshooting a piece of gear armed only with a scope, voltmeter and general idea of how the hardware works, are gone forever. Today, unless you have a detailed maintenance manual and the right test equipment, you're out of luck.

The test bench of the 1970s — stocked with a VTVM, oscilloscope, signal generator and signal analyzer — is a relic of the past. The work bench of today resembles a small computer repair center more than anything else.

Some equipment manufacturers have built sophisticated test and diagnostic routines into their products. This trend is welcome, and will likely accelerate as the maintainability of products becomes an important selling point.

This month, in our 7th annual Maintenance Special Report, we examine the following topics:

It's easy to get into a rut and conclude that the old ways, tried and true, are the best ways. Change for the sake of change doesn't make sense, but the electronics industry has gone through a revolution within the past 10 years. Every facility should re-evaluate its inventory of tools, supplies and procedures. Technology has altered the way electronic products are designed and constructed. The service bench needs to keep up as well.

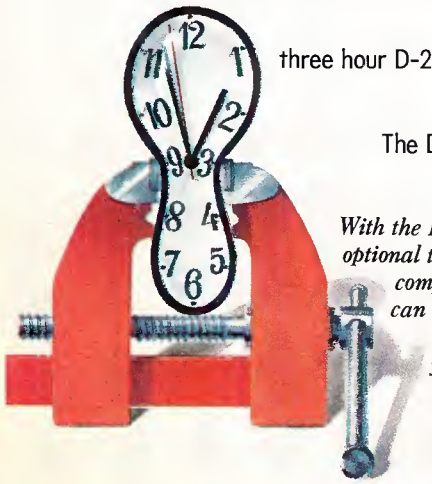


Jerry Whitaker,
associate publisher

D-2 has expanded the l
Now it can co

It was only a matter of time. Now Sony D-2 composite digital video offers broadcasters something they've been waiting for. Time compression.

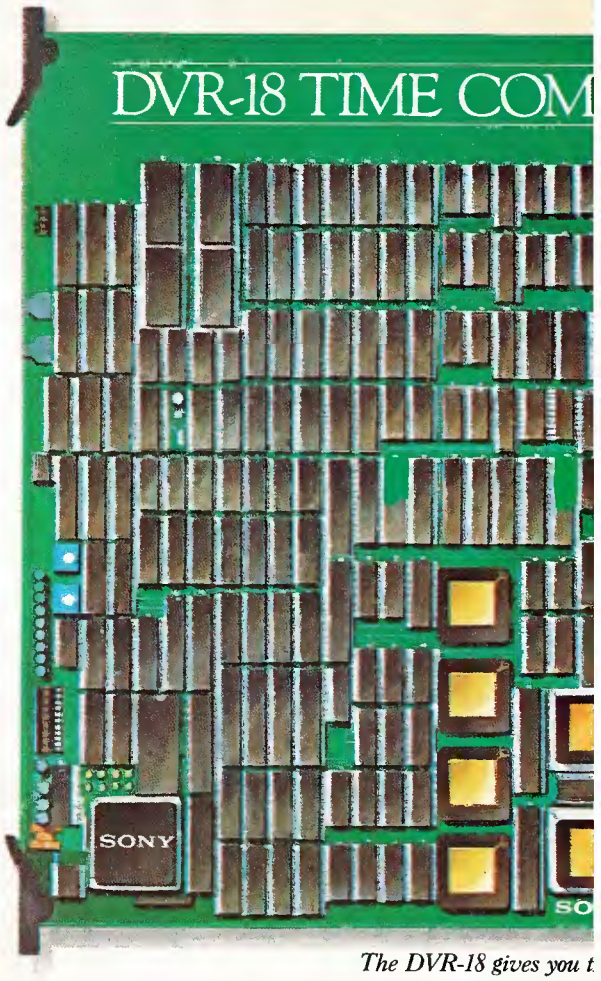
It's an option now available on the DVR-18, Sony's three hour D-2 VTR.



With the DVR-18's optional time compression, you can squeeze more out of the time you've got.

The DVR-18's time compression and expansion feature is remarkably advanced. A single plug-in module provides full audio data recovery as well as precise digital pitch correction for two stereo pairs of audio signals at the same time. For example, your main audio channels and your SAP. All without the need for any external equipment.

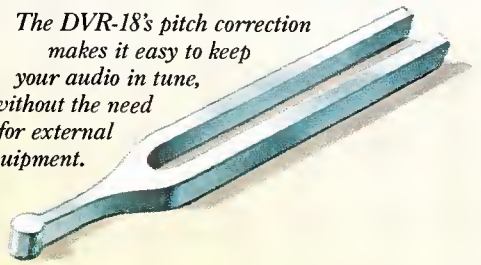
Plus, the DVR-18 gives you Sony's advanced picture processing for the highest quality video playback. And since it's digital, you'll get a time



The DVR-18 gives you t

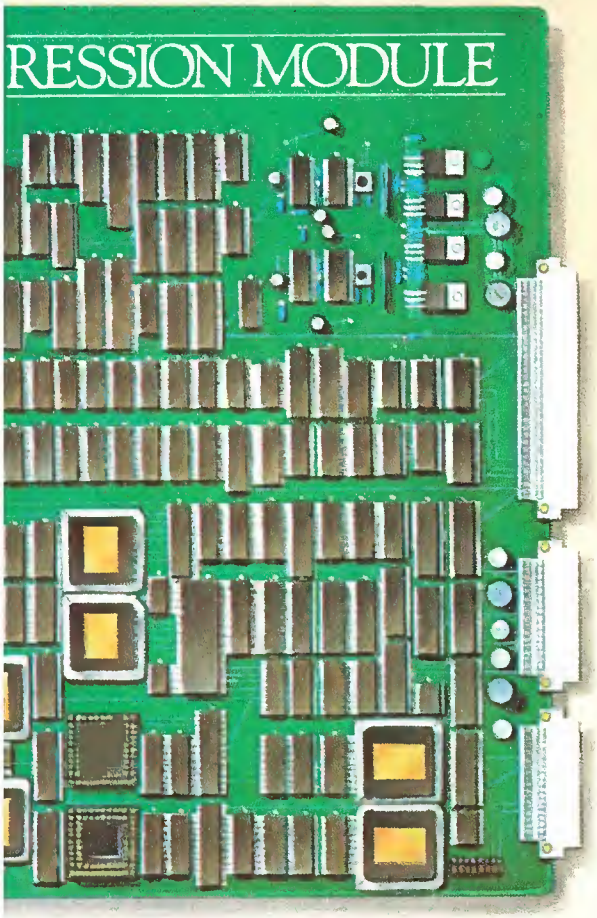
compressed program without losing a generation.

Of course, the DVR-18's time compression and expansion isn't the only reason why broad-



The DVR-18's pitch correction makes it easy to keep your audio in tune, without the need for external equipment.

mits of video and audio. mpress them.



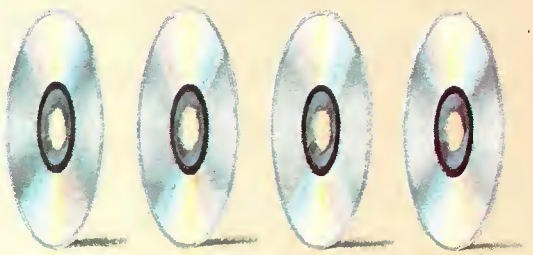
option of time compression.

casters should consider D-2. The DVR-18 offers recagnizable calar pictures at shuttle speeds up to 100X play speed. It can also accammadate all three D-2 cassette sizes. Sa it can give you a full three hour capacity. And it can pre-stripe tape stock at three times normal speed far insert editing.

The DVR-18 also has an optional serial digital interface. Which means simple, convenient connection to other digital equipment.

When you compare the size of a Sony DVR-18 to a regular 1-inch video tape recorder, you'll find the DVR-18 to be about three times smaller. That's a pretty big advantage to a TV station, where space is always at a premium.

To find out more information abaut the DVR-18, call 1-800-635-SONY.



The DVR-18 lets you compress four audio signals at the same time.

Because if you haven't thought about what Sany D-2 technolagy can do for your station, maybe now is the time.

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BROADCAST PRODUCTS

Test equipment for RF systems

By Jerry Whitaker, associate publisher, and Don Markley, P.E.

Maintaining mobile and fixed transmission equipment requires the proper test instruments.

The goal of every maintenance engineer is to ensure top-quality transmission standards, and to provide the most reliable equipment possible for the end-user. These objectives don't just happen. They are the result of a carefully planned maintenance program. Such a program involves correct setup of the equipment whenever maintenance is required. Having the proper RF test equipment is an integral part of this maintenance effort. Setting up a maintenance shop for an RF facility can be an expensive proposition. However, good-quality test instruments are required to protect the investment in the transmission system. Acquiring the proper test equipment is like having an insurance policy on that investment. Thorough knowledge of the use of the test equipment can only produce a better yield on the investment.

The actual test equipment requirements to perform most maintenance and adjustment procedures on transmission equipment are relatively modest, compared to the expense and complexity of the transmission system. A technician armed with the following instruments will be able to deal with most common RF problems:

- Digital multimeter (DMM), including a high-voltage probe and a clamp-on current probe.
- Logic probe.
- Wideband oscilloscope.
- SMPTE (Society of Motion Picture and Television Engineers) standard color bar generator (for video transmission systems).
- Waveform monitor and vectorscope (for video transmission systems).
- Wattmeter and a selection of power-level slugs.
- FM and/or AM modulation monitor (or deviation meter).
- Spectrum analyzer.
- Network analyzer.

Most maintenance engineers are familiar with the majority of these instruments. Two of the most powerful instruments, and perhaps least understood, are the spectrum analyzer and network analyzer.

Spectrum analyzer

Although oscilloscope-type instruments display voltage levels referenced to time, the spectrum analyzer indicates signal levels referenced to frequency. The frequency components of the signal applied to the input of the analyzer are detected and separated for display against a frequency-related time base. Spectrum analyzers are available in a variety of ranges. Some

Markley is a consulting engineer based in Peoria, IL.

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models are designed for use with audio or video frequencies, and others are intended for use with RF frequencies.

The primary application of a spectrum analyzer is the measurement and identification of RF signals. When connected to a small receiving antenna, the analyzer can measure carrier and sideband power levels. By expanding the sweep width of the display, offset or multiple carriers can be observed. By increasing the vertical sensitivity of the analyzer and adjusting the center frequency and sweep width, it is possible to observe the occupied bandwidth of the RF signal. Convention dictates that the vertical axis displays amplitude and the horizontal axis displays frequency. This frequency-domain presentation allows the user to glean more information about the characteristics of an input signal than is possible from an oscilloscope. Figure 1 compares the oscilloscope and spectrum analyzer display formats.

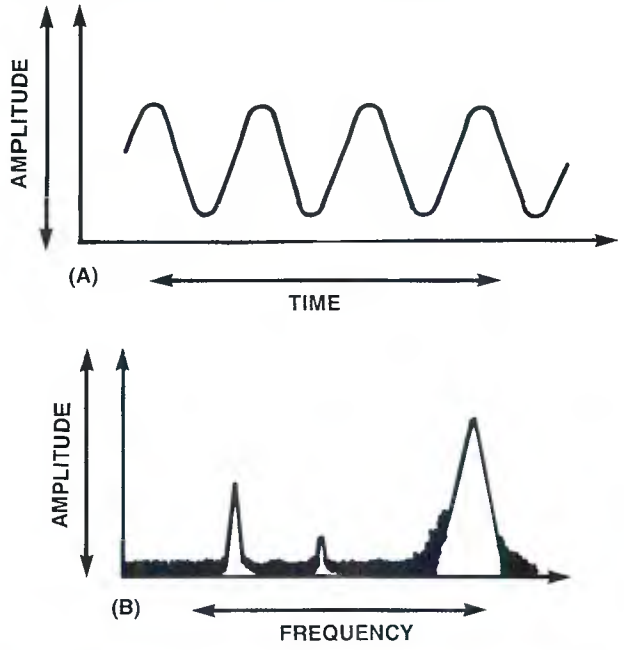

Figure 1. *Comparison of waveform displays: (a) oscilloscope; (b) spectrum analyzer. (From Kinley, Harold. "Using Service Monitor/Spectrum Analyzer Combos."* Mobile Radio Technology *magazine, Intertec Publishing, Overland Park, KS, July 1987.)*

Principles of operation

A spectrum analyzer intended for use at RF frequencies is shown in block diagram form in Figure 2. The instrument includes a superheterodyne receiver with a swept-tuned local oscillator (LO) that feeds a CRT display. The tuning control determines the center frequency (F_c) of the spectrum analyzer, and the *scan-width* selector determines how much of the frequency spectrum around the center frequency will be covered. Full-feature spectrum analyzers also provide front-panel controls for scan-rate selection and bandpass filter selection. Key specifications for a spectrum analyzer include:

- *Resolution.* The frequency separation required between two signals so that they may be resolved into two distinct and separate displays on the CRT screen. Resolution is usually specified for equal-level signals. When two signals differ greatly in amplitude and are close together in frequency, greater resolution is required to separate them on the display.
- *Scan width.* The amount of frequency spectrum that may be scanned and shown on the CRT display. Scan width is usually stated in kilohertz or megahertz per division. The minimum scan width available usually is equal to the resolution of the instrument.
- *Dynamic range.* The maximum amplitude difference that two signals may have and still be viewed on the CRT display. Dynamic range is usually stated in decibels.
- *Sensitivity.* The minimum signal level required to produce a usable display on the CRT screen. If low-level signal tracing is planned, as in receiver or off-air monitoring, the sensitivity of the spectrum analyzer is important.

When using the spectrum analyzer, care must be taken not to overload the front end with a strong input signal. Overloading can cause "false" signals to appear on the display. These false signals are the result of non-linear mixing in the front end of the instrument. False signals may be identified by changing the RF attenuator setting to a higher level. The amplitude of false signals (caused by overloading) will

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drop much more than the amount of increased attenuation.

The spectrum analyzer is useful in troubleshooting receivers as well as transmitters. As a tuned signal tracer, it is well adapted to stage-gain measurements and other tests. There is one serious drawback. The 50Ω spectrum analyzer input can load many receiver circuits too heavily, especially high-impedance circuits, such as FET amplifiers. Isolation probes are available to overcome loading problems. Such probes, however, attenuate the input signal, and unless the spectrum analyzer has enough reserve gain to overcome the loss caused by the isolation probe, the instrument will fail to provide useful readings. Isolation probes with 20dB to 40dB attenuation are typical. As a rule of thumb, probe impedance should be at least 10 times the impedance of the circuit to which it is connected.

Applications

The primary application for a spectrum analyzer centers on measuring the occupied bandwidth of an input signal. Harmonics and spurious signals may be checked and potential causes investigated. Figure 3 shows a typical test setup for making transmitter measurements.

The spectrum analyzer is also well suited to making accurate transmitter FM deviation measurements. This is accomplished using the *Bessel null* method, which is a mathematical function that describes the relationship between spectral lines in frequency modulation. The Bessel null technique is highly accurate; it forms the basis for modulation monitor calibration. The concept behind the Bessel null method is to drive the carrier spectral line to zero by changing the modulating frequency. When the carrier amplitude is zero, the modulation index is given by a Bessel function. Deviation may be calculated by using the following equation:

$$(\text{delta})\ F_c = MI * F_m$$

where:

(delta) F_c = deviation frequency
MI = modulation index
F_m = modulating frequency

The carrier frequency "disappears" at the Bessel null point, with all power remaining in the FM sidebands.

A tracking generator may be used in conjunction with the spectrum analyzer to check the dynamic response of frequency-sensitive devices, such as transmitter isolators, cavities, ring combiners, duplexers and antenna systems. A tracking generator is a frequency source that is locked in step with the spectrum analyzer horizontal trace rate. The resulting display shows the relationship of the ampli-

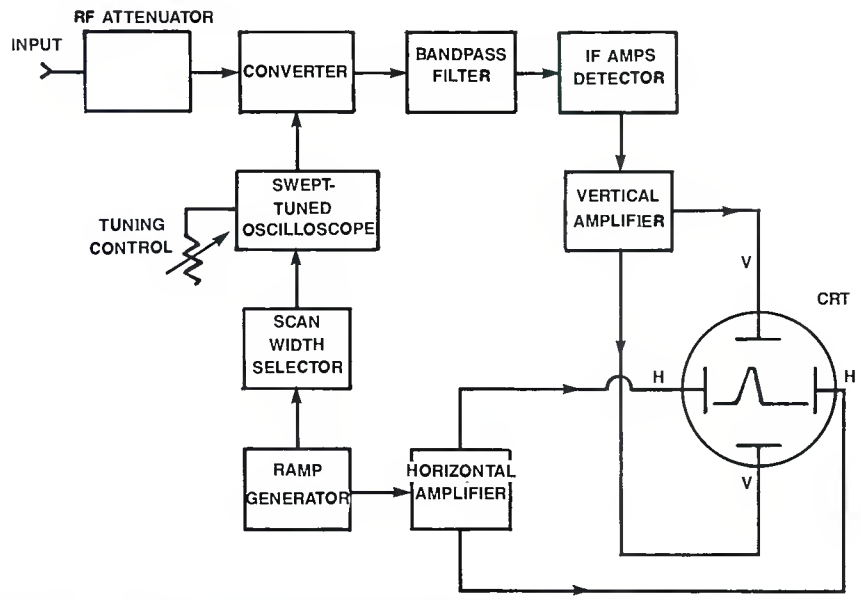

Figure 1. *Block diagram of a spectrum analyzer. (From Kinley, Harold. "Using Service Monitor/Spectrum Analyzer Combos."* Mobile Radio Technology *magazine, Intertec Publishing, Overland Park, KS, July 1987.)*

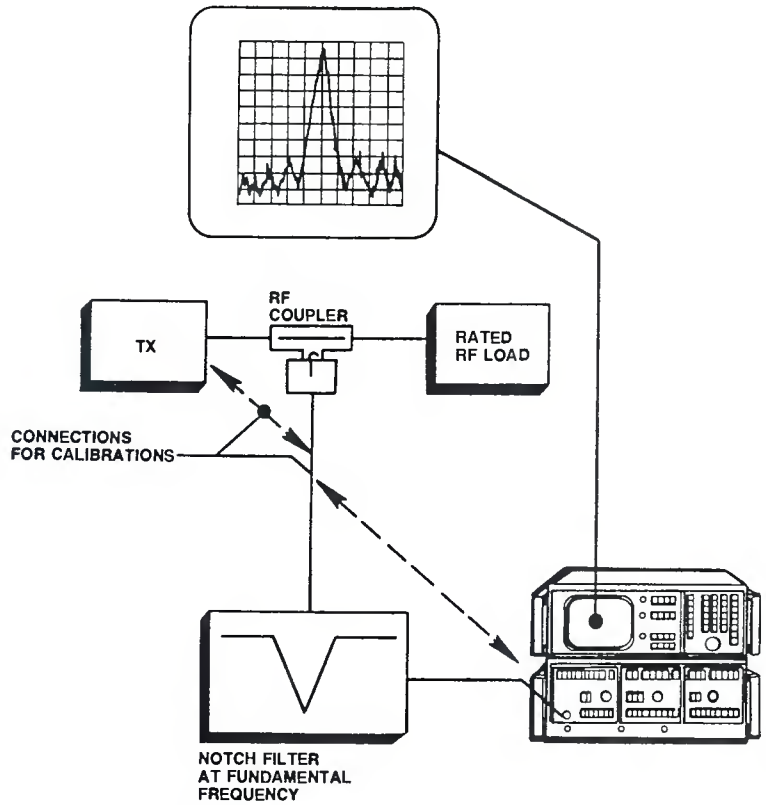

Figure 3. *Typical test setup for measuring the harmonic and spurious outputs of a transmitter. The notch filter is used to remove the fundamental frequency to prevent overdriving the spectrum analyzer input. (From: Pepple, Carl. "How to Use a Spectrum Analyzer at the Cell Site."* Cellular Business *magazine, Intertec Publishing, Overland Park, KS, March 1989.)*

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tude vs. frequency response of the device under test. The spectrum analyzer may also be used to perform gain-stage measurements. The combination of a spectrum analyzer and a tracking generator makes filter passband measurements possible. As measurements are made along the IF chain of a receiver, the filter passbands become increasingly narrow. (See Figure 4.)

Network analyzer

Antenna and transmission line performance measurements are among the most neglected and least understood parameters at most transmission facilities. Many facilities do not have the equipment to perform useful measurements. Experience is essential, because much of the knowledge obtained from such measurements is derived by interpreting the raw data. In general, the transmission system's measurements should be made:

- Before and during installation of the antenna and transmission line. Excluding unforeseen operational problems, this will be the only time that the antenna is at ground level. Ready access to the antenna allows a variety of key measurements to be performed without climbing the tower.
- During system troubleshooting when attempting to locate a problem. Following installation, these measurements usually

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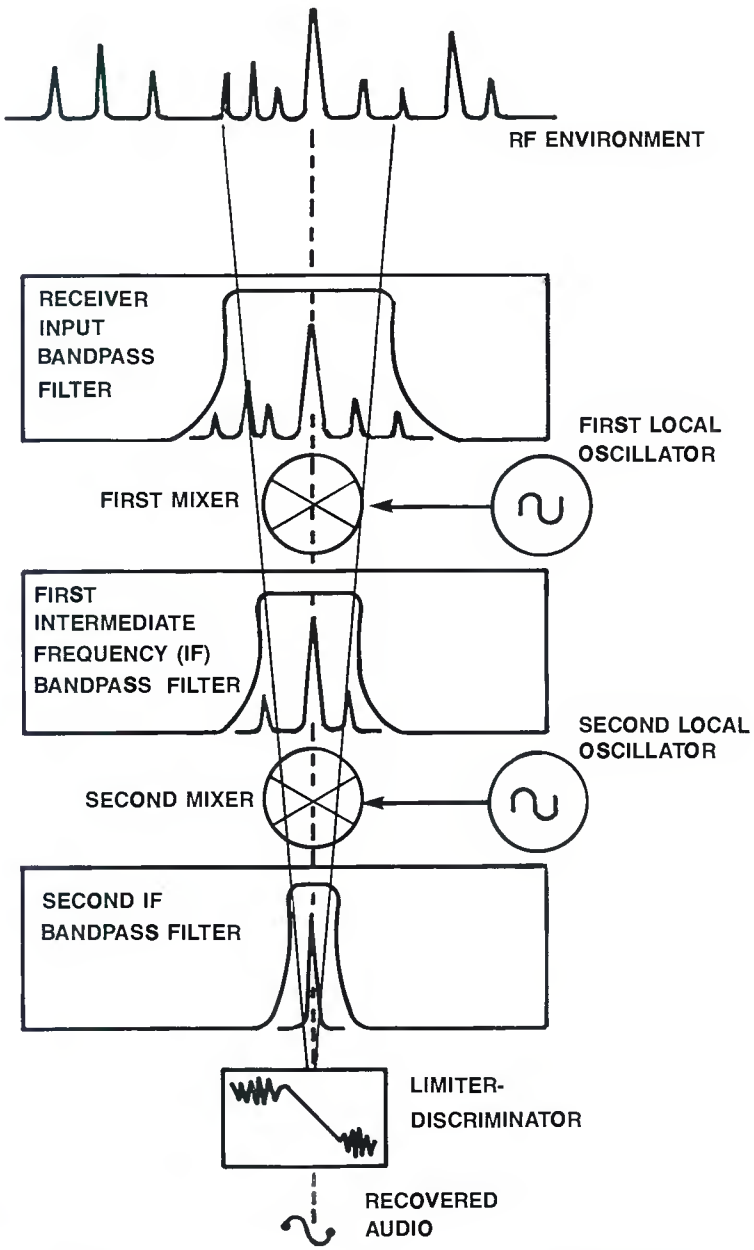

Figure 4. *Using a spectrum analyzer to measure the tunnel effect of bandpass filters in a receiver. (From: Pepple, Carl. "How to Use a Spectrum Analyzer at the Cell Site."* Cellular Business *magazine, Intertec Publishing, Overland Park, KS, March 1989.)*

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concern the transmission line.

- To ensure that the transmission line is operating normally. Many stations check the transmission line and antenna system on a regular basis. A quick sweep of the line with a network analyzer and a time-domain reflectometer (TDR) may disclose developing problems before they can cause a transmission line failure.

Ideally, the measurements should be used to confirm a good impedance match, which can be interpreted as minimum VSWR or maximum *return loss*. Return loss is related to the level of signal that is returned to the input connector after the signal has been applied to the transmission line and reflected from the load. A line perfectly matched to the load would transfer all energy to the load. No energy would be returned, resulting in an infinite return loss or an ideal VSWR of 1:1. The benefits of matching the transmission line system for minimum VSWR include:

- Most efficient power transfer from the transmitter to the antenna system.
- Best performance with regard to overall bandwidth.
- Improved transmitter stability with tuning following accepted procedures more closely.
- Minimum transmitted signal distortions.

The network analyzer allows the maintenance engineer to perform a number of critical measurements in a short period of time. The result is an antenna system that is tuned as close as practical for uniform impedance across the operating band-

Continued on page 42

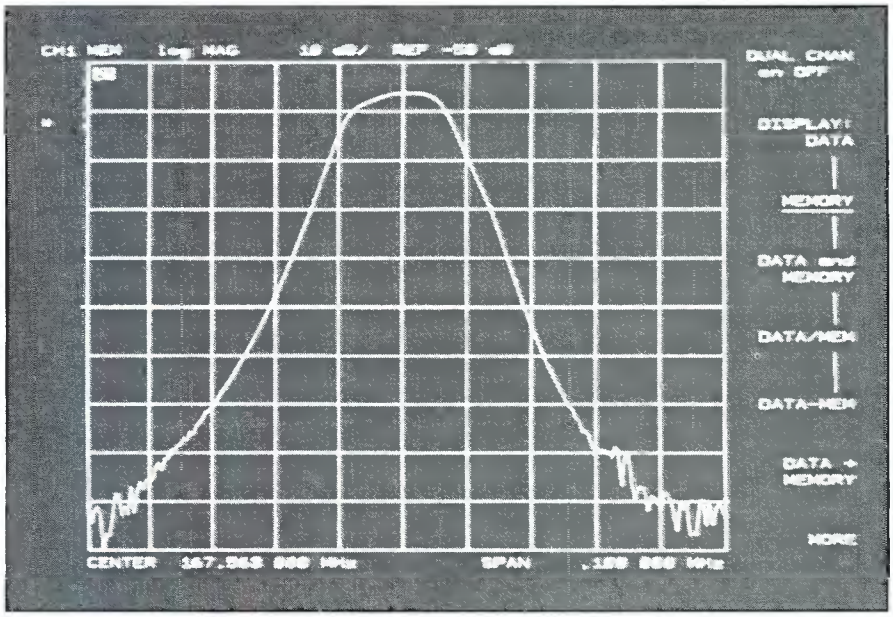

Figure 5. Conventional Cartesian display of swept frequency vs. signal level on a network analyzer. (Courtesy of Hewlett-Packard.)

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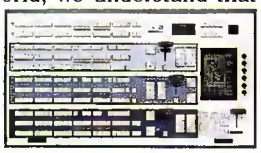

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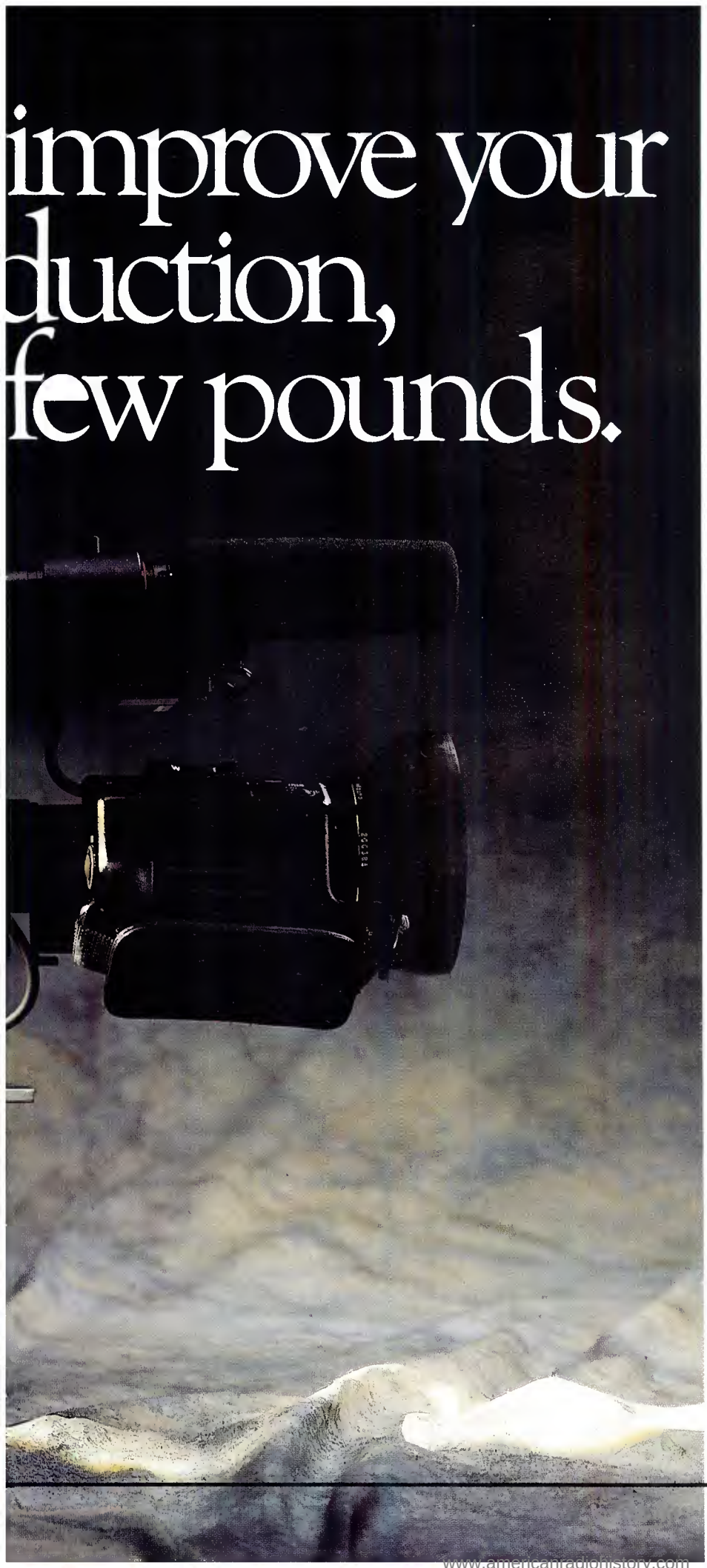

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Continued from page 38

width. A well-matched system increases operating efficiency by properly coupling the signal from the transmitter to the antenna. Figure 5 shows a typical Cartesian display of antenna system performance.

Measuring VSWR

Historically, a *slotted line* device was used to measure VSWR on a transmission line. A slotted line includes a probe that penetrates the outer conductor of the line through a slot. The probe, in close proximity with the inner conductor, measures the voltage or samples the field along the center conductor. The sample is detected, which results in a voltage proportional to the actual signal on the center conductor. It is an accurate, reliable instrument. However, the slotted line procedure takes a considerable amount of time to accurately sweep a transmission line over a wide bandwidth, and then to plot the resulting data.

A network analyzer incorporating a return loss bridge performs antenna measurements more quickly. The analog network analyzer consists of a sweep generator coupled to a tracking receiver. A sample of the signal applied to the transmission line is compared to the return signal through a return loss bridge or directional coupler. By adding a storage or *normalizer* device to store the signal digitally, the instrument can provide a stable display while sweeping the line at low speed to find all irregularities that may exist at discrete frequencies.

Digital designs do not use a sweep generator. Instead, they use an integral synthesizer. In this way, the return loss is measured at discrete frequencies. Software-calibration procedures correct each measurement for system frequency and phase-response errors, delay irregularities, and directivity errors in the return-loss bridge or directional coupler. By calibrating a software-controlled unit at the top of the transmission line, measurements will accurately show antenna characteristics without effects of the transmission line. Results are plotted on an X–Y plotter or defined and stored for later print-out.

One particularly desirable feature of a network analyzer is its capability to display either a Smith chart or a more simple Cartesian X–Y presentation of return loss vs. frequency. (Some units may provide both displays simultaneously.) The Smith chart is useful, but interpretation can be confusing. The Cartesian presentation is usually easier to interpret, but technically it is not better.

Calibration

Calibration methods vary for different instruments. For one method, a short circuit is placed across the network analyzer terminals, producing a return loss of zero (the short reflects all signals applied to it). The instrument is then checked with a known termination. This step often causes the inexperienced technician to go astray. The termination should have known characteristics and full documentation. It is acceptable procedure to check the equipment by examining more than one termination, where the operator knows the characteristics of the devices used. Significant changes from the known characteristics suggest that additional checks should be performed. After the test unit is operating correctly, check to ensure that the adapters and connectors to be used in the measurement do not introduce errors of their own. An accepted practice for this involves the use of a piece of transmission line of known quality. A 20-foot section of line should sufficiently separate the input and output connectors. The results of any adjustment at either end will be noticeable on the analyzer. Also, the length allows adjustments to be made fairly easily. The section of line used should include tuning stubs or tuners to permit the connectors to be matched to the line across the operating channel.

The station's dummy load must next be matched to the transmission line. Do not assume that the dummy load is an appropriate termination by itself, or a station reference. The primary function of a dummy load is to dissipate power in a manner that allows easy measurement. It is neither a calibration standard nor a reference. Experience proves it is necessary to match dummy and transmission line sections to maintain a good reference. The load is matched by looking into the transmission line at the patch panel (or other appropriate point). Measurements are then taken at locations progressively closer to the transmitter, until the last measurement is made at the output connection of the transmitter. After the dummy load is checked, it serves as a termination.

Antenna measurements

An antenna should be properly tuned before it is placed on the line. Any minor tuning adjustments to the antenna should be made at its base, not by compensation at the input to the transmission line. Impedance adjustments are typically made with tuning rings on the center conductor or with an impedance-matching section. Adjustments are performed while observing the return loss on the network analyzer. Transmission line rings are less convenient, but less expensive than an impedance-matching section. The rings can be used for matching short runs or the overall line between the transmitting equipment and antenna. Either tuning method may be used at the antenna.

Both tuning systems operate by introducing a discontinuity into the transmission line. The ring effectively changes the diameter of the center conductor, causing an impedance change at that point on the line. This introduces a reflection into the line, the magnitude of which is a function of the size of the ring. The phase of the reflection is a function of the location of the ring along the length of the center conductor.

Installing the ring is usually a cut-and-dry process. It may be necessary to open, adjust, close and test the line several times. However, after a few cuts, the effect of the ring will become apparent. It is not uncommon to need more than one ring on a given piece of transmission line for a good match over the required bandwidth. When a match is obtained, the ring normally is soldered into place.

Impedance-matching hardware also is available for use with waveguide. A piece of material is placed into the waveguide and its location is adjusted to create the desired mismatch. For any type of line, the goal is to create a mismatch equal in magnitude, but opposite in phase, to the existing undesirable mismatch. The result is a minimum mismatch and minimum VSWR.

A tuner alters the line characteristic impedance at a given point by changing the distance between the center and outer conductors by effectively moving the outer conductor. In reality, it increases the capacity between the center and outer conductors to produce a change in the impedance, and to introduce a reflection at that point.

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2. Kinley, Harold. "Using Service Monitor/Spectrum Analyzer Combos." *Mobile Radio Technology* magazine, Intertec Publishing, Overland Park, KS, July 1987.

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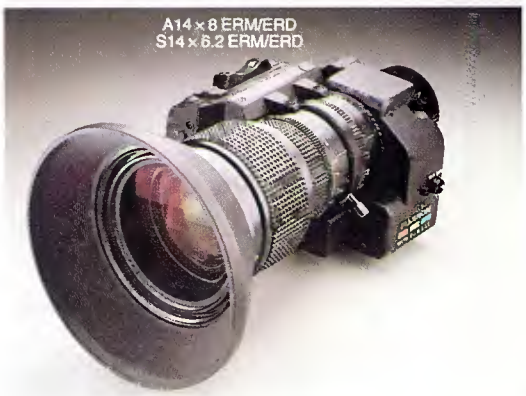

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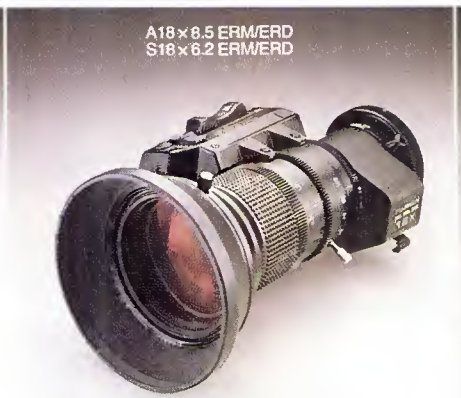

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Trouble-shooting digital systems

By Jerry Whitaker,
associate publisher

Repair of microprocessor-based hardware requires a different approach to maintenance.

Troubleshooting computer hardware is not as difficult as most technicians might think. With the proper technical documentation, a well-built system should not present significant repair problems. Virtually all computer systems conduct a power-on self-test (POST) routine when power is applied. This routine checks the operational condition of each major component of the computer, and initializes system controllers. The initialization and self-test functions of the POST process are tightly interwoven. Functions can be divided into two basic categories:

1. Checking and initializing central system hardware. A failure during this process may result in a fatal error that will prevent the system from booting. The error may be identified either by a message on the CRT or by a series of beeps from the internal speaker (if the monitor cannot be initialized). If the system detects a fatal error, the ROM monitor will place the processor into a hard loop with the error code in a specified register and all interrupts disabled. The effect is a processor halt without going into a true halt state. Under this condition, no further checks will be made on the motherboard.
2. Checking and initializing peripheral hardware on the I/O expansion bus. A failure during this process usually does not result in a fatal error, unless a defective expansion printed wiring board (PWB) holds a data or address line high or low. The booting process can also be halted by an interrupt or DMA request signal from a peripheral device that will not clear when the *acknowledge* signal is transmitted by the CPU.

