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JULY 2005

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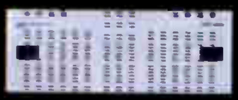

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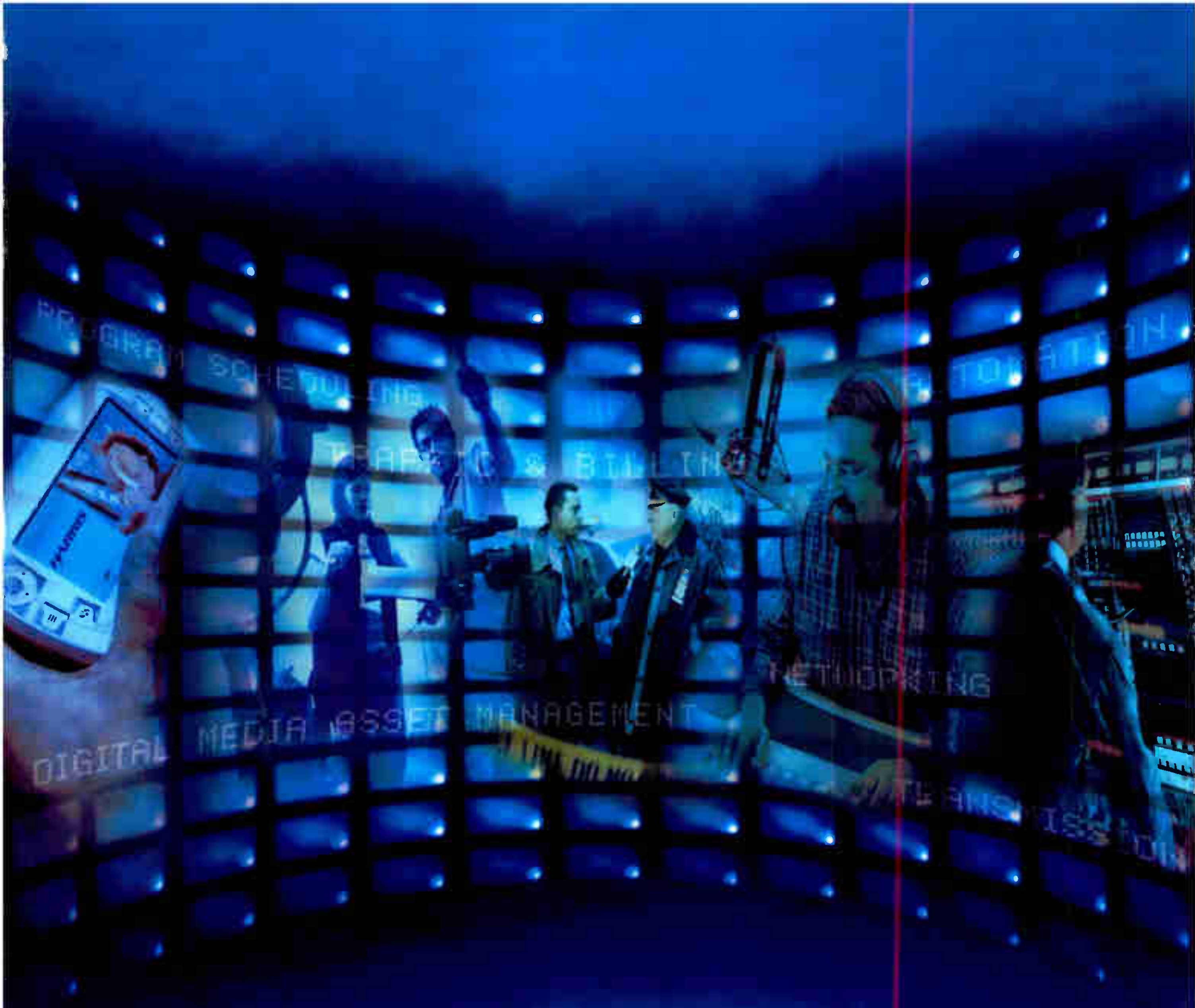

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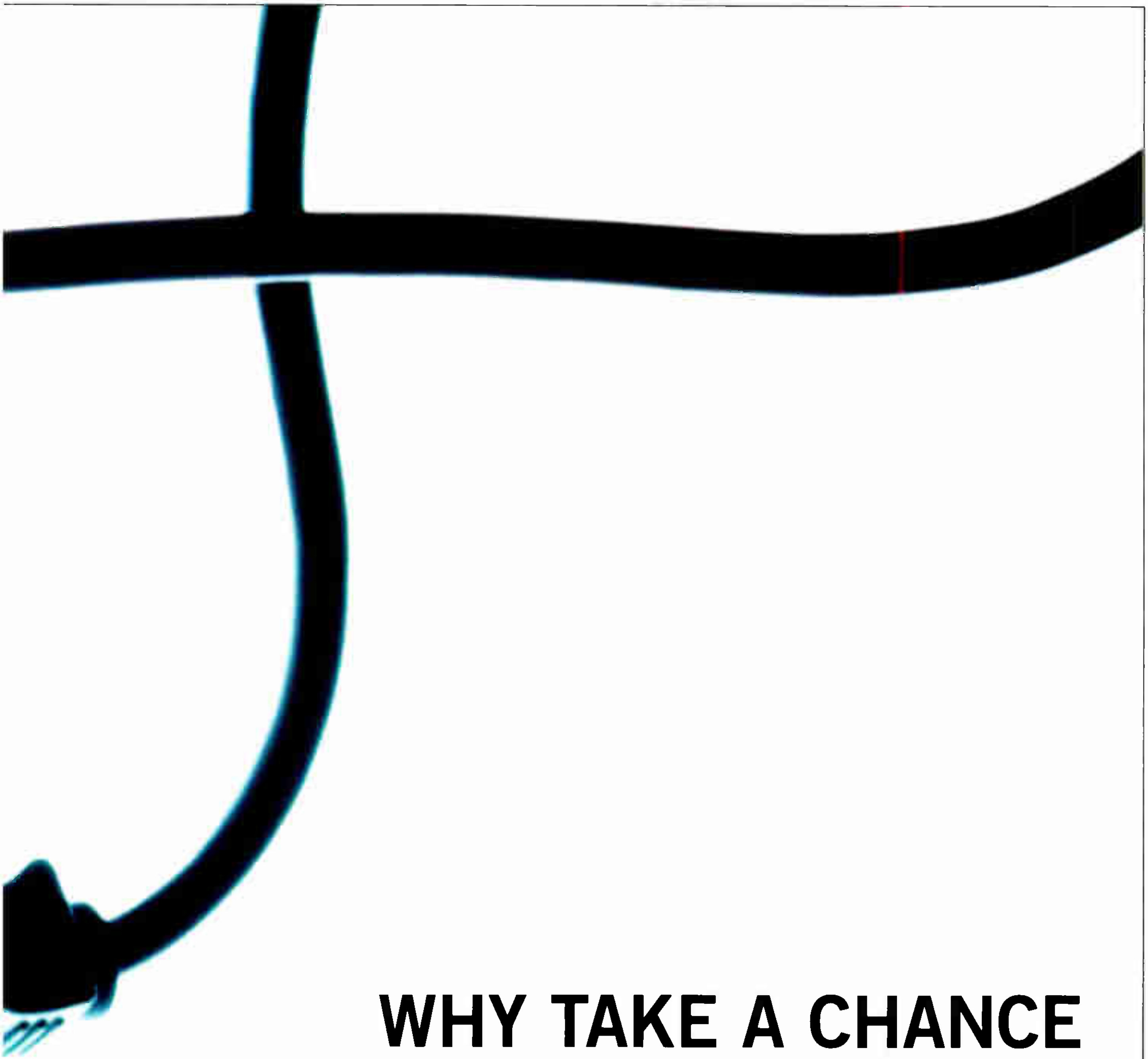

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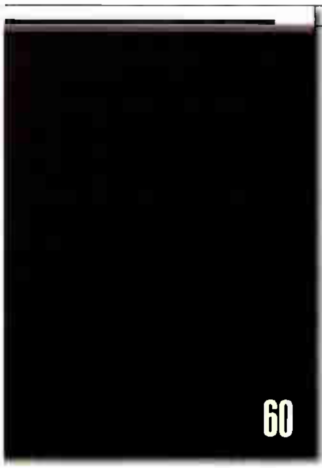
ON THE COVER:
WSAV-TV in Savannah, GA, uses an NTSC/DTV Dielectric TUV Dualband antenna to broadcast channels 3 and 39.



BEYOND THE HEADLINES

DIGITAL HANDBOOK

(Continued on page 8)

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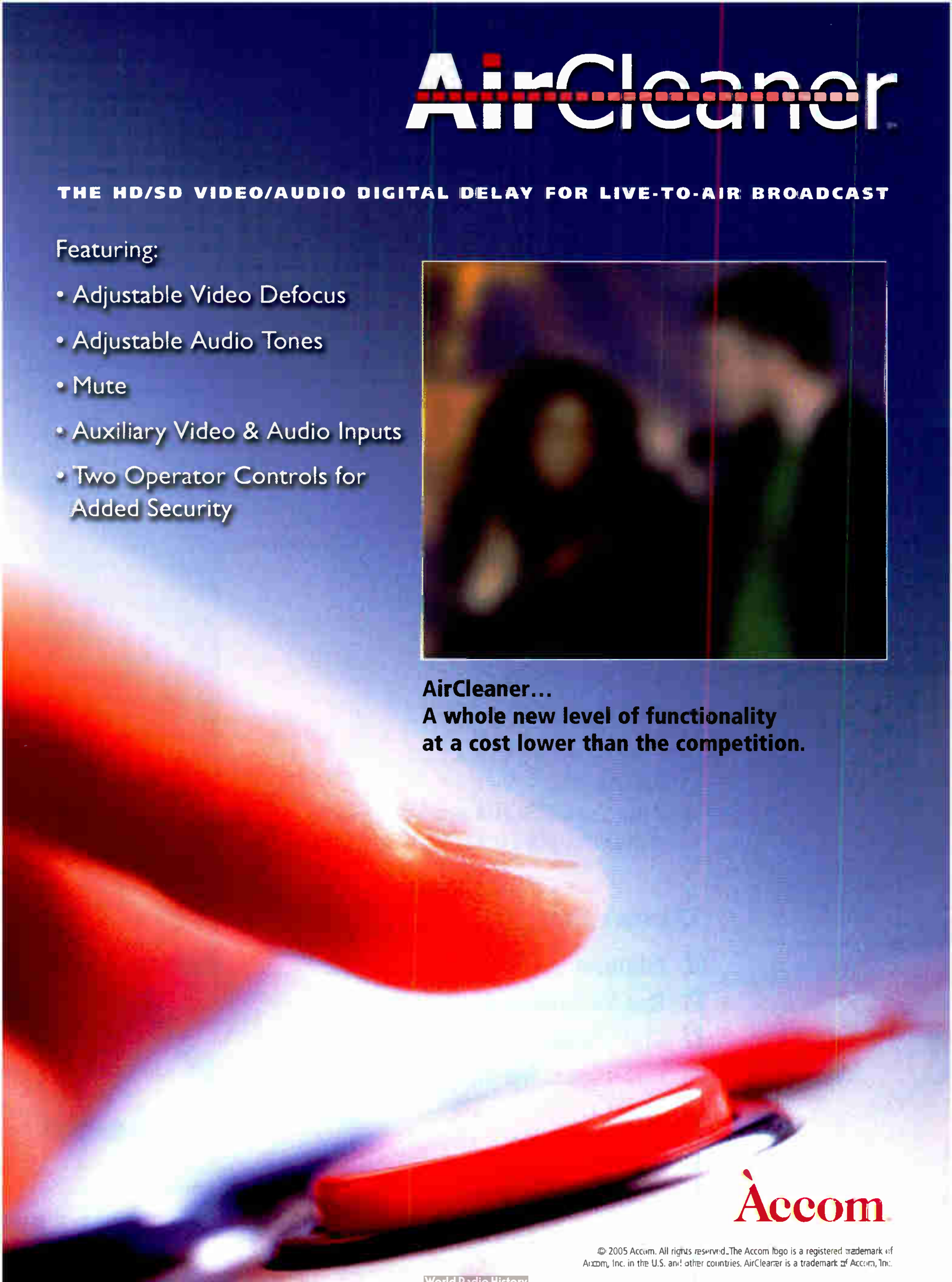

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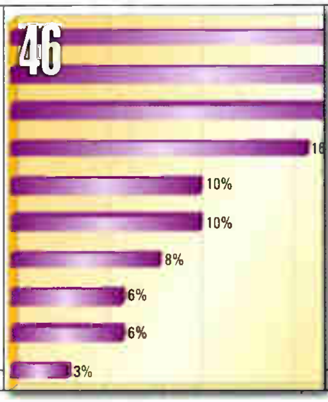

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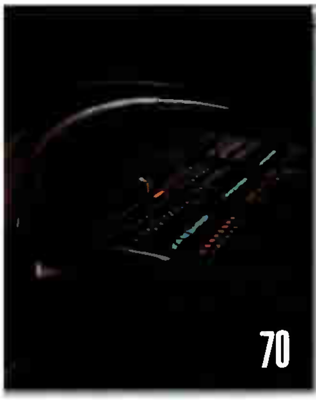


New Products & Reviews

Departments

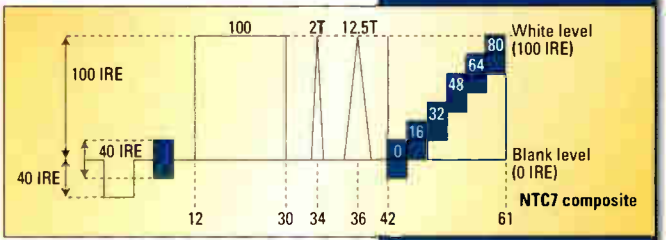
Freezeframe

Which of the following NTSC test signals can be used to measure chroma/luma gain and delay?

- Color multipulse
- FCC composite
- Modulated bar
- Multipulse 100
- NTC-7 composite

Readers submitting winning entries will be entered into a drawing for *Broadcast Engineering* t-shirts. Enter by e-mail. Title your entry "Freezeframe-July" in the subject field, and send it to: editor@primediabusiness.com. Correct answers received by Sept. 1, 2005, are eligible to win.

Question courtesy Tektronix 2005 desktop calendar.



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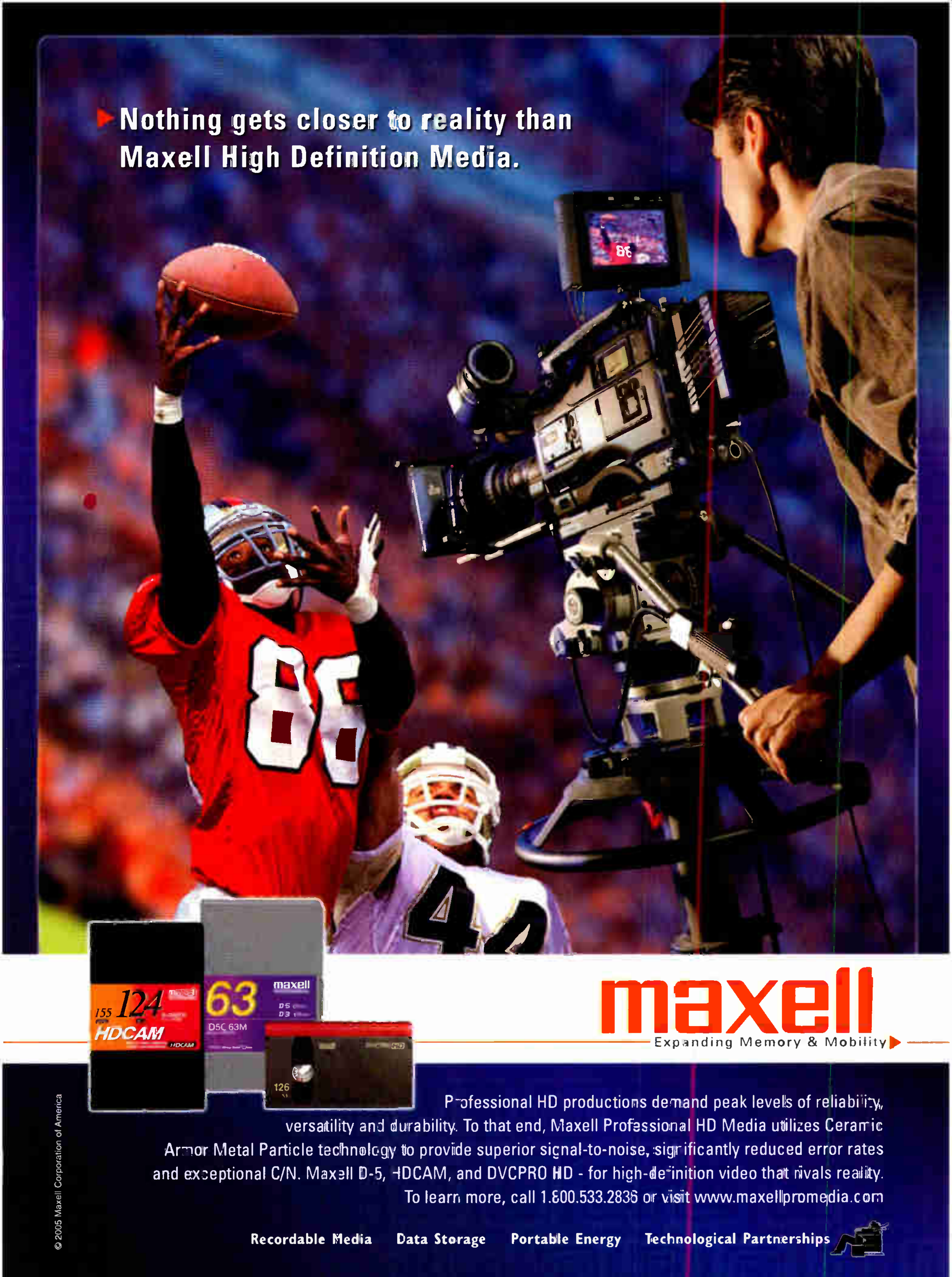

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Diversity
or be damned

"Come on, Knight Adelstein, just one more hill. You can do it," said Knight Copps. The two knights of the Federal Censorship Committee (FCC) were engaged in a battle against the sinister forces of Time Warner, Viacom, Comcast and other corporate dragons hiding in Media Forest.

Armed with regulations, government bureaucracy, rules and penalties, the two knights of the FCC round table had spent years battling filthy-rich broadcasters and the dreaded mega-moguls residing in the forest. Driven on by the priests of the American Church of Liberal Unity (ACLU), knights Adelstein and Copps were leading the holy war for diversity. Just up Potomac Hill lay victory.

One evening, the knights stopped at a small inn for a brew. Knight Copps seized the opportunity to spread his message to the village pilgrims. He leapt onto a table and said, "Attention, citizens! We must arm ourselves against the corporations. *Big companies already control radio, television, newspapers and cable — cable systems and cable channels. They own the production of programming. They own its distribution.*" Thrusting his sword into the air, he shouted, "*Increasingly, they control creativity itself.* Unite and follow me!"

The crowd remained silent.

Big companies controlling creativity? How could that be? Would not the TV peasants revolt? After all, if they don't get their rations of gruel and bread — "Fear Factor" and "American Idol" — they become insolent, irritable and ill-tempered.

A small hand arose from the inn's crowd. "Sir, why would big companies want to control creativity? After all, don't they make money from being creative?"

"Hush, you idiot!" roared Knight Copps. "I don't give a damn if they make money; first they must create diversity. Diversity for one; diversity for all." No response came from the inn's customers.

Without blinking an eye, Knight Copps launched into his conclusion, "*I worry that anything with the name 'independent' on it seems to be on the endangered species list. I worry about the toll this takes on media diversity. I worry about the effects on creativity across whole regions of this broad land. I see the effects wherever I go. News anchors and radio and TV journalists no longer needed as stations are consolidated.* Those wicked station managers are focused on the bottom line when they should be focusing on diversity."

Jumping to the floor, Knight Copps said, "Come on, Knight Adelstein. This industry will either be diverse or die if I have anything to say about it."

Exiting the inn, Knight Copps mounted his trusty steed and turned the horse into the evening's chilled winds. "Forge on, trusty fellow," he commanded.

"Hold up, Michael. I can't get my foot into the stirrup," pleaded Knight Adelstein.

Rolling his eyes, Knight Copps replied, "Get with it, you idiot. Diversity needs us. We've an entire nation to save, corporations to slay and politics to play.

"Besides, I've only got two more years on this lousy government soapbox, and I still need to get that sweet lobbyist job lined up. Then, screw 'em all. It's money time!" laughed Knight Copps as he galloped off toward Potomac Hill.

Brad Dick

editorial director

Editor's note: Text in italics are quotes from FCC Commissioner Michael Copps' speech to NATPE 2005.

Send comments to: • editor@primediabusiness.com • www.broadcastengineering.com

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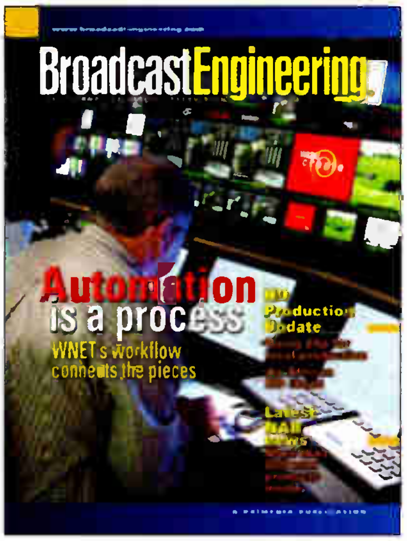

The bottom line

Hello Michael,

I just read your April 2005 article about active lines. In the NTSC standard, there are 485 lines. But other articles have talked about 480 lines. Which is right?

