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AUGUST 2004

Broadcast Engineering®

THE JOURNAL OF DIGITAL TELEVISION

Cameras

It takes more than electronics

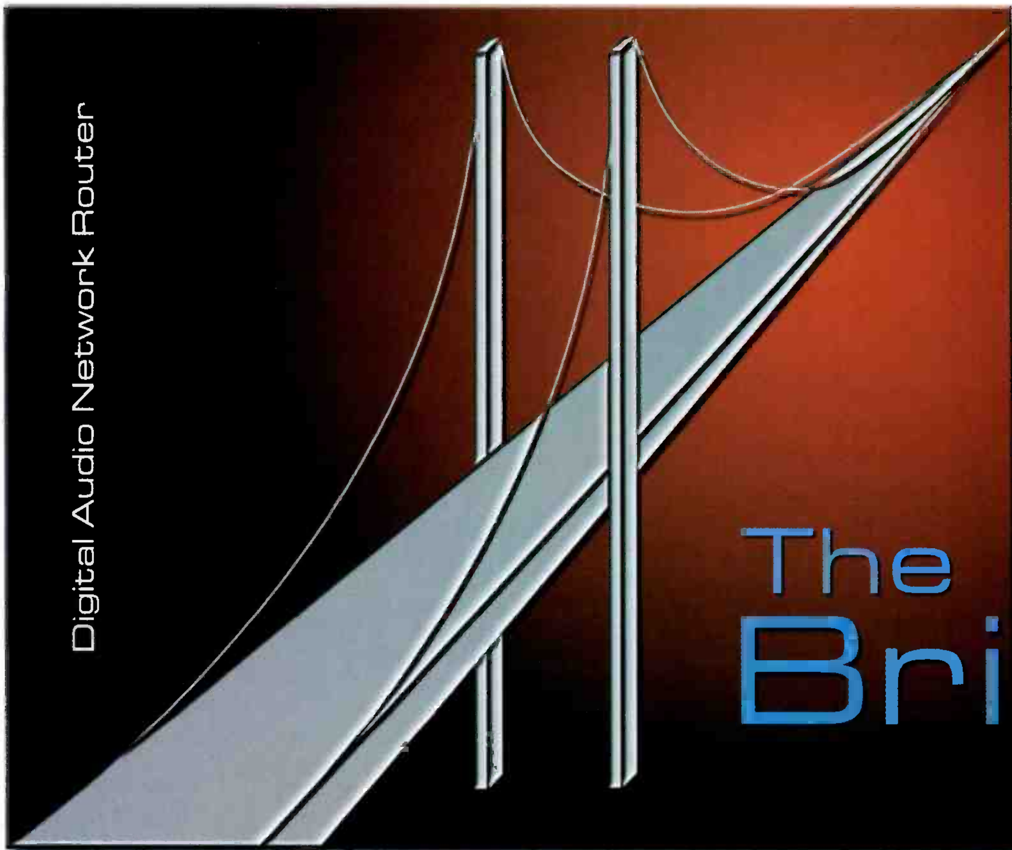
FOX News NY

Building on IT-based broadcast technology

Houston Livestock Show

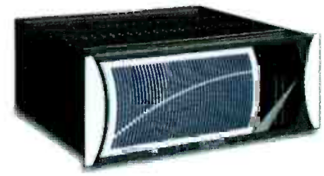
Broadcasting a rodeo isn't horseplay

A PRIMEDIA PUBLICATION



The Bridge

The Bridge Router can hold all the electronics you'll need for a small console: I/O cards, mix engines, and DSP processors. Naturally it can also have automatic fail-over DSP and CPU cards to keep you on-air. You can expand the system with a simple cage-to-cage interconnect.

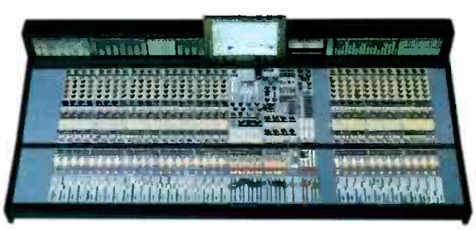


It's not just a Digital Console, It's an ENTIRE Audio Infrastructure

You Can Start with a simple AES router with analog and digital inputs and outputs. From there you can add logic I/O cards and scheduling software; you can link multiple master bridge cages together to achieve thousands and thousands of I/O ports; you can create a custom system that includes multiple smaller remote satellite cages— with everything interconnected via CAT5 or fiberoptic links.

But That's Just the Beginning: you can also add mix engine cards, interface to your automation system; you can choose from two different WHEATSTONE series control surfaces (D-5.1 or D-9), each specially configured for production room, on-air or remote truck applications. We also provide a full complement of Ethernet protocol remote router control panels, as well as a complete family of plug-in modules that interface the routing system to existing Wheatstone digital and analog standalone consoles.

The D-9 is Compact yet Powerful: It can route, generate and monitor 5.1 surround signals and produce simultaneous 5.1 and stereo master signals for your dual broadcast chain. The console also provides extensive, rapid communication paths throughout your entire Bridge system. Motorized faders and control setting storage and recall make show-to-show transitions fast, easy and accurate.



Wheatstone Knows Live Audio. The D-5.1 is loaded with MXMs, foldbacks, and clear easy-to-read displays. You'll have all the power you need when the news breaks! Its intuitive layout helps your operators work error-free, and it can handle and generate all the 5.1 content and simultaneous stereo capability any large or medium market station could need.

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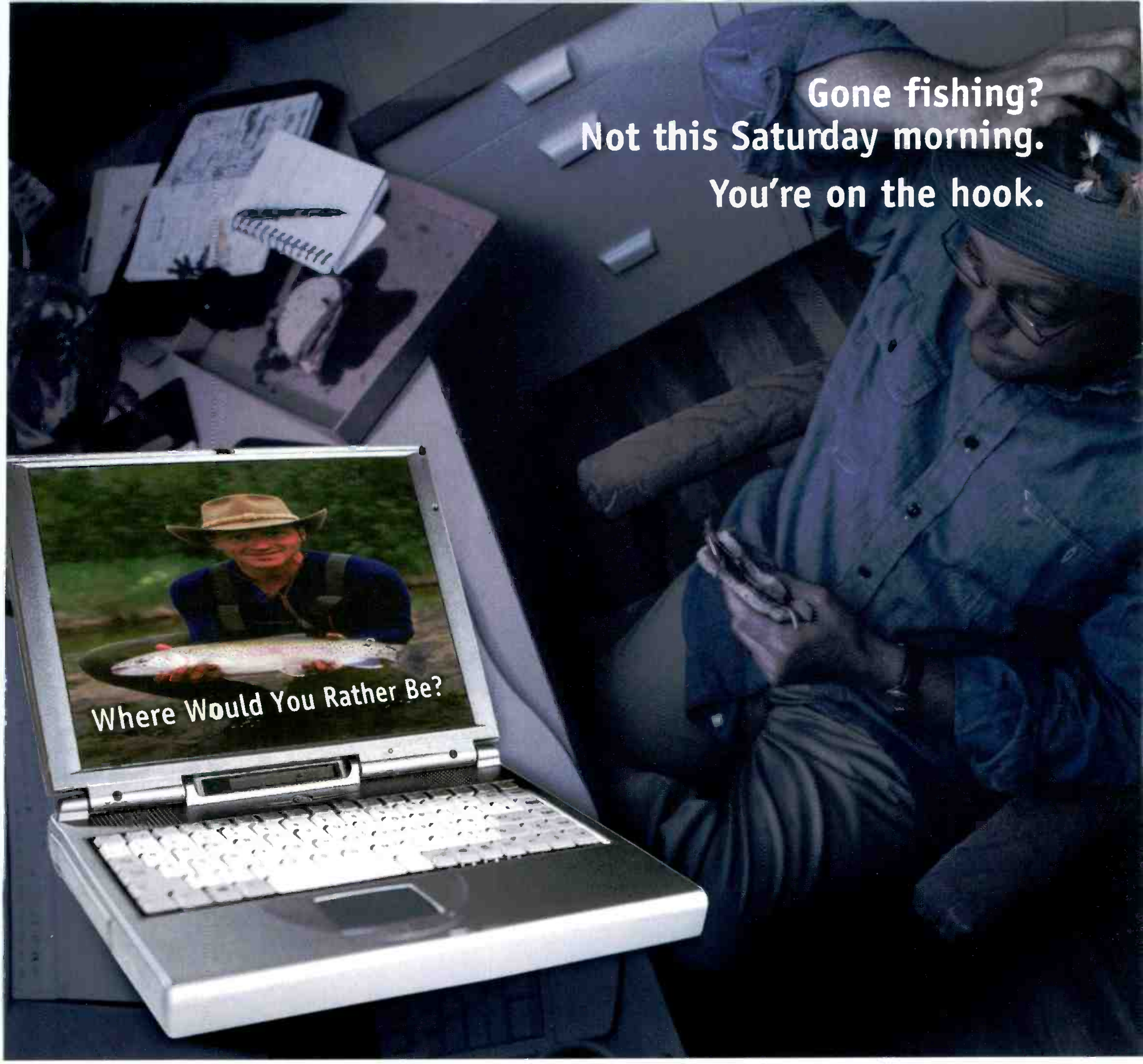
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Not this Saturday morning.
You're on the hook.
Where Would You Rather Be?

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This is technology you can touch. AirSpeed™, a revolutionary new breed of broadcast video server, accelerates your I/O by providing immediate access to incoming feeds. Affordable, reliable AirSpeed systems scale easily and play to air within moments of editing the story – with an interface you already know how to use. Call your Avid broadcast sales manager today or visit www.avid.com/airspeed.

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BroadcastEngineering

THE JOURNAL OF DIGITAL TELEVISION

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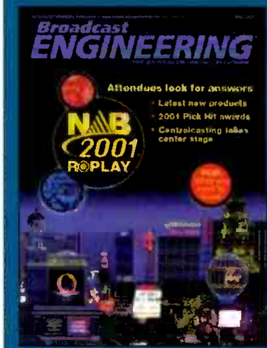
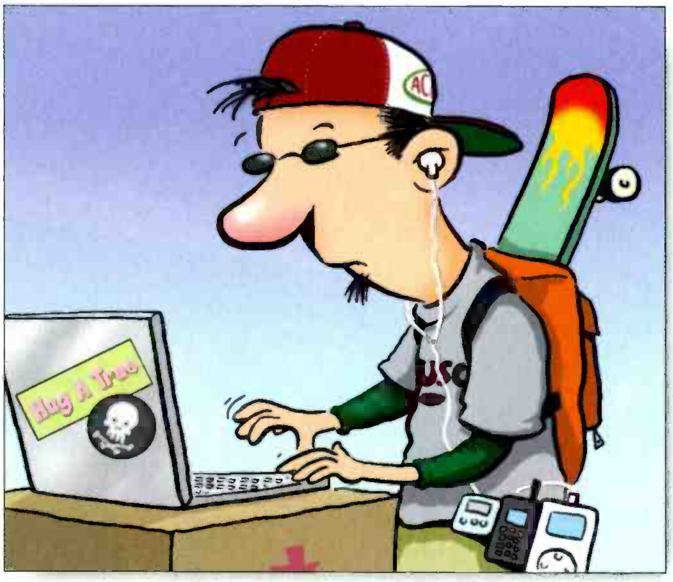


What do the following acronyms stand for?
ACATS
DVD
MPEG
VADA
THX
Correct entries will be eligible for a drawing of *Broadcast Engineering* T-shirts. Enter by e-mail. Title your entry "Freezeframe-August" in the subject field and send it to: editor@primediabusiness.com. Correct answers received by Oct. 1, 2004, are eligible to win.

Attend school — get cool stuff.

I want to go back to school. Why would I want to return to the classroom? I've already got a BA and MA degree. Some would say I have a PhD in BS, but that's another story.

No, I'm not looking for another degree; I just want all the cool stuff that new students are being given. Today's students are no longer buying hundreds of dollars worth of books. Instead, they're given cool new technology and electronic freebies under the guise of better education.



The latest taxpayer giveaways are free Apple iPods to freshman entering Duke University. Yes, it seems that the popular MP3 recorder has been reclassified from toy to tool by Duke's professors. The university received a $500,000 grant to equip new students with "minicomputers for educational uses." In reality, the minicomputers are Apple iPods. Calling an Apple iPod loaded with 5000 songs an educational tool is like telling your parents you need an HDTV because you want to watch the Weather Channel. While Apple did discount the Duke iPods, the university's cost was nowhere near the FOB wholesale price on a generic MP3 player ($18.00). But, of course, we couldn't have our new students running around with a generic $20 MP3 player when we can get federal funding for a $300 one, could we?

Initially, the iPods will be loaded with Duke-related downloads, including freshman-orientation information and the school calendar. Just how long do you think it will take the students to erase that information to make space for some serious tunes? Duke also will create a special Web site modeled on the Apple iTunes site, where students can download music and course content, including language lessons, recorded lectures and audio books. Doesn't this all sound so academically important?

Not content with just giving away MP3 players, the grant also will fund the hiring of an academic computing specialist (that means one new head count), provide additional funding for faculty (that means bonus money for the professors) and provide research funds (that means an academic slush fund for all the stuff they'll want to buy later).

This program is only one of many federally funded grants allowing schools to scam (I mean, distribute) free technology to students under the guise of new technology for education.

Here in Kansas City, one elementary-school district recently gave all its students PDAs, complete with wireless interconnection capability. The reasoning was that the technology would allow teachers to walk among students and wirelessly distribute class assignments, tutorials and other teaching aids. Students are supposed to "sync" their PDAs nightly to get the latest assignments.

Colleges regularly give entering freshmen laptop computers, claiming these, too, are "tools." I wonder what the MTBF is for those "free" $1400 laptops. I spent 15 years on college campuses and I know how students treat things for which they don't pay.

I'm not suggesting that students regress to the days of chalk and slate, but classifying MP3 players as "minicomputers for education" goes way too far in my book.

Oh well, I just hope that, by the time I reapply for admission, they are giving away free HDTV sets. After all, couldn't that be called "digital image-enhancement technology" for education? There's probably a federal grant program somewhere for just that.

Brad Dick
editorial director

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

Hollywood obsoletes six million HDTV sets

Brad,

Yes! In previous years, the MPAA and RIAA have called the consumers (in general) crooks, criminals, whatever. They've been doing everything they can to prove they are criminals without any true evidence of it en masse. Yes, it happens, but at the level they claim? I truly doubt it!

In the meantime, while they've used their efforts to prove this, they've lost the true focus of what they should have paid attention to ... the changing markets. TV and radio have changed in incredible ways, not just in the technology in our areas, but in technologies everywhere.

Your editorial is so right on the money that I was almost giggling after reading it. I have become so disenchanted with Mr. Valenti's words that I don't listen anymore. Personally, I wouldn't take the time to copy movies due to the effort and money involved. Yes, I agree that there are people out there that would do that. But should Congress mandate the copy protection flag in the DVI interface? No. Let the industry continue to work closely with Hollywood to keep on top of this.

As always, Congress is slightly behind the curve when enacting laws. So even this CP Law will be outdated ... again! And in the meantime, while the MPAA waits for the law, the industry will continue to step quickly and aggressively toward new technologies with all of their protection problems. Maybe the MPAA and RIAA will get tired of chasing their tails and ours?!

Terry White
Columbia, MD

IT engineer vs. video engineer

Being an ex-IT girl and now the president (and operator) of my own facility, as well as dealing with real-time audio and video issues for clients, I find your view of IT personnel ignorant of reality.

Let's try your logic for a moment. Taped show goes off the air due to analog tape-transport drive motor seizing and spilling tape all over the machine room floor. Lost time? ... Heck, lost show, lost ad time and lost fees ... Cost? Let us suggest, moderately extensive.

Taped show previously transferred to digital disk on video server ... Drive fails during show, but no downtime ... We implemented a RAID technology array.

Ok, how about drive goes down and RAID controller goes down ... Still, no downtime. The entire system was set up with a cluster configuration with dual systems on hot standby. And when the tape op loaded the show it was automatically duplicated on the RAID subsystem on the hot standby system, as well as the RAID subsystem on the primary video server.

A full-on analog system can fail and bring down the house as fast as a completely digital IT-based system ... It's all about quality of personnel. Hire good people and don't try to save 15 cents on a system. Hire cheap IT help with no experience and you get what you pay for. Just like in video land.

Georgia
World Wide Audio

Twilight Zone

I read your e-zine editorial and had to laugh at your wonderful weaving from the 60's television show to the present-day content providers. One thing of note is the program for which you attribute the lines "We control ...." I believe it was actually "The Outer Limits" and not "The Twilight Zone." This was one of my favorite shows as a kid. I loved the "high-tech" oscilloscope display they used. Good portrayal. Keep up the great work.

Bill Robertson
Acterna BE

June Freezeframe:

Q. In what year were 12 video serverlike products introduced at the same NAB?

A. In 1994, the 12 products were:

Cable products:
Micropolis AV Server series 100
Channelmatic Adcart/D digital ad insertion system

Broadcast products:
EMASS storage system
IBM fully scalable video server
BTS Media pool (private suite)
HP video server
Tektronix Profile
Avid Media Recorder media server/library
Alamar Mach II
Dynatech Digistore Broadcast Spot playback system
Basys MAESTRO
ASC VR virtual recorder

Winner:

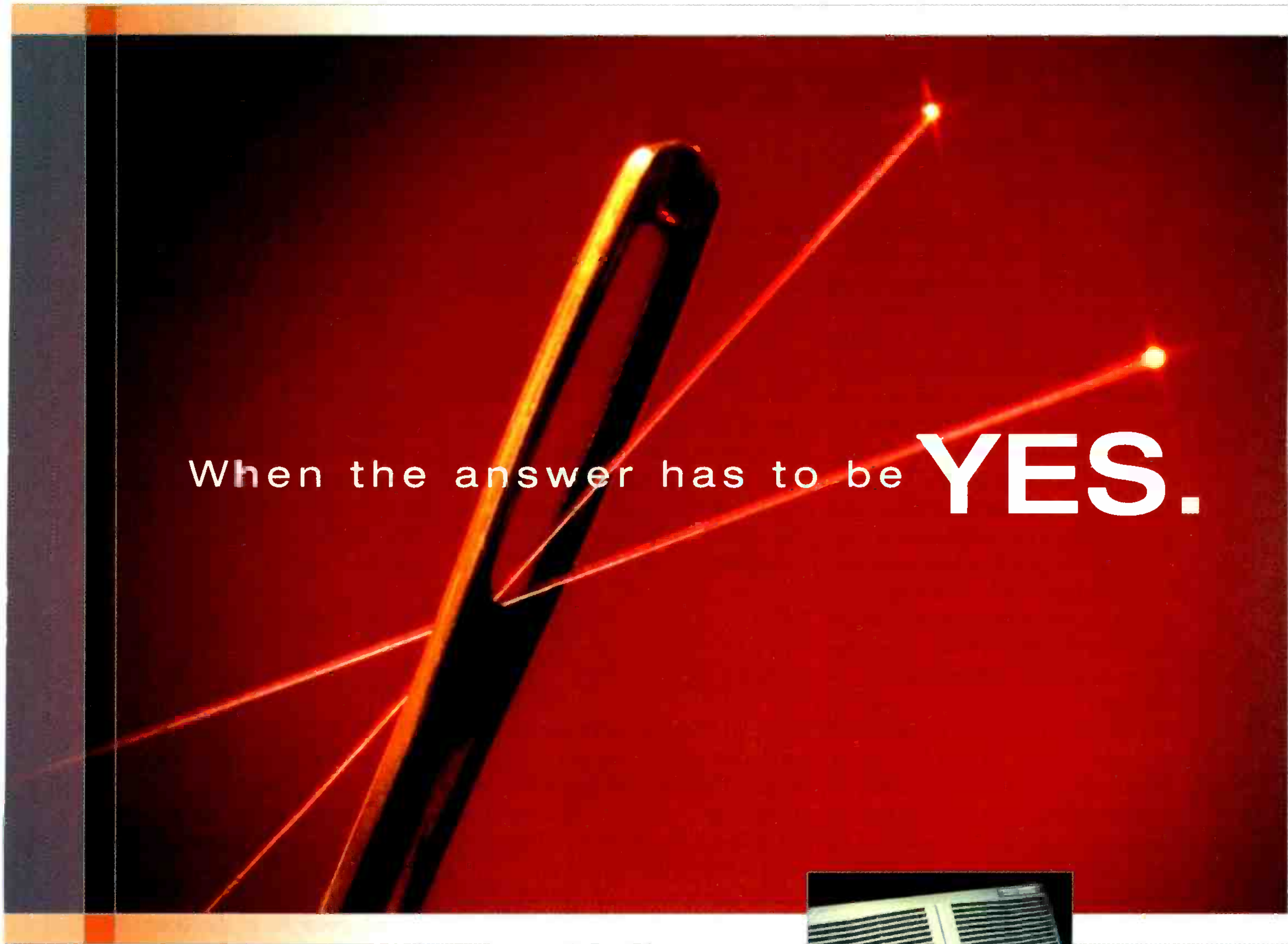
No correct entries this month

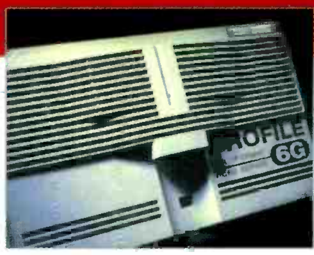
Test your knowledge!

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*

AFFORDABILITY THROUGH INNOVATION

SD to HD in half the channels





You need to thread multiple formats through one server as cost-effectively as possible

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The new Profile® 6G server line is the sixth generation of our Emmy® award-winning line of video servers. Built for today's multi-format transmission needs, it supports SD and HD materials in the same server—and the Profile 6G PVS 3500 does it on the same timeline. No external devices. No extra staff for converting materials. No automation system reprogramming.

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Profile 6G server products feature the same familiar, highly intuitive user interface found on all Profile XP Media Platform systems, but go a step further by providing simplified media management and built-in HD encoders and decoders and built-in SD/HD up-and down-conversion. They also feature a 2 Gb Fibre Channel storage system that is 40 percent less expensive than previous generations. The new Profile 6G line also supports a new Grass Valley™ Universal Interface Module (UIM) that supports high-speed Fibre Channel and Gigabit Ethernet connectivity and industry-standard streaming file formats such as the Material eXchange Format (MXF) and SMPTE 360M to transfer files in and out of standalone Profile servers and Grass Valley Open Storage Area Network (SAN) systems.

In fact, whatever the topology—standalone, distributed, or centralized—Profile 6G servers are a perfect fit. Need to upgrade an existing Profile XP Media Platform system to a Profile 6G server? We can do that, too.

To learn more about the Profile 6G line, please visit: **www.thomsongrassvalley.com/Profile6G**.

grass valley

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BEYOND THE HEADLINES

Squeeze harder

BY CRAIG BIRKMAIER

It seems like broadcasters are being squeezed at every turn these days. The networks are putting the squeeze on compensation for affiliates. In many cases, the cash flow has been reversed; networks are forcing affiliates to return commercial inventory even as affiliate compensation has slowed to a trickle. Then there's the ratings squeeze, as the programming diversity offered by multichannel services like cable and DBS continues to fragment audiences and eat into broadcasters' viewing share. Recently, Clear Channel Communications announced an initiative to reduce commercial clutter on local radio, where it is not uncommon to find more than 20 minutes of each drive-time hour crammed full of commercials. Across the board, broadcasters are starting to acknowledge that they have maximized the number of spots they can squeeze into programming. Despite all of this, broadcasting is still a highly profitable business, which probably accounts for the desire of those who have business relationships with local stations to tap into the substantial cash flow the stations generate.

But there is one area where squeezing harder could benefit broadcasters. One of the big advantages of going digital is the ability to use digital compression to squeeze more programs into the bandwidth that previously could carry only one standard-definition (NTSC) program. With MPEG-2 compression, a 6MHz channel can carry HDTV, a mix of HD and SD, or a multicast with five or more SD programs. With the new Advanced Video Codec (AVC), a.k.a. MPEG-4 part 10 or H.264, such a multicast could carry up to 10 SD-quality programs.

But broadcasters may have to think twice about using AVC. For one thing, the ATSC standard does not currently support its use. And, as the FCC DTV-receiver mandates kick in, MPEG-2 becomes even more firmly entrenched. And then there's the issue of the royalty structure created for using the AVC codec. MPEG-LA, the licensing authority for both MPEG-2 and MPEG-4, is joining the long list of broadcast business partners trying to tap into a lucrative ongoing cash flow. Improved compression technologies, such as those offered by MPEG's AVC and Microsoft's Windows Media (VC-9), have the potential to squeeze more channels into a broadcast multiplex. But using these technologies could put a squeeze on profits as well.

Broadcasters may have to think twice about using AVC.

Meet your new partner

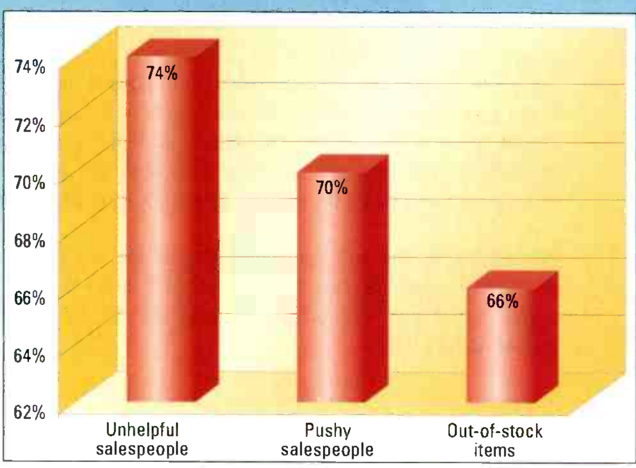
Last year, in a column entitled "Devolution," we explored the history behind the development of digital video compression standards, leading to the current crop of next-generation codecs. In that column, we noted that video compression technology is evolving rapidly. Faster processors and cheaper memory make it possible to use advanced algorithms that need computational power four to five times what the MPEG-2 algorithms require. And we noted that, since the MPEG-2 algorithm was standardized in 1995, processing power has increased by the requisite four to five times.

The past year has seen significant developments associated with the next-generation codecs discussed in that column. Most significant is the

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

What bugs women CE shoppers?

Unhelpful sales staff tops complaint list



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growing manufacturer support for both the AVC and VC-9 codecs, and the decision by the DVD Consortium to support three codecs in the new HD-DVD standard: MPEG-2, AVC and VC-9. Of most concern, however, are MPEG-LA's licensing terms for the AVC codec and the announcement that MPEG-LA will issue a license for Microsoft's VC-9 as well.

Microsoft took an unprecedented step last year, submitting the VC-9 standard to the Society of Motion Picture and Television Engineers (SMPTE) for standardization. In so doing, Microsoft was required to publish the complete specifications for VC-9. This revealed what many, including this author, have suspected: VC-9 shares many algorithmic techniques with the AVC standard. Microsoft helped develop AVC and was included in the AVC intellectual property pool. Early this year, MPEG-LA announced its intention to provide a license for VC-9, issuing a call for intellectual property. Companies with intellectual property claims on VC-9 are meeting now to work out licensing terms.

Meanwhile, MPEG-LA has been working on the terms of the AVC license. The organization created a firestorm of controversy last year when it announced its intention to include a wide range of new, so-called use fees for the AVC codec, including fees on broadcasters who use the codec to deliver advertiser-supported programming. MPEG-LA established the precedent for use fees with the MPEG-2 license, which requires DVD manufacturers to collect a small royalty on each DVD they manufacture that uses MPEG-2 compression.

The initial terms for the MPEG-4 standard, which uses a compression codec less advanced than AVC, included use fees for Internet streaming, subscription video services and pay-per-view applications. The announcement of licensing terms for AVC included a proposal that broadcasters pay use fees based on the number of potential viewers in their market. Over-the-air broadcasters and cable/DBS systems that might use the new compression technology reacted to this proposal with broad concerns.

This past March, Japanese broadcasters helped MPEG-LA set another precedent, agreeing to new licensing terms for the AVC codec. The Japanese DTV broadcast system includes a robust channel that can deliver video services to portable and mobile receivers. The enhanced compression efficiency of AVC is a critical component of this reduced-data-rate service. The Japanese broadcasters agreed to a one-time $2500 license for each AVC encoder that they will use to program a channel in the new service. This approach is far less cumbersome than calculating royalties based on market size or per-use fees. Thus, the Japanese broadcasters have set the precedent for charging royalties for the ongoing use of a technology. Perhaps this is just a sign of the times, because the royalties associated with the manufacture of a digital television receiver dwarf the modest royalties paid for the use of the NTSC and PAL video-encoding (compression) standards.

There are no published figures for the royalties that DTV receiver manufacturers must pay to comply with the FCC mandates. The first of these requirements activated in July on sets with screens that are 36 inches or larger. These sets also include content protection systems to meet the FCC mandate for the broadcast flag. Estimates are that the total royalties may exceed $25 per set. By comparison, the royalty to build an NTSC receiver was approximately $1. A wide range of organizations are tapping into this new source of cash flow. LG Electronics (which acquired Zenith) expects to take in more than $100 million per year from the royalties on 8-VSB. Then there is the Grand Alliance patent pool and other patents related to the implementation of the ATSC standard. MPEG-LA tacks on a few bucks for the MPEG-2 decoder. Then there are royalties associated with IEEE 1394 for digital transmission content protection (DTCP) and DVI for high-bandwidth digital content protection (HDCP). Most of the large consumer electronics companies are involved in these patent pools, but the computer industry is starting to tap in as well.