POST routine

Central hardware is checked first during the POST. The system then tests peripheral devices. The POST routine varies from one type of system to another. However, computers built with a particular type of microprocessor tend to initialize the same. A typical POST routine for a 80286-based IBM-compatible AT-type system is shown in Table 1. (IBM is a registered trademark of International Business Machines.) A number of checks are made to confirm the operational status of each device or subsystem of the computer. Common routines include the following:

- *CPU test*. Data retention of all internal general purpose registers is confirmed. Processor flags and conditional jumps are checked for functionality.
- *ROM checksum*. All bytes of the ROM are added to produce one 8-bit sum. The

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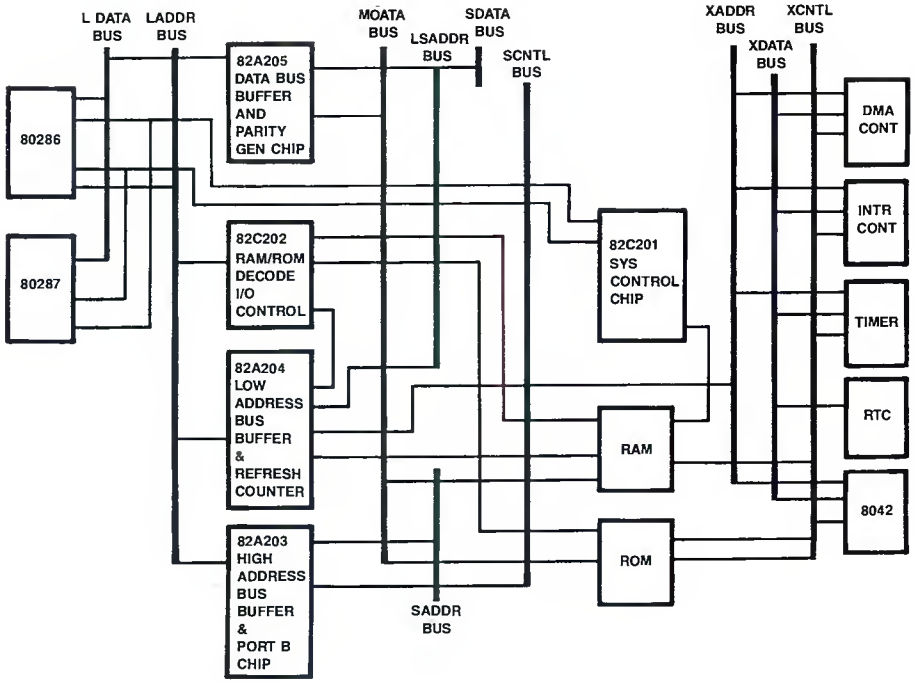

Figure 1. *Block diagram of an AT-class personal computer based on a chip set design. (Courtesy of Chips and Technologies.)*

result of the summation should always be zero. During summation, overflow carries are ignored. This process is repeated for each ROM device.

- *Parallel peripheral interface* (PPI). The PPI is initialized to operate as three output ports. Each port is written with unique data patterns, and the data is verified for accuracy. As a final check, the opposite data pattern is written and verified.
- *Programmable timer.* The timer is initialized as a down counter. An initial value is programmed into the device and the processor waits for the counter to go to zero. The processor then reinitializes the counter and waits for it to count up to a given value.
- *DMA.* The direct memory access controller register bank is checked by first writing a value for each port, and then writing the opposite data pattern. Verification is performed after each write. After completion of the test, the DMA controller is configured for dynamic RAM refresh.
- *DRAM.* All devices are cleared to zeros at power-up. A value is written into the memory banks and the read-out to confirm proper data retention. A value of op-

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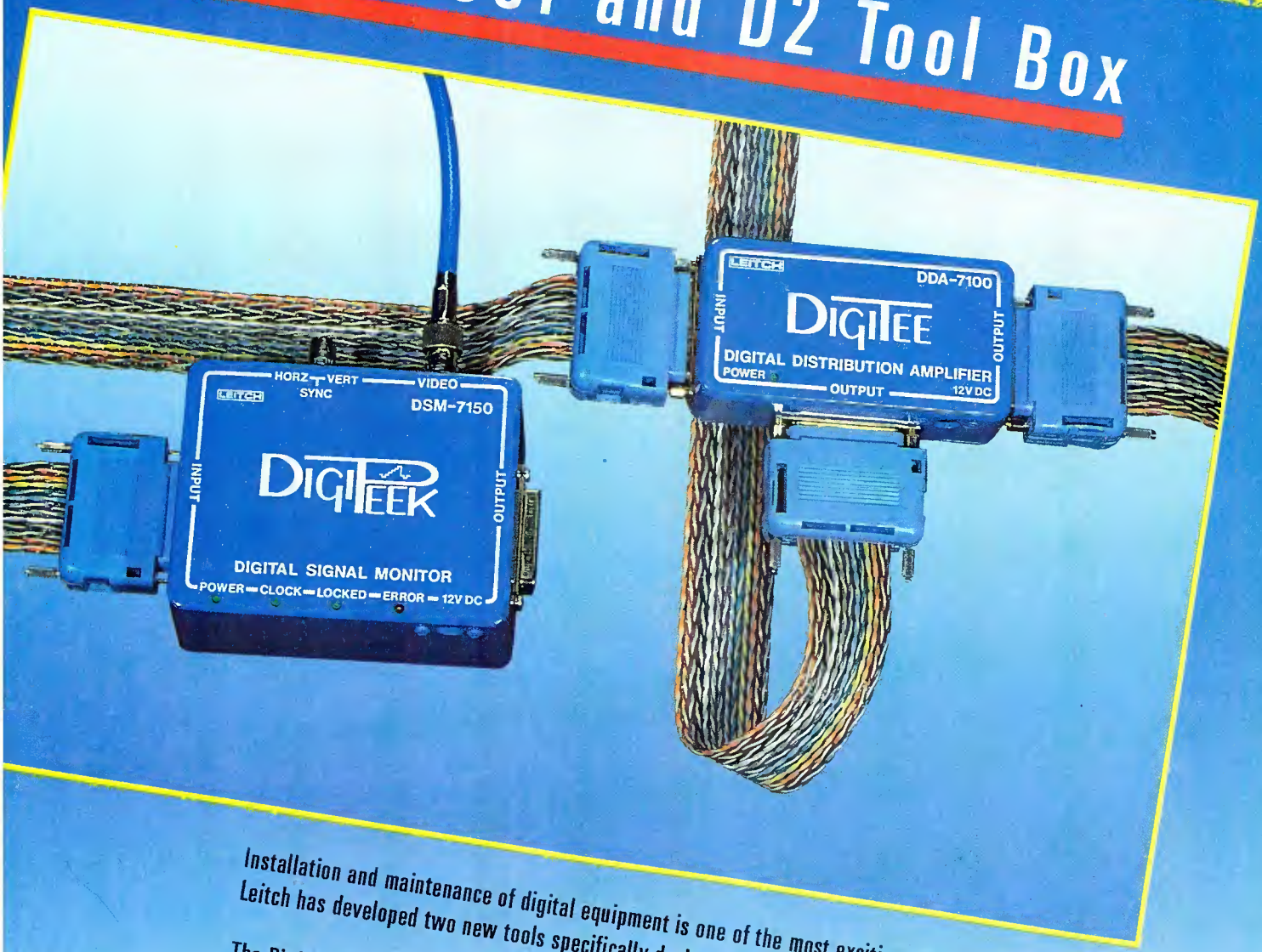

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posite bit patterns is then written, and data retention confirmed. During the early POST stages, only the first 3kb of DRAM is checked. If the lower 3kb passes, the processor proceeds to check the remaining DRAM. All memory is cleared to zeros upon completion of the test.

- *Interrupt controller.* The interrupt mask port is checked for data retention by writing two opposite data patterns and verifying the results. A temporary interrupt vector is then established and interrupts are masked-off. The processor then waits for a given interval to check for spurious interrupts.
- *CRT monitor.* A video reset command is sent to the monitor controller card, which initializes the PWB. A video RAM test of the screen and attribute memory is then performed.
- *Math co-processor.* Commands are issued to read and write the entire register set from system RAM. All registers and bit patterns are tested.
- *Serial interface.* Opposite data patterns are written to the serial interface controller (SIC), and proper data retention is confirmed.
- *Parallel interface.* The operational status of all bidirectional lines are checked.
- *Floppy disk controller (FDC).* The FDC

PRIMARY HARDWARE TESTS

- Central processing unit
- Memory mapper
- Configuration control register
- ROM BIOS checksum
- CMOS RAM
- Peripheral interface
- Programmable interrupt timer (PIT)
- Direct memory access (DMA) controller
- Memory refresh logic
- Base 64kb system RAM
- CRT monitor
- Protected-mode memory size
- Integrity of address lines A16 to A23
- Programmable interrupt timer (PIT)
- Memory cache controller

SECONDARY HARDWARE TESTS

- CMOS RAM configuration data
- RAM memory above 64kb
- Math co-processor (if present)
- Keyboard status
- Floppy disk drive status
- Hard disk drive status
- Serial interface
- Parallel interface
- Other expansion bus devices
- Error class check

Table 1. *Typical power-on self-test routine for a personal computer system.*

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registers are checked for data retention and addressability by writing opposite data patterns to the control registers and verifying proper data retention.

Error messages are usually displayed on the monitor. Technical documentation for the system usually contains an explanation of the error messages. If the monitor cannot be initialized, a series of beeps may be heard. When a failure is encountered, first check the on-board configuration jumpers and the CMOS RAM configuration data. Both must agree for proper operation. The CMOS configuration routine is usually resident in ROM. A battery-backed CMOS RAM chip is used to store the current configuration. Failure of the battery will result in error messages at POST. Table 2 shows a typical CMOS configuration display.

In addition to POST-related tests, some computer system ROMs include a series of diagnostic routines that can be invoked to check the operational status of individual pieces of hardware. ROM-based diagnostics are preferred to disk-based routines because an operational floppy disk is not required to check the motherboard. Table 3 lists the diagnostic routines available in one design. Diagnostic programs that permit examination of status registers provide the maintenance technician with valuable troubleshooting data. The technical service manual for a given system should provide the port addresses for all major registers.

System/CPU board

VLSI technology has significantly simplified the design of a computer system. Chip sets of four to six devices are used to replace much of the small-scale integration (SSI) devices found in earlier systems. A representative design based on the CS8220 chip set (*Chips and Technologies*) is shown in Figure 1. Major elements of the system include:

- CPU chip (80286). Manages operation of the entire system and performs mathematical calculations as needed.
- Math co-processor chip (80287). Performs high-level math as required. The co-processor responds to a unique instruction set.
- System controller/clock generator VLSI device (82C201). Generates most of the clock and control signals required for the system; handles decoding and timing of all bus cycles.
- Memory and I/O decoder VLSI device (82C202). Manages chip control signals for RAM, ROM and a portion of the I/O hardware; manages real time clock and keyboard controller chips.
- Bus buffer VLSI devices (82C203, 204 and 205). Provides address latching and

Continued on page 52

ROM BIOS V4.01

Current time is 20:22:13
Current date is 08-23-1990
First floppy drive is 1.2Mb
Second floppy drive is 360kb
First hard drive is type 8
Second hard drive is type 8
Primary display is monographics
Enhanced keyboard is installed
Conventional memory size is 640kb
Extended memory size is 1Mb
Number of parallel ports is 2
Number of serial ports is 2

Table 2. *CMOS configuration data for an AT-class personal computer.*

DIAGNOSTIC ROUTINES

1.	System Tests:	
	A.	8259 interrupt controller
	B.	8254 timer
	C.	ROM checksum
	D.	8042 programmable peripheral interface
	E.	80287 co-processor
	F.	Sound test
2.	Memory Tests:	
	A.	Conventional memory (up to 640kb)
	B.	Extended memory (above 1Mb)
	C.	Display memory map
3.	Floppy Disk Tests:	
	A.	Format [drive] [type]
	B.	Read [drive] [type]
	C.	Read/write [drive] [type]
	D.	Random read [drive] [type]
	E.	Random read/write [drive] [type]
4.	Fixed Disk Tests:	
	A.	Controller diagnostic test [drive] [type]
	B.	Read last cylinder [drive] [type]
	C.	Read/write last cylinder [drive] [type]
5.	Keyboard Tests:	
	A.	Reset/status return
	B.	Check key positions
	C.	Interactive key test
6.	Video Display Tests:	
	A.	Check alignment
	B.	Character set
	C.	Character attributes
7.	ROM Monitor Tests:	
	A.	Boot system
	B.	Display current configuration
	C.	Display contents of I/O port [hex value]
	D.	Dump contents of register [address/range]
	E.	Go to specified address [address]
	F.	Move data from one location to another [address] [address]
	G.	Update CMOS RAM configuration

Table 3. *Test routines available in a common ROM-based diagnostic monitor. (Adapted from data contained in: Technical Staff.* "Technical Reference ITT XTRA-286 ATW (TM) Business Computer." *ITT Information Systems, San Jose, CA, 1986.)*

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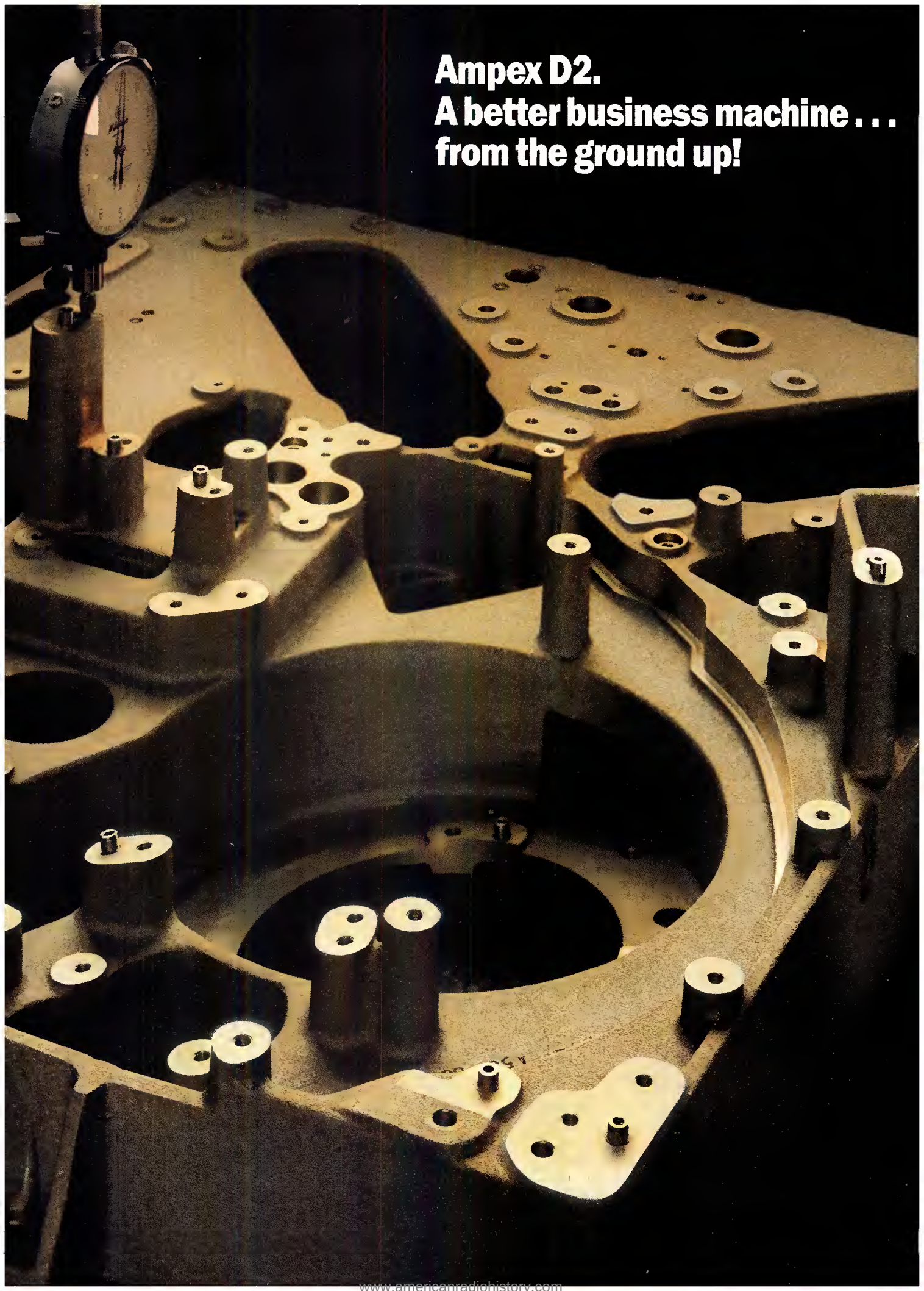

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control buffering for internal, peripheral and I/O hardware.
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The system motherboard includes three major buses that carry data, address and control signals. They include:

1. CPU bus (LDATA and LADDR).
2. Memory and I/O bus expansion (MDATA and LSADDR, SDATA, SADDR and SCNTL).
3. Peripheral bus (XADDR, XDATA and XCNTL).

Any troubleshooting job is made easier by fully documenting a working system. By understanding how the system is supposed to work, repair is simplified. Document the status of the expansion bus pins in a specified mode, such as just after a successful boot. Compare this data with the unit under test (UUT). Many computer failures can be diagnosed simply by checking the status of the expansion bus.

The first step in the troubleshooting process is to narrow the scope of the work at hand. Before proceeding to troubleshoot the motherboard, confirm that all voltages from the power supply are within acceptable limits. Remove PWBs from the expansion bus one at a time to confirm that a problem really exists on the motherboard. In the case of some boards, such as the video driver, a substitute PWB will be needed.

Never rush into replacing a device on the motherboard. Carefully identify the potential cause and effect of a failure. Proper testing of an SSI device is usually possible with a logic probe. Testing of a VLSI device is usually practical only through substitution. Eliminate socket-mounted devices first as the possible cause of a failure; do not unsolder a device unless absolutely necessary.

Catastrophic failures

A catastrophic failure will prevent the system from booting. Check the expansion bus for proper signal status. Confirm that all data and address lines are pulsed. Investigate any lines that are stuck high or low. Failures on the expansion bus are commonly the result of ESD-induced damage to line drivers or receivers, or accidental shorting of card edge connectors while power is applied. Either condition can result in an address or data line that is stuck low. Such a fault will usually prevent the computer from booting. If a line is found to be stuck low (which is usually the case), remove power and take resistance measurements on the lines involved. Values of 1.5kΩ to ground (or more) are common for a properly operating system.

Line drivers and receivers (transceivers) are usually the first suspects when a bus failure is detected. Transceivers serve to isolate the CPU and other elements of the microprocessor kernel from the outside world. More often than not, failures are the result of an external influence under the control of the user.

If a bus test reveals that multiple address and/or data lines are stuck high or low, check the address and data lines at the CPU. If the CPU is found to be malfunctioning, carefully check the socket for proper contact with the device. A VLSI socket is delicate and may be damaged easily. Repair of a damaged socket is usually not possible; replacement may be the only solution.

As noted previously, certain failures will cause the CPU to shut down, preventing data line tracing. In this event, try remov-

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ing one of the ROM chips from its socket and then reapplying power. Removal of the ROM will prevent the POST routine from being executed, and prevent a programmed system shutdown when a catastrophic failure is detected. If the data and address lines return to a pulsed state, additional troubleshooting will be possible.

Check the master reset bus. Monitor the status of the bus with a logic probe when power is applied. It should hold a given logic level for a brief period after power is applied, and then switch to the alternate state. If a digital storage oscilloscope is available, store the reset waveform and examine it for glitches. The power supply may provide a "power OK" signal to the motherboard. If so, this signal is required for proper system initialization. Confirm the presence of the "power OK" signal.

Non-catastrophic failures

The occurrence of a non-catastrophic failure will impair operation of the system, but it will not prevent booting. Failures are usually associated with devices outside the kernel. Common problems include interrupt, DMA and RAM parity errors. Troubleshooting non-catastrophic failures is aided by the fact that most of the computer is operating. ROM-based or disk-based diagnostic routines may be used to troubleshoot the system.

Clock circuits. A problem in the clock generator can cause intermittent or catastrophic failure of a system. Confirm that the clock is running at the correct frequency. Use a frequency counter or the frequency function of a waveform analyzer. Check the peak-to-peak amplitude of the clock output. A low-amplitude signal may cause the microprocessor to miss some of the clock pulses. Low output may also

Continued on page 58

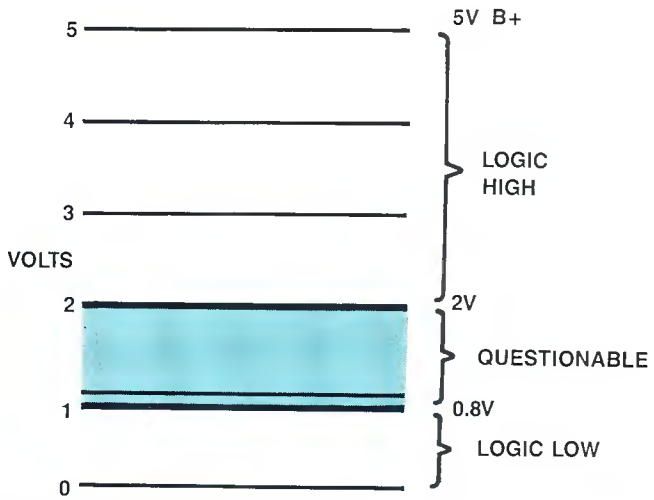
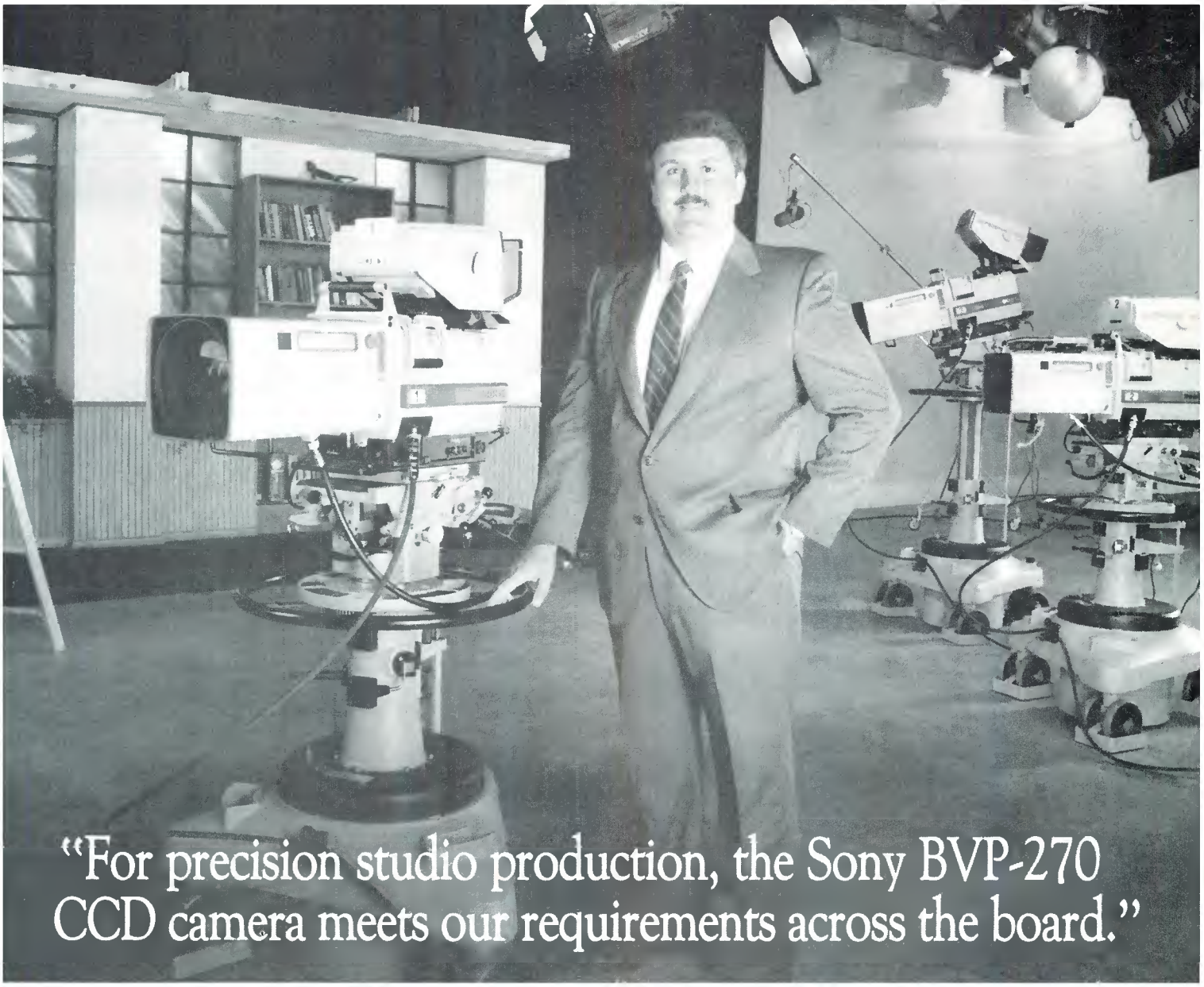


Figure 2. *Logic level tolerance envelope for TTL-based systems. (From: Carey, Gregory D. "Isolating Microprocessor-Related Problems."* Electronic Servicing and Technology *magazine, Intertec Publishing, Overland Park, KS, June 1988.)*



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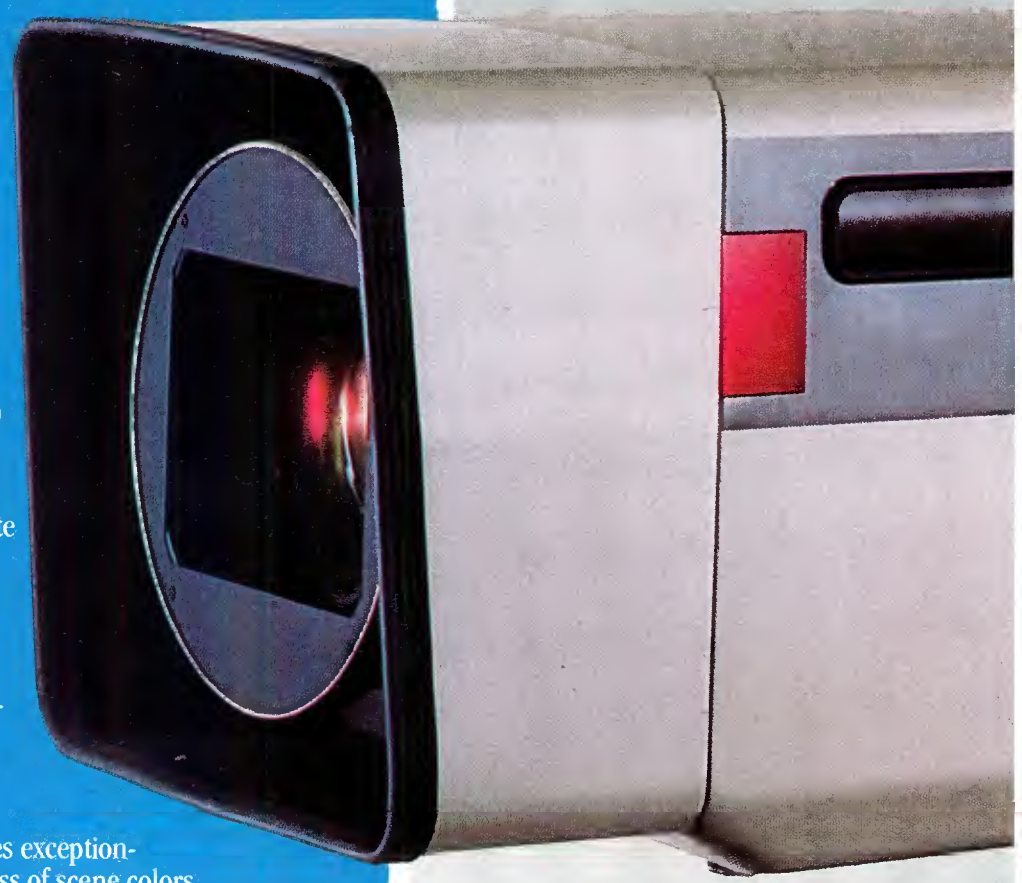

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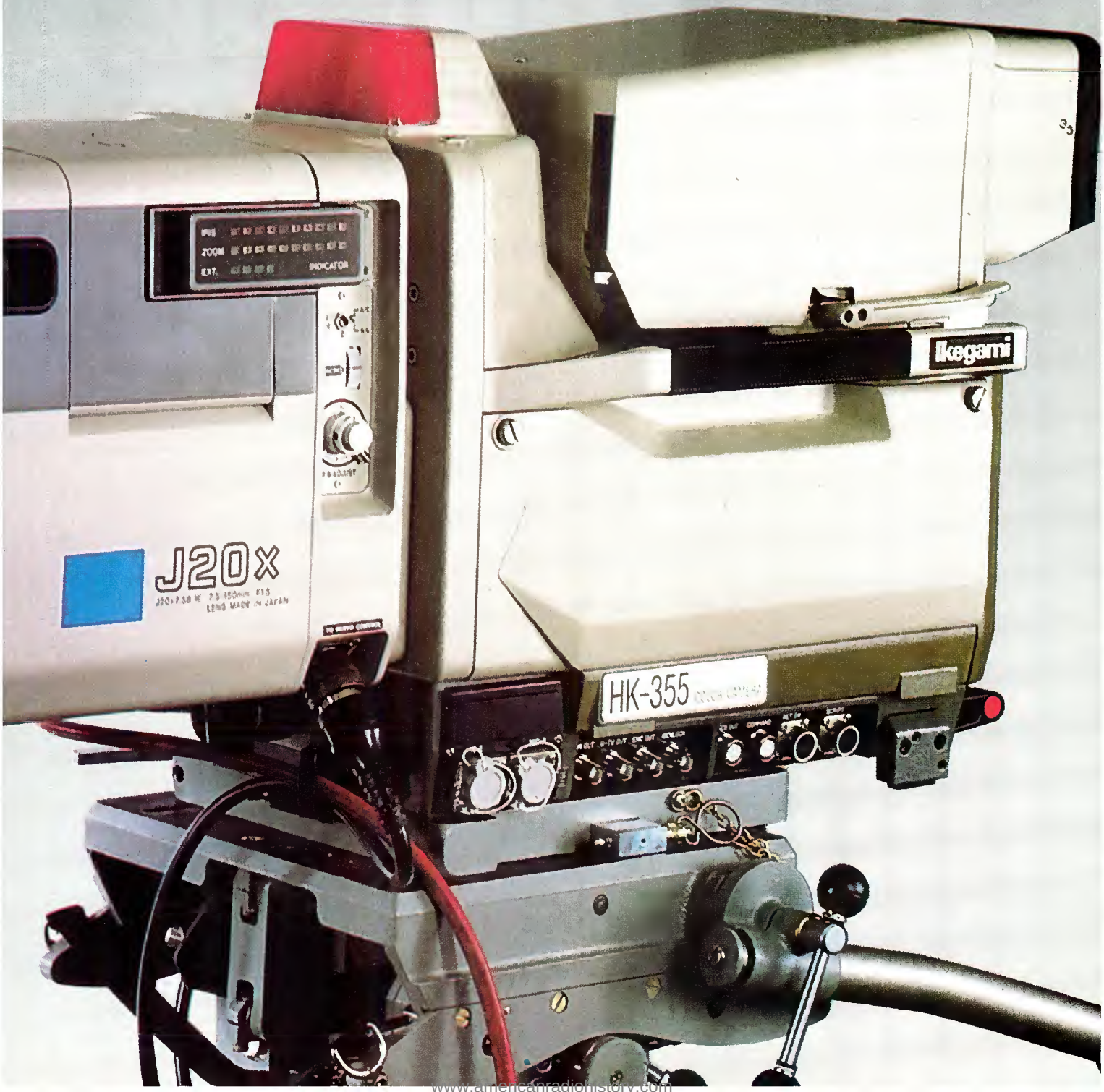
HK-355 Studio Chip

eye on the future."

–George Wensel, V.P. Operations, NEP



Continued from page 54

cause the system to run slow overall (even though the clock is operating at the proper frequency), or result in erratic operation (some devices may trigger on the low-amplitude clock signals, while others do not). Figure 2 shows the usual logic level tolerances for TTL devices. Examine the clock pulse train on an oscilloscope. Look for poorly formed pulses or glitches on the waveform.

Peripheral interface problems. The failure of a peripheral interface circuit is usually the result of ESD-induced damage or shorting of one or more output pins. Hardware typically involved includes parallel, serial, display and keyboard ports. Incorrect cabling during system setup can result in a short circuit that will render the hardware interface inoperative. Depending on the nature of the failure, the POST routine may detect the problem. Use a logic probe to check the output status of the inoperative port. Look for stuck data or control lines. A failed line driver or receiver is often at the root of the problem.

Memory problems. Most memory-related failures on a motherboard are identified by parity error messages. Never defeat parity error detection. ROM-based or disk-based diagnostic routines are available to identify individual defective DRAMs. The failure of an entire bank of devices could point to a shorted address or data pin on one chip, a driver failure, or a short or open circuit on the PWB. Failure of the entire DRAM memory block can be caused by the failure of the refresh circuitry, which may be generated by a timer/counter chip separate from the memory block.

Emulative test instrument

Emulative testers are among the most effective troubleshooting tools for microprocessor-based circuitry. An emulative tester emulates the function of a key component of the microprocessor kernel — either the microprocessor itself, the ROM chip(s) or DMA controller(s). Emulative testers work in much the same fashion as the components they emulate, sending out read and write commands to various parts of the circuit. Such instruments, therefore, offer the advantage of testing a board from the inside out. This approach is more effective than backdriving the circuitry from the edge in because it allows every component on the board to be exercised. Emulative testers also permit the board to run in its native environment during the test process, which allows both static and time-dependent faults to be detected.

Like the DMA controller, a DMA emulator borrows clock cycles from the microprocessor while it performs internal operations. The instrument uses these intervals to perform data read and write functions. The instrument test harness typically clips over the microprocessor to gain access to the needed signals. DMA emulators do not require a circuit design that supports DMA operations. In most cases, DMA functions can be simulated for the purposes of troubleshooting analysis.

Most emulative instruments contain a number of standard test procedures that significantly simplify the troubleshooting process. Although tests differ from one unit to another, they generally fall into the following categories: bus tests, memory tests and input/output tests.

In order for an emulative test instrument to function properly, the following conditions must be met:

- The power supply of the UUT must be functioning properly. The emulative tester receives power from the UUT.
- The clock of the UUT must be function-

Continued on page 131

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Circle (38) on Reply Card

Maintaining a classic tower site

By Steve Walker

A dozen towers dot the Dallas array.

It was another hot day in Texas in the summer of 1969. The engineering staff at KLIF-AM, Dallas, and a utility tower crew were putting the finishing touches on one of the largest AM directional arrays in the country — two parallel rows of six towers each. It must have been quite a surprise when one of the workers looked up and saw an airplane on its final approach, descending on the brand-new array.

Big-time coverage

Broadcasting at 1,190kHz, KLIF installed the 12-tower array in Rockwall, TX, so that the station could operate at a nighttime power of 5kW. The dramatic array was needed to protect other stations. According to Norm Phillips, corporate chief of Susquehanna Broadcasting, which now owns KLIF and its sister station, KPLX-FM, the pattern looks like "a big zeppelin blimp with fish tails." The tight pattern primarily protects WOWO-AM in Fort Wayne, IN.

Figure 1 shows the KLIF installation as it looked from above in the summer of 1969. The array is about a ½-mile long, and the two rows of towers are approximately 200 feet apart. Note the resemblance of the tower site to a single-runway rural airport.

Dave Hultsman was chief engineer when the array was constructed. At that time, the rules and regulations required meter readings every 30 minutes. However, because the array was so long, there was no way to read all 12 base currents and be back in time to read the meters on the transmitter. To enable the engineering staff to take the meter readings, the station built a road between the towers with a turnaround at each end. A Jeep was purchased so that engineers could drive from tower to tower.

The towers sit on a hill. The uneven ground and the length of the array created a problem: the bases of the outer towers would be much lower than those of the inner towers. To avoid the expense of flattening out the whole area to solve the problem, the crew dug holes for the inside towers and used the dirt to build mounds for the outer towers, making all the foundations at the same level.

The 12-tower array of Dallas' KLIF-AM

Walker is operations manager, Broadcast Automation, Dallas.

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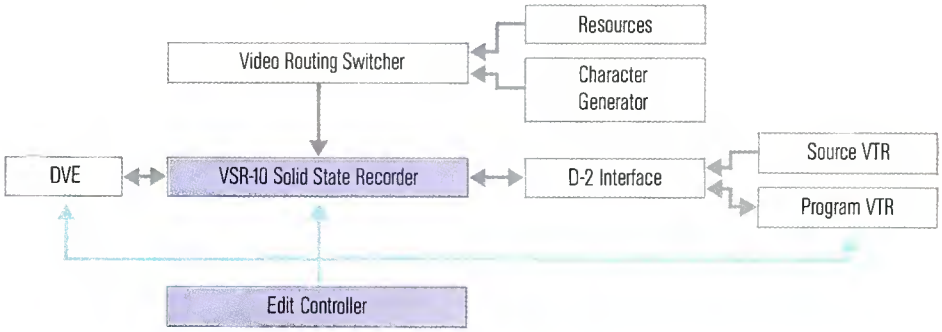

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Circle (39) on Reply Card

NEC

An array of challenges

The array has presented engineers with a few problems over its lifetime. At first, it was not stable. Later, when weeds began to grow on the mounds, the vegetation affected the tuning of the towers. The engineers began to joke that they didn't just mow the grass, but "tuned" the weeds. They found out, however, that the vegetation around the towers was necessary. Once, when they killed it, the soil on the mounds started eroding because there was nothing to hold it in place.

Also, the original sampling coils used unjacketed line. Because the most distant towers were so much farther away than the nearest, there was a lot of line coiled up underground. Combined with the alkaline soil on the hill, it created a huge battery.

The array is about a ½-mile long, and the two rows of towers are approximately 200 feet apart.

By rebuilding the phasers and doing some fine-tuning, the array was stabilized. It has not been necessary to make major adjustments in more than four years.

Don't land here!

It's not much of an airport, however. That's what a student pilot from Oklahoma found out on that hot summer day. Students training at the nearby Rockwall flight school were not allowed to venture far from the airport on their training flights. Indeed, the student wasn't far from the airport, but his sense of direction was way out of line. When the workers heard a plane going over, they didn't think much about it. But suddenly, they heard the pilot cut back his engines.

One of the workers was Bill Walker. A flier himself, Walker feared that the plane was going to either land or crash. A couple of his co-workers started jumping up and down, hoping their acrobatics would signal the approaching pilot that the towers were not the airport. It must have worked, because the student realized his mistake, gave it the throttle and sailed away toward the real airport, which was several miles to the north.