JEAN-PAUL

Michael Robin responds:

The SMPTE 170M standard, Composite Analog Video Signal — NTSC for Studio Applications, describes the composite analog color video signal as NTSC, 525 lines/picture, 59.94 fields/sec, 2:1 interlace with an aspect ratio of 4:3.

The standard assumes that the original picture is scanned horizontally and vertically in the camera and the synchronized reproduction device. It specifies the duration of the field blanking and the line blanking required to normalize the display characteristics in terms of vertical and horizontal resolution.

The specified vertical blanking duration for the odd fields is 20 lines, plus 1.5ms (or a total of 1272.62ms). For the even fields, it is 20 lines (or 1271.12ms).

The vertical blanking duration for the complete picture is 40 lines, leaving a nominal number of active scanning lines. So much for the heritage analog composite video world.

MPEG-2 4:2:2 starts with component digital video signals as per ITU-R BT601. ITU-R BT601 features a luminance sampling grid of 720 horizontal active samples by 485 lines. The digital field 1 has 262 lines, and the digital field 2 has 263 lines to avoid half-lines. The number of active lines is 485, just as in analog NTSC.

One of the basic functions of the MPEG-2 compressor is to divide the picture into blocks and macroblocks. The luminance information is transformed into 16 pixels by 16-line macroblocks. It is essential to have an integer number of macroblocks per active picture width, as well as per active picture height. Given 720 active horizontal samples, the picture can accommodate 720:16 = 45 macroblocks per active picture width. To obtain an integer number of macroblocks per active picture height, the number of active video lines is reduced from 485 to 480, which can accommodate 480:16 = 30 macroblocks per active picture height.

It is, therefore, in the MPEG-2 compressor that the number of active lines is reduced to 480 from the original 485. Evidently, an NTSC composite analog signal derived from an MPEG-2 compressed video signal will only have 480 active lines and will thus be slightly different from the SMPTE 170 standard.

PAL color bars

Why are 75-percent color bars used in the PAL system?

KISHORE
MAA TV

Michael Robin responds:

Seventy-five percent color bars are used in cases where some element in the television distribution chain, for instance NTSC or PAL transmitters, cannot handle 100 percent color bars.

The difficulty in handling 100 percent color bars is due to the frequency division multiplexing of NTSC and PAL chrominance information with the luminance information, resulting in excessive video signal amplitude and transmitter overload.

Because normal camera-generated video signals are unlikely to reach chrominance signal levels equal to those of 100 percent color bar signals, under normal operating conditions, the transmitter will not be overloaded.

Early VTRs also had difficulties in handling 100 percent color bars. Current digital equipment and systems don't have this problem, so A/D and D/A converters are aligned using 100 percent color bar signals.

Problems may arise when synthetically generated video signals (e.g., from character generators) with excessive analog video signal amplitudes reach an analog NTSC or PAL transmitter. These problems will disappear with the imminent demise of analog television.

Alive and well

Mark O'Brien, executive VP technology for SpectraRep, reports that his firm is alive and well, despite our contrary mention in the June issue. Readers can contact the firm at: 703-802-2975, mobrien@spectrarep.com or *www.spectrarep.com*. BE

March Freezeframe:

Q. Name the product in the photo. Its original name was spelled slightly differently from today.

A. Chiron II

Winners:

Jeff Suarez
Tim Costley
Kevin K. Ruppert
Steve Alhart
Tony Michalski
Bruce N. Goren
Larry Fukunaga

Test Your Knowledge!

See the Freezeframe question of the month on page 8 and enter to win a *Broadcast Engineering* T-shirt.

Send answers to bdick@primediabusiness.com

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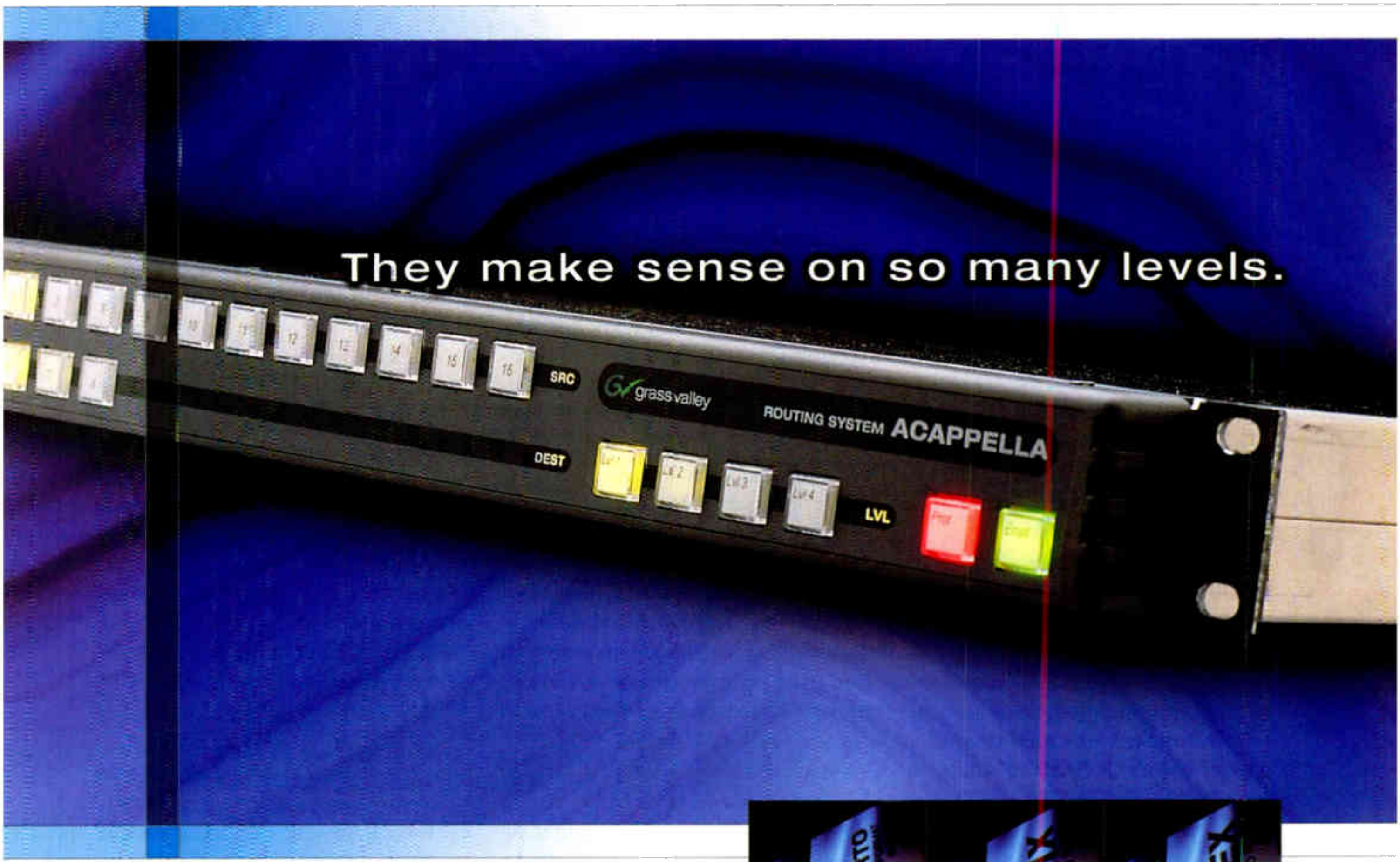

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The broadcast protection racket

BY CRAIG BIRKMAIER

There is a massive debate taking place at a global level about the future of creativity and innovation. At the center of this debate is a single concept: What does it mean when we say that something is *free*?

In our culture, the expected response is that the commodity in question is offered without an expectation of payment from the consumer. But there is a larger and more important meaning — one the French distinguish with the words *libre* and *gratis* — freedom vs. economic cost.

A resource is free if one can use it without the permission of anyone else or if the permission one needs is granted neutrally. Richard Stallman, founder of the Free Software Foundation, says to think of free as in free speech, not free beer.

For nearly a century, broadcasters have been in the business of providing free entertainment and information. Anyone with a radio or TV receiver can pull this commodity out of the air without permission from the content owners.

In reality, we all understand that broadcast radio and TV are not free. We support non-commercial broadcasts via taxes and donations. We support commercial broadcasts through the consumption of the products that are advertised, knowing the advertising revenues pay for the broadcaster's content, operations and profits.

At the center of the debate on the future of digital media is the question of whether content should remain free, in the traditional sense of our freedom to consume it without permission, or whether our access to content will be controlled.

Much of what I have just written borders on plagiarism. These are not my original thoughts, but rather an extension of the ideas put forth by Richard Stallman and Lawrence Lessig, both authors of several books on the subject. Although Lessig is a lawyer, I have no concern that he will seek compensation for the use of his ideas. Just the opposite is true. You can obtain a copy of his book, "Free Culture," in PDF format for free via the Internet. The license only requires that I acknowledge his work.

Such is the nature of free culture. We continuously build on the efforts of creators and innovators. And we are building on a centuries-old tradition of granting these creators and inventors a limited window of opportunity to exploit their efforts before their work enters the public commons for others to build on.

The most commonly cited precedent for American copyright is a 1710 British decree called the Statute of Anne. According to Don Lambriola, who writes for *PC Magazine*: "It was ostensibly designed to control heretical texts that were deemed a danger to society, but it also helped eradicate rogue Scottish publishers who, by printing pirate editions of registered books, had been cutting into the profits of Crown-licensed printers." The law gave printers a 28-year monopoly on the reproduction of books that they had registered with the Crown. Lambriola explores the history of copyright as part of a series on digital content protection. (For more, see "Web links" on page 16.)

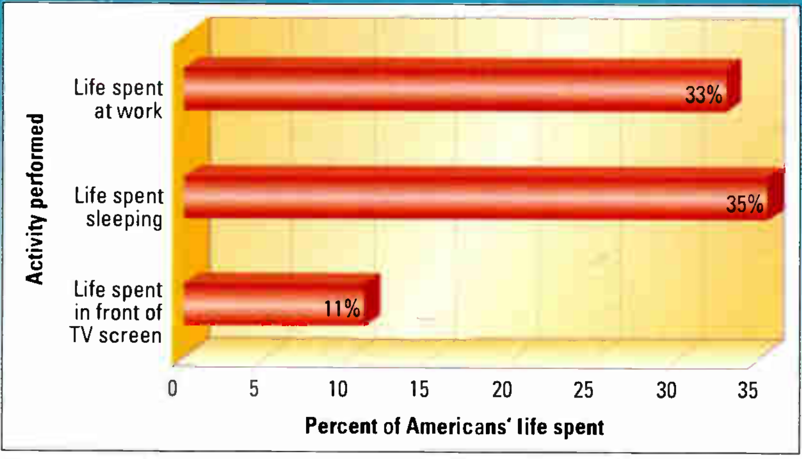
What made the Statute of Anne particularly noteworthy was its strict limitation on the duration of these printing monopolies. At the end of that period, rights owners were considered to have been fairly compensated, and books became property of the general populace. In this way, the statute provided an elegant balance between the public good and the interests of content owners.

The framers of the U.S. Constitution recognized this delicate balance and gave Congress the power to give

FRAME GRAB A look at the issues driving today's technology

TV third after sleep and work

Americans spend 11 percent of their lives in front of the TV



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Channel 242: *Birds of the Rainforest*

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authors and inventors exclusive rights to their creations for a limited time. This resulted in the 1790 Copyright Act, which, in the spirit of the Statute of Anne, established 28-year protection for books, maps and charts.

Over the past century, U.S. copyright law has been rewritten 11 times, each time extending the period of protection, the scope of content that is protected and the penalties for illegal copying. The Constitutional intent for the rapid proliferation of ideas into the public commons has all but been eliminated.

The broadcast flag

As you read this, new regulations from the FCC were supposed to take effect to protect digital television broadcasts from potential redistribution via the Internet. (See "Free no more?" in "Web links.") The regulations would require that all new products, which may come in contact with the bits from a digital television broadcast, must look for and deal properly with the broadcast flag.

To implement these regulations, the FCC set itself up as the arbiter of technologies that can be used to protect DTV broadcasts, in essence dictating design requirements for every new TV, personal computer and digital networking product that can be sold in the United States.

On May 6, 2005, the U.S. Court of Appeals for the District of Columbia issued a decision that vacates the FCC regulations. "The broadcast flag regulations exceed the agency's delegated authority under the statute," a three-judge panel unanimously concluded. "The FCC has no authority to regulate consumer electronic devices that can be used for receipt of wire or radio communication when those devices are not engaged in the process of radio or wire transmission." (For the full court ruling, see "Web links.")

Piracy or promotion?

If content protection is so crucial to the future of broadcasting, how did broadcasters manage to survive without it for nearly a century?

Broadcasters have been providing content in the free and clear since the bargain was reached to grant licenses for use of the public spectrum resource. One can argue that no technology has had a more profound impact on our lives than broadcasting. For decades, it reigned supreme as the public hearth around which the masses shared entertainment and information. It became the 20th century's public commons.

One can now argue that the Internet

Web links

"Free no more?" by Craig Birkmaier; bg.broadcastengineering.com/ar/broadcasting_free_no

"Digital content protection: How anti-piracy technologies are transforming digital media" by Don Labriola; www.extremetech.com/article2/0,3973,13923,00.asp

The Electronic Frontier Foundation; www.eff.org

"Free Culture: How big media uses technology and the law to lock down culture and control creativity" by Lawrence Lessig; www.free-culture.cc

United States Court of Appeals decision on the broadcast flag; http://pacer.cadc.uscourts.gov/docs/common/opinions/200505/04-1037b.pdf

Supreme commandment: Thou shalt not *induce* to steal

On June 27, the U.S. Supreme Court issued a variety of decisions related to the Ten Commandments, Internet file sharing and the access of competitors to the facilities operated by cable companies.

The court called upon the 10th Commandment — thou shalt not steal — to underscore its finding that the sharing of copyrighted materials via peer-to-peer (P2P) networks is an illegal activity comparable to common theft. But it stopped short of a ruling that would shut down P2P networks, keeping in place the basic tenants of its 1984 Sony Betamax decision.

In 1984, the Court ruled that just because a product or technology can be used to infringe on copyrights, if there are substantial non-infringing uses, the inventor could not be held liable for the infringing uses. Because most consumer copying is for personal use, permitted under the Fair Use provision of U.S. copyright law, the Betamax decision protects manufacturers of copying and distribution products despite the fact their products can be used to make and distribute illegal copies.

The Supreme Court's ruling in the current case brought by Metro-Goldwyn-Mayer Studios et al. vs. Grokster et al. creates a new conduct-based test called *inducement*. In its decision, the Supreme Court stated: "For the same reasons that Sony took the staple-article doctrine of patent law as a model for its copyright safe-harbor rule, the inducement rule, too, is a sensible one for copyright. We adopt it here, holding that one who distributes a device with the object of promoting its use to infringe copyright, as shown by clear expression or other affirmative steps taken to foster infringement, is liable for the resulting acts of infringement by third parties." Upholding the Betamax decision, the Supreme Court rejected any specific numerical tests, such as a certain percentage of a product's use, for infringing purposes. The full decision can be downloaded at: http://a257.g.akamaitech.net/7/257/2422/27jun20051200/www.supremecourtus.gov/opinions/04pdf/04480.pdf

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Professional Services

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has become the public commons of the 21st century. Broadcasters now compete not only with a variety of alternative means of distribution for radio and television content, but also for the attention of consumers faced with a multitude of choices related to how they spend their entertainment dollars and time.

Facing these challenges, one must question why broadcasters would support any efforts to place more restrictive controls on their products. Certainly there is reason to be concerned about any threat to the sustainability of the medium. We have all heard the warnings: If broadcast content is not protected, the content conglomerates will not make their best content available to broadcasters.

But this is a hollow argument; it has been a long time since these conglomerates have relied upon broadcasters to deliver their best content. That privilege is now reserved for premium cable and DBS distribution channels and packaged media. Hollywood pulled out all the stops to kill the VCR and then used it to make billions. Now the DVD — perhaps the most securely protected medium in the history of consumer electronics — is turning into a distribution channel, not only for movies, but television content as well.

Helping the content conglomerates consolidate their power, their control over the ways in which they will grant consumers permission to use this content, would appear to run counter to the interests of broadcasters. What broadcasters do best is proliferate entertainment and information into the public commons to make the masses aware of the creative efforts of the content creators and performers. The content conglomerates depend on broadcasting to promote virtually everything they do.

What is radio (at least the music side of it), but a gigantic promotional engine for the music industry? What is the most important role of a TV station? To distribute content to the masses or provide a public commons for the communities they serve?

Perhaps the time has come for broadcasters to consider which side of this battle they are on. Protecting the interests of the media conglomerates who seek to control all forms of digital media distribution is shortsighted. Broadcasters are in the business of proliferation of culture — not controlling it. **BE**

Craig Birkmaier is a technology consultant at Pcube Labs, and he hosts and moderates the OpenDTV forum.

SEND Send questions and comments to: craig_birkmaier@primediabusiness.com

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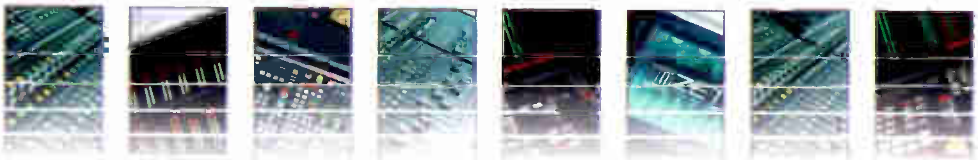

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World Radio History

Standards for measuring distant digital signals revisited

BY HARRY C. MARTIN

The FCC recently released a Notice of Inquiry related to the proper measurement and testing procedures for distant digital television signals. This inquiry was initiated as a result of the passage of the Satellite Home Viewer Extension and Reauthorization Act of 2004.

In particular, the commission wants to determine whether the current signal strength standard and testing procedures remain accurate or whether revisions are necessary. The standards are used to determine if a household is entitled to receive distant network programming from satellite services. The commission seeks comment on the following questions:

- *Antenna placement*: Should the commission modify the procedures for determining if a digital signal is available to a particular household based on different antenna installations and orientation? In particular, the FCC asks whether a digital signal can be received in light of the various placement locations for receiving antennas and the variety of different receiving antennas available in the marketplace.
- *Signal strength measurement*: Should the commission revise the measurement procedures for DTV signal strength? The current rules rely on the measurement of the television visual carrier, but the DTV signal does not contain a visual carrier. Therefore, should the measurement of the DTV signal be based on the pilot signal or the center of the DTV channel?
- *Signal strength standard*: Currently, to determine whether a household is eligible to receive a distant signal, the commission measures the Grade B analog signal at that particular household. Should the commission's use of a particular signal strength at a certain household continue to be used? The FCC is interested in identifying any alternative methods that might better establish whether a household is capable of receiving a high-quality DTV signal.
- *Development of predictive model*: In developing the DTV Table of Allotments, the commission used the OET 69 predictive method for measuring signal strength. In response to the passage of the Satellite Home Viewer Act of 1999, the commission developed a new predictive model for determining whether a household was eligible to receive a distant signal from a satellite service provider. Is there a different methodology that could be developed to better determine a household's eligibility?
- *DTV receiver standards*: How does the quality of a consumer's DTV receiver affect its ability to receive a local signal? Should this be a factor in establishing a household's eligibility?
- *DTV receiver interference*: How should a DTV receiver's ability to sift through interference and find a usable DTV signal be factored into this analysis? More specifically, how should the FCC account for factors such as foliage and man-made sources of interference?

The FCC is interested in identifying any alternative methods that might better establish whether a household is capable of receiving a high-quality DTV signal.

Resolution of these issues will establish the standards that will govern the outcomes of future battles between broadcasters and satellite carriers. But for now, the delivery of distant signals to individual households at the periphery of broadcast station local service areas still remains in conflict. BE

Harry C. Martin is the immediate-past president of the Federal Communications Bar Association and a member of Fletcher, Heald & Hildreth PLC, Arlington, VA.

SEND
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harry_martin@primediabusiness.com

Dateline

August 1 is the deadline for TV, TV translator, LPTV and Class A TV stations in Illinois and Wisconsin to file 2005 renewal applications, and where applicable, biennial ownership reports and EEO program reports.

August 1 also is the start date for pre-filing renewal announcements by TV stations in Iowa and Missouri. Stations in those states must file renewals by October 1.

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Audio signal distribution methods

BY MICHAEL ROBIN

The unbridled development of radio broadcasting in the 1920s and 1930s demonstrated the need for the standardization of audio equipment, studio-to-transmitter links (STLs), and static and dynamic audio signal measurement methods. Different concepts and solutions were developed on the two sides of the Atlantic, and today we still bear the consequences. Remember NTSC and PAL?

The power-matching concept

In the early days of broadcasting, there were many so-called standard audio reference levels, including 1mW, 6mW, 10mW, 12.5mW and 50mW. Bell Telephone introduced the concept of power matching. It wanted to develop reliable, high-performance STLs. It seemed normal to have an impedance-matched source (studio output), distribution link (cable) and destination (radio transmitter input) system. The matching of impedances to tight tolerances is necessary to avoid echoes on long cable lengths. In 1939, the standard reference level of 1mW into a 600Ω line was proposed. The result was a voltage of .77459V RMS. This reference level conforms to Bell Telephone's standards of limiting the signal level to a value that would produce a minimum of cross talk and provide a satisfactory signal-to-noise ratio (SNR).

After creating the reference level, the development of a new audio level meter was jointly undertaken by Bell Telephone, CBS and NBC. The result was the volume unit meter (VU meter), as well as the standardization of the reference level of 1mW, a unit that was adopted by the electronics industry. A standard operating level (SOL), also known as an alignment level of +8dBm into 600Ω, was initially chosen in North America. Some authorities, including sound recording studios, opted for a +4dBm SOL inside the plant. The SOL represents the steady-state maximum level or peak program level as measured with a VU meter.