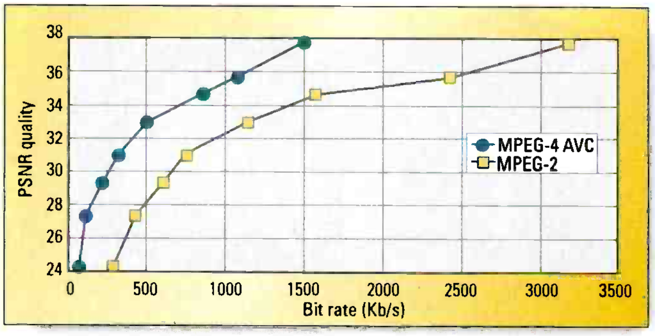

Figure 1. A comparison of picture quality versus bit rate illustrates MPEG-4 AVC's superiority over MPEG-2.

In June, MPEG-LA announced the final license terms for the AVC codec. Broadcasters can pay either the one-time $2500 license per AVC encoder or pay annual use fees, which could be significantly higher, thus making this option largely irrelevant. Given the current cost of hardware encoders for AVC, the license fee represents only a small fraction of the cost. In a few years, however, it could equal the cost to manufacture an AVC encoder. The bottom line is that, while squeezing harder may be desirable, being squeezed harder is something that broadcasters may need to get used to, unless they want to keep using

Being squeezed harder is something that broadcasters may need to get used to.

MPEG-2 for the next 50 years. Then again, this may be exactly what the companies behind the MPEG-LA patent pool are trying to achieve.

Competitive pressure

Unfortunately, broadcasters may not be able to sit on their legacy much longer. Improved compression technology is a significant factor that enables new competitors to capture market share.

One of the major stories coming out of NAB this year was the reality that a desktop computer can easily handle the task of producing HDTV content. Likewise, the home entertainment PC will soon be able to display HDTV-quality content using either the AVC or VC-9 codecs. Apple demonstrated a software AVC codec playing HD content on an Apple Cinema HD display. The company will include AVC support in the next major release of QuickTime. Microsoft demonstrated a variety of applications using HD video compressed using VC-9. And virtually all of the companies that supply professional MPEG-2 encoders for broadcasters were demonstrating support for AVC and/or VC-9. Just before NAB, a new start-up, Modulus Video, announced that it will offer AVC encoders for both standard- and high-definition video. The initial thrust for Modulus will be in the backhaul markets where bandwidth is at a premium and the more expensive AVC licensing provisions do not apply.

A desktop computer can easily handle the task of producing HDTV content.

For more information, visit the following Web sites:

Download February 2003, "Devolution"
http://broadcastengineering.com/aps/transmission/broadcasting_devolution/index.html

MPEG-LA licensing for MPEG-2, MPEG-4, AVC, VC-9
http://www.mpegla.com/

Modulus Video
http://www.modulusvideo.com/ **BE**

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

Send questions and comments to: cbirkmaier@primediabusiness.com

TECHNICAL

BULLETIN

4th Edition • TB 65

This Digital Studio Cable Guide will help you understand the important aspects of digital cables and the correct part numbers to use for a given format.

Digital Studio Cable Guide

We are in the midst of a digital revolution. Radio and television broadcasters are going digital. Digital formats have worked their way into recording studios, video post-production, film production and many associated applications, and the reason is clear – digital provides superior audio and video performance.

Binary coding is a vast simplification of complex audio and video signals. But because the signal is binary, receiving equipment can decipher the bit stream, ignore any noise and correct for any attenuation. Audio and Video signals are so sophisticated and complex however – reducing them to binary code requires much higher frequencies than if they were left in analog sine waves. Digital A/V cables need to handle ever-higher digital frequencies. Also because this is A/V, it must be processed in real-time, in sequence, and live. We only give alphanumeric "data" the luxury of re-transmits, processing delay, and blank screen tolerance. A/V signals must remain on-air, without any pause to "compile." These are the challenges broadcast quality A/V cables have to meet.

Digital is very stable, which reduces equipment adjustments significantly. Copies or reproductions retain the quality of the original. Signal degradation is virtually eliminated, and noise immunity is greatly improved. Whether it's a radio, TV or post-production application, all of these advantages result in improved picture and sound quality as well as interactivity, high-speed data and Internet access, pay-per-view services, simultaneous data/Internet access and personalized electronic news.

Although digital promises to revolutionize the A/V industry as we know it, it also poses a challenge when it comes to designing, choosing, and installing a new system. It has been estimated that there may be as many as 18 different DTV formats to choose from, with new ones being proposed all the time, all of which vary in the level of compression and transmission frequency. Various options also face the radio industry.

With all of these equipment options available, it becomes very important in the design phase to determine the correct cable to connect each of these pieces of equipment. The wrong choice in cable can be as costly as the wrong choice in equipment.

This Digital Studio Cable Guide will help you understand the important aspects of digital cables and the correct part numbers to use for a given format.

BRILLIANCE®

Belden

BRILLIANCE®

Although digital promises to revolutionize the A/V industry as we know it, it also poses a great challenge when it comes to designing, choosing, and installing a new system.

Digital Audio

The specification for digital audio was developed jointly by the Audio Engineering Society and European Broadcast Union (AES/EBU). The two key electrical parameters in this specification that pertain to cable are the data rate, which depends on the sampling rate *(see table below)* and impedance of 110 ohms ±20% for twisted pair constructions and 75 ohms for coax designs.

Sampling Rate	Bandwidth
32.0 kHz	4.096 MHz
38.0 kHz	4.864 MHz
44.1 kHz	5.645 MHz
48.0 kHz	6.144 MHz
88.2 kHz	11.289 MHz
96.0 kHz	12.228 MHz
192.0 kHz	24.576 MHz

Twisted Pair Parameters

The AES/EBU specification, with its broad impedance tolerance, allows for cables with impedances from 88 ohms to 132 ohms to be used, with 110 ohms being ideal. The twisted pair should be shielded, and in the case of multi-pair, each pair individually shielded. Foil shielding is recommended for permanent installs, and foil plus braid for flexed applications. One pair is capable of carrying two channels of digital audio.

The cables are terminated with either XLR connectors or are punched down or soldered in patch panels. Most digital audio cables utilize foam polyethylene to minimize the cable's size. Standard foam polyethylenes are susceptible to crushing which can change impedance. Belden cables utilize a special foam high-density polyethylene that provides exceptional crush resistance when compared to standard foam insulations.

The advent of digital microphones requires AES/EBU cable designs with added flexibility, such as Belden 1800F, a 110 ohm design featuring our ultra-flexible "French Braid" construction.

Although AES/EBU specifications require shielding on each channel of data, data-grade UTP "Category 5" can easily meet the common mode balance requirements (-30 dB) without being shielded.

Can analog cables be used for digital? Yes, but only for distances of roughly 50 ft. or so. The actual length is determined by the error correction and jitter tolerance of the receiving device. The impedance of most analog cables ranges from 40 ohms to 70 ohms. This large mismatch from the nominal 110 ohms results in signal reflection and jitter causing bit errors at the receiver. Also, the high capacitance of analog cables greatly increases the rise time of the digital square wave.

Can digital cables (paired) be used for analog? Absolutely! The capacitance of digital cables is extremely low, making them a superior analog cable.

Digital Audio Over Coax

The transmission of digital audio over 75 ohm coax requires the use of baluns unless the device contains unbalanced coax AES inputs or outputs or the audio signal is embedded on a digital video signal. The baluns convert the unbalanced coax signal to a 110 ohm balanced transmission.

Much greater transmission distances are obtainable over coax as compared to twisted pair. The same coax used for digital video is ideal for digital audio. The coax used should have a pure copper center conductor (no copper covered steel or aluminum) and have good braid coverage (90% or more). Using one coax for both audio and video gives the added advantage of using one type of strip and crimp tool and one type of connector.

Embedding the audio is popular in TV applications. Embedded signals are often used in "pass through" installations such as cable head-ends. However, if audio manipulation is desired such as spot insertion or replacement, then audio must be "de-embedded" or de-multiplexed from the video stream. This is a complex and expensive procedure. For maximum versatility, separate audio and video runs are suggested.

Digital and HD Radio

When radio broadcast converts to digital – the cable selection will be equally critical and arguably more so. The basic specification parameters for digital audio cable are entirely different than for analog audio. The key attribute for the cable is no longer lower capacitance as in analog audio. The Digital Audio signal is impedance specific and it is the impedance of the cable that is now critical. Fortunately, by nature of their design, Digital Audio cables have built-in low capacitance which makes them excellent analog cables. (The converse is not true: almost no excellent (or even good) analog audio cables are suitable for digital, because they were not designed with digital audio's impedance in mind.) The point: whether you're converting to

digital now or later, whether you're converting wholly or partially, whether you'll be broadcasting 100% digitally or simulcasting analog and digital – Digital Audio cabling is essential to efficient design and value engineering. Even if your immediate needs are strictly analog, installing AES/EBU digital audio cable, like 1800B, now will give you the best performing analog audio service, and will spare you cable replacement when the day arrives that you upgrade to digital. This is the key to "futureproofing."

Where AES/EBU format is used, 110 ohm shielded balanced line cables are the standard. IP technology may be employed to integrate station data networking resources and requirements with programming and advertising content. Where IP technology is deployed, high quality UTP (Category 5e, Category 6 UTP, or MediaTwist®) can be used. Television stations may choose to use AES3 format, employ baluns, and multiplex digital audio over 75 ohm coax infrastructure. Where the environment may be electrically noisy, the shielded AES/EBU cables, or AES 3, and coax will be preferred.

Radio Broadcasts will benefit tremendously from Digital Conversion and will be driven by the benefits it offers – even without government mandate: AM clarity equal to current FM; FM clarity rivaling current CD's; new embedded text offering news, weather, traffic, and financial market information, interactivity, customization, and audio-on-demand. Digital Conversion in radio broadcasting may happen quickly because of low entry barriers: A low cost to convert, it's use of the existing spectrum, and the preservation of existing analog service permitting consumers to upgrade on their own timetable. However this revolution unfolds, and however your station deploys: Belden has the cable for AES/EBU, IP or AES 3 digital and HD Radio upgrades.

Digital Video (SDI)

The Society of Motion Picture and Television Engineers (SMPTE) has developed two different standards for serial digital transmissions (SDI). A third format that transmits at 540 Mb/s is under development. There is also a European standards body known as ITU (formerly CCIR) that developed the specifications for Europe known as PAL. Each of these specifications differs in frequency and transmission technology, i.e., composite or component.

> SMPTE 259M – Covers digital video transmissions of composite NTSC 143 Mb/s (Level A) and PAL 177 Mb/s (Level B). It also covers 525/625 component transmissions of 270 Mb/s (Level C) and 360 Mb/s (Level D).

> SMPTE 292M – Covers the newest format for HDTV transmissions at 1.458 Gb/s.

> SMPTE 344M – Covers component widescreen transmissions of 540 Mb/s.

> ITU-R BT.601 – International standard covers component PAL transmissions of 177 Mb/s.

Coax Parameters

All of the above standards were designed to work with standard analog video coax cables. It is true, analog coax cables of precision grade will work okay at the higher digital frequencies. However, newer coax constructions that have been designed specifically for digital transmissions offer performance advantages over the old analog designs. These new constructions employ several design parameters to provide the precision electrical characteristics required for high frequency transmissions over longer distances.

> **Center Conductor** – The center conductors are solid bare copper. Solid conductors provide better impedance stability and return loss (RL). RL expresses the amount of signal lost due to the signal reflecting back to the source. This reduces the signal reaching the receiver, thus increasing attenuation and decreasing effective transmission distance.
>
> Digital transmissions contain low frequency elements that travel down the center of the conductor and high frequency elements that travel on the outside of the conductor due to skin effect. For these reasons, uncoated pure copper conductors are used for optimum performance.

> **Dielectric** – The dielectric material (insulation) consists of solid or foam high-density polyethylene. The special formulation Belden uses is more crush-resistant than standard foam polyethylenes and is less prone to conductor migration. Both crushing and conductor migration can cause a change in the cables impedance which, in turn, will cause an increase in RL. While the nominal velocity of propagation of a solid dielectric is 66%, gas injection technology provides extremely consistent foaming and high velocities of propagation (82 to 84%). The velocity is kept very constant to minimize timing problems. Foam dielectrics reduce the size of the coax compared to older solid dielectric designs.

> **Shield** – Precision analog cables utilize double braid shields which are effective but not optimum for digital's high frequencies. Braid shields are ideal for frequencies under 10 MHz while foil shields work best above that frequency. Since digital transmissions contain both low and high frequencies, foil-braid designs are used.

> **Testing** – Lastly, to ensure that the cables are electrically sound, every reel must be 100% sweep tested for RL to at least the third harmonic of the fundamental frequency and exhibit no less than SMPTE's minimum suggested level of 15 dB. For HD cables at an uncompressed data rate of 1.485 Gb/s, this gives a bandwidth of 750 MHz and a third harmonic frequency of 2.25 GHz (3 x 750). Belden sweep tests all of its HD cables to 3 GHz, with guaranteed minimum RL steps of 23 dB to 850 MHz and 21 dB from 851 MHz to 3 GHz. More technical information on RL and other cable parameters can be found on Belden's Web site at www.belden.com.

Installable Performance®

When looking at guaranteed performance on a cable's data sheet, one naturally expects that the cable will deliver that same performance after it has been installed. This assumption doesn't always hold true, however, because the installation itself can dramatically alter the cable performance.

Typically, when cables are installed they are pulled and yanked on, bent around corners, stepped on, and may kink when coming off the reel. All of these factors can change the physical properties of the cable, which in turn may degrade the cable's electrical performance.

To help ensure that the cable's electrical performance is not compromised through improper installation techniques, three key cable attributes must be held to a high level: conductor adhesion, crush resistance and Return Loss.

Conductor Adhesion

Conductor adhesion is most important to connectorization and connector reliability. Improper levels of conductor adhesion can make the connectorization process harder and can cause connector failures both during and after installation. If adhesion levels are too low, the conductor can

Belden

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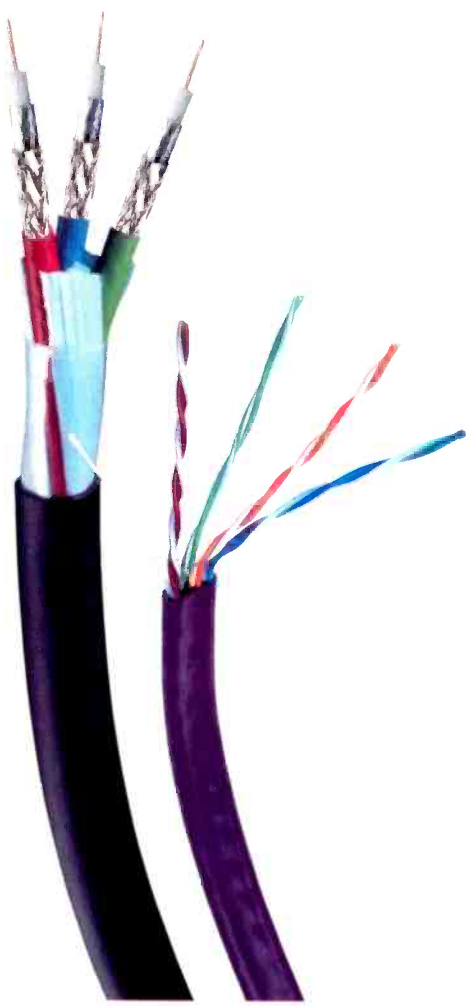
With digital audio cables, much greater transmission distances are obtainable over coax versus twisted pair. The coax used should have a pure copper center conductor and good braid coverage.



move within the dielectric and actually migrate and appear to grow or lengthen in the cable. A cable with low conductor adhesion may appear to be fine prior to installation. However, the rigors of installation can break the conductor adhesion due to all of the pulling and bending that occurs. Once the bond between the conductor and insulation is broken, the conductor migration can, in some cases, result in the center pin of the BNC connector being pushed out of the casing. To prevent this from occurring, Belden uses a skin/foam insulation process that ensures a high degree of conductor adhesion. In addition, all Belden cables are tested for conductor adhesion to further ensure performance.

Crush Resistance

As stated earlier, most of the cables used for SDI are foam dielectrics. Foam dielectrics are, by nature, softer than their solid counter parts. If the cable is improperly handled or installed, the dielectric can be crushed and deformed thereby changing the impedance and causing RL. The special proprietary formulation Belden uses is more crush-resistant than standard foam polyethylene making it far less prone to deformation.

Return Loss Headroom

In order to ensure the SMPTE minimum level of 15 dB RL is met, the cables used must be several dB better to ensure the minimum level is met after the rigors of installation. Other components in the transmission chain can also degrade RL such as a bad termination or improper patch bay connections. Belden's guaranteed minimum level of 21 dB RL gives the user 6 dB of RL headroom to account for such potential inconsistencies.

Careful attention to all of the above attributes ensures that the cable the customer receives from Belden will meet performance specifications after installation. After all, that is what Installable Performance is all about.

Can analog coax cables be used for digital? Yes, only if it is of precision video grade. Standard video cables may have stranded center conductors or copper covered steel. They also may not have adequate shielding as mentioned above. Standard video cables are usually not tested for RL. Beware of plain old coax!

Can digital coax cables be used for analog? Yes, but only if your plant has cable equalization (EQ) designed to work within the loss characteristics of the particular coax. If the transmission distance is short, equalization may not be a problem. Many equipment manufacturers are now making equalization cards designed specifically for the new digital cables when running analog.

Can I mix foam and solid polyethylene designs together in the same run?
If you run analog in short un-equalized runs, you can mix cables together. However, you will have two connectors, with different dimensions, two different stripping tools, and two different crimping tools. For longer EQ'd runs you will need two different EQ cards as well. Belden suggests you standardize on one cable for as long as you can. Foam core cables have a delay of 1.24 ns/ft compared to 1.54 ns/ft. for solid polyethylene. The loss characteristics of the cables will also be different. Both parameters must be taken into consideration if mixing cable types. As a rule of thumb, it's best to stay with one design throughout.

Video Connectors

Most connectors used for analog video are 50 ohm BNCs. In analog video, where the quarter wavelength of the signal is approximately 60 feet, the impedance mismatch of a 1/2 inch BNC connector, or even a dozen in a row, is minimal. However, the quarter wavelength of a digital signal can be as short as three inches at HD frequencies. While one or two 50 ohm connectors would probably not have an effect, a dozen of them (6 inches) is significant and will result in a RL problem. Most video signals go through many connectors in a typical studio. For this reason, it is recommended to use not only 75 ohm connectors, but also connectors demonstrated to maintain their impedance up to at least the third harmonic (2.25 GHz).

Cable Installation

Care must be taken when installing digital, and especially high definition, coax. Improper handling, cable pulling and installation techniques can deform the cables which can in turn cause a RL problem. The following practices should be utilized when installing any digital cable.

Installation Basics

> Do not step on the cables.

> Do not lay equipment on the cables.

> Do not kink the cables.

> Cable pulls should be done in a slow steady fashion – no jerking. Do not exceed the cables maximum pulling tension (call the manufacturer for this information).

- Do not exceed the minimum bend radius of the cable: 10 times the diameter of the cable.
- Do not cinch cable ties too tightly. If you cannot move any cable inside a tied bundle, the cable tie is too tight.
- Do not put cable ties or J hooks at identical distances apart. This can lead to deformation at a given wavelength, which can cause RL. Place cable ties at random distances.
- Cables should be supported by cable trays, J-hooks, etc. to take the gravitational forces off of the cable. Cable sag should be less than 8 inches.
- Conduit runs in excess of 90′ and/or with more than two 90° equivalent turns should include a pull box. Each 90° turn is equivalent to the friction of a 30′ straight conduit run.
- If cable is pulled into conduit, an anti-friction lubricant should be used that is compatible with the cable jacketing material.
- Maintain the original physical shape of the cable.

Testing Digital Video

Currently there are no standards to test digital video or HDTV. However, Belden suggests measuring and documenting the RL on every link to ensure that the SMPTE minimum suggested level of 15 dB is met. RL is the measurement of reflected signal caused by impedance discontinuities in the channel. These discontinuities are caused by connectors, cable, transition devices, patch panels and improper cable installation or handling. Any reflected energy reduces the power of the transmitted signal. Measuring RL will give a good expectation of just how well each link will do with SDI or HD video.

Digital Camera Cables

In 1998 the Society of Motion Picture and Television Engineers (SMPTE) developed the industry standard SMPTE 311 for High-Definition Television Camera cables to assure clear, reliable transmission of audio, video and camera control cables.

Belden's new composite cable incorporates two tight-buffer, single-mode 10µm optical fibers for video, four 20 AWG or two 16 AWG conductors (depending on the design) are used for power and two 24 AWG conductors for control and sound. The fibers, color-coded blue and yellow, permit long-haul transmission of critical audio and video signals with extraordinary reliability and clarity. The new standard provides a cable smaller in diameter and lighter in weight than traditional camera cables resulting in easier handling during installation or in field applications.

Belden's SMPTE 311 cables are 7804R and 7804C. 7804R is made with tight buffer fiber designs and (4) 20 AWG auxiliary (power) conductors per traditional design parameters. 7804C has been designed with breakout fibers to enhance ruggedness and with (2) 16 AWG auxiliary (power) conductors to simplify termination and reduce installation time. In addition, a central stainless steel strength member is used for additional durability during installation. The overall jacket is black Belflex® providing exceptional flexibility.

The Future

Unshielded Twisted Pairs (UTP)

The digitization of audio and video signals has given rise to a convergence with data wiring technology, which utilizes unshielded twisted pairs.

It is a misconception to equate digital A/V signals to digital data signals though, simply because "they are both digital." Ethernet is digital coding of very discreet alphanumeric data: 26 letters and 10 numbers. And Ethernet protocols allow for the use of packets which may be scrambled, transmitted, certain packets re-transmitted, unscrambled and recompiled before the information is presented. All that processing and reprocessing introduces delay which we tolerate for this media. A/V signals are comprised of millions of colors, hues and tones, with different volumes, inflections, tempo and motion. And we require its playback to occur live and in real time. Just as a picture is worth a thousand words and can be taken in the blink of an eye — A/V signals are much more than "data" — even when they are digital.

While almost any UTP cable can handle low-bandwidth or low data-rate applications (such as a telephone), few cables can handle signals like 270 Mb/s digital video for appreciable distances. Like coax, it's a question of what bandwidth (frequency) or data rate and how far. Distance is the key.

The consistency of a UTP cable determines the transmission distance. Physical characteristics of concentricity, conductor-to-conductor and pair-to-pair spacing relationships, and how well they are maintained along the length of the cable determine how far a signal at a given frequency can be carried without excessive attenuation. The quality of the cable determines the quality of the signal at a distance.

NanoSkew®

NanoSkew (7987R) is a 4-pair, 100 ohm 24 AWG UTP cable with no EIA/TIA data category rating. It is designed for the lowest possible skew delay difference between pairs, which is the critical factor for component video applications. NanoSkew is designed specifically for video, and is *strictly* for video applications. It should not be used where Ethernet data will be transmitted. See Belden new product bulletin *NP212* for complete details about NanoSkew Cables.

Brilliance VideoTwist®

Brilliance VideoTwist cables are Category 5e and Category 6 cables incorporating low-skew characteristics for video performance. Ethernet cables not designed with video in mind do not pay as close attention to minimizing skew and to delivering consistent skew performance. The insulated conductors of each pair are bonded together so they maintain their spacing and orientation throughout the run, around bends, and enduring the rigors of installation. This gives them the consistent physical characteristics so important for stable impedance. Their blend of Video performance (low skew between pairs) and Data rating make Brilliance VideoTwist the ideal choice for shared sheath applications, for video over IP, for KVM applications, and where one cable is preferred for both data circuits and for video circuits. Belden bulletin *NP212* gives the full details of Brilliance VideoTwist.

Fiber Optic Cables

At some point, either in bandwidth or distance, copper cables may not be able to perform the task at hand. In these cases, fiber optic cables are an option. Fiber comes as either single-mode or multimode core constructions. Multimode has a 50 micron or 62.5 micron fiber core. 62.5 micron fiber has a modal bandwidth of 160 MHz at 850 nm and 500 MHz at 1300 nm. Single-mode has an 8.3 micron core with a theoretical exit bandwidth into the gigahertz, essentially unlimited. Technologies are now extending even these bandwidths. Multimode and single-mode connectors are easy to install and can be field installed in minutes. Belden offers a comprehensive line of fiber optic cables.

AES/EBU Digital Audio Cable

Single- and Double-Pair Cables

BRILLIANCE®

26 AWG Stranded (7x34) .018″ Tinned Copper • Twisted Pair • Beldfoil® Shield • 26 AWG Stranded TC Drain Wire

Datalene® Insulation • Chrome or Violet PVC Jacket

Description	Part No.	UL NEC/ C(UL) CEC Type	No. of Pairs	Color Code	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Nom. DCR Cond.	Nom. DCR Shield	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nom. Capacitance * pF/Ft.	* pF/m	** pF/Ft.	** pF/m
2-Conductor Digital Video Time Code Cable 80°C	**9180**	NEC: CMR CEC: CMG FT4	1	Black, White	1000	304.8	11.0	5.0	37.3Ω/M′ 122.3Ω/km	23.1Ω/M′ 75.8Ω/km	.144	3.66	110	76%	13	43	26	85

Shorting Fold

For cross-connect use with 7891A (et al.) Digital Audio Snake Cables, see page 7.

24 AWG Stranded (7x32) Tinned Copper • Twisted Pairs • Overall 100% Beldfoil Shield • 24 AWG Drain Wire

Datalene Insulation • Slate Gray or Violet PVC Jacket

Description	Part No.	UL NEC/ C(UL) CEC Type	No. of Pairs	Color Code	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Nom. DCR Cond.	Nom. DCR Shield	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nom. Capacitance * pF/Ft.	* pF/m	** pF/Ft.	** pF/m
60°C	**1800B**	NEC: CMG CEC: CMG FT4	1	Black, Red	500• U-1000 1000 5000•	152.4 U-304.8 304.8 1524.0	12.0 18.0 18.0 88.8	5.5 8.2 8.2 40.4	23.7Ω/M′ 77.7Ω/km	18.9Ω/M′ 62.0Ω/km	.177	4.57	110	76%	13	43	26	85

For cross-connect use with 1803F (et al.) Digital Audio Snake Cables, see page 7.

For Plenum version of 1800B, see 1801B.

•500 ft. put-up available in Gray only. 5000 ft. put-up available in Violet only.
The jacket and shield are bonded so both can be removed with automatic stripping equipment.

24 AWG Stranded (42x40) HC Bare Copper • Conductors Cabled with Fillers • TC “French Braid” Shield (95% Coverage) • BC Drain Wire

Datalene Insulation • Matte PVC Jacket (Red, Yellow, Green, Blue, Gray or Black)

Description	Part No.	UL NEC/ C(UL) CEC Type	No. of Pairs	Color Code	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Nom. DCR Cond.	Nom. DCR Shield	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nom. Capacitance * pF/Ft.	* pF/m	** pF/Ft.	** pF/m
Digital Mic Cable High-Flex 60°C	**1800F**	NEC: CL2R	1	Black, Red	500▲ U-1000 1000▲	152.4 U-304.8 304.8	13.5 26.0 26.0	6.1 11.8 11.8	23.7Ω/M′ 77.7Ω/km	5.0Ω/M′ 16.4Ω/km	.211	5.36	110	76%	13	43	26	85

French Braid

▲500 ft. and 1000 ft. put-ups available in Black only.

24 AWG Stranded (7x32) Tinned Copper • Twisted Pairs • Overall 100% Beldfoil Shield • 24 AWG Drain Wire

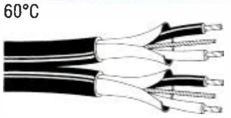
Plenum • Foam FEP Teflon® Insulation • Natural White or Violet Flamarrest® Jacket

Description	Part No.	UL NEC/ C(UL) CEC Type	No. of Pairs	Color Code	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Nom. DCR Cond.	Nom. DCR Shield	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nom. Capacitance * pF/Ft.	* pF/m	** pF/Ft.	** pF/m
75°C, Non-conduit	**1801B** new	NEC: CMP CEC: CMP FT6	1	Black, Red	500† U-1000† 1000†	152.4 U-304.8 304.8	9.0 14.0 14.0	4.1 6.4 6.4	23.7Ω/M′ 77.7Ω/km	18.9Ω/M′ 62.0Ω/km	.165	4.19	110	78%	13	43	26	85

24 AWG Stranded (7x32) Tinned Copper • Dual Twisted Pairs • Overall 100% Beldfoil Shield • 24 AWG Drain Wire

Datalene Insulation • Violet PVC Jacket in Zip-Cord Construction

Description	Part No.	UL NEC/ C(UL) CEC Type	No. of Pairs	Color Code	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Nom. DCR Cond.	Nom. DCR Shield	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nom. Capacitance * pF/Ft.	* pF/m	** pF/Ft.	** pF/m
60°C	**1802B**	NEC: CMG CEC: CMG FT4	2	Black, Red	500 U-1000 1000	152.4 U-304.8 304.8	18.5 36.0 37.0	8.4 16.4 16.8	23.7Ω/M′ 77.7Ω/km	18.9Ω/M′ 62.0Ω/km	.180 x .360	4.57 x 9.14	110	76%	13	43	26	85



The jacket and shield are bonded so both can be removed with automatic stripping equipment.