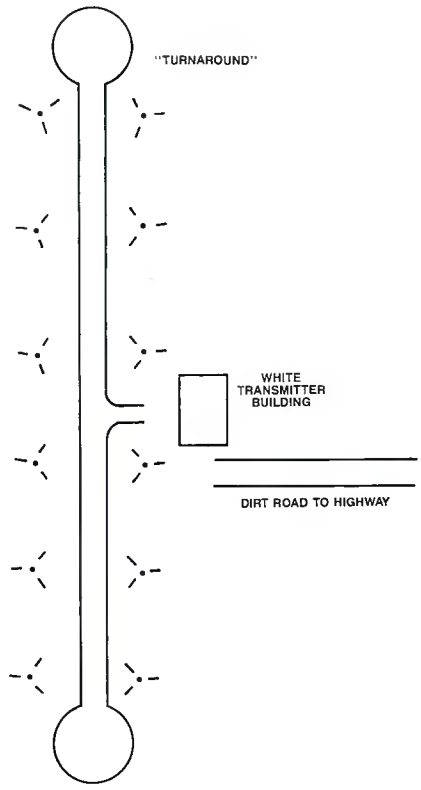
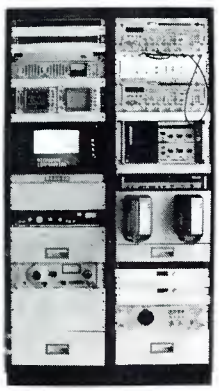


Figure 1. *The KLIF array as it appeared in the summer of 1969.*

You can rely on a Microdyne satellite link to deliver your program. Anytime. Anyplace.

One-stop source for all of your satellite communications needs. From a turnkey uplink to a fully automatic downlink. Microdyne has the experience and technical expertise to provide a system tailored to your exact requirements.

Turnkey uplink eliminates buyer's risk. Microdyne's system approach starts with an evaluation of the desired goals. The units required to achieve that goal, with the stated confidence level, are then matched to an antenna for system testing. The final phase includes installation, verification, and on-site training. Microdyne uplinks are currently being used at major networks and local stations throughout the nation.



Uplinks can provide 100% redundancy for all signal processing equipment, video and audio monitors, plus a full complement of test instrumentation.

cast quality receiver, and a programmable system controller. The terminal will automatically switch to any channel, from any satellite, at the desired time. It may also be used to activate other units.

"Microdyne quality, backed with a service plan, eliminated my worries on link availability."

MAT™ units may be easily preprogrammed to hundreds of channels.

Extended term warranties, up to five years, are available for all Microdyne systems. Or, select a custom tailored service plan to insure that your system will always be operating at peak performance.

Nationwide service network provides fast response. Microdyne maintains an extensive spare parts inventory to minimize downtime on non-redundant units. In most cases, replacement boards are on-site in less than 24 hours.

Fully automatic downlink never misses a broadcast. Microdyne's Automated Terminal (MAT™) consists of a motorized antenna, a broad-

Put our satellite experience to work for you. Microdyne has been in from the beginning. This experience assures cost-effective solutions without compromising operating performance or system reliability. ***For additional information, just give us a call at (800) 441-9084.***

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Circle (41) on Reply Card

Naturally, everyone was quite relieved. The last pieces of the final tower were being hoisted into place and soon it would be time to begin the long process of testing and tuning the large array. The episode of the near catastrophe was over, or so they thought. A couple of days later, an unfamiliar car drove up the road to the transmitter site. Inside were the student pilot and an official from the Federal Aviation Administration. The FAA ordered KLIF-AM to paint huge black Xs at each end of its "runway."

According to Rick Neace, who became chief engineer of the station after Hultsman, the order was not really practical. Nighttime was when the array really looked like an airport, but the Xs could not be seen in the dark. Besides, Neace said, the tower markers are red, which means "Don't land here."

The big, black Xs are gone now, and the paved road is history. But the 12 towers still stand like sentries in formation, protecting WOWO-AM and 1,190kHz stations in Phoenix and Portland, OR.

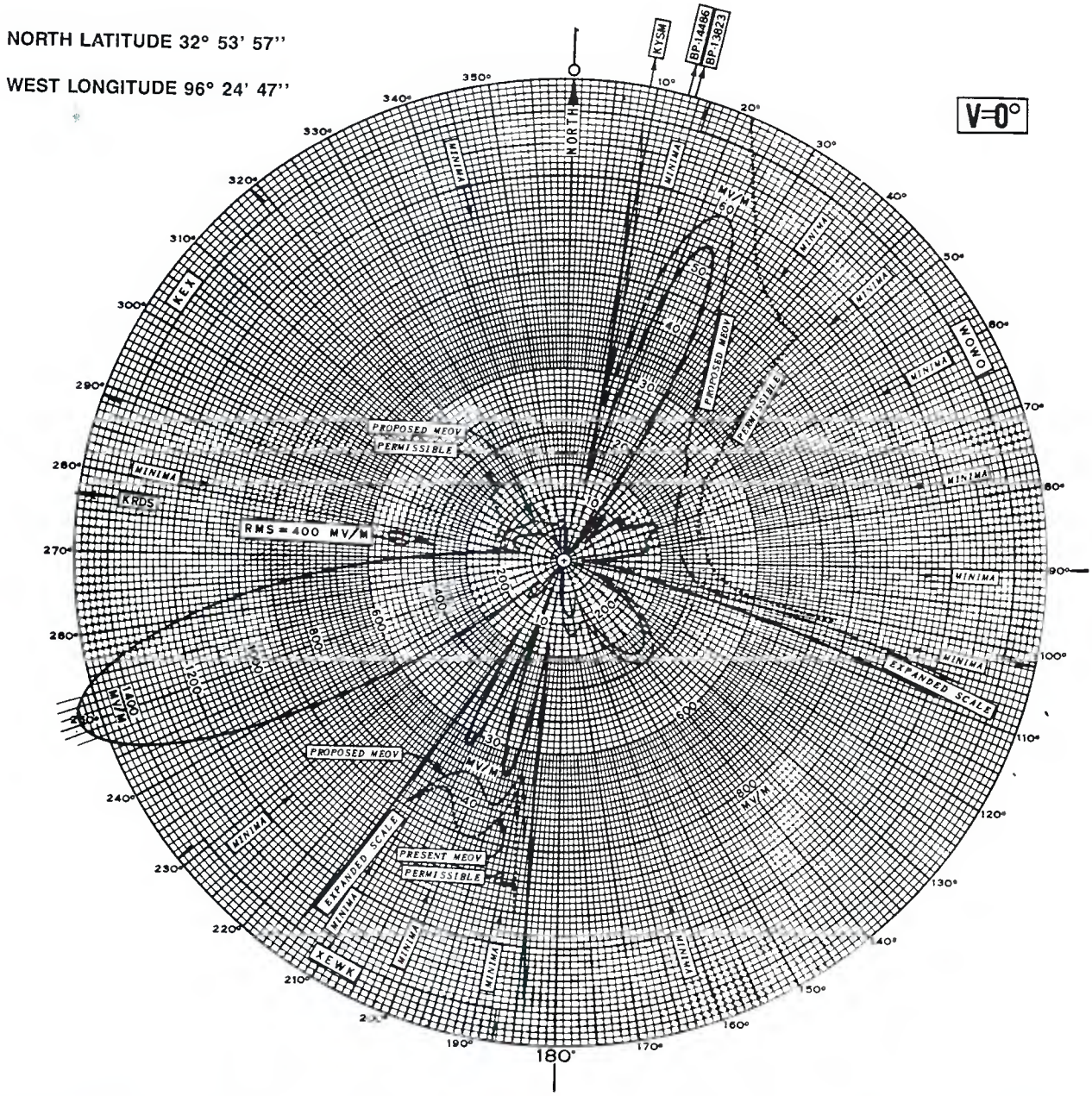
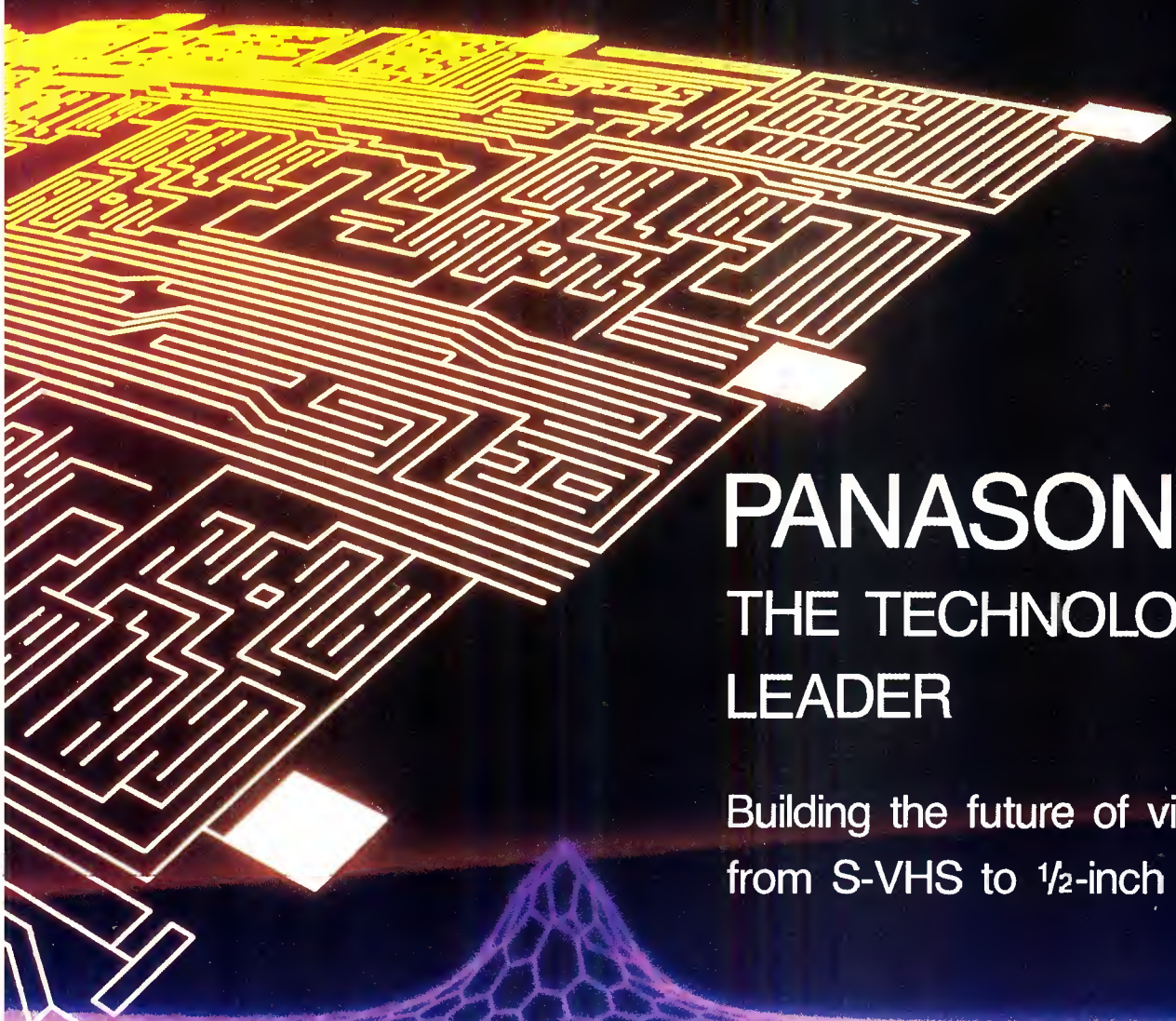


Figure 2. *Proposed nighttime pattern of station KLIF, Dallas (July 1967). (Courtesy of Cohen, Dippel and Everist, consulting engineers, Washington, D.C.)*

BROADCAST engineering
SPECIAL ADVERTISING SUPPLEMENT



PANASONIC:
THE TECHNOLOGY LEADER

Building the future of video
from S-VHS to ½-inch digital

PANASONIC:
Building the future of video

½-inch tape technology: A product for every application

Video technology is moving at a lightning-fast pace. New technology has brought a bewildering array of new products loaded with new features. At the same time, economic pressures are forcing video professionals to budget purchases more carefully than ever before. In this environment, end-users must maximize their return on any investment in equipment. Only one company today offers both affordable technology and a planned, orderly progression of videotape formats. That company is Panasonic.

The Panasonic story is really the story of ½-inch videotape. Matsushita Electric pioneered VHS tape during the 1970s. It applied the experience gained with consumer products to develop MII, the premier ½-inch broadcast analog component format. Recognizing the growing need for an inexpensive acquisition and production format, Matsushita developed the S-VHS Pro Series. With an eye toward the future of broadcast and post-production, the company then developed the digital ½-inch composite format.

The common thread that weaves through each of these key product developments is ½-inch tape. From acquisition through on-air spot playback, Panasonic is there.

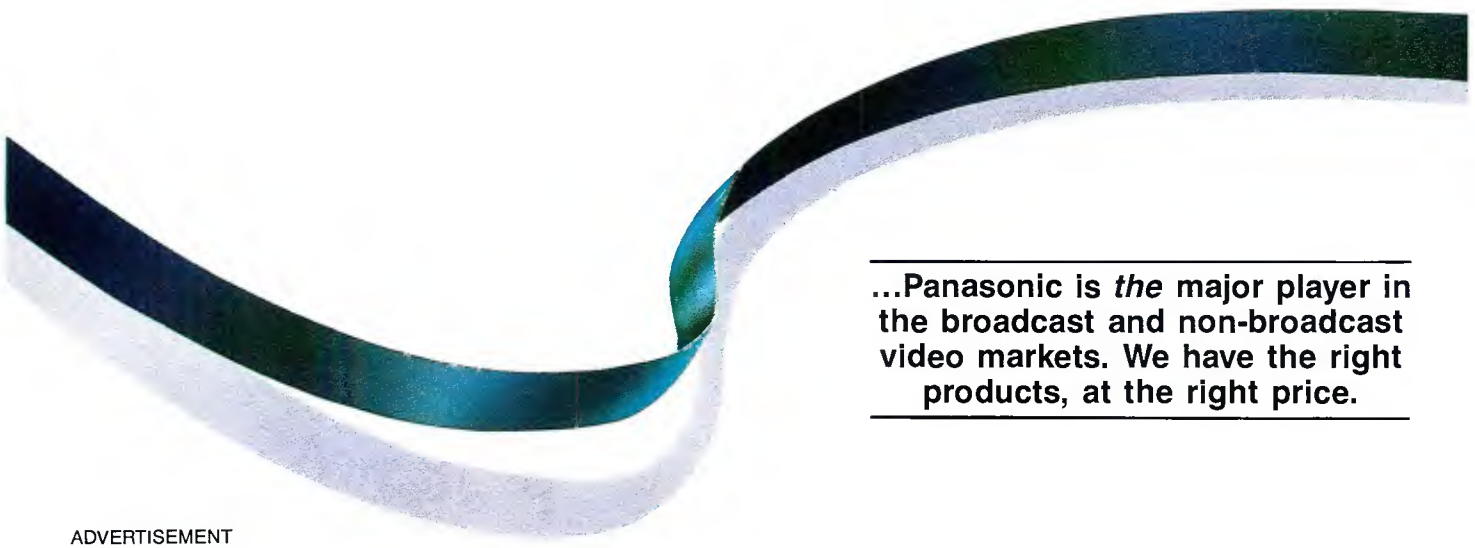
Bold moves for a bold company

Panasonic, from its position as the leader in tape technology, is planning bold new moves into new markets. Armed with new product lines, a beefed-up direct sales force, topnotch service and the best dealer network in the industry, Panasonic is proud to unveil a refined operating structure designed to better serve its customers.

Camera and tape recorder products up and down the line now have full interconnectability, not only from the signal point of view, but also from the control standpoint. The Panasonic ½-inch story can be summarized in a simple equation: S3, M9, D100.

- S3 = S-VHS, which provides good picture quality to at least three generations.
- M9 = MII, good to at least nine generations.
- D100 = the digital ½-inch format, good to 100 generations.

The progression from S-VHS to MII to digital ½-inch is logical. It makes sense from the technical standpoint. It makes sense at the bottom line. Selection of a



...Panasonic is *the* major player in the broadcast and non-broadcast video markets. We have the right products, at the right price.

PANASONIC:

Setting the pace

Steve Yuhas
Senior Vice President

The professional video marketplace has undergone significant changes within the past few years. Budgets are tight everywhere. Yet, customers still are committed to producing the highest-quality video and audio possible.

The Panasonic story, our story, evolved from a blank slate. We did not have to deal with the status quo. We were able to take a fresh, clean approach. Our product line today is unmatched in the industry for cost and performance. It stretches from low-cost S-VHS camcorders for event videographers to full-featured digital recording systems for the most demanding network or post-production facility.

I am proud to say that Panasonic is *the* major player in the broadcast and non-broadcast video markets. We have the right products, at the right price.

The changing video industry

Cost pressures today are forcing customers to look closely at the bottom line. Business does not support top quality at any price. Features are important. Quality is important. But so is price. This trend, coupled with the fact that technology is getting better, has led to increased interest in S-VHS for a number of applications, including large group stations and networks. For operations requiring multigeneration editing capabilities, Panasonic offers the MII product line. For still more demanding applications, we offer the D-X digital recorder.

What separates Panasonic from competitors is our planned, step-by-step approach to the natural progression of videotape recording. All of our equipment is built around ½-inch tape technology. We know how it works. We know how to optimize it for the last decibel of performance. We make more ½-inch tape machines than anyone in the world. When it comes to tape recording, we know what we're talking about.

Advances in design and manufacturing techniques have produced machines that are far superior to their predecessors. As an example of this momentum, the story in acquisition today is S-VHS for an increasing number of customers. Panasonic has introduced an entirely new line of full-featured S-VHS decks. The machines include built-in time base correction, digital noise reduction and RS-422 serial control.

Panasonic also has introduced an entirely new MII product line. It offers the same features and same quality, but the units are priced at about one-half of their previous cost. Economies in the manufacturing process have made it possible to pack more power into a recorder for less money. We are passing those savings on to our customers.

The new MII product line is, in fact, priced at less than most ¾-inch equipment. That puts MII into an entirely different market. We are opening up a new avenue for customers who want full analog component quality, but until now could not afford it. That is a strong story.

Dealing with customers

To properly address the changes taking place in the broadcast and professional video markets, Panasonic has just completed a restructuring of customer sales and support. The purpose of the changes is to better serve the end-user. The reorganization represents a shift from a product-based structure to a customer-based structure. The changes evolved out of the basic facts of the marketplace, namely that "broadcast" products, such as MII and related gear, are used and needed in non-broadcast operations as well. Furthermore, because of the improving quality of "industrial" products, broadcasters are buying S-VHS equipment for certain applications.

To properly serve the important area of broadcast and high-end post-production, we have doubled the size of the Panasonic Broadcast Systems Company sales and service organizations. At the same time, the company recognized that we should not limit the direct sales force to selling only the broadcast product line. Therefore, the PBSC direct sales force also will be handling S-VHS products, including cameras and peripheral devices.

On the other side of the coin, we have a topnotch dealer organization that has been in place for many years selling to the industrial user. In recognition of these converging markets, we decided to also offer broadcast products through our dealer organization to the broader industrial marketplace, which is not so easily identified.

The bottom line is that we have refocused our marketing approach based on the reality of what the market itself is doing. After all, serving the customer is what it's all about.

given format simply depends on what the customer requires.

A number of broadcast stations are using the S-VHS Pro Series as an acquisition/production format for news, where the number of generations is limited. S-VHS also is finding some use in post-production as a cost-effective format. To meet the demands of users for high-quality products, a new series of S-VHS pro recorders and editors has been developed. Plus, a new series of cost-effective MII products now is available to put MII quality within reach of a whole new group of customers.

Panasonic's philosophy regarding recording formats is simple: Develop a basic technology that works, and refine it to meet the needs of a variety of markets. It makes no sense to reinvent the wheel. The company utilizes ½-inch technology all the way from the consumer market to the top of the broadcast market. A step-by-step progression has been established to meet the needs of customers at any level, from VHS to digital ½-inch.

The use of proven technology provides a number of benefits, including faster response to market needs, greater reliability and more cost-effective production. There is no question that today's video market is price-sensitive. The economies of scale that a large consumer business can provide are significant. For the professional video user, those economies translate into more features for a lower price.

Although many types of products are necessary to make a production center operate, tape technology is clearly the driving force. The importance of a quality tape format, with a clear upgrade path, cannot be overemphasized.

A technology leader

Panasonic, the company that pioneered the concept of a unified broadcast format with its MII product line, is charting new ground in digital technology with the ½-inch digital composite format.

The Panasonic digital VTR was developed to overcome the picture degradation that plagues analog VTRs in editing and dubbing. Panasonic took the challenge of attempting high-density recording on ½-inch tape. The reasons were simple. First, as the ½-inch VTR grew in global popularity with ½-inch analog component formats, there was little logic in weighting down ENG/EFP operators with a large, 19mm cassette. Second, the camera/recorder already had become the equipment of choice in the field. For a digital format to reach its full potential, a digital camcorder was needed. It made little sense to take a step backward by splitting the camera/recorder into two separate boxes.

The solution was clear: Develop an entire single-format, digital VCR system, including camera/recorders, portable VCRs and studio VCRs. The following are among the benefits of ½-inch tape to the digital format:

- The cassette is pocket-sized and easy to handle.
- Ample recording time is available for editing, production and playback.
- The system is adaptable to combined camera/recorder operation.
- The system may be adapted easily into library cartridge systems.
- Major cost savings in equipment and tape are possible.

PANASONIC:

Building on a solid foundation of experience

Stan Basara

Stan Basara, President
Panasonic Broadcast Systems Company

The Panasonic Broadcast Systems Company was formed nearly five years ago with the introduction of the MII product line. We have been successful with MII. Following the lead of NBC-TV, a wide range of broadcast stations and post-production facilities have accepted the products. MII has, in fact, redefined format integration. It is now possible to use a single format from acquisition to on-air playback. The benefits of this logical approach to operating a facility have been demonstrated convincingly by NBC, probably the toughest customer in the world. Building on this foundation of experience and strength, Panasonic is pleased to announce an entirely new MII product line that will lead to exciting new opportunities for the broadcast division.

We recognize that broadcasters have a serious problem today with increased competition from cable, home VCRs and other sources of video entertainment. Broadcasters have found themselves in a position where cost efficiencies must be made. Some manufacturing companies might have viewed this trend as a sign of bad times to come. We saw it as an opportunity.

We worked closely with the Panasonic manufacturing facilities to develop a product that would give the broadcaster 1-inch quality at a ¾-inch price. When we introduced MII, the products were priced in the $30,000-$40,000 range. With our new low-cost MII gear, we are able to offer the same product-quality level in the range of $15,000 to $20,000.

We have cut our prices for the new MII line by about half. That is an exciting development for the many stations and production houses that wanted to upgrade to MII, but until now could not afford it.

Serving the customer

The new MII product line offers a number of new opportunities. To better serve the broadcast and high-end post-production marketplace, we have doubled the size of our direct sales force. Now, our customers will receiver greater attention, faster response and better service.

Furthermore, it was clear that as lower prices opened new markets for MII, our direct sales staff alone would not be able to do a complete task of addressing all the potential markets. The core market for MII always has been broadcast and post-production. Now, however, MII will find applications in a number of new markets, including corporate/industrial, educational, government, medical and cable. There is a whole world of video users in the corporate/industrial marketplace that currently use video for training, marketing and presentations. To properly serve all these diverse fields, we have decided to share product lines between the direct sales force and the existing PIV dealer network.

We see these new markets as a significant new opportunity for Panasonic Broadcast Systems Company. It gives us the increased product volume to do a more comprehensive job of serving our core market — broadcast and post-production. This is clearly a win-win situation.

For the broadcast customer, and really all end-users, the new arrangement provides the benefits of one-stop shopping. In the past, if call letter station chief engineers wanted to buy monitors or some S-VHS product, we had to send them to dealers. We no longer have to do that. Our customers now can purchase anything they want from the Panasonic video line through their local sales representatives.

It's one-stop shopping, and it's a big advantage to the customer.

A proven track record

Panasonic Broadcast Systems Company offers not only the right products at the right price, but also a proven service organization to back up those products. We recognize that broadcasters sell a fleeting commodity called *time*. If the product doesn't work, you can't go back and make up the time. There's no way to do that. We address the stringent requirements for reliability by having quality built into our products and standing behind them with a superb service organization. In fact, under the marketing realignment we have just completed, the size of our service organization has more than doubled. Our ability to service the broadcaster is our greatest strength.

I want to emphasize that Panasonic Broadcast Systems Company is serious about this business. We are in broadcasting to stay. We back our customers. We have leading edge technology, from MII to ½-inch composite digital, and we have it now.

The evolution of VTR formats is a story of increasingly higher recording density. A time-proven metal tape — the same tape that led the industry with the MII format — made it possible for Panasonic to add countless refinements to achieve more than twice the recording density of other digital formats. While maintaining a level of input/output performance equal to that of digital VTRs using 19mm tape, the new ½-inch format offers easier handling, easier operation and lower cost. And, the compact cassette can be incorporated into every step of production, from the field to the studio.

MII: A success story

More than 7,000 MII units have been placed into service around the world since the first delivery to NBC in 1986. The MII format has attracted the worldwide attention of video professionals as a format that succeeds in achieving both high picture quality and low operating cost. Its growing impact also is reflected in the large number of TV stations and post-production houses switching to MII. With 60 MII cart machines in use or on order at stations worldwide, MII rapidly is becoming a leading contender for the format of choice in automated broadcasting.

S-VHS: Improving on a winner

Three years have passed since Panasonic introduced S-VHS. The high-performance S-VHS format added higher picture quality to a world-recognized leading format for important applications ranging from training to point-of-purchase sales.

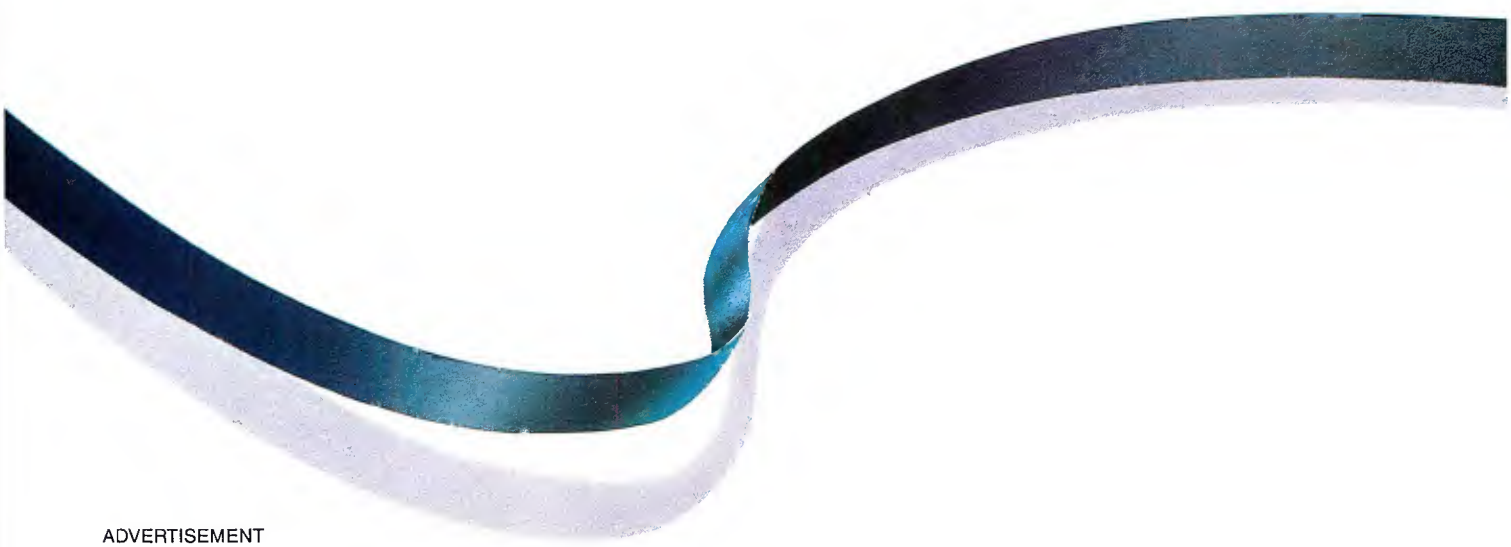
The VHS format has earned an enviable track record. More than 200 million units are in use around the world today. VHS also has a well-deserved reputation for unparalleled reliability. S-VHS incorporates the latest technology available to produce top-quality pictures. The outstanding performance of the S-VHS Pro Series, coupled with attractive prices, has opened the doors to thousands of new professional applications for video.

Taken together, the ½-inch digital composite format, MII and S-VHS make a formidable team. A team built around ½-inch tape. A team capable of meeting any professional requirement anywhere in the world.

Changing markets

The lines of distinction between broadcast and the corporate/industrial markets have diminished in recent years. The corporate user, more than ever before, is looking toward higher-quality product. The basic problem, however, is cost. In keeping with the philosophy of Panasonic, the company is offering a new line of cost-effective MII products that are not only of high quality, but also are within the price range of a whole new group of video professionals. New products from Panasonic are pulling new segments of the professional video marketplace up toward broadcast quality, at prices they can afford.

As non-broadcast users become more sophisticated, MII products will find new and varied applications. As the performance of S-VHS continues to improve, and the economic pressures facing broadcast stations mount, S-VHS will find increased applications in broadcasting. The two markets are blurring as a



The Service Story

PANASONIC:

Changing to meet the needs of its customers

Wint Ramsay, Assistant General Manager,
Technical Support Division

Technical support is a key element of the video business. The importance of customer support after the sale has been recognized by the Panasonic Audio/Video Systems Group for more than two decades. More than 120 technical professionals, located at the home office and in seven regional centers, support dealers and individual broadcast customers.

The unique needs of broadcasters are recognized with a high level of direct company support. Furthermore, a dedicated headquarters engineering staff acts as a window back to the factory for product refinements. The integration of the professional video organizations at Panasonic provides a number of benefits to end-users. It offers additional staffing and backup support for broadcast and post-production customers, and it provides corporate/industrial customers with additional highly experienced technical resources.

Service mission

The service mission of the Technical Support Division is clear: Meet the needs of customers, wherever they might be. For PIV customers, the primary mission is the support of the dealer network. For PBSC customers, the primary mission is to support end-users directly.

Training is an important part of this effort.

We recognize the importance of supporting our customers.

Classes are held regularly to keep dealers and technical support personnel up-to-date on the latest equipment in the field. We recognize that reliability is a *systems concern*. It begins with quality in product specification and design. It continues with the use of quality components and advanced manufacturing techniques. It extends to comprehensive training of technical service and sales personnel.

Video equipment users are a demanding group. They expect a high level of support. They get it from Panasonic.

Changing needs

The service needs of professional video customers have changed significantly within the past few years. New manufacturing techniques require a new approach to repair. It is estimated that within the next two years, fully 40% of all components on a typical printed circuit board will be surface-mounted. This presents special challenges to maintenance technicians, and Panasonic is responding to the need. The Technical Support Division, equipped with sophisticated test instruments and staffed with highly skilled technicians, is prepared to support every product in the field.

Video equipment users are a demanding group. They expect a high level of support. They get it from Panasonic.

Service, however, is only half of the reliability equation. To improve the quality of future products, we provide to the factory detailed analysis of any product problems observed by customers. Changes implemented as a result of field experience lead to greater reliability. Greater reliability translates into greater value.

Operating a large maintenance department represents a significant investment by Panasonic in its customers. The Technical Service Division logged more than 18,000 phone calls on the tech support hot line last year alone. Product turnaround is typically 24 to 48 hours for most professional products.

We recognize the importance of supporting our customers. When you buy from Panasonic, you buy more than just a box. You buy a company.

reflection of changes in the economy. This trend has led to the need to restructure the way Panasonic markets its products. In this day and age, it makes more sense to divide products by applications, rather than by types of facilities.

The organizational structure

Panasonic has been in the professional video business in the United States for more than two decades. It is in the video business to stay. When you deal with Panasonic, you deal with the 17th largest corporation in the world. Matsushita Electric, the parent company of Panasonic, is one of the largest total electronics manufacturers in the world. The company does about $45 billion in sales every year.

Panasonic employs more than 10,000 people in America. Three years ago, the company had six U.S. manufacturing facilities. Today, it has 12.

Matsushita manufactures an enormous range of professional, industrial and consumer products. The global structure of the company results in extensive feedback for the Matsushita Electric research organization, which is staffed by more than 20,000 engineers and commands an annual R&D budget of more than $2.1 billion. Broadcast and professional video users are the beneficiaries of this ongoing research.

When professional end-users in the United States think of Panasonic, they think of the Audio/Video Systems Group (A/VSG). This organization consists of a number of divisions. Principal among them are:

- Professional Industrial Video (PIV).
- Technical Support Division, which encompasses service, operations and product engineering.
- Industrial Camera Division.
- Closed Circuit Video Equipment Division (CCVED).
- Video Communications Division (VCD), which handles cable TV products.

The Panasonic Broadcast Systems Company (PBSC), organized nearly five years ago to market MII and related product lines, now has been expanded in size to better serve existing and potential customers. The service structure, critical to success in the broadcast market, also has been expanded and strengthened.

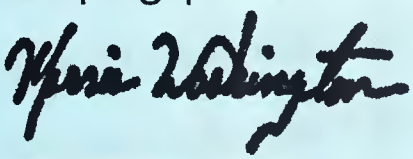
A just-completed refocusing of the Panasonic sales and marketing organization will permit PIV dealers to sell into the broadcast market, and broadcast direct sales personnel to sell PIV products, principally S-VHS hardware. This subtle, but significant, change is a reflection of the video market today. The unified marketing effort will lead to a greater number of product options for customers, as well as better service from direct sales personnel and dealers.

Panasonic recognizes that special expertise is required to service broadcast customers. TV stations have unique requirements that must be met. For that reason, PBSC continues to serve as a critical link to broadcasters. The organization will continue to service the top-end professional users through a commitment to more resources, enhancements in the existing product line, new cost-effective products and comprehensive technical support.

While Panasonic Broadcast Systems Company continues to operate as its own entity, a new engineering group has

The Sports and Medical Story

PANASONIC:
Keeping pace with video



Morris Washington, Manager
Special Markets Division

Vertical markets have taken on new importance at Panasonic. We have concentrated our efforts on key applications that require focused attention. The Sports and Medical Division is one such example. We now have established an organization that is geared specifically toward the needs of sports and medical customers.

As a part of this effort, we are expanding our support of existing dealers who are selling into those markets. Furthermore, we have brought specialists on board in the area of sports and medical video. We are listening to our customers. We are speaking their language.

The requirements of sports and medical video are different from most other applications. A product generalist simply will not do. The customer is sophisticated; the application is sophisticated. We want our customers to know that when you talk with a Panasonic representative, you are talking with an expert.

The dealer network is extremely important in this effort. There are dealers across the United States who sell only to the sports or medical markets. They are involved in the industry. They attend the coaches' conferences, high school and collegiate conferences, and various trade shows across the country. We have positioned ourselves so that we can support these specialized dealers, as well as the end-user, and take a lead role in selling.

This division also takes a lead role in listening. We measure the needs of the market regularly and provide input to our engineers regarding new product development.

The medical market

The medical video market is of keen interest to Panasonic. There are currently a number of companies around the United States that specialize in integrating videotape recording into medical diagnosis and monitoring equipment. Video plays an important role in documenting, for example, ultrasound and CAT-scan measurements. Our Sports and Medical Division is working with these specialists to provide the benefits of Panasonic video products to hospitals around the country.

Input from customers, and potential customers, is critical to success in the medical market. The specialized requirements of the medical environment demand that companies discuss in detail the requirements for a new system before it is built. In the medical business, "good enough" isn't good enough.

We are currently working with our factory to develop new products specifically tailored towards medical applications. That's our mission.

We are listening to our customers. We are speaking their language.

Putting the customer first

At Panasonic, we have an impressive array of available resources. We can draw on the expertise of other divisions within our organization to solve particular problems for our customers.

In terms of products, the Sports and Medical Division has the luxury of being able to sell any Panasonic video product, from a simple VHS VCR to a ½-inch composite digital system. The needs of the user dictate the type of equipment. For example, there is an application in which a doctor may use an MII VCR to document a microsurgery procedure. In the teaching environment, that MII tape would be edited to produce a finished program, then be duplicated onto S-VHS for distribution to other doctors.

Panasonic is in the unique position of being able to meet the needs of the user from VHS all the way to composite digital. And when high definition becomes practical, we will be there with products that customers want. It is all a part of listening to the end-user, determining what they want, and then developing products to meet their needs.

Service is an important component of the sports and medical video markets. We are able to respond quickly to any problems that may surface in the field. The needs of a hospital are no less demanding than those of a broadcast station. The equipment must work on cue. Our extensive service organization is available to back up end-users no matter where they may be located. Collectively, we have a lot of resources to draw upon, internally — within the division — and externally.

Professional video equipment today is application-driven. Users are sophisticated. They know what they want. Our greatest strength is that we deliver what they ask for.

been established. Specialized engineering functions have been integrated to increase efficiency and to provide faster response to customer needs. The organizational refinements include the establishment of four new sales divisions for the Panasonic Audio/Video Systems Group:

- The dealer sales division of PIV, which consists of more than 325 dealers, 10 regional managers and four zone managers, all working together in 34 sales districts.
- The PBSC sales division, which has been expanded to include a direct sales force of more than 40.
- The sports and medical sales division.
- The duplication sales division.

In addition, Panasonic has an 8-person government marketing organization, headquartered in Washington, DC, that focuses strictly on government-related business.

The Panasonic reorganization goes hand in hand with the increased sophistication of customers. Prices have declined to a point at which more users can afford better equipment. At the same time, increased quality and features have permitted hardware that is less expensive to meet the operational demands of increasingly sophisticated users. These trends have emerged to establish the framework of a market based on the needs of the customer.

An expanding service network

The 1987 establishment of Panasonic Broadcast Europe gave the company a European base to complement PBSC operations in the United States and Matsushita Electric's Audio and Video Systems Division in Japan.

With more than 13 sales companies across Europe, Panasonic now boasts more than 100 sales and manufacturing bases around the world. This expanding network gives Matsushita Electric the worldwide presence needed to offer the highest level of professional service in the industry.

Panasonic is building on 22 years of experience in the professional video marketplace. Its speciality is VCRs, cameras and monitors. When you talk about experience in video recording technology, Panasonic is without parallel.