The VU meter was developed primarily for the control and monitoring of audio programs. The specifications of the VU meter reflect the philosophy of the 1930s. Essentially, the VU meter is a moving-coil RMS-type audio signal level measuring instrument. It is fitted with two scales:

- A VU scale marked 0 (reference deflection) at about 71 percent maximum scale reading extending to +3 (maximum) and -20 (minimum).
- A percentage scale with 100 percent corresponding to VU reading.

The VU meter has an input impedance of 7500Ω and has a minimum loading effect on the 600Ω source impedance. Its sensitivity is adjustable such that the VU reference level (0VU) can be made to correspond to the SOL under steady-state sinusoidal audio voltage conditions. Its dynamic characteristics are such that, if a sinusoidal signal of a frequency between 35Hz and 10kHz and such amplitude as to give reference pointer deflection under steady-state conditions is suddenly applied, the pointer will take 0.3s to reach reference deflection. If this signal is suddenly removed from the input of the VU meter, the needle will take 0.3s to return to its initial position.

This characteristic was chosen in order to approximate the assumed response of the human ear. The 0.3s rise time and decay characteristic of the VU meter introduce a masking effect. Essentially, the instrument is unable to give accurate audio signal level indications under complex wave, fast rise time, input signal conditions. The instantaneous speech or music signal level may, in reality, be 10VU or more above the average readings of the VU meter.

FRAME GRAB — A look at tomorrow's technology

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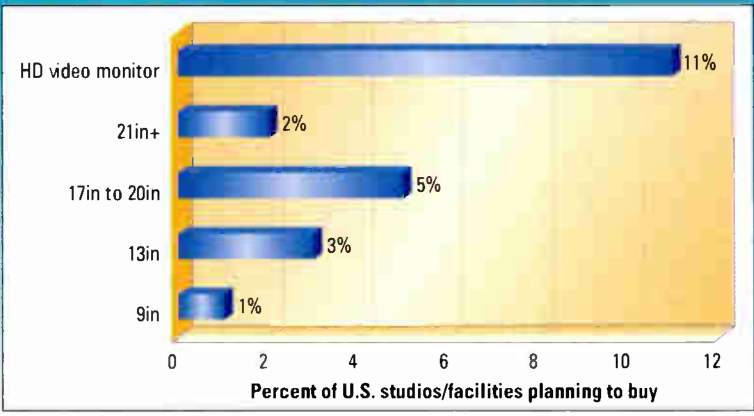

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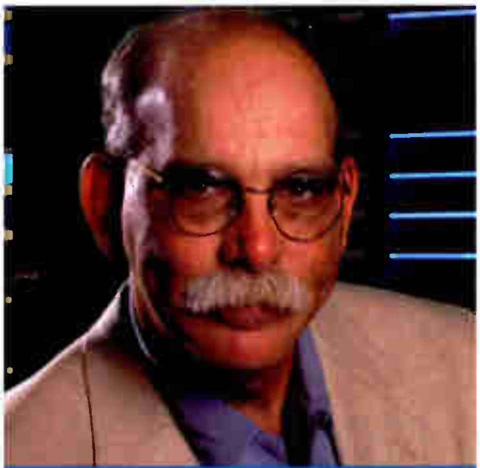

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Typically, if a device is designed to handle an SOL of +8dBm, it will be capable of supplying an output level in excess of +18dBm at a total harmonic distortion not exceeding 1 percent. Such undistorted audio peaks, unnoticed by the operator, are likely to reach the audio tape recorder or transmitter and overload it.

The situation is further complicated by FM audio transmitters, which use high frequency pre-emphasis with a time constant of 75μsec, resulting in a 14dB boost at 10kHz. Various types of limiter/compressor combinations are used in an effort to avoid transmitter over-modulation and achieve an acceptable SNR.

The voltage-matching concept

This concept is typical of modern studio installations. The signal source has 0Ω impedance. This impedance is raised to 50Ω by inserting a 25Ω resistance in series with each of the balanced cable conductors to avoid possible output transistor breakdown in case of a short circuit. The load is of the order of 10kΩ or higher. The signal level is expressed in dBu; 1dBu is equal to .775V RMS or the voltage resulting in dissipating a power of 1mW across a 600Ω load.

The voltage matching considerably reduces the power requirements of the signal source since it is required to dissipate only a minute amount of power across the bridging load. An added advantage is the improved frequency and transient response of the system. This is due to the fact that the capacitive loading of the shielded-balanced audio cable has a lesser effect across a source impedance of 50Ω than it has across a source of 600Ω.

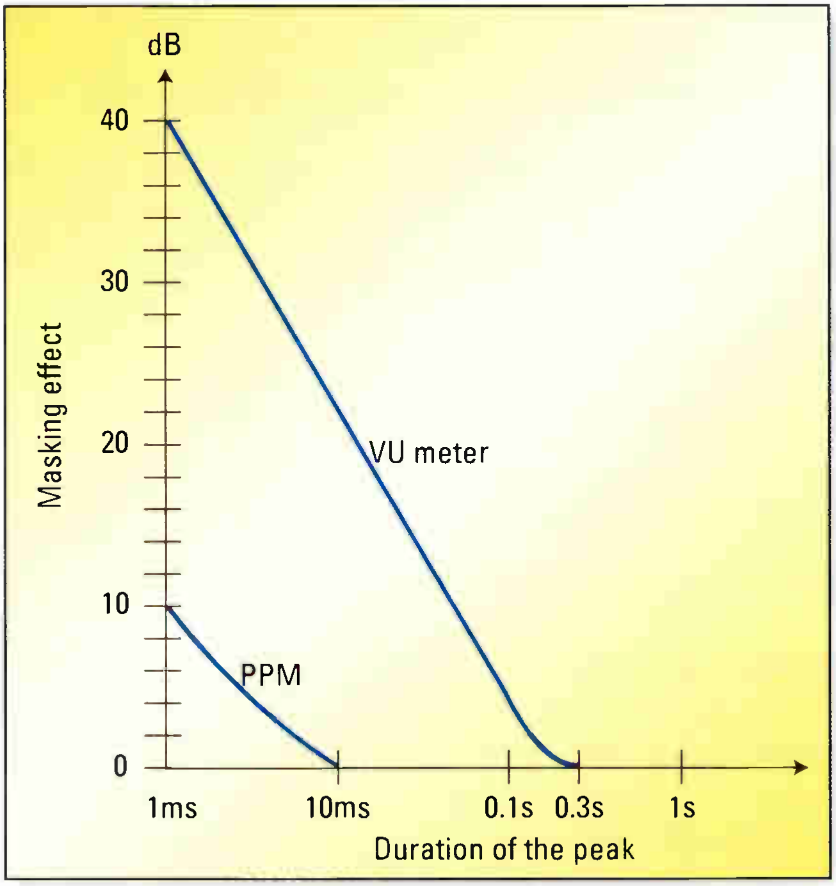

Figure 1. The masking effect of a typical VU meter and peak program meter (PPM) for a given tone duration

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Photo of New York Network studios by Joe Schuyler.

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The interface with common carriers retains the power-matching philosophy to avoid return-loss problems with long cables resulting in echoes. The SOL in North America is +4dBu or +8dBu.

The voltage-matching concept normally uses a peak program meter (PPM) for audio signal-level monitoring. Since the late 1930s, the European broadcasters — with the exception of France, where VU meters are still used — have been using some type of PPM. The PPM is a peak reading instrument capable of accurately displaying audio signal transients. The input impedance is bridging, meaning it is greater than 6000Ω. Some current designs feature a 10ms attack time (rise time) and a 2.65s fall back time. This characteristic amounts to a sample-and-hold approach to audio-signal-level monitoring. It allows the user to accurately monitor audio signal levels under steady state as well as program conditions and reduces the need for large amounts of headroom in amplifiers. Neither the scale nor the display is universally standardized. Some type of compression is required to reduce the dynamic range of the audio signal, which otherwise might exceed the transmitter and receiver capabilities.

Figure 1 on page 24 shows that the PPM is capable of more accurately displaying audio signal peaks than the VU meter. There are, unfortunately, two entrenched camps steadfastly preferring the PPM or the VU meter. In an effort to satisfy all users, some contemporary equipment manufacturers offer equipment with selectable VU or PPM rise/fall times.

Figure 2 shows details of the upper part of the display scale of some audio level meters used in various countries. It shows clearly that in addition to transit response differences, various organizations have different reference levels (SOL) and meter display scales. This situation creates problems in international television program exchanges and is not likely to change in the near future. The problem is complicated by the digital equipment that normally references all audio levels to the maximum signal level before clipping, which is identified as 0dBFS. All audio levels have, therefore, a negative value with the SOL set normally to -20dBFS, indicating that the equipment has 20dB headroom. Interestingly, the EBU suggests headroom of 18dB.

This new approach creates confusion with audio operators having an analog background and a strong attachment to the VU meter. Some efforts to change the reference signal from 0dBu = 0.775V RMS to 0dBV = 1V RMS have been poorly received by the audio community. So, until further notice, the reference audio level is 0.775V RMS, strongly related to 600Ω and 1mW. Old habits die hard! **BE**

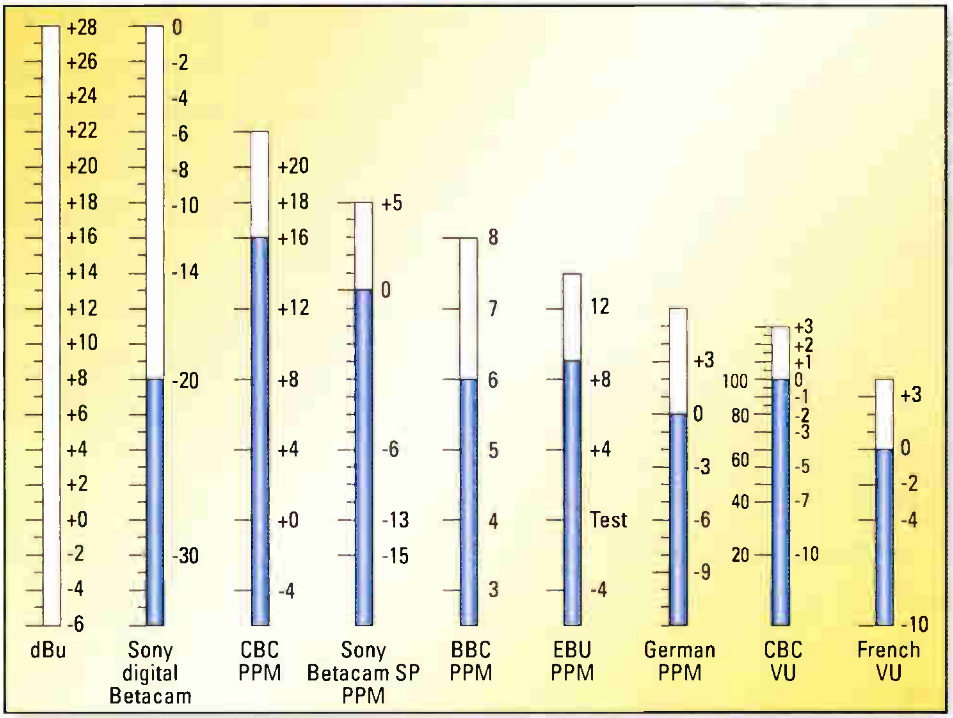

Figure 2. Upper-scale details of some audio level meters used throughout the world and the corresponding steady-state signal level in dBu

In an effort to satisfy all users, some contemporary equipment manufacturers offer equipment with selectable VU or PPM rise/fall times.

Michael Robin, a fellow of the SMPTE and former engineer with the Canadian Broadcasting Corp.'s engineering headquarters, is an independent broadcast consultant located in Montreal. He is co-author of "Digital Television Fundamentals," published by McGraw-Hill and translated into Chinese and Japanese.

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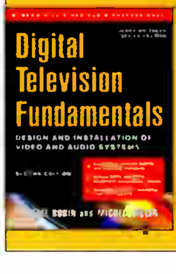

The second edition of Michael Robin's book may be ordered directly from the publisher by calling 800-262-4729. The book is available from several booksellers.

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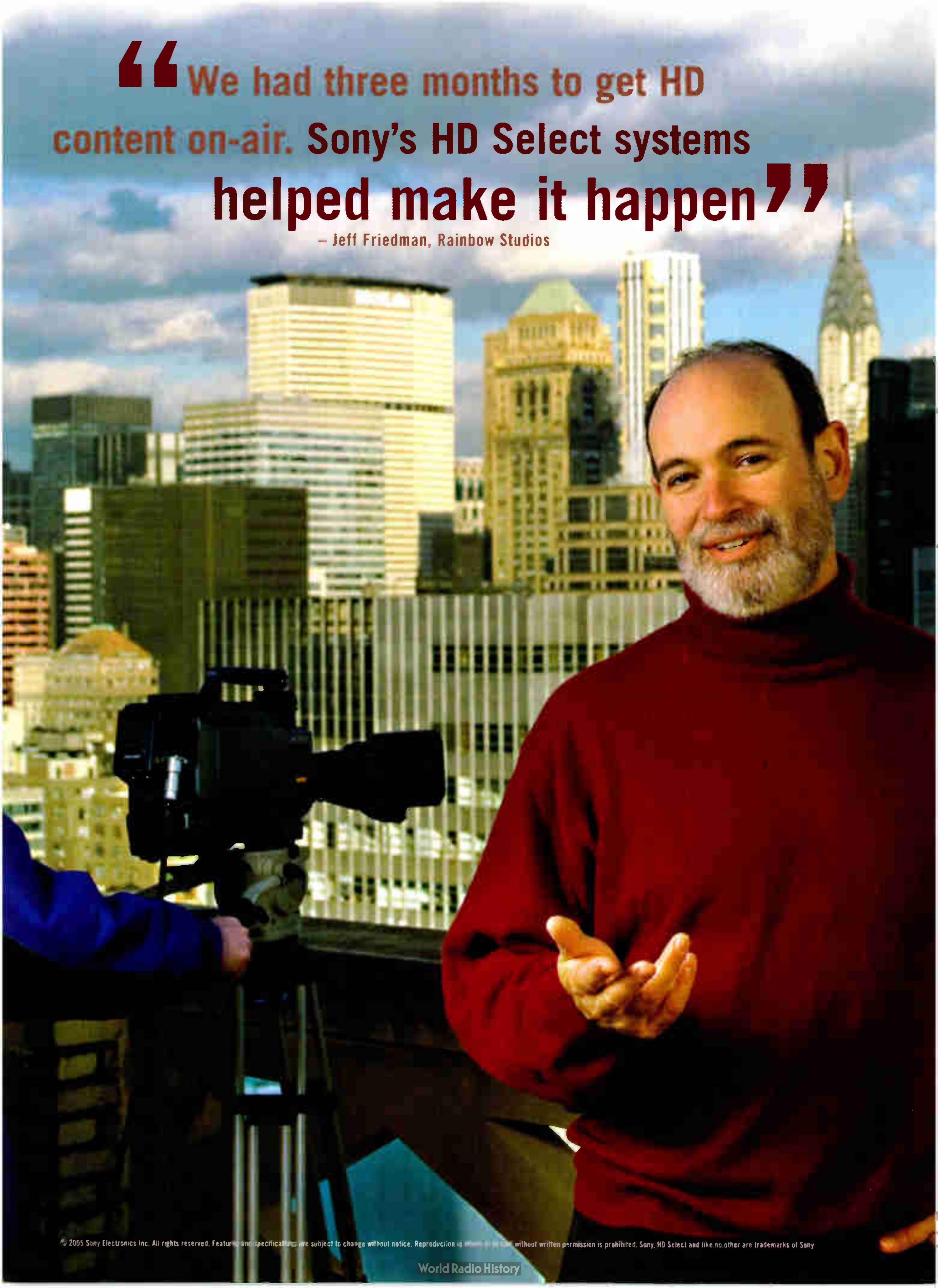
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Network security

BY BRAD GILMER

As technologists, we are generally thorough when we design or build a project. But when thinking about security issues in the professional IT environment, it is important to remember that not all threats are technical in nature. Physical security can be just as important as technological security. When dealing with physical security, there are two general classifications of threats: malicious and non-malicious. Malicious threats involve the active attempt by someone to break into your network. Non-malicious threats occur when a good person makes a mistake. Fortunately, both threats can be addressed with effective physical security.

Physical security

In most broadcast facilities, once someone is inside the technical area, they can wander the building at large. I have been in a few facilities where access to on-air areas was restricted, but this has been the exception rather than the rule. It goes without saying that allowing everyone physical access to on-air or technical core areas is a physical threat. When designing a new facility, it's a good idea to consider employing some sort of physical security system to keep people out of these critical areas, unless their job requires access.

One common mistake people make is taking their laptops home, letting their kids play games on the Internet with them, picking up a malicious code, and then bringing the laptops back to the office. If that person plugs the laptop into the core network, there is a good chance that the malicious code will spread.

There are a number of ways to stop this from happening. One way is to restrict the employee's ability to run certain applications or install new software on company laptops. Another way to handle this threat is to purchase a router that uses Layer 2 port authentication. The router is configured so that it will only pass packets from authorized Media Access Control (MAC) addresses. Each network interface card (NIC) has a unique MAC address. By restricting access on the network to authorized MAC addresses, you can prevent someone from plugging an unauthorized computer into your core network. As with all security measures, there is an additional administrative load required, and you will have to determine if the additional work is worth the added security.

It goes without saying that allowing everyone physical access to on-air or technical core areas is a physical threat.

Password security

Another area of both physical and technical security is passwords. Security experts generally agree that a system that consists of "something you have and something you know" allows technologists to create relatively secure systems. An example of this is a network logon system where the user is issued a small device that creates a new password every few minutes. The user has this device, and the user knows his or her logon information. One of the strong points of this system is that the device creates the system passwords, thus avoiding several pitfalls of password-protected systems.

Needless to say, users should protect their logon and password information. Here is an interesting experiment: Walk around your office and ask your fellow employees how many of them have written their passwords down and either taped them to the bottom of their keyboard or to the side of their top desk drawer. As amazing as it seems, this physical security threat is common. While you are talking to your colleagues, ask them whether their user name and password are the same, or whether their password is their first name. Weak passwords are also a threat to security.

Weak passwords are typically obvious. They are short (less than six characters) or without punctuation. A malicious person might use common sense to guess a password, or he or she could use a brute-force dictionary attack. A dictionary attack employs a relatively simple program that uses a dictionary of words in an attempt to break into the system. The program uses dictionary words to figure out user names and passwords. Strong passwords, which are longer and contain random punctuation, are much less vulnerable to dictionary attacks.

Another password-related issue is simple login names. Certain names such as Administrator, Admin and Root should be disabled for remote login, if possible. Also, short first names should be avoided. Attackers will likely probe login names like Bill, Sue and Fred.

Internet threats

In several previous articles, I have written about threats to the core

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technical network and strategies for minimizing those threats. For many people, the chief concern is that an attacker will be able to reach the core technical network via the Internet. It may help to look at general Internet-borne threats.

There are a number of threats that may cause problems when you connect to the Internet. Common threats include port probes, viruses and worms, Denial of Service (DoS) attacks, Ping of Death (PoD) attacks, and Universal Datagram Protocol (UDP) flood attacks.

Port probes check a computer connected to the Internet for vulnerabilities. The attacking computer systematically checks for ports that are open and available on your computer. He or she will use this information to launch attacks on open ports. An attacker can also use port probes to determine which operating system is running on the computer. This information allows them to craft an attack against well-known weaknesses of the particular version of the operating system on the target machine.

Many readers are personally familiar with viruses and worms. Viruses usually pass from computer to computer through infected files or removable media. Worms are most often transmitted via e-mail. The user opens an attachment and the attachment contains an executable code (the worm), which runs and causes the computer to be infected. The worm then reads the e-mail address book on the infected computer and e-mails itself to everyone on the list.

For many people, the chief concern is that an attacker will be able to reach the core technical network via the Internet.

Worms can be used to spawn DoS attacks. In some cases, the worm remains dormant on the computer until a specific time, or until a specific command is received from a remote computer. When the worm is activated, it sends repeated requests to the target system's IP address. As Figure 1 on page 34 shows, there may be hundreds or thousands of infected computers on the Internet, which are all directed to go to a specific server at the same time. When this happens, the server cannot service all the requests, and the system is effectively knocked off the air.

Almost all computers on the Internet contain a utility called Ping.

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Ping is a simple but useful utility that checks the round-trip time between your system and another computer. By manipulating Ping, an attacker can create Ping messages that can cause the target machine to quit working. This attack is called the Ping of Death.

The UDP can be used to attack target systems in flood attacks. Because of the way UDP is designed, it is possible for an attacker with a high-speed Internet connection to send a large, continuous stream of data to the target machine. UDP is not fair to all traffic. If the stream or streams are large enough, they can crowd out other traffic, effectively bringing other Internet communications with the target computer system to a halt. If the attacker can generate enough simultaneous UDP streams, all directed at a particular machine, he or she could overload the routing systems that feed the machine.

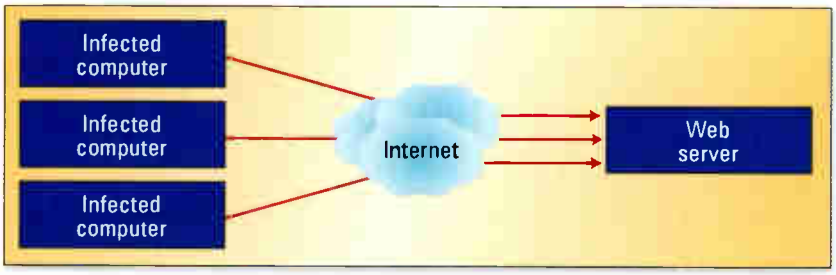

Figure 1. When hundreds or even thousands of computers all try to contact the same Web server at the same time, the Web server will become unavailable. This is called a Denial of Service attack.