22 AWG Stranded (7x30) Tinned Copper • Twisted Pair with Fillers • Overall 100% Beldfoil Shield + 90% TC Braid Shield • 24 AWG Drain Wire

Datalene Insulation • Black High-Flex Matte PVC Jacket

Description	Part No.	UL NEC/ C(UL) CEC Type	No. of Pairs	Color Code	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Nom. DCR Cond.	Nom. DCR Shield	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nom. Capacitance * pF/Ft.	* pF/m	** pF/Ft.	** pF/m
High-Flex 60°C	**1696A**		1	Blue, White	250 500 U-1000 1000	76.2 152.4 U-304.8 304.8	8.0 16.0 32.0 32.0	3.6 7.3 14.5 14.5	14.8Ω/M′ 48.5Ω/km	4.6Ω/M′ 15.2Ω/km	.234	5.94	110	76%	13	43	26	85

Z-Fold®

BC = Bare Copper • DCR = DC Resistance • HC = High-conductivity • TC = Tinned Copper

*Capacitance between conductors. **Capacitance between one conductor and other conductors connected to shield.
†Spools and/or UnReel® cartons are one piece, but length may vary ±10% for spools and ±5% for UnReel from length shown.

Teflon is a DuPont trademark.

AES/EBU Digital Audio Cable

Multi-Pair Snake Cables

Individually Shielded and Jacketed Pairs

BRILLIANCE®

Individually Shielded and Jacketed Pairs

NEC: CMG (CEC: CMG FT4)

Product Description

26 AWG or 24 AWG stranded tinned copper conductor. Datalene® insulation. Pairs individually shielded with bonded Beldfoil® and have numbered and color-coded PVC jackets (see Chart 7 in Technical Information Section for colors). Pair jackets and shields are bonded so both strip simultaneously with automatic stripping equipment. Overall Beldfoil shield plus overall Purple PVC jacket and nylon rip cord.

Datalene insulation features include low dielectric constant and a dissipation factor for high-speed, low-distortion data handling. Physical properties include good crush resistance and light weight.

Color Code: Black, Red.

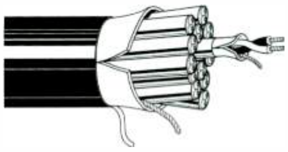
Specifications

Nominal OD — Conductor	
26 AWG	.019″ (.48mm)
24 AWG	.024″ (.60mm)
Nominal OD — Insulation	
26 AWG	.054″ (1.37mm)
24 AWG	.070″ (1.78mm)
Inner Pair Jacket OD	
26 AWG	.136″ (3.45mm)
24 AWG	.167″ (4.24mm)
Approvals	NEC: CMG (CEC: CMG FT4)
Nominal DCR (26 AWG)	
Conductor	37.3Ω/M′ (122.3Ω/km)
Shield	23.1Ω/M′ (75.8Ω/km)
Nominal DCR (24 AWG)	
Conductor	23.7Ω/M′ (77.7Ω/km)
Shield	18.9Ω/M′ (62.0Ω/km)
Nominal Impedance	110Ω ±10Ω
Nominal Velocity of Propagation	76%
Nominal Capacitance	
Between Conductors	13 pF/Ft. (43 pF/m)
Between Conductor/Shield*	26 pF/Ft. (85 pF/m)

DCR = DC Resistance

*Capacitance between one conductor and other conductors connected to shield.

For A/V cable assemblies, visit the Belden Web site for a list of Belden Certified Assemblers.



Part No.	No. of Pairs	Standard Lengths		Standard Unit Weight		Nominal OD	
		Ft.	m	Lbs.	kg	Inch	mm
Individually Shielded & Jacketed							
26 AWG (7x34) • NEC: CMG (CEC: CMG)							
7891A new	2	500	152.4	28.0	12.7	.343	8.71
		1000	304.8	56.0	25.5		
7890A new	4	100	30.5	8.2	3.7	.399	10.13
		250	76.2	18.0	8.2		
		500	152.4	31.0	14.1		
		1000	304.8	61.0	27.7		
7880A† new	8	250	76.2	29.8	13.5	.541	13.74
		500	152.4	57.0	25.9		
		1000	304.8	141.0	64.1		
Fits D-Sub connectors.							
7892A new	12	500	152.4	85.0	38.6	.679	17.25
		1000	304.8	174.0	79.1		
7893A new	16	500	152.4	109.5	49.8	.770	19.56
		1000	304.8	240.0	109.1		
24 AWG (7x32) • Flexible • NEC: CMG (CEC: CMG FT4)							
1803F	4	250	76.2	30.0	13.6	.488	12.40
		500	152.4	57.5	26.1		
		1000	304.8	107.0	48.6		
1805F	8	250	76.2	52.3	23.8	.661	16.79
		500	152.4	103.5	47.0		
		1000	304.8	205.0	93.2		
1806F	12	250	76.2	78.8	35.8	.829	21.06
		500	152.4	156.0	70.9		
		1000	304.8	322.0	146.4		
1850F new	16	250	76.2	99.5	45.2	.944	23.98
		500	152.4	209.5	95.2		
		1000	304.8	410.0	186.4		
1852F new	24	250	76.2	156.0	70.9	1.205	30.61
		500	152.4	322.0	146.4		
		1000	304.8	646.0	293.6		
1854F new	32	250	76.2	224.0	101.8	1.346	34.19
		500	152.4	434.0	197.3		
		1000	304.8	846.0	384.5		

Length may vary -10% to +0% from length shown.

†7880A is designed to fit in 25-pin D-sub connectors used in digital console board equipment.

AES/EBU Digital Audio Cable

Plenum-Rated, Multi-Pair Snake Cables
Individually Shielded Pairs

BRILLIANCE®

Individually Shielded Pairs

NEC: CMP (CEC: CMP FT6)

Product Description

24 AWG stranded (7x32) tinned copper conductor. Foam FEP insulation. Twisted pairs individually shielded with 100% Beldfoil®. Overall Gray fluorocopolymer jacket (except 82729 which has Natural Flamarrest® jacket). 24 AWG stranded tinned copper drain wire.

Color Code: See Chart 5 (in Technical Information Section)

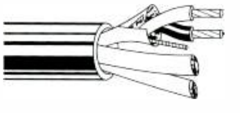
Specifications

Nominal OD — Conductor	.024″ (.60mm)
Nominal OD — Insulation	.062″ (1.57mm)
Approvals	
NEC	CMP
CEC	CMP FT6
UL Ratings	Non-conduit Plenum
Voltage Rating	300V RMS
Nominal DC Resistance	
Conductor	23.7Ω/M′ (77.7Ω/km)
Shield	18.9Ω/M′ (62.0Ω/km)
Nominal Impedance	100Ω
Nominal Velocity of Propagation	76%
Nominal Capacitance	
Between Conductors	13.5 pF/Ft. (44 pF/m)
Between Conductor/Shield*	22.5 pF/Ft. (73.8 pF/m)

*Capacitance between one conductor and other conductors connected to shield.

Part No.	No. of Pairs	Standard Lengths		Standard Unit Weight		Nominal OD	
		Ft.	m	Lbs.	kg	Inch	mm
Plenum Individually Shielded NEC: CMP (CEC: CMP FT6)							
24 AWG							
82729	2	U-1000 1000	U-304.8 304.8	27.0 28.0	12.3 12.7	.255	6.48
89729	2	500 1000	152.4 304.8	18.5 31.0	8.4 14.1	.261	6.63
89730	3	500 1000	152.4 304.8	23.0 40.0	10.5 18.2	.278	7.06
89728	4	500 1000	152.4 304.8	26.5 50.0	12.0 22.7	.307	7.80
89705	5	500 1000	152.4 304.8	30.5 62.0	13.9 28.2	.327	8.31
89731	6	500 1000	152.4 304.8	35.0 71.0	15.9 32.3	.361	9.17
89757	7	500 1000	152.4 304.8	39.5 80.0	18.0 36.4	.361	9.17
89732	9	1000	304.8	106.0	48.2	.433	11.00
89734	12	500 1000	152.4 304.8	71.0 140.0	32.3 63.6	.498	12.65
89758	18	500 1000	152.4 304.8	100.5 204.0	45.7 92.7	.616	15.65

Spools are one piece, but length may vary ±10% from length shown.



Digital Audio Attenuation

Part Number	2 MHz		4 MHz		5 MHz		6 MHz		12 MHz		25 MHz	
	dB/100 Ft.	dB/100m	dB/100 Ft.	dB/100m	dB/100 Ft.	dB/100m	dB/100 Ft.	dB/100m	dB/100 Ft.	dB/100m	dB/100 Ft.	dB/100m
9180, 7880A Series	1.67	5.48	2.11	6.92	2.30	7.55	2.46	8.07	3.16	10.37	4.22	13.85
1800F	1.28	4.20	2.17	7.12	2.62	8.60	3.01	9.88	4.72	15.49	7.17	23.52
1800B, 1801B, 1802B, 1803F Series	1.30	4.27	1.56	5.12	1.70	5.58	1.81	5.94	2.28	7.48	3.08	10.10
1696A	.93	3.05	1.15	3.77	1.20	3.94	1.30	4.27	1.60	5.25	1.97	6.46
179DT (coax)	1.34	4.40	1.67	5.48	1.74	5.71	1.99	6.53	2.77	9.09	3.83	12.57
1855A (coax)	.57	1.86	.82	2.70	.92	3.02	1.00	3.29	1.30	4.27	1.80	5.91
1505A (coax)	.41	1.35	.58	1.89	.63	2.07	.69	2.25	.90	2.95	1.30	4.27
1505F (coax)	.34	1.11	.53	1.74	.60	1.97	.67	2.20	.98	3.22	1.44	4.72
1694A (coax)	.16	.52	.48	1.57	.54	1.77	.59	1.93	.80	2.62	1.00	3.28

Values reflect typical results.

Maximum Recommended Transmission Distance at Digital Audio Data Rates (AES3-2003)*

Part Number	2 MHz		4 MHz		5 MHz		6 MHz		12 MHz		25 MHz	
	Ft.	m	Ft.	m	Ft.	m	Ft.	m	Ft.	m	Ft.	m
9180, 7880A Series	1198	365	948	289	870	265	813	248	633	193	474	144
1800F	1563	476	922	281	763	233	664	203	424	129	279	85
1800B, 1801B, 1802B, 1803F Series	1538	469	1282	391	1176	359	1105	337	877	267	649	198
1696A	2151	655	1739	530	1667	508	1538	463	1250	381	1015	309
179DT (AES3)†♦	1493	455	1198	365	1149	350	1005	306	722	220	522	159
(AES-3id)††	597	182	479	146	460	140	402	123	289	88	209	64
1855A (AES3)†♦	3521	1073	2427	740	2174	663	1992	607	1538	469	1111	339
(AES-3id)††	1408	429	970	295	869	265	796	242	615	188	444	135
1505A (AES3)†♦	4866	1483	3478	1060	3175	968	2911	887	2222	677	1538	469
(AES-3id)††	1946	593	1391	424	1270	387	1164	355	888	270	615	188
1505F (AES3)†♦	5882	1793	3774	1150	3333	1016	2985	910	2041	622	1389	423
(AES-3id)††	2353	717	1509	460	1333	406	1194	364	816	249	556	169
1694A (AES3)†♦	5882	1793	4184	1275	3704	1129	3407	1039	2500	762	2000	610
(AES-3id)††	2353	717	1673	510	1482	452	1363	416	1000	305	800	244

*Longer transmission distances are achievable but are contingent upon system component quality of input/output voltages.
†Transmission distance calculations assume minimum allowable output signal amplitude (2V per AES3-2003) and minimum allowable input signal amplitude (200mV pe AES3-2003).
††Per AES-3id-2001, when using analog video distribution equipment to implement AES-3id, maximum transmission distances are 40% of AES3 values assuming a minimum allowable output signal amplitude of 1V and a minimum allowable input signal amplitude of 320mV.
♦Implementation of AES3 with coaxial cable and 110-75Ω baluns can be achieved with transmission distances of 91% of the AES3 coaxial distances listed above.

Precision Video Cable for Analog and Digital

DigiTruck™ Miniature Coax for Broadcast Production Trucks and Sub-Miniature RG-59/U Type

BRILLIANCE®

28.5 AWG Solid .012" Bare Copper • Duobond® Foil (100%)+ 95% Tinned Copper Braid Shield

Gas-injected Foam HDPE Insulation • PVC Jacket (Red, Green, Blue, White, Yellow, Brown, Orange, Gray, Violet, Black)

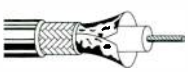
Description	Part No.	UL NEC/ C(UL) CEC Type	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Conductor (stranding) Diameter Nom. DCR	Nominal Core OD Inch	Nominal Core OD mm	Shielding Materials Nom. DCR	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nominal Capacitance pF/Ft.	Nominal Capacitance pF/m	Nominal Attenuation MHz	dB/ 100 Ft.	dB/ 100m
DigiTruck	**179DT**	NEC:	500	152.4	4.2	1.9	28.5 AWG	.056	1.42	Duobond	.100	.254	75	77%	17.4	57.4	1	1.18	3.87
SDI/HDTV		CM	1000	304.8	8.0	3.6	(solid)			Foil (100%)							3.6	1.54	5.05
Digital Video							.012"			+ 95%							10	2.25	7.38
75°C							BC			TC Braid							71.5	5.66	18.57
							108Ω/M'			8.9Ω/M'							135	7.51	24.64
							350Ω/km			29.2Ω/km							270	10.50	34.45
																	360	12.20	40.03
																	540	15.10	49.54
																	720	17.50	57.41
																	750	17.80	58.40
																	1000	20.70	67.91
																	1500	25.40	83.33
																	2250	31.50	103.35
																	3000	36.70	120.41

100% Sweep tested. 5 MHz to 3 GHz.

25 AWG Stranded (19x37) .021" Bare Copper • Duofoil® + 95% Tinned Copper Braid Shield

Gas-injected Foam HDPE Insulation • PVC Jacket (Available in 10 colors)*

Description	Part No.	UL NEC/ C(UL) CEC Type	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Conductor (stranding) Diameter Nom. DCR	Nominal Core OD Inch	Nominal Core OD mm	Shielding Materials Nom. DCR	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nominal Capacitance pF/Ft.	Nominal Capacitance pF/m	Nominal Attenuation MHz	dB/ 100 Ft.	dB/ 100m
SDI/HDTV	**1865A**	NEC:	1000	304.8	16.0	7.3	25 AWG	.094	2.39	Duofoil	.150	3.81	75	82%	16.5	54.1	1	.5	1.5
Digital Video		CMR					(19x37)			+ 95%							3.6	1.0	3.1
75°C		CEC:					.021"			TC Braid							10	1.6	5.2
		CMG FT4					BC			6.0Ω/M'							71.5	3.7	12.1
							27.4Ω/M'			19.8Ω/km							135	5.0	16.4
							89.9Ω/km										270	7.1	23.3
																	360	8.2	26.9
																	540	10.1	33.1
																	720	11.8	38.7
																	750	12.0	39.4
																	1000	13.9	45.6
																	1500	17.0	55.8
																	2250	20.8	68.2
																	3000	24.0	78.7

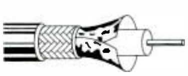


100% Sweep tested. 5 MHz to 3 GHz.

23 AWG Solid .023" Bare Copper • Duofoil + 95% Tinned Copper Braid Shield

Gas-injected Foam HDPE Insulation • PVC Jacket (Available in 10 colors)*

Description	Part No.	UL NEC/ C(UL) CEC Type	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Conductor (stranding) Diameter Nom. DCR	Nominal Core OD Inch	Nominal Core OD mm	Shielding Materials Nom. DCR	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nominal Capacitance pF/Ft.	Nominal Capacitance pF/m	Nominal Attenuation MHz	dB/ 100 Ft.	dB/ 100m
SDI/HDTV	**1855A**	NEC:	500▲	152.4	9.0	4.1	23 AWG	.102	2.59	Duofoil	.159	4.03	75	83%	16.3	53.5	1	.4	1.3
Digital Video		CMR	1000	304.8	18.0	8.2	(solid)			+ 95%							3.6	.8	2.6
75°C		CEC:	U-1000•	U-304.8	18.0	8.2	.023"			TC Braid							10	1.2	3.9
		CMG FT4					BC			4.1Ω/M'							71.5	3.1	10.2
							20.1Ω/M'			13.5Ω/km							135	3.8	12.5
							65.9Ω/km										270	5.4	17.7
																	360	6.2	20.3
																	540	7.7	25.3
																	720	9.5	31.2
																	750	9.6	31.5
																	1000	10.5	34.5
																	1500	13.0	42.7
																	2250	16.0	52.5
																	3000	18.5	60.7



Also available in multiples, bundled. See 7787A through 7792A.

100% Sweep tested. 5 MHz to 3 GHz.

▲500 ft. put-up available in Black only.
•U-1000 ft. put-up available in Gray only.

BC = Bare Copper • DCR = DC Resistance • HDPE = Foam High-density Polyethylene • TC = Tinned Copper

For Connector Cross Reference, visit www.belden.com or call Customer Service 1-800-BELDEN-1. For A/V cable assemblies, visit the Belden Web site for a list of Belden Certified Asssemblers.

*Available in Brown, Red, Orange, Yellow, Green, Blue, Violet, Gray, White or Black.

Precision Video Cable for Analog and Digital

RG-59/U Type

BRILLIANCE®

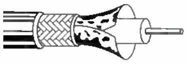
23 AWG Solid .022″ Bare Copper • Duofoil® + 95% Tinned Copper Braid Shield

Polyethylene Insulation • Black Polyethylene Jacket

Description	Part No.	UL NEC/ C(UL) CEC Type	Standard Lengths		Standard Unit Weight		Conductor (stranding) Diameter Nom. DCR	Nominal Core OD		Shielding Materials Nom. DCR	Nominal OD		Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nominal Capacitance		Nominal Attenuation		
			Ft.	m	Lbs.	kg		Inch	mm		Inch	mm			pF/Ft.	pF/m	MHz	dB/100 Ft.	dB/100m
80°C	**9209**		U-500	U-152.4	15.0	6.8	23 AWG	.146	3.71	Duofoil	.220	5.59	75	66%	21.0	68.9	1	.4	1.2
			U-1000	U-304.8	29.0	13.2	(solid)			+ 95%							3.6	.5	1.8
							.022″			TC Braid							10.0	1.2	3.8
							BC			4.5Ω/M′							71.5	2.9	9.5
							20.4Ω/M′			14.8Ω/km							135	4.0	13.0
							66.9Ω/km				100% Sweep tested. 5 MHz to 850 MHz.						270	5.6	18.4
																	360	6.6	21.5
																	540	8.3	27.2
																	720	9.7	31.7
																	750	9.9	32.5
																	1000	11.6	38.0

20 AWG Solid .032″ Bare Copper • Duofoil + 95% Tinned Copper Braid Shield

Gas-injected Foam HDPE Insulation • PVC Jacket (Available in 10 colors)•

Description	Part No.	UL NEC/ C(UL) CEC Type	Ft.	m	Lbs.	kg	Conductor	Core OD Inch	Core OD mm	Shielding	OD Inch	OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	pF/Ft.	pF/m	MHz	dB/100 Ft.	dB/100m
SDI/HDTV	**1505A**	NEC:	500▲	152.4	17.5	8.0	20 AWG	.145	3.68	Duofoil	.234	5.94	75	83%	16.3	53.5	1	.3	1.0
Digital Video		CMR	1000•	304.8	36.0	16.4	(solid)			+ 95%							3.6	.6	2.0
75°C		CEC:	5000•	1524.0	165.4	75.2	.032″			TC Braid							10	.9	3.0
		CMG FT4					BC			3.8Ω/M′							71.5	2.1	6.9
							10.0Ω/M′			12.5Ω/km	For Plenum version of 1505A,						135	2.7	8.9
							32.8Ω/km				see 1506A.						270	3.8	12.5
																	360	4.4	14.4
											Also available in bundled versions.						540	5.5	18.0
											See 7794A through 7798A.						720	6.4	21.0
											100% Sweep tested. 5 MHz to 3 GHz.						750	6.5	21.3
																	1000	7.6	24.9
																	1500	9.3	30.5
																	2250	11.6	38.1
																	3000	13.4	44.0

▲500 ft. put-up available in Black, Red or Blue only.
•1000 ft. and 5000 ft. put-ups available in all ten colors: Black, Brown, Red, Orange, Yellow, Green, Blue, Violet, Gray or White.

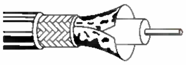
22 AWG Stranded (7x29) .031″ Bare Compacted Copper* • Double Tinned Copper Braid Shield

Gas-injected Foam HDPE Insulation • PVC Jacket (Matte Black, Red, Green, Blue, Yellow, White or Violet)

Description	Part No.	UL NEC/ C(UL) CEC Type	Ft.	m	Lbs.	kg	Conductor	Core OD Inch	Core OD mm	Shielding	OD Inch	OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	pF/Ft.	pF/m	MHz	dB/100 Ft.	dB/100m
High-Flex	**1505F**	NEC:	1000	304.8	44.0	20.0	22 AWG	.145	3.68	TC Double	.242	6.15	75	80%	17.0	55.7	1	.2	.7
SDI/HDTV	new	CM					(7x29)			Braid							3.6	.5	1.6
Video Patch		CEC:					.031″			95% Shield							10	.9	2.9
75°C		CM					BCC			Coverage							71.5	2.5	8.2
							12.2Ω/M′			2.4Ω/M′							135	3.5	11.5
							40.0Ω/km			7.8Ω/km							270	5.1	16.7
																	360	6.0	19.7
											100% Sweep tested. 5 MHz to 3 GHz.						540	7.4	24.3
																	720	8.7	28.5
																	750	8.9	29.2
																	1000	10.5	34.4
																	1500	13.3	43.6
																	2250	16.9	55.4
																	3000	20.3	66.6

20 AWG Solid .032″ Bare Copper • Duofoil + 95% Tinned Copper Braid Shield

Plenum • Foam FEP Insulation • Flamarrest® Jacket (Available in 10 colors)'

Description	Part No.	UL NEC/ C(UL) CEC Type	Ft.	m	Lbs.	kg	Conductor	Core OD Inch	Core OD mm	Shielding	OD Inch	OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	pF/Ft.	pF/m	MHz	dB/100 Ft.	dB/100m
SDI/HDTV	**1506A**	NEC:	500†▼	152.4	16.5	7.5	20 AWG	.133	3.38	Duofoil	.199	5.05	75	84%	16.1	52.8	1	.3	1.0
Digital Video		CMP	1000†'	304.8	33.0	15.0	(solid)			+ 95%							3.6	.6	2.0
75°C		CEC:					.032″			TC Braid							10	1.1	3.4
		CMP FT6					BC			3.8Ω/M′							71.5	2.3	7.4
							10.0Ω/M′			12.5Ω/km							135	3.2	10.5
							32.8Ω/km										270	4.6	14.9
																	360	5.3	17.2
											100% Sweep tested. 5 MHz to 3 GHz.						540	6.4	21.0
																	720	7.3	23.9
																	750	7.5	24.6
																	1000	9.4	30.8
																	1500	12.8	42.0
																	2250	17.5	57.4
																	3000	21.9	71.8

Suitable for Outdoor and Direct Burial applications.
▼500 ft. put-up available in Black or Natural only.
'1000 ft. put-up available in all ten colors: Black, Brown, Red, Orange, Yellow, Green, Blue, Violet, Gray or Natural.

BC = Bare Copper • BCC = Bare Compacted Copper • DCR = DC Resistance • HDPE = High-density Polyethylene • TC = Tinned Copper

For Connector Cross Reference, visit www.belden.com or call Customer Service 1-800-BELDEN-1. For A/V cable assemblies, visit the Belden Web site for a list of Belden Certified Asssemblers.

*Compacted conductor combines impedance uniformity of solid conductors and "nick-resistance" of stranded conductor.
†Spools are one piece, but length may vary ±10% from length shown.

Precision Video Cable for Analog and Digital

Double Braided RG-59/U Type

BRILLIANCE®

Description	Part No.	UL NEC/ C(UL) CEC Type	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Conductor (stranding) Diameter Nom. DCR	Nominal Core OD Inch	Nominal Core OD mm	Shielding Materials Nom. DCR	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nominal Capacitance pF/Ft.	Nominal Capacitance pF/m	Nominal Attenuation MHz	Nominal Attenuation dB/100 Ft.	Nominal Attenuation dB/100m
20 AWG Solid .031″ Bare Copper • 98% Tinned Copper Double Braid Shield																			
Polyethylene Insulation • Polyethylene Jacket (Available in Red, Yellow, Green, Light Blue, White, Orange or Black)																			
80°C 	**8281**		500▲ 1000	152.4 304.8	37.0 74.0	16.8 33.6	20 AWG (solid) .031″ BC 9.9Ω/M′ 32.5Ω/km	.198	5.03	TC Double Braid 98% Shield Coverage 1.1Ω/M′ 3.6Ω/km	.305	7.75	75	66%	21.0	68.9	1 3.6 10.0 71.5 135 270 360 540 720 750 1000	.3 .5 .8 2.1 3.0 4.3 5.1 6.3 7.4 7.6 9.2	.8 1.8 2.6 6.9 9.8 14.1 16.6 20.7 24.3 24.9 30.2
For Plenum version of 8281, see 88281. 100% Sweep tested. 5 MHz to 850 MHz.																			
▲500 ft. put-up not available in White.																			
Flame-retardant Semi-Foam Polyethylene Insulation • PVC Jacket (Available in 10 colors)•																			
UL AWM Style 1354 (30V 80°C) 	**8281B**	NEC: CMR CEC: CMG FT4	1000	304.8	85.0	38.6	20 AWG (solid) .031″ BC 9.9Ω/M′ 32.5Ω/km	.198	5.03	TC Double Braid 98% Shield Coverage 1.1Ω/M′ 3.6Ω/km	.305	7.75	75	66%	21.0	68.9	1 3.6 10.0 71.5 135 270 360 540 720 750 1000	.3 .5 .8 2.1 3.0 4.4 5.1 6.6 7.8 8.0 10.2	.8 1.8 2.6 6.9 9.8 14.4 16.6 21.5 25.4 26.2 33.5
For Plenum version of 8281B, see 88281. 100% Sweep tested. 5 MHz to 850 MHz.																			
•8281B available in Brown, Red, Orange, Yellow, Green, Blue, Violet, Gray, White or Black.																			
22 AWG Stranded (7x29) .031″ Bare Compacted Copper* • Double Tinned Copper Braid Shield																			
Polyethylene Insulation • PVC Jacket (Matte Red, Blue, Green, Gray or Black)																			
High-Flex 60°C 	**8281F**		500• 1000	152.4 304.8	32.0 65.0	14.5 29.5	22 AWG (7x29) .031″ BCC 12.2Ω/M′ 40.0Ω/km	.193	4.90	TC Double Braid 98% Shield Coverage 1.7Ω/M′ 5.6Ω/km	.305	7.75	75	66%	21.0	68.9	1 3.6 10.0 71.5 135 270 360 540 720 750 1000	.3 .5 .9 2.5 3.6 5.1 6.0 7.4 8.7 8.9 10.5	.9 1.7 2.9 8.0 11.6 16.7 19.7 24.3 28.5 29.2 34.4
100% Sweep tested. 5 MHz to 850 MHz.																			
•500 ft. put-up available in Black only.																			
20 AWG Solid .031″ Bare Copper • 98% Tinned Copper Double Braid Shield																			
Plenum • FEP Insulation • Black Fluorocopolymer Jacket																			
150°C 	**88281**	NEC: CMP CEC: CMP FT6	500† 1000†	152.4 304.8	46.0 86.0	20.9 39.1	20 AWG (solid) .032″ BC 9.9Ω/M′ 32.5Ω/km	.185	4.70	TC Double Braid 98% Shield Coverage 1.1Ω/M′ 3.6Ω/km	.271	6.88	75	71%	19.0	62.4	1 3.6 10.0 71.5 135 270 360 540 720 750 1000	.2 .5 .8 2.3 3.3 5.1 6.1 8.0 9.7 10.0 12.3	.7 1.6 2.6 7.5 10.8 16.7 20.0 26.2 31.8 32.8 40.3
100% Sweep tested. 5 MHz to 216 MHz.																			
Suitable for Outdoor and Direct Burial applications.																			