Panasonic: The partner that listens

Even the most innovative product is of practical value only to the extent that it meets an actual need. That is why Panasonic listens to its customers. It responds to their needs for performance, productivity and bottom-line benefit.

The phenomenal growth of Panasonic can be attributed largely to one important talent: *listening*. The company listens to the requirements of not only the industry in general, but each and every user. Panasonic believes that every customer counts, from the largest TV network to the consumer who purchases a single VCR. The company listens to problems large and small and welcomes all forms of feedback.

Equally important is the dedicated after-sales support and reliable maintenance guaranteed by the many resources available to Panasonic's vast global service network. At Panasonic, a handshake signifies a pledge of dedicated long-term service and a commitment to customer satisfaction.

The Duplication Story

PANASONIC:

New dimensions for a new time

George T. Currie

George Currie, Manager
Duplication Sales Division

Because Panasonic recognizes the importance of the duplication market, we have set up a new marketing division dedicated to serving duplication customers. Under our new structure, we can view the total duplication business — not just the reproduction of tapes, but also from the standpoint of the filmmaker. We are focusing on how filmmakers go about producing programs, and how they would like to have them distributed. We carry our attention to the first-tier duplicators and their requirements in terms of equipment and services. We complete the distribution loop by considering the needs of distributors and end-users.

From the film producer to the consumer who rents a tape in the neighborhood video store, Panasonic is involved. We listen to our customers. We deliver what they want.

Because Panasonic handles a number of product lines, we are able to look at the "big picture" when it comes to any particular segment of professional video. When the entire combined market is considered, the interplay between each group can be seen. As a company, it gives us a much better idea of what types of products to produce, when to make them, and how many the market wants. This synergy has a significant beneficial spinoff to end-users. It means that we can be market-driven and respond more rapidly to changes in customer requirements.

Panasonic's greatest single advantage over our competitors is that we can take a look at the *total market*, not just a segment of it. From another point of view, this approach also allows us to bring to our users broadcast products that are suitable for the head-end duplication market. We are doing that now with MII. In the near future we will be offering ½-inch digital recording equipment as well for first-tier duplicators.

The duplication market is a component of the larger professional-to-consumer production and distribution medium. Panasonic has a wide variety of products to meet each application in each market.

Changing markets

The duplication world is becoming more specialized. Panasonic realizes that it must not only provide products for specialized applications, but also find ways to introduce existing broadcast and corporate/industrial products to duplicators where they make sense. The benefits of volume production apply just as much to the equipment business as they do to the tape-duplication business.

We recognize that in a vertical market such as tape duplication, it is important to sit down with customers and ask them what they need.

As a case-in-point, consider this recent example. We have just introduced to the market a new cassette duplication machine. Success of the new product has been phenomenal. We have about 90 percent market share. We have been successful because we did our homework before designing the machine.

Panasonic engineers visited the top duplicators and asked them what they needed. We took this information back to the factory and designed a machine specifically for the duplication market. It is about half the size of the standard-type machines in use, runs on half the power, includes all of the options and features required by duplicators, and is more rugged than its predecessors.

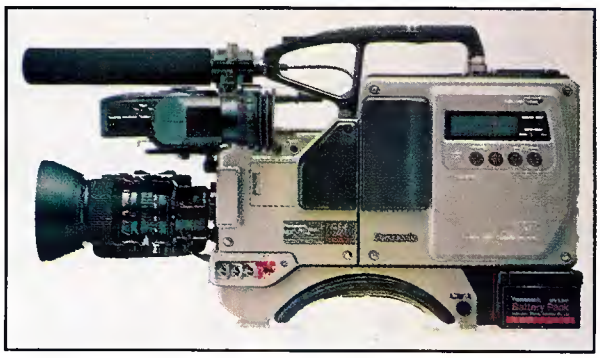
We have the specialized knowledge of what makes a duplication operation tick.

While we work closely with major duplication houses, we also are exploring new avenues for Panasonic products. Currently, we are looking at what can be done in terms of smaller businesses, such as corporations and government operations that need to do some in-house duplication. New products at the right price permit these potential customers to enjoy the quality associated with Panasonic products.

We have the specialized knowledge of what makes a duplication operation tick. We have a dedicated team of problem-solvers. Our customers recognize that, and they draw upon the experience we can provide.

New Products from Panasonic

Panasonic Professional Video: New products for new applications



WV-F250H Camera:

The WV-F250H color video camera combines a high-precision F1.4 prism with three frame interline transfer (FIT) CCDs having 380,000 picture elements each. Spatial picture element offset signal processing, coupled with a new prism assembly, enables the WV-F250H to provide horizontal resolution as high as 700 lines. The camera, based on three ½-inch CCDs in an RGB arrangement, offers 60dB S/N performance. A *peltier* cooling element on the blue CCD chip minimizes fixed-pattern noise. Features include:

• *Electronic shutter*. An advanced, variable-speed electronic shutter permits dramatic, high-speed action to be captured with complete clarity.
• *Electronic viewfinder*. A 1.5-inch electronic viewfinder makes shooting easy and comfortable.
• *Output flexibility*. The WV-F250H provides separate Y (luminance) and C (chrominance) outputs for direct S-VHS compatibility. It also provides analog component signal outputs (Y/Pb, Pr) for connection with broadcast recorders.

The WV-F250H docks directly to the AG-7450 recorder without an adapter, providing a compact package. Two docking adapters are available for the WV-F250H for use with MII or Betacam recorders.

AG-7450 Video Cassette Recorder:

The AG-7450 is a directly docking S-VHS portable recorder for the WV-F250H camera. The recorder features laminated amorphous video heads, which are able to pull more information from the tape than heads of more conventional design. The greater frequency response of the heads extends the performance capabilities of the machine, most notably S/N (color S/N measures 46dB). More than 400 lines of horizontal resolution are provided by the AG-7450. Rotary erase heads and an auto backspace function ensure clean assembly edits.

The AG-7450 provides 4-channel audio capability with Dolby noise reduction. Included are two linear stereo channels and two high-fidelity audio channels. A switch-selectable LCD bar-graph display permits accurate adjustment of audio levels. XLR input connectors are standard.

WV-F300 Camera:

The Panasonic WV-F300 prism optics 3-CCD color video camera features high sensitivity, image burn resistance, low power input requirements and stable performance. The camera, based on ⅔-inch CCD devices, offers 700 lines of resolution and 60dB S/N. It uses *semi-FIT* (frame interline transfer) chips to reduce vertical smear. Advanced functions, such as a variable-speed electronic shutter, make the WV-F300 ideal for a host of professional applications.

The WV-F300 is small and lightweight. It combines outstanding picture quality and convenient features, including:

• *Auto balance*. The auto white balance adjustment can be preset at 3,200°K and will remember two different settings.
• *Viewfinder display*. Camera functions can be monitored through a 1.5-inch electronic viewfinder.
• *Electronic shutter*. The WV-F300 offers electronic shutter speeds of 1/250-, 1/500- and 1/1000-second to enable virtually blur-free recording of action at almost any speed.

Outputs include NTSC composite and Y/C component analog. Docking adapters are available to accommodate S-VHS, MII and Betacam recorders.

AG-7750 Editing Video Cassette Recorder:

The AG-7750 S-VHS editing VCR combines many popular features into one unit, including time base correction, digital noise reduction and an RS-422 serial port. Laminated amorphous heads are used in the deck to improve high-frequency response and to lower S/N. The features packed into the AG-7750

are aimed at extending the number of generations possible in the S-VHS format with acceptable signal quality. These enhancements permit at least five generations without significant loss of quality.

The TBC within the AG-7750 eliminates even small amounts of jitter, skew and color blurring. Its time base correction capability is particularly important for A/B-roll editing. Operation of the 16-line TBC is complemented with an 8-bit, memory coefficient digital noise-reduction circuit.

A dual loading mechanical system, with half- and full-loading modes, is provided on the AG-7750 to balance the need for high-speed response with the need to protect the tape and heads from excessive wear. The tape-transport mechanism incorporates five direct-drive motors, including two reel drive motors, to attain accurate and fast response to tape shuttle requirements. A new servo-control system enables high-speed search at 32X normal speed. The AG-7750 may be combined with the optional AG-F700 time code generator/reader to permit longitudinal and vertical interval time code recording and playback.

The *AG-7650* source player VCR is virtually identical to the AG-7750, but it is intended for playback use only. The AG-7650 offers the same basic specifications and features as the editing machine, including built-in time base correction, digital chroma noise reduction and RS-422 serial port.

AG-A800 Edit Controller:

The AG-A800 is a multi-event A/B-roll editing system. Up to 128 different events can be programmed (based on SMPTE time code), including a variety of wipe or transition patterns, for automatic editing. Up to two source machines can be controlled, in addition to an editor. The source VCRs can be alternated for multisource editing. The edit controller includes both preview and review capabilities, with auto tag of endpoints. Edit points may be entered by tagging scenes or by entering edit points based on either time code or control pulses.

In addition to basic audio editing functions such as assembly, insert, preview and review, the AG-A800 also provides for audio split editing if required.

The addition of the *AG-SW800* audio/video switcher enables simultaneous playback from two source machines for creation of special effects in multisource editing. Characters can be superimposed with the downstream keyer. The AG-SW800 also offers fade-in/out, dissolve and eight wipe patterns. An auxiliary input is provided for a key camera, character generator or other source. Component, as well as composite, inputs are accepted by the AG-SW800.

The *AG-RM800* remote controller for the AG-SW800 is available to increase editing flexibility. The remote panel gives the user full control over wipe patterns and transition speed, as well as audio level. Transitions can be "learned" by the system and stored in memory for later recall, permitting creative flexibility in the editing process. Four independent audio faders permit full control over audio production.

EGP-7 Production Switcher:

The EGP-7 is a broadcast-quality production/post-production video special effects and audio switcher suitable for studio and mobile applications. It accommodates component (Y/C 3.58MHz) or composite (NTSC) video signals with six external inputs, plus internal black and background. Features include:

- Built-in audio-follow-video capability with breakaway control for six stereo or monaural audio inputs, balanced or unbalanced source; mic and line inputs; and a built-in test tone generator.
- Multiple preview and program outputs for video and audio.
- A total of 28 effects patterns, including circle and two rotary wipes, plus reverse; joystick positioner with on/off control; soft or bordered edges; and manual or adjustable-rate automatic transitions.
- A 99-event memory, three external key signal inputs and three digital color matte generators.

Optional accessories include SMPTE-format RS-422 edit control interface for post-production work, RGB or NTSC chroma-keyer and audio intercom mixer for production applications.

UTP-2 Video Signal Transcoder:

The UTP-2 transcodes video signals from a selected input format to a desired output format.

- Input modes are RGB, Y/C, or Y/R-Y/B-Y. Input formats are Y/C 3.58MHz, Y/C 688kHz, Y/R-Y/B-Y (MII or Betacam), RGB, or RGB with separate sync.
- Outputs are Y/C 3.58MHz, Y/C 688kHz, NTSC (for monitoring), and sync. Front-panel selected outputs are RGB, RGB sync, or Y/R-Y/B-Y (MII or Betacam).

New Products from Panasonic

Panasonic Broadcast Systems Company: Innovative products for demanding customers

AU-65/AU-63/AU-62 MII Tape Machines:

The new MII-series VCRs offer customers MII quality at competitive prices. The AU-65 is a recorder, and the AU-63 (with auto-track) and AU-62 are play-only units. The AU-62 is the least expensive MII product available. This studio player, with built-in TBC, sells for less than $10,000.

Performance of this new series is comparable to the rest of the Panasonic Broadcast MII line. Quality has not been compromised; features have not been eliminated. The new series of MII decks provides all the benefits of ½-inch analog component recording at a low price.

The machines incorporate amorphous heads for top performance with metal-particle tapes. A unique head design helps reduce eddy current loss and provides optimized high-frequency response characteristics to enhance picture quality.

The standard-sized ½-inch metal tape cassette permits more than 90 minutes of record/playback time. A small 20-minute cassette also can be used without an adapter. Field tapes can be edited and broadcast directly without dubbing. The AU-65/63/62 machines also include internal time base correctors. Other features include:

- *Auto-Tracking (AT).*
- *Variable memory playback.*
- *S-video out connector.*

Through the addition of an optional *AU-F65* time code generator/reader, the new MII machines can read SMPTE time codes from recorded tapes, switching between vertical interval and longitudinal data according to tape speed. User bit data can be retrieved independently from either VITC or LTC.

AK-450 Camera:

The AK-450 is a high-performance, multipurpose, hand-held 3-chip camera suitable for use in a variety of demanding broadcast applications. The adoption of a new frame interline transfer CCD as the image sensor results in a compact, lightweight camera with low power consumption. The AK-450 also offers high resistance to the effects of shock and magnetic fields. The carefully aligned, high-pixel-density RGB CCD image chips result in an impressive 800 lines of horizontal resolution, with low registration error.

The AK-450 also features high sensitivity, S/N ratio of 62dB (typical) and variable electronic shutter to minimize image lag when viewing moving objects. Utilization of the CCD image sensors results in a well-balanced, low-profile camera design.

The AK-450 is configured to permit direct docking to the Panasonic Broadcast AU-400 series MII recorder. An optional camera adapter docks directly to the AK-450, making it a stand-alone camera for 2-piece operation.

AU-410 Recorder:

The AU-410 is a new, low-priced MII camera-mounted recorder featuring improved electrical and mechanical design, lower power consumption and lighter weight than previous models. The AU-410's electronic design, newly developed integrated circuits and high-density packaging techniques reduce total power consumption to just 15W. In the power save mode, consumption is only 2W. The result is greater convenience and reliability in the field. The AU-410 weighs just 3.6kg.

Video/audio confidence heads for both the luminance and chrominance channels allow playback to be checked in the viewfinder while recording. Audio is monitored via headphones or an internal speaker.

Compact ½-inch metal tape cassettes and CTCM recording allow more than 20 minutes of continuous recording. Other important features of the AU-410 include:

- *Time code capabilities.*
- *Dual user bits.*
- *Warning indicators.*

With the use of the optional *AU-S400* adapter, the AU-410 can serve as a stand-alone portable VCR. The 26-pin terminal of the AU-S400 permits input of both composite and component signals, allowing connection to a wide range of cameras.

AU-520 MII Recorder:

Designed for portability, the AU-520 is an improved version of the AU-500. More than 120 different enhancements have been made in the mechanical and electronic design to provide a more reliable, better-performing product. The AU-520 was designed with serviceability in mind. Lower power requirements permit longer record time per battery.

This portable VCR is constructed of a 1-piece aluminum die-cast chassis to withstand shock and vibration. Direct-drive motors and careful mechanical design ensure long-term dependability.

The standard-sized ½-inch metal tape cassettes permit more than 90 minutes of recording/playback time for extended field recordings. Small, 20-minute cassettes also can be used without an adapter. An internal SMPTE time code generator is included, along with an 8-digit LCD readout for both LTC and VITC. Additional features of the AU-520 include:

- *Confidence playback.*
- *Automatic backspace edit.*
- *External time code.*

The internal battery compartment allows the use of either two compact battery packs or one large-capacity battery pack. An external dc input augments the internal battery.

M.A.R.C. Spot Playback System:

The Panasonic Multiple Automated Recording/ Playback Cassette (M.A.R.C.) system has proved its value to broadcasters around the world. With more than 52 M.A.R.C. systems in operation today, reliability has been clearly demonstrated in the field.

The basic system accommodates more than 100 cassettes and up to five VCRs. The modular configuration of M.A.R.C. permits up to 1,176 cassettes on-line for exceptional flexibility. Access time is extremely fast. Continuous playback of 10-second events is possible (15-second events in the 1,176-cassette configuration). One-event-per-cassette and multi-event-per-cassette operation are supported. Bar-code readers are built into the system. Centralized control is performed by a desktop computer.

Interface protocols are available for most common external computer systems to accommodate downloading of the daily play list into the cart machine. Sophisticated software in the M.A.R.C. sequencer permits multiple cuts to be placed on a single cassette, including intermixing of spots and program material.

AQ-20 Digital Camera:

The AQ-20 is a landmark product. It is the world's first and only digital color camera. After the actual CCD pickup device, video processing is done in the digital domain. The camera output is converted to analog only upon leaving the unit. This approach has resulted in the elimination of about 100 analog adjustment controls, each of which had to be set manually. Trade-offs that used to be a normal part of camera setup are now a thing of the past.

Adjustment for best operating parameters on the AQ-20 is accomplished through a menu system. The operator simply plugs in the appropriate parameters, and the camera is reconfigured automatically. Multiple parameter sets can be stored for later recall.

The AQ-20 supports applications ranging from ENG/EFP to studio use. It is dockable with the AU-400 VCR to form an integrated camera/recorder for 1-person operation with top picture quality. The ENG adapter and the multicore adapter permit a wide range of specialized needs to be met easily.

AJ-D350 Digital Recorder:

The AJ-D350 composite digital ½-inch studio VCR incorporates the outstanding advantages of the new digital recording format developed by NHK and Matsushita Electric. Offering a comprehensive digital solution to dubbing-related picture and sound degradation, the format is also at work in a number of ENG/EFP applications that quickly are bringing the all-digital VTR production system closer to reality.

The new format records digital video signals onto MII-proven ½-inch cassette tape with more than double the recording density of the other digital formats. A maximum of 125 minutes of recording time is available with a cassette only slightly larger than that used with MII. In addition to the standard cassette, a small cassette allows a maximum of 64 minutes of recording time on a digital camera/recorder. The result is a single-format production, from recording and editing all the way to on-air playback.

Four channels of PCM sound are provided for the ultimate in performance and flexibility.

The era of the all-digital studio rapidly is approaching, with development by Panasonic of a complete range of production equipment, from 1-piece camera/recorders to cart machines. The introduction of the AJ-D350 marks the first milestone.

½-inch digital to star at Olympics

The Panasonic ½-inch composite digital video format has been designated the official recording format for the 1992 Barcelona Olympic Games. The endorsement by the Olympic Organizing Committee launches Panasonic's newest and most powerful format into the world scene.

The RTO, Radio Television Olympica '92, chose the ½-inch digital format to record, edit, archive and play back all activities at the event. D-X will be the key link in distributing to the world the 1992 Olympics in Barcelona.

The RTO will use 400 D-X videotape machines in the mammoth production. PESA Electronica, S.A., the authorized primary contractor for the RTO, will install and maintain the video production systems, including the D-X VCRs.

The ½-inch composite digital video format was developed jointly by NHK (Japan's national broadcasting company) and Matsushita, parent company of Panasonic. Both studio and field recording equipment will be used in Barcelona.

The Panasonic digital camcorder, the AJ-D310, will be the world's first 1-piece unit to incorporate a fully digital camera and the new ½-inch digital VTR. There are obvious advantages to the Panasonic ½-inch digital format. Primary among them is superb picture quality, generation after generation. The new format also uses significantly less tape than present D-2 format machines.

1992 will not be the first time Panasonic is front-and-center at an Olympic event. Two years ago in Seoul, South Korea, Panasonic's MII format broke records of its own. As millions around the world delighted in the on-the-field drama, Panasonic was a star performer behind the scenes. Its MII VTRs provided indisputable proof of the world-class status of the format.

NBC, host organization for the Olympics coverage in North America, employed more than 200 MII units for on-site recording, editing and transmission to the United States. The acclaim was universal. Other leading networks, such as KBS in South Korea, NHK in Japan, and NOS in Holland, also used MII VTRs. In Seoul, Panasonic's MII format proved to be a consistent performer of gold-medal caliber.

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For further information on our complete line of Broadcast and Television Systems products, please call 1-(800)-524-0864 for your nearest Panasonic regional sales office.

Is magnetic tape an endangered species?

By Skip Pizzi, technical editor

Not long ago, the horizon seemed to hold great promise for change in broadcast recording media. Optical recording technology, using erasable laser disks, seemed certain to overtake the industry and render magnetic media into fodder for broadcasting museums.

But, as optical recording made its way over that horizon and into our neighborhoods, its true nature became more evident, and its luster of ultimate panacea has faded. It, too, is a real world system, with strengths and weaknesses. After considering the positive and negative attributes of the recording media available, the continued viability of magnetic tape seems assured for a good while yet.

A primary impediment to optical recording's future is its "diffraction-limited" nature, meaning that its recording density is restricted by the wavelength of the light used to write and read the medium. This implies that the optical recording technologies in use today are already at or close to their theoretical recording density limit.

On the other hand, magnetic media's current density limits are merely a function of refinements in design and manufacturing technique and quality, such as the gap lengths of record and play heads, the particle density of tape formulations, and the development of new higher-density recording formats. There is much possible improvement in storage density over where magnetic media currently stands, before any theoretical limits of physics are reached. Magnetic media can potentially eclipse optical media several times over in storage density and cost-effectiveness, and work continues in the industry toward those ends. In the digital domain, DAT already carries nearly twice the data that a CD holds. DAT also wins easily in terms of "shelf density," meaning the amount of recorded material per physical volume of the medium and its package.

What does the future hold for magnetic tape in the broadcast environment?

Magnetic coating is scanned for microscopic defects by laser, which counts and pinpoints areas requiring corrective action. (Courtesy of Ampex.)

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circa 1960

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Television News
circa 1990

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Circle (46) on Reply Card

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Consider the flexibility of magnetic media. The "full coat" process with which it is made is cheap, simple and versatile when compared to most recordable optical media. The same width of magnetic tape can be used for a wide variety of track formats or speeds, unlike the typical optical disk, which must be physically preformatted for one particular recording hardware system.

Nevertheless, magnetic recording is an inherently non-linear medium. If it were not for the overwhelming practical advantages it provided over previous recording technologies at the time of magnetic tape's introduction in the 1930s and '40s, it may have been discarded as an impractical system. The development of AC bias in the early 1940s sealed magnetic recording's fate as the medium of preference for any application in which editing was desirable. (The first magnetic recording was attributed to Danish inventor Valdemar Poulsen in 1898, with AC bias first used at U.S. Navy facilities in 1923.)

The loss of the transcription disc's random accessibility was more than made up for by the ability to mechanically edit the serially recorded magnetic tape, at least for the original performance recordings. Subsequent distribution of copies remained the province of mechanical discs for four more decades, until high-speed magnetic tape duplication became practical. Again, tape's benefits were acknowledged, this time by the consumer.

Helical-scan recording added even more cost-effective capacity to magnetic recording, but with the concurrent loss of mechanical editing capability. Electronic editing systems have filled that need, but tape splicing still is used by audio practitioners in stationary head applications.

The high densities required by the recording systems of today and tomorrow are dictated by a need for greater resolution, with a concurrent importance placed on cost. Rotary-head formats will predominate, with their inherent efficiency in these respects, but the limiting factor to resolution and the cost of operation still rests with the recording medium. In these regards, magnetic tape holds the lead, but its efficiencies remain tempered by technical challenges.

An environmental chamber used for accelerated aging tests of magnetic tape. (Courtesy of Ampex.)

The weakest link

Magnetic recording/reproduction traditionally has been the bottleneck in the broadcast production chain. Analog recording of an analog signal will unavoidably leave some analog artifacts in the reproduced signal that are difficult, if not impossible, to remove from the original signal upon playback. Digital recording solves much of this problem, but places a new and different set of equally stringent demands on any storage medium used. Analog or digital, video or audio, a recording system's performance is no better than the medium it is stored on. The medium must perform consistently from head to tail, from batch to batch, and from year to year off the library shelf after recording.

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Circle (48) on Reply Card

Because recording *hardware* is purchased from the capital budget, but recording *media* typically is bought with operating funds, and on a regular basis, there is frequent pressure to reduce cost on the tape budget line at most facilities. However, from a technical perspective, because magnetic tape is the limiting factor in most broadcast operations, magnetic tape is the *last* place in which you would want to reduce expenditures. It will produce the most audible and visible degradation from the least amount of savings, even when the latter is considered over the medium and long term. Conversely, in many (especially analog) recording applications, the greatest overall quality improvements can be achieved from the smallest annual increase in expenditures by upgrading tape stock used, when compared to the cost of new recording hardware.

Analog tape lives on

Analog recording continues to flourish in the broadcast industry despite the technical advantages of digital. The cost of digital recording hardware and tape seems to be the most significant motivation for this longevity, although issues of production flexibility and compatibility with existing formats are also involved. Archivists are also reluctant to cast their lot with digital formats because of their uncertainty with its life span. In this case, one advantage of digital recording becomes disadvantageous — namely its error-correction and concealment process. Although sophisticated error-correction codes are what makes digital recording possible in a practical manner, they also mask deteriorations of the recording medium as they occur and grow incrementally over time, until the unrecoverable data becomes too large to correct, and a dropout results. In other words, error-correction and concealment systems prevent the detection of a gradually worsening media-aging problem until it's too late to do anything about it. This, of course, is an archivist's worst nightmare, although the error-correction indicators available on some machines may help with this problem.

The electron microscope has become a valuable tool in the development of new tape formulations, allowing detailed magnetic particle observation. (Courtesy of Ampex.)

Magnetic media can potentially eclipse optical media several times over in storage density and cost-effectiveness.

Meanwhile, even as digital equipment becomes commonplace for audio recording, the number of analog audio recorders sold continues to grow, especially in the multitrack area. In video, digital recording is a more recent entrant, and still only inhabits the higher-end facilities in the D-1 (component) and the more common D-2 (composite) formats. Analog recording remains strong throughout the industry.

On the audio side, noise-reduction systems have helped the cause of analog systems dramatically. Recent introductions in this area have breathed new life into the analog recording industry. Meanwhile, one American tape manufacturer has introduced a new professional analog audiotape formulation that provides 3dB higher output and 3dB lower print-through than its best previous product. A European manufacturer is reportedly at work on a radically improved (+10dB output) but downwardly incompatible analog audiotape product, which would require new equalization curves and modified recorder head design. The Japanese tape manufacturing community continues to develop higher-density metal tapes (along with at least one U.S. tape maker), for analog audio use at lower tape speeds, and for analog video, digital and HDTV applications.

In a related audio development, progress has also been made in computer-controlled, adaptive single-ended noise-reduction systems, for use primarily in enhancing archival recordings. First appearing in less-than-real-time, mainframe-only applications, one developer recently introduced a real time program for use in a popular desktop computer.

Metal formulations for digital and video

The high-frequency (short wavelength) content and low dropout needs of digital recording (audio and video) require extremely high densities of magnetic domains. Newer video formats using component analog signals (S-VHS, Betacam-SP, Hi-8) also require such tape, as will HDTV recording formats. This kind of density and uniformity is currently available with metal particle tape. Unlike the oxide-based formulations of earlier days (using ferric and chromium oxide types), pure ferrous particles are used, resulting in smaller and more uniform magnetic domains.

Metal particle tape is more expensive to produce, because of higher raw material and production costs, and is of little value for analog audio, except at slower speeds, such as the 1 $^{7}/_{8}$ips used by the audiocassette. Metal tape's primary asset is its ability to retain greater high-frequency content. It does not provide a lower noise floor or lower distortion, and has only slightly higher broadband MOL (maximum output level) relative to oxide tapes. So where oxide tapes are adequate in frequency response at reasonable tape speeds, metal tapes are not advantageous. Metal particles also require a higher bias current because of their higher coercivity and are also harder to erase. In portable use, batteries will run down faster when using metal tape, relative to oxide tape, all other things held equal.

A solvent recovery tower at a magnetic tape plant. State-of-the-art facilities, such as this, now recover nearly 95% of all reclaimable raw materials. (Courtesy of Ampex.)

These disadvantages of cost and bias needs are outweighed only when spectral requirements of the signal to be recorded are wide enough, or where pragmatism dictates lower recording areas (slower tape speeds and/or narrower tapes), such as in the small-format component video and digital systems.

Current metal tapes are made with a process similar to oxide tapes, in that the dry metal particles are mixed in powder form with a binder or "glue," and the resulting "metal pigment" is spread over a large sheet of plastic carrier in a smooth, uniform layer and left to dry. In many cases, a non-ferric backcoating material (for increased durability and reduction of

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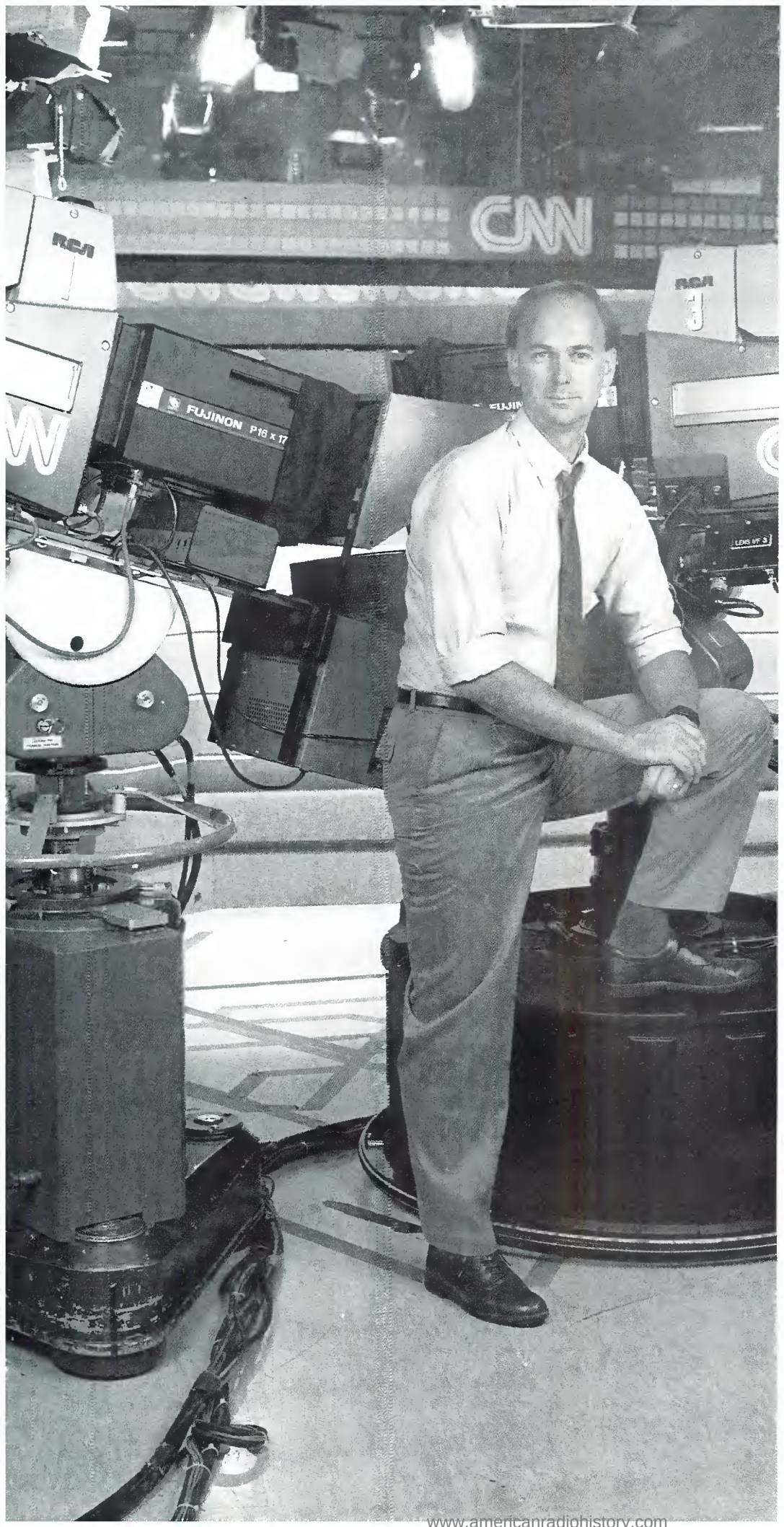

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Continued from page 70

static discharge) is applied in a similar manner, and some tapes receive a clear, thin, oil-like top coating over the metal particle layer for protection and lubrication. The coated sheet of plastic is precision-sliced into various appropriate widths, wound onto individual reels, and packaged in cassettes or boxes.

A newer, still largely experimental process uses "metal evaporation" to make even higher density and more highly uniform tapes. An ultrathin sheet of metal is laid over the plastic carrier, and the two sheets are fused by laser heating. No binder is used in the process, so the magnetic material on the tape is pure metal. The absence of binder guarantees a more uniform magnetic layer, meaning even greater short-wavelength capacity and lower dropout rates. Higher outputs are also possible with these tapes, especially at shorter wavelengths. The extremely smooth surface produced by the metal evaporation process will also result in lower noise levels. (It has long been understood that the rougher the surface of a tape, the higher the modulation noise that will be produced when recording on it.) The thin nature of the tapes manufactured in this manner will also provide longer playing times.

The negative side to metal evaporated (ME) tapes is their lack of durability. The magnetic material is so thin a layer that it is easily scraped off, especially in rotating-head applications. Several tape manufacturers are currently at work on a substance that will sufficiently protect and lubricate the top surface of ME tapes with-

Metal tape's primary asset is its ability to retain greater high-frequency content.

Figure 1. *Photomicrographs showing particle densities of metal particle tape (left) and standard ferric oxide tape (right). (Courtesy of DIC Digital Supply Corporation.)*

David Layne, Manager of Operations/Engineering, KCNC-TV, Denver, CO (NBC owned and operated) with LDK-910 cameras

David Layne, KCNC-TV, on LDK-910 cameras...

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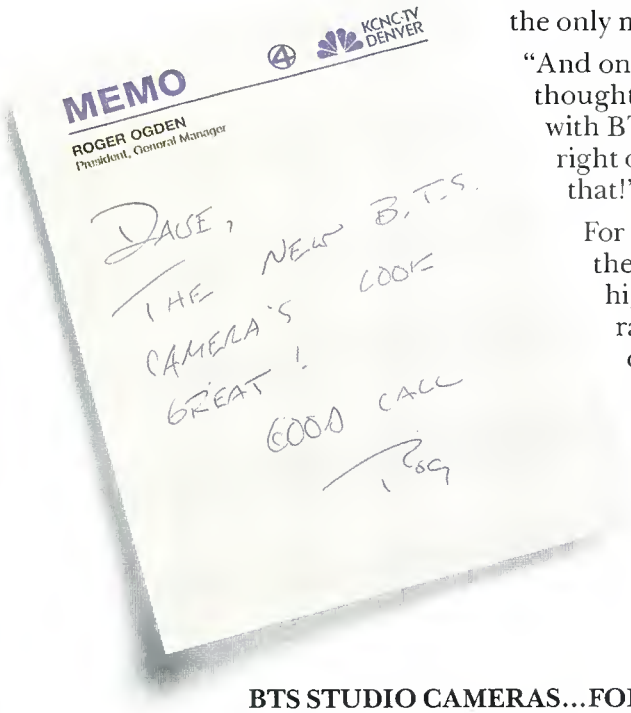

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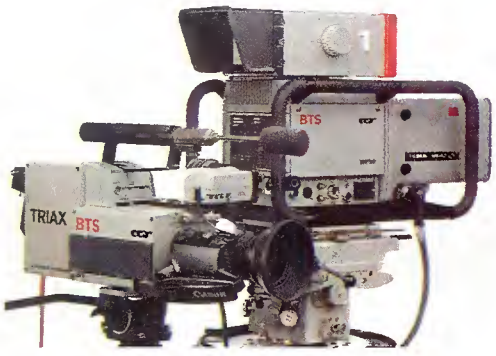

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out wearing off over time and with repeated plays. If and when this problem is solved, ME tapes may become commonplace in the broadcast industry.

Tapes formulated especially for digital recording have different design parameters from those used in analog tape design. Noise floor is not a consideration for digital recording, print-through is of no concern, and bias is not used, because all recording is at or near saturation level, and only two signal levels are recorded. The transition between these two states must occur unambiguously, however, and will occur at a fast rate, so recording density must be high and dropouts low.

Analog recording remains strong throughout the industry.

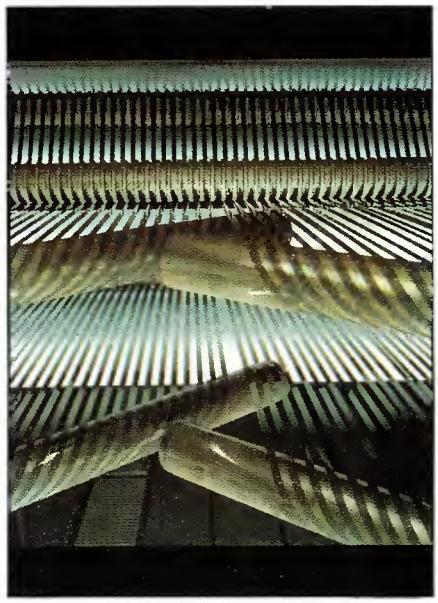
Perhaps digital recording's "ace-in-the-hole" that analog recording can never match is its time-domain accuracy. The uniqueness of each bit in the reproduced datastream allows the system clock to perform accurate time base correction on the output data, effectively eliminating wow and flutter. Noise-reduction systems and careful tweaking may allow analog recording to approximate digital results in the amplitude and frequency domain, but the time-domain performance of a digital system remains out of reach. The audible importance of this phenomenon is often underestimated; *no* wow and flutter is different than *low* wow and flutter, and it goes a long way in adding to the realism of reproduced audio. The elimination of phase jitter also makes for a more stable stereo image. Digital tape need only maintain its robustness over repeated playings without dropouts or significant stretching to do its part, although this is often challenging enough under the conditions of rotary head cassette applications.

Progress in formulations

The ideal magnetic recording medium would have magnetic domains that were all exact replicas of each other, and all physically oriented in exactly the same direction on the tape. Although this is a utopian dream to tape manufacturers, significant progress toward this goal has been made. Tape makers have achieved incremental increases in the purity of the magnetic particles, the homogeneity of the binder, and even the uniformity of the plastic carrier.

Of great importance is the range of magnetic particle size and coercivity. Consider that each magnetic particle dispersed in the tape's magnetic layer contains many magnetic "domains." Each domain acts as an individual permanent magnet, but its "direction" of magnetism (north/south, or +/−) can be changed. A domain is actually made up of millions of atoms of the magnetic element (iron, nickel or chromium), all of whose electron shells' spin axes are aligned on the same plane as a result of the particle substance's (iron oxide, chromium dioxide and pure iron) crystalline structure. Each domain operates as a "binary" magnetic entity, in that it is either north or south, but always at its full strength either way. It is never at zero, nor is it anywhere in between — it toggles north or south depending on the external magnetic forces it finds itself subjected to, and stays that way until it is again impressed with magnetic force.