In all cases, knowledge is important in combating these attacks. Properly configured firewalls and routers can protect core networks from these attacks. In previous articles, I have described firewalls in detail. For this article, let's look at a high-level description of their functionality.

Firewalls: what they will and will not do

There are several things a firewall can do to protect your local network while permitting Internet access. A firewall can:

- conceal local computer IP addresses from an observer on the Internet
- hide the actual IP address of Web and other dedicated servers from Internet users
- block port probes
- allow an administrator to admit only the traffic types that are acceptable across the firewall and on to the local network
- provide logging so that security threats from the Internet can be analyzed.

While a firewall can do a lot to protect computers on your network, there are certain things it cannot do. A firewall cannot:

- protect your network or servers from a DoS attack
- stop the spread of viruses or worms, since these are typically spread by e-mail applications that are allowed to traverse the firewall
- provide a totally bulletproof solution to all security attacks.

Firewalls provide a reasonable level of security while granting users the necessary Internet access. **BE**

Brad Gilmer is president of Gilmer & Associates, executive director of the Video Services Forum and executive director of the AAF Association.

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1 M/E Control Panel

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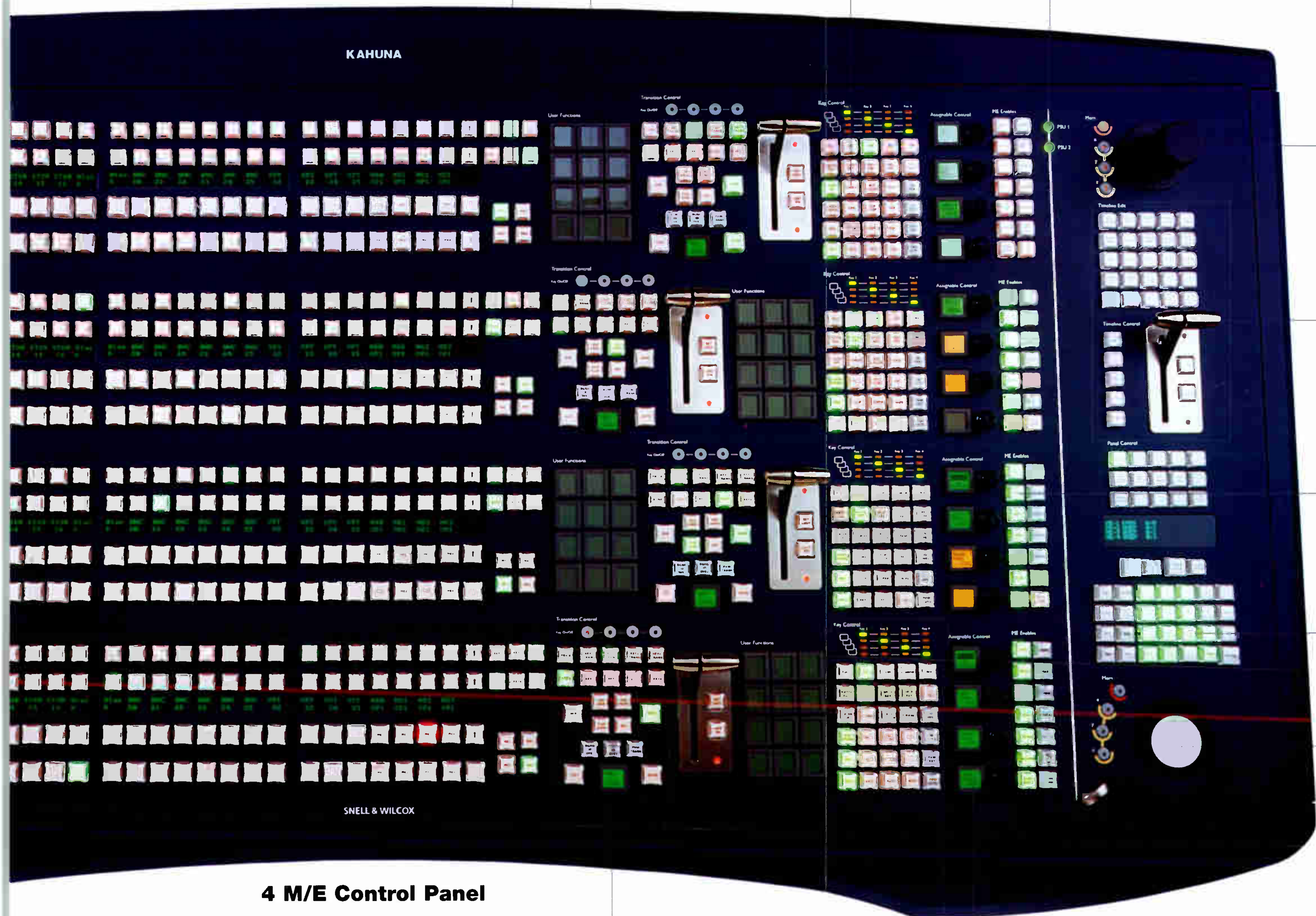

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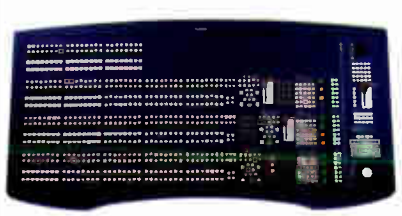

3 M/E Control Panel

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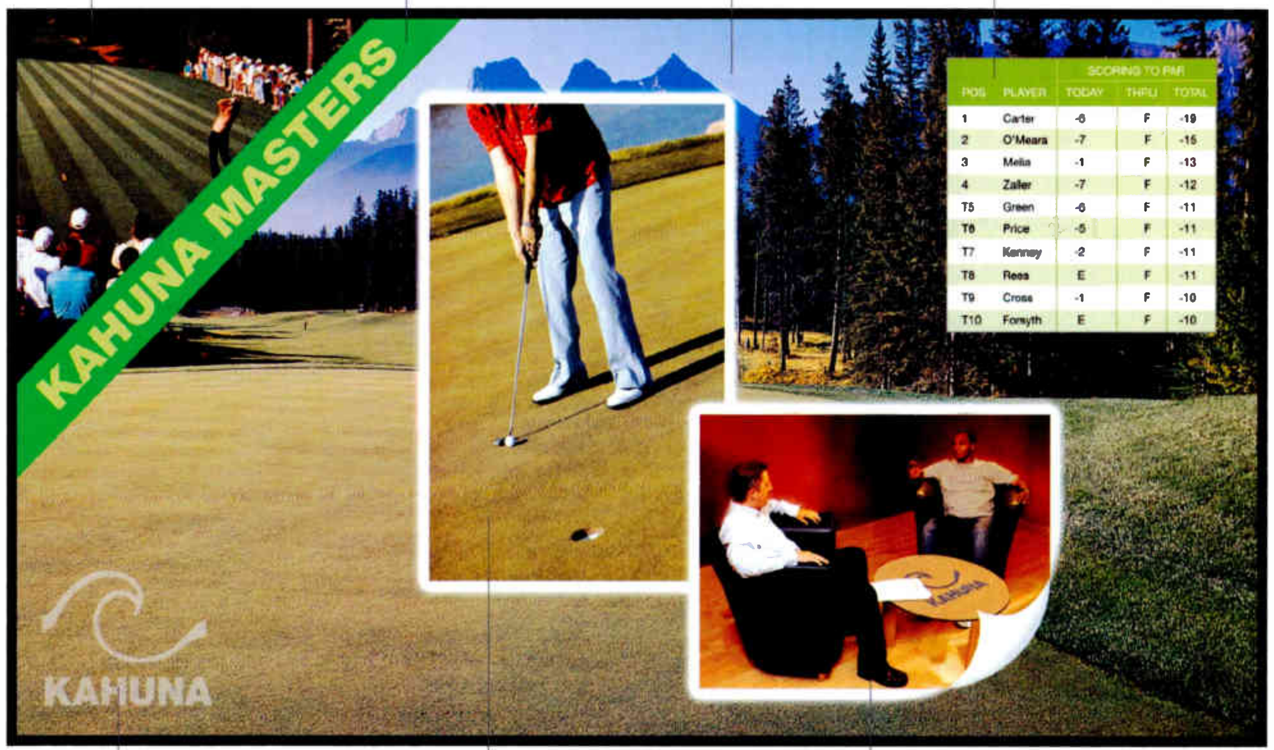
Example of HD Output from a Single M/E Using Mixed SD/HD Inputs

HD background B

Wipe bar provided by Utility Bus

HD background A

SD character generator output using FormatFusion and resize engine



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The elements controlling loudness

BY JEFF RIEDMILLER

Controlling program loudness begins with an accurate estimation of the loudness either on a continuous (short-term) or an overall (long-term) basis. This is best expressed by a single value that represents the loudness of the entire program. In a Dolby Digital, or AC-3, bit stream, this value is known as the dialogue normalization, or dialnorm value.

The term "loudness" can be defined as the attribute of auditory sensation in which sounds can be placed on a scale extending from quiet to loud. It is a highly subjective quantity that involves psychoacoustic, physiological and other factors. This often results in substantial differences in loudness perception between listeners, making a single measurement solution that considers all of the factors, for all individuals, incredibly complex. This is borne out by real-world experience, as there is often no single loudness level that satisfies all listeners (or even a single listener) all of the time.

> There is often no single loudness level that satisfies all listeners (or even a single listener) all of the time.

At best, we can only approximate the loudness of sounds by artificial means. One study Dolby performed showed that even when a group of people normalize a program by ear (still the best loudness estimation device we all have), the normalized program will satisfy a different group of listeners only about 86 percent of the time. Given this level of uncertainty, how can we estimate the loudness of programming for level-control purposes and satisfy the largest portion of the listening audience? And how can we do it without having to develop an overly complex system?

Loudness perception

Before answering this question, let's briefly recap what we know about the science behind loudness perception. First, the human auditory system is nonlinear with respect to frequency. Perceived loudness is dependent on the frequency content of a sound.

For example, a person with normal hearing would perceive a low-frequency sound, such as a 20Hz tone at 40dB SPL, to be quieter than a 1kHz tone at 40dB SPL. If this process is repeated for various frequencies (with the 1kHz tone still fixed at 40dB SPL), a 40-phon equal-loudness contour is created (where *phon* is defined as a unit of loudness level). For example, if a given sound is perceived to be as loud as a 40dB SPL sound at 1000Hz, then it is said to have a loudness of 40 phons.

You may be familiar with the equal-loudness contours that were first developed by Fletcher and Munson in 1933. Approximations of these contours have been used in sound level meters for several years and are commonly referred to as frequency weighting networks (e.g., an Leq(A) meter used for setting the dialnorm value in AC-3).

In such a network, the intensity of each frequency is weighted according to the shape of the equal-loudness contour — and for a particular loudness level in phons (for example, A-weighting approximates the sensitivity of human hearing similar to the 40-phon loudness contour) — before summing the energy across the entire frequency range. Devices of this type are good at estimating the relative loudness of signals with similar spectra, such as dialogue.

Calculating the loudness of more complex groupings of sounds, such as those with heterogeneous spectra, however, requires further thought, as something called the critical bandwidth comes into the picture. Critical bandwidth is a measure of the frequency resolution of the ear.

For example, if two sounds of equal loudness are close together in pitch (narrowband) when sounded separately, then their combined loudness when sounded together will be perceived as only slightly louder than one of them alone. Hence, they are probably in the same critical band where they are competing for the same nerve endings on the basilar membrane of the inner ear.

However, if the two sounds are widely separated in pitch (wideband), the perceived loudness of the combined tones will be considerably greater because they don't compete for the same nerve endings. Third-octave frequency bands can, and have been, used as an approximation to the critical bands in some standardized methods of calculating loudness (namely ISO 532-1975 Method B).

As a side note, the critical band is about 90Hz wide below 200Hz and increases to about 900Hz for frequencies around 5kHz. Because loudness perception is dependent on whether the signal is wideband or narrowband, it becomes challenging to design a measurement system that detects and applies a specific loudness measurement function for each of these signal

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types on a continuous basis.

The human ear is also not particularly sensitive to instantaneous peaks in signal level. While peaks of short duration may be present in a signal, the perceived loudness of the overall signal is typically not significantly affected. This is why a peak program meter (PPM) is less effective in indicating loudness. Psychoacoustic experiments show that for short intervals of time, loudness is less for shorter sounds but that at some time interval, somewhere between 100ms and 200ms, increasing the duration of a sound doesn't make it any louder.

What about volume-unit (VU) meters? The VU meter has considerably slower ballistics than the PPM and will indicate somewhere between the average and peak values of a complex waveform. Moreover, the VU meter only approximates momentary loudness changes in program material and can indicate moment-to-moment level differences that are greater than what our ears perceive. The VU meter also incorporates a relatively flat frequency response over the entire audio spectrum and therefore does not address the nonlinear nature of the human auditory system. This can result in very large meter deflections that do not highly correlate with a change in perceived loudness. Perhaps most important, these types of devices can lead to subjective interpretation errors among operators.

Given all this, you can see how the development of a measurement system that factors in even these few characteristics of human hearing (as well as numerous others not described here) would be quite complex, and yet it still wouldn't provide a measurement method perfect for every individual! Considering this, is there a way of simplifying the measurement of loudness of broadcast programming without impacting our accuracy or the satisfaction of your listeners?

While peaks of short duration may be present in a signal, the perceived loudness of the overall signal is typically not significantly affected.

Taking a new look

If we take a step back and look at the problem from a different angle, we know that we already have a proven and standardized method of estimating the relative loudness of signals that performs quite well, particularly with signals that have similar spectra, such as an A-weighted (Leq) measurement. Furthermore, because a significant portion of broadcast content contains dialogue, where any one sample of dialogue is spectrally similar to another, why not leverage the use of a classification system that intelligently chooses which portions of the signal (to be measured) that have strong similarities among most broadcast programming? This approach would better address the limitations of a basic frequency-weighted measure by only measuring the dialogue portions of the signal.

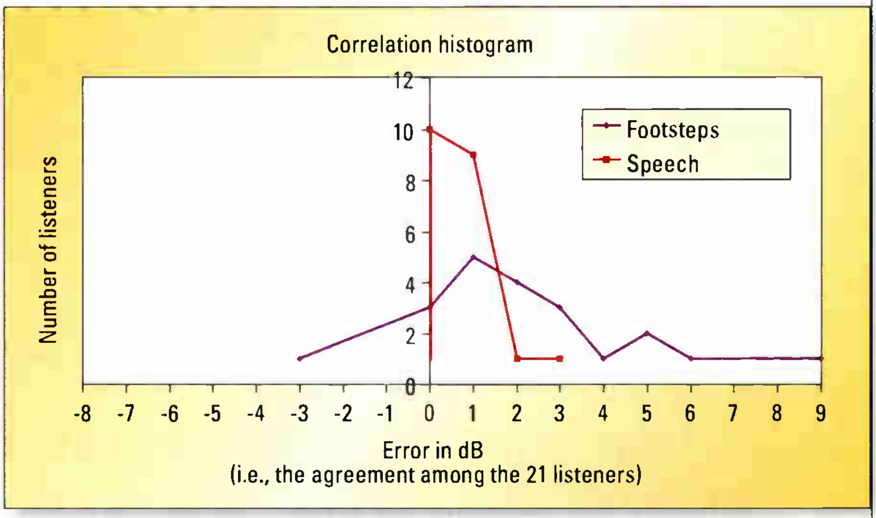

Figure 1. The level of agreement among 21 listeners, leveling speech and footstep signals by ear

Consider the following: Evidence suggests that television listeners make adjustments to their volume controls in an effort to create consistent (perhaps conversational) speech levels from program to program (or channel to channel). Simply stated, as viewers, we use the television volume control to normalize the dialogue level to our own individual taste for each program, from scene to scene, between commercials and so on. For most television programs, speech can be considered the most important portion of the audio signal, because it carries the information describing the pictures we are viewing.

Television viewers in a living room environment prefer the dialogue level at a mean sound pressure level of 60.5dBA.[1] Speech levels during ordinary conversation range from 55dBA SPL to 66dBA SPL. Television viewers choose to set the listening levels such that the program is, in a sense, speaking to them at a normal conversational level.

Considering the research results above, estimating the level of dialogue seems beneficial — and perhaps even a shortcut — to developing a more accurate loudness estimation for television programs. In a study that supports this claim, 21 listeners evaluated two samples of programming

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compared with a reference.[2] During this test, each of the listeners leveled (by ear) each sample to match the reference. One of the samples contained dialogue, and the other contained a portion of a program where someone was walking down a hallway and heard only the sound of footsteps.

Figure 1 on page 42 shows the correlation histogram of listener results. There was general agreement among the listeners when they leveled the dialogue item. Nineteen out of the 21 listeners agree with each other within 1dB.

By contrast, there was pronounced disagreement within the group when they attempted to level the footsteps piece to the reference. One person indicated a need to adjust the footsteps up by 3dB, while another indicated a decrease of 9dB to make it agree to the reference.

Users more closely agree on relative loudness when comparing two dialogue segments.

Users more closely agree on relative loudness when comparing two dialogue segments than when comparing arbitrary audio signals. Thus, a device that successfully predicts the average perceived level of dialogue (for example, the Dolby LM100 broadcast loudness meter) will be in close agreement (within approximately 1dB) with a significant portion of your listeners. **BE**

Jeff Riedmiller is product manager for Dolby Laboratories.

[1] *117th Audio Engineering Society Convention Paper 6233, Eric Benjamin*

[2] *115th Convention Audio Engineering Society Convention paper 5900, Riedmiller et al.*

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Transmitter technology

BY DON MARKLEY

The modern TV transmitter seems to be treated as a component in a much larger system, which may be scattered anywhere the Internet can reach. Remote control system manufacturers are heavily involved in systems that provide control of multiple transmitters, while monitoring the parameters of those stations automatically to insure their operation stays within a prescribed set of limits.

The transmitters themselves are designed toward that goal. It has been several years since there were show demonstrations where the entire exciter was controlled by a laptop. That included viewing the eye diagrams, turning the necessary corrections on and off and manually adding to those corrections if one didn't trust the automatic circuitry. Actually, the automatic circuitry usually did a better job than the manual adjustments.

The technology of the transmitters themselves has not made huge strides in the past few years, other than improved control systems. Perhaps the most notable improvement in the past year has been the elimination of the crowbar circuit. At NAB2005, Thales showed its product without that little device, and it can safely be assumed that other manufacturers will follow.

The purpose of the crowbar was to crash the energy existing in the power supply when that system was shut down due to a detected arc in a klystron amplifier. The result was that klystron would not suffer catastrophic failure. Now, the power supply folks have developed a method whereby the inrush of current to the klystron is controlled by the supply itself, eliminating one more high-voltage device from the system.

Perhaps the most notable improvement in the past year has been the elimination of the crowbar circuit.

Otherwise, the change in transmitters has been a migration rather than a huge leap. Several manufacturers are offering both VHF and UHF DTV transmitters at power levels up to 20kW in solid-state units and as high as you want to go in klystron-type systems. Solid-state transmitters that are air-, oil- or water-cooled are now available. Klystrons in various configurations are also available, each with its own set of advantages or problems. And the klystrode is even still around, though not in the great abundance that was once anticipated.

Obviously, a great deal of work is not going into NTSC transmitters these days. Like it or not, that buggy whip technology will eventually go the way of the slide rule. The work is on the DTV side, where some fascinating test systems are available to help adjust the transmitter to meet the critical requirements of the 8-VSB modulation scheme.