BC = Bare Copper • BCC = Bare Compacted Copper • DCR = DC Resistance • HDPE = High-density Polyethylene • TC = Tinned Copper

For Connector Cross Reference, visit www.belden.com or call Customer Service 1-800-BELDEN-1. For A/V cable assemblies, visit the Belden Web site for a list of Belden Certified Asssemblers.

*Compacted conductor combines impedance uniformity of solid conductors and "nick-resistance" of stranded conductor.
†Spools are one piece, but length may vary ±10% from length shown.

Precision Video Cable for Analog and Digital

Low Loss Serial Digital Coax
RG-6/U, RG-7/U and RG-11/U Type

BRILLIANCE®

RG-6/U Type • 18 AWG Solid .040″ Bare Copper • Duofoil® + 95% Tinned Copper Braid Shield

Gas-injected Foam HDPE Insulation • PVC Jacket (Available in 10 colors)*

Description	Part No.	UL NEC/ C(UL) CEC Type	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Conductor (stranding) Diameter Nom. DCR	Nominal Core OD Inch	Nominal Core OD mm	Shielding Materials Nom. DCR	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nominal Capacitance pF/Ft.	Nominal Capacitance pF/m	Nominal Attenuation MHz	Nominal Attenuation dB/100 Ft.	Nominal Attenuation dB/100m
SDI/HDTV Digital Video 75°C 	1694A new	NEC: CMR CEC: CMG FT4	500▲ 1000 4500	152.4 304.8 1371.6	23.0 45.0 207.0	10.5 20.5 94.3	18 AWG (solid) .040″ BC 6.4Ω/M′ 21.0Ω/km	.180	4.57	Duofoil + 95% TC Braid 2.8Ω/M′ 9.2Ω/km	.275	6.99	75	82%	16.2	53.1	1 3.6 10 71.5 135 270 360 540 720 750 1000 1500 2250 3000	.2 .5 .7 1.6 2.1 3.0 3.4 4.3 4.9 5.0 5.9 7.3 9.1 10.7	.7 1.6 2.3 5.2 6.9 9.8 11.2 14.1 16.1 16.4 19.4 24.0 29.9 35.1

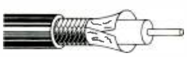
For Plenum version of 1694A, see 1695A.

Also available in bundled versions. See 7710A through 7713A.

100% Sweep tested. 5 MHz to 3 GHz.

▲500 ft. put-up available in Black only.

Plenum • Foam FEP Insulation • Flamarrest® Jacket (Available in 10 colors)**

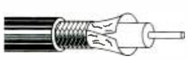
Description	Part No.	UL NEC/ C(UL) CEC Type	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Conductor (stranding) Diameter Nom. DCR	Nominal Core OD Inch	Nominal Core OD mm	Shielding Materials Nom. DCR	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nominal Capacitance pF/Ft.	Nominal Capacitance pF/m	Nominal Attenuation MHz	Nominal Attenuation dB/100 Ft.	Nominal Attenuation dB/100m
SDI/HDTV Digital Video 75°C 	1695A new	NEC: CMP CEC: CMP FT6	500†• 1000†	152.4 304.8	22.5 45.0	10.2 20.5	18 AWG (solid) .040″ BC 6.4Ω/M′ 21.0Ω/km	.170	4.32	Duofoil + 95% TC Braid 2.8Ω/M′ 9.2Ω/km	.234	5.94	75	82%	16.2	53.1	1 3.6 10 71.5 135 270 360 540 720 750 1000 1500 2250 3000	.2 .5 .8 1.8 2.4 3.4 4.0 5.2 6.1 7.3 7.5 9.2 11.6 13.7	.8 1.5 2.5 5.8 7.9 11.2 13.1 17.1 20.0 23.9 24.6 30.2 38.0 44.9

100% Sweep tested. 5 MHz to 3 GHz.

•500 ft. put-up available in Black, Red, Yellow, Violet or Natural only.

RG-7/U Type • 16 AWG Solid .064″ Bare Copper • Duofoil + 95% Tinned Copper Braid Shield

Gas-injected Foam HDPE Insulation • PVC Jacket (Available in 10 colors)*

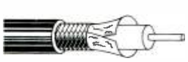
Description	Part No.	UL NEC/ C(UL) CEC Type	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Conductor (stranding) Diameter Nom. DCR	Nominal Core OD Inch	Nominal Core OD mm	Shielding Materials Nom. DCR	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nominal Capacitance pF/Ft.	Nominal Capacitance pF/m	Nominal Attenuation MHz	Nominal Attenuation dB/100 Ft.	Nominal Attenuation dB/100m
SDI/HDTV Digital Video 75°C 	7855A	NEC: CMR CEC: CMR FT4	500▼ 1000	152.4 304.8	32.5 62.0	14.8 28.2	16 AWG (solid) .064″ BC 1.2Ω/M′ 3.9Ω/km	.225	5.71	Duofoil + 95% TC Braid 1.7Ω/M′ 5.6Ω/km	.320	8.13	75	84%	16.1	52.8	1 3.6 10 71.5 135 270 360 540 720 750 1000 1500 2500 3000	.2 .4 .6 1.1 1.8 2.5 2.9 3.6 4.2 4.3 5.0 6.1 7.9 8.7	.6 1.2 1.9 3.6 5.8 8.1 9.4 11.7 13.7 14.0 16.3 20.0 25.9 28.5

100% Sweep tested. 5 MHz to 3 GHz.

▼500 ft. put-up available in Black only.

RG-11/U Type • 14 AWG Solid .064″ Bare Copper • Duofoil + 95% Tinned Copper Braid Shield

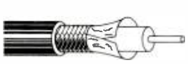
Gas-injected Foam HDPE Insulation • PVC Jacket (Available in 10 colors)*

Description	Part No.	UL NEC/ C(UL) CEC Type	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Conductor (stranding) Diameter Nom. DCR	Nominal Core OD Inch	Nominal Core OD mm	Shielding Materials Nom. DCR	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nominal Capacitance pF/Ft.	Nominal Capacitance pF/m	Nominal Attenuation MHz	Nominal Attenuation dB/100 Ft.	Nominal Attenuation dB/100m
SDI/HDTV Digital Video 75°C 	7731A	NEC: CMR CEC: CMG FT4	500‣ 1000 4000	152.4 304.8 1219.2	48.0 94.0 467.0	21.8 42.8 212.3	14 AWG (solid) .064″ BC 2.5Ω/M′ 8.2Ω/km	.280	7.11	Duofoil + 95% TC Braid 1.5Ω/M′ 4.9Ω/km	.405	10.3	75	85%	16.0	52.4	1 3.6 10 71.5 135 270 360 540 720 750 1000 1500 2250 3000	.2 .3 .5 1.1 1.5 2.1 2.5 3.1 3.6 3.7 4.3 5.5 6.9 8.2	.5 1.0 1.5 3.6 4.8 6.9 8.0 10.0 11.7 12.0 14.1 18.0 22.6 26.9

100% Sweep tested. 5 MHz to 3 GHz.

‣500 ft. put-up available in Red or Black only.

Plenum • Foam FEP Insulation • Fluorocopolymer Jacket (Available in 10 colors)**

Description	Part No.	UL NEC/ C(UL) CEC Type	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Conductor (stranding) Diameter Nom. DCR	Nominal Core OD Inch	Nominal Core OD mm	Shielding Materials Nom. DCR	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nominal Capacitance pF/Ft.	Nominal Capacitance pF/m	Nominal Attenuation MHz	Nominal Attenuation dB/100 Ft.	Nominal Attenuation dB/100m
SDI/HDTV Digital Video 150°C 	7732A new	NEC: CMP CEC: CMP FT6	500✦ 1000 2000✢	152.4 304.8 609.6	45.0 88.0 176.0	20.5 40.0 80.0	14 AWG (solid) .064″ BC 2.5Ω/M′ 8.2Ω/km	.274	6.96	Duofoil + 95% TC Braid 2.5Ω/M′ 8.2Ω/km	.348	8.84	75	83%	16.3	53.5	1 3.6 10 71.5 135 270 360 540 720 750 1000 1500 2250 3000	.2 .3 .4 1.2 1.8 2.6 3.1 3.9 4.6 4.7 5.5 6.9 9.2 10.2	.5 .9 1.3 4.1 5.8 8.5 10.2 12.8 15.0 15.4 18.0 22.7 30.2 33.5

100% Sweep tested. 5 MHz to 3 GHz.

✦500 ft. put-up available in Black or Natural only.
✢2000 ft. put-up available in Natural only.
Suitable for Outdoor and Direct Burial applications.

BC = Bare Copper • DCR = DC Resistance • HDPE = High-density Polyethylene • TC = Tinned Copper

For Connector Cross Reference, visit www.belden.com or call Customer Service 1-800-BELDEN-1.

* Available in Black, Brown, Red, Orange, Yellow, Green, Blue, Violet, Gray or White.
** Available in Black, Brown, Red, Orange, Yellow, Green, Blue, Violet, Gray or Natural.
† Spools are one piece, but length may vary ±10% from length shown.

VideoFLEX® Snake Cable for Precision Analog and Digital

Bundled Miniature and RG-59/U Type

BRILLIANCE®

Miniature • 23 AWG Solid .023″ Bare Copper • Duofoil® + 95% Tinned Copper Braid (100% Shield Coverage)

Solid Copper, Gas-injected Foam HDPE Insulation • Overall Matte Black PVC Jacket (Color Code: See chart below)

Description	Part No.	UL NEC/ C(UL) CEC Type	No. of Cond.	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Conductor (stranding) Diameter Nom. DCR	Nominal Core OD Inch	Nominal Core OD mm	Shielding Materials Nom. DCR	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nominal Capacitance pF/Ft.	Nominal Capacitance pF/m	Nominal Attenuation MHz	Nominal Attenuation dB/100 Ft.	Nominal Attenuation dB/100m
SDI/HDTV Digital Video 75°C (1855A Bundled) 	7787A new	NEC: CMR CEC: CMG FT4	3	500 1000	152.4 304.8	47.5 94.0	21.6 42.7	23 AWG (solid) .023″ BC 20.1Ω/M′ 65.9Ω/km	.102 Coax OD: .159	2.55 4.03	Duofoil + 95% TC Braid 4.1Ω/M′ 13.5Ω/km	.432	10.97	75	83%	16.5	54.1	1 3.6 10 71.5 135 270 360 540 720 750 1000 1500 2500 3000	.4 .8 1.2 3.2 3.9 5.5 6.3 7.9 9.7 9.8 10.7 13.3 16.3 18.9	1.3 2.6 3.9 10.5 12.8 18.0 20.7 25.9 31.8 32.2 35.1 43.6 53.5 62.0
	7788A new	NEC: CMR CEC: CMG FT4	4	1000	304.8	111.0	50.5	same as above	.102 Coax OD: .159	2.55 4.03	same as above	.481	12.22							
	7789A new	NEC: CMR CEC: CMG FT4	5	500 1000	152.4 304.8	72.5 141.0	33.0 64.1	same as above	.102 Coax OD: .159	2.55 4.03	same as above	.539	13.69							
	7790A new	NEC: CMR CEC: CMG FT4	6	500 1000	152.4 304.8	88.5 175.0	40.2 79.5	same as above	.102 Coax OD: .159	2.55 4.03	same as above	.597	15.16							
	7791A new	NEC: CMR CEC: CMG FT4	10	500 1000	152.4 304.8	155.5 303.0	70.7 137.7	same as above	.102 Coax OD: .159	2.55 4.03	same as above	.796	20.22							
	7792A new	NEC: CMR CEC: CMG FT4	12	500 1000	152.4 304.8	171.5 353.0	78.0 160.5	same as above	.102 Coax OD: .159	2.55 4.03	same as above	.825	20.96							

Sweep tested 5 MHz to 3 GHz.

RG-59/U Type • 20 AWG Solid .032″ Bare Copper • Duofoil + 95% Tinned Copper Braid (100% Shield Coverage)

Gas-injected Foam HDPE Insulation • Overall Matte Black PVC Jacket (Color Code: See chart below)

Description	Part No.	UL NEC/ C(UL) CEC Type	No. of Cond.	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Conductor (stranding) Diameter Nom. DCR	Nominal Core OD Inch	Nominal Core OD mm	Shielding Materials Nom. DCR	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nominal Capacitance pF/Ft.	Nominal Capacitance pF/m	Nominal Attenuation MHz	Nominal Attenuation dB/100 Ft.	Nominal Attenuation dB/100m
SDI/HDTV Digital Video 75°C (1505A Bundled) 	7794A new	NEC: CMR CEC: CMG FT4	3	500 1000	152.4 304.8	94.5 188.0	43.0 85.5	20 AWG (solid) .032″ BC 10.0Ω/M′ 32.8Ω/km	.145 Coax OD: .235	3.68 5.97	Duofoil + 95% TC Braid 3.8Ω/M′ 12.5Ω/km	.631	16.03	75	83%	16.3	53.1	1 3.6 10 71.5 135 270 360 540 720 750 1000 1500 2500 3000	.3 .6 .9 2.1 2.8 3.9 4.5 5.6 6.5 6.6 7.8 9.5 11.8 13.7	1.0 2.0 3.0 6.9 9.2 12.8 14.8 18.4 21.3 21.7 25.6 31.2 38.7 44.9
	7795A new	NEC: CMR CEC: CMG FT4	4	500 1000	152.4 304.8	116.5 237.0	53.0 107.7	same as above	.145 Coax OD: .235	3.68 5.97	same as above	.706	17.93							
	7796A new	NEC: CMR CEC: CMG FT4	5	500 1000	152.4 304.8	150.0 293.0	68.2 133.2	same as above	.145 Coax OD: .235	3.68 5.97	same as above	.790	20.07							
	7798A new	NEC: CMR CEC: CMG FT4	10	500 1000	152.4 304.8	319.5 625.0	145.2 284.1	same as above	.145 Coax OD: .235	3.68 5.97	same as above	1.166	29.62							

Sweep tested 5 MHz to 3 GHz.

BC = Bare Copper • DCR = DC Resistance • HDPE = High-density Polyethylene • TC = Tinned Copper

For Connector Cross Reference, visit www.belden.com or call Customer Service 1-800-BELDEN-1. For A/V cable assemblies, visit the Belden Web site for a list of Belden Certified Asssemblers.

Color Code Chart

Cond.	Color	Cond.	Color	Cond.	Color
1	Red	5	Yellow	9	Violet
2	Green	6	Brown	10	Black
3	Blue	7	Orange	11	Pink
4	White	8	Gray	12	Tan

VideoFLEX® Snake Cable for Precision Analog and Digital
RG-6/U Type

BRILLIANCE®

RG-6/U Type • 18 AWG Solid .040" Bare Copper • Duofoil® + 95% Tinned Copper Braid Shield

Gas-injected Foam HDPE Insulation • Overall Matte Black PVC Jacket (Color Code: See chart below)

Description	Part No.	UL NEC/ C(UL) CEC Type	No. of Cond.	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Conductor (stranding) Diameter Nom. DCR	Nominal Core OD Inch	Nominal Core OD mm	Shielding Materials Nom. DCR	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nominal Capacitance pF/Ft.	Nominal Capacitance pF/m	Nominal Attenuation MHz	Nominal Attenuation dB/100 Ft.	Nominal Attenuation dB/100m
SDI/HDTV Digital Video 75°C (1694A Bundled) 	7710A	NEC: CMR CEC: CMG FT4	3	500 1000	152.4 304.8	131.5 273.0	59.8 124.1	18 AWG (solid) .040" BC 6.4Ω/M' 21.0Ω/km	.180 Coax OD: .257	4.57 6.99	Duofoil + 95% TC Braid 2.8Ω/M' 9.2Ω/km	.770	19.56	75	82%	16.2	53.1	1 3.6 10 71.5 135 270 360 540 720 750 1000 1500 2500 3000	.2 .5 .7 1.6 2.1 3.1 3.5 4.4 5.0 5.1 6.0 7.4 9.3 10.9	.7 1.6 2.3 5.2 6.9 10.2 11.5 14.4 16.4 16.7 19.7 24.3 30.5 35.8
	7711A	NEC: CMR CEC: CMG FT4	4	500 1000	152.4 304.8	174.0 339.0	79.1 154.1	same as above	.180 Coax OD: .257	4.57 6.99	same as above	.900	22.86							
	7712A	NEC: CMR CEC: CMG FT4	5	500 1000	152.4 304.8	209.5 440.0	95.2 200.0	same as above	.180 Coax OD: .257	4.57 6.99	same as above	.942	23.93							
	7713A	NEC: CMR CEC: CMG FT4	10	500 1000	152.4 304.8	450.0 878.0	204.5 399.1	same as above	.180 Coax OD: .257	4.57 6.99	same as above	1.386	35.20							

Sweep tested 5 MHz to 3 GHz.

BC = Bare Copper • DCR = DC Resistance • HDPE = High-density Polyethylene • TC = Tinned Copper

Color Code Chart

Cond.	Color	Cond.	Color	Cond.	Color
1	Red	5	Yellow	9	Violet
2	Green	6	Brown	10	Black
3	Blue	7	Orange		
4	White	8	Gray		

Video Triax Cable
RG-11/U Type

14 AWG Solid .064" Bare Copper • Two Bare Copper Braids (95% Shield Coverage)

Gas-injected Foam HDPE Insulation • Black PVC Jacket (PVC Insulation between Braids)

Description	Part No.	UL NEC/ C(UL) CEC Type	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Conductor (stranding) Diameter Nom. DCR	Nominal Core OD Inch	Nominal Core OD mm	Shielding Materials Nom. DCR	Nominal OD Inch	Nominal OD mm	Nom. Imp. (Ω)	Nom. Vel. of Prop.	Nominal Capacitance pF/Ft.	Nominal Capacitance pF/m	Nominal Attenuation MHz	Nominal Attenuation dB/100 Ft.	Nominal Attenuation dB/100m
80°C 	8233A	NEC: CMR CEC: CMG FT4	1000 2000 4000	304.8 609.6 1219.2	142.0 240.0 574.0	64.5 109.1 260.9	14 AWG (solid) .064" BC 2.5Ω/M' 8.2Ω/km	.285	7.24	(2) BC Braids 95% Coverage Inner: 1.6Ω/M' 5.2Ω/km Outer: 1.4Ω/M' 4.6Ω/km	.475	12.07	75	84%	16.1	52.8	1 3.6 10 71.5 135 270 360 540 720 750 1000 1500 2250 3000	.2 .3 .4 1.1 1.5 2.3 2.7 3.5 4.2 4.3 5.2 7.1 9.6 12.0	.7 1.0 1.3 3.6 4.9 7.5 8.9 11.5 13.8 14.1 17.1 23.3 31.5 39.4

100% Sweep tested. 5 MHz to 3 GHz.

For additional sweep-tested digital video Triax Cables, see the Belden Master Catalog and/or www.belden.com.

BC = Bare Copper • DCR = DC Resistance • HDPE = High-density Polyethylene • PE = Polyethylene

For Connector Cross Reference, visit www.belden.com or call Customer Service 1-800-BELDEN-1. For A/V cable assemblies, visit the Belden Web site for a list of Belden Certified Asssemblers.

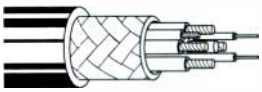
Audio and Video Composite Camera Cable

SMPTE 311M HDTV Cables

Single-mode Fiber with Copper Conductors

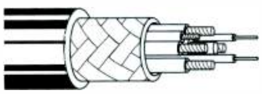
BRILLIANCE®

Description	Part No.	UL NEC/ C(UL) CEC Type	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Conductor (stranding) Nom. DCR	Nominal Core OD Inch	Nominal Core OD mm	Shielding Materials Nom. DCR	Nominal OD Inch	Nominal OD mm	Nominal Optical Attenuation (@1310nm) dB/1000 Ft.	Nominal Optical Attenuation (@1310nm) dB/km
4 Power Conductors • SM Fiber w/ 24 and 20 AWG Stranded (7x32 and 19x32) Tinned Copper • Overall 95% TC Braid Shield														
PVC Insulation • Black Belflex® Jacket														
75°C	**7804R** new	NEC: CMR CEC: CMG FT4	328 500 1000 1640 3280	100.0 152.4 304.8 500.0 1000.0	33.5 50.0 98.0 155.8 321.4	15.2 22.7 44.5 70.8 146.1	(2) Fibers: SM/125µ/900µ (core/clad/buffer)	.079	2.00	36 AWG TC Braid 95% Shield Coverage 2.9Ω/M' 9.5Ω/km	.362	9.20	.14	.45
							(2) Cond.: 24 AWG (7x32) .024" Tinned Copper 23.3Ω/M' 76.4Ω/km	.050	1.27					
							(4) Cond.: 20 AWG (19x32) .037" Tinned Copper 8.8Ω/M' 28.9Ω/km	.063	1.60					



Plenum version and other conductor counts/diameters available by special order.

Description	Part No.	UL NEC/ C(UL) CEC Type	Standard Lengths Ft.	Standard Lengths m	Standard Unit Weight Lbs.	Standard Unit Weight kg	Conductor (stranding) Nom. DCR	Nominal Core OD Inch	Nominal Core OD mm	Shielding Materials Nom. DCR	Nominal OD Inch	Nominal OD mm	Nominal Optical Attenuation (@1310nm) dB/1000 Ft.	Nominal Optical Attenuation (@1310nm) dB/km
2 Power Conductors • SM Fiber w/ 24 and 16 AWG Stranded (7x32 and 65x34) Tinned Copper • Overall 95% TC Braid Shield														
PVC Insulation • Black Belflex Jacket														
75°C	**7804C** new	NEC: CMR CEC: CMG FT4	328 500 1000 1640 3280	100.0 152.4 304.8 500.0 1000.0	32.0 46.0 87.0 140.0 288.0	14.5 20.9 39.5 63.6 130.9	(2) Breakout Fibers: SM/125µ/900µ (core/clad/buffer)	.079	2.00	38 AWG TC Braid 95% Shield Coverage 2.8Ω/M' 9.2Ω/km	.362	9.20	.14	.45
							(2) Cond.: 24 AWG (7x32) .024" Tinned Copper 23.3Ω/M' 76.4Ω/km	.050	1.27					
							(2) Cond.: 16 AWG (65x34) .059" Tinned Copper 4.3Ω/M' 14.1Ω/km	.093	2.36					



Plenum version and other conductor counts/diameters available by special order.

DCR = DC Resistance • SM = Single-mode • TC = Tinned Copper

For Connector Cross Reference, visit www.belden.com or call Customer Service 1-800-BELDEN-1. For A/V cable assemblies, visit the Belden Web site for a list of Belden Certified Asssemblers.

Belden

BRILLIANCE®

Brilliance® Precision Digital Video Coaxial Cables 3 GHz Sweep Tested for Return Loss

Maximum Transmission Distance at Serial Digital Data Rates

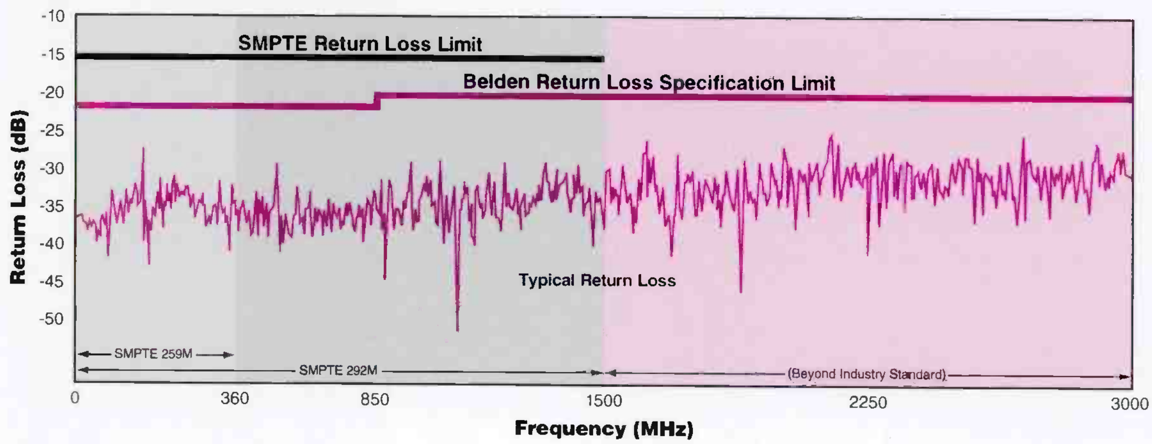
Data Rate:	143 Mb/s		177 Mb/s		270 Mb/s		360 Mb/s		540 Mb/s		1.5 Gb/s	
Spec:	SMPTE 259M		ITU-R BT. 601		SMPTE 259M		SMPTE 259M		SMPTE 344M		SMPTE 292M	
Application:	Composite NTSC		Composite PAL		Component Video		Component Widescreen		Component Widescreen		HDTV	
Part No.	Ft.	m	Ft.	m	Ft.	m	Ft.	m	Ft.	m	Ft.	m
179DT	504	154	457	139	384	117	242	74	196	60	110	34
1865A	810	247	760	232	600	183	520	158	420	128	170	52
8279	910	277	810	247	640	195	550	168	440	134	170	52
1855A–7787A	1000	305	910	277	750	229	650	198	530	162	210	64
9209	1030	314	930	283	750	229	650	198	540	165	200	61
9209A	1030	314	930	283	750	229	650	198	540	165	200	61
1505A–7794A	1430	436	1320	402	1110	338	960	293	790	241	300	91
1505F	1200	366	1071	326	857	261	732	223	588	179	225	69
1506A	1360	415	1200	366	940	286	810	247	670	204	270	82
9231	1430	436	1270	387	1000	305	850	259	680	207	260	79
9141	1430	436	1270	387	1000	305	850	259	680	207	260	79
8281	1430	436	1270	387	1000	305	860	262	700	213	260	79
8281B	1430	436	1270	387	1000	305	850	259	680	207	250	76
8281F	1250	381	1100	335	860	262	730	222	590	180	240	73
88281	1300	396	1150	351	910	277	770	235	600	183	200	61
1694A–7710A	1760	536	1620	494	1360	415	1180	360	970	296	370	113
1695A	1670	509	1520	463	1250	381	1080	329	880	268	310	94
7855A	2220	677	2000	610	1670	509	1460	445	1210	369	470	143
7731A	2730	832	2460	750	2000	610	1740	530	1430	436	540	165
7732A	2420	738	2140	652	1690	515	1440	439	1150	351	430	131

The serial digital interconnect standards are designed to operate where the signal loss at 1/2 the clock frequency does not exceed the approximate loss values listed below. The maximum length values shown are based on typical attenuation values for the cables listed and the following criteria:

Maximum length = 30 dB loss at 1/2 the clock frequency: SMPTE 259M, PAL, Widescreen.
Maximum length = 20 dB loss at 1/2 the clock frequency: SMPTE 292M.

The bit error rate (BER) can vary dramatically as the calculated distances are approached. BER is dependent on receiver design and the losses of the actual coax used. Distribution and routing equipment manufacturers should be contacted to verify their maximum recommended transmission.

Return Loss Headroom (1694A)



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FCC proposes unlicensed use of TV channels

BY HARRY C. MARTIN

The FCC has released a controversial Notice of Proposed Rulemaking (NPRM) that could open the door for the use of unlicensed devices on vacant TV channels in each market. Typically, an off-the-air TV at a given location can receive a picture on only a small fraction of the 68 possible channels. The FCC wants to make the unused channels in each area available to unlicensed transmitters.

An earlier proposal in this proceeding drew strong opposition from broadcasters who feared interference from unlicensed devices would cause adverse effects during the transition to digital TV. Other opponents to the current proposal include public safety entities that use two-way radio service in the TV bands. By contrast, wireless Internet providers strongly endorse the plan because it would make more spectrums available to them.

The FCC is proposing to address broadcasters' interference concerns differently for low-power "personal/portable" unlicensed devices, Wi-Fi laptop cards and home networks, and higher-power "fixed-access" equipment, such as that used for wireless Internet access links to fixed locations.

Personal/portable devices would have to receive and comply with a "control signal" that identifies vacant channels in the local area. The control signal could emanate from a DTV station, an analog TV station (in the vertical blanking interval), an FM station (in a subcarrier), a licensed wireless provider, or a fixed-access unlicensed device. It would have to update channel availability at least daily to allow for changes during the DTV transition. An unlicensed device unable to receive the control signal would not be permitted to transmit.

Personal/portable devices would have to receive and comply with a "control signal."

The NPRM invites comment on whether TV broadcasters might provide the control signal in return for payment from unlicensed device manufacturers or service providers. Because unlicensed devices must incorporate receivers to get the control signal from a DTV station, the station could provide pay services, such as sports and stock market information, to unlicensed users.

Fixed-access devices would be allowed 1W of power. Antenna gains over 6dBi would be permitted, but at reduced output power. These devices would have to protect TV operations by (1) identifying vacant channels using a built-in GPS receiver and database of occupied TV channels; or (2) requiring professional installation by someone who consults a database of occupied channels for that location; or (3) responding to an enhanced control signal that indicates channel availability in various parts of the service area. Fixed units would also have to transmit an ID signal.