The amount of magnetic force required to turn a north domain into a south one, or vice versa, is what determines the coercivity of the formulation. A magnetic force below the coercivity required will not affect any domains, but all domains will be affected when the applied flux goes above the coercivity limit — or at least that would be the case in the ideal tape. In reality, there is a range of coercivities among the particles on the tape, and manufacturers attempt to minimize this range. The better aligned these uniform coercivity particles are in the binder, the more the tape will retain the full magnetic force applied to it.



A videotape slitter at work. (Courtesy of Agfa.)

Even a highly uniform batch of particles will have some of its members broken during the process of mixing the magnetic material with the binder and placing it on the plastic carrier. The fracturing of the particles' crystalline structure will create smaller "rogue" particles whose coercivity may be significantly lowered. Their ability to be magnetized with a weaker force is what causes print-through to occur. Formulations with more of these easily magnetized particles will exhibit worse print-through than tapes with fewer rogues. The manufacturer's intent is to use more durable particles that will survive the manufacturing process intact.

A reduced spreading in the coercivity distribution function (a statistical "bell" curve) produces higher sensitivity and output, while reducing print-through. (See Figure 2.) Such uniformity in the dispersion of particles in the binder, and in the binder itself, will also keep dropouts low.

In some cases, print-through seems to be affected by the surface finish of the tape. A rougher coating often produces

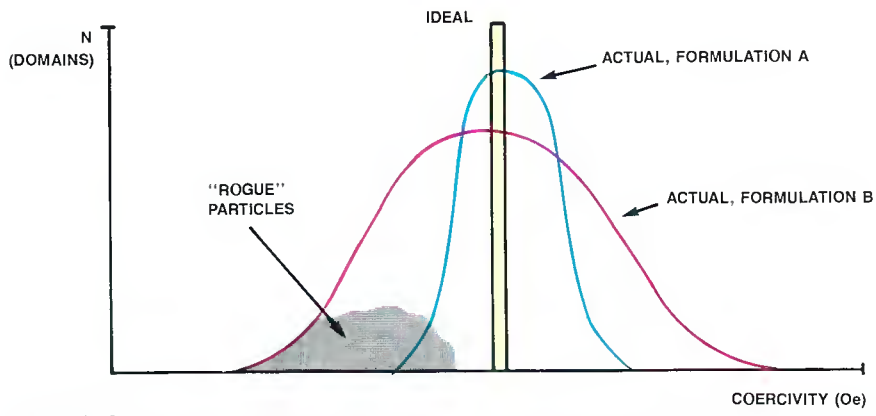


Figure 2. *Coercivity distribution curve of two hypothetical tape formulations. Formulation A will exhibit superior characteristics in terms of MOL and print-through, the latter caused primarily by low-coercivity "rogue" particles at left.*

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less print-through than a smooth one, but at the expense of higher modulation noise. This may be due to the greater range of distances between domains in adjacent layers of the tape pack on a rougher coated tape. Another advantage of such rough-coated tapes is their ability to provide a smooth wind even at high fast wind speeds, thus reducing the susceptibility of the tape to edge damage. Storage temperature, and to some extent humidity, seem to have a directly proportional effect on print-through, such that the proverbial "cool, dry place" is most appropriate for keeping tapes and ensuring minimum print-through over time. Apparently, the coercivity of many tapes changes with temperature. Formulations of tape exhibiting insensitivity to such ambient conditions are another recent development goal among manufacturers.

A frontier in tape duplication involves the "contact-printing" method, in which the recorded signals on a master tape are transferred to a copy via contact between them, under specific conditions. The wide coercivity range of a tape formulation known as barium ferrite shows promise in one of these contact processes. Refinements to the technique are still necessary before it can be considered viable. Meanwhile, the latest currently workable developments in high-speed duplication involve the "tapeless bin," in which a RAM storage system is used as the master, with copies made at extremely high dubbing speeds (128:1). Both of these aspects reduce wow and flutter in the resulting copies. Azimuth consistency for prerecorded audiocassettes has also improved, because of the development and acceptance of highly stable standard azimuth test cassettes. These also may be useful in the broadcast facility. An adjustable-azimuth cassette deck is also a useful tool for broadcast production, especially when playing back tapes recorded in the field on a portable machine.

A roll of polyester base film being loaded into machines that will prepare it for coating. (Courtesy of Agfa.)

Related developments and recommendations

Magnetic tape packaging has garnered some attention as several manufacturers introduce new storage boxes. Emphasis is on size, weight, flexibility and durability in long-term storage or transit.

Solvents used in cleaning tape paths on recorders have been under study, particularly in terms of what the solvents do to tape over extended periods. This exposure can occur when tape is passed through a machine that has been recently cleaned with the solvent, or more importantly, when tape sits near an open bottle of the solvent. General recommendations call for the use of denatured isopropyl alcohol as a cleaner, and tightly closing all solvent containers immediately after use. (Denatured alcohol is defined as 99% pure, with the other 1% being mostly water.) Leaving the bottle open also allows water vapor in the air to condense into the alcohol, diluting it from its denatured state. If alcohol seems to lose its strength as the bottle gets close to empty, this is prob-

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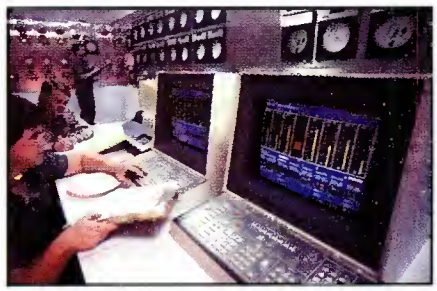
ably the reason. The additional water content may also have a corrosive effect on the ferric materials in tape heads. For this reason, standard rubbing alcohol (70% alcohol, 30% water) is not recommended for head cleaning.

Cleaning the tape path with a dry applicator after application of alcohol is also recommended to remove the residue left when the solvent evaporates. The first few feet of tape will also remove this residue, but the residue may have deleterious effects on that section of the tape and adjacent layers over the long term. For rotary head recorders, it is imperative that lint-free applicators be used.

Tapes will deteriorate over time, but one tape manufacturer recently developed a process that temporarily restores badly shedding tape to a playable condition. Via a customized, multistep process, the aging tape is diagnosed and treated; splices are checked and repaired, the tape is carefully cleaned and then heated to a temperature that reactivates aging binder, thereby reducing the flaking and shedding of oxide that plagues many old magnetic recordings. The binders often return to their problematic condition shortly after the heating process, however, so immediately after treatment, the tapes are copied, typically to a digital format, and these new recordings become the replacement masters. Many priceless old master tapes have already been given new life and reissued by this process.

Also, calibration tapes wear out and will no longer provide accurate values for hardware adjustment. Annual replacement and careful storage are recommended.



Hundreds of variables in the tape manufacturing process are computer-monitored in this mix prep control room. (Courtesy of Ampex.)

Magnetic tape appears to have a long, healthy and continuously improving future in the broadcast industry. Despite the development and concurrent usefulness of other media, it will hold its position as the dominant recording medium. If recent investments by manufacturers are any indicator, metal particle tape will be the primary class of tape used in the next few years, with the somewhat revolutionary metal evaporated types becoming the choice in the middle to late 1990s. ME formulations may, in fact, spawn new recording formats that would not otherwise be viable without their higher densities, uniformities and HF output capabilities.

What tape-based formats give up in random access, they make up for in cost-effectiveness, reliability and capacity. With higher storage densities, such as the DAT format provides, even access time becomes less of an issue, because linear tape speeds are so slow and fast wind/location so quick. For many, if not most, broadcast recording and archiving applications, magnetic tape is, and will continue to be, the medium of choice.

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A postcard from Brighton

By Jerry Whitaker, associate publisher, and John Battison

The International Broadcasting Convention, held for a decade at the seaside resort of Brighton, England, is moving into a new era. The show, which became synonymous with the town, has made its last stand along the waterfront. The 1992 IBC gathering will be held in Amsterdam.

The tradition of Brighton

Although the IBC convention has been closely associated with the town of Brighton, it had three other venues. The first show, in 1967, was held in London at the Royal Lancaster Hotel. A year later it moved to the Grosvenor Hotel. By 1978, IBC had outgrown the facilities in London and was moved to the exhibition center in Wembley, about 18 miles north of London. This venue also proved too small, so in 1980 IBC moved to Brighton in Sussex, on the English Channel.

Now, as before, lack of adequate exhibition space is forcing a change of venue. Many long-time attendees (including these two observers) view the move from the white cliffs of England to the tulip-covered slopes of Amsterdam with some sadness. Without doubt, there is a great deal of nostalgia involved in Brighton.

Battison is a technical consultant for *Broadcast Engineering*.

Brighton is the Atlantic City of England. In years gone by it was a popular place with the British aristocracy. As with most of the British seaside resorts, the character of the city has changed over the years following World War II.

To the casual visitor, the most striking landmarks of Brighton are its two piers. One has been restored to its original splendor and one has fallen into complete disrepair. Unfortunately, necessary invasion precautions executed during World War II led to the deterioration of the West Pier, which has never recovered. The East Pier was reopened in 1988 following a major renovation effort. The beaches, by the way, were mined during the war. We assume that all of the mines have been found and disarmed.

Following the 1986 IBC convention, the British Conservative Party held its annual convention in Brighton, and Prime Minister Margaret Thatcher narrowly escaped death when an IRA bomb exploded in the Grand Hotel. Echoes of this bombing were felt during the 1988 IBC show, when all guests were thoroughly searched by armed British police before being allowed to enter their rooms.

Exhibition madness

For all of its qualities, Brighton is a lousy place to hold a major trade show. The facilities are cramped and inadequate, the hotels are unacceptable or too expensive, and parking is practically non-existent.

Finding an exhibition stand (booth) is not a minor consideration. Exhibits are spread throughout two hotels — the Grand and the Metropole — (on multiple levels), the Brighton exhibition center (on multiple levels), and the Esplanade. There was a new twist to the seafront stands this year. In a dramatic move, Sony constructed a huge pavilion on the beach and placed all of its exhibits in the center. The accomplishment was impressive, a lack of adequate air-conditioning notwithstanding.

All things considered, the show was a success. Traffic levels were reasonable, and the number of attendees was high, according to most exhibitors.

Total attendance (including exhibitors) topped 19,000, down about 3,000 from 1988. The 276 exhibits covered more than 10,000 square meters.

Amsterdam, here we come

Nostalgia aside, the 1992 IBC show in Amsterdam promises to solve the exhibition and hotel problems that have plagued Brighton for years. The RAI Congress and Exhibition Center is one of Europe's top trade show venues. The center offers nine exhibition halls and 17 meeting rooms. Everything is under one roof.

Accessibility is excellent. The Schiphol Airport is just eight minutes away by train. The RAI Center is just three kilometers from Amsterdam's "inner city," and is close to many quality hotels.

Amsterdam is one of Europe's most popular and exciting cities. Picturesque, with broad canals and more than a thousand bridges, the city has a cheerful atmosphere, appealing architecture, superb shopping and a unique cultural heritage.

Although many long-time IBC attendees will miss the seaside charm of Brighton, no one will miss the inadequate physical facilities. Brighton is best enjoyed as a tourist, not as a trade show attendee.

The Sony pavilion along the waterfront captured the attention of convention attendees.

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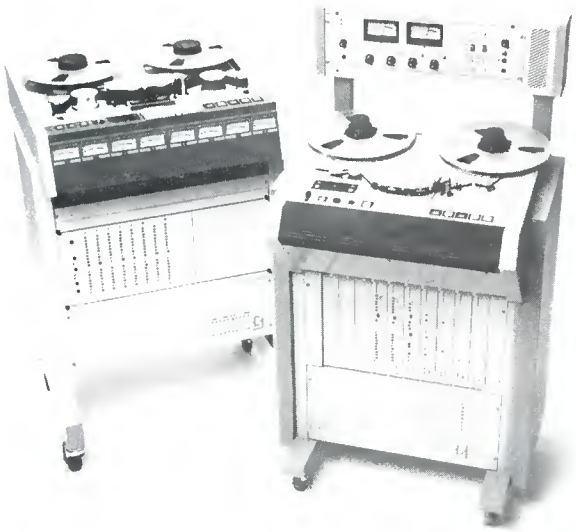

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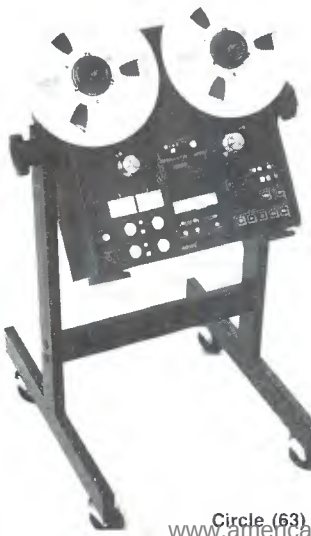

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A case for SBE certification

By Robert D. Weiss

Since 1977, the Society of Broadcast Engineers (SBE) has provided a beneficial certification program for broadcast engineers. This program is the only technical certification that has been widely accepted by the broadcast industry.

The dictionary defines certification as the awarding of credentials that serve as written testimony as to the status, qualifications, privileges or the truth of something. The SBE considers certification to be the recognition by your industry peers that you are qualified for the demands of the broadcast engineering profession, and that you have the ability to perform within the parameters of the position for which you were hired.

The SBE developed its certification program to help fill a void. This void was created by FCC deregulation when it eliminated the operator licensing program. The SBE proposed a certification program that would provide an industry-recognized title signifying a certain level of technical competence. That program has now gained widespread acceptance by the broadcast industry.

Obtaining certification

SBE certification can be acquired in one of two ways. You can either take an examination or you can qualify because of your relevant professional experience. However, some levels of certification do require an examination in addition to professional experience. The exams are based on situations and technology that are common to the broadcast industry today. Questions are developed from the areas of video and audio practices, FCC rules and regulations, safety, AM and FM modulation and electronics theory, satellite communications, and the principles of supervision and management found in typical broadcast facilities.

Examinations for the following levels include broadcast technologist, broadcast engineer and senior broadcast engineer. The engineer level exams are broken down into radio and TV areas. The SBE professional broadcast engineer classification of certification requires that at least one lower level of certification has been obtained by passing a test. Also, you must be recommended by a fellow SBE professional broadcast engineer and a previous supervisor, and provide evidence of 20 years of relevant professional experience.

Weiss is an SBE-certified broadcast technologist and a member of Chapter 18 in Philadelphia.

Practical questions

The questions on the certification tests are designed to represent practical applications of broadcast technology and theory. The examinations are separated into levels of difficulty and based on the area of expertise. Unlike the old FCC exams, the SBE tests address the particular area of broadcast for which the certification is applicable. You do not need to be knowledgeable about areas that don't apply to the typical work you might encounter.

The old FCC exams often just tested your ability to memorize. They were not accurate appraisals of your ability to perform the work of a broadcast engineer. Many people went through the so-called "licensing mills," which were classes designed to get the student through the FCC test. Such programs were seldom intended to provide a thorough background in electronics.

The SBE certification program accomplishes an important objective that the FCC examinations never achieved — they ascertain whether particular job candidates are qualified for the positions for which they are being considered.

Structured training programs

Testing is only one phase of a quality education program. The primary intent is to see that people receive the proper training. The society has expanded the work of the certification program to provide guidance for students wanting to obtain an education in electronics. The SBE provides a free service to schools and colleges that examines their instructional programs. Upon meeting the SBE guidelines, graduates of these schools can obtain SBE certification as a part of their training process.

Professional competence

Certification, according to some engineers, is the element that helps you establish yourself and provides the credentials that set you apart from others in the industry. Certification also shows that you are committed to working in the broadcast industry. Certification, unlike the old first-class license radio telephone operator's permit, shows your degree of preparation and tells management that you possess certification technical qualifications.

Research shows that SBE certification can result in higher income. The yearly surveys conducted by *Broadcast Engineering* show that the median salaries of SBE-certified engineers tend to be higher than those of non-SBE certified engineers. These results are similar every year, a further indication of the industry's acceptance of the value of SBE certification.

Expanding program

The SBE is about to introduce another certification category designed to address the needs of operators. This is important as stations struggle to discover ways to find and train their audio and video operators. As stations reduce their staffs, untrained operators are sometimes left to control equipment and the legal operation of radio and TV stations. Without a program like the one being considered by the SBE, managers will have few tools with which to train their staffs, nor a standardized measuring instrument for competence.

The SBE certification program will provide this important missing element. The result will be better-trained operators, and, therefore, better operation of the stations. Just as important, trained operators can help prevent FCC fines.

Although the commission has eliminated its work with testing, it still issues fines. Trained broadcast engineers used to be the station manager's "eyes," looking out for infractions and operating practices that could hurt the station. These days, this task is often overlooked as engineers address larger and more complex issues.

Stations that embrace the advent of adequate operator training and certification will reap the benefits of a better (legally) operating station. The bottom-line result may be money saved because stations will not be fined for improper or illegal operation. This is something every manager will understand.

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Power conditioning:

How to protect your facility

Every electronic installation requires a steady supply of clean power in order to function properly. Recent advances in technology have made the question of ac power quality even more important, as microcomputers are integrated into a wide variety of electronic products. The high-speed logic systems prevalent today can garble or lose data because of power supply disturbances or interruptions.

The ac power line into a facility is the lifeblood of any operation. It is also, however, a frequent source of equipment malfunctions and component failures. The utility company ac feed contains not only the 60Hz power needed to run the facility, but also a variety of voltage sags, surges and transients. These abnormalities cause different problems for different types of equipment.

The details of power distribution in the United States vary from one utility company to another, but the basics are the same (see Figure 1). Power from a generating station or distribution grid enters 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 delivers output voltages of approximately 60kV to subtransmission circuits, which feed distribution substations. The substations convert the energy to approximately 12kV and provide voltage regulation and switching provisions that permit *patching around* a problem. The 12kV lines power the pole- and surface-mounted transformers, which supply various voltages (typically 120-208 wye, 277-480 wye, 120-240 single phase, and 480 delta) to individual loads.

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 is strung between the top insulators of each pole, attracting lightning to the ground wire (utility companies call this a shield wire), and not the hot leads.

Transient disturbances

Transient overvoltages come in a wide variety of forms, from a wide variety of sources. They can, however, be broken down into two basic categories: those generated through natural occurrences and those generated through the use of equipment, either on-site or elsewhere. Transient disturbances are what headaches are made of. Whatever you call them — spikes, surges or power bumps — they can take your equipment down and leave you with a complicated and expensive repair job.

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

Classifications

Figure 2 shows the four major classifications of short-term ac voltage disturbances. The generally accepted definitions for these disturbances are:

- *Voltage surge*. An increase of 10% to 35% above the normal line voltage for a period of 16ms to 30 seconds.
- *Voltage sag*. A decrease of 10% to 35% below the normal line voltage for a period of 16ms to 30 seconds.
- *Transient disturbance*. A voltage pulse of high energy and short duration impressed upon the ac waveform. The overvoltage pulse may be one to 100 times

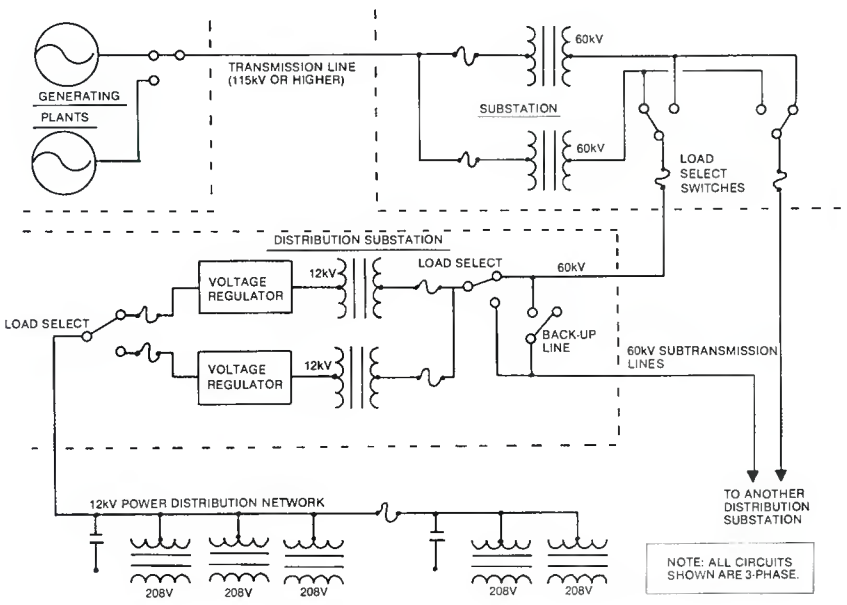

Figure 1. *Simplified block diagram of a basic utility company power distribution system. The devices shown as fuses could be circuit breakers or reclosers, which function as automatic-resetting circuit breakers. All circuits shown are 3-phase. The capacitors perform power factor correction duty.*

WHERE DO ALL THOSE LITTLE DIGITS GO WHEN THE POWER DIES?

Digital equipment is great. All those little numbers running around making pictures and sounds for you all at your command. But they're completely addicted to power. And preferably good, clean, non-noisy power. Take away their power and they not only stop running around, they may get all scrambled.

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the normal ac potential and may last up to 15ms. Rise times can measure in the nanosecond range.

• *Momentary power interruption*. A decrease to zero voltage of the ac power line potential, lasting from 33ms to 133ms. (Longer-duration interruptions are considered power outages.)

Voltage surges and sags occasionally result in operation problems for equipment on-line, but automatic protection or correction circuits generally take appropriate actions to ensure that there is no equipment damage. Such disturbances can, however, garble computer system data if the disturbance *transition time* (the rise or fall time of the disturbance) is sufficiently fast. System hardware also may be stressed if there is only a marginal power-supply reserve or if the disturbances are frequent.

Momentary power interruptions can cause a loss of volatile memory in computer-driven systems and place severe stress on hardware components, especially if the ac supply is allowed to surge back automatically without *soft-start* provisions. Successful system reset may not be accomplished if the interruption is sufficiently brief.

Although voltage sags, surges and momentary interruptions can cause operational problems for equipment used today, the possibility of complete system failure because of one of these mechanisms is relatively small. The greatest threat to the proper operation of electronic equipment rests with transient overvoltage disturbances on the ac line.

Transients are difficult to identify and difficult to eliminate. Many devices commonly used to correct sag and surge conditions, such as ferroresonant transformers or motor-driven autotransformers, are of limited value in protecting a load from high-energy, fast rise-time disturbances on the ac line.

In the computer industry, the majority of unexplained problems resulting in disallowed states of operation actually are caused by transient disturbances on the utility feed. With the increased use of microcomputers in the broadcast industry, this warning cannot be ignored. Because of the high potential that transient disturbances typically exhibit, they can cause data and program errors, and can also damage or destroy electrical components.

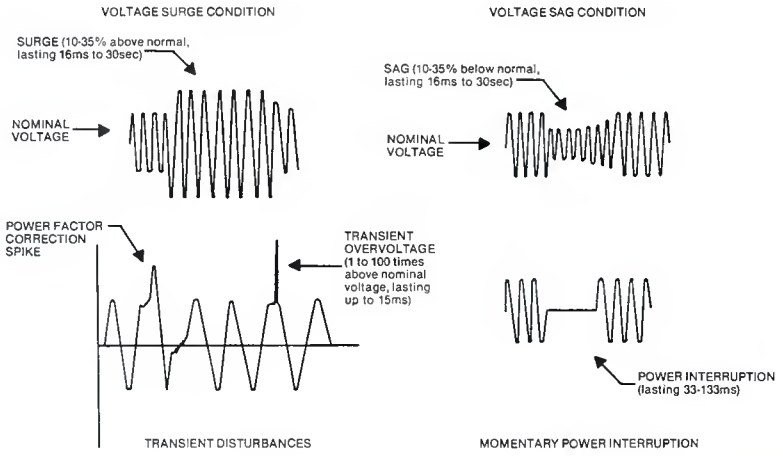


Figure 2. *The four basic classifications of short-term power-line disturbances.*

This threat to electronic equipment involves sensitive integrated circuits and many other common devices, such as capacitors, transformers, rectifiers and power semiconductors. Thus, it's clear that common components are vulnerable to high-energy pulses. What's more, the effects of transient disturbances on electronic devices are often cumulative, resulting in gradual deterioration and, ultimately, catastrophic failure.

Power system protection alternatives

Most utility companies make a good-faith attempt to deliver clean, well-regulated power to their customers. Most disturbances on the ac line are beyond the control of the utility company. Large load changes (imposed by customers on a random basis), power-factor correction switching, lightning and accident-related system faults all combine to produce an environment in which tight control over ac power quality is difficult to maintain.

Therefore, the responsibility for ensuring ac power quality must rest with the users of sensitive equipment. The selection of a protection method for a given facility is as much an economic question as it is a technical one. A wide range of power-line conditioning and isolation equipment is available. A logical decision about how to proceed can be made only with accurate, documented data on the types of disturbances typically found on the ac power service to the facility. This data can be gained from a power-quality survey, available from a number of consulting firms and power-conditioning companies.

The susceptibility of electronic equipment to failure as a result of ac disturbances has been studied by many organizations. A benchmark study was conducted by the Naval Facilities Engineering Command (Washington, DC). The far-reaching program, directed from 1968 to 1978 by Lt. Thomas Key, identified three distinct categories of recurring disturbances on utility-company power systems.

It is not the magnitude of the voltage, but the duration of the disturbance, that determines the classification. In the study, Key found that most equipment failures caused by ac line disturbances occurred during bad weather. According to a report on the findings, the incidence of thunderstorms in an area may help to predict failures. The type of power transmission system used by the utility company was also found to affect the number of disturbances observed on power company lines.

For example, an analysis of utility system problems in Washington, DC, Norfolk, VA, and Charleston, SC, demonstrated that underground power-distribution systems experienced 33% fewer failures than overhead lines in the same areas. Based on his research, Key developed the *recommended voltage tolerance envelope*. The design goals of this development are recommendations to computer manufacturers for implementation in new equipment.

Protection using the systems approach

A facility can be protected from transient disturbances in two basic ways: the *systems* approach or the *discrete device* approach. These are the major alternatives available for the systems approach to transient suppression:

- UPS (uninterruptible power system) and standby generator.
- Stand-alone UPS.
- Motor-generator unit (MGU).
- Shielded isolation transformer.

- Solid-state line-voltage regulator/filter.
- Secondary ac spot network.
- Secondary selective ac network.

Uninterruptible Power System. One example is a basic UPS system built around a rectifier-inverter combination. Ac from the utility is rectified to continuously charge a bank of batteries, which powers an inverter. The closed-loop inverter provides voltage and frequency regulation. The output of the inverter is generally a sine wave, or pseudo sine wave (a stepped square wave). If the utility voltage drops or disappears, 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.

Motor-Generator Unit. As the name implies, a motor-generator 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 0.5 seconds on many models). Other features 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.

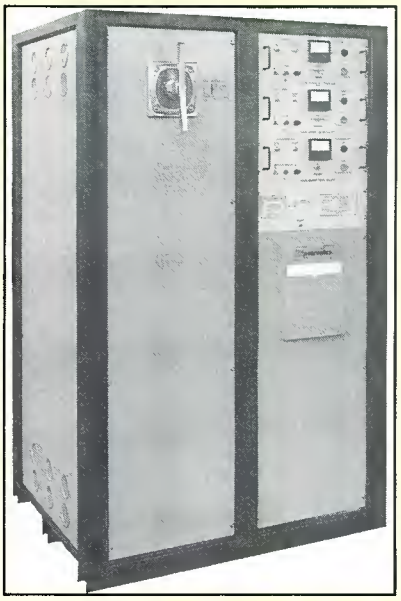
High-Performance Isolation Transformer. Transients, as well as noise (RF and low-level spikes), can pass through transformers, not only by way of the magnetic lines of flux between the primary and the secondary, but also through resistive and capacitive paths between the windings. Increasing the physical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

A better solution involves shielding the primary and secondary windings from each other to divert the primary noise current to ground. This approach leaves the inductive coupling basically unchanged. The concept can be carried a step further by placing the primary winding in a shielding box to shunt noise current to ground

Hipotronics

If there's one word that comes to mind when describing Hipotronics and its line of voltage regulators, it would be Peschel. For more than 27 years, Hipotronics has designed and manufactured high-voltage, high-power test equipment and power sources. The Peschel Automatic Voltage Regulator (PAVR) is the workhorse for Hipotronics, Brewster, NY.

In use worldwide with all types of broadcast transmitters (UHF-TV, VHF-TV, SW, MW and FM), the PAVR overcomes the problem of improper voltage fluctuation, which degrades performance and shortens the life span of the elements of a high-power transmitting tube. Among its customers are the Harris Corporation, with 94 units in service; Comark, 24 units; Townsend Associates, 24 units; and Philips TV Systems, 16 units.



The unit is a 50/60Hz, wye-connected, dry-type, convection cooled ac line voltage regulator. It is designed to maintain line voltage to within ±1% of nominal, with an input voltage variation of +9/–14% or ±20%, because of line and/or load changes.

The PAVR is neither an impedance changing nor a ferroresonant device and uses no SCRs. It is an electromechanical device, using electromagnetic transformer action to regulate. All standard service line voltages are available with current ratings from 40A to 100A.

Best Power Technology

Zero defects and a commitment to quality are more than just slogans at Best Power Technology. The entire staff takes a professional approach to every phase of the manufacturing process, and the result is reflected in the company's growth over the last 13 years.

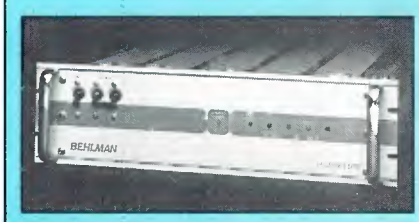
Best was formed in March 1977 in Necedah, WI, by the Paul family. Willard is chairman and Marguerite is vice president of administration. Their eldest son, Terry, is president. Son Bill is president of the company's sales corporation, and another son, Steve, is vice president of engineering. Their only daughter, Terese, is sales coordinator.

The company introduced its first-generation FERRUPS, a single-phase UPS, in September 1983, followed by new generations in March 1986, October 1987 and May 1990. In addition to typical applications, the product keeps track of outages during the night, including frequency and duration. It monitors battery time and the amount of charge available, as well as voltages going in and out of the unit. An onboard microprocessor lets the user control the system from the front-panel keyboard or RS-232 port.

From the beginning, Best has focused on the development of high-efficiency, low-cost inverters and UPS that incorporate the latest in power electronics. Because of its engineering background, the company has been recognized by the Wisconsin Society of Professional Engineers with the Governor's New Product Award four times (1985, 1986, 1987, 1989).

Behlman Electronics

For years the Behlman name has been associated with high-quality ac power for test applications and systems. Now Behlman Electronics, Ventura, CA, has developed the H-Series 19-inch rack-mount UPS for critical communications applications. Numerous government agencies employ Behlman's units around the world to protect and insure essential communication networks.



The H-Series is rugged, light and is used in fixed and mobile applications. It's designed to handle critical broadcasting loads, which are more demanding than everyday computer room requirements. This product safeguards your entire system, eliminating catastrophic power losses and line disturbances.

Unique linear/switching power technologies are incorpoarted to reduce rack space requirements (the H-1000 is only 5.25 inches high). All H-Series units handle load crest factors of more than two times their normal operating capacity without the need for a bypass to the utility line. Conservatively rated components allow them to drive the most unusual loads, even down to power factors of 0.5 leading or lagging.

Contact closure and RS-232 are available on all models for 2-way communications for status and control. Input and output frequencies of 50Hz and/or 60Hz are also available. Front-panel metering is available for monitoring voltage parameters, and battery run time can be extended by adding auxiliary battery packs.

and to reduce capacitive coupling between the windings.

One application of this technology involves this scenario: A 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 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 0.005 pF. Common mode noise attenuation is generally greater than 60dB.

Solid-State Line Voltage Regulator. A variety of proprietary techniques are used to implement solid-state line voltage regulation. Although the technology is not usually discussed by manufacturers, most rely on a combination of series and shunt elements constructed of semiconductor-

based devices. The shunt element clamps voltage excursions, and the series element counteracts the *iceberg effect* of many transients. The iceberg effect is the negative voltage excursion that typically follows a positive voltage pulse. Performance varies greatly between types of units, as does cost. The insertion loss of a solid-state regulator/filter is usually small.

Regulation may also be accomplished through the use of a silicon-controlled rectifier (SCR) bank feeding an isolation transformer. A filter network within the system attenuates common-mode and transverse-mode noise. SCR-based systems are effective in compensating for voltage surge and sag conditions. They are relatively ineffective, however, in removing transient disturbances.

Selective/Secondary Spot Networks. Ac power backup based on a selective or secondary spot network relies on the probability that most utility company failures are localized events that do not affect large geographic areas. The customer contracts with the local utility company to bring two separate service drops into the facility. The service drops are fed from different area distribution substations, and usually are routed via different physical paths. If power service fails on one line, an automatic transfer switch defaults to the secondary line. This approach does not protect a facility from transient disturbances or surge and sag conditions. It will, however, protect the facility from power outages that are localized in nature.

STANDBY POWER SYSTEMS

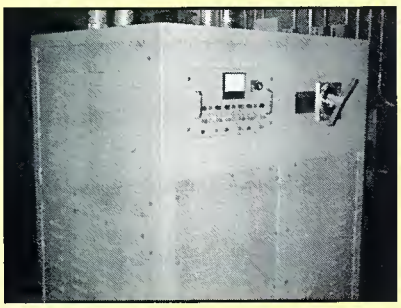
When utility company power problems are discussed, most people immediately think of blackouts. The lights go out and everything stops. With the facility down and in the dark, there is nothing to do but sit and wait until the utility company finds the problem and repairs it. This generally takes only a few minutes. There are times, however, when it can take hours. In some remote locations it can even take days.

Blackouts are without a doubt the most troublesome utility company problem that a facility will have to confront. Statistics show that power failures are, generally speaking, a rare occurrence in most areas of the country. They are also short in duration. Studies have shown that 50% of blackouts last six seconds or less, and another 35% are less than 11 minutes long. These failure rates are not usually cause for concern to commercial users, except where computer-based operations and broadcast stations are concerned.

A facility that is down for 11 minutes — or even five minutes — can suffer a significant loss of audience or data that can take hours (or perhaps days) to rebuild. Coupled with this threat is the possibility of extended power service loss from severe storm conditions. Many broadcast and communications relay sites are located in remote rural areas or on

Staco Energy Products

Staco Energy Products Company, Dayton, OH, has been in the voltage control and regulation field for more than 50 years. In addition to medical, industrial and marine applications, Staco serves the broadcast industry with a variety of systems, offering power ratings in its AVR series of 2kVA to 1,500kVA. Optional products include bypass switches, individual phase control, and digital meters.



As seen in the photo at WPTD, Channel 16, in Dayton, Staco installed a 500kVA automatic voltage regulator to work in conjunction with a Townsend transmitter. The unit provides protection from brownouts, sags, surges, noise, transients, spikes, harmonics and unbalanced 3-phase lines.

All of the systems in the AVR series feature output level, sensitivity, control circuit on/off switch, pilot light, and analog voltmeter on the front panel. Knockouts on the sides and back are provided for wiring access. A large terminal block is provided for making I/O connections, and a chassis ground is provided for safety.

Staco's power line conditioners combines AVR voltage regulator modules with shielded isolation transformers and transient suppression networks. When the output voltage changes, because of input voltage fluctuations or changes in the load, the deviation is immediately sensed, and the voltage is corrected.

Superior Electric

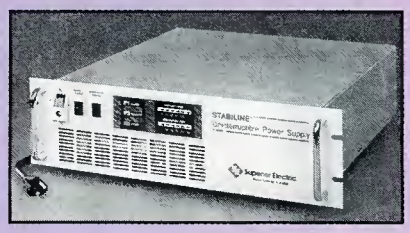
This manufacturer of the STABILINE voltage conditioning line has been in the business 52 years, long enough to develop many different products and sell to a varied customer base. The original STABILINE product series has evolved into more than 360 standard catalog model from which to choose.

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

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

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

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



mountaintops. Neither of these locations is well-known for power reliability. It is not uncommon in mountainous areas for utility company service to be out for days after a major storm.

Few operators are willing to take such risks with their business, and they choose to install standby power systems at appropriate points in the equipment chain. The cost of standby power for a facility can be substantial, and an examination of the possible alternative should be conducted before any decision on equipment is made. Management should clearly define the direct and indirect costs and weigh them appropriately. This cost vs. risk analysis should include the following:

- Cost of purchasing and installing standby power hardware.
- Exposure of the system to utility company power failure.
- Alternative transmission or production methods available to the facility.
- Direct and indirect costs of lost up-time because of blackout conditions.

Current Technology

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

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

Virtually all products achieve UL best performance ratings, and Current Technology's internal life test standard is more than 10 times the UL requirement. This year, Current Technology added power supplies to its product line in response to continued customer requests.

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

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

- Very low dark current
- Improved dynamic range
- Freedom from lag
- Improved spectral characteristics
- Electronic "shutter" for each pixel

Dark currents and fixed pattern noise

Dark current is one of the basic assessment criteria of CCD camera performance. Dark current characteristics limit the imager's dynamic range at the lower end. Dark current effects increase with temperature (doubling in level for every 10°C rise).

Also, the level of dark current from pixel to pixel has a random distribution. The degree of variation is a measure of device design and quality control in manufacturing. This random level distribution is the primary cause of the *fixed-pattern noise* (FPN) behavior of CCDs. For some devices, FPN seriously limits imaging capabilities in low-light scenes. Figure 2 is a simplified illustration of the effect of random dark current level on FPN.

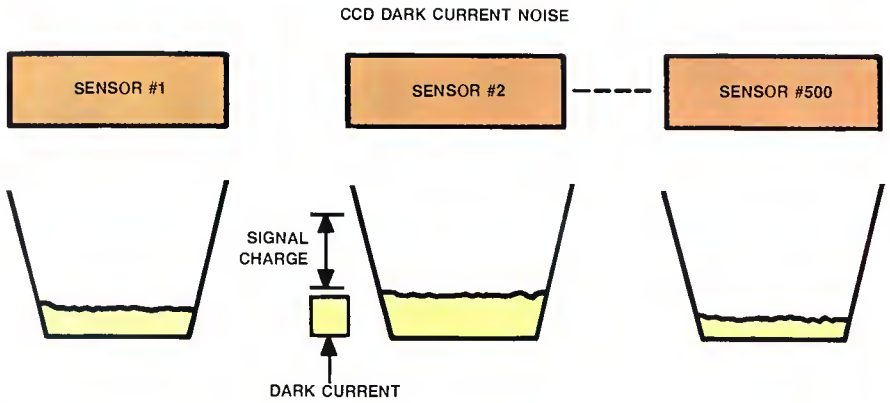


Figure 2. CCD dark current noise leads to fixed-pattern noise when taken over a line or series of lines.