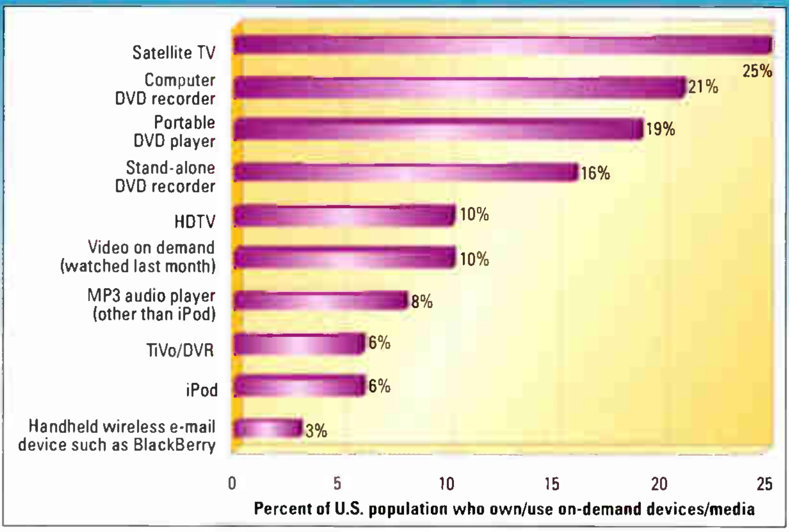
Essentially all of the manufacturers will furnish their transmitter purchasers with a complete set of test equipment, mounted in a rack of their own including all the interconnecting wiring harnesses to plug right into the transmitter. In addition to an HD

FRAME GRAB

A look at the consumer side of DTV

On-demand devices owned by Americans

Twenty-five percent of Americans subscribe to satellite TV



Source: Arbitron/Edison media research *www.arbitron.com/www.edisonresearch.com*

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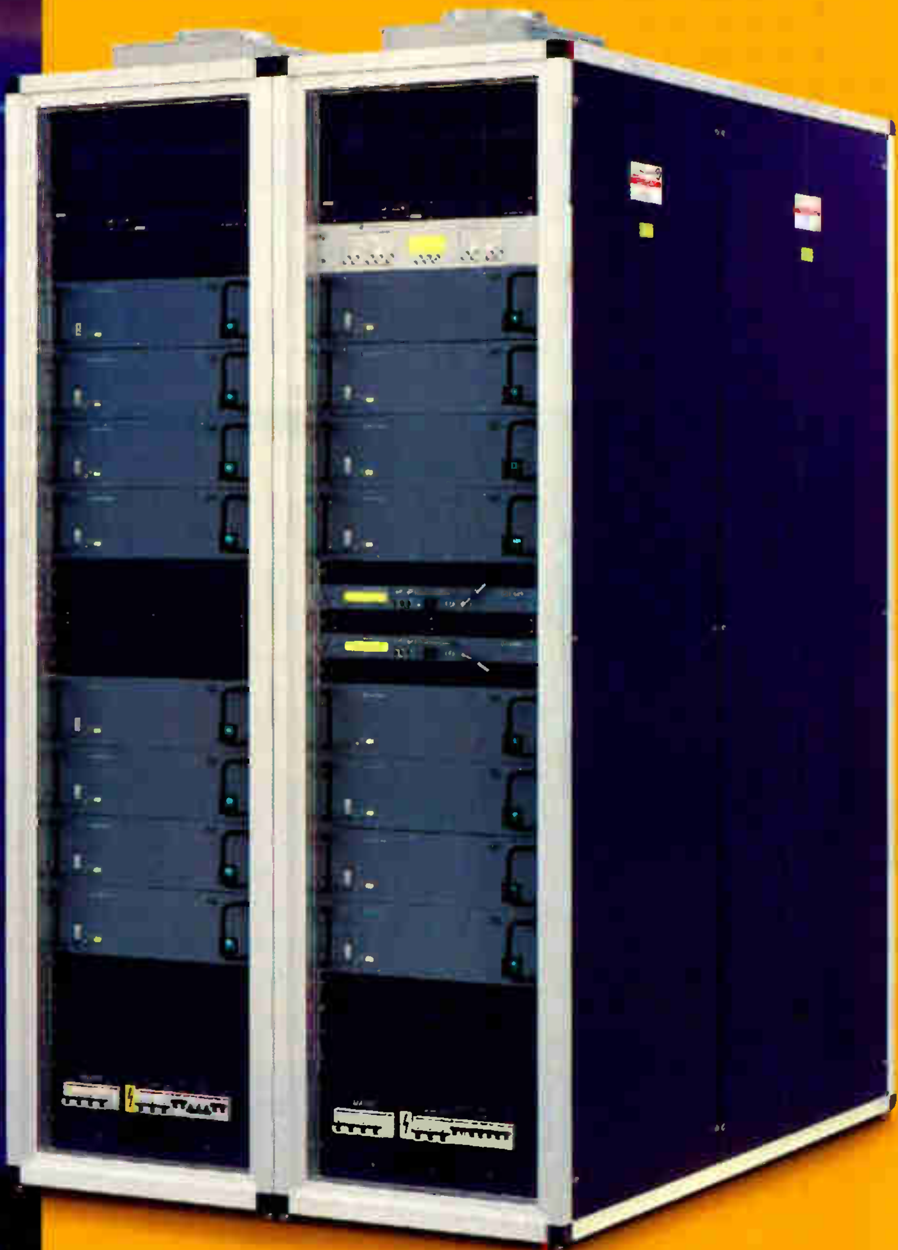

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video monitor, the system will usually include something like the Tektronix RFA300A or one of its competitive products.

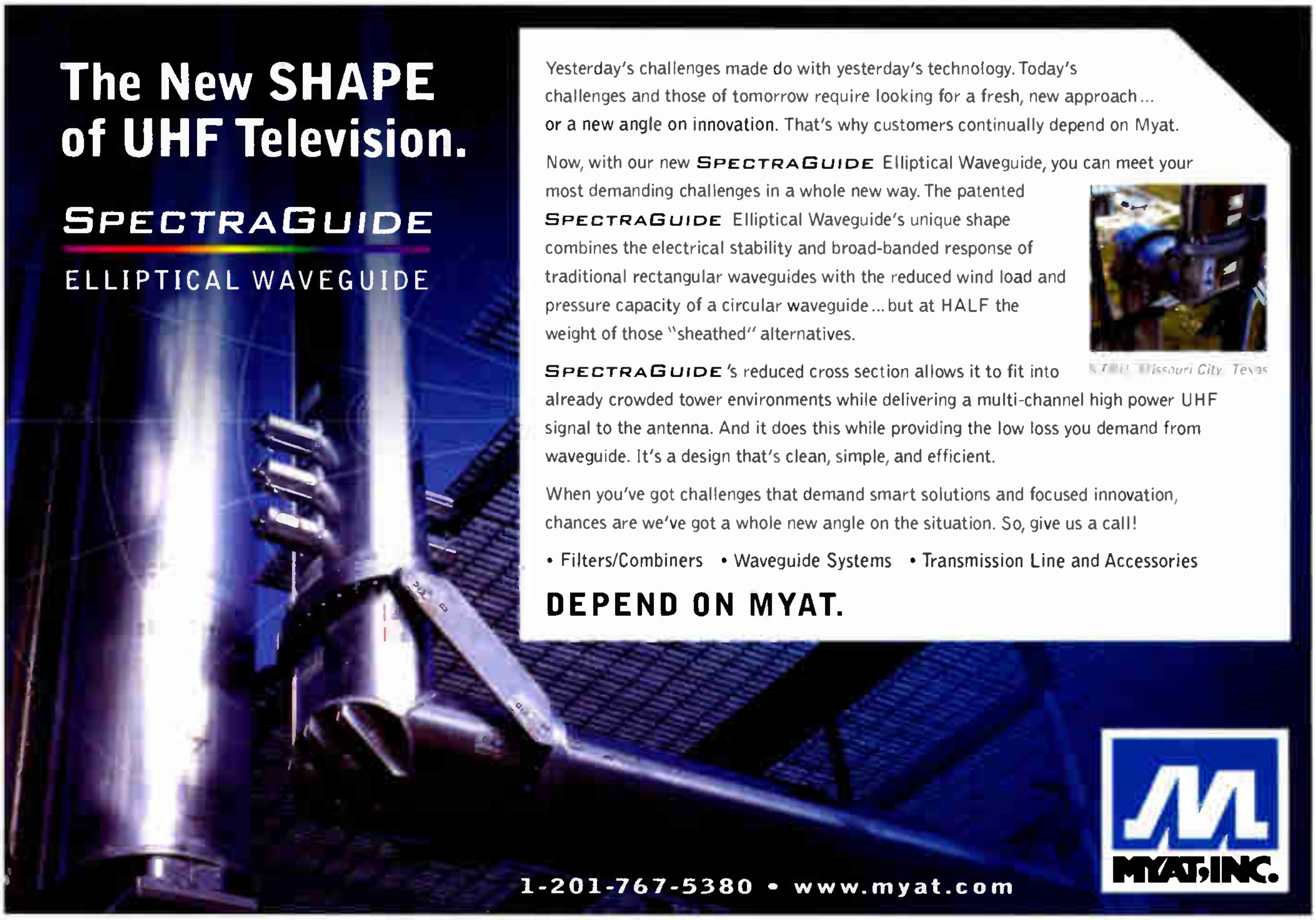
The RFA300A is a good example of the measurement sets offered. It really is designed to be installed with the DTV transmitter and used not only for repairs but also as a continuous monitoring system. The device measures a broad range of parameters starting with signal-to-noise, error vector magnitude, the eye diagram and constellation.

The system will permit the operator to easily monitor compliance with the DTV mask. The FCC recently clarified methods for ensuring that the transmitter emissions complied with the mask. For more, see DA 05-1321, May 10, 2005, at *www.fcc.gov*. That document primarily deals with the use of spectrum analyzers to do the measurements. Basically, don't try this measurement with an older analog spectrum analyzer. However, the mask compliance, as well as other out-of-channel emissions, is simple to analyze with this test system.

It also measures transmitter group delay. In days happily gone past, group delay was a parameter that was essentially confirmed by simply wishing it so. Supposedly, a measurement was done at the factory, and that data furnished with the transmitter. As almost no one had the equipment to do this measurement in the field, an automatic assumption was made that nothing had changed and everything was fine. It was sort of like saying that if the current and voltage on an amplifier were just like in the original test data, the power must be right. Sure. You bet. However, if a little group delay error did creep into the system, it wasn't a really big deal in NTSC days. It is a big deal for DTV.

In days happily gone past, group delay was a parameter that was essentially confirmed by simply wishing it so.

The frequency response and spurious functions are equally easy to use. Again, not like the days when one used an early sideband measuring system to proof the transmitter. Standard practice was to keep the camera ready while the sideband measuring equipment was slowly adjusted. If the camera operator noticed anything that looked like the pictures



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in the transmitter manual, he would immediately take the photograph so it could be included in the proof.

Before it appears that this is a Tektronix advertisement, it is worth noting that many of the measurements and displays found with the RFA300A can also be found in some interesting portable equipment.

> The station engineer can control his system from the convenience and privacy of his favorite bar or recliner.

A choice example is the Rohde & Schwarz FSH3-TV — a small, handheld, battery-powered unit that provides the demodulation and testing capabilities to meet most transmitter tuning requirements. The necessary output waveforms can be connected directly to a monitor as well as be observed in smaller scale on the instrument. In addition, the instrument will perform as a vector network analyzer when connected to a suitable bridge. It even will do distance-to-fault measurements when that option is added. The price is reasonable when compared with the big systems, and the quality is typical Rohde & Schwarz.

So, the name of the game around the transmitter room seems to be that the transmitters themselves are being designed toward self control and monitoring.

The test equipment has become infinitely more sophisticated and capable. The large systems for permanent installation not only provide essentially all the information needed in the adjustment of a modern transmitter, but also will send you an e-mail or page you if a problem does occur. The station engineer can control his system from the convenience and privacy of his favorite bar or recliner. However, it may be a little bit hard to convince the front office that you are really on duty with your feet propped up and a cold one next to you. **BE**

Don Markley is president of D.L. Markley and Associates.

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Understanding DTV transmission measurements

By John D. Freberg

While virtually all TV stations have DTV transmission systems on the air, many station engineers have never performed detailed measurements on the effectiveness of those systems. While the transmitter may have passed a proof when the manufacturer installed it, how many RF engineers really know if their DTV RF system is operating properly?

This article will provide a basic understanding of some key parameters that can be checked to ensure a properly operating DTV transmission system. Armed with this background, an analog-based engineer can begin to better understand how those parameters can affect the quality of the broadcast signal and what to look for when making tests.

I and Q modulation

A key to understanding the 8-VSB is to remember that a single-sideband RF signal can be produced by summing two modulated RF carriers, one offset from the other by 90° (cosine, sine). The cosine carrier is modulated by the in-phase, or I signal (baseband data). The in-phase components are shifted by 90° to produce the quadrature phase, or Q signal, which is then used to modulate the sine carrier. The two carriers are combined, and one of the sidebands is eliminated through phase cancellation. The resultant signal vector therefore contains both I and Q components.

Constellation diagram

Figures 1 through 3 illustrate the development of a constellation diagram from the 8-VSB waveform. As the signal propagates through time, the position of the carrier vector moves continuously along the time axis. Simultaneously, the carrier vector rotates around the time axis at approximately the carrier frequency. (See Figure 2.) The tip of the vector

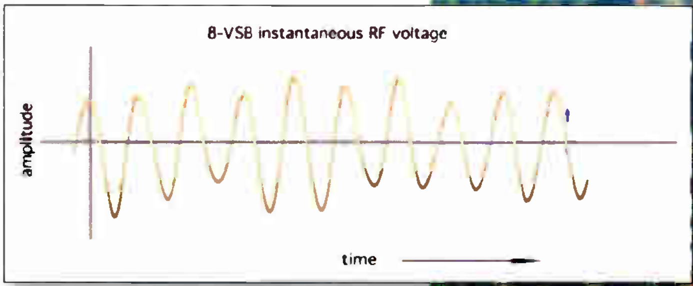

Figure 1. Several cycles of an 8-VSB RF signal

traces out the instantaneous values of the I and Q components when measured along those respective axes.

In Figure 3, the RF signal is viewed directly perpendicular to the I and Q axes. In this view, it becomes clear how the 8-VSB carrier vector assumes constantly changing I and Q values.

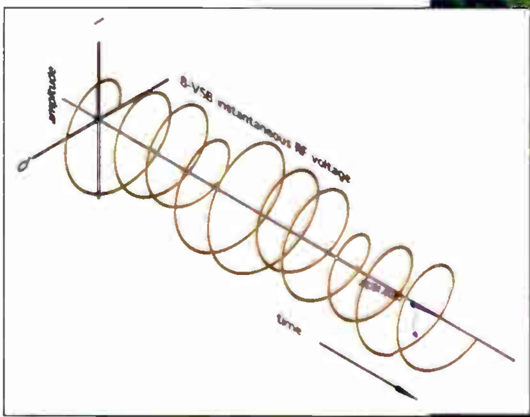

Figure 2. Signal has been rotated in phase space to illustrate the 3-D aspects

The tip of the carrier vector shown in the diagram represents the position of the signal at one instant in time.

In a DTV receiver, the 8-VSB RF signal is sampled RF signal every 92.917ns (1/symbol rate). The receiver is interested in the value of the RF signal only at those specific sample

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WSAV-TV in Savannah, GA, uses an NTSC/DTV Dielectric TUV Dualband antenna to broadcast channels 3 and 39.

times. For data recovery purposes, the receiver doesn't care about the signal values in between samples. In Figure 3, the eight symbol value lines represent the sample points. Several RF

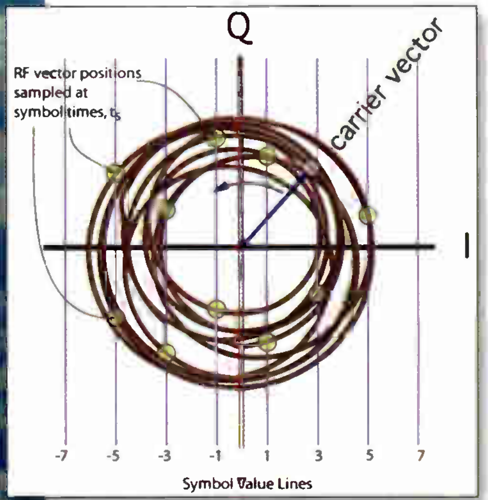

Figure 3. Signal display rotated to show the I and Q characteristics of an 8-VSB signal

vector samples are shown as small circles at increments of the symbol time. A constellation diagram is therefore a plot of the tip of the carrier vector sampled at symbol times over a large number of carrier cycles.

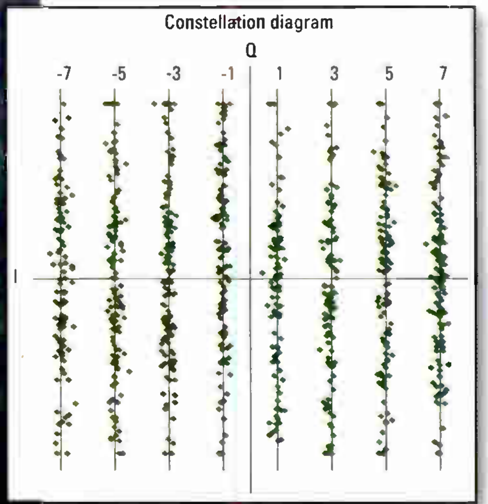

Figure 4. Constellation representing about 3 percent RMS EVM, 30dB MER, 15dB margin

Constellation units

The vertical lines on the diagram represent the eight amplitude levels in 8-VSB also known as constellation

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units. If a sample falls anywhere along one of these vertical lines, it indicates that the I (amplitude) component of the signal is equal to the corresponding 8-VSB symbol.

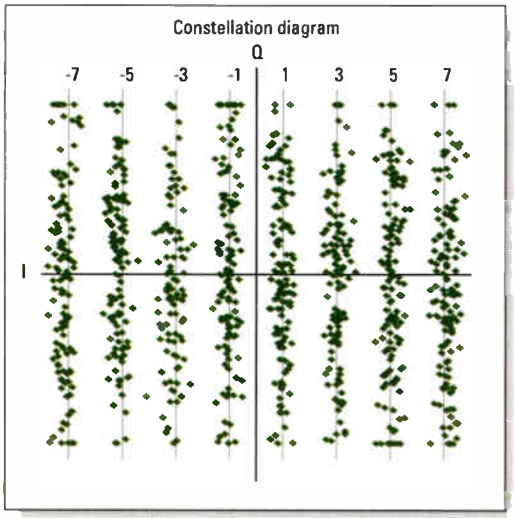


Figure 5. Constellation representing about 5 percent RMS EVM, 25dB MER, 10dB margin

The position of the sample measured vertically along the symbol line indicates the value of the Q component. In 8-VSB, the Q component carries no data, but it does provide information regarding signal quality and transmission impairments.

In a perfect system, the sampled points would fall exactly on one of the eight symbol lines. However, propagation errors cause the sample points to fall to the left or right of the lines. As long as the samples are clustered close enough to the lines, the receiver can still distinguish the eight discrete symbol levels and recover the data. But if the spread of the samples grows too large, samples for one symbol level will cross over the threshold for the adjacent symbol level, resulting in a symbol error.

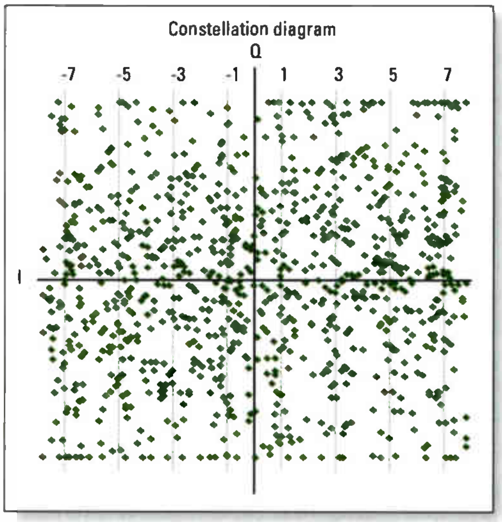


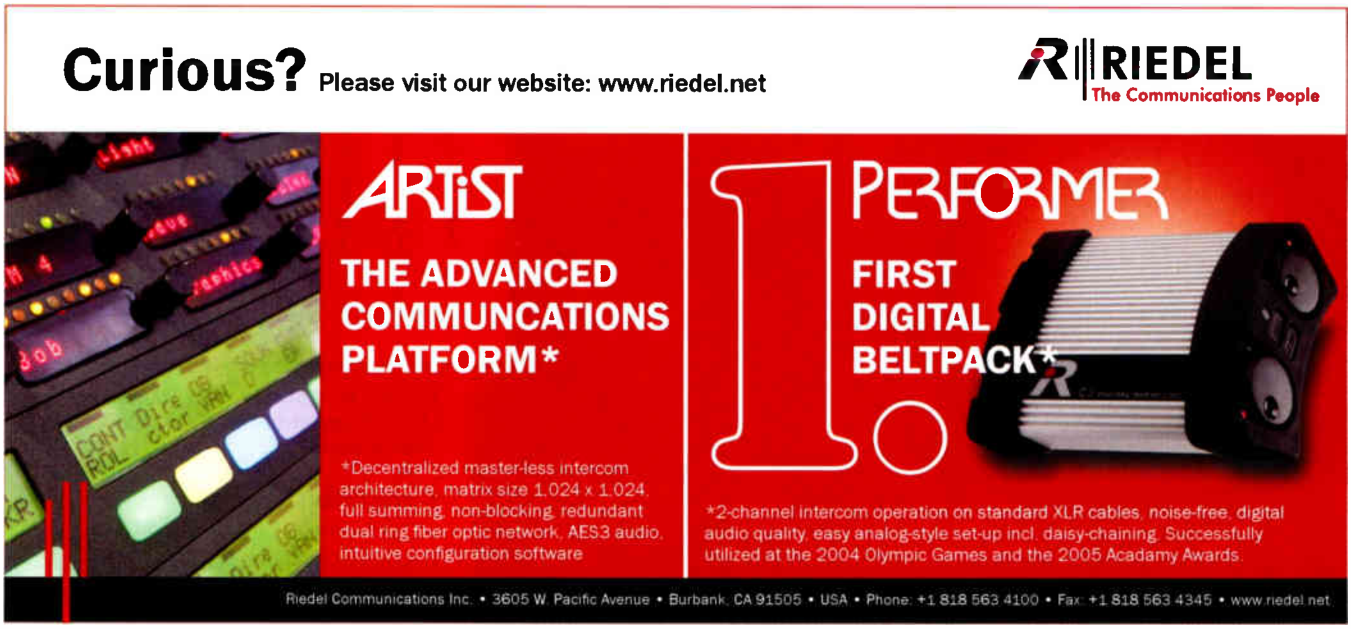
Figure 6. Constellation representing about 10 percent RMS EVM, 20dB MER, 5dB margin

Error vector magnitude

Figures 4 (on page 53), 5 and 6 are constellation diagrams of off-air signals. In Figure 4, the error vector magnitude (EVM) is about 3 percent. In Figure 5, the EVM has increased to approximately 5 percent and to about 10 percent in Figure 6. It's important to note that even with an EVM of 10 percent, the signal was still producing essentially perfect pictures due to the ability of the receiver's adaptive equalizer to correct for propagations effects.

The difference between a sampled symbol value and the theoretical ideal value can be represented by a vector diagram. The length of this error vector, or its magnitude, is the hypotenuse of the right triangle formed by the I error and the Q error, as shown in Figure 7. (See page 56.) EVM is expressed as a percentage of the outer symbol levels.

Over a short period of time, there will be millions of sample points in a constellation display. It's neither practical nor useful to evaluate the error vector for individual samples, so an RMS value of the error vector



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magnitude is calculated for a large number of sample points and then periodically updated.

Because the original I and Q channel components are defined by the well-known narrowband filter pulse response, any calculated EVM or errors shown on the constellation display represent the effects of the transmission system on the 8-VSB signal. Therefore, when measured at the transmitter output, EVM represents a figure of merit for the overall transmitter plant.