Inflation increases forfeiture amounts

The FCC, acting pursuant to the Debt Collection Improvement Act of 1996, increased its maximum monetary forfeiture penalties to reflect inflation. The new levels for broadcasters are $32,500 per violation or per day of a continuing violation, with the amount for a continuing violation not to exceed $325,000. That's up from $27,500 per violation and a $275,000 cap for continuing violations. The new levels take effect 30 days after those levels are published in the Federal Register. Note that these changes affect only the maximum fines, not the base fines for various violations. Note also that there is legislation pending that would increase the maximum fines for indecency-related violations up to $275,000 per violation. Still, the maximum indecency fine approved by the Senate — $275,000 — is lower than the $500,000 already approved by the House, necessitating further Congressional action. BE

Dateline

Oct. 1 is the deadline for TV, LPTV and TV translator stations in Florida, Puerto Rico and the Virgin Islands to file their renewal applications, and for TV stations only, their ownership reports. Also on Oct. 1, TV stations in those locations must place their annual EEO public file reports in their public files and on their Web sites.

Oct. 1 is the date TV stations in Alabama and Georgia must begin broadcasting their pre-filing renewal announcements.

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

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

Bit-serial digital video distribution

BY MICHAEL ROBIN

The 4:2:2 bit-parallel digital signal is distributed using a shielded twisted 12-pair (balanced) cable of conventional design. The bits of the digital words that describe the video are transmitted in a parallel arrangement using 10 (eight for eight bits/sample) conductor pairs. An 11th (ninth for eight bits/sample) pair carries a parallel clock.

The 4:2:2 digital signal bit-parallel equipment interconnection is adequate for short distances and simple, point-to-point signal distribution patterns. It is inadequate for large teleproduction centers with complex signal distribution patterns where the high cost of multicore cables and the large size of multipin connectors come into play and bit-serial digital distribution is preferred.

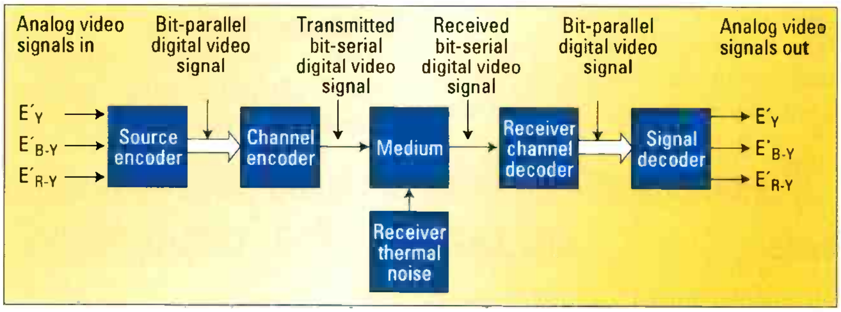


Figure 1. 4:2:2 bit-serial digital distribution model

The SDTV bit-serial distribution standard

The SDTV SMPTE standard 259M specifies the characteristics of the bit-serial interface for 525/60 and 625/50 digital equipment operating with either component digital signals or $4f_{SC}$ composite digital signals. It has applications in a television studio using 75Ω coaxial cable lengths not exceeding the amount specified by the equipment manufacturer. Typically, a 4:2:2 bit-serial digital signal loss of 30dB at the clock frequency at the receiver input is acceptable.

Figure 1 shows a block diagram of a 4:2:2 component digital bit-serial distribution. The source encoder is the conventional set of three (E'_Y, E'_{B-Y}, E'_{R-Y}) A/D converters followed by a time division data multiplexer. The output of the multiplexer is a sequence of C_B, Y, C_R parallel 10-bit words. The channel encoder transforms the bit-parallel digital signal into a bit-serial digital signal suitable to transmission via the chosen medium (for example, 75Ω coaxial cable).

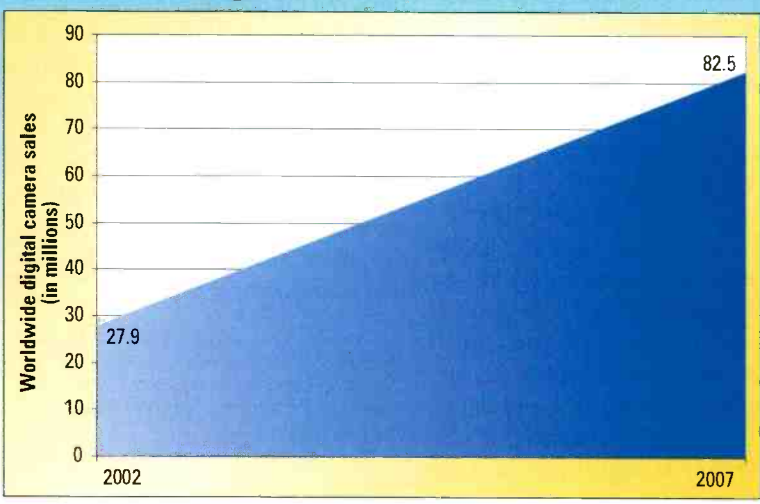
The signal is corrupted by thermal noise, which in a studio environment is contributed by the receiver input stage. The receiver channel decoder deserializes the received bit-serial signal and recovers the bit-parallel digital video signal. Poor signal-to-thermal-noise ratio at the receiver input may affect its capability to reconstruct the original signal, resulting in bits in errors or missing altogether.

The output of the receiver channel decoder is the original sequence of C_B, Y, C_R. The signal decoder is the conventional demultiplexer followed by a set of three D/A converters recovering the original analog component video signals (E'_Y, E'_{B-Y}, E'_{R-Y}).

FRAME GRAB A look at tomorrow's technology

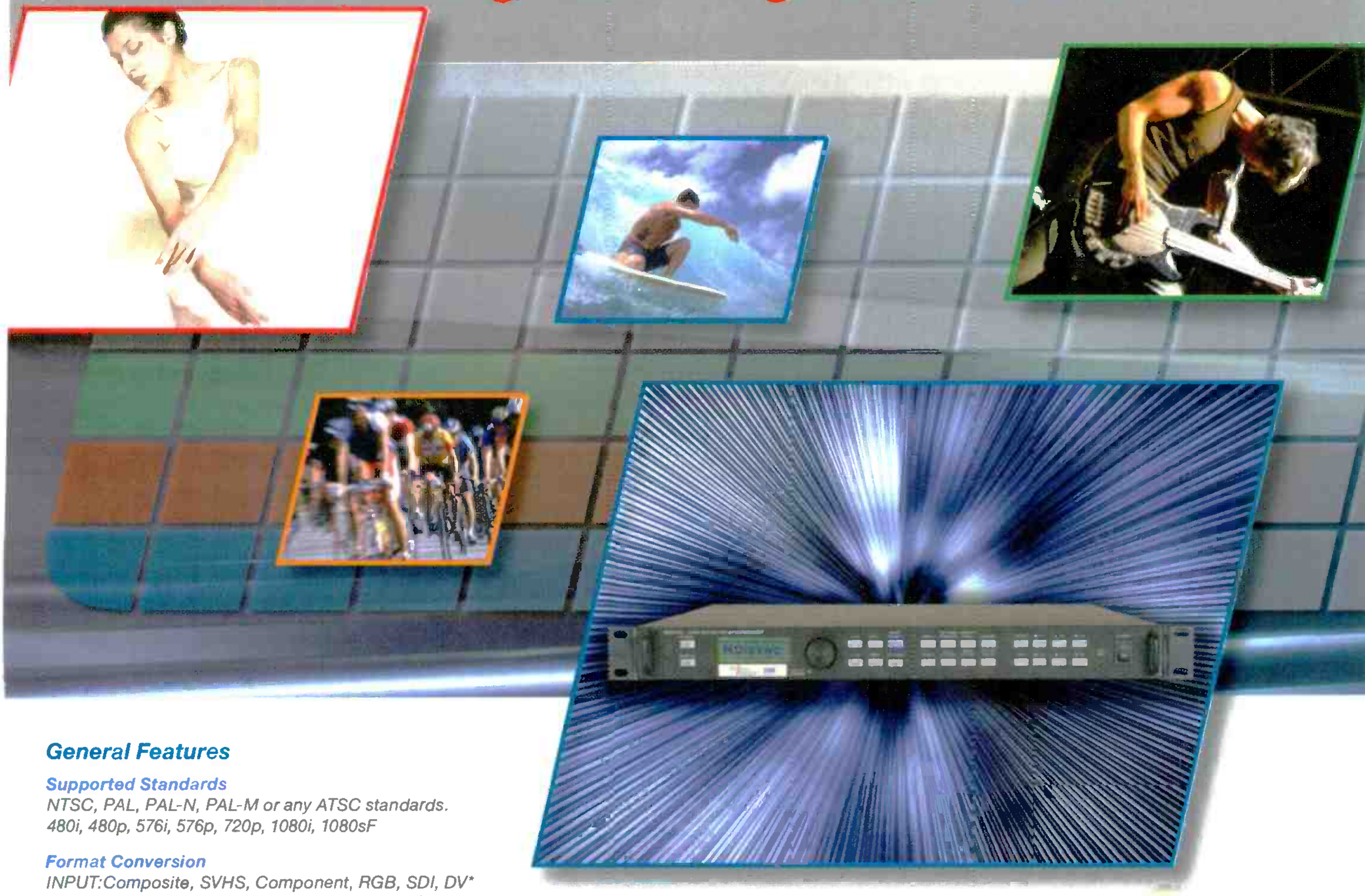
Digital cameras growing in popularity

82.5 million digital cameras will be sold in 2007



SOURCE: IDC estimates and projections *www.idc.com*

signal integration solution.



General Features

Supported Standards
NTSC, PAL, PAL-N, PAL-M or any ATSC standards.
480i, 480p, 576i, 576p, 720p, 1080i, 1080sF

Format Conversion
INPUT:Composite, SVHS, Component, RGB, SDI, DV*
to OUTPUT: Composite, SVHS, Component, RGB, SDI, DV*

Genlock
REFERENCE: Composite Black Burst, or HD tri-level sync.

Video Test Generator
SIGNALS: Various patterns + zone plate + size chart with circle.

Optional 4 Channel Audio Delay
SIGNALS: SDI–Embedded audio.; Analog Audio (balanced)
25 F Dsub (Industry standard pinout); AES (unbalanced)

Remote Control
SERIAL: RS232 / RS422 (SONY pinout)
NETWORK: 10/100 ETHERNET
GPIO: 2 Programmable BNC's for control inputs or outputs.

Miscellaneous Features

TBC/Sync, Auto freeze/trouble slide, Hot switch, Auto Proc adjust, Noise reduction, Color correction, Audio/Video test signal generator, VITS inserter, Audio embedder/de-embedder, animated logo inserter, User presets, 64 Meg user frame/logo storage, Upload/download stills through Ethernet to emulates still store with dissolve/clean cut. FLASH firmware/software upgradable.

1 RU x 17 inches x 17 inches case.
Power = 100 – 120/120 – 240 VAC 60/50 Hz Auto Switching

*DV (IEEE 1394) can be configured for input or output but not both simultaneously

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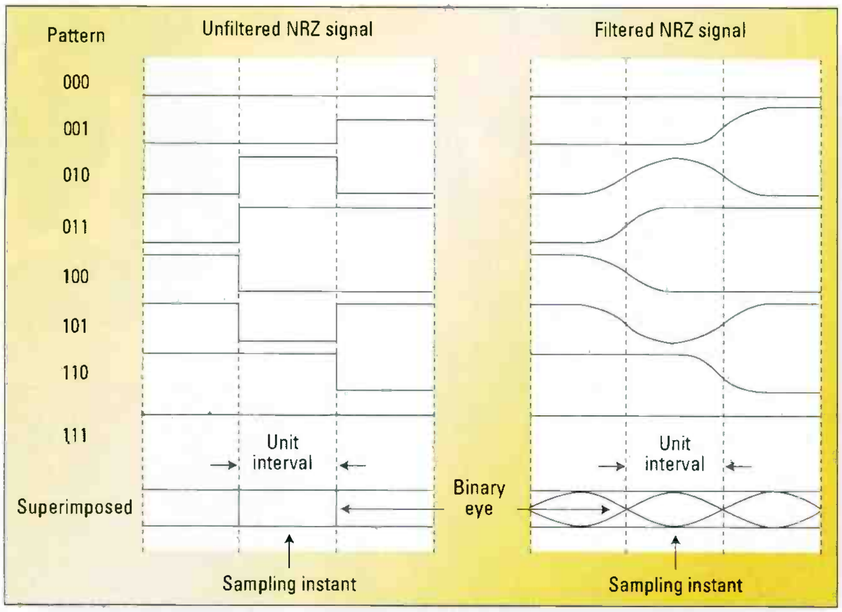

Figure 2. Formation of the eye pattern from superimposed binary patterns

The serializer (channel encoder)

The serializer converts the bit-parallel digital signal into an analog physical representation. The eye pattern (or eye diagram) is used in specifying and verifying the characteristics of a bit-serial digital signal. The name results from the appearance on a storage oscilloscope of sections of digital symbol patterns superimposed on one another.

Figure 2 shows the formation of an eye pattern from superimposed binary patterns. For an infinite-bandwidth system, the transitions from zero to one to zero are instantaneous and, consequently, the eye is rectangular. A practical system has a finite bandpass, resulting in transitions with a slower risetime and the familiar eye shape. Bit-serial signals are specified in terms of eye amplitude, risetime and decaytime, overshoot, and jitter.

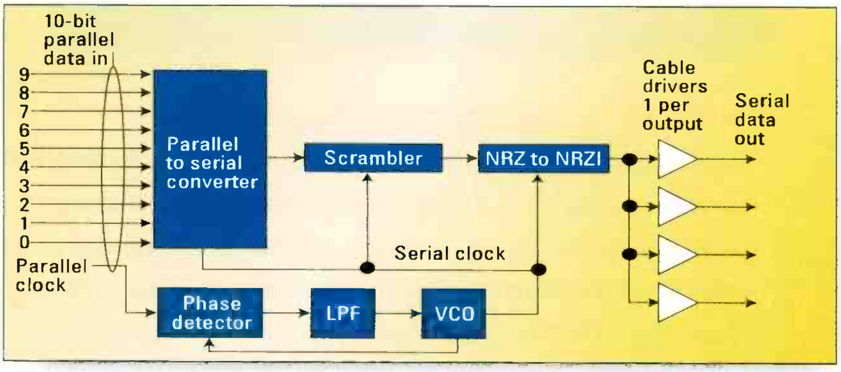

Figure 3. Block diagram of an SDTV 4:2:2 component digital serializer

Figure 3 shows the simplified block diagram of an SDTV 4:2:2 component digital serializer. It performs several functions implemented in dedicated ICs. These are:

- *Parallel-to-serial conversion.* This is performed by a 10-bit shift register that is clocked at 10 times the input rate.
- *Scrambling.* The scrambling randomizes long sequences of 0s and 1s as well as repetitive data patterns that could result in clock regeneration difficulties in the deserializer. It helps eliminate the DC content and provides sufficient signal transitions for reliable clock recovery in the deserializer.
- *Conversion from non-return-to-zero(NRZ) to non-return-to-zero-inverted (NRZI).* The scrambler can produce long runs of ones. These are converted to transitions by an NRZ-to-NRZI converter.
- *Serial clock generation.* The serial clock is generated using a voltage-controlled oscillator (VCO) operating at the bit-serial clock frequency (270MHz). Its frequency is derived from the parallel clock frequency (27MHz) and is controlled by a phase-locked loop (PLL) circuit. The derived VCO frequency control voltage is low-pass-filtered by an unspecified filter that determines the capture range and the hold range of the VCO and removes high frequencies from the control voltage. This allows the serial clock to follow low-frequency jitter or drift (wander) of the parallel clock as well as correct for a temperature-related drift of its own.
- *Cable driving.* Following the NRZI converter, there are 75Ω source impedance unbalanced active line drivers for each output, unlike baseband video, where multiple outputs can be split from a single active driver.

Figure 4 shows a typical eye diagram as displayed on a wideband oscilloscope. Table 1 on page 40 lists some interface specifications.

The deserializer (receiver channel decoder)

Figure 5 on page 40 shows a simplified block diagram of a 4:2:2

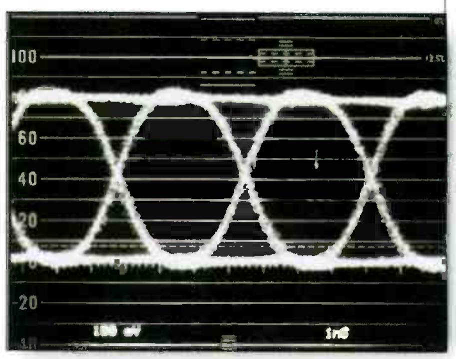

Figure 4. Oscilloscope display of an eye diagram

Parameter	Specification
Signal format	Unbalanced
Source impedance	75Ω nominal
Return loss	≥15dB (5MHz to 270MHz)
Signal amplitude	$800mV_{p-p}$ ±10%
DC offset	0.0V ±0.5V
Rise/fall time	0.4 to 1.5ns (20% to 80%)
Overshoot	<10% of signal amplitude
Jitter	Above 10Hz: 0.74ns p-p maximum

Table 1. Interface specifications

component digital deserializer. The system performs several functions implemented in dedicated ICs. These are:

• *Cable-loss equalization.* An automatic cable-loss equalizer for high-frequency (>8MHz) and low-frequency (<8MHz) losses introduced by the coaxial cable. The equalization capability is a manufacturer's choice.

• *NRZI-to-NRZ conversion.* This process is the reverse of the process taking place in the serializer.

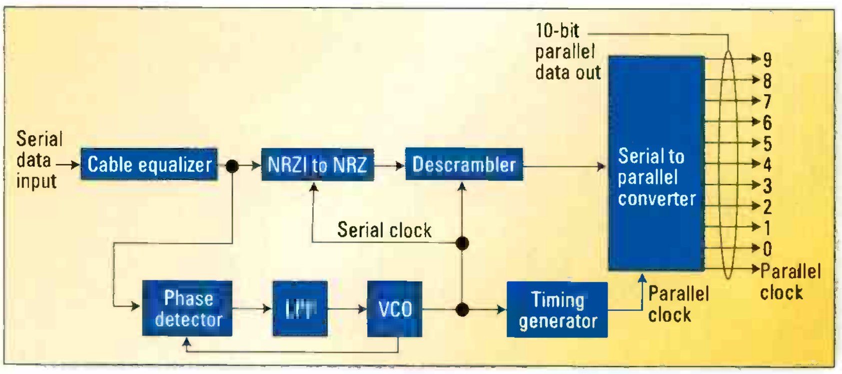

Figure 5. Block diagram of a 4:2:2 component digital deserializer

• *Descrambling.* This process is the reverse of the process taking place in the serializer resulting in the recovered data being identical to the original data.

• *Clock recovery.* The bit-serial digital signal is self-clocking. This means that it carries no specific clock. Rather, the clock is recovered by counting the zero-to-one-to-zero transitions in the signal. The clock recovery relies on the fact that the scrambled NRZI datastream contains a large number of transitions.

Current state-of-the-art technology relies on PLL concepts for locking the receiver data extraction circuitry to the incoming data. PLLs have a specific bandwidth determined by the low-pass filter at the output of the phase detector. The bandwidth should, ideally, be narrow to achieve a high level of noise immunity. Narrow-bandwidth PLLs have a correspondingly narrow pull-in (capture) range, requiring a highly stable crystal-controlled VCO to stop it from drifting beyond the PLL capture range. Noise immunity and capture range are conflicting requirements in the design of PLL circuitry. The current dominant technology relies on a PLL bandwidth of the order of 2MHz. This means that the VCO will follow incoming signal jitter frequency-domain components up to a limit of 2MHz. It also means that the VCO free-run frequency may drift up to a limit of 2MHz from the wanted frequency and the PLL will correct for this frequency drift. The regenerated serial clock feeds the NRZI-to-NRZ converter and the descrambler. It also feeds a timing generator that regenerates the 27MHz clock required by the serial-to-parallel converter.

• *Serial-to-parallel conversion.* The serial-to-parallel converter recovers the original parallel data for further processing.

• *Regeneration of a reclocked bit-serial signal.* This function, available with some designs, permits the regeneration of a high-quality noise-free bit-serial signal from the corrupted input signal. The low-frequency jitter of the input signal, inside the PLL bandwidth, will be carried through, but the high-frequency jitter will be eliminated.

Parameter	Specification
Signal format	Unbalanced
Input impedance	75Ω nominal
Return loss	≥15dB (5MHz to 270MHz)
Optional cable loss equalization	30dB at 270MHz

Table 2. Deserializer specifications

Table 2 lists some deserializer specifications. The bit-parallel digital signal interface has been superseded by the bit-serial digital signal interface, which is far more practical in large installations. The SDTV model, as described above, has served as a model for HDTV implementations with some application-related approaches. **BE**

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, Canada. He is co-author of Digital Television Fundamentals, *published by McGraw-Hill and translated into Chinese and Japanese.*

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michael_robin@primediabusiness.com

Network cabling and infrastructure

BY BRAD GILMER

To get the most out of your network infrastructure, pay attention to details — such as cabling. There are always areas in which a good engineer can economize, but buying cheap, non-rated network cabling or failing to install it properly can increase maintenance costs down the road.

Cable categories

Let's assume that your network is Ethernet. These networks invariably use unshielded, twisted-pair (UTP) cable. UTP cable manufacturers classify their products according to several categories and frequently label them CAT-3, CAT-5, CAT-6E and so on. As a facility engineer, you don't have to understand the subtleties of CAT ratings, but there are several things you should know. First, there is a difference between rated and nonrated cable. Rated cable has guaranteed performance characteristics that meet or exceed IEEE Ethernet specifications. This is important because Ethernet network interface cards (NICs) are designed to work within these specifications. If the cabling in your facility does not meet the required specifications, it may cause errors on the network. The wire's performance may be so bad that the link between two Ethernet devices fails entirely, even though an ohmmeter indicates the connection is good. Second, the CAT ratings generally describe the type of service for which you can use the cable, and the maximum frequency or data rate the cable can handle. For example, CAT-3 wire is typically used for telephone service. CAT-5 is appropriate for Ethernet and works in 10Base-T networks. CAT5-E (the E stands for extended) has been certified for use at data rates up to 1000Mb/s.

The wire's performance may be so bad that the link between two Ethernet devices fails entirely.

CAT-5 cable

A CAT-5 cable consists of four pairs of wires (eight wires total) twisted together in a specific way. The IEEE Ethernet specifications specify the twist direction (left-hand or right-hand), twist per inch and so on, so that the cable meets certain requirements for crosstalk, return loss, etc. If you think that crosstalk and return loss sound like parameters that apply to a transmission line, you are correct. Design engineers use transmission line models when designing their cables. As for the color of the wires, Standard 568 of the Electronic Industry Association/Telecommunications Industry Association (EIA/TIA) standardizes the colors of the wires in Ethernet cables. Each pair is color-coded; one wire in a pair is a solid color and the other is striped. For example, in one pair, one wire is solid blue while the other wire is blue/white. This helps greatly when assembling connectors or troubleshooting a wiring problem. Figure 1 shows how the EIA/TIA Standard 568 assigns specific pair colors.

Figure 1. EIA/TIA 568 assigns CAT-X cable colors in a standardized way. (Illustrations used with permission of Robert Kerr, NetSpec)

Cable connectors

CAT-X cables are invariably terminated in an RJ-45 connector (RJ stands for registered jack). The telecommunications industry has standardized several registered jacks. The two most common are the RJ-11 connector, which is used with telephones, and the RJ-45, which is used with Ethernet UTP cable.

Roll your own

You can easily make up your own RJ-45 cables. All you need are some connectors, a crimp tool, some patience and this article. As Figures 2 and 3 on page 44 illustrate, the EIA/TIA 568B RJ-45 wiring scheme standard specifies that pair two connects to pins one and two, pair three connects to pins three and six, pair one connects to pins four and five, and pair four connects to pins seven and eight. For the cable to work correctly, you must follow the specific colors in the illustrations. Be sure that the wires are all fully seated in the connector before crimping. Also, many connectors include a strain relief that crimps the jacket of the cable near the back of the connector.

Be sure that you trim the wires such that the strain relief engages the jacket.

Plenum, please

One option you have when considering different network cables is whether to buy plenum-rated cable. Plenum-rated cable is designed for use inside an air plenum (duct). It's unlikely that you'll run your computer cables though an air duct. But consider this. Most equipment racks in a post-production or television facility are cooled by forcing cool air into the bottom of the rack and exhausting it out the top. (You can do it the other way around, but you would be fighting the tendency of hot air to rise.) In the author's locality, the fire marshals consider the racks part of an air plenum system. Therefore, we must use plenum-rated cable. The author is not an expert on cable jackets but believes that plenum-rated cable is designed to be less toxic if the wires inside the jacket overheat and cause a fire. The most important thing project engineers need to know about plenum-rated cable is that it is expensive. In fact, plenum-rated cable can be more than double the price of non-plenum-rated cable.

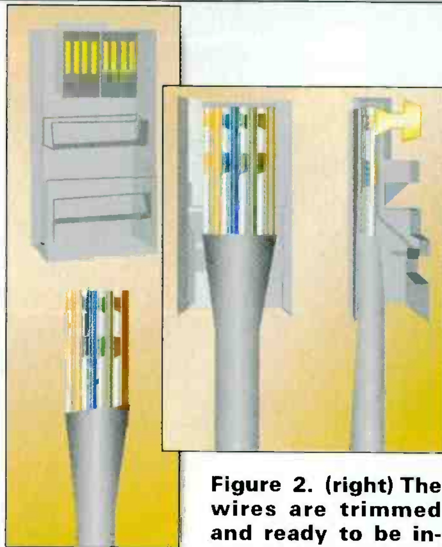


Figure 2. (right) The wires are trimmed and ready to be inserted in the RJ45 cable.
Figure 3. (left) Make sure that all wires are fully inserted into the RJ-45 connector before crimping.

CAT-rated jumpers

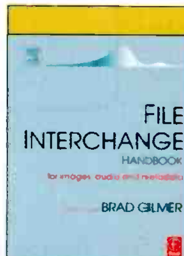
Frequently, installers run Ethernet cables from patch panels to computer equipment. They use patch cords to jumper between the patch panel and an Ethernet switch. This type of installation is flexible, and can give years of trouble-free service. But beware of non-CAT-rated jumpers. If you use the wrong cable for jumpers, you can run into all sorts of difficulties. For example, the author was involved with a facility where the installation team had used flat (nontwisted) ribbon cable for jumpers. Everything worked fine initially. But, after the installation was complete, some computers began to experience symptoms of network congestion. We spent a great deal of time trying to locate the source of congestion but, of course, we were unable to find a computer that was generating an inappropriate amount of network traffic. Ultimately, we discovered that several of the flat jumper cables were degrading the Ethernet signal to the point where the NIC cards were unable to function properly. We replaced all jumpers with CAT-5-certified cables and the problem went away.

Cable test sets

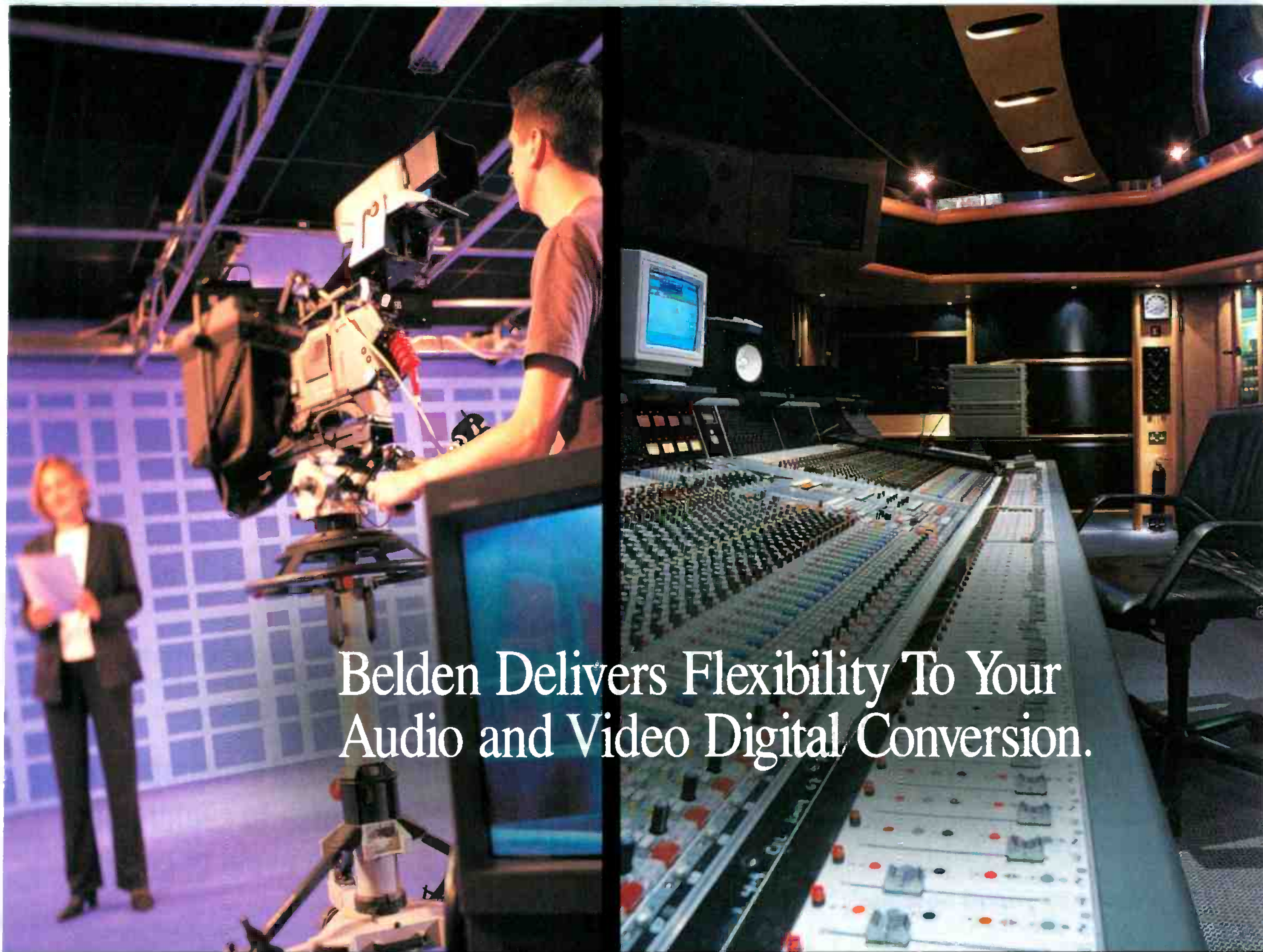
Finally, you should know that compact, full-featured LAN-cable test sets are available. If you are going to be doing LAN cabling on a regular basis, you should definitely purchase one of these. It can save you hours of troubleshooting time. BE

Brad Gilmer is president of Gilmer & Associates, executive director of the Advanced Authoring Format Association, executive director of the Video Services Forum, and editor in chief of the "File Interchange Handbook."