This enhanced dynamic range is a major boon to nighttime ENG shooting. It allows extraction of a quiet, lag-free image from poorly lit scenes.

The HAD sensor has a dark current level some 10 times less than that of the 510-element MOS diode sensor previously described. This is a significant step forward. The noise floor has been lowered dramatically, and adverse effects at elevated operating temperatures also are reduced.

CCD dynamic range

Figure 3 shows the boundaries of a sensor's signal-generating capabilities. These define the sensor's dynamic range. A limitation at the upper boundary is caused by the capacity of the sensor "well" to accumulate charge. Today, the HAD sensor can handle light levels linearly up to 600% of normal exposure. When this level is exceeded, an overflow mechanism absorbs the excess charge, preventing blooming. At the lower boundary, the noise floor is defined by dark current, thermal and 1/f noise and reset noise.

The extension of both boundaries within the HAD sensor has produced a dynamic range typically greater than 80dB. This is far in excess of most pickup tubes, and is about 10dB beyond the capabilities of most contemporary CCDs. This enhanced dynamic range is a major boon to nighttime ENG shooting. It allows extraction of a quiet, lag-free image from poorly lit scenes. It simultaneously handles excessive background highlights without any

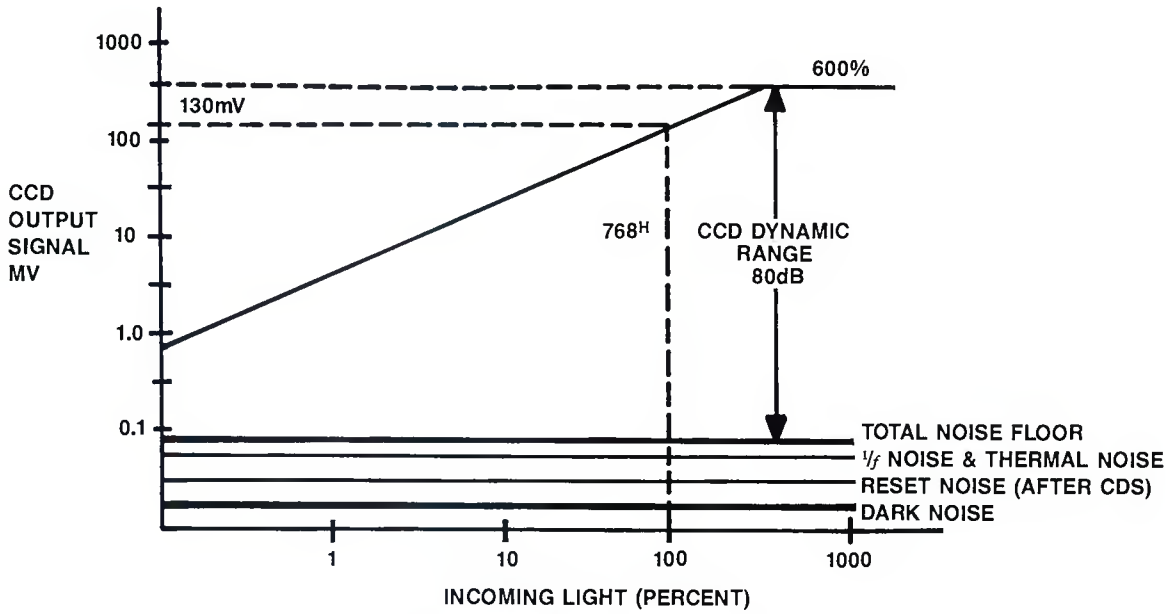


Figure 3. The dynamic range of a CCD sensor is the proportion of the signal between the noise floor and the sensor well's ability to accumulate charge. The HAD sensor has a dynamic range in excess of 80dB.

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blooming or comet-tailing.

In production work, the HAD sensor allows a close approximation to the contrast-range handling capabilities of modern film. This offers new video production capability.

In production work, the HAD sensor allows a close approximation to the contrast-range handling capabilities of modern film.

CCD sensitivity

The HAD sensor exhibits better spectral sensitivity than the 510-element CCDs. The term "opening ratio" describes the proportion of the optical sensor area to the total pixel area. (See Figure 4.) The pixel area in the HAD sensor is smaller than that of the 510-element devices, but the opening ratio is 35%. This is in contrast to an opening ratio of 25% in earlier devices. The larger opening ratio improves light capture. This boosts the HAD sensor's effective sensitivity, but its intrinsic sensitivity is essentially the same as that of the earlier devices.

One new camera employing the HAD sensor has the following sensitivity performance characteristics:

- *Nominal sensitivity:* f/5.6 for 2,000lx incident 3,200°K light on an 89.9% reflectance white at nominal 0dB gain.
- *Low-light sensitivity:* 15lx required to produce full luminance-level output with

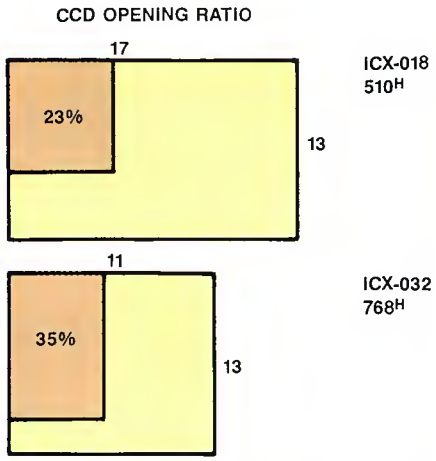

Figure 4. The smaller pixel size in the HAD sensor is more than offset by the larger opening ratio, which effectively increases the sensor's sensitivity.

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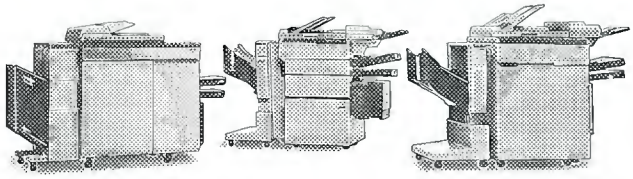

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f/1.5 lens wide open and gain set to +18dB.

In particular, removal of a thin polysilicon film layer used on the 510-element CCDs has resulted in a 50% improvement in blue sensitivity. This raises the HAD sensor's sensitivity in the region of the shorter blue wavelengths.

CCD vs. tube colorimetry

Colorimetry of imagers directly affects camera colorimetry. Earlier cameras face two obstacles in achieving a colorimetry approximating that of pickup tubes. At the blue end of the spectrum, their sensor's response falls off more sharply than a PbO or Saticon tube. At the red end, an IR filter impairs the sensor's response. This filter often is severe in cameras using interline-transfer CCDs. Designers must strike a compromise between an adequate red response and an attenuation of the red wavelength vertical smear.

The HAD sensor faces no such limitations. Figure 5 contrasts the spectral characteristic of the new HAD imager with that of the IT ICX-018. The improved blue response and broader spectral curve allow better optimization of the prism "taking" characteristic. By carefully controlling the spectral taking characteristics of the beam-splitting block and using an appropriately tailored linear matrix, cameras using the HAD sensor exhibit color reproduction closely matching that of modern Plumbicon cameras.

Electronic shutter

The new HAD pixel design is a major advancement in interline-transfer CCD design, namely the incorporation of an electronic shutter mechanism. To date, IT CCD designs have been without an electronic shutter. Such shuttering has conventionally required the use of a FIT or semi-FIT mode of operation. The HAD sensor IT CCD, however, takes an entirely different approach. It accomplishes shuttering within each pixel. (See Figure 6.) The shutter action takes place by semiconductor "charge separation" action, which separates the wanted charge information from that which is shuttered out.

When the substrate potential is held high, normal IT action takes place. That is, the sensors first integrate charge during the active field period. Then, a readout pulse (which occurs in the succeeding vertical blanking period) rapidly empties all sensors simultaneously into the adjacent registers. From there, they are clocked during the next active field period.

When the shutter is actuated, a series of pulses (occurring during each horizontal blanking period) are applied to the substrate. These lower the potential barrier

By carefully controlling the spectral taking characteristics of the beam-splitting block and using an appropriately tailored linear matrix, cameras using the HAD sensor exhibit color reproduction closely matching that of modern Plumbicon cameras.

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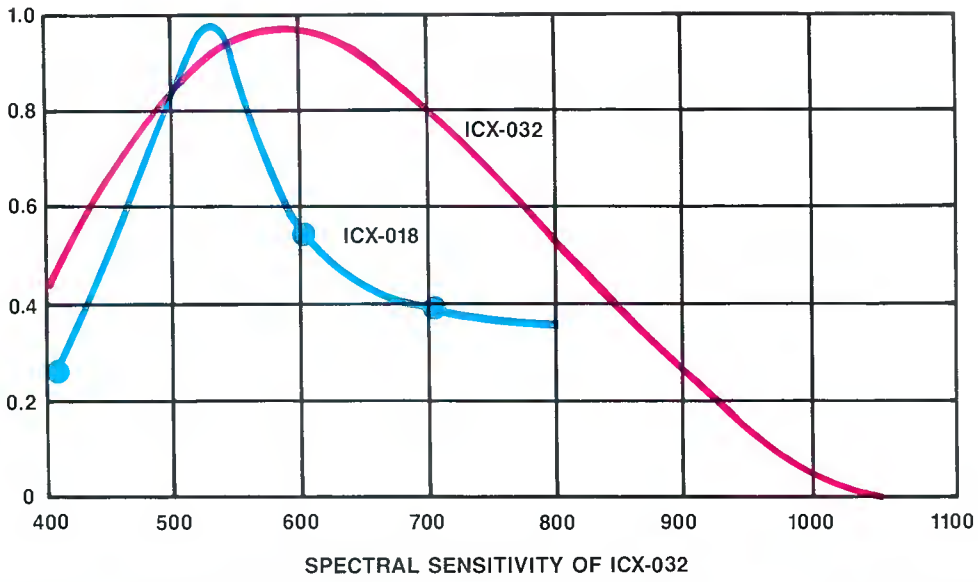

Figure 5. *The spectral characteristic of the new HAD imager, plotted with that of the IT ICX-018, shows the improved blue response and broader spectral curve. This enables cameras using HAD sensors to approximate the colorimetry of tube cameras.*

of the well, sweeping the accumulated charge off into the substrate. This effectively dumps the charge collected while the shutter is closed. Figure 7 shows the operation of the control pulses.

Modern cameras have an operator control on this shutter timing position, and hence on shutter speed. This is typically switchable from 1/60th to 1/100th, 1/250th, 1/500th, 1/1000th or 1/2,000ths of a second.

CCD vertical smear

The artifact of vertical smear, which occurs when a camera encounters a strong backlight, is indigenous to CCD imagers. It is solved in the frame-transfer (FT) CCD by interposing a mechanical shutter between the beam splitter input and the lens final port. This shutter is synchronized carefully to cut off light input during vertical blanking, when the actual frame transfer occurs. This solution introduces the vexing anomaly of using an archaic mechanical device in a new-generation all-solid-state camera.

In the IT CCD, vertical smear occurs by different means, primarily highlight contamination of the charge packets as they pass vertically through the registers. Semiconductor design precautions can reduce

Continued on page 108

Major CCD development programs are driven primarily by the advent of devices that can be used in the large consumer camera marketplace.

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Most of the engineers I talked to emphasized the exceptional after-sale service and support Odetics provided. We found that out for ourselves when our new machine was installed. The training and support our operations people got was efficient, thorough and highly professional.

If you'd like to know about what the Odetics cart machine has done for KPHO, why not get some firsthand information? Feel free to give me a call at (602)264-1000."

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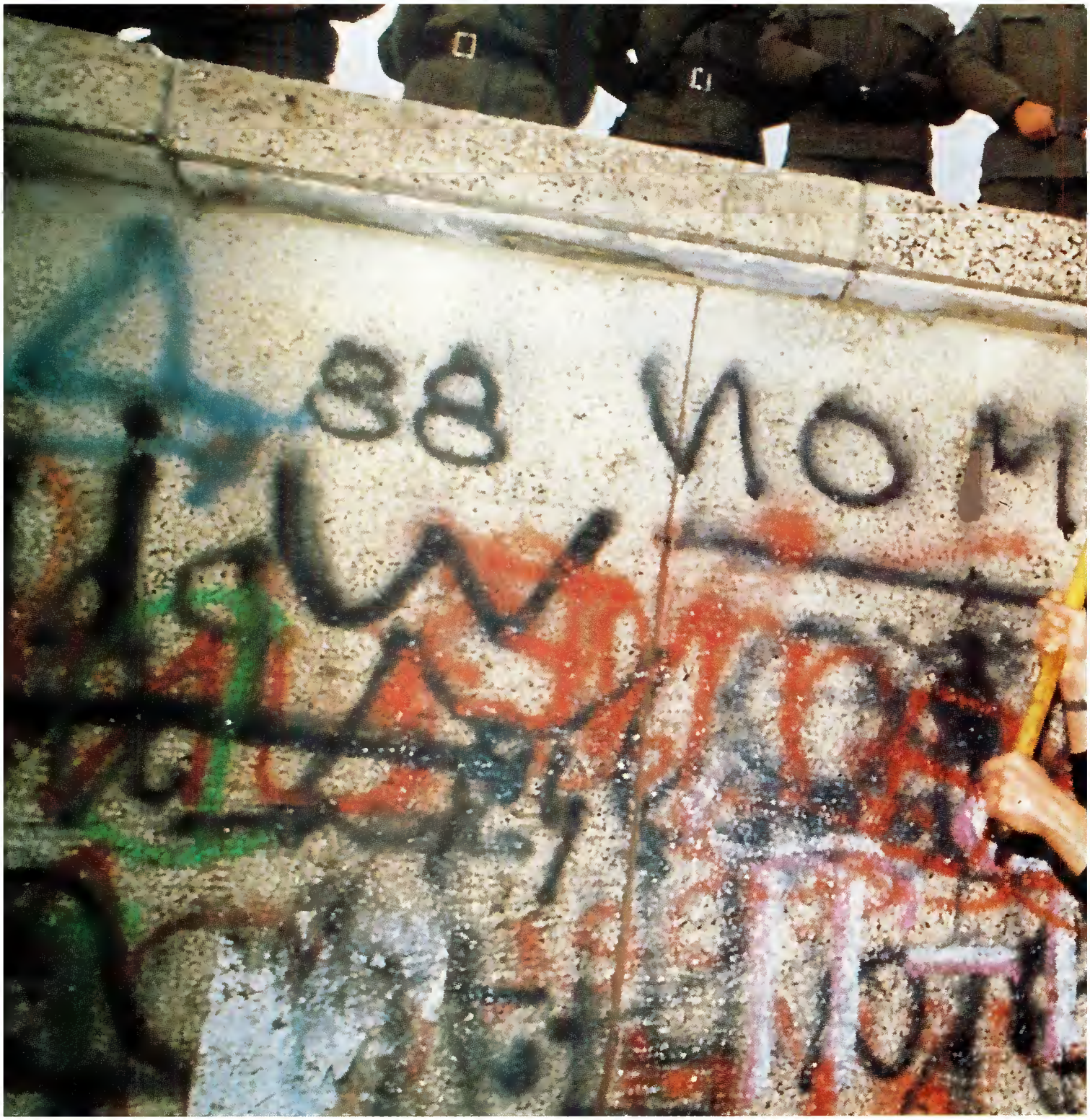

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Continued from page 104
this contamination to a low level, but can't eliminate it.

The FIT CCD, on the other hand, can eliminate smear with the use of a dual high-speed transfer. This mechanism, being totally electronic, requires no mechanical shutters and is a good solution to the problem.

In the HADS CCD, the N substrate absorbs the primary source of contamination, the stray carriers. This removes the wavelength-dependent mechanism that causes the unpleasant red tinge in the smear in conventional IT CCDs. However, this now exposes the remaining mechanism of contamination, usually masked, which is optical "sneak paths." This stimulates a much lower-level vertical smear, which becomes visible on only the most severe of highlights. Figure 8 shows the

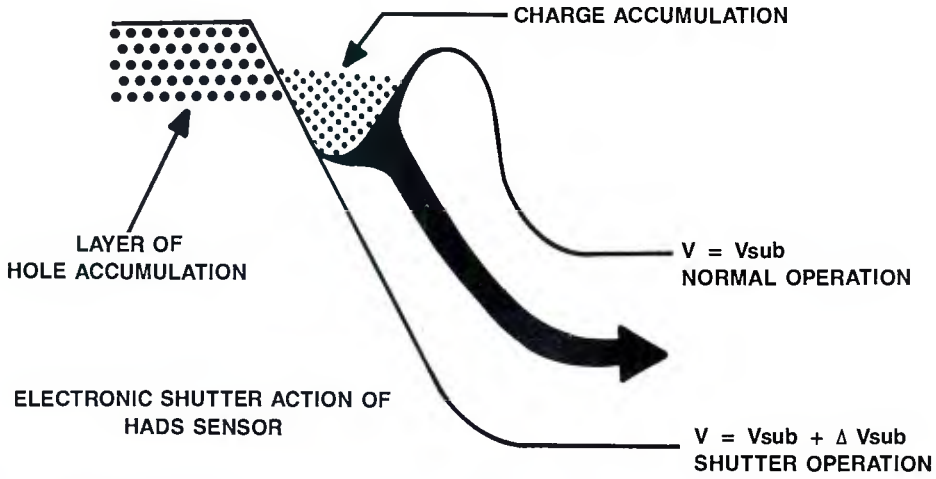

Figure 6. *In a HAD sensor, each pixel has its own electronic shutter. When the shutter is actuated, the substrate is pulsed, lowering the potential barrier of the well and effectively dumping the collected charge.*

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mechanism by which a stray optical path directly stimulates the vertical register.

Only the most intense of highlights will activate the generation of stray carriers by this means. Thus, vertical smear levels are, overall, lower than those of IT CCDs. This smear also is monochromatic in nature, and consequently has a less objectionable appearance.

It has taken years to advance CCDs to the status they enjoy today.

FIT version of HAD sensor

The initial 510-element interline-transfer CCD was followed by the important refinement of the dual frame-interline transfer CCD. So, too, a new imager, the ICX-40, brings into one new device all the important attributes of the 768 HAD sensor, coupled with the advantages of the FIT transfer mechanism.

The vertical shift register has a transfer speed of 1.5μs, approximately 60 times faster than the IT system. This has the beneficial effect of removing the image quickly, before a highlight can contaminate it. Smearing is further reduced by a factor of 40, curtailing sneak in even the most severe highlight conditions.

Broadcast vs. consumer imagers

Major CCD development programs are driven primarily by the advent of devices that can be used in the large consumer camera marketplace. Manufacturers ensure that each generation of CCD imagers will meet the luminance and chroma needs of single-chip consumer cameras. They carefully choose device parameters that also will provide high performance in professional broadcast cameras, which use three of these imagers. This approach has served well in focusing R&D programs and in capitalizing on volume manufacturing. It has elevated device yield and performance while lowering device cost.

Continued refinement of CCD imagers is likely to lead to continued performance gains. A corresponding effect may be improved prices for the cameras required in professional video applications.

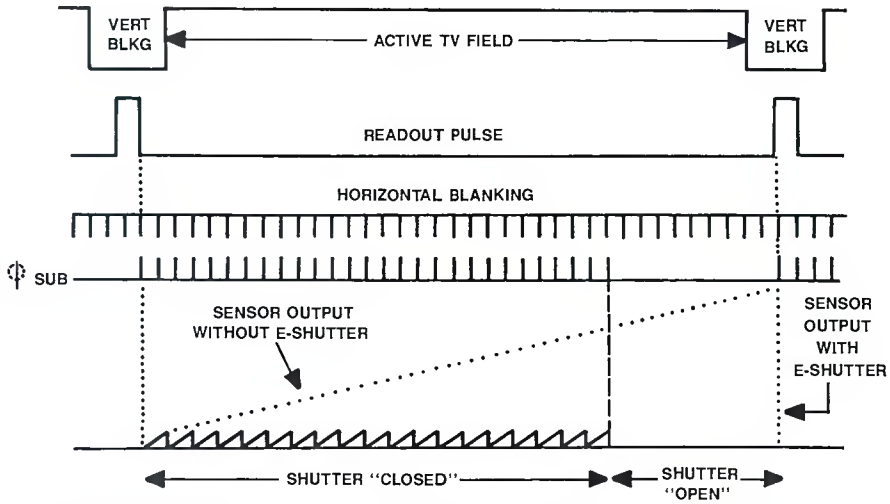

Figure 7. Pulses in the substrate periodically dump the well in a HAD device. This is equivalent to closing a shutter over the device face.

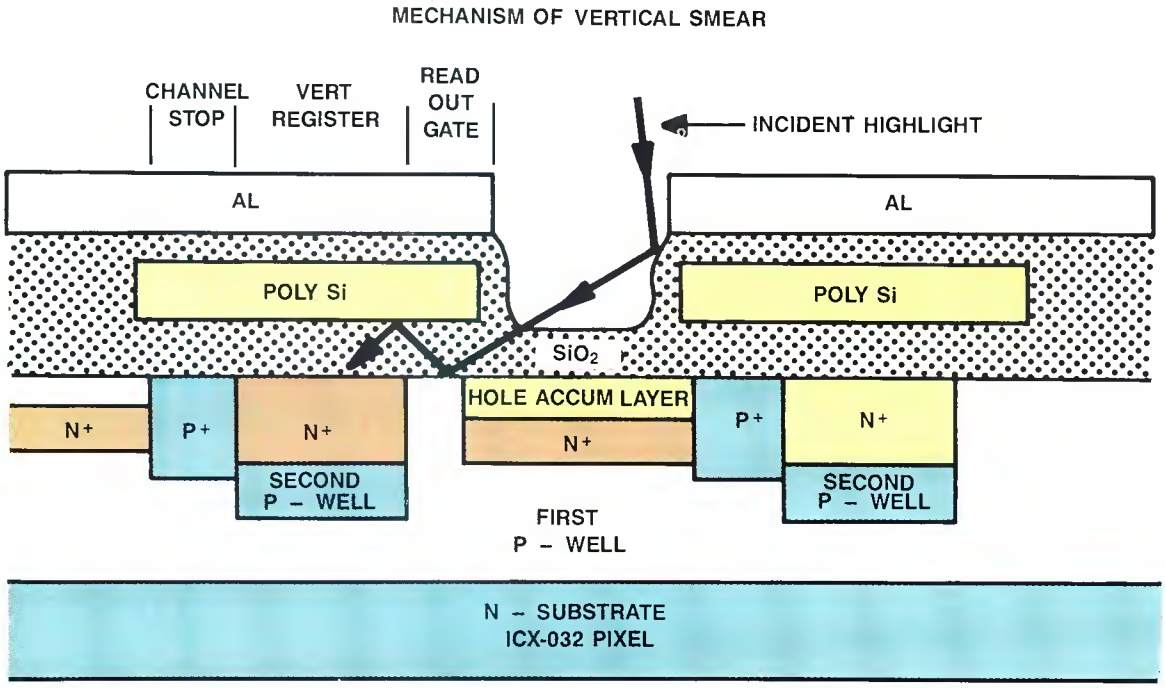

Figure 8. Optical "sneak paths" cause smear when bright highlights are propagated within the CCD and contaminate wells in the registers. Only the most intense of highlights will activate the generation of stray carriers by this means.

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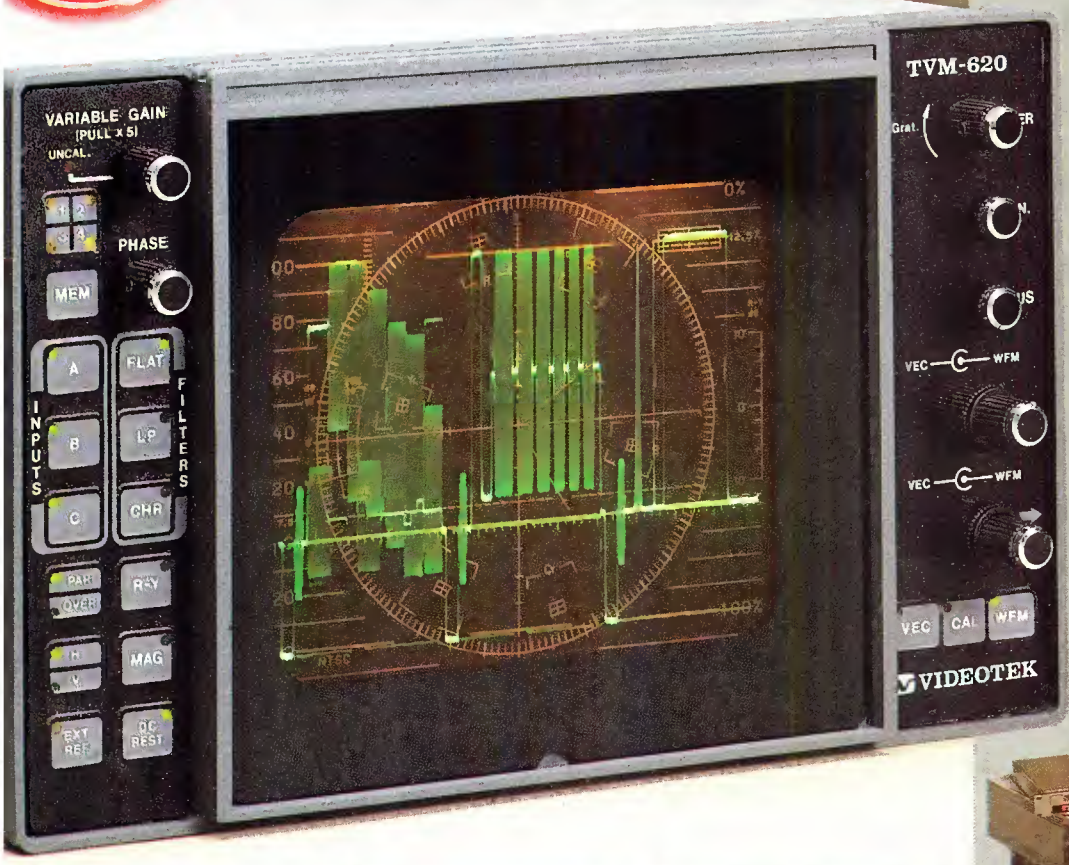

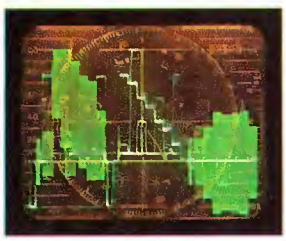

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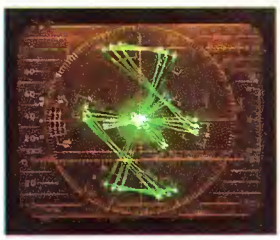

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Comark 60kW UHF Klystrode transmitter

By George Castle

In the broadcast world, change is the only constant. Not so with broadcast transmitters. Even though transmitters are fundamental to every TV station, the power tube technology within them has remained basically unchanged for decades. Consequently, most chief engineers are skeptical about claims of increased transmitter performance through "new technology."

The experience of installing and operating a new Comark 60kW Klystrode transmitter at our station, WFWA-TV, Channel 39 in Fort Wayne, IN, was eye-opening. It showed that Klystrode technology is not only reliable, but can provide better performance and lower operating costs than more traditional designs.

Rapid expansion

WFWA-TV is a public broadcast station serving the Fort Wayne area. Its origins can be traced to 1975. As a 100W public TV station, it received its programming from a neighboring PBS channel in Bowling Green, OH. Of course, 100W was simply not enough power to deliver good, reliable broadcast performance to any substantial geographic area.

In 1984, the station moved to a new location. It constructed a taller tower, bought a better antenna and increased power to 1kW. Although these changes improved coverage, they still didn't produce an acceptable picture outside the city. Station management realized that to attract a broader segment of the area's viewing public, a better signal was needed.

The station soon increased its transmitter output to 5kW with an ERP of 115kW visual. This covered Fort Wayne and some neighboring areas. However, because of the considerable competition for viewers in this market, the signal needed to cover an even larger geographic area if the station was to be truly successful. The staff worked hard to find a way to realize this goal within the strict financial constraints common in public broadcasting.

Examining the choices

One of the first tasks we undertook was to determine the level of transmitter power needed, based on the 14dB gain of the station's 33JRC antenna. The next step was to find an economical transmitter to provide that power. There were several choices, including transmitters using the latest klystron device, called a multistage depressed collector (MSDC) klystron. This device delivers more economical performance than its predecessors.

Castle is chief engineer, WFWA-TV, Fort Wayne, IN.

Performance at a glance

- *60kW*
- *Two Klystrodes in common amplification*
- *High efficiency — figure of merit 130%*
- *High redundancy*
- *Straightforward system design with no diplexer*
- *Water-cooled*

However, station engineers also were aware of a new tube, called a Klystrode, that was raising considerable interest in the broadcast community. Klystrodes promised greater efficiency and excellent RF and picture performance. They offered lower initial outlay and dramatically reduced operating costs. PBS, always concerned with cost savings in the broadcast business, had participated in the development of the Klystrode.

A fellow PBS station, WCES-TV in Wrens, GA, would soon become the first Klystrode-powered TV station. The WFWA-TV staff kept close watch on the progress at WCES-TV and simultaneously conducted an extensive analysis of UHF TV transmitters from every major manufacturer. Our final choice, by a considerable margin, was the Klystrode transmitter. It was determined that it would cost less, be less complex, and probably save the station tens of thousands of dollars in electricity costs.

On June 5, 1988, the Georgia station went on the air. Comments from the staff concerning the Klystrode's performance and ease of installation were favorable. The Georgia staff members also were impressed by the way the vendor supported the project. Based on their experience and the conclusions of our own analysis, we decided to buy the Comark transmitter.

About the Klystrode

The Klystrode is one of the latest significant developments in broadcast transmitting tube technology. It was made available as a commercial product only five years ago by the Eimac division of Varian Associates. The Klystrode combines the efficiency of a tetrode and the reliability of a klystron (hence the name), without the undesirable characteristics of either device.

Compared with a klystron, a Klystrode is less complex and less hardware-intensive. Many of the high-voltage components required in klystron transmitters are simply not needed by a Klystrode. It does not require a complex cooling system, and because it is not a pulsed device, it also does not require a beam-pulsing system. Rather, the beam current in the Klystrode varies with the average picture level.

The result is a power tube that can deliver significant cost savings through elegantly simple design. The Academy of Motion Picture Arts and Sciences considers the commercial implementation of the Klystrode so significant that it awarded Comark an Emmy.

Sculpting the system

Based on our requirements, the company designed a transmitter using two 2KDW60LF Klystrode power amplifiers driven by two solid-state exciters. Each tube can deliver 60kW in visual service, but they are operated at 30kW to permit common amplification in both tubes.

There are no diplexers or high-power switches in the system because the transmitter uses common amplification, which combines the aural and visual signals in the modulator, where levels are low. This eliminates the need for the high-power diplexers and many of the RF switches found in most high-power transmitters. Eliminating these and the associated high-power components increases reliability and reduces cost, size and complexity. (After 40 years of diplexers, I admit to having been skeptical of this configuration. Nevertheless, the Klystrode works extremely well in this mode.)

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Aural and visual signals in the transmitter are fed from the modulator to an upconverter. The upconverter drives two 300W solid-state amplifiers. These amplifiers, in turn, feed the two Klystrodes. The outputs of the Klystrodes pass through harmonic rejection filters and through a phasing network where they are combined. The signals then go through a notch filter and to the antenna. (See Figure 1.)

A motor-driven RF switch is used to provide the greatest operating flexibility. The switch reduced the plumbing required for signal routing and allowed us to keep the old 5kW transmitter on the air while we were installing the new one.

Either the first or second Klystrode amplifiers can be coupled into the antenna or into the dummy load. It's possible also to bypass both of them and put the 5kW transmitter (now a standby) into the antenna or the load.

The installation

I have installed two other high-power transmitters from the ground up, but no installation was as simple, straightforward and problem free as this one. The transmitter comes with major sections prewired and bolted together. This reduces installation time and lessens the job complexity.

The entire project went smoothly. We had estimated that we should allow 30 consecutive days to complete the installation. It took 29 days, from Oct. 2 to Oct. 30, and was only a few hundred dollars over budget.

The vendor lived up to its reputation for support during the installation, and its crew ensured that the transmitter was adjusted to its peak performance. It has stayed that way since we switched the output from the 5kW system to the 60kW Klystrode transmitter in December 1989. We haven't had a single problem. In my experience, this is rare indeed. Usually, an engineering staff still is learning the nuances of a new system months, even years, after installation.

Operating the transmitter

Because the station does not have a full-time technical staff, reliability, stability and simplicity of operation are extremely important. I have been associated with some transmitters that required an engineer to be on call 24 hours a day to solve technical problems. However, with this installation, I have received only three telephone calls from the staff. In each case, the situation was cleared up with the push of a button, not requiring my presence. The non-technical staff members have had no trouble working with the transmitter. Maintenance consists largely of periodically cleaning filters.

As for performance, the station's coverage has improved dramatically, allowing it to draw from a much larger potential viewer population. In fact, during telethons, it is not unusual to receive viewer calls from more than 75 miles away.

Reduced operating cost

Of course, TV station management wants to hear about the cost. In this area, the Klystrode transmitter is exemplary. The station — the entire building, not just the transmitter — now operates at 40% less than other local stations that have one-third the output power. Latest estimates show that the station's total electric bill will be about $45,000 this year. Another local station, which operates with an output power of less than 30kW, will pay more than $75,000 this year for the transmitter power alone.

Although it is too soon to tell from actual on-the-air experience, Varian estimates that, based on its accelerated life-cycle tests and experience with development of the tube, life expectancy should be about 40,000 hours (four to five years).

In short, the Klystrode transmitter is proving itself to be rugged, reliable and inexpensive to operate. Its design is comparatively uncomplicated, so there are fewer things that can go wrong. We feel confident that the transmitter's design eliminates many of the failure mechanisms that afflict some high-power broadcast transmitters.

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

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

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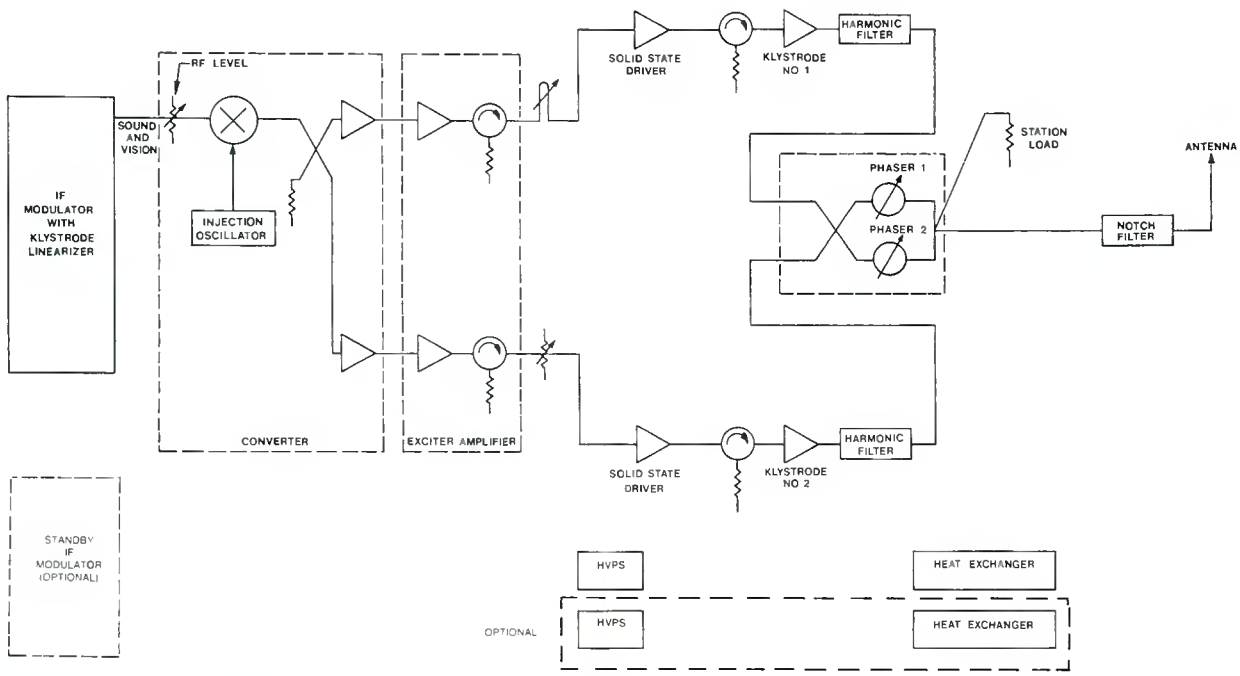

Figure 1. Block diagram of the Klystrode transmitter. It does not require many of the components of klystron transmitters, and fewer still because of its common-amplification system.

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Circle (88) on Reply Card

A baffling mystery, an unusual culprit

By Robert A. Jones
and Carl Gluck

Did you know that the Earth — good old *terra firma*, soil, dirt — can act as a *capacitor*? Although it may be hard to believe, it can happen. And when it does, it can be really confusing for the engineer who is trying to make sense out of an AM directional array.

Case history

A couple of years ago, KEBR-AM constructed a new AM directional antenna system near Sacramento, CA. The construction was easy. So was the tune-up, aside from a few mechanical problems with the phaser and the towers. Tests and measurements duly completed, the station obtained operating authority in the summer of 1988.

The system displayed good stability during the summer and the fall. When the wet season came around, however, the No. 3 tower showed signs of instability.

The system displayed good stability during the summer and the fall. When the wet season came around, however, the No. 3 tower showed signs of instability. As luck would have it, No. 3 was the reference tower.

Time of the season

When the pattern began to shift, it was attributed to a seasonal effect. This directional had not yet been through the wet season. Every directional antenna has a seasonal cycle. It normally takes a year or two to understand how variations in the climate may affect an array.

However, as the array went through the winter of 1988-89 and into the spring, the cycle of change did not seem to follow any pattern. A problem of some sort seemed to be indicated.

The station's used transmitter would, on occasion, go into spurious oscillations. Repairing this problem seemed to bring the system under control. A normal antenna monitor cannot detect the difference between the carrier signal and a spurious or harmonic signal. There was no instability for three months after the repairs were made, and the engineers were convinced they had solved the problem. This interim, however, turned out to be the lull before the storm.