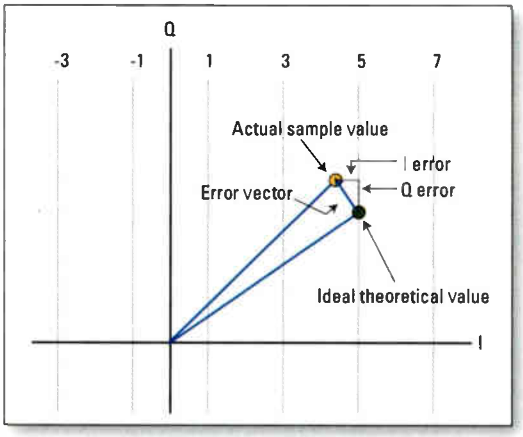


Figure 7. The EVM is the hypotenuse of the right triangle formed by the I error and the Q error signals.

Error ratio

A common way to look at overall system performance is to compare the desired signal level with background noise. This is familiar in the analog world as signal-to-noise ratio (SNR). The 8-VSB equivalent is modulation error ratio (MER).

In the 8-VSB world, a desired output signal looks a lot like random noise, so you might think that an SNR measurement would be invalid. The secret to measuring SNR in an 8-VSB system measurement is to compare desired noise-like symbol power with the noise power resulting from all other errors caused by various factors.

From the section on EVM above, the concept of the ideal theoretical symbol value can be used to calculate the noise-like power level that would be produced by a stream of undistorted symbols. This undistorted power value is then compared with the error noise power from all other sources. The error noise power can be derived from the RMS value of the squared I and Q errors. (See Figure 7.) Using the usual decibel equation, the MER value represents the ratio of the carrier power to the background noise power level.

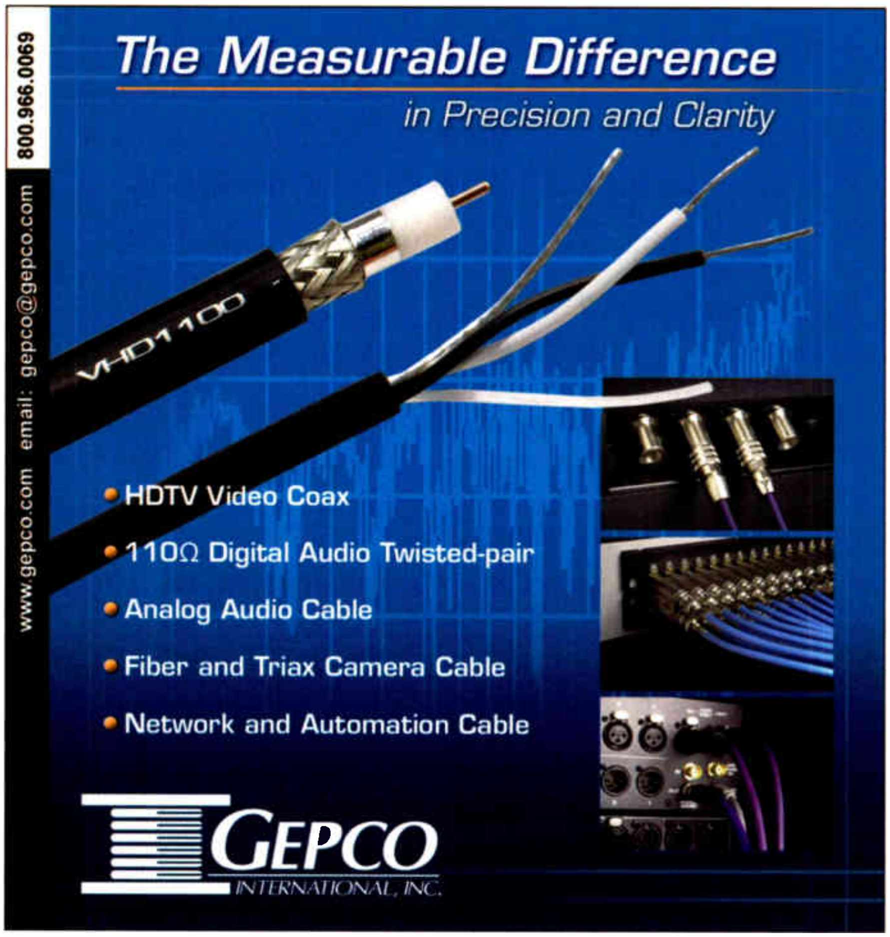
The ATSC recommends a minimum MER of 27dB at the transmitter to ensure signal availability within the designated coverage area. MER values will decrease with distance from the transmitter due to propagation attenuation, multipath, noise and interference from other sources.

Eye patterns

An eye pattern is a display of a number of symbols overlaid on one another and synchronized to the start of a symbol time. Anyone who has worked in digital audio, video or data communications for the past few years has probably seen a two-level eye pattern. The 8-VSB eye pattern extends this to eight levels.

Even in digital transmission systems, the actual information is carried from point-to-point by analog voltage or current waveforms. Therefore, while these waveforms represent digital symbols, they are still subject to all limitations associated with analog transmission. Pulses get rounded by limited bandwidth, signals are attenuated by distance, atmospheric and manmade interference are encountered, and distortion from excessive levels may be present.

To assess the transmitted quality of a digital system quickly, look



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at the eye pattern of the symbols. At the symbol times, the amplitude of the displayed signal should be at or near the defined symbol amplitudes. The space between the defined symbol levels at the sample times (eyes), should be open, i.e., there should be no signal traces through those spaces. Between symbol times, the signal waveforms will be in transition between symbol values. The display will be filled in with traces from many symbols during this period.

As noise, distortion and other impairments affect the signal, some symbol traces will deviate from the defined symbol levels, reducing the amount of empty space in the eyes. At some point, the system can't distinguish the correct level of a symbol. The eye patterns will close, and an error will occur.

Figures 8, 9 and 10 (below and on page 58) show eye patterns corresponding to MER's of 30dB, 25dB and 20dB, respectively. Note that even with the apparently closed eyes in Figure 10, 8-VSB error correction techniques will still allow the recovery of the data and provide an essentially perfect picture.

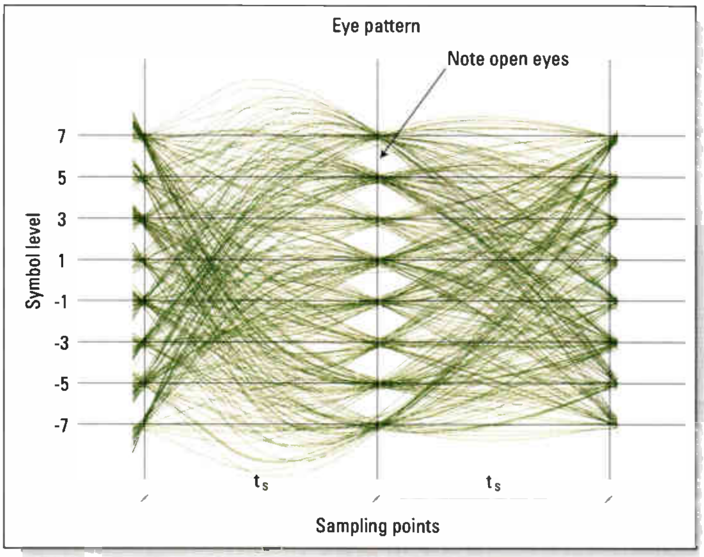

Figure 8. Eye pattern at about 3 percent RMS EVM, 30dB MER, 15dB margin

Pilot level

In the 8-VSB system, a pilot signal is inserted by adding an offset of 1.25 constellation units to the eight defined symbol levels. This results in a DC offset of the baseband signal.

In single-sideband modulation, a DC offset

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at the input to the modulator results in a fixed amplitude component at the carrier frequency. The amount of DC offset directly determines the pilot amplitude. The 1.25 constellation unit offset results in a pilot level 11.62dB below the total average signal power in the DTV channel. For practical purposes, the pilot is independent of anything related to modulation. The pilot is simply used by the receiver as a first step in tuning.

Power levels

Measuring power levels on an 8-VSB RF signal is more complicated than for an NTSC transmitter. Segment sync pulses do not provide the same peak reference as NTSC video sync, so there is no convenient point on the 8-VSB RF waveform to use as a reference.

The peak envelope power of noise-like signals is essentially random. The noise-like characteristics of the 8-VSB signal mean that energy is spread relatively evenly across the 6MHz channel. As a result, to arrive at a single power measurement number, the energy must be integrated (added up) across the correct bandwidth.

The most accurate measurement of total average power is provided by a thermal (calorimetric) sensor. This is impractical for most situations, so stations often use a broadband, full-wave rectifier-based power meter calibrated to read true average power on digital signals. (Some rectifier-based power meters need a correction factor when measuring noise-like signals.) This measurement also assumes that only the desired station's signal is being measured; there are no significant adjacent channel components from other analog or DTV stations contained in the sample.

One might be tempted to use the pilot level as a reference and infer the total average power from that point. Pilot level measured at the transmitter output can be an indicator of power level, but it is not a substitute for accurate power measurement. In the field, the pilot level can be affected by selective fading or cancellation and is therefore not a reliable indicator of received signal strength.

DTV mask

The IEEE Broadcast Technology Society RF Standards Committee G-2.2 is working on a draft standard for 8-VSB emissions mask compliance. It introduces the term dB_{DTV} and refers to spectrum amplitude measure-

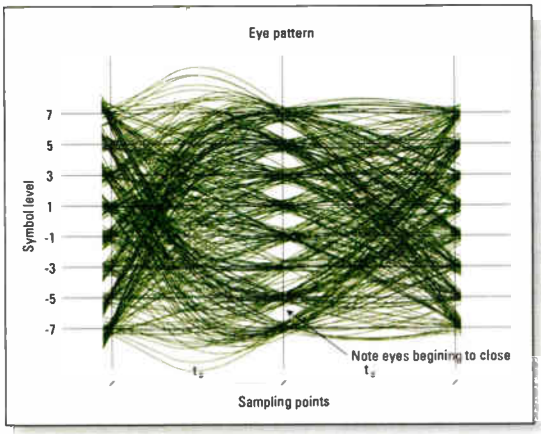

Figure 9. Eye pattern at about 5 percent RMS EVM, 25dB MER, 10dB margin

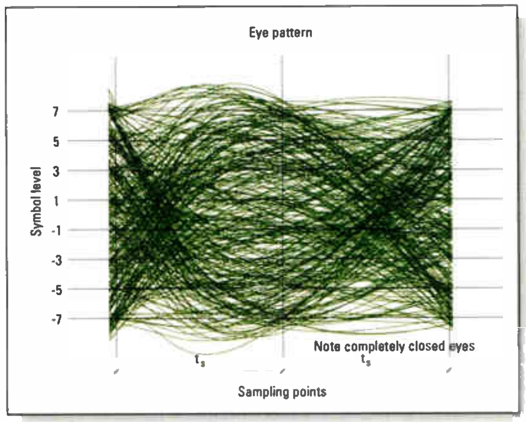

Figure 10. Eye pattern at about 10 percent RMS EVM, 20dB MER, 5dB margin

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ments made with 500kHz resolution bandwidths. $0dB_{DTV}$ is defined as the total average power within the 6MHz bandwidth, including the pilot.

Figure 11 shows the full-service DTV emissions mask along with key reference points for an 8-VSB signal. Note the small circle at the center of the 0dB line on the diagram. This refers to the total average power within

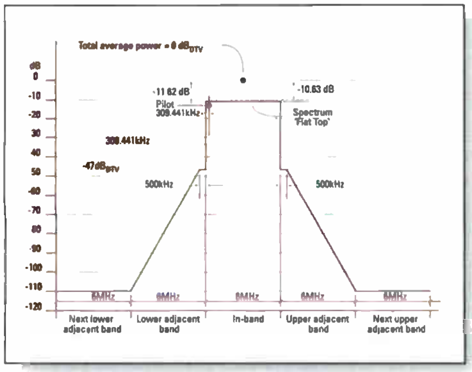

Figure 11. DTV mask with spectrum reference points

the 6MHz channel at the licensed transmitter power output.

The -10.63dB line refers to the flat-top portion of the 8-VSB spectrum, measured using a 500kHz bandwidth. To derive total average power from this, 12 500kHz bands must be integrated across the 6MHz channel, with appropriate corrections applied for pilot level.

Spectrum analyzers are typically used for these measurements. Newer spectrum analyzers provide highly desirable marker bandwidth power measurement capabilities that can automatically integrate power over various bandwidth settings. Proper use of the spectrum analyzer for mask compliance and other 8-VSB measurements requires skill and attention to details that are beyond the scope of this article. I am currently engaged in efforts to standardize the use of spectrum analyzers as part of the IEEE G-2.2 Committee efforts.

More to learn

There are many details to consider when establishing a monitoring and measurement program for your DTV operations. Not all measurements need be done on a regular basis. However, engineers need to become just as familiar with testing digital signals as they are with analog NTSC measurements. These new tests aren't necessarily more difficult than analog ones, but they are different. A key distinction is that with digital transmission, viewers won't get a poor signal. They'll either get a good one — or none at all.

This article represents a brief introduction to several important measurements for 8-VSB signals. It is an abridged version of a presentation I made at NAB2005. A complete copy of this presentation is available in the 2005 Proceedings. BE

John D. Freberg is president of The Freberg Engineering Company.

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Iomega's REV drive:

Yet another storage technology

BY MICHAEL GROTTICELLI

Just when you thought it was safe to invest in a new tapeless recording technology like solid-state memory or optical disc, another way to store video and audio has emerged.

It's actually not a totally new storage method, but an innovative repackaging and improvement of hard disk recording. It's called the REV drive, and it comes from Iomega, the inventors of the Zip drive, which became ubiquitous in the print industry for storing large graphics files. The company recently partnered with Grass Valley to develop a next-generation removable disk cartridge, this one targeted for use with professional production and broadcast applications.

Grass Valley's interest lies partially in the format's IT-friendly design. Also, the company thinks it might have found the Holy Grail for ENG recording: a widely

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available, low-cost recording media that helps stations get stories on-air faster with less complexity. By improving production workflow, the companies claim the technology will pay for itself in the first two years of use.

Grass Valley's Pro AV line

Grass Valley and Iomega have entered into an OEM and joint technology development agreement that will result in the REV disk being integrated into a variety of products from Grass Valley's Pro AV line. The first in this series is the Turbo iDDR, which was announced in May and can now be ordered with built-in REV drives. It's not hard to imagine that down the road, the REV cartridge could be integrated into cameras, source decks and a variety of other production equipment that relies on storage.

Iomega currently offers the REV drive as part of its line of NAS servers, in capacities of 160GB to 1.6TB. But can the REV disk stand up to professional audio and video production use? For the answer to that question, let's look into the actual disk mechanism.

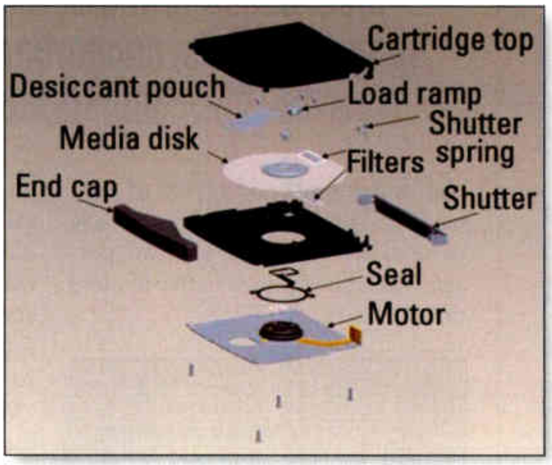

Figure 1. Components of the Iomega REV cartridge

Under the hood

The REV drive resembles both a floppy disk and a hard drive. (See Figure 1.) It has a spinning disk like a floppy, but the disk is actually a 2.5in rigid hard-disk platter, similar to that used in laptop computers. In addition, the motor to spin the disk resides inside the actual REV drive, not the player/recorder, as is the case with a floppy drive.

To enable the high storage capacities that the disk provides, there can be no floppy give-and-take here. We're talking about hard-disk manufacturing tolerances. The hard plastic shell is supported by a rigid steel bottom plate. The shell is securely fixed to the plate by four screws.

Also attached to the steel plate is the motor that spins the disk and the platter's shaft bearings. The disk is supported by two bearings at the top and bottom of the center shaft.

Because the system is really a hard disk, the storage surfaces must be protected from any contamination. The platter must remain completely clean and dust-free. To protect the storage medium, a contaminant-free environment is maintained by a locked and sealed door mechanism. Only after the REV is loaded into a player/recorder, and into another clean environment, does the front door open, exposing the hard-disk surface.

The drive is loaded by a powered, docking mechanism, much like videotape. The drive is sucked into the player/recorder and then locked firmly into position by a set of guides and fingers. It's important that the drive remain precisely positioned at all times because the next step is for the hard-disk heads to rotate out from the player/recorder to fly just above the platter's magnetic surface.

As the drive is locked down, power and speed-sensing connections are established through four contacts on the right side of the disk. The drive motor now spins up, under the control of the player/recorder.

Once a REV disk is inserted into a drive, play and record functions can start within about 13ms. This access time will improve in future generations, according to both Grass Valley and Iomega. If power is lost during recording, the drive is automatically disengaged, and the data recorded up to that point is already safely recorded on the disk.

Current capacity of the drive is 35GB of storage, or about two hours of 25Mb/s SD or 45 minutes of 75Mb/s HD. Iomega officials say storage capacity will increase significantly as the data density for its rigid removable disk technology continues to improve.

The drive has only been available for just over a year. Even so, Iomega has tested the system in a variety of extreme vibration, temperature, altitude and humidity conditions and said it meets or exceeds all of the requirements of video and audio professionals.

The benefits

So, what are some of the benefits of the REV disk? First of all, it provides all the advantages of true random access to stored material. Second, the REV disk is up to eight times faster than comparable tape-based systems and up to five times faster than the DVD format. External drives

It's not hard to imagine that the REV cartridge could be integrated into cameras, source decks and a variety of other equipment.

with Firewire or USB connectivity and internal drives with SCSI interfaces are available from Iomega, so there are plenty of playback options.

When compared with optical media, REV drives are faster and cheaper. The drives are shock- and vibration-resistant, provide storage density of 60Gb per square inch and have a hard bit error rate of 1/000. The REV technology is

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Clearly the technology provides many advantages over tape-based formats. It offers I/O transfer rates up to 200Mb/s, supporting faster-than-real-time import and export of digital files. The REV cartridge can also be used for long-term archival storage, with a shelf life estimated at more than 30 years.

The technology provides many advantages over tape-based formats. It offers I/O transfer rates up to 200Mb/s, supporting faster-than-real-time import and export of digital files.

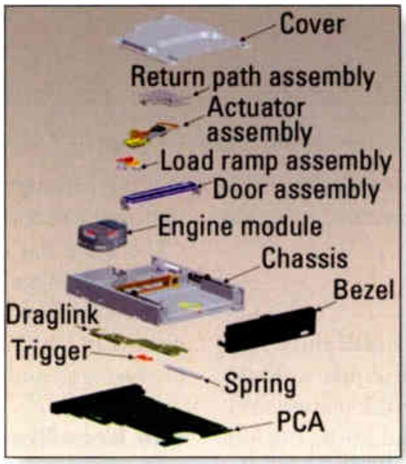

Figure 2. Components of the Iomega REV drive

Also important for broadcast applications is the disk's portability. The 3in x 3in x 3/8in package is easy to handle, yet small enough to provide dense storage.

What's next?

The toughest part might be selling the Iomega name to the broadcast industry, but the Grass Valley name will certainly help in this regard.

To help facilitate the REV disk's overall acceptance within the broadcast industry, Grass Valley is developing a Partners Program of third-party manufacturers that already offer production technology, including audio workstations, NLE systems, graphics and special effects devices. The goal is for these partners to develop REV-compatible solutions.

When it comes to video storage, there are emerging alternatives, but the Iomega REV disk could be the best replacement yet for videotape. It offers all the workflow advantages of a hard drive while avoiding the size and durability issues. Also, if the format takes off, everyone will benefit from a widely available media format and lower prices from volume manufacturing.

The true test might come when broadcasters try it themselves for news and other portable applications. Only then will we know just how good the REV technology really is. **BE**

Michael Grotticelli regularly reports on the professional video and broadcast technology industries.

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HDTV LENS DESIGN: Management of optical aberrations

By Larry Thorpe and Gordon Tubbs

As discussed in previous editions of this article series, the design of a modern HDTV lens involves wrestling with an enormous number of variables. The goal of such design is an overall optimization of desired performance criteria (which often entails conflicts in design criteria) within the limits of various fundamental optical and physical boundaries. Powerful computers, advanced software, new optical materials and refinements in manufacturing processes have made the remarkable overall performance of today's HDTV lenses possible.

Despite their excellent performance, however, these latest HD lenses are all still challenged by multiple optical impairments that can be collectively minimized but never totally overcome. Optical impairments generally fall into two categories:

- Distortions to the optical image in shape and size.
- Aberrations, which are image defects associated with the fundamental behavior of light rays passing through a lens element.

Ultimately, the strategy of HDTV lens design seeks to optimize all of these factors so aberrations are reduced to an acceptable level and picture impairments are subjectively invisible.

Optical image distortions

Distortions are an inherent part of all lenses. They relate to the unwanted alterations to the overall size and shape of the image created by the lens.

Geometric distortion

Geometric distortion alters the accuracy of the geometric representation of an object scene in the optical image plane. A distortion of the image shape — described as a pincushion effect (positive geometric distortion) or a barrel effect (negative geometric distortion) — and the amount of that distortion is generally expressed as a percentage of the picture height. (See Figure 1.)