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



To order Brad Gilmer's book, "File Interchange Handbook for Images, Audio and Metadata," from Focal Press, visit www.focalpress.com or call 800-545-2522. The book is also available from most major booksellers.



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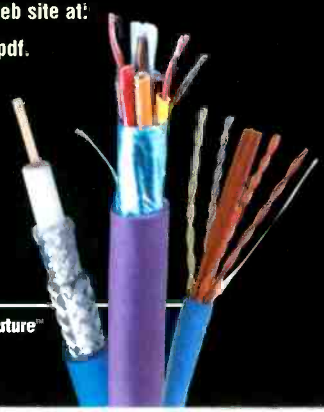

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Selecting microphones for noise suppression

BY EDDY B. BRIXEN

Having too much unwanted sound in a microphone can cause problems, such as reduced intelligibility, comb filtering and pumping effects from bad limiters. Broadcasters are hoping for an improvement to the ratio between wanted and unwanted sounds. The best solution to these problems is selecting a quality microphone and putting it in the right position. This article will address how to reduce the amount of unwanted sounds when using microphones in noisy environments.

Types of sound sources

Before selecting a microphone, it's important to define what type of sound source to capture and what type to avoid or control. Sound pressure level from a point source in the free field will double (+6db) each time the distance is halved. In a diffuse sound field, the level more or less remains constant. Also, close to a large-plane sound source, the sound field is rather constant. The primary rule when capturing the speaking voice (a point source) in noisy surroundings (large sources, many sources or diffuse sound field) is to reduce the microphone's distance to the mouth. The level of the voice increases as the background noise remains constant. This rule should be applied to all types of microphones. Bringing a miniature microphone from the chest to the corner of the mouth, for example by using a headband or the like, yields a gain of at least 10dB.

Before selecting a microphone it's important to define what type of sound source to capture and what type to avoid or control.

Pressure microphones

The pressure microphone (or omnis) has by definition an omnidirectional characteristic. The frequency response is not affected by the change of distance to the sound source (as with pressure-gradient microphones).

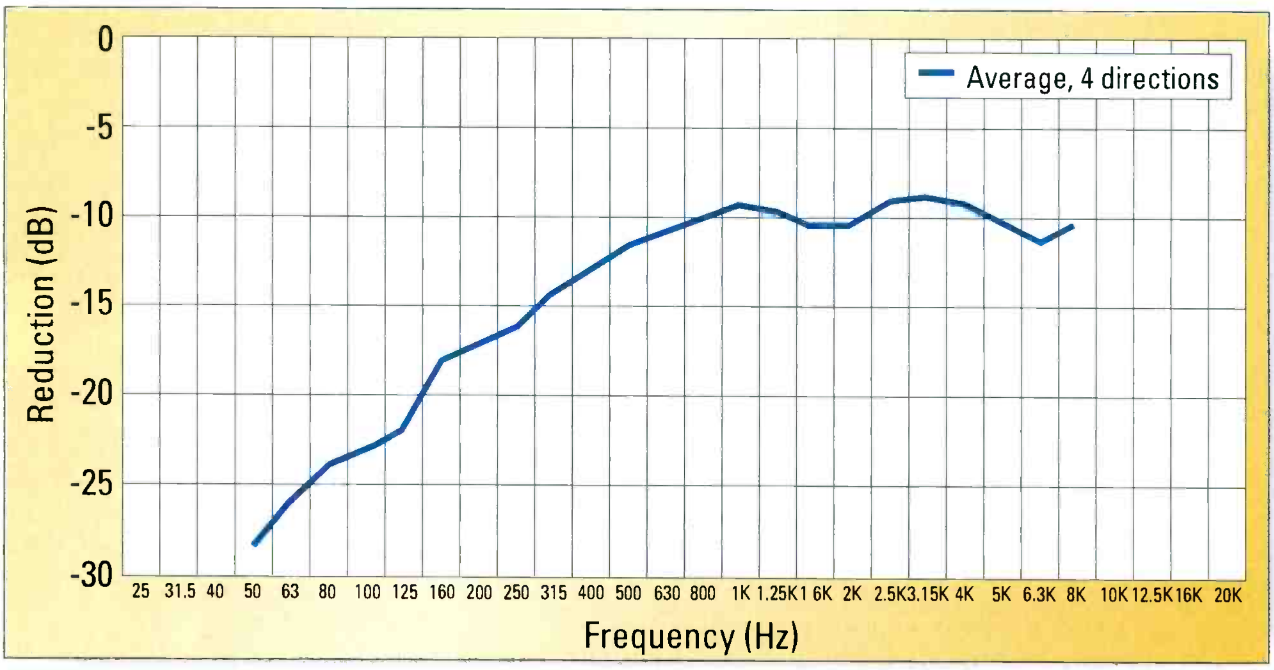
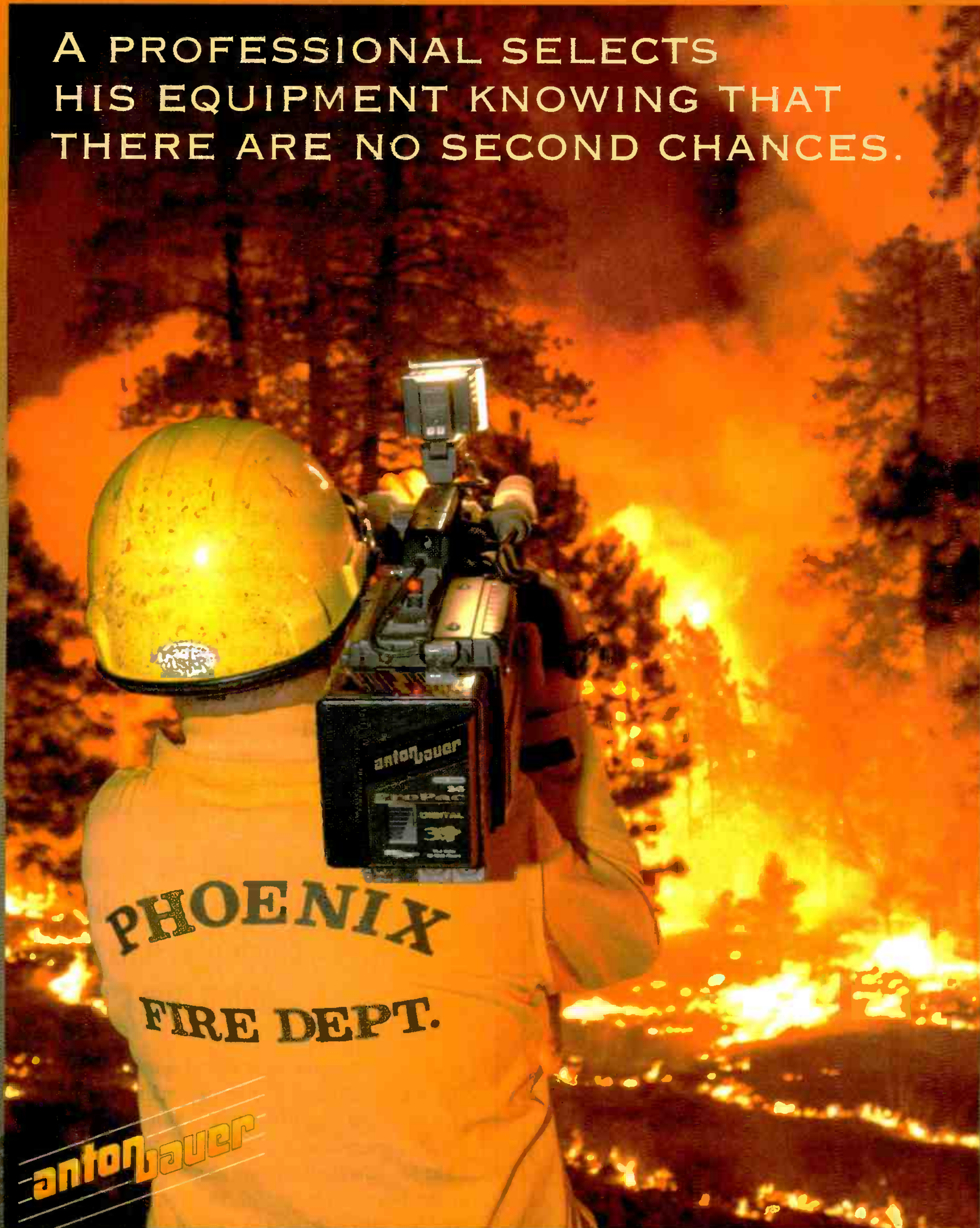


Figure 1. The suppression of distant sound sources obtained by using a cardioid headband microphone is shown in comparison with an omni-headband microphone. The curve represents the actual measurement of a 4088 (cardioid) compared to a 4066 (omni) from DPA Microphones. The voice would be at exactly the same level.



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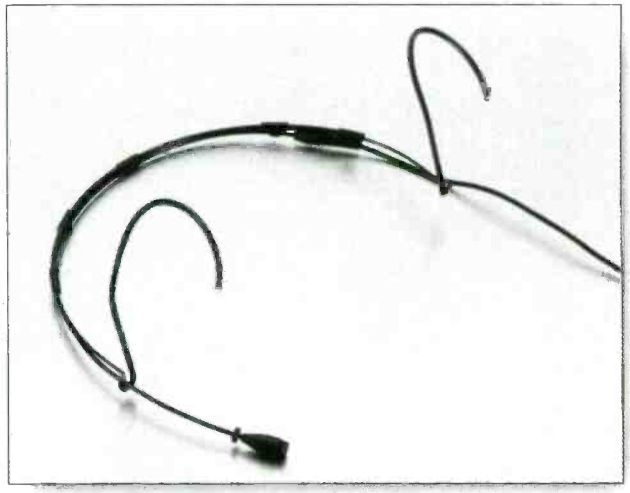


The 4066 (omni) from DPA Microphones is designed to handle sound pressure levels up to 144dB SPL before clipping occurs.

Hence, it is unproblematic to retain a constant timbre no matter the distance. On the other hand, it can be difficult to get rid of distant noise; only the law of distance works here.

The frequency response goes all the way down to dc if not compensated. However, in general, the pressure microphone is the least sensitive to wind/turbulence because the membrane is mounted in front of a small, airtight chamber, which to some extent controls the membrane.

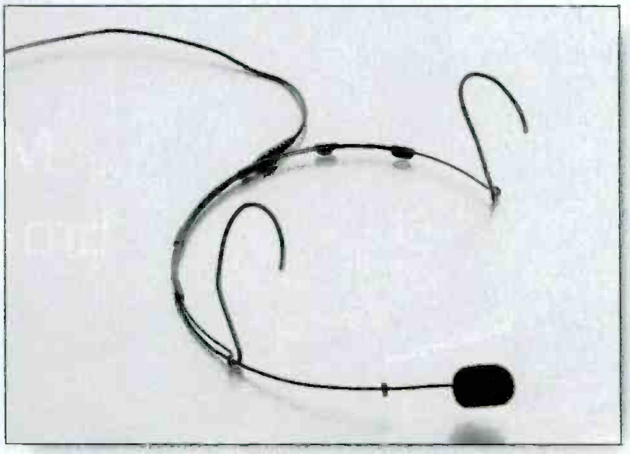
Pressure-gradient microphones

Pressure-gradient microphones (figure eight/cardioids) are sometimes called noise-canceling microphones. This is true if the wanted sound (a point source) is in the near field, and if the unwanted sound source is in the far field. The noise canceling is obtained mainly by the so-called proximity effect and only to a minor degree by the directional characteristic.

Concerning a low-frequency sound wave (meters long), there is not much pressure difference within two centimeters.

The sound wave has admission to both the front and back of the microphone membrane (or membranes if it is a double-capsule design). A typical distance between front and back is in the range of two centimeters. When a sound wave passes, it will reach the front side first and a little later the rear side of the membrane. The membrane will move (vibrate) if a pressure gradient is present, which means that the pressure is different on the two sides.

Concerning a low-frequency sound wave (meters long), there is not much pressure difference within two centimeters. The pressure gradient is low at low frequencies. The gradient increases with frequency as the wavelength



The 4088 (cardioid) from DPA Microphones is a miniature cardioid headband designed for acoustically demanding live performance environments, where background noise and feedback are concerns.

decreases. The "raw" frequency response of a pressure-gradient microphone is "thin," with only limited low-frequency content. This is to some degree compensated for in the design of the membrane in order to provide a proper frequency response. Now, if the sound source is close to the microphone — for example, a few centimeters — a pressure difference between the front and back will occur due to the law of distance. This difference, or gradient, exists at all frequencies. Nevertheless, it will only affect the lower end of the frequency range (typically <500Hz) due to the lack of gradient at low frequencies.

The result is low-frequency content from distant sound sources that is not gained as compared to a low-frequency content of close (<0.5 meter) sound sources. (See Figure 1 on page 46.) This is also why a vocal microphone for stage use sounds "thin" if used on distant sound sources.

In addition to this, the directional characteristic (off-axis) will help to keep unwanted sounds attenuated. By reducing the entry to the backside of the membrane, the directional pattern may change to a cardioid type.

Interference tube (shotgun)

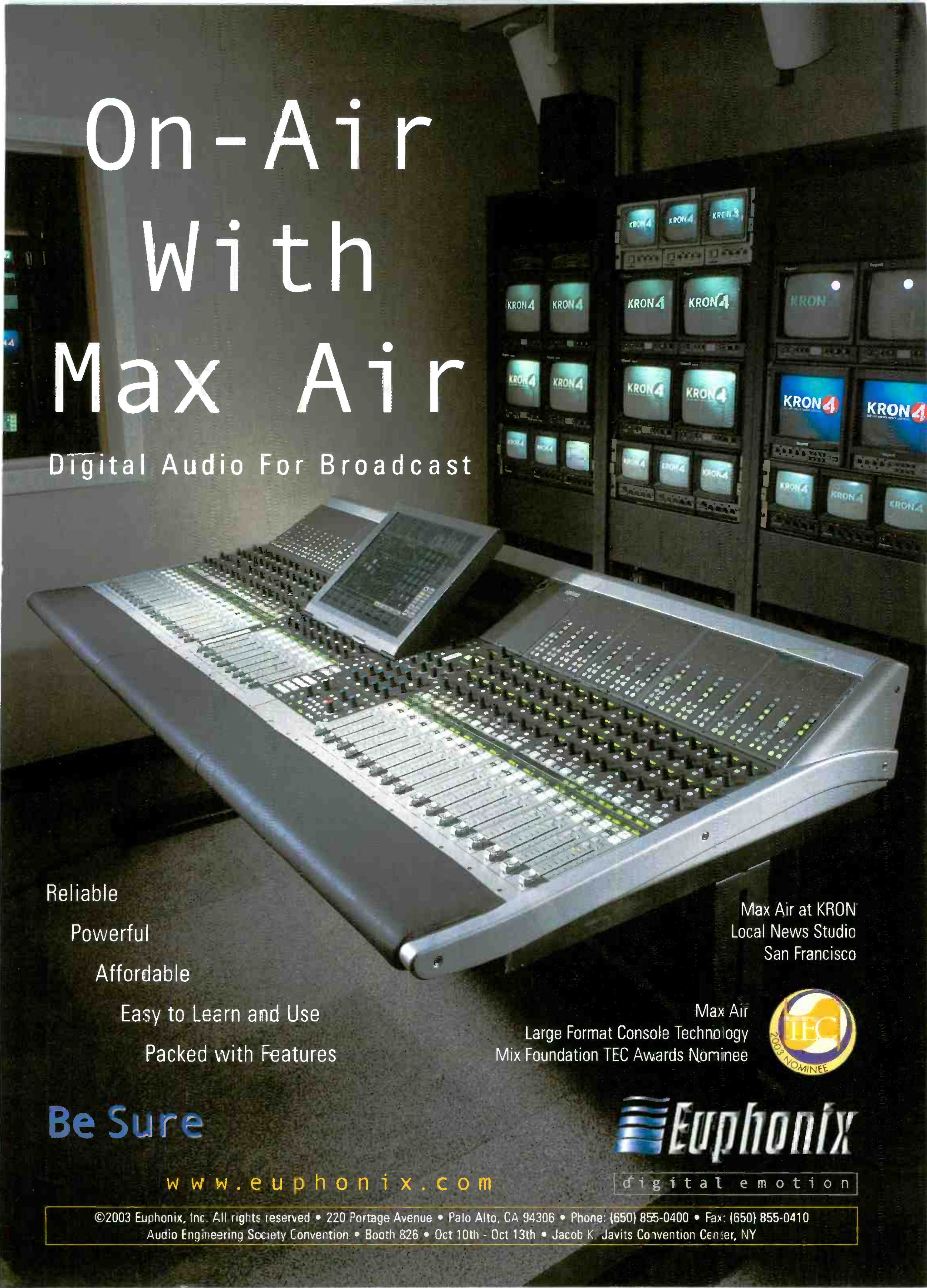
The shotgun is popular in sound recording for film, and it works fine for that purpose. At times, it may be used for stand-up or interviews in noisy surroundings. This is normally a misunderstood usage, as the off-axis response is poor, and it is difficult to get the sound source (the voice) close to the microphone element at the bottom of the tube.

Boundary layer

In the boundary layer (close to large reflecting surfaces), the direct sound is doubled (+6dB gain) whereas the diffuse sound field is only gained by 3dB. The relation of the direct-sound field to the diffuse-sound field is improved by 3dB. Putting the microphone in a corner will improve this further.

A dedicated boundary-layer microphone or any small microphone may be used in the boundary layer. **BE**

Eddy B. Brixen is an acoustic consultant for Danish Broadcasters.



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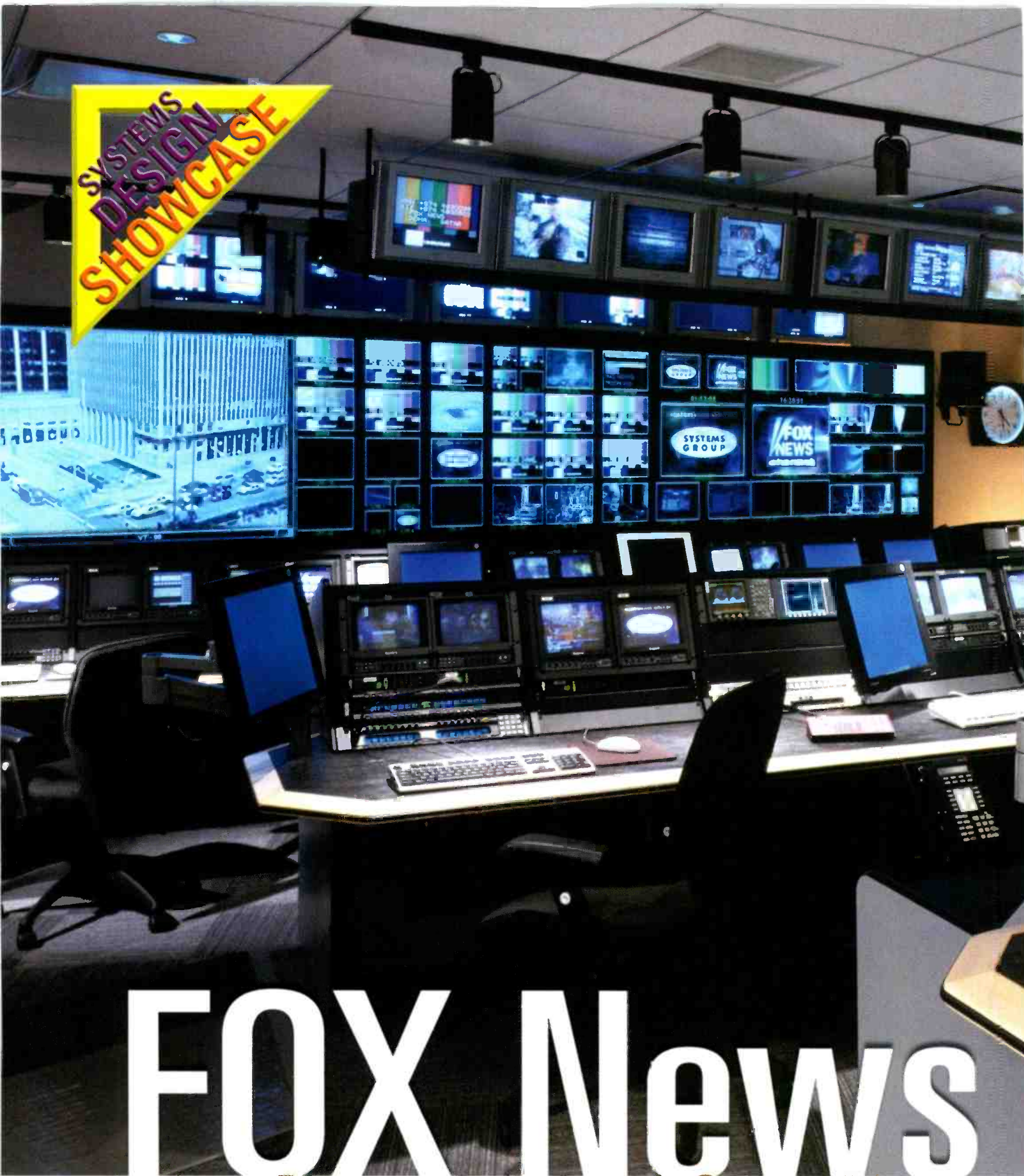
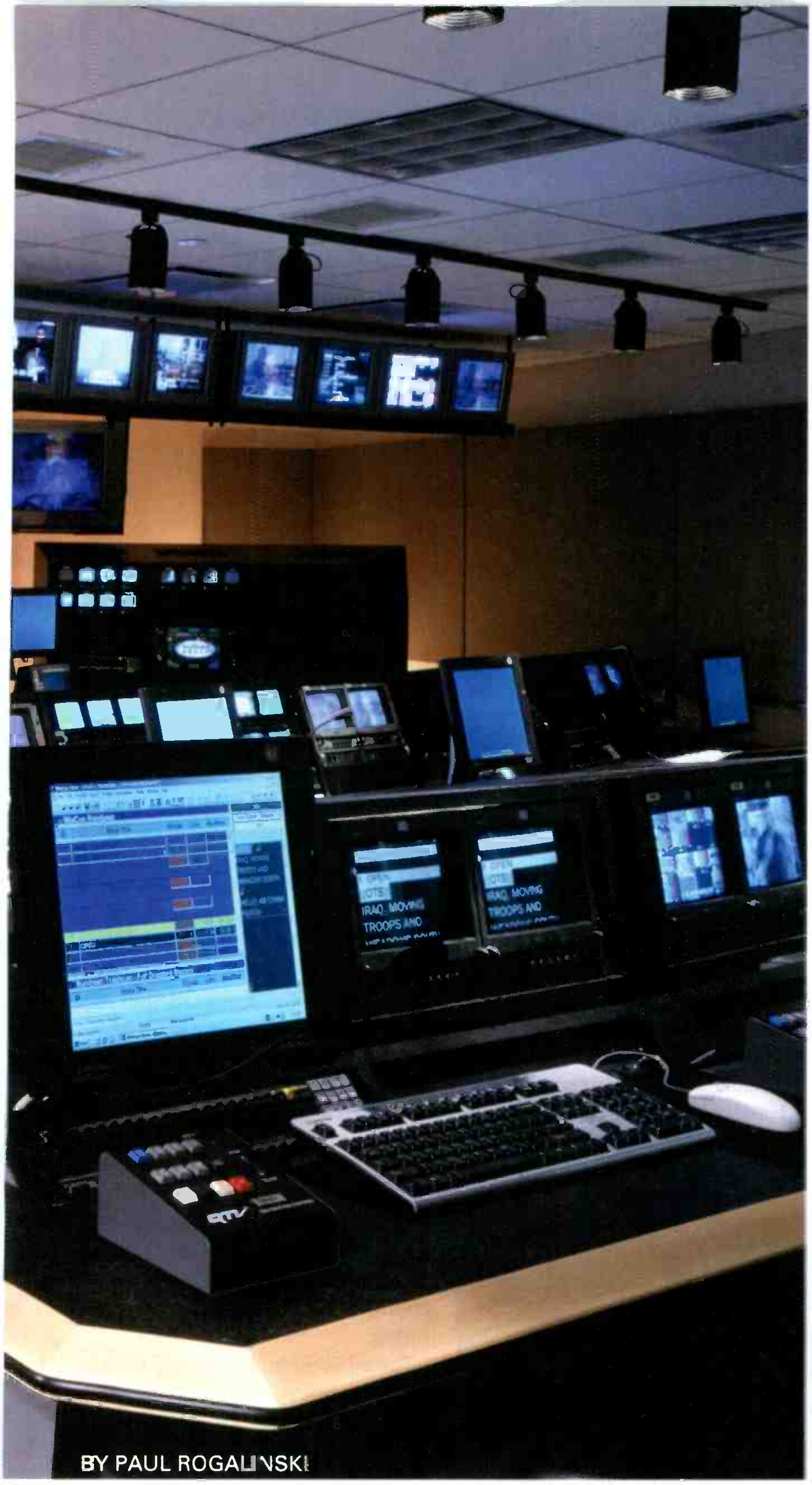


FOX News updates NY facility

FOX News realized recently that it was out of space. For more than six years, its broadcast center in midtown Manhattan was able to support the needs of the operation. But the growth of the FOX News channel since its launch in 1996 had stretched the capacity of the broadcast operations center to its limits. As the channel's daily programming demands continued to swell, it became clear to the en-



BY PAUL ROGALINSKI

A high level of monitoring is employed in FOX's production control room. Clarity Lion 67-inch LCD monitors are used in the monitor wall, which is completely routable and reconfigurable.

gineering department that the broadcast facility was becoming the limiting factor to the capabilities sought by the production department. With all three studios full and more new shows on the way, an expanded facility core and an additional studio cluster were necessary.

Then, a street-level space right in FOX's own building, located in a high-traffic area on 47th Street, became vacant. The channel determined that the new space provided the best location for an advanced production facility, including a studio that could support a variety of programming. Spectacular 25-foot ceilings and glass on two sides of the building provided an opportunity for the live NYC backdrop the producers sought. Unfortunately, the space also came with enormous structural and logistical concerns that had to be tackled, including the need to bridge the long distance back to the existing technical core.

Project team

With a six-month launch target, the channel needed a project team that could move quickly. Architects from HLW provided space planning, structural analysis and interior design, while Arthur Metzler & Associates (AMA) assessed the expansion of the electrical and mechanical infrastructure required in the new space. The Systems Group (TSG) of Hoboken, NJ, was chosen as integrator for the broadcast systems. The facility's director of engineering, led the design team in technology directives, operational needs and plant integration.

The design concepts incorporated into the production environment marked a new direction in operational design for the channel. Previous designs and integration had been based on traditional network news models. The new control room required flexibility to support a range of production requirements.

The control room design included a three-tiered environment with preferred sight lines from all viewing locations. The team selected TBC Consoles to provide production consoles and cabinetry to meet the room's equipment requirements. The control room needed a large number of LCD displays mounted on movable arms to maintain critical sight lines to the monitor wall. The ability to customize specific console sections was a key benefit in providing the technical director with control of the switching, monitoring and processing required for live news production.