Rainy season arcing

In the early spring of 1989, wet weather returned, and so did the instability. Again, tower No. 3 seemed to be the most problematic. Station engineers went through the usual steps to track down the problem. They checked, cleaned and tightened all connections in the system. They replaced every capacitor in the antenna. They even explored around the tower base to determine whether some ground wires possibly had become loose or disconnected. No luck.

One day, an engineer thought he smelled ozone, which, of course, can be generated by an electrical or RF arc. If there was arcing, it could explain the shifting pattern. The shift occurred at about a 3-second repetition rate.

It was unclear why tower No. 3 would be arcing. One reason could be some kind of problem in the tower joints or the guy wires. The chief engineer went out at night with field glasses and carefully spotted the tower, its guy wires and joints. He could not find any arcing.

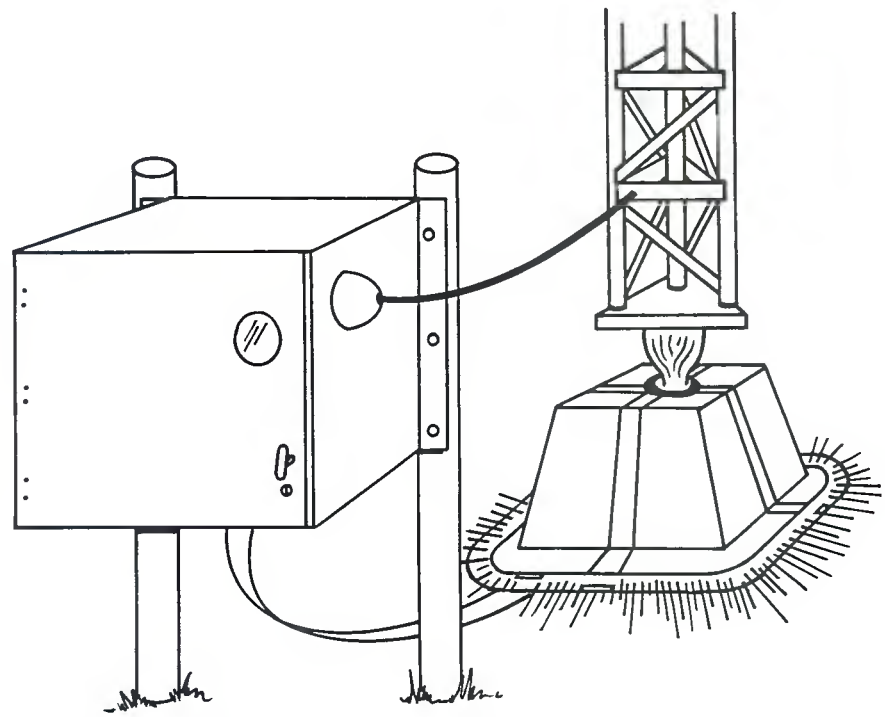

Figure 1. The ATU boxes were supported by pairs of metal pipes driven into the ground.

Jones is a retired consulting engineer based in La Grange, IL. Gluck is general manager of KYFR-AM, Shenandoah, IA.

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Perhaps the arc was happening where it could not be seen from the ground. To check, the station retained a climber. He climbed at night, carefully looking and listening as he ascended the tower. Again, no luck.

One day, an engineer thought he smelled ozone . . . If there was arcing, it could explain the shifting pattern.

An old trick used by engineers to find loose connections in a tower is to shake the guy wires and look at the meters. The engineers shook not only tower No. 3, but each of the other five towers as well. They discovered nothing. It certainly appeared as if a physical problem was afflicting tower No. 3, but it would not reveal itself through the usual tests and tricks.

Bad ground straps?

As they were about to run out of ideas, the engineers discovered that by pushing against the tuning box at tower No. 3, they could speed up or slow down the instability. Figure 1 is a representation of the tower base and antenna tuning unit (ATU) boxes. Inspection revealed that the tuning box door was not grounded. It is normal with metal tuning boxes to connect metal braid jumpers across each door hinge to ensure a perfect RF ground. For some reason, the manufacturer had overlooked the grounds on these ATU doors. The engineers quickly added grounds, but the in-

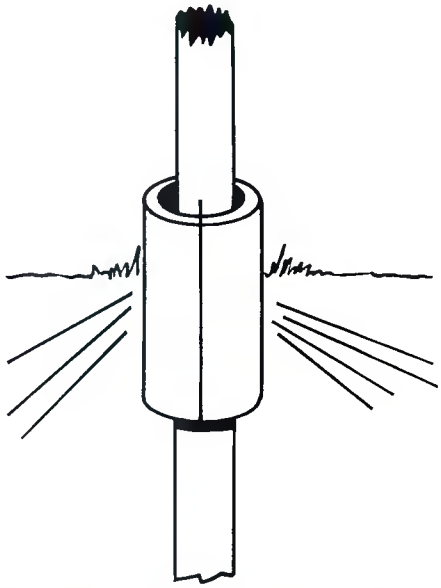


Figure 2. A sheath fashioned from split PVC pipe put an end to the pattern-shifting problem.

Every directional antenna has a seasonal cycle. It normally takes a year or two to understand how variations in the climate may affect an array.

stability continued. Pushing against the ATU box, however, still affected the rate of instability.

A careful look in and out of the box revealed that a good continuous 4-inch copper strap was correctly installed and brazed to the circular ring at the tower pier. However, the metal brackets and metal parts that supported the ATU boxes had not been grounded with copper straps. They were connected solely via their nuts and bolts. The obvious conclusion was that these unbonded pieces of metal were, on occasion, adding to or subtracting from the coupling to the tower.

As they were about to run out of ideas, the engineers discovered that by pushing against the tuning box at tower No. 3, they could speed up or slow down the instability.

The station hired a welder, who carefully bonded each brace and both metal posts to the ground strap. The instability slowed to one-third of its former rate. This clearly showed that the bonding near the base of tower No. 3 had affected the problem. But why?

Give it a whack!

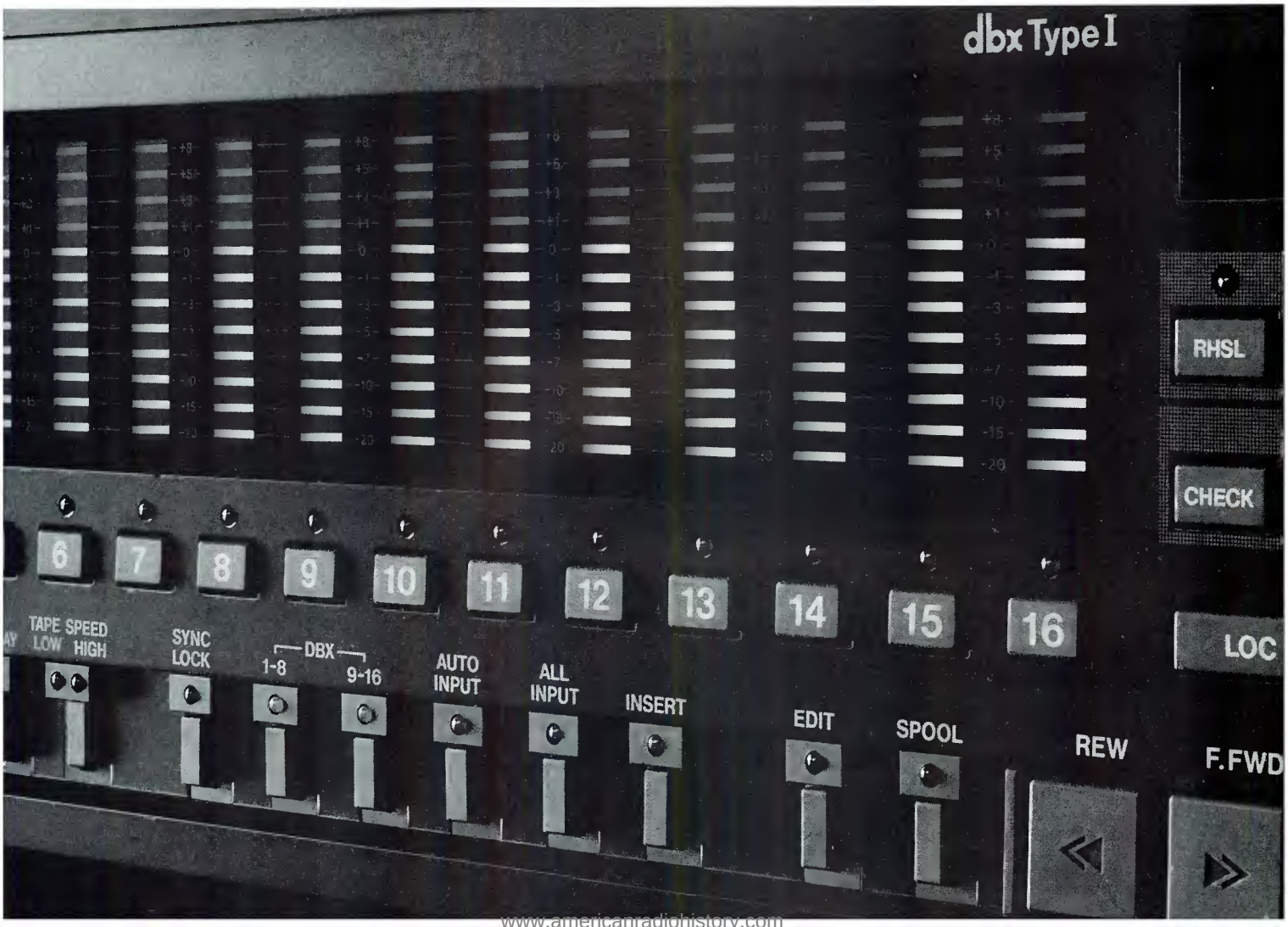
The frustration level among members of the engineering staff was peaking. At that point, an agitated engineer picked up a nearby piece of wood and took a good whack at a metal support post on one of the ATU boxes. The instability stopped. The obvious next step was to hit the pipe again. The jumping recurred.

Seeing nothing above ground to account for any changes, the crew began to dig down along the support pier. About eight to 10 inches down, they encountered the buried copper ground wires. While carefully removing the dirt from the wires closest to the pipe, they saw a blue flash. The arc was occurring between the ground wires and the pipe.

Gently pushing the ground wires away from the ATU box's supporting pipe quickly halted all the instability. The solution was to either tie the copper ground wires to the pipe or insulate the pipe from them. The engineers chose to insulate the pipe,

At that point, an agitated engineer picked up a nearby piece of wood and took a good whack at a metal support post on one of the ATU boxes. The instability stopped.

and bought some PVC pipe at the local hardware store. After cutting it longitudinally, they slid it down the supporting pipe, insulating several inches above and below the level of the copper wires. To be certain none of the other towers had the same problem, they did the same to each leg of every ATU box. (See Figure 2.)



The earth as a capacitor

In hindsight, it's apparent that the earth was acting as a dielectric between two plates of a large capacitor. One plate of the capacitor was the copper ground system, and the second plate was the metal pipe. As soon as RF energized the system, this capacitor would begin to charge up. When it reached breakdown potential, it would arc over and discharge itself. Having discharged, it would then recharge and continue the cycle.

While carefully removing the dirt from the wires closest to the pipe, they saw a blue flash.

The fact that it turned out to be a capacitive problem explained why the temperature of the ground and the water content had a distinct influence upon the repetition rate of the discharge. During Sacramento's dry season, the soil was too dry to arc over. When it rained, however, the arcing would reappear. A brief rain shower or a foggy day would not affect the arcing. After all, it took time for the moisture to soak into the earth to the depth of the ground wires.

This case history demonstrates two lessons that should be heeded by all station engineers. First, the unusual can happen. A ground system should not act like a capacitor, but in this case, it did. Second, be careful about using metal parts, such as the pipes used to support the ATUs. Do not install any metal near a tower without making provisions to either insulate or ground it.

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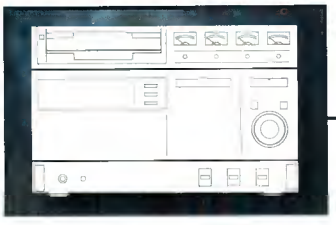

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Manufacturer test techniques at the end-user level

By Paul McGoldrick

Straight-line test techniques speed equipment maintenance.

Test and measurement instruments are among the staples of every broadcast or post-production facility. Whatever the complexity of an operation, there will always be a need to verify that all the pieces in the equipment chain are working at optimum levels.

Over the years, broadcasters have developed some tried-and-true methods for testing. But are those methods really the most effective ones for today's facilities? Or are they simply "the way it's always been done?"

Manufacturers also must use test and measurement equipment. However, the way they use it may vary greatly from the traditional approaches taken by broadcasters. This article will examine some of these manufacturer techniques and discuss the benefits they might offer to a typical broadcast, production or maintenance operation.

The broadcaster's basic needs

If asked to count on their fingers the names of all the test signals they could think of, many engineers would stop before they got to their second hand. A more careful look, however, will reveal that test signals are central to much of broadcast equipment servicing.

SMPTE color bars are a must. Beyond this, most operational needs could be satisfied with multiburst or sweep (for frequency-response testing), a linearity signal, such as ramp (for low-frequency checking), a high-frequency linearity signal, such as modulated ramp (for differential phase and gain testing), and a chrominance-modulated pulse signal (for chrominance-luminance gain and delay testing).

In network operation, there is also the need for network-approved test signals — composite signals, such as NTC-7, for example. Depending on the network's rules or labor agreements, much more detailed or product-specific signals also may be needed.

When stations adopt component video formats, these signals must be repeated in the component domain (except for certain adjustments performed using composite signals). Furthermore, stations must have suitable tests for the verification of timing and gain between the component channels. Adding D-2 to a station requires the capability to generate digital test signals.

For maintenance areas, these signals often are augmented with specific signals recommended by the equipment manufacturer. These allow for speedy recognition of problems in various parts of the circuits, or for easier alignment following repairs.

For a separate area, such as post-production, which today often involves D-1 equipment, an even greater variety of test signals is required. This is particularly so

McGoldrick is vice president of sales and marketing at Magni Systems, Beaverton, OR.

with respect to the timing of signals in the digital and the analog-converted environment. Equipment-specific test signals also are essential for the alignment of certain apparatus, such as standards converters, telecines, computer VGA formats and codecs.

Manufacturer testing: more, simpler, faster

Manufacturers of broadcast equipment also need test and measurement equipment. If you can't test it, goes the adage, then you can't make it.

In striving to achieve speedy, highly accurate and easily obtained measurements and adjustments, progressive equipment manufacturers have developed some imaginative approaches. Central to many of these is the use of specialized test signals. Test and measurement manufacturers get involved early in the development of new formats. Major equipment manufacturers often ask them to provide various strange and unusual signals during the R&D phase. They are asked for equipment-specific test signals when the new formats start to hit the production line.

Many of these signals are produced on programmable signal generators. These devices can produce virtually any wave shape in any of the current or projected video formats. This equipment can reduce a large range of calibrations and setups, which normally would require many hours of a highly-skilled test technician's time, to simple "straight-line" testing.

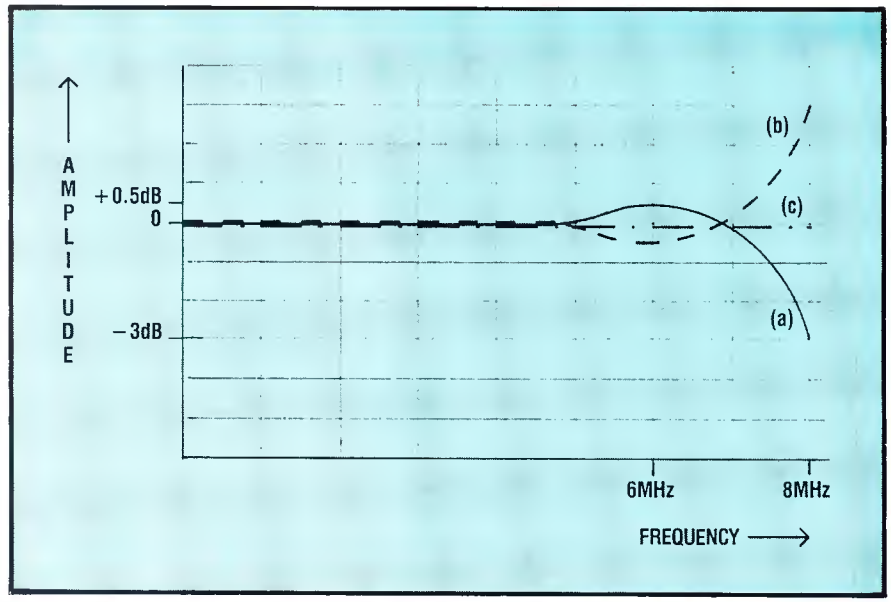

Figure 1. A frequency-response measurement based on the straight-line approach.

The straight and narrow

The straight-line concept is easily illustrated. Take, for example, an adjustment for frequency response. Figure 1a shows the curve of what might be a desired frequency response from a video circuit. The response in this case shows a slight rise at 6MHz, then a falloff to a −3dB point at 8MHz. The tried-and-true test procedure for aligning this circuit probably would involve adjusting the equipment so that its response matches a curve drawn on the test equipment's graticule.

Manufacturers of broadcast equipment also need test and measurement equipment. If you can't test it, goes the adage, then you can't make it.

Now for the straight-line approach. Instead of adjusting to the curve, suppose you inject a test signal with a characteristic that is exactly the opposite of the one desired. In this case, it would be a falling response of −0.5dB at the 6MHz point and a rising response, to +3dB at the 8MHz point. (See Figure 1b.) The result, assum-

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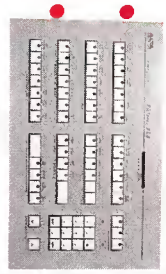

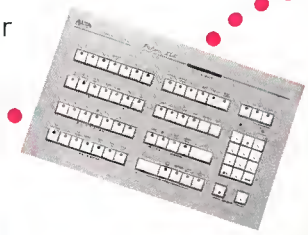

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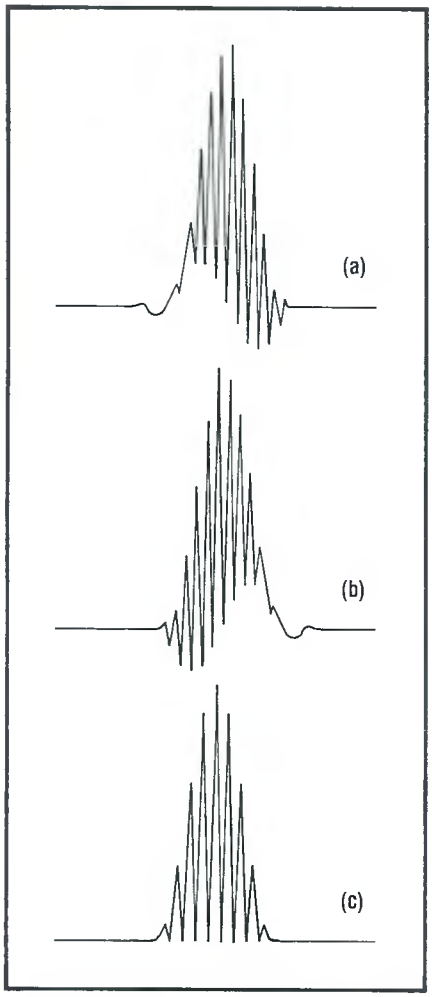

Figure 2. A group delay adjustment using the straight-line approach.

ing the circuit is linear to this rising response characteristic, will be a flat line out to the testing limit, as shown in Figure 1c. To accommodate adjustment tolerances, range markers can be generated in the field of the signal. The test technician then can see whether the adjustment is within the range specified for the circuit.

A similar technique can help adjust for group delay in a filter. The pulse shown in Figure 2a might be the known setup characteristic of a filter at a particular frequency of the envelope modulation. (Normally, of course, there would be a range of pulses modulated at the different frequencies of interest.) The wave shape generated in Figure 2b is the exact opposite of that group delay distortion. The filter then is adjusted for a perfect pulse response with an undistorted modulation, as shown in Figure 2c. Tolerance markers are more difficult to generate in these circumstances, but they could take the form of three sequential pulses in the video line. The first and third pulses could represent the limits, with the middle pulse being the ideal.

Zero-sum solution

Broadcasters can use a modification of the straight-line technique to align equipment without having to first derive the inverses of the various desired outputs. With standard inputs attached, sample the waveforms found at each stage of a known-good device — perhaps one that is fresh from the factory — with a programmable test generator. Save these data files. The next time the device comes in for service, feed the waveforms that were taken when the device worked perfectly to the inverted channel of an oscilloscope. Feed the output of the stage or device under test to the non-inverted channel. When the two waveforms null each other out, the equipment has been restored to its original level of performance.

Figure 3 illustrates an application for this technology. The two programmable generators in this example could be in any video format. The drawing shows a 1-wire (composite-type) signal for clarity. The device under test could be a complete unit or just part of the unit.

One of the generators provides a "perfect" input signal, undistorted unless some particular predistortion (a certain signal level or a pre-emphasis) is required. The second generator provides a copy of the desired output from the device. When the two signals are subtracted, the difference should be zero. If the difference is not zero, then the adjustment procedure, using different test signals for each specific distortion, should make them zero. The results can be analyzed by a digitizing video-recording device and held in memory, back in the same PC that issued the signal instruction sets to the generators. A printed hard copy presented to the end-user can be held as a QC record for that device.

Deliberate distortion

How do you calibrate an SC/H measurement circuit, or a circuit that is designed to switch or alarm at NTSC limits? A programmable signal generator makes this easy. Generate the desired non-zero SC/H signal, whether just a few degrees or at the 45°, 90° or 180° points. Placing these incorrect SC/H references on standard signals enables technicians to get a precise view of what these circuits are (or aren't) doing.

For another example, say that your vid-

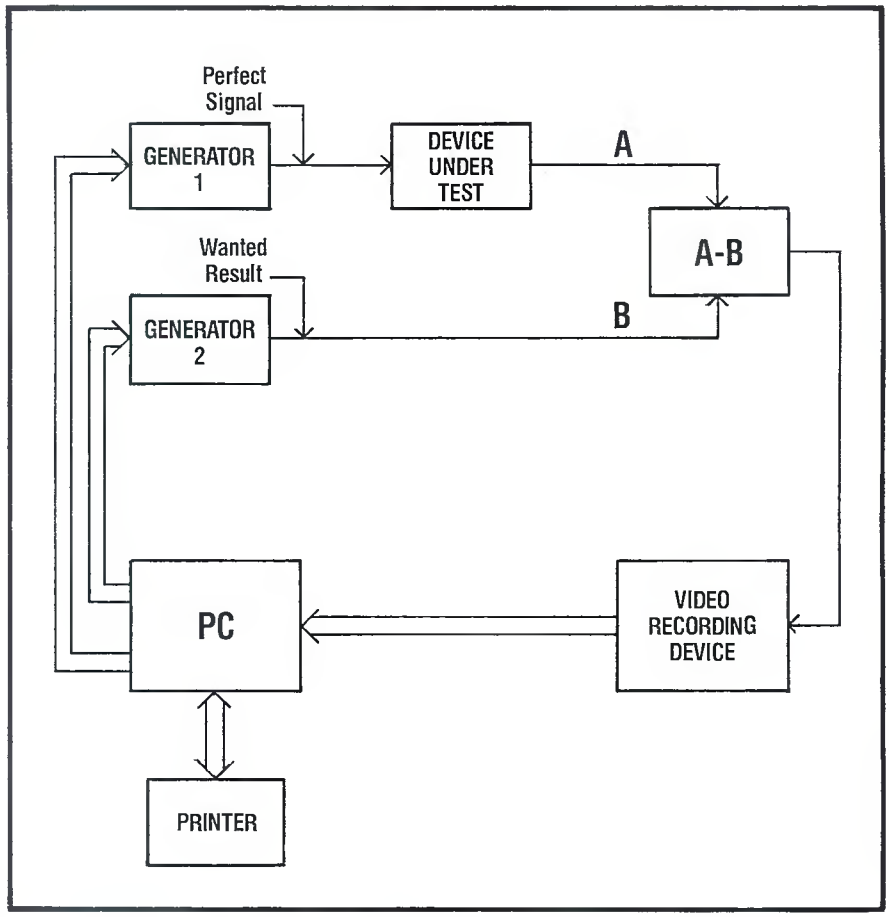

Figure 3. The straight-line approach can be adapted to align devices or modules within a device.

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eo switcher or router is specified as "flat to 30MHz" and is factory-checked to those levels. How are station engineers supposed to verify its performance? They could use an RF system, with a 30MHz sweep, diode detectors and all that, but anyone who has gone through this routine knows that it is a pestilential procedure. It is difficult because the engineer needs to calibrate both the sweep and detection system, then measure against that.

To avoid these pitfalls, engineers could generate a 30MHz line sweep on a standard NTSC sync and burst, then view it directly on an oscilloscope. (See Figure 4.) Remember to calibrate the scope against the signal directly. It is surprising how far down the response is, even on a new 200MHz oscilloscope.

Some measurement results are dubious when arrived at through conventional means. For instance, the classic method of measuring differential phase and gain in a low-distortion device, such as a video distribution amplifier, is to daisy-chain several of the devices together and measure the overall distortion. The result is then averaged for all the devices.

This procedure invites problems. The distortion of the devices themselves is so low that you cannot be sure you are not just measuring a distortion inherent to the generator itself. Also, the averaging of distortion creates a dangerous assumption, it may not be true that each device is producing the same distortion at the same luminance levels.

Programmable signal generators...can reduce a large range of calibrations and setups, which normally would require many hours of a highly-skilled test technician's time, to simple "straight-line" testing.

There is a way around this, again borrowing a leaf from manufacturers. The first step is to ensure that the generator itself is producing the lowest possible differential phase and gain. Figure 5 shows two channels of the same generator, producing between them a luminance ramp and a subcarrier. The ramp has an amplitude of 2Vp-p, and the subcarrier has an amplitude of 600mVp-p. Both the ramp and the subcarrier are produced with the same constant dynamic range of bits at identical clock rates, hence there is a strong coincidence between the signals. Generating the two signals at higher-than-normal levels allows them to be resistive-

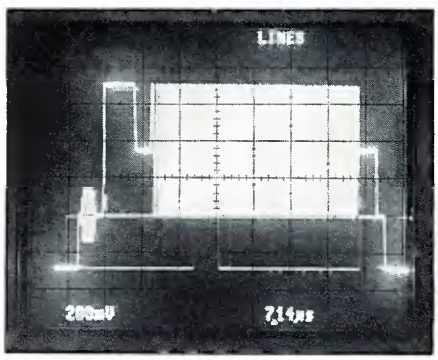


Figure 4. *Using a 30MHz line sweep imposed on standard NTSC sync and burst is a fast and convenient way to verify the performance of wide-bandwidth switchers.*

ly mixed together, producing a standard 1Vp-p modulated ramp with a literally immeasurable amount of differential phase and gain distortion.

Say that your video switcher or router is specified as "flat to 30MHz" and is factory-checked to those levels. How are station engineers supposed to verify its performance?

This signal would be serviceable for testing a daisy-chained series of devices. However, as mentioned previously, that approach is suspect. A better test can be made using a comparative approach. The programmable signal generator can produce a series of different subcarrier signals with different, calibrated amounts of distortion. By changing phase and the amplitude of the subcarrier in extremely small amounts, testers can see what exactly 0.1% of differential gain, or 0.1° of differential phase, looks like. They can make their measurements by inspection, or by inversion and summation as before.

CAV testing

Timing component video signals has now become a matter of course for many users. Many broadcasters that have CAV equipment use "bow tie" testing on a daily basis for machine checking. Manufacturers or servicers who wish to align the CAV test equipment must use a signal of greater

Special-purpose bow ties can solve problems in special areas.

precision than 10ns or 20ns markers provided by standard 500kHz bow ties. Bow ties done on different frequencies can meet this need. With 5.000MHz and 5.002MHz, for example, the markers will be spaced 1ns apart. Users, therefore, can resolve time differences down to about 0.25ns.

Special-purpose bow ties can solve problems in special areas. Modern equipment uses a large number of transcoder circuits. A programmable generator makes it relatively simple to devise a bow tie to check the timing of those circuits. Figure 6 shows a transcoding bow tie from color-difference signals to RGB.

Putting it all together

Automated signal generation and testing can make the maintenance and checking of broadcast equipment more of a shared process between manufacturers and station technical personnel. Manufacturers could put together files on computer disk that would include both the relevant standard test signals and the special test signals that have been written just for that piece of gear. These can be joined with a text file that tells the technician where to inject the signal, where and what to measure, where to adjust on the circuit board, whether there are any necessary precautions, and so forth. Figure 7 shows one such text screen from an instrument

calibration procedure involving a popular combination waveform monitor and vectorscope.

Consider the usefulness of this approach in the broadcast maintenance environment, where many different models and formats of VTRs, each with its individual quirks, might be seen. Such an approach also would simplify the training of personnel who are learning the ins and outs of a new piece of equipment.

Because it is shipped in an electronic format, documentation also would be simplified. Documentation would cost less to develop because technical writers could adapt large portions of the user manual directly from the internal procedures in use at the factory floor. Some of the files used for testing and alignment are proprietary in nature, because they reveal secrets about the products. However, access to at least part of those signals would give the broadcast engineer much more to work with than conventional bars and tone.

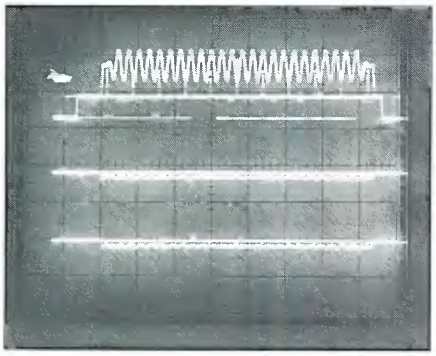


Figure 1. *A special bow tie signal used to align a CAV-to-RGB transcoder.*

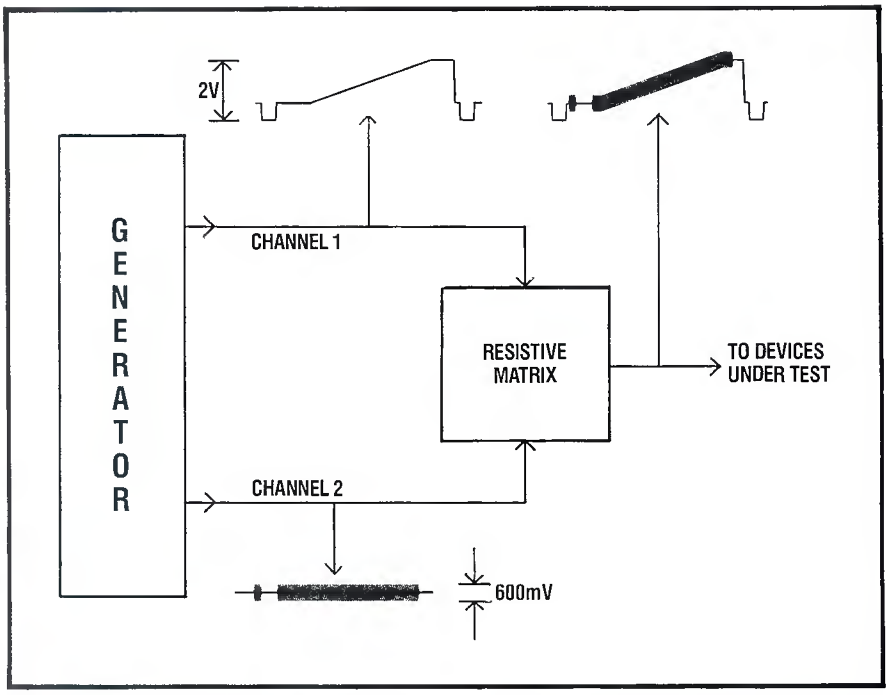
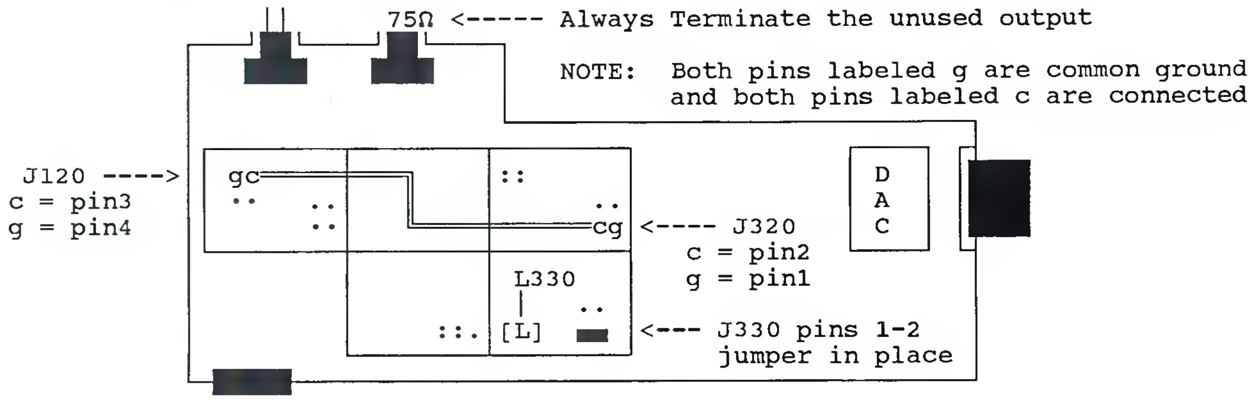


Figure 5. *Two outputs of a programmable signal generator can be used to create an inherently low-distortion modulated ramp signal.*

ADJUST FREQUENCY RESPONSE (1)

a. Remove five shorting jumpers from the Filter Section of the Output Board. Do not remove the jumper on J330-1,2.
b. Connect a wire jumper from J320-2 to J120-3.
c. Tune L330 for the minimum peak-to-peak amplitude of the waveform on the oscilloscope display.



PRESS ANY KEY TO CONTINUE

Figure 7. *A test procedure file page print-out from a PC display. Technicians can use this information to speed testing.*

In use today

Mention any of the household names in our industry, and you probably will find that these companies take the economics of the factory floor seriously enough to have adopted at least parts of this approach in their manufacturing operation. We might even go so far as to say that manufacturing test techniques such as these are already benefiting broadcasters. The more of the manufacturing-line tasks that manufacturers can solve with technology, the more stimulating, rewarding and productive tasks can be performed by skilled manufacturing technicians. The best ideas for improving factory procedures and quality come from these people. The rewards to the end-user? Better equipment that more closely matches the ideal specifications right out of the box.

Automated signal generation and testing can make the maintenance and checking of broadcast equipment more of a shared process between manufacturers and station technical personnel.

Continued from page 4

NAB accepting nominations for achievement awards

Nominations for the broadcast industry's highest engineering honors, the National Association of Broadcasters' Engineering Achievement Awards, are now being accepted. This year, for the first time, two awards will be given, one to a TV engineer and the other to a radio engineer.

The awards will be presented at the Engineering Luncheon during the 1991 NAB Convention in Las Vegas, April 15-18.

To qualify for consideration, candidates must have made a single contribution or contributions over a period of time, which measurably advanced the state-of-the-art of broadcast engineering. A contribution may include an invention, the development of new techniques, leadership in broadcast engineering or the dissemination of technical knowledge and literature.

Nominations must be received by Dec. 1. For additional details on selection criteria, or to request a nomination form, contact NAB's Science and Technology Department at 202-429-5346.

New approach needed for FCC's DAB coverage areas

Research by NAB's Science and Technology Department suggests that current FM coverage charts and assumptions used by the FCC in the VHF and UHF spectrum should be revised before the FCC considers establishing a table of allocations for digital audio broadcasting (DAB) stations.

Revising these charts begins the creation of a technical foundation for the allocation of digital broadcast stations, which one day may deliver CD-quality sound over the nation's airwaves. The research was conducted jointly by Michael Rau, NAB senior vice president, Science and Technology, and Lynn D. Claudy and Stanley Salek, two NAB engineers. The findings were presented at the 40th annual Broadcast Symposium of the Institute of Electrical and Electronic Engineers (IEEE) Broadcast Technology Society in Washington, DC.

Example calculations accompanying the presentation estimate a maximum signal radius of 43 miles for DAB stations using 1kW effective radiated power (ERP) at 100MHz, with the signal deteriorating rapidly beyond 43 miles. At 500MHz, the same power would provide a coverage radius of 31 miles, with rapid deterioration beyond that.

The Science and Technology Department welcomes technical contributions to this research. For more information, contact 202-429-5346. |:-)))|

Continued from page 58

ing. The system clock serves to synchronize data transfers on the buses.

- The tester must be able to drive the *DMA request* line. In order to borrow cycles from the microprocessor, the DMA request line must be driveable, not only at power-up, but every time it attempts a DMA access.
- The *DMA acknowledge* line must be operating. After requesting a DMA access, the test instruments wait until receiving a DMA acknowledge signal from the microprocessor before initiating a test.
- The *wait line* must be operative. Long duration tests require that the instrument temporarily halt operation of the microprocessor. This is accomplished with the wait line.
- The *reset line* must be functional. After the test instrument has issued a wait instruction, a reset signal is needed to resume operation.

Bus tests. Bus testing verifies the driveability of the address, data and control lines inside the buffers and address decoders. This process identifies lines that are stuck high, stuck low or shorted together. The integrity of the bus lines should always be checked first. Tests on the remainder of the circuitry will not yield valid results if problems exist on the bus lines.

Memory tests. Memory testing exercises each of the memory components of the system (RAM, ROM and peripherals). The operator typically specifies the starting and ending addresses, and the emulative tester performs the required quality assurance checks. ROM devices are checked by determining the checksum and comparing it with a known good device. RAM devices are checked by reading data into and out of memory. Memory patterns of various complexity may be used to exercise support circuitry. Data patterns typically used for RAM tests are designed to check each line for high and low conditions. For example, a hex 55 (10101010) followed by a hex AA (01010101) will confirm that no lines are stuck high or low. Tests for memory-mapped peripherals are identical to RAM tests, except that instead of specifying the RAM address range, the address of the desired peripheral is specified.

Input/output tests. I/O checks are used to test peripherals that are accessed through I/O addresses rather than being memory-mapped. I/O tests involve writing data to a specified address range and reading the results. If the data stored at each location corresponds to the data written to the address, the I/O port is functioning properly.

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New products

Audio routing control

By Harrison by GLW

• **ARS-9 routing switcher:** for multiroom recording, broadcast, film facilities; microprocessor-controlled router offers expansion to 256-in, 256-out matrix; completely transformerless design uses differential unit on all inputs and outputs; use as stand-alone system or with audio consoles, such as Harrison Series Ten B automated mixer.