Typically, a zoom lens will exhibit barrel distortion at the short focal length (i.e., at the wide angle) and pincushion distortion toward the telephoto extreme. In addition, the wider 16:9 aspect ratio of HDTV imposes a more severe challenge to managing geometric distortion over the entire zoom range. Within the 2/3in image format size, a 1.5 percent level of pincushion or barrel distortion in a 4:3 image translates into almost 2.2 percent in the 16:9 format. This exacerbation of geometric image distortion in 16:9 widescreen is illustrated in Figure 1.

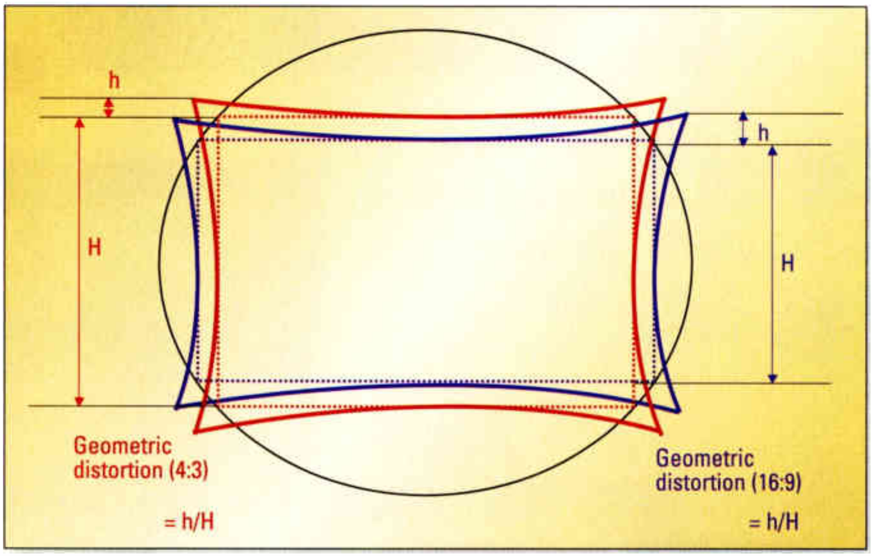

Figure 1. Shown here is the same degree of pincushion (a positive geometric distortion) for a 4:3 aspect ratio image and a 16:9 aspect ratio image. The percentage of distortion is visibly greater in the widescreen image.

Focus breathing

Focus breathing is not strictly classified as a distortion. In the eyes of practitioners, however, it behaves as an image distorter. The term refers to the phenomenon of the change in image size when operating the focus control. Focus breathing is an unwanted alteration in picture angle of view that is a consequence of moving optical elements

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while focusing. While traditionally accepted in ENG shooting, it is sometimes totally unacceptable in high-end drama and movie shooting.

Optical image aberrations

Optical aberrations largely arise from limitations imposed by fundamental optical physics, coupled with practical compromises that must be made in the overall lens design, especially in the design criteria that relate to the closely associated camera beam-splitting system. The degree of presence of the various aberrations is also a function of inevitable manufacturing tolerances related to each optical element.

Wavelength-independent aberrations

Long ago it was mathematically predicted that there were four aberrations associated with the passage of monochromatic (single wavelength) light through a single lens element. Geometric distortion is an additional element within this prediction. If a fine point of monochromatic light is sent to one lens element (as shown in Figure 2 on page 66), it will emerge with some degree of these four defocusing impairments:

• *Spherical aberration.* Spherical aberration relates to an aberration common to all lenses made up of spherical elements. (See Figure 3.) It manifests itself as differential focusing, with those rays (emanating from a physical point

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on the axis of the lens) that pass through the outer edges of the lens, converging at a focal point that is closer to the lens than the rays that pass through the central optical axis. Forming doublets of lens elements having equal and opposite spherical aberrations can considerably reduce spherical aberration.

- *Coma.* When a lens is completely corrected for spherical distortion, it may still create other forms of aberration on points in the scene that are off the central axis. If the rays from a point object are incident at an angle to this central optical axis, they exhibit a comet-like tail instead of forming a focused point. Such distortion is called coma or comatic aberration. The blur sometimes seen near the edges of the tail is often termed a comatic flare. (See Figure 4.)
- *Curvature of field.* Curvature of field relates to a defocusing phenomenon where the lens fails to focus a plane scene object as a plane optical image. When the center of that object plane is sharply focused, the edges are out of focus. Conversely, if the edges are symmetrically focused, the center of the image is out of focus. The lens, in effect, is forming the optical image in a bowl-like shape. (See Figure 5.)

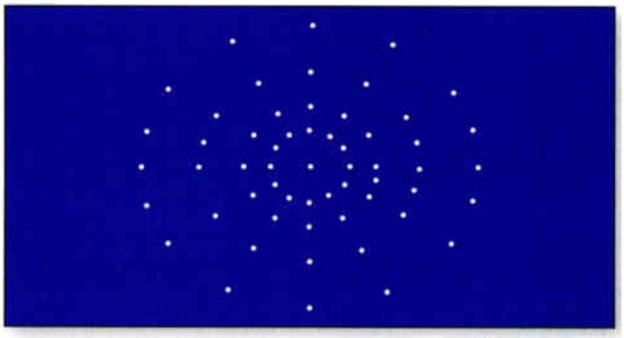

Figure 2. Light input to a lens element, consisting of an array of infinitely small point light sources that will stimulate the lens focusing aberrations

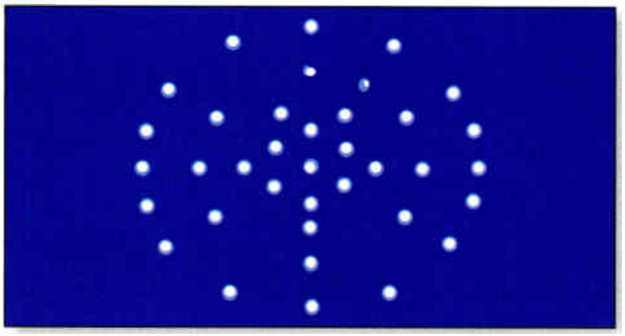

Figure 3. Spherical aberration (exaggerated for visibility) at the lens output

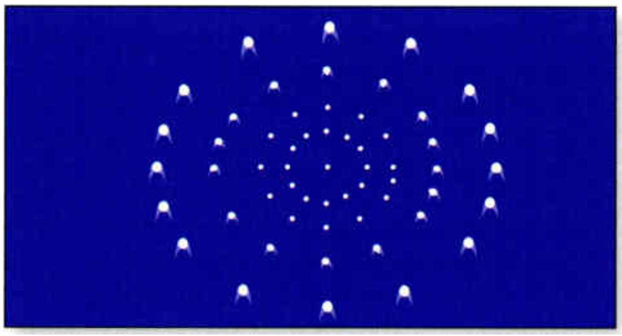

Figure 4. Comatic flare (exaggerated for visibility)

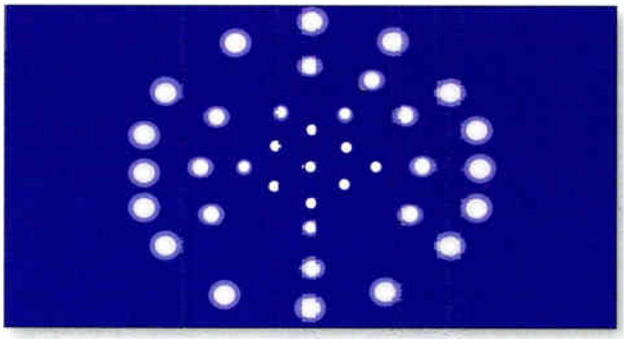

Figure 5. Note the progressive center-to-edge defocusing associated with curvature of field

- *Astigmatism.* A lens that has been corrected for spherical distortion sometimes will still not properly focus an off-axis point in the scene. Instead, the point adopts an elliptical shape or becomes a line in the lens-created image. Adjusting the lens focus, the image can change between two ellipses at right angles to each other — failing to achieve a sharp point focus. (See Figure 6.)

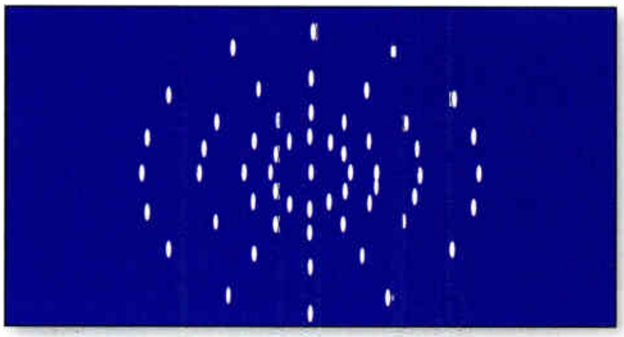

Figure 6. Exaggerated case of lens astigmatism

All four of these aberrations combine to detract from overall image sharpness. Controlling the degree of these impairments in a multi-element lens constitutes a crucially important second level of management of the modulation transfer function (MTF) of the lens.

Wavelength-dependent aberrations

In addition to monochromatic aberrations, there are a variety of additional aberrations associated with colored light; these distortions are wavelength-dependent. They result from fundamental optical properties that vary with wavelength. These aberrations are the nemesis of HDTV lenses. And, their curtailment represents the toughest design challenge for optical designers.

Different wavelengths of light encounter a different index of refraction within a given optical material, referred to as dispersion. A single lens element will accordingly

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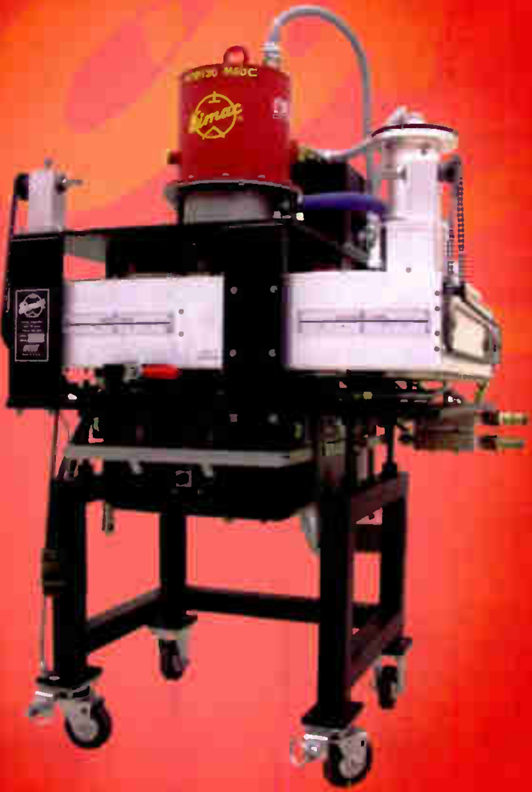

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form a number of images — one for each color present in the light beam. These are technically described by two aberrations: a *longitudinal chromatic aberration* (different focus plane for constituent colors) and a *lateral chromatic aberration* (focal length of colored light rays vary, which causes an associated variation in the lateral magnification, producing an effective misregistration). This complex topic of chromatic aberration will be treated in-depth in our next article.

Aberrations of light transmission

As light passes through the lens, it is subject to a variety of impairments that can contaminate the darker portions of the optical image. Such contamination of the black portions of an image can severely detract from the contrast performance of the lens, which, in turn, impairs the lens MTF and, consequently, the overall picture sharpness. The overall optical image can also be impaired with unique optical interferences created by the passage of strong light sources from the object scene.

In severe cases, ghosting can show up as multiple images.

These transmission impairments are, in a sense, an optical signal-to-noise issue. Just as the design of a digital HD camera system struggles to enhance all of those attributes that collectively ensure the highest quality video output while simultaneously attempting to submerge noise and other electronic artifacts, a similar technological struggle is inherent in the design of an HD lens system. Here, the collective of all of these light-transmission aberrations is analogous to the optical noise of the system.

Additional degrees of freedom in managing the multiple variables inherent in lens design are facilitated if more lens elements are used. This does, however, increase the number of air-to-glass surfaces, and this increases the total amount of reflected light from these boundaries. This reflected light will impact the camera image sensors in a variety of forms.

• *Flare.* Flare is an impairment that can arise from strong highlights in the scene and is most obviously manifested in dark regions of the image. The highlights can interact with the multiple optical surfaces within the zoom lens, causing light to spread around sharply defined highlights. These highlights may even originate from regions of the object scene that lie outside of the specific picture being imaged. The highlights may also reflect off the interior lens barrel, the iris blades or even the camera sensor itself. The advent of exotic multicoatings on each lens element provided a powerful means of alleviating these impairments. These coatings are thin transparent film materials deposited on the optical surfaces to reduce reflection and to increase transmittance. Multilayer coatings in high-performance lenses have become more popular because of their increased protection. High-quality optical materials, extremely tight control of manufacturing tolerances and carefully blackened internal mechanical surfaces must all be mobilized to lower this aberration.

• *Veiling glare.* Veiling glare is an unwanted diffuse stray light that can abruptly fog across the image plane under certain imaging conditions, consequently detracting from the image contrast. Scatter from optical element surfaces (usually the front elements) or reflections from the surfaces of iris shutter blades and the internal surface of the lens barrel cause veiling glare. Again, precision optical design, special materials, exotic coatings and tight manufacturing tolerances are all harnessed to control such interference. The appropriate use of a lens hood when shooting in strong sunlight is also an important protection against the possibility of out-of-image strong light interference.

• *Ghosting.* Ghosting refers to the creation of a sharply defined reflection — caused by the sun or other unusually strong light source in the scene — that can stimulate a complex series of reflections among the multiple lens surfaces. It often manifests itself as an image of the mechanical diaphragm that constitutes the iris control, and it usually appears in a position symmetrically opposite that light source (thus, manifesting a ghost-like appearance). In severe cases, it can show up as multiple images. Depending upon the effectiveness of the lens design, these images may be monochrome or separate color reproductions. The ghost image can be introduced by the highlight source even when it is outside the picture area. To reduce such impairments, special coatings are applied to lenses.

Summary

By now it is recognized that the nature of the multi-element HDTV lens system is a far more complicated and unyielding system than a modern digital HD camera. The digital camera is technically disciplined. In comparison, the lens is — by the very nature of optical physics — highly dynamic in its management of many parameters when dealing with a wide range of light levels and a wide range of focal lengths. As a consequence, design optimization strategies must vary considerably between categories of HD lenses. The specific application of lenses determines the priorities assigned by the designers as they seek the best performance for each category.

Our next article will examine the most vexing lens aberration — chromatic aberrations. Managing them to an acceptable level within the physical dynamics of a zoom lens has tasked optical designers for decades. In the context of the highly challenging imaging goals of HDTV — especially within the small 2/3in image format — chromatic aberrations are the most daunting image impairment. BE

Larry Thorpe is the national marketing executive and Gordon Tubbs is the assistant director of the Canon Broadcast & Communications Division.

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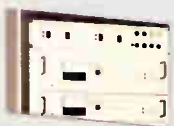

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Smart AV's
Smart Console

BY ROBERT SMALLWOOD

When audio mixes were small (i.e., fewer than 24 input channels), designing an audio console was simple — one channel strip of dedicated controls per channel, the strips lined up side by side. The operator sat in the middle of the channel strips and could easily reach all of the controls without moving from the sweet spot.

As input channel demands grew and the length of audio consoles grew in direct proportion, accommodating up to 100 channels meant designing an impressive looking but functionally compromised control surface. At 26ft in length, the operator now had no chance of remaining in the center of the sound field during the mix. Computers came to the rescue (or so we hoped), and multifunction controls entered the scene. Now the operator could remain in the center but at the cost of having to constantly re-assign a smaller number of controls. Operators could stay centered in the mix, but without ergonomic efficiency. Suddenly, sound mixers were becoming computer operators and were spending more time clicking on menus than mixing. We had solved one problem but replaced it with another.

Accommodating up to 100 channels meant designing an impressive looking but functionally compromised control surface.

Staying central

Rather than 26ft of dedicated controls or 3ft of multifunction controls

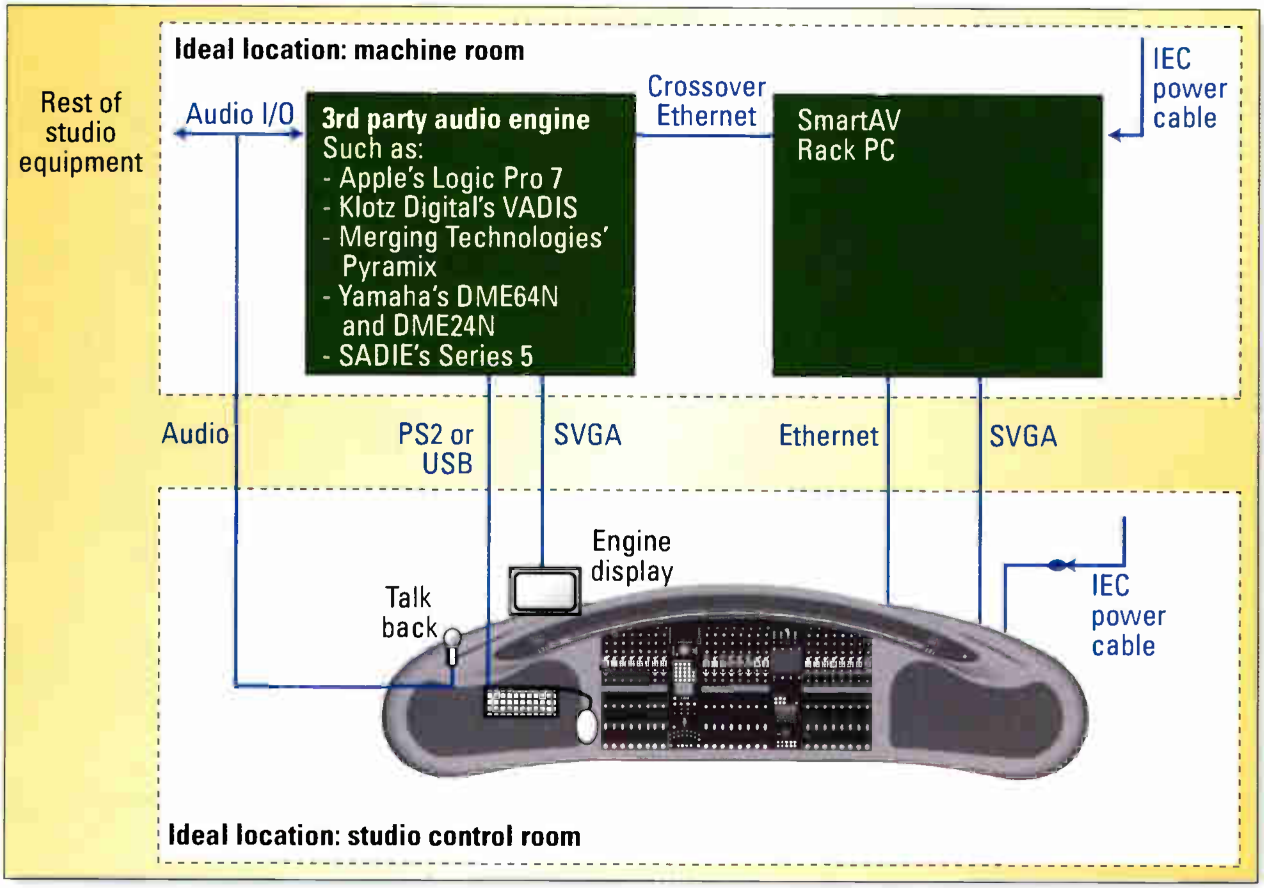

Figure 1. The Smart Console control surface communicates with digital engines via Ethernet connection.

World Radio History

and a computer monitor, Smart AV's Smart Console looks like a traditional 16- or 24-channel long console with a futuristic arc spanning the length of the console, representing a condensed version of a traditional 96-channel long console. Along the arc is a touch-sensitive strip providing an overview and control of 96 input channels. All controls are within reach of the operator, without the need to move from the center sweet spot.

The Smart Console's modular design and Arc technology reduce the number of knobs on the control surface.

In the driver's seat

The console is an open-source Ethernet protocol control surface, which communicates via standard fast-Ethernet CAT-5 cables to a number of digital audio engines. Whatever capabilities are inherent in the engine connected to the console, those capabilities are now available and can be controlled in an ergonomically efficient manner.

Currently, the console has interface protocols available for Merging Technologies' Pyramix, Klotz Digital VADIS and Apple's Logic Pro 7. Under development are interface protocols for Media Matrix's NION, SADiE's Series 5, Yamaha's DME64N and DME24N and Mackie's HUI. The Smart Console is available in 96-, 72- and 48-channel versions.

The benefits of this new technology will be obvious in applications such as OB vans, concert theatres, B studios and any place where space is limited and operational efficiency is paramount.

For years, audio mixing engineers have been frustrated with increasingly complex and overly computerized mixing systems. The Smart Console provides mixing engineers with an alternative to screen mixing, with ergonomic improvements and the elimination of computer menus and mouse clicks. With the console, engineers can now focus on the mix, not the menus! **BE**

All controls are within the reach of the operator, without the need to move from the center sweet spot.

When the operator touches a spot along the length of the touch-sensitive strip, as many as 800 dedicated controls snap into place, as if the operator had been instantly transported to that location along the length of a traditional long console. The operator now has access to all the dedicated controls for those channels — without clicking on a single computer screen or re-assigning any multifunction controls using a computer monitor.

The result is improved ergonomic efficiency. And there's no longer a need to learn any computer programs, or to use a computer mouse.

Robert Smallwood is the general manager of sales and marketing for Smart AV.

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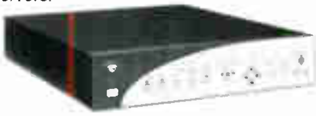

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World Radio History

Graphics and effects

BY JOHN LUFF

The graphics department at a television station used to be staffed by artists skilled in "flat art," the creation of pen, pencil, ink, pastel, oil or other art. Commercial artists in general were highly trained in the graphic arts and were taught the special needs of commercial art. Portfolios were moved in carriers appropriately sized for large-format art. It was a gentle art, and a skilled person who could create the art needed for a television broadcast rapidly was needed in every television station. "Rapidly" did not mean in a matter of minutes, but rather hours, so the graphic content of broadcasts had to be established early in the day so there would be a chance of getting what you needed in time to shoot it with a camera, live to air, or perhaps stored on tape or a still store.