The team selected a Thomson Grass Valley XtenDD 4M/E production switcher, an Accom Dveous DVE and Quantel's Picturebox still store. Operator positions were supplied with a standard pod of Telex communications panels, routing control, phone systems and flat-panel PC monitors for access to show rundowns and networked office tools including e-mail.

The team undertook an extensive study to analyze the cost and benefits of using a traditional CRT-based system versus the emerging multiviewer technologies. To achieve flexibility early on, the production control room was designed around a multiviewer processor driving a rear-projection display monitor wall controlled by serial tallies from the production switcher, as well as router-driven dynamic tally and source IDs. This allows the TD to change monitoring configurations through snapshot recall between and during shows.

The main monitor wall comprises four Clarity Lion UX 67-inch rear-projection screens fed by four 32-input Miranda Kaleido-K2 multi-image processors. A TSL USC-21 system controller coordinates and tracks the

FOX's audio control room overlooks the production control room. The new audio room is designed around a Calrec Sigma 100 digital audio console.

source identification, routing selections, switcher tally and audio level metering of the various sources assigned to the specific displayed images. A bank of six 24-inch LCD monitors mounted above the Clarity systems are fed through an analog monitoring router. Evertz Quattro quad-split imagers support the monitoring of 24 selectable remotes. A bank of traditional 12-inch CRTs, fed from the in-house cable system, were hung from the ceiling to provide an economical solution to traditional competition monitoring within the viewing angle of the second and third decks. Three additional 24-inch LCDs, fed by a mix of multi-imagers, were designed into the audio control room for main system monitoring.

The adjacent audio control suite is designed around a Calrec Sigma 100. This hybrid console uses snapshot recall to quickly reconfigure for specific productions.

An adjacent rack room located behind the main production monitor wall was built to support the Calrec processor frames and racks of communications equipment, as well as to provide a central point for all PCs required in the control room cluster. By using industrial rack-mount PC chas-

Design team

FOX News:
- Warren Vandeveer, vp operations and engineering
- Chris Bauer, dir. of engineering

HLW International:
- John Gering, partner in charge
- Phillip Fishel, project mgr.
- Steve Newbold, project architect
- Thornton Tomasetti, structural engineer

The Systems Group:
- Paul L. Rogalinski, senior project mgr.
- John Holt, sr.systems engineer
- Darwin Clermont, installation supervisor
- Steve Losquadro, lead technician

AMA Associates:
- Conrad Chang, project mgr.

sis and KVM extenders, virtually all fan noise was eliminated in the control rooms. This area also provided a connectivity-demarcation point for the control room.

A local technical support room accommodates 20 racks of broadcast and IT-systems equipment processing and interconnection, as well as the required technical power distribution, filtering and monitoring. The Studio 4 cluster is fully protected with a UPS backed up by a diesel-powered generator. This system was put to the test during the East Coast blackout last summer. The system kicked in appropriately, supporting seamless news reporting throughout the blackout.

Directly underneath this technical operations cluster, new studio production systems include seven Thomson Grass Valley LDK 200 digital cameras. Four of these are equipped with Canon E20X8BIE studio lenses mounted on Vinten Quattro four-stage studio pedestals with Radamec robotic heads. Three cameras are set up with Canon J21ax7.8 lenses, with a seventh camera supplied with a jib for audience shots.

Logistics planning and integration

The new studios are located two stories above the existing technical and production core and just over a breezeway that runs between the two buildings. Tying the studios into the existing network operations required extensive connectivity for communications, camera control, graphics, system reference and centralized routing. To complete the interconnections, a carefully planned design-and-build integration effort was required.

The installation schedule required that the cable pulls and terminations be in place before the facility documentation was completed. Using separate groups of technicians, the wiring began from five separate demarcation points. The wiring between the two buildings was installed in 12 four-inch conduits carrying more than 275 coax and 400 audio pairs. The plan allowed separate groups of technicians each to focus on a different set of cables, knowing that when they reached their demarcation point, another group technicians would be ready for the handoff.

FOX's street-level studio, with its backdrop of NYC streets, would have been impossible without the removal of an enormous column that supported the building.

Equipment list

Accom Dveous DVE
Quantel Picturebox SS
Miranda Kaleido K2
TSL USC-21 system controller
Clarity Lion UX 67-inch display
Calrec Sigma 100 audio mixer
Fujinon studio and ENG lenses
Radamec camerarRobotics
Canon E20X8BIE and J21AX7.8 lenses
Vinten Quattro four-stage studio pedestals
Evertz Quattro quad split imagers
Thomson Grass Valley LDK 200 cameras
XttenDD production switcher
QTV prompter
360 Systems DigiCart II
Telex communications panels

Centralized core facilities

In addition to expanding the crosspoints on the routing and communications systems, the addition of the fourth studio and its camera systems pushed the capacity of the existing video-shading area beyond its limit. To accommodate the expansion, a larger area was required. The team designed a new graphics area into the annex, freeing up valuable space in the technical core. Combining existing and expansion hardware, engineers were able to provide for current and future operational requirements. The team renovated the vacated graphics area to support not only a larger centralized camera area with better robotics and intelligent server controls, but also an expansion of the existing central equipment room and a new, larger area for master control.

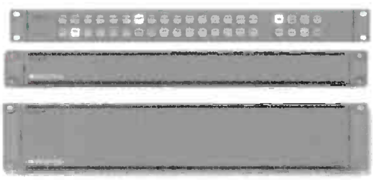
FOX News and TSG worked together to complete this addition in four weeks, and the entire project took only six months to complete. **BE**

Paul Rogalinski is the director of installation and a senior project manager for the Systems Group.

Ross Video Introduces 10 New Multi-Definition Synergy Switchers

OVERDRIVE PRODUCTION CONTROL SYSTEM

OverDrive is a powerful production control system that enables touch screen control over devices used in productions such as news, sports or live events. OverDrive integrates with the Synergy SD and MDX series of production switchers, leveraging powerful control interfaces over video servers, VTRs, DDRs, audio mixers, robotic cameras, routers, still stores and more.
www.rossvideo.com/overdrive/overdrive_overview.html



TALIA NK ROUTING

The NK Series is a new line of compact and cost effective routing switchers. NK routers are available in sizes of 16x16 or 32x32 and in a full range of signal formats including serial digital, analog video, AES/EBU, analog audio and data routing. NK ships with a powerful web browser based configuration system and is available immediately.
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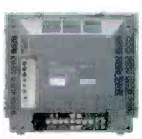
GEARLITE MD

GearLite MD is a line of Multi-Definition (High Definition & Standard Definition) products. These include the DAC-9213 Multi-Definition Digital to Analog Converter, the SRA-9201 Multi-Definition Reclocking DA, and the



SEA-9203 Multi-Definition Serial Equalizing Amplifier.

A -PVM version of the DAC-9213 is used specifically for Sony PVM/BVM monitors.

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Using the absolute latest technology, these switchers are full of standard features at a price point that puts a multi-definition switcher within reach of a typical mid-market customer.
www.rossvideo.com/synergy/switchers.html

SYSTEMS DESIGN SHOWCASE

Northern Virginia Community College goes tapeless

By Trenton J. Mengel

NVCC's new automated and tapeless control room increases the programming to 24 hours a day while reducing the labor to less than 20 hours a week.

Northern Virginia Community College (NVCC) served more than 300,000 students in credit and non-credit courses the 2001-2002 academic year. Its television center broadcasts over cable to Arlington, Fairfax, Loudoun and Prince William counties and the city of Alexandria.

The television center recently underwent a project to eliminate all tape formats. The primary goal of the project was to store video and audio data centrally in a 7TB RAID-5 system and to use a 2GB/s Fibre Channel to share data among computers. The secondary goal was to reduce the personnel needed to run the cable channel so they could be assigned to other duties. And, of course, the total expense of the project had to be kept to a minimum. The project was carried out in five phases.

The new master control room was an old broadcast studio that had not been used for years.

At the heart of the completely tapeless system is a TiltRac hybrid server system, which uses DVD-RAM for archive. The server will act as network-area storage until the new 8TB storage-area network is installed.

Phase 1, June 2000: Master control

The new master control room was an old broadcast studio that had not been used for years, located next to the existing control room. The empty studio was a clean slate; it needed power, AC and raised flooring. The old equipment consisted of eight Sony VO-9600s controlled by a Matco-A control system.

The heart of the new control room is the TiltRac (now Synergy Broadcast) master control system. It includes a master control computer, an online server, two video encoders, a Web encoder and a digital archive unit (DAU) with DVD-RAM media. The online server can hold 100 hours of programming at 8MB/s and output eight independent video streams simultaneously. If the first selected output channel fails, the system can reconfigure itself to play a video file on another output channel, if there are other channels open.

Each of the two encoders has its own 60GB hard drive. The encoders are configured to record most shows at 6MB/s in MPEG-2 long-GOP 480p, but they can be set up to record an encoder level of 10MB/s. As mentioned earlier, the online server only holds 100 hours of video, but the station has over 1500 hours of video stored on DVD-RAMs. The DAU holds 500 9.4GB DVD-RAMs and has a maximum capacity of 4.7TB. But that capacity is possible only if each disc is filled to its capacity. To avoid dropped frames and other playback discontinuities, the data for each show must be recorded contiguously on the disc. Each side of a 9.4GB disc can hold 4.7GB. A typical hour-long encoded show uses about 2.5GB, and a half-hour show uses about 1.25GB. Thus, a one-hour show and a half-hour show (a total of about 3.75GB) can be stored on each side of a disc, leaving about 0.95GB per side (1.9GB

SYSTEMS DESIGN SHOWCASE

per disc) unusable. Another problem is that erasing old programs and re-using parts of a disc for new programs sometimes leaves only half of the total disc space usable. So, in practical terms, the capacity of the DAU is actually closer to 3TB.

Originally, all the IP data passed through a Netgear eight-port switch. But, the college installed a VoIP phone system and it needed a switch that was controllable. So it replaced the Netgear with a Cisco 3424. All the signals pass through a Sigma Matrix 32x32 audio-follow-video stereo router.

A Leitch DPS-575AV digital processing synchronizer provides auto level control and final adjustment of the video and audio signals at the cable headend. Also, it is configured to insert on line 19 odd, which has full field bars for test and level control for the entire cable system. In addition to the test signal, the station uses the keyer option on the synchronizer to insert the college's logo. The logo can be replaced with a school-closing lower-third as needed.

The audio production room handles all of the audio needs for the 53x31-foot studio, voice-over booth and Sony's ACID 3.0 audio workstation.

The old master control signal was run into one of the Sigma router's inputs so the college could run its programming while the shows were going through the encoding process. After most of the college's programming was encoded, the old master control system was turned off and the router input was converted to a PowerPoint trouble slide. After a semester of running the normal programming schedule, the college decided to increase the total programming to run 24 hours a day.

Phase 2, July 2002: Studio control

The studio control room equipment was as old as the master control equipment. Studio control was crammed into a 10x15-foot room, leaving little space to walk or sit. The plan was to divide the audio and video equipment into separate rooms and upgrade the entire plant to a tapeless format from 3/4-inch U-Matic. It would cost less than an upgrade to a digital tape format and would make the plant more efficient. If the file is already in the computer, why record it to tape, record it back into the edit server, perform the editing, then record it back out to tape for the final encode back into IP? It would be much easier just to send the file over the network to the computer station that needs it.

The college moved the video equipment into a 10x15-foot room next door and the audio mixer from its 6x8-foot room into the larger space where the video equipment used to be. The old audio room became a desperately needed voice-over booth. At the heart of these rooms is a Sierra Video Tahoe router. The Tahoe is configured to handle video separately from the audio through three router controllers, saving the cost of buying separate routers. The controllers for the router were placed in the audio room, the technical director's station and the engineering station. Only the engineering station can change both audio and video from the same controller.

To handle the video needs for the studio control room, another TiltRac encoder and a smaller online server were purchased. Because TiltRac made the equipment in the master control room, the files pass between the two rooms without any problems. The online server has half the storage of the master control system and can output only four video streams. The encoder is identical to the two in the master control room.

The audio side is mixed through an existing Mackie 24-8 and captured into the TiltRac encoder computer or a digital audio workstation (DAW). Then the DAW is used to create new audio beds using Sony's ACID, which are then sent to the NLE for insertion into the video clip. The video side uses an existing Echolab 6. The final output from the room is captured into the encoder. When the file is complete, it is sent over IP either to an NLE or to the master control online server for air or archive.

The old audio room became a desperately needed voice-over booth.

Phase 3, November 2002: NLE systems

The NLE systems were placed in the redundant master control room, which had not been used for more than five years. Paint and new carpet were the only things needed to prepare the edit room. Two Dell Precision

The production studio engineer position controls the video levels, encoders and client copy tape decks.

650s were purchased for NLE. The computers have dual 2.8GHz processors, 2GB RAM, 100GB RAID-5 storage and a DVD+R burner. Vegas with DVD authoring proved to work with the TiltRac MPEG-2 long-GOP 480p file format. Prior to the purchase of Vegas, the facility used Adobe Premiere.

All of the monitors for the technical director position are routable.

The system was used to convert the files to AVI, then back into MPEG-2 on the final render — a time-consuming process. The raw field video was recorded into the Laird DV drive, then dragged and dropped onto the NLE drives. When the final program was rendered, the file was transferred either onto the master control online server and archived in the DAU, or burned into a data or video DVD-ROM.

Phase 4, July 2003: Backup online systems and Web streaming

With the addition of a second master control computer and a second online master control server, unscheduled downtime is reduced to less than 15 seconds a year. This low downtime is possible because the redundant and primary systems simultaneously play the same file. When there is a problem with the primary system, an automatic router switch puts the backup system on-air. Web streaming is done through two servers: an off-site, third-party host and an intranet server that both output 300Kb/s Windows Media streams. All VOD telecourse files are located on the intranet servers to prevent unauthorized viewing. The students have to be on campus and sign onto the streaming page with their user name and password to access the files.

Nonlinear editing is done with two Dell Precision 650s and Sony's Vegas 4.0 with DVD authoring software.

SYSTEMS DESIGN SHOWCASE

Phase 5, May 2004: SAN

The broadcast center will use the TiltRac servers as network-area storage until the storage-area network (SAN) can be purchased. The SAN will add a lot more storage for online files (including Windows Media files) and production files. Figure 1 shows how the SAN will connect to the other station devices. All the files for the station are kept on the SAN's seven usable terabytes. The SAN also uses a 2GB/s fiber backbone to reduce data-transfer times dramatically. Transfer time over 10/100 Ethernet was reduced from 15 minutes to two minutes. Another plus is that, if a computer is connected to the Fibre Channel, the SAN behaves as a local drive for that computer — eliminating the need for data transfer. The SAN will be set up in a RAID-5 configuration and will serve as both long- and short-term storage for the television center's data. Reducing the digital archive's workload will allow it to be what it was designed to be: a true archive.

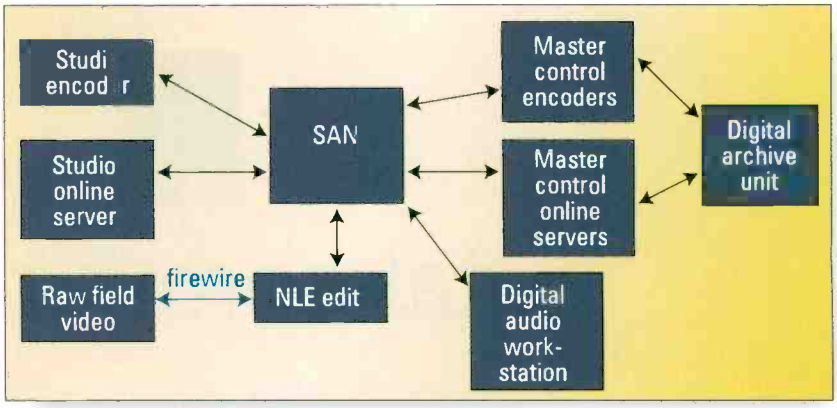

Figure 1. Flowchart of connections to SAN

Some snags

Finding an NLE system capable of handling the Synergy-encoded MPEG-2 long-GOP 480p file format was time-consuming. For the first year, a product simply was not available. Encoding all the video into the system was a time-consuming process, with each show taking 1-1/2 times as long to process. The SAN has a 2TB storage limitation. This is not a problem yet. But, with HD files or other large file formats, it could become an issue. Asset management is becoming a concern as well, with multiple

Design team

Installer:
Trenton Mengel, CE

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Toll Free: 800-800-5719 • Direct: 610-327-2292 • www.videotek.com copies of the same file, or revised copies of files, stored in multiple locations in the system. Another issue to be resolved had to do with the college's virus checking software. It slowed the data tranfer rate from 2GB/s to 100MB/s, and had to be turned off.

Benefits and costs of tapeless operation

Transferring files over IP, rather than tape, has improved the quality of the facility's product dramatically, as well as reducing the time it takes to finish a show. This has led to 24-hour programming. Before, when the station was off the air, it aired a PowerPoint slide. Now, the station runs a selection of programming and college promotional material. The new system has reduced maintenance cost and repair time greatly. The labor for master control has been reduced from 96 hours per week to less than 20 hours. The personnel that maintained and operated master control have been moved to other positions in the television center. Table 1 shows the approximate cost for each phase of conversion. The total cost of converting to a tapeless plant was about $500,000. BE

Master control conversion	$250,000
Studio control conversion	$100,000
Dell Precision 650s for NLE	$10,000
Web server	$10,000
SAN	$160,000
Total	$530,000

Table 1. Breakdown of costs for converting to a tapeless plant

Trenton J. Mengel is the chief engineer at NVCC's television center.

Equipment list

Master control room:
TiltRac
- Master control computers
- Online server computers
- 509GB RAID-5 storage
- Encoder computers
- Webcaster computer
- Digital archive unit

Digibox 1x16 RS-232 multiplier
Vela Quad decoders
Leitch DPS-575AV synchronizer
Panasonic
- External SCSI DVD-RAM drives
- BT-S915DA and BTM 1950 color monitors
- AJ-450 DVCPRO VTRs

Cisco 3424 Ethernet switch
Sigma
- SS-2100 DAs
- Matrix 32x32 audio-follow-video router
- TSG-470 test-signal generator

Viewcast Osprey-210 video-capture card
Black Box 16-port ServSwitch
Videotek VTM-300 multiformat on-screen monitor
Iris Video Commander 16x16 video stereo router
Sony BVU-900 U-Matic VTRs

Studio control room:
TiltRac online server/encoders
Lynx audio card for DAW
Panasonic AJ-230H VTRs
Videotek VTM-300 multiformat on-screen monitor
Echolab 6 video switcher
Black Box eight-port ServSwitch
Sierra Video Tahoe 32x32 video stereo router
Mackie 24-8 mixer

NLE room:
Dell Precision 650 dual-processor computers
Sony Vegas 4.0 NLE software

SAN:
Dual-controller 2GB/s Fibre Channel RAID

QScript & CNN

CNN™
THE WORLD'S NEWS LEADER

...concept

Autocue

...creation

QScript

...product

An Integrated Software Solution Case Study

A breakthrough in CNN production practices

Concept

In the fall of 2002, CNN International contacted Autocue to discuss their interest in a solution for their news production process that would eliminate paper scripts with a substitute electronic view. Such a solution would significantly reduce the high cost of supporting numerous laser printers (paper, toner, repairs and replacement). In addition, they could put a number of VJs (video journalists) back in the newsroom, rather than chasing paper from printers to production staff.

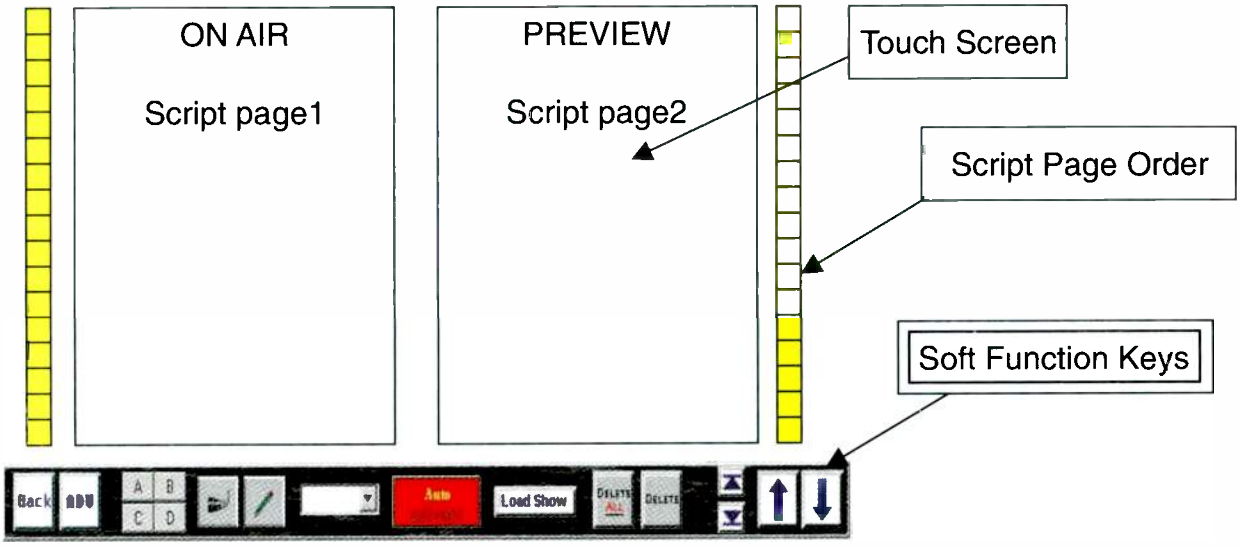
Autocue's unique set of products and newsroom expertise made a perfect fit. With its QSeries product line that included the QNews NRCS, automation capabilities, Unicode compliance, redundant server architecture and full integration with QTV's prompting systems, a large and stable code base offered a running start to the solution.

The early goals set out by CNNi and Autocue included:

- Mirror the iNews® rundown. Must continuously update with any changes including adds, deletes, updates, reorders and floats (similar to prompter interface or machine control integration with the rundown). Update speed is critical. Any changes made in iNews should be reflected as quickly as they are in the prompter interface.
- Display scripts on flat-panel touch screen monitors, minimum size 17", mounted on adjustable monitor arms to provide flexibility and preserve space in control room. Monitor arms should be adjustable by each operator, and should allow for viewing from two control room workspaces approximately 3 feet apart.
- Display at least two complete scripts at a time in two separate panels - an Air panel for displaying the current on-air script and a Preview panel for displaying the next script to go to air, or another script of the user's choosing.
- Allow user to activate Air or Preview panel by touching the panel on the screen or by pressing Air or Preview key on keypad. Through some visual indicator, it should be very clear to the user which panel is active at any time.
- Offer 2 modes:
    - Auto mode - This is the default. In Auto mode, when the user advances the Air script, the Preview script automatically advances along with it to the script that follows the new Air script.
    - Manual mode - If at any time the user manually changes the script in the Preview panel, he switches into Manual mode. The two panels are now independent of each other and will not advance together. The user can continue to advance the Air script while viewing scripts from any location in the rundown in Preview.
- If the user wants to go back to Auto mode, he can touch the Auto button on the screen. The Preview panel will then display the script that follows the current Air panel script, and the two panels will once again advance together.
- Allow user the following options for navigating through scripts:
    - Advance through scripts using arrow buttons on the touch screen
    - Advance through scripts using arrow keys on keypad

Design

Designs for QScript began to take shape quickly as the project got under full swing in January 2003. Early views looked like this:



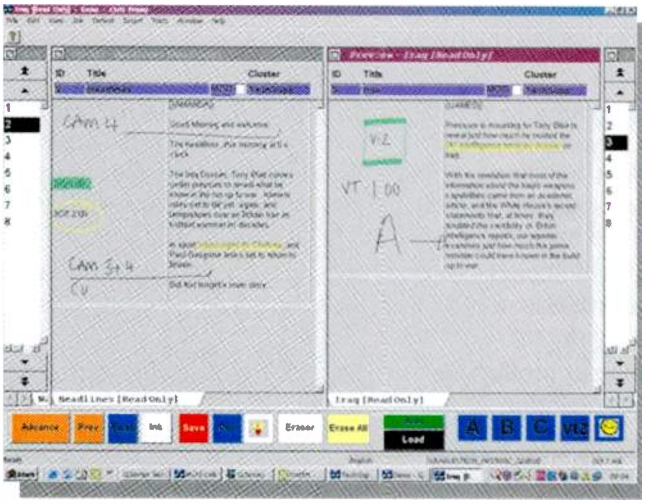
While QScript was conceived as a wireless production system, CNNi chose to physically connect the user workstations to the QScript network with a wired network connection. After several experiments, they choose to use flat touch screens that could be used either with a fingertip or a stylus.

Beginning in the spring of 2003, beta releases were used by CNNi off-air to find bugs, conduct load testing and to enhance functionality as hands-on experience was collected.

QScript On-Air

Ahead of schedule, CNNi went on-air with QScript in June of 2003. Under live conditions, CNNi directors observed some of the hidden benefits. Because directors could prepare for their shows earlier and because out-of-order scripts no longer congested the production process, much of the pressure and anxiety that accompanies producing a live newscast, dissipated. Control over this part of the production process was a stress reliever.

With some experience under their belts, Autocue and CNNi could push the envelope further by adding additional features such as 'personal inking', archiving and printing. This additional functionality allowed different groups of users to apply different sets of notations to the same script, provided a way to archive and subsequently retrieve the marked-up scripts and added the ability to print the scripts together with the notations.

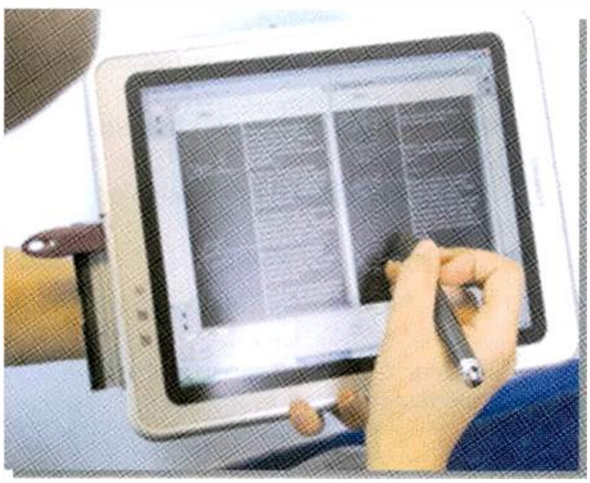


Final implementation of the main screen work area took this form.

The custom QScript layout displays two scripts at the same time - typically the current on-air script on the left-hand side and the next script on the right-hand side. The narrow bars on either side of the screen provide a quick way of navigating between scripts when in manual mode.

The director can make annotations (scribbles, highlights or stamps) on either script, with a choice of pen colors, widths and opacities. Once the annotations have been saved for a particular script, they will be displayed immediately on all other workstations viewing that script.

Across the bottom of the screen are easy-to-access buttons that help the director to navigate or annotate, quickly and easily. QScript is designed to be fast and simple to operate ... relieving complexity, not increasing it.



This view is of QScript while being used in a wireless mode. This allows the user to be freed from a fixed position to mark up and annotate their show. In a wireless implementation, QScript can easily be mounted on cameras in the studio making it easy for camera operators to see the scripts and anticipate camera cues.

The implementation of QScript at CNNi was a success and has resulted in CNN adopting QScript for all their facilities under a global license.

"We have simplified our entire production process," - Anne Woodward, Director of Technical Operations

"There are no more late or out of order scripts. Everything is right there at their fingertips," - John Davies, News Production Supervisor.

Whether by evolution or revolution, QScript has, after 20 years of NRCS development, finally achieved the goal of paperless news production.

For further information about QScript visit the Autocue website on www.autocue.com

Meeting SHVA
measurement requirements

BY DON MARKLEY

Many TV viewers choose to use satellite service to receive signals other than their local stations. Viewers who cannot receive their local stations' terrestrial broadcasts can request that the satellite service provider offer the main network signals. There are two sets of legislation that allow such viewers to request this service: the Satellite Home Viewer Act (SHVA) of 1988, 17 U.S.C. Section 119, and the Satellite Home Viewer Improvement Act (SHVIA) of 1999, PL 106-113. But, for the viewer, it's a confusing mess.

First, the viewer has to request network service. The satellite service provider then checks the viewer's zip code to see if a local station claims service to that area. That is where the first abuse of the system happens. Some stations claim service to zip codes where their signal could only be received on a tethered balloon. If a station claims service to the viewer in question, the satellite service provider may then request a waiver so it doesn't have to provide network service.

Some stations claim service to zip codes where their signal could only be received on a tethered balloon.

Here's the second abuse of the system. Naturally, the television station in question is reluctant to admit that there is any area it doesn't serve or to relinquish claim to a household as part of its viewership. While the legislation specifies the time allowed for the station to act on the waiver request, stations routinely drag out their denial for as long as possible in the hopes that the request will simply go away. If at all possible, a station will try to justify a denial of the waiver request.