Circle (360) on Reply Card

International VCR

By Instant Replay

• **World Traveler:** videocassette recorder plays cassettes recorded in NTSC, PAL and SECAM standards; playback may be viewed on a receiver of any of the three standards; NTSC and PAL/SECAM tuners, multiple voltage power supply permit recording off-air.

Circle (361) on Reply Card

Video radio systems

By Microwave Radio

• **MicroLink III:** 18GHz and 23GHz microwave products for broadcast applications in heavy congestion, interference-prone environments; uses many of the same models of existing FLR series long-haul radio products, permitting quick access to replacement items in case of failure; rack-mount baseband interface, antenna-mount RF unit; AC/DC operation for up to four audio subcarriers; single, dual polarization antennas in two-, four- or six-foot diameters.

Circle (364) on Reply Card

Audio measurements

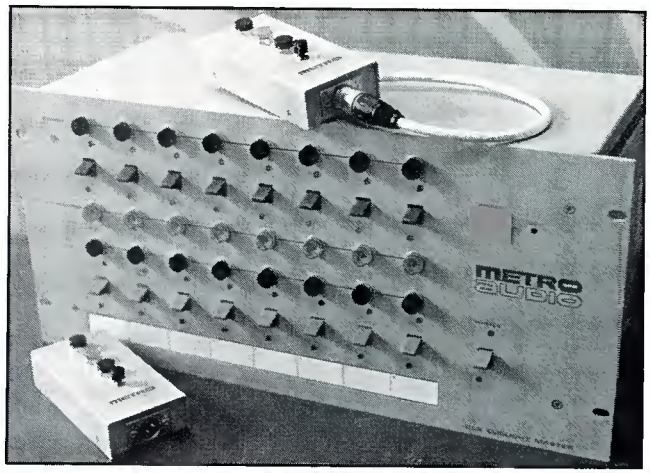
By Lindos Electronics

• **LA100 analyzer:** combines tests for distortion, noise, frequency response, phase, crosstalk, wow/flutter and quantizing distortion in addition to frequency and level measurements; LA101 synthesized oscillator and LA102 measuring set units; single tests or test sequences initiated by single-button operation or by RS-232 control; LCD panel provides numeric values, graphics, pass/fail indication; output port for documentation on most standard printers.

Circle (362) on Reply Card

Visual cuing

By Metro Audio & Communications



• **QL8 system:** 8-channel visual cuing system; red, yellow and green indications denote standby, acknowledgment and go status with series connections enabling quick discovery when out-station bulb failure has occurred; systems may be linked for 16-, 24- or 32-way systems; satellite out-stations connect via 3-pin XLR mic cable and standard connectors.

Circle (363) on Reply Card

Titling system upgrade

By Paltext Imaging Systems

• **Fast Font processor:** five-fold increased speed in typeface processing available in Version 6 software for Aston 4 and Caption character generator systems; page boundaries are deleted for roll and crawl operations permitting simplified addition or removal of rows of text; automatic page sequencing with varying dwell time for each page if desired; batch function allows sequential processing of 100 display fonts.

Circle (370) on Reply Card

PAL equipment, booklet

By Tektronix

• **VS-211:** video synchronizer strictly for PAL standard; uses 10-bit A/D, D/A conversion with $4\times f_{SC}$ sampling for four times increased accuracy and resolution; analog, dual composite digital inputs, outputs; delay port for 118-AS audio synchronizer; remote-control unit operates six VS-211 systems with control or selection of all proc-amp controls, freeze, ID assignment and round-off to 8-bit digital output during active video.

• **PAL manual:** "Television Measurements—PAL Systems" discusses 20 measurements noted by the CCIR for PAL TV; narrative describes correct practices for measurements; appendices with valuable information on the PAL standard.

• **TSG-120:** signal source for maintenance shop provides composite, Y, C and Y/C outputs as well as a stereo audio signal.

Circle (400) on Reply Card

Betacam is rapidly becoming one of the most popular production formats in both field and studio applications. And Ampex 198 Betacam and 298 Betacam SP videocassettes are popular professional choices for a full range of needs. When you need high reliability in an ENG/EFP tape, the choice is Ampex 198. Or, when you need the ultimate in performance, the choice is Ampex 298, with its high-coercivity metal-particle formulation. Both offer you high-impact ABS plastic cassettes for rugged dependability and the unique Ampex labeling system for easy access and storage. And all backed by the industry's most acclaimed service and support organization. No wonder they're so popular. They're from Ampex.

AMPEX

THE PROFESSIONAL CHOICE

Ampex Recording Media Corporation
401 Broadway, Redwood City,
CA 94063, (415) 367-3809

Circle (100) on Reply Card

Test source, linear DSK

By Polar Video

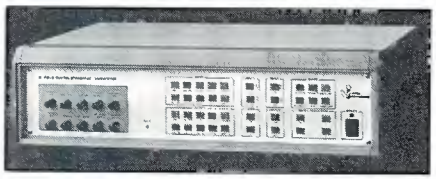
• **PTSG-601:** digital or digital and analog generator for YUV or RGB signals; 24 standard patterns switchable between NTSC, PAL; permits user-programmed patterns; gen-lock capability. Edit interface: allows Polar Video PVM-1 and PVM-2 production switchers to be used with editing controllers providing GVG-100 protocol; controls mix, wipe, effects key, crosspoints.

• **PCK-2 keyer:** chroma-key and linear downstream key with RGB or YUV chroma inputs from Betacam source; foreground, background inputs and outputs may be Y-C/S-VHS or composite signals.

Circle (398) on Reply Card

Video processing systems

By James Grunder & Associates



• **DTC 2604:** bidirectional standards converter; supports NTSC, NTSC-4.43, PAL, PAL-M, PAL-N and SECAM as well as ½-inch, ¾-inch, 1-inch, S-VHS and component video formats; 4:2:2 8-bit processing offers full time base correction, with 4-field, 4-line interpolation for adaptive motion processing; features include noise reduction, image enhancement; from International Video.

Circle (401) on Reply Card

Dealing with EBS

By National Association of Broadcasters

• **EBS training videotape:** 28-minute tape available from NAB explains proper procedures in an EBS emergency situation; indicates procedures to be followed by technical, management and on-air staff; gives the information to remain compliant with FCC regulations regarding EBS operation.

Circle (389) on Reply Card

Klystron accessories

By GAMMA Microwave

• **Focusing electromagnets:** spare or replacement assemblies for many Varian klystron and Klystrode power devices; all products per original drawings and specifications of Varian Microwave Components and Magnetics Operation for complete interchangeability with Varian counterparts; following acquisition of Varian division, also provides repair, overhaul and remanufacture of original Varian magnets.

Circle (375) on Reply Card

Audio editing system

By New England Digital

• **SoundDroid:** second-generation digital audio editing software; developed with Lucasfilm; works with PostPro and PostPro SD recorder/editor systems; graphic representations of cuesheets permit point-and-click approach to moving sounds and setting cue points; parametric EQ, filtering performed in real time; non-destructive editing.

Circle (390) on Reply Card

Radio automation system

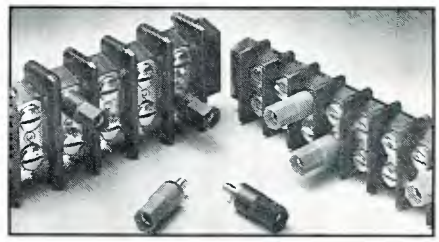
By SMARTS Broadcast Systems

• **SMARTCASTER:** computer stores commercials on hard disk drive with 240 30-second spots on one 60Mbyte drive; interface for satellite-relayed programming service; 7-day programming stored on hard disk to avoid loss of schedule in the event of power failure; link to accounting and traffic systems; automatic change of liners with change of announcer shifts; use as full-time or live-assist system.

Circle (409) on Reply Card

Measurement assistance

By ITT Pomona Electronics



• **Model 5699 jacks:** threaded banana jack replaces screws in terminal strip, permitting measurement equipment to be plugged in to free hands from holding metering probes; available in 6-32, 8-32 and 10-32 standard threads, various colors.

Circle (383) on Reply Card

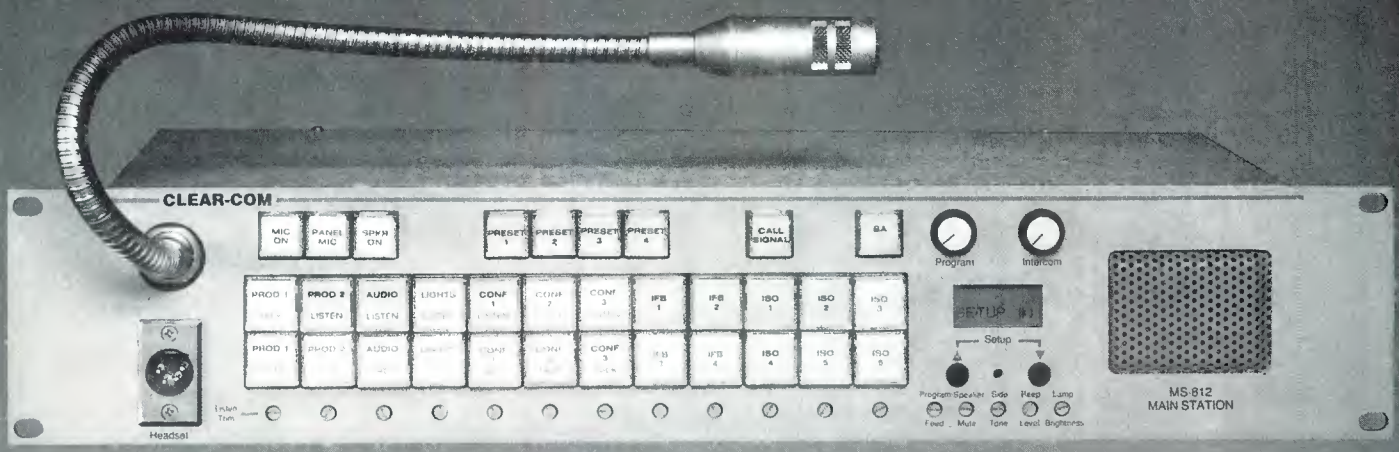
Wiring components

By Wireworks

• **12 channel series:** audio wiring products to augment multiple channel operation; series includes isolated mic splitters, main/extension multitrunk cables, XLR multitail fanouts and stage boxes with various input configurations; splitters incorporate Jensen transformers.

Circle (419) on Reply Card

Thought you couldn't afford a programmable master station?



For $3,100* we think you can!

Introducing Our New 12-Channel Communications Control Center.

The new MS-812 party-line intercom master station is so incredibly easy to program, you'll wonder how you ever got through a production without it!

Special prompts in the LCD window show you exactly what you're doing every step of the way. Programming 8 IFB channels, talks, listens, privacy, even walkie-talkies is a snap.

You can preset up to four configurations and recall them with the touch of a button. So go ahead, switch between rehearsals, live performances and taped shows. You might not remember all the configurations, but the microprocessor memory never forgets.

Renting Your Mobile Truck Or Facility?

No problem. Four complete setups can be stored in memory to instantly recall any event. Just think of the time you'll save. You can go from a football game to a golf tournament to late breaking news coverage without having to reconfigure the whole setup. No other master station can do that!

*8-Channel version even less.

A Front Panel You'd Know In The Dark.

All the "dual-action" controls are where you'd expect them to be. Each responds instantly to the lightest touch. And since your lighting conditions can vary, we've installed an adjustable brightness control, too.

There's individual channel "listen" adjustments, 12 talks, 12 listens, interruptible program feeds, and up to 16 external ISO channels. Plus visual and audible signaling, automatic headset detection, and so much more.

Clear-Com. You've Been Using Our Remote Stations and Beltpacks For Years.

Our quality is legendary in theaters and performing arts centers around the world. Now with the new MS-812, you can have more flexibility in a TV production intercom system. For less than you ever thought possible. Call us for complete specs today.

Clear-Com SYSTEMS

945 Camelia Street, Berkeley, California 94710
USA/Canada-TEL 415-527-6666 FAX 415-527-6699
International-FAX 415-932-2171

Circle (101) on Reply Card

Expanded music library

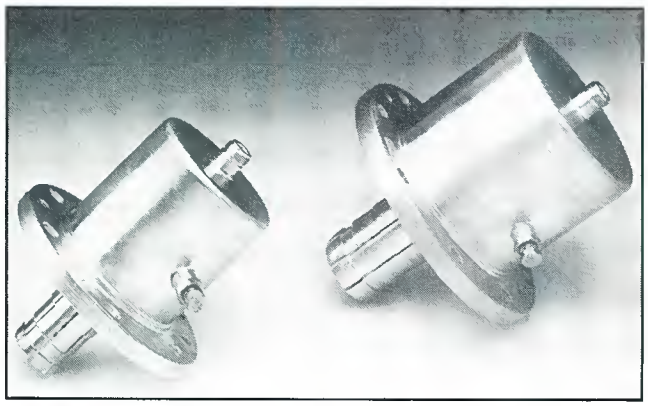
By QCCS Productions

• **PBTM IV:** Pro-Background Theme Music; new volume of sports and action music available on chrome cassette or CD containing 10 full length themes with :30 and :60 spot versions of each; total buyout plan.

Circle (371) on Reply Card

Line couplers

By Myat

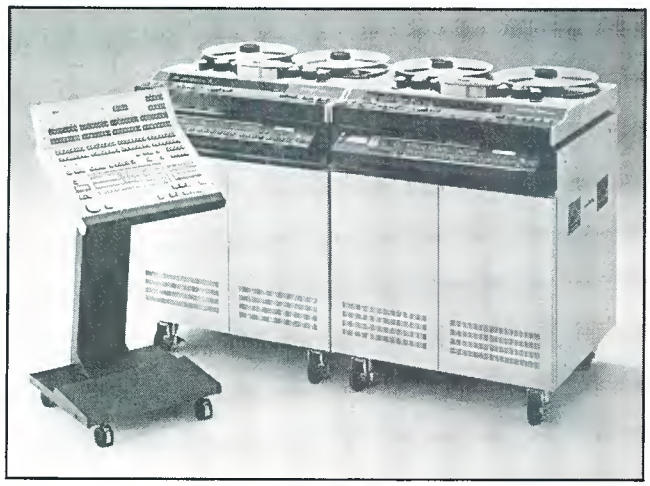


• **Step reducers:** RF devices to simplify transmission line diameter change; 401-059 for 4 1/8-inch and 301-059 for 3 1/8-inch to type N; solid brass construction with VSWR of 1.02:1 or better over a frequency range to 800MHz; pressure ports with pressure-tight, O-ring-sealed flanges avoid gas barrier requirements.

Circle (367) on Reply Card

Digital, analog ATRs

By Otari



• **DTR-900-II:** second-generation design using PD digital format; 32-track units may be used in tandom to 64-track operation; 8× oversampling; linear power for analog electronics; optional synchronizer and machine controllers; selectable crossfade times, crossfade curves; time advance output.

• **MTR 90 Series III:** analog multitrack audio recorder with 16-channel and 24-channel versions using 2-inch tape; 50% faster winding speed; tape load error detection, auto shutoff, end of reel sensing and reel size sensing features; variable speed from 0.2× to 0.2.5× forward or reverse.

Circle (368) on Reply Card

Radio spectrum data

By Strother & Associates

• **FM channels source book:** state-by-state listing of available FM channels; special reports available on by-state basis for individual channels or entire state showing spacing and usable areas for each channel; electromagnetic interference studies for specified transmitter sites of available FM channels.

Circle (374) on Reply Card

Integrated production

By VATEK

• **UNITY:** combined functions of 8-input component analog switcher with D-1 capability; dual-channel digital effects; CCIR-601 processing with full bandwidth key channel; supports RGB, YC, component analog and composite sources; D-1 and D-2 capabilities optional; permits control panels from effects, switcher, keyers, M/Es, etc. to control from easily entered editor controller inputs.

Circle (380) on Reply Card

Multipurpose mixer

By Otari

• **Series 54:** 24-bus audio console serves production, recording, broadcast and post-production functions; each input module contains separate dual paths, including faders, access to EQ, auxiliary sends and assignment to either of two stereo mix buses; may include DISKMIX 3 moving faders and automation systems; configurations to 60-channels with 120 independent inputs.

Circle (369) on Reply Card

Enhanced listening environment

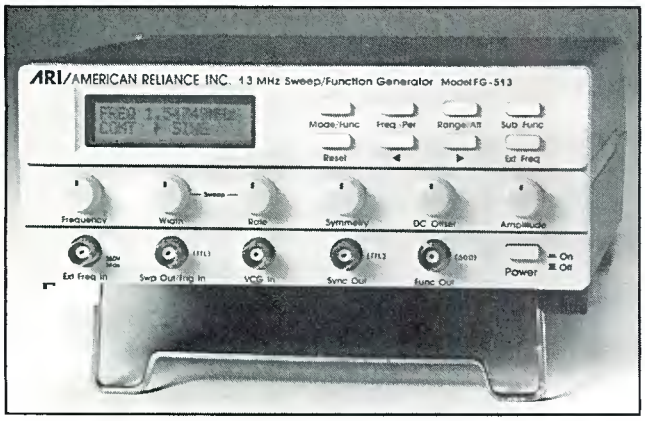
By AKG Acoustics

• **K 1000:** reference listening system; headphone system with "earphones" angled away from the ears; permits sound from one transducer to be heard by the other ear, giving an enhanced spatial perspective unavailable with most headset designs with typical shells and ear cushions; VLD ventilated linear dynamic magnets help to produce an acoustically open transducer.

Circle (351) on Reply Card

Maintenance shop products

By American Reliance/ARI



• **GS-500 series:** function generators with frequency counter capabilities to 100MHz; -506 generates sine, square, triangle, ramp forms from DC to 6MHz; -513 extends the output to 13MHz; adjustable linear or logarithmic sweeps and waveform symmetry permit variation from 10% to 90% duty cycle; 6½-digital display indicates frequency, waveform type, mode.

• **Programmable power supply:** control from front-panel keyboard or GPIB bus; several models cover 0-32VDC range with current levels of 0-2A or 0-5A and 0-7VDC at 0-10A; 3-year warranty.

Circle (352) on Reply Card

Video encoder

By Broadcast Systems Design

• **Model 130:** produces RS-170A composite NTSC as well as Y/C, Y/688 and Y/629 component signals from RGB components with composite sync; 800-line resolution; available in PAL version; avoids chroma-luminance crosstalk, chroma smear and crawling edges without the use of comb filter circuits.

Circle (353) on Reply Card

Editing, processing options

By ColorGraphics Systems

• **DP 4:2:2 speed enhancement:** incorporation of Intel 80486 CPU with software optimization increases the speed of operation of the DP 4:2:2 paint and animation system; speed enhancement from 4× to 8× faster than previous design.

• **Enhanced editing:** simplifies mix effects, machine control, layering with DP 4:2:2 graphics equipment; video-clip approach used to determine edit point locations rather than entry of time code numbers.

Circle (355) on Reply Card

Multisource monitor

By Broadcasters General Store

• **The Master Spy:** radio programming skimmer, monitor from Kyfho Labs; permits tracking of eight signal sources with programmable record and pause times for eight remote-controllable cassette recorders; easily keeps a day-part "snapshot" of programming material broadcast in the market; can also be used to monitor other types of signal sources.
Circle (354) on Reply Card

Power analysis

By Dranetz

• **Series 656A analyzer:** monitors power line AC or DC voltage and current disturbances; analyzes stored data quickly with integral CRT to show voltage, current and impulse activity profiles; ZOOM mode magnifies selected portion of waveform for more accurate analysis and measurement; helps track power-line problems in dirty power environments.
Circle (356) on Reply Card

Bandwidth enhancement

By DYNAIR Electronics

• **Dynasty 100 upgrade:** extended frequency response to 120MHz for high resolution, multiple-level component video in RGB or monochrome formats; 10×10 to 50×100 size matrices; plug-in modules accommodate coaxial or fiber-optic inputs and outputs.
Circle (357) on Reply Card

Image storage, retrieval

By Electro Communications Systems

• Optical disk storage with scan conversion, permits creation of VHS/S-VHS tape from stored images. EC3033 HR OMDR magneto-optical recorder. FSC-64000AL automatic frame scan converter.
Circle (358) on Reply Card

30MHz utility router

By Grass Valley Group

• **PERFORMER:** 10×1 series, wideband signal distribution and control; RS-422/232 interface; removable screw type terminals; 3-level switching with LED status indicator; lockout avoids accidental switcher operation; available with wideband video and dual audio matrices; compatible with TEN-XL, TEN-20/20-TEN control panels.
Circle (359) on Reply Card

Business

High-technology company founded

Nucomm, Hackettstown, NJ, was established on July 27 when it purchased Nurad's commercial microwave radio division. The company will initially produce portable analog microwave transmitters, receivers, modulators, demodulators, ENG central receiver systems, STLs and ICRs, and ancillary devices to provide complete turnkey systems.

Nucomm will also perform all warranty repairs on Nurad equipment.

Tektronix to support CADRA-III design software

Tektronix, Wilsonville, OR, has announced its support for CADRA-III, computer-aided design software from Adra Systems.

Tektronix has also unveiled a discount program to encourage users of its TekniCAD design software to upgrade to CADRA-III on Tektronix's new XD88 series of visualization workstations and TekXpress color X stations.

Tektronix is offering CADRA-III, Plot software and a TekniCAD-to-CADRA file translator free to TekniCAD users who purchase CADRE training and a 1-year CADRE maintenance contract. The offer expires Aug. 15, 1991.

Digital Microwave establishes R&D division

Digital Microwave, San Jose, CA, has established DMC Laboratories, a separate division that will focus on advanced development and new technologies.

Audio Kinetics signs agreement with Sondor

Audio Kinetics, Hertforshire, England, has signed an agreement with Swiss film machine manufacturer Sondor. Sondor will distribute Audio Kinetics' ES.Lock machine control and synchronization products throughout Eastern Europe, using its own network of representatives. Sondor has also adopted Audio Kinetics' ES.Lock as its standard machine control system.

Lightning Prevention Systems chooses new sales rep

Lightning Prevention Systems, Berlin, NJ, has chosen Dixie Electronics Association as its sales representative in Georgia and Florida.

Tech-Sym purchases Continental Electronics

Tech-Sym, Houston, has completed the purchase of nearly all of the business and assets of the Continental Electronics Division of Varian Associates through a newly formed, wholly owned subsidiary. The subsidiary, named Continental Electronics, has assumed certain liabilities of the Continental Electronics Division. The purchase price is subject to certain post-closing adjustments.

Tel Test relocates headquarters

Tel Test, a Corporate 100 company, has relocated its headquarters within Gainesville. The new address is 2208 NW 71 Place, Gainesville, FL 32606.

Professional services

Preview

December...

TECHNOLOGY FORECAST FOR 1991

- **State of the Industry Report**

Predicting how broadcasters plan to meet the challenges of new technology and alternative-entertainment media is a difficult task, but one made easier by the annual *Broadcast Engineering* survey of radio and TV stations' buying plans.

- **Bottom-Line Quality in Broadcasting**

Stations need to be as concerned about quality as manufacturers. What's the key to bringing high-quality signals to your audience?

- **Direct Broadcast Satellite in the United Kingdom**

Our European friends are running full speed toward DBS broadcasting. Last April, the United Kingdom implemented five channels of TV satellite broadcasting using D-MAC encoding and 1-foot-square receive antennas.

- **View From the Top**

While looking toward the future, this year's panel of experts also tells what it's like in the trenches.

January 1991...

BROADCASTING FROM THE FIELD

- **Getting Your Signal Back Home**

Remote broadcasts can be a lucrative — or a loosing proposition. The difference usually depends on the technology needed to distribute and back-haul broadcast signals.

- **Communicating With the Field**

One of the most crucial aspects of remote broadcasting is effective communications with the crew working away from the station. This article looks at cellular technology as one method to keep in touch with remote crews.

- **Sharing Part 74 Spectrum**

Today's compact frequency spectrum means that everyone has to cooperate — or everyone looses. Because the FCC has, for the most part, washed its hands of frequency coordination, it's more difficult than ever to find an interference-free frequency.

Classified

Classified advertising now available as Classified Display or By-the-word.

Classified Display: $100 per column inch, per insertion, with frequency discounts available. 1 inch minimum, 10 inches maximum per ad. Blind ads $40 additional. Reader Service number $50 additional. Spot color available for $150 (color determined by publisher).

By-The-Word: $1.75 per word, per insertion. Initials and abbreviations count as full words. Blind ads $40 additional. Minimum charge $40 per insertion.

Contact Renée Hambleton, at (913) 888-4664, for information on frequency and pre-payment discounts. To place your classified ad send your order and materials to Broadcast Engineering, Classified Ad Mgr., P.O. Box 12901, Overland Park, KS 66212.

HELP WANTED

CHIEF ENGINEER WNOL-TV, Fox 38 New Orleans is looking for an experienced, hard working engineer with engineering management experience. Strong knowledge of digital and analogue electronics is required, as well as background in studio electronics, including Sony Betacam and one-inch formats. Comprehensive knowledge of RCA UHF transmitters essential. Responsible for operating and capital budgets and managing master control and maintenance staffs. Minimum of three years experience in broadcast engineering management as well as FCC General Class license of SBE certification essential. Please send resume with salary history to Madelyn Bonnot, General Manager, WNOL-TV, 1661 Canal Street, New Orleans, LA 70112-2862. No phone calls, please. EOE 11-90-1t

MAINTENANCE ENGINEER Top Florida post house with CMX, Sony D-2, 1", & Beta Decks, ADO's, Rank Cintel, Graphics Etc. Seeks experienced maintenance engineer to grow with us. Good opportunity for right person. Broadcast Video, Inc. 20377 NE 15th Court, Miami, FL 33179 Rick Legow 1-800-826-8864 11-90-1t

HELP WANTED

CHIEF TELEVISION ENGINEER. WKYU-TV, the Public Television Service of Western Kentucky University, is seeking a chief television engineer to assume responsibility for the transmitting system, production center, and associated television facilities. The Channel 24 400KW ERP transmitting plant is less than 2 years old. The production facility includes Sony 1", Betacam, Chyron, Ampex ADO, etc. Required qualifications include at least five years experience with RF and studio maintenance and formal training in electronics. Knowledge of microwave, broadband cable and fiber optics is desirable. Applicants must demonstrate good interpersonal and leadership skills. The position offers a competitive salary and excellent benefits. Bowling Green, Kentucky is a progressive and growing community with a diversified economic base located just one hour north of Nashville, Tennessee. Western Kentucky University is a comprehensive institution with an enrollment in excess of 15,000. Send a letter of application, resume and names of three references to: Chief Television Engineer Search, Office of Academic Affairs, Western Kentucky University, Bowling Green, KY 42101. Women and minorities are encouraged to apply. An Affirmative Action, Equal Opportunity Employer. 11-90-1t

RF ENGINEERS AND SATELLITE EARTH STATION TECHNICIANS. Military experience OK. Please send resume to: S.T.A.R.S., 16250 Filbert St., Sylmar, CA 91342. Attention: Diane Streett. 11-90-1t

Use BE classified ads

HELP WANTED

VIDEO MAINTENANCE TECHNICIAN

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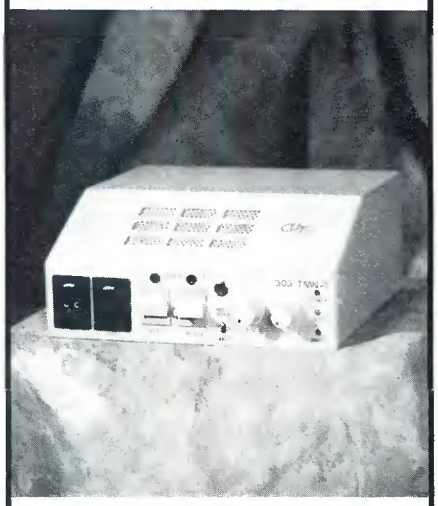

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19	52	85	118	152	186	220	254	288	322	356	390	424	458	492	526	560	594
20	53	86	119	153	187	221	255	289	323	357	391	425	459	493	527	561	595
21	54	87	120	154	188	222	256	290	324	358	392	426	460	494	528	562	596
22	55	88	121	155	189	223	257	291	325	359	393	427	461	495	529	563	597
23	56	89	122	156	190	224	258	292	326	360	394	428	462	496	530	564	598
24	57	90	123	157	191	225	259	293	327	361	395	429	463	497	531	565	599
25	58	91	124	158	192	226	260	294	328	362	396	430	464	498	532	566	600
26	59	92	125	159	193	227	261	295	329	363	397	431	465	499	533	567	601
27	60	93	126	160	194	228	262	296	330	364	398	432	466	500	534	568	602
28	61	94	127	161	195	229	263	297	331	365	399	433	467	501	535	569	603
29	62	95	128	162	196	230	264	298	332	366	400	434	468	502	536	570	604
30	63	96	129	163	197	231	265	299	333	367	401	435	469	503	537	571	605
31	64	97	130	164	198	232	266	300	334	368	402	436	470	504	538	572	606
32	65	98	131	165	199	233	267	301	335	369	403	437	471	505	539	573	607
33	66	99	132	166	200	234	268	302	336	370	404	438	472	506	540	574	608
REA			133	167	201	235	269	303	337	371	405	439	473	507	541	575	609

FOR ISSUE OF NOVEMBER 1990
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☐ Yes ☐ No

_____
Signature required

Title _____

Date _____

2 **Please check the ONE type of facility or operation that best describes your business classification.**
20 ☐ TV Station
21 ☐ AM Station
22 ☐ FM Station
23 ☐ AM & FM Station
24 ☐ TV & AM Station
25 ☐ TV & FM Station
26 ☐ TV, AM & FM Station
19 ☐ Low-Power TV Station
27 ☐ CATV Facility
39 ☐ Cable Television
28 ☐ Non-Broadcast TV including CCTV
29 ☐ Recording Studio
30 ☐ Teleproduction Facility
40 ☐ Post Production Facility
31 ☐ Microwave, Relay Station or Satellite Company
32 ☐ Government
33 ☐ Consultant (Engineering or Mgmt.)
34 ☐ Dealer, Distributor or Manufacturer
35 ☐ Other (Specify) _____

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A ☐ **Company Management**—(1) Chairman of the Board, (2) President, (3) Owner, (4) Partner, (5) Director, (6) Vice President, (7) General Manager (other than in charge of Engineering or Station Operations Mgt.), (8) Other Corp./Financial Officials
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D ☐ **Other:** Specify _____

4 **If you checked 19 through 26 on question No. 2, which of the following best describes your over-the-air station? (check only one):**
A ☐ Commercial
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C ☐ Religious
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F ☐ Municipally Owned

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A ☐ Less than $25,000
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C ☐ $50,000 to $99,999
D ☐ $100,000 to $250,000
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If you have immediate interest in any products in this issue, write in the number(s) below and check all the appropriate boxes.

I am interested in these items

	Immediate Need	Have Sales-person Call	Name Nearest Dealer	Send Literature	For Future Reference
#					
#					
#					
#					

Circle reader service numbers below for more information

1	34	67	100	134	168	202	236	270	304	338	372	406	440	474	508	542	576
2	35	68	101	135	169	203	237	271	305	339	373	407	441	475	509	543	577
3	36	69	102	136	170	204	238	272	306	340	374	408	442	476	510	544	578
4	37	70	103	137	171	205	239	273	307	341	375	409	443	477	511	545	579
5	38	71	104	138	172	206	240	274	308	342	376	410	444	478	512	546	580
6	39	72	105	139	173	207	241	275	309	343	377	411	445	479	513	547	581
7	40	73	106	140	174	208	242	276	310	344	378	412	446	480	514	548	582
8	41	74	107	141	175	209	243	277	311	345	379	413	447	481	515	549	583
9	42	75	108	142	176	210	244	278	312	346	380	414	448	482	516	550	584
10	43	76	109	143	177	211	245	279	313	347	381	415	449	483	517	551	585
11	44	77	110	144	178	212	246	280	314	348	382	416	450	484	518	552	586
12	45	78	111	145	179	213	247	281	315	349	383	417	451	485	519	553	587
13	46	79	112	146	180	214	248	282	316	350	384	418	452	486	520	554	588
14	47	80	113	147	181	215	249	283	317	351	385	419	453	487	521	555	589
15	48	81	114	148	182	216	250	284	318	352	386	420	454	488	522	556	590
16	49	82	115	149	183	217	251	285	319	353	387	421	455	489	523	557	591
17	50	83	116	150	184	218	252	286	320	354	388	422	456	490	524	558	592
18	51	84	117	151	185	219	253	287	321	355	389	423	457	491	525	559	593
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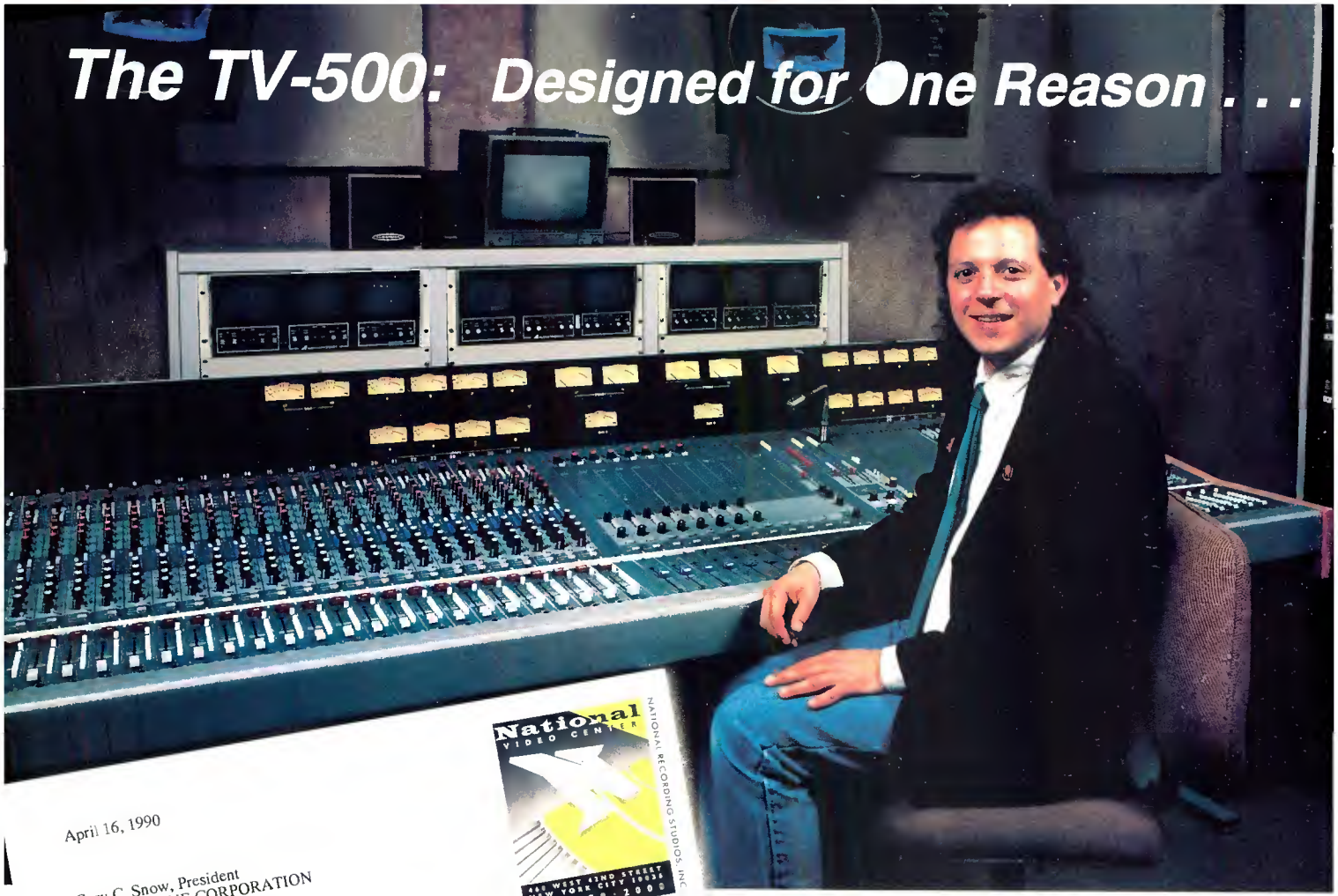

Al Centrella, Audio Engineer

April 16, 1990

Gary C. Snow, President
WHEATSTONE CORPORATION
6720 V.I.P. Parkway
Syracuse, New York 13211

Dear Gary:

When National Video Center decided to upgrade the audio rooms for our TV–1 and TV–2 studios, we knew we needed consoles that could take us into the 1990s by giving us the ability to handle musical entertainment shows, game shows and dramatic series as well as other demands placed on us by clients.

During the course of the next several months we reviewed designs from approximately ten console manufacturers. After many days of discussion we all decided upon the Wheatstone TV–500 for its performance, flexibility, features and ease of operation.

The cooperativeness of your engineering staff has been wonderful. There were severe time constraints for delivery of the consoles. Installation was required in a matter of days to fit around productions that were scheduled in the studios. They really cared about the process, and have been professional from start to finish. With all of the customizations we ordered for the consoles, we were concerned that all of our needs would be met. To our pleasant surprise, we were able to uncrate the consoles, install them and start production immediately. All systems operated flawlessly.

The response from our clients has been extremely favorable. Our studio productions have utilized the boards to the limit, for series such as Nickelodeon's *Eureeka's Castle* and MTV's *Unplugged* as well as live shows, teleconferences and home video productions. The basic input/output architecture exactly matched our expectations for the needs of the 1990s.

Your custom boards are priced similarly to other consoles, but we've gotten far more value and technical performance from the TV–500s. We are completely satisfied with their performance in live, analog and digital recording environments.

Thanks to Tim, Andy, Paul, all the staff at Wheatstone and especially to you for providing us with a colorful, natural-sounding, state-of-the-art console to service the industry.

Sincerely,
Al Centrella
Al Centrella, Audio Engineer
NATIONAL VIDEO CENTER

Clients Demand Production Power

This console will give you what you need: a totally stereo signal path—inputs, sends, subgroups, cues, and IFBs. It includes powerful EQ, VCA mastering, complete with twin stereo mixes and triple mono outputs. The TV–500 is the console to use for live local and international events, or for the most demanding clients in your production suite.

And, because Wheatstone makes it, you can count on engineering excellence, prompt delivery, and first class technical support.

Our sales engineers can help you configure the TV–500 to exactly match your needs. Draw on our experience—call a Wheatstone sales engineer today!

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