The need for speed

The time pressure of broadcasting, as well as with newspapers, magazines and other modern media, created a need that software stepped up to fulfill admirably. Beginning in the 1980s, computers gained enough horse-power to be capable of running sophisticated, graphically intensive software. Special-purpose systems were expensive and required long periods of training to make a transition from "flat art" to computer art. The results were astonishing. Often the art created for television electronically was much more sophisticated in its use of manipulation of existing media than anything that could be done with conventional means.

Over the last two decades, there has been a process of "democratization" in technology. Nowhere is this more obvious than in graphics and effects systems. Electronic touch-up of images has reached a level of sophistication that allows incredible productivity and creativity at the same time the cost of hardware and software has plummeted. Photoshop and other software packages are now ubiquitous, used for marketing communications, media production, photography retouch and even home use. Barely a decade ago, the scale of computers needed to be effective in the graphic arts (for television or other purposes) put it in the realm of specialty hardware. Today, mail order PCs have more than enough capability, and consumers are retouching their own digital photos as a matter of course rather than going to professionals for expensive assistance (sometimes with predictable results, of course).

Electronic touch-up of images has reached a level of sophistication that allows incredible productivity and creativity.

A new generation of commercial artists has been trained. These artists have no less skill than their counterparts from the 1970s, but they also are just as comfortable with a mouse and tablet as they are with a pen, pencil and brush. They have new skills not available to their predecessors when they graduated and entered our industry, many of whom have made the transition to technology quite effectively. The parallel to film editors is quite striking. In both cases, technology, while initially restrictive of the creative arts, has evolved into powerful tools, freeing creative professionals to do things they only dreamed would be possible.

From a technical standpoint, this transition has been all about the education of computer software and hardware professionals about technologies for which they initially had little appreciation. Color science has developed for 100 years, more or less. Computer graphics are barely 20-years-

Graphics and effects systems have come a long way in the past 20 years. (Left) Shown here is the Chiron II, the first character generator from Chyron, in use at ABC more than 30 years ago. The system occupied an entire rack by itself.

(Right) Shown here are the HyperX, Duet LEX, Duet LE and C-Mix systems from Chyron, installed at WDBJ-TV in Roanoke, VA. The systems all fit into one rack.

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old. Translating the science of the reproduction of color to software has been somewhat of an iterative process extending over a long time. Unfortunately, many early graphics systems did not take into account colorimetry issues, or at least not to a sufficient degree. The second problem was that the graphics output cards were often adapted from designs intended to simply feed a CRT, with poor results for broadcast uses.

Today, a number of hardware solutions are available with SMPTE 259M SD and SMPTE 292M HD outputs, including the requisite reference inputs. Software too has become much more sophisticated in dealing with the issue, and often now offers the option of using ITU-R Rec 709 colorimetry, or SMPTE 240M. Obvious caution should be exercised if you think you might need to create a graphic that must be used for print and broadcast purposes. The file will have to be output specifically with the intended output medium.

Effects for broadcast use began at about the same time that serious character generators and computer graphics systems were first available. However, early effects systems needed much more horsepower than early desktop computers could supply, and often the most effective systems used mainframes, in at least one case on the campus of a major university. It didn't take long for that to evolve, and as early as the late 1980s, PC effects software was reasonably credible.

Today, rendering farms of microprocessor computers not unlike high-end desktop machines create motion picture scenes in very high resolution using software capable of modeling even human and animal movements with remarkable results. Simply flying through a logo? Any desktop can do it with off-the-shelf shrink-wrapped software packages.

More power

One might logically ask where is this all going. Clearly, the power of desktop computers continues to roughly increase following Moore's Law. Microsoft has issued a release of Windows (Windows XP Professional x64 Edition) with 64-bit and hyperthreading. Graphics and effects-intensive applications are one of the intended targets of these advanced products. One audio mixing application claims a speed gain of 30-percent simply by compiling for the new operating system. Memory space is increased from 4GB to 128GB, allowing much more complicated modeling without using virtual memory. It is entirely logical that applications that can take advantage of Hyperthreading and larger memory space will become more powerful and at the same time faster.

It is interesting to note that for the last 15 years or so, graphics professionals have often preferred to use Apple computers due to better support for graphics applications. A recent announcement that Apple will be switching to x86 platforms adds momentum to the Intel architecture. Apple still plans to tightly couple hardware to its fine OS X operating system. However, with more capable processors, one might logically expect even more compelling reasons to be expounded for keeping graphics professionals on MAC platforms.

So we are back to the beginning. The key to graphics has always been professional training using the tools available to promote creativity and efficiency for business. Recent graduates of schools of art, universities and trade training schools are given the best technology with the best training in art, which still yields superior employees who are creative in a process that remains time bound. BE

Simply flying through a logo? Any desktop can do it with off-the-shelf software packages.

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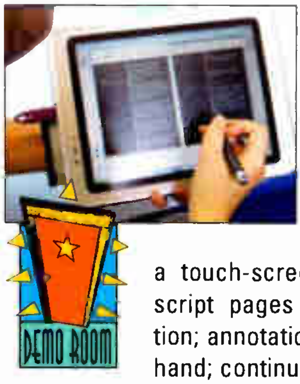

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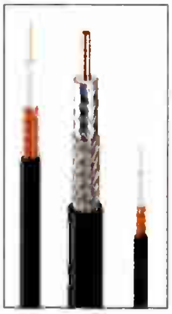

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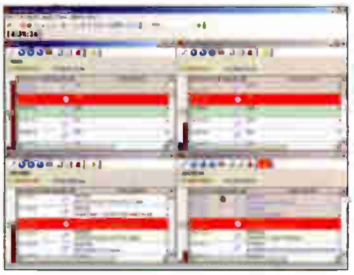

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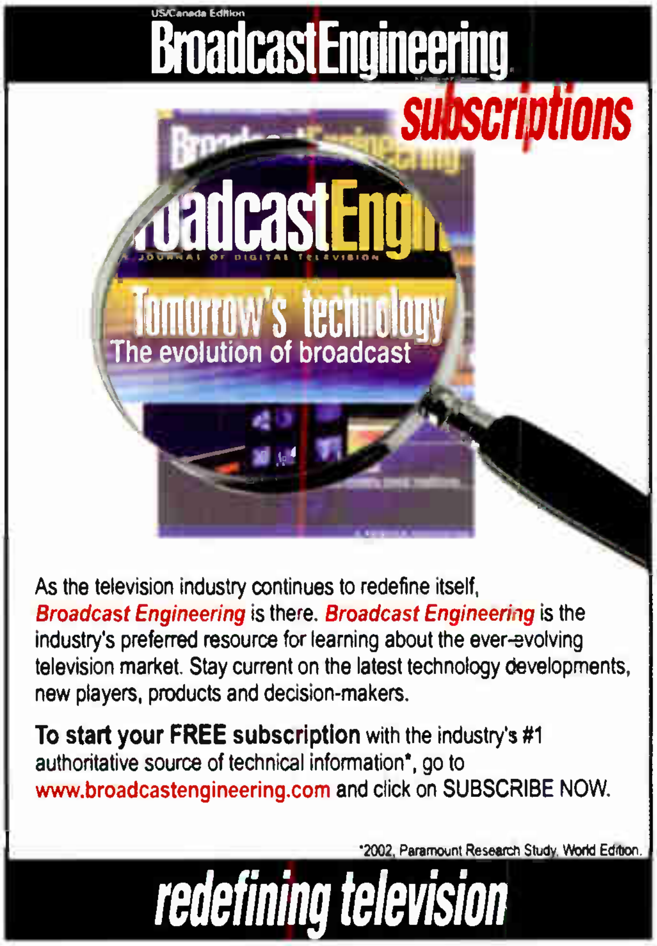

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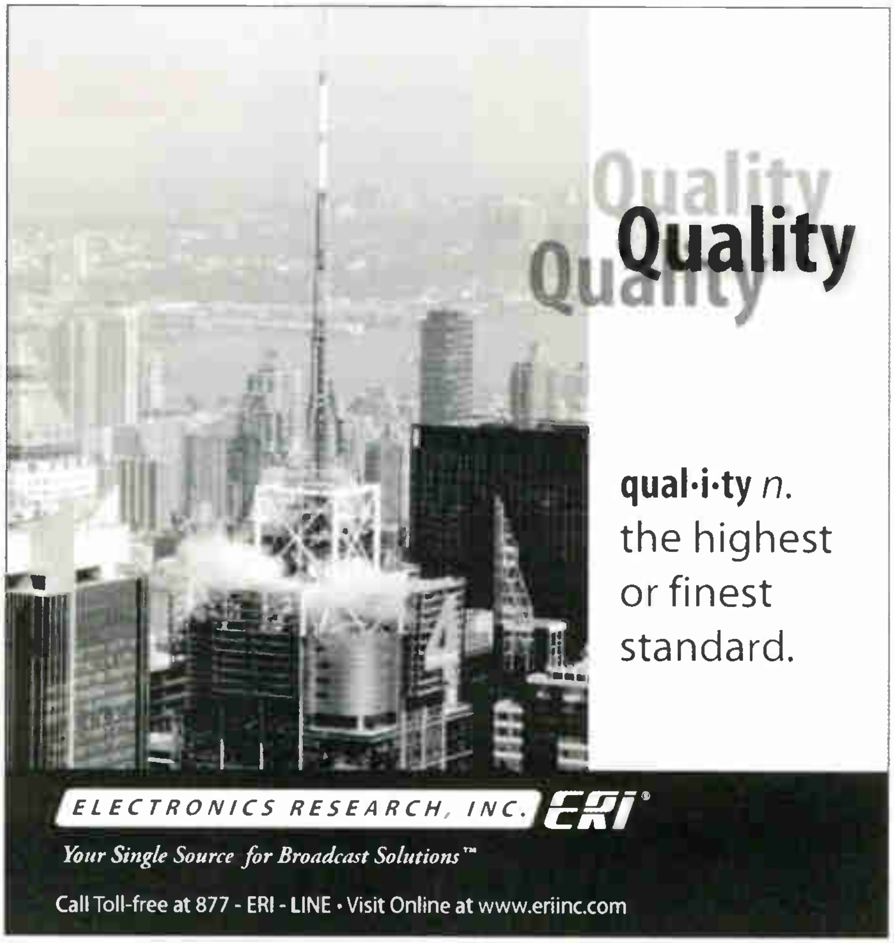

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Help Wanted

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KSEE24 TV is looking for a Maintenance Technician with 5 years previous television broadcast maintenance experience, FCC radio/telephone license or SBE certification preferred. Duties includes: maintaining and installing television broadcast equipment including trouble shooting systems, devices, circuit boards and component level failures. Transmitter maintenance preferred.

No phone calls. Send resume to:
5035 E. McKinley Ave
Fresno, CA 93727
ATTN: Human Resources. OE

BROADCAST CHIEF ENGINEER
2 POSITIONS

Washington State University/ETT seeks two Broadcast Chief Engineers. One position located in Pullman, WA and one in Richland, WA. Experience in construction, installation, operation and maintenance of digital microwave, distance learning systems, radio and television broadcasting and production required. Strong supervisory and customer service skills also required. This is a 12-month, full-time, Administrative/Professional position. Salary range: $48,000-$52,000 annually with excellent benefits through Washington State University. **Position description, qualifications, application procedure and more details at www.ett.wsu.edu.** Position review begins July 18, 2005. WSU is an EO/AA educator and employer. Members of ethnic minorities, women, Vietnam-era or disabled veterans, and/or persons 40 and over are encouraged to apply.

Help Wanted

CUSTOMER SUPPORT ENGINEER
Locations: Bristol, CT & New York, NY

Quantel, a world leader in the manufacture of post production, broadcast & imaging equipment is seeking experienced professionals for it's support team. If you possess the necessary skills and experience, we may have just what you're looking for.

Bristol, CT - Successful candidates will be involved in the ongoing support and installation of our ground breaking server based production system at ESPN's facility. Responsibilities will include diagnosing system issues, installation and configuration of equipment and software and providing ongoing support for the system during live programming. (Some shift work will be required.)

New York, NY - Responsibilities of this position include diagnosing product problems, installation and configuration of equipment and answering customer engineering questions over the phone as well as on site.

The above positions requires the ability to develop an excellent rapport with customers whilst maintaining a high level of technical competence relative to both Quantel products and industry standards. Experience in IT and IT infrastructure a must, experience in post production and broadcast environment a definite advantage.

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Please email a resume to:
melissa.dengler@quantel.com
For more information check our web site at: www.quantel.com

Help Wanted

POSITION TITLE: CHIEF ENGINEER
LOCATION: KRCR-TV, REDDING
STATUS: FULL-TIME
DATE OPEN: IMMEDIATELY
SALARY RANGE: DOE
RESPONSIBLE TO: GENERAL MANAGER
DESCRIPTION:

We need a CHIEF! KRCR, the ABC affiliate in picturesque Redding, CA is looking for a Chief Engineer who possesses hands on experience in broadcast equipment both old and new; installation as well as repair and maintenance a must. This individual must be well versed in DVC PRO equipment with a strong IT background. This individual must be an organized self-starter with excellent coaching and managerial abilities.

Interested parties should send their resume to:
Sarah Smith, VP/GM
755 Auditorium Drive
Redding, CA 96001
or ssmith@krcrtv.com

BROADCAST ENGINEER

WFLA NewsChannel 8 in Tampa Fla. is seeking a Broadcast Engineer. This position is responsible for troubleshooting, repairing and installing broadcast equipment with heavy emphasis on ENG systems. Must have thorough knowledge of electronics theory and be proficient performing repairs down to the component level. Two year technical degree or equivalent and 3 years broadcast equipment maintenance with emphasis in videotape and ENG experience required. Thorough knowledge of DVCPro a plus.

To apply for this position please send a resume and cover letter to:
WFLA, Attn: Alicia Kilburn
202 S. Parker Street
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ASSISTANT CHIEF ENGINEER

WCBI-TV is seeking to fill the position of Assistant Chief Engineer. This is a hands on position. WCBI is a full power DTV station with one HD and two SD programming streams. WCBI has a modern technical plant and a full News department. Experience is required.

Send resumes to:
Chief Engineer, WCBI-TV
P.O. Box 271
Columbus, Ms 39703
email: savageg@wcbi.com
WCBI-TV is an Equal Opportunity Employer.
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BROADCAST & IT ENGINEER

Belo Capital Bureau is looking for a Broadcast & IT Engineer to be based in Washington, D.C. Responsible for technical operation and IT support for broadcast and newspaper journalists. Go to www.belo.com for more information on position requirements.

Resume and references to:
Craig Harper
Director of Engineering
400 South Record St.
Dallas, TX 75202

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No more hum bars

BY PAUL MCGOLDRICK

After the Japanese surrendered in 1945, they switched to driving on the left side of the road. Driving on the left allowed them to protect their burgeoning vehicle industry, with Detroit unable to switch the steering wheel position.

This same industrial-political mindset was reflected in the TV broadcasting industry. When I started working in broadcasting, each country was vying to protect its own electronics industry from vendors outside its normal economic circles. But one decision about broadcast video standards was not political: frame rate. With standards not locked to the country's power grid distribution frequency, hum bars were a certainty on early receivers.

Power supplies improved over the years, and by the early 1960s, most video operations were running with sync pulse generators operating on crystal lock rather than line lock. There were no ultra-visible hum bars — unless there was a receiver fault.

The pre-World War II 405/50 standard in the UK was revived after the war, and although there was an opportunity to choose 525/50 for color operations, 625/50 was selected. The decision to go PAL instead of NTSC was a European political statement. Some people in BBC engineering sacrificed their careers by backing NTSC. France, always an oddball in the business world, went SECAM with the Soviet Union as its buddy.

There were benefits with PAL in the early days. Color phase corrections in the receiver were automatic, to a certain extent. However, the benefits didn't last long because improvements in circuit electronics were just about everywhere in the chain. SECAM was a fringe-lunatic standard with studio equipment made more expensive and complicated — even just to mix two FM signals together.

Hollywood has already sold out with 24-frame standards when it had the perfect opportunity to improve motion performance over film; now Europe is selling out too.

But standardizing PAL was not the last move by the UK to protect its own — now non-existent — receiver industry. They also moved the aural carrier 0.5MHz further out than the rest of Europe. So the studio video signals were still PAL-B/G, but the transmitted signal became PAL-I. South America didn't want to be left out of the signal race, so it created the PAL-M and PAL-N standards.

None of this national individualism worked, naturally. Japan was the first of the Asian manufacturers that were hardly fazed by the protectionism.

One would have hoped that the fight for business protection would have been seen as a disaster and, ultimately, more expensive for everyone. But for a different reason, perhaps, there is a great danger of elongating the standards problem. And, again, it is Europe that is missing the chance.

Europe is beginning to endorse HDTV. The push comes with the availability of larger displays at reasonable prices, which will allow for the additional resolution to be appreciated. European engineers remember the disaster of the HD-MAC standard that was created many years ago — and adopted by no one — so they cautiously are pushing for 720p and 1080i. The pressure is from the pay-per-view providers rather than the national broadcasters, and that is probably the right way. Those with the more popular content should make the gamble — not that you have *ever* read about content in this column.

But now Europeans are perpetuating a mistake. They are going for 720p/50 and 1080i/50. Hollywood has already sold out with 24-frame standards when it had the perfect opportunity to improve motion performance over film; now Europe is selling out too.

There is absolutely no reason why the standards adopted should not be 720p/60 and 1080i/60. It would get rid of the flicker we all see for the first few days of watching European television, and it would make simple international program-sharing a reality at last. Now we will have to wait (10 years, maybe) for second-generation HDTV, when the United States will probably go for 1080p/60. And that's no ho-hum. BE

Paul McGoldrick is an industry consultant based on the West Coast.

SEND Send questions and comments to:
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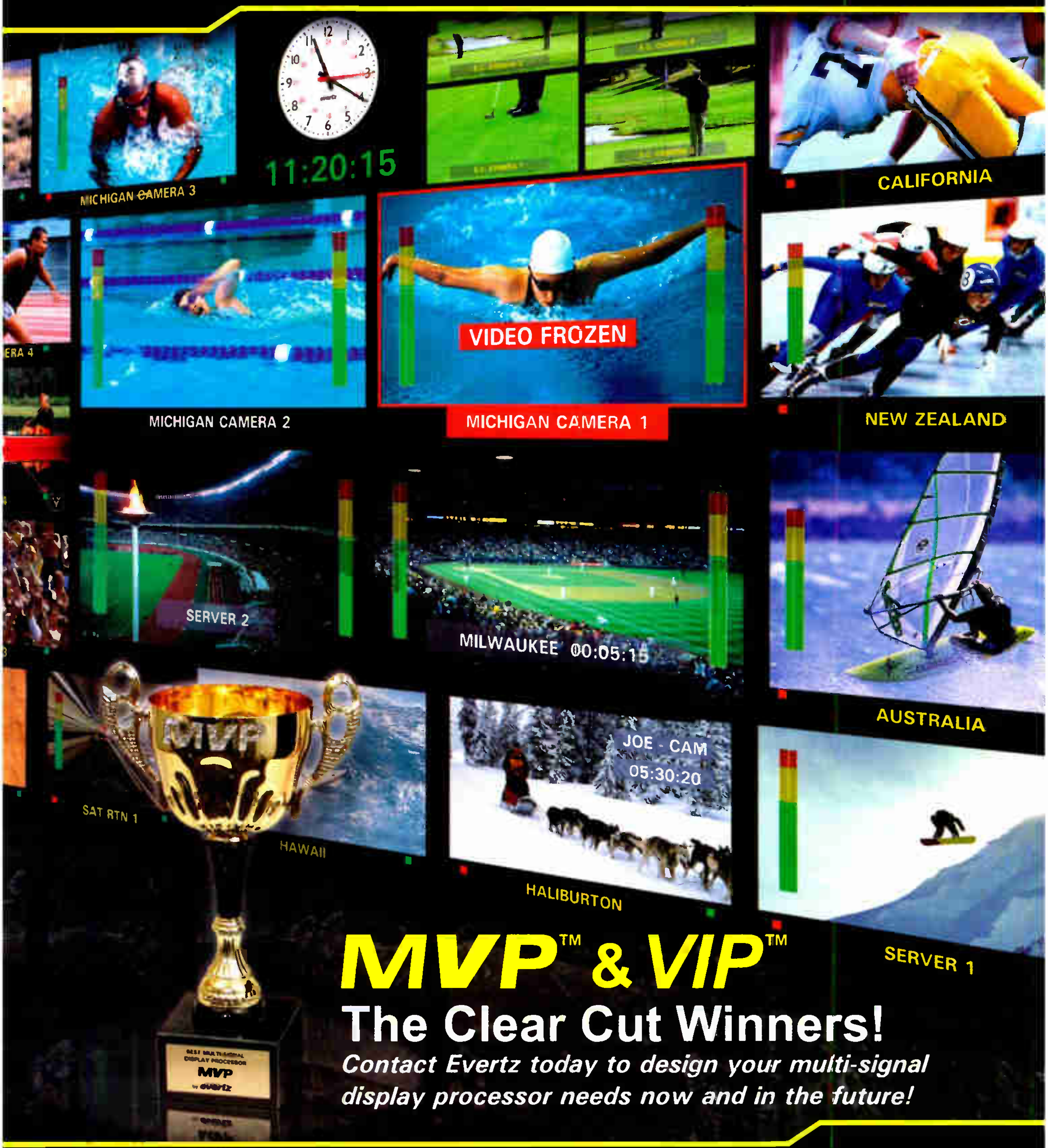

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