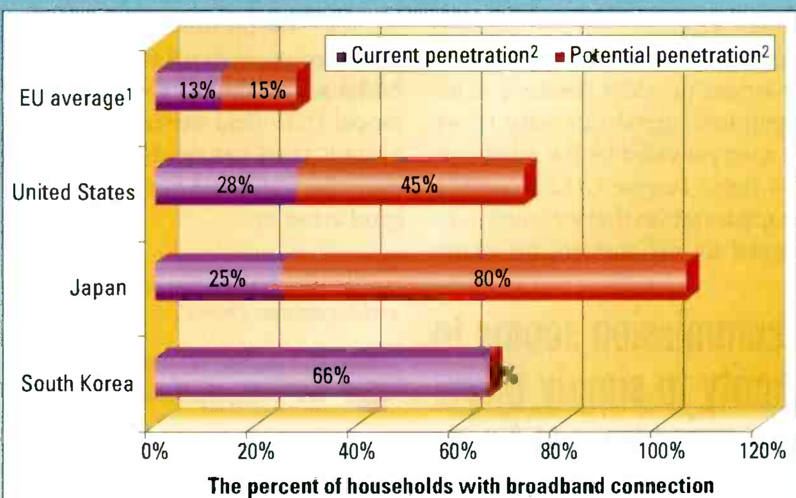
The first thing the station has to do is calculate the predicted field strength at the viewer's location. SHVA has defined rigid criteria using the Longley-Rice Propagation Model, Technote 101 and OET Bulletin 69 for this calculation. For a single location, the FCC states that stations must use the Individual Location Longley-Rice (ILLR) model. This is basically the same model applied to other broadcast-oriented calculations, with some small variations. For example, the ILLR calls for running the model in the individual mode instead of the broadcast mode. In addition, the station must consider terrain elevation every 0.1 kilometers, use a confidence-variability factor of 50 percent, ignore any error codes and consider the antenna height to be 20 feet above ground level (AGL) for single-story buildings or 30 feet AGL for buildings taller than one story. The Cable Services Action CS 99-1 contains this specification. OET 69 gives the elevations as six and nine meters. Section 73.686(d), for measurements as opposed to calculations, specifies the elevations as 6.1 and 9.1 meters.

FRAME GRAB

A look at the consumer side of DTV

Use of broadband connections is increasing

South Korea has highest number of broadband users



1- Penetration is significantly higher in certain EU member states - for example, Sweden at 23%, Belgium at 20%, Netherlands at 19%.
2- Current penetration based on estimated 2003 data; potential penetration assumes households are willing to spend up to 1% of income on broadband.

SOURCE: McKinsey & Company *www.mckinsey.com*

If any reader thinks that there is going to be some significant difference between 6 and 6.1 meters or between 9 and 9.1 meters AGL, he should seek a different field of endeavor. Yet, that is one of the complaints raised in Petitions to Deny the First Report and Order in this matter, ET Docket No. 00-11, 15 FCC Rcd 12118 of 2000. Again, this is an abuse of the system. That type of action is obviously an attempt to delay enforcement of the act for as long as possible. It is easy to pick on the commission's decisions because it often seems to do dumb things. But it's a pity the commission seems to have no authority to simply throw out nuisance petitions. Our good vice president would know what to tell them, but the commission can't use that type of language.

To predict the eligibility of the viewer to receive the satellite signal, the station must run the calculations using ILLR. At least one of the popular software services includes this ability in its program. While a station would naturally be hesitant to purchase all that software for one calculation, the station's consulting engineer should be empowered to do so. A big difference shows up at that point in the individual study. Normally, the station would perform the study only for a small area where the viewer is located. To do the study with points at 1/10 of a kilometer all the way out to the edge of service would cause the poor computer to slog away for hours for no good purpose. The predicted field-strength value is required only at the viewer's location — not everywhere in the service area.

If the station, based on ILLR, does not grant the waiver, the viewer can request field measurements. The satellite service provider then selects an independent signal-intensity tester from a list provided by the American Radio Relay League (ARRL) — the same organization that we hams have belonged to, off and on, for many years. It is considered to have the right people and the right technical skills to perform the measurements. Right. While some members are hams who could design and build excellent TV field-strength meters, others are truck-driver CBers who have upgraded to technician class to get away from the noise. In other words, the technical ability of these people varies greatly. The commission does touch on a rough technical requirement for field-strength meters in Section 73.686, but there are no real criteria to judge the accuracy of the meter, the ability of the operator or the calibration of the antenna, feed line and meter.

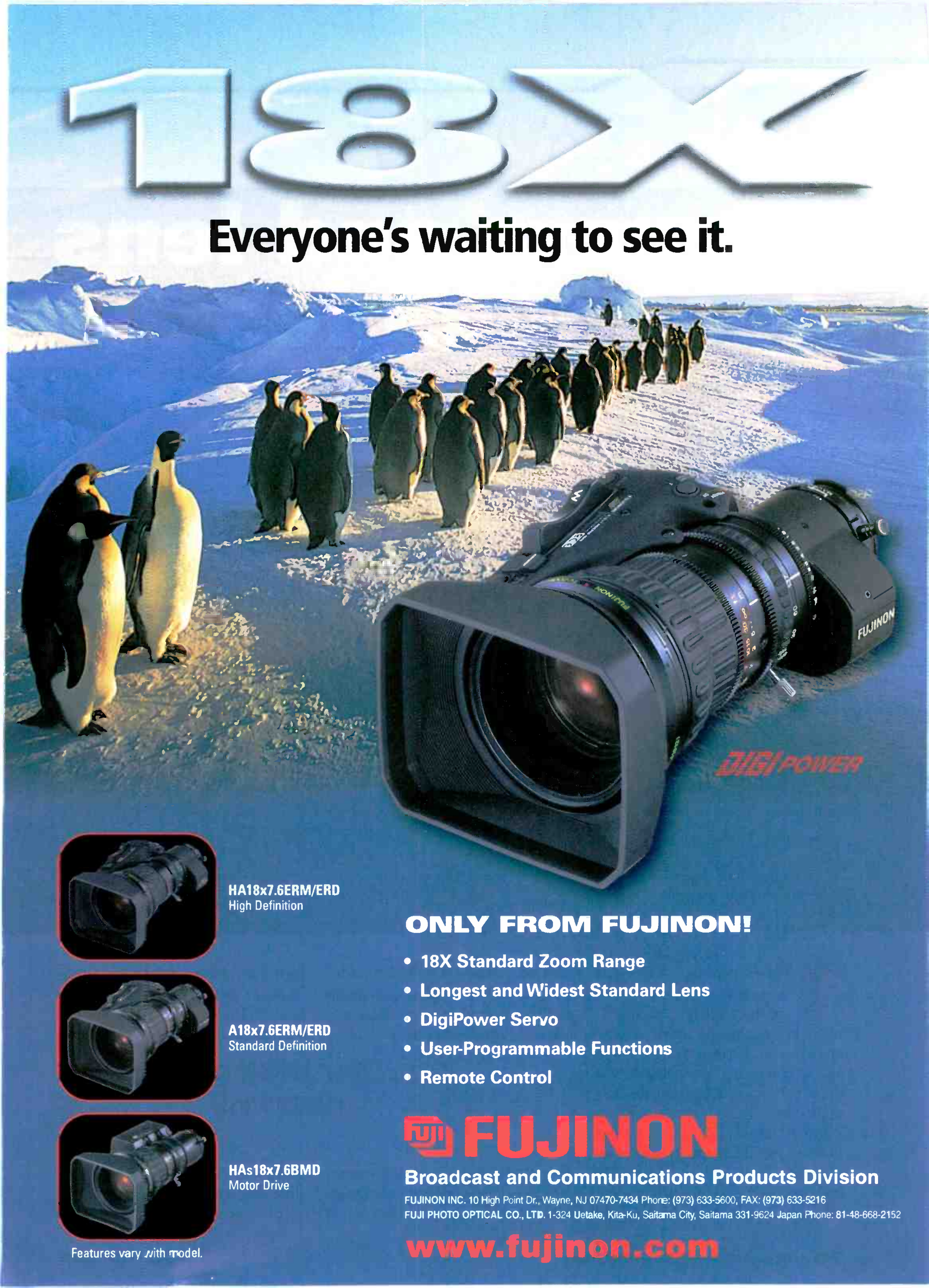
Stations sometimes must conduct field-strength measurements to verify coverage. This truck is operated by WRAL-TV, NC. Photo courtesy Potomac Instruments.

It's a pity the commission seems to have no authority to simply throw out nuisance petitions.

But that's enough complaining. If the measurements reveal that the viewer does not receive a signal sufficient for off-air viewing, the television station gets to pay for the measurement. It seems, to this humble author, that there's a lot of wiggle room here. For example, the cost of doing the measurement seems to be closely related to the experience and qualifications of the person doing the work. If a ham operator — using a meter of unknown brand from the last ham fest — does the work, the cost would probably be minimal. On the other hand, if an experienced professional engineer in the business does the work with the latest model UHF field meter, freshly calibrated, then get ready to face the equivalent of a few hours time for a good attorney. **BE**

Don Markley is president of D.L. Markley and Associates, Peoria, IL.

SEND Send questions and comments to: don_markley@primediabusiness.com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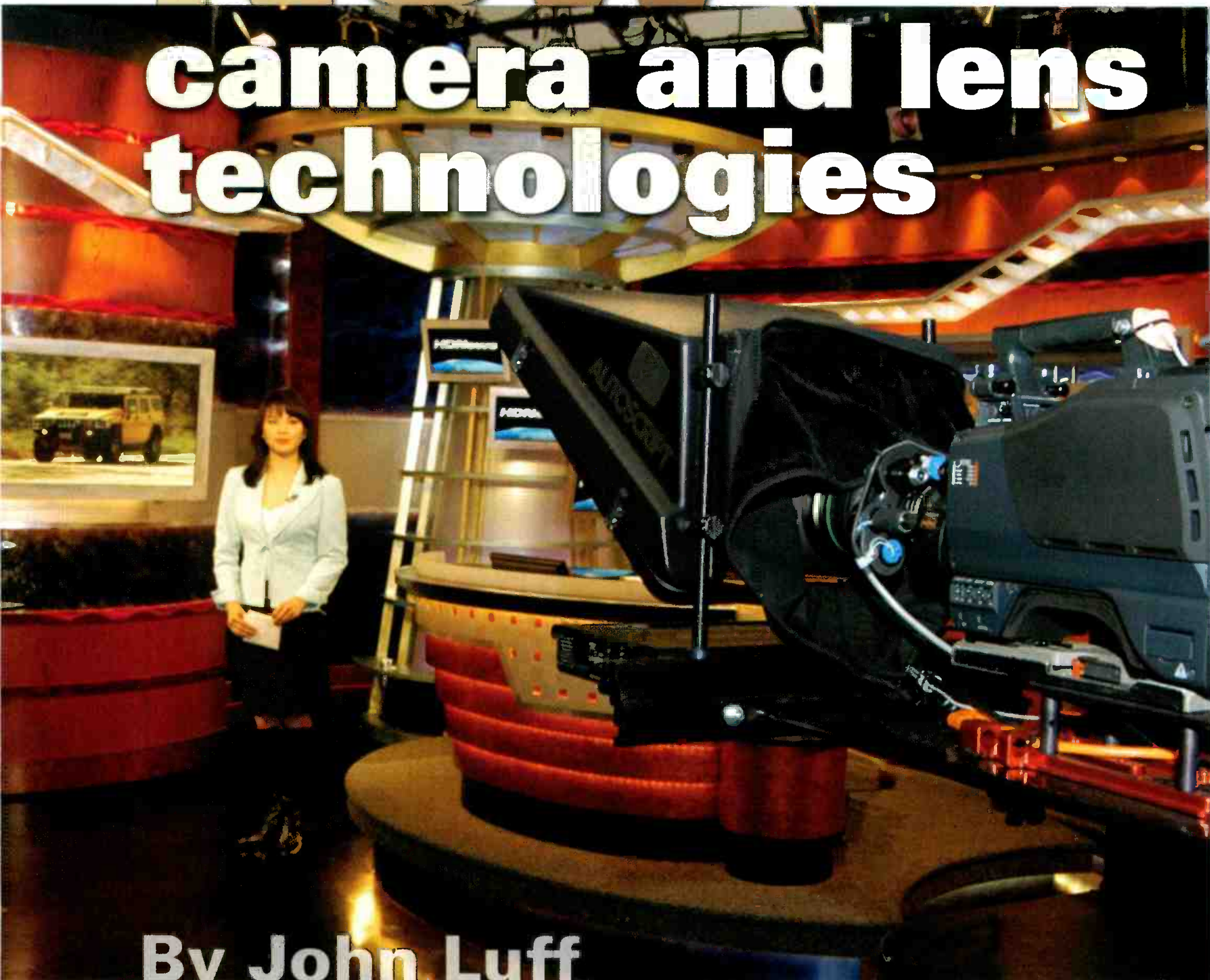
New camera and lens technologies



By John Luff

The modern digital television camera is an impressive piece of technology. In fact, it might be the ultimate analog-to-digital converter. It converts light-intensity variations into an analog electrical signal, and then converts that to a digital signal. Given the high bandwidth of the video signal and the fact that the digital conversion is three dimensional (one temporal dimension and two spatial dimensions), the digital video camera ranks high on the scale of commercially available converters. And the range of resolutions available in modern video cameras is huge, from Webcams to eight-megapixel electronic cinematography cameras and everything in between. Some scientific image sensors run at high frame rates; some hang on the back of telescopes and are cooled by liquid nitrogen to reduce noise and increase sensitivity. Of course, such devices don't serve broadcast television. But the research-and-development funding for such advanced

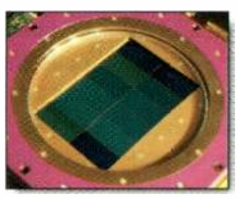
Image sensor technology has advanced tremendously since the days of tube cameras.

Today, high-definition, multiformat, multi-frame-rate cameras are the norm. Photo courtesy Panasonic.

third and fourth generations. At the same time, some research institutions have begun to define extremely high-definition television for the next generation of camera technology. A 12-megapixel image sensor might be the seed for research into real-time imaging at stunning quality levels. But remember that HDTV's native resolution is already adequate for most of today's consumer applications.

Imaging technologies

Image sensor technology has advanced tremendously since the days of tube cameras. Plumbicon, orthicon and other tube technologies served well in their day. But factors such as lifetime operating cost (capital and replacement cost), sensitivity, labor cost for constant adjustment, size, power consumption, weight, limiting resolution, and modulation transfer function have consigned tube cameras to the scrap heap of TV history. Early CCDs struggled to match the performance of modest plumbicon cameras, but CCD technology quickly advanced to eclipse tube technology and has become today's standard. The newest technology for image sensing is CMOS. These image sensors offer lower noise, higher sensitivity and other improvements. CMOS image sensors are showing up in consumer still cameras and in both consumer and professional video cameras. It is logical to expect that the research dollars invested in developing CMOS image sensors for consumer applications will drive it to higher levels of performance, challenging CCD's dominance in professional cameras.



High-resolution image sensors like this 12-megapixel CCD chip represent the upper limit in electronic imaging technology. Photo courtesy Canada France Hawaii Telescope.

sensor technology has over time trickled down to mainstream television applications, resulting in improved sensitivity and resolution, effective methods for managing defective pixels, and other important developments.

Image sensors designed for scientific and technical applications define the upper limits of electronic imaging technology. It is important to recognize that, though HDTV is just now beginning to impact consumer products, HDTV cameras are well into their

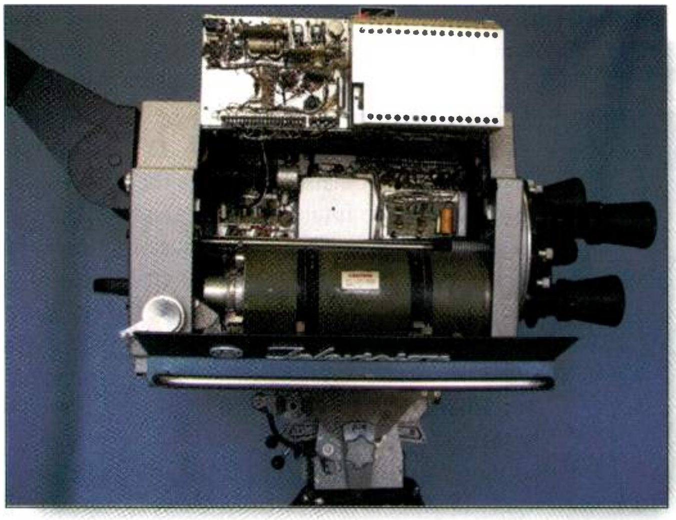
The ultimate criterion for imaging devices is the distance between display pixels. The human visual system can distinguish adjacent pixels only when the distance between them is at least one arc minute, depending on age and several other factors. One current HDTV format, 1920x1080 pixels, satisfies the limits of the human visual system's resolving power when viewed from approximately 3.3 times the picture height. (For NTSC, the corresponding viewing distance is about six times the picture height.) An image created with twice as much horizontal and vertical resolution, using square pixels, would either increase the allowable viewing distance or increase the picture's surface area by roughly four times. Such displays would not be very useful in most consumer environments, but could be attractive for virtual reality and other applications. They are aimed at futuristic markets or industrial applications. But the purpose of this article is to review real-time imaging systems.

The lens

It is also important to consider a television camera and its lens as a combined system. The camera and lens contribute equally to picture quality. For instance, buying an HDTV camera and using an older lens with a modulation transfer function that is not a good match to the performance of the camera's imager will yield inferior results, or at the least impaired performance. Larry Thorpe, former Sony executive and advocate for HDTV for nearly two decades, was recently asked — only slightly facetiously — if his current position with a lens manufacturer might lead him to view television cameras merely as a lens accessory. Indeed, some manufacturers have reduced the size of their high-quality television cameras until they are significantly smaller than the lens to which they are coupled. Modern HDTV system performance would not be possible without the incredible advances in lens performance over the last decade. But such performance does not come cheaply;

long-zoom-ratio HDTV lenses still cost between $150,000 and $200,000.

The combined camera-lens system affects many aspects of performance, including colorimetry. The combination of image-sensor sensitivity and the spectral bandpass of the optical system is additive. In general, lens manufacturers design their products to provide a flat spectral response to be compatible with any other manufacturer's cameras without modification. The only customization on the lens is its electronic interface to the camera. But, today, SD/HD-switchable cameras increasingly dominate the marketplace. So, when buying a lens, you must consider carefully whether the lens should have a ratio converter that will allow the taking angle of the lens/camera system to remain fixed in both 16:9 and 4:3 aspect-ratio imaging modes. If the lens is intended for use with a specific image sensor at 4:3 and the camera is switched into 16:9 mode, two effects can happen. The image becomes significantly narrower for a given focal length. And, if poorly adapted to the application, vignetting can occur, especially at wider focal lengths.



A glimpse inside this old RCATK-60 camera reveals a 4-1/2-inch orthicon tube image sensor (at bottom). Photo courtesy Pavek Museum of Broadcasting, MN.

For modern three-chip CCD or CMOS cameras, the mechanical alignment of the three color channels can be close to perfect. With tube cameras — even early HDTV cameras — chromatic aberration was not nearly as critical because it often was masked to a certain extent by the performance of the imaging tubes. To be equal partners in today's improved camera systems, lenses have had to improve along with the image sensors. Manufacturers of today's lenses have dramatically reduced the effects of design compromises that were significant in lens technology only a few years ago. In addition to reducing chromatic aberration, they also have reduced focus breathing. Focus breathing appears as zooming when users adjust the lens' front focus. All lens manufacturers have improved the performance of their products in large part to satisfy the changed characteristics of today's cameras.

Canon and Fujinon both have presented papers at technical conferences in the last several years to discuss improvements in lens technology as they apply to both television and electronic cinematography products (TV zoom and cinema prime lenses).

One recent paper described experimental technology to allow automated focus for HDTV camera systems. It uses advanced electronics in the lens system, including a second imager. The purpose of the imager in the lens is solely to sample the image and determine when the captured image is in sharpest focus, and then provide feedback to the focus servo to correct errors. This may become critically important in some future applications. HDTV applications suffer from an apparent reduced depth of focus, making it more difficult for camera operators to maintain optimal focus, especially when the lens is operating at wide aperture settings as in a night sporting event. An automated focus assist might provide a more pleasing result for the viewer.

Oversampling

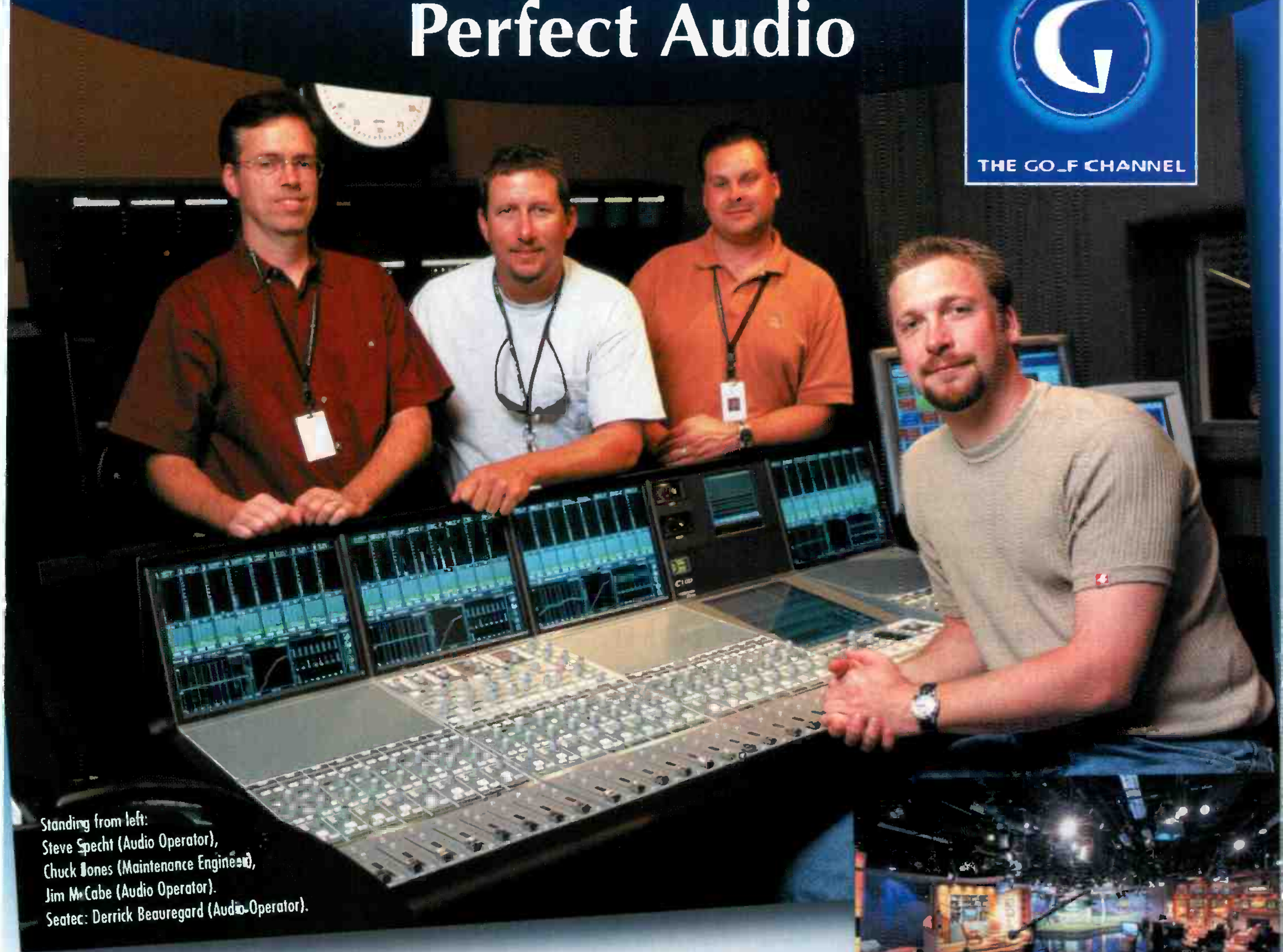
One important distinction between HD and SD cameras is the significant difference in cost and performance. Some manufacturers have begun to whittle away at the problem by designing image sensors that are inherently oversampled for all resolutions. Thomson Grass Valley employs this technique and has sold many HDTV cameras that are capable of native resolutions from SD through 2.4:1 aspect ratio HDTV for electronic cinema applications. This technique uses vertical oversampling while maintaining 1920 horizontal pixels. It permits a native 1080 horizontal resolution.

The lens is just as important as the camera. Photo courtesy Thomson Grass Valley.

And, by combining samples before processing the picture, it permits other horizontal resolutions, such as 1280 samples for 720p and 720 samples for 525/625.

Teeing Up For Perfect Audio

THE GOLF CHANNEL



Standing from left:
Steve Specht (Audio Operator),
Chuck Jones (Maintenance Engineer),
Jim McCabe (Audio Operator).
Seated: Derrick Beauregard (Audio Operator).

Performance shines as The Golf Channel chooses the SSL C100 Digital Broadcast Console

"It's the inherent design functionality that makes the SSL C100 the console of choice for The Golf Channel," states VP of Network Operations Andy Murphy. "The maximizing of console power in a compact space, while retaining the intuitive logic of one-knob-one-function control operation in a console with multiple layers is truly remarkable. Combine this engineering feat with SSL's great reputation for quality build, excellent service and great sound, and you have a product that is perfect for the live-to-tape and live-to-air programs we produce."

C100 delivers 'Next Generation' Digital Broadcast Features

- Secure operation with Self-Healing and Redundant features • Future-proof investment (surround capable for HDTV)
- Dedicated broadcast design that is simple and powerful • Network integration as standard
- Cost-effective, scalable design to fit a wide range of budgets

C100

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The same concept can apply in the vertical dimension, combining multiple vertical samples to achieve 1080-, 720-, 525- or 625-line outputs. This technique of oversampling in the vertical dimension is both clever and effective at achieving native resolution. A purist might argue that it is not truly native resolution because the samples are not sited in the precise locations that a native sample might be, but it's still a good approximation and yields good results. One argument put forward by other manufacturers is that such a technique comes with a sensitivity penalty. Other manufacturers are known to be working toward similar variable-aspect-ratio and variable-resolution image sensors and camera systems, so look for even more options.

Cost versus performance

Other factors also differentiate the wide variety of television cameras. The biggest factor is price. The differences between many current production cameras and high-end consumer cameras include marketing, the amount of metal in the case and the quality of the lens. High-end consumer cameras that use three image sensors can produce high-quality pictures indeed. Many producers of entertainment and documentary programs have put such lower-cost hardware in the hands of capable videographers and achieved stunning results. The cost secret is the hidden fact that the development of the consumer hardware is amortized across perhaps millions of delivered cameras, while the professional camera is sold at higher margins but delivered in quantities of hundreds or perhaps a few thousand. Usually, the biggest factor separating these cameras is the optics. A $4000 consumer camcorder cannot have a high-quality lens without raising the cost. But, put a $4000 lens on a high-end consumer camera and it will be clear (no pun in-

Sony's HDC-910 can capture 1080i 50/60 images and output them as 1080i 50/60, 480i 60 or 720p 60.

other direction. Initially, the only 24fps cameras on the market were high-end HDTV cameras. Then, Panasonic introduced a professional SD model for under $5000 that could record 24p images. Now, the same feature has shown up in consumer hardware, at an up-cost to the consumer, but little additional manufacturing cost. This kind of product differentiation is not unique in the broadcast business. Indeed, helical-scan VTRs existed in the professional domain before the consumer electronics industry in Japan brought us Betamax and VHS. Today, the same crossover of features and technologies is making products much more capable. For example, DVD camcorders arrived on the market soon after the cost of DVD burners for computer applications came down to a modest amount. V olume drives the manufacturing cost, and features sell the new application of the hardware.

Studio versus handheld

Two decades ago, the difference in image quality between a studio camera and a handheld was substantial. Handheld cameras were versions of their big-brother studio cameras. To cut size and weight, camera makers sought a practical package by eliminating everything unessential. It is not unreasonable to compare the picture quality of some early (and expensive) handheld professional cameras to the image from today's three-chip consumer camcorders. In fact, the current consumer products probably produce a superior picture. Interestingly, the difference in price between these two types of cameras may be about two to four orders of magnitude.

Put a $4000 lens on a high-end consumer camera and the results are spectacular for the price.

Today, the difference in image quality between portable and studio cameras is less dramatic. The electronics are simply so small that housings larger than that of a portable camera are not necessary. Digital processing, solid-state image sensors and digital transmission make a large package unnecessary. Some manufacturers have taken to building only portable cameras, notably Thomson Grass Valley, and resorting to "sleds" to mount the camera body to larger lenses. Here, the camera truly becomes a lens accessory, with the rear of the lens often holding the camera weight and the sled simply holding the lens. By camera truly becomes a lens accessory, with the rear of the lens often holding the camera weight and the sled simply holding the lens. By doing this, manufacturers have minimized the cost differential between applications, and companies needing both types of cameras can buy a quantity of sleds to match their collection of long lenses without having to duplicate expensive electronics in camera heads that might not be used for every show. Because the number of cameras that broadcasters use per production has increased steadily over the years, any flexibility in camera cost makes the mobile television business more affordable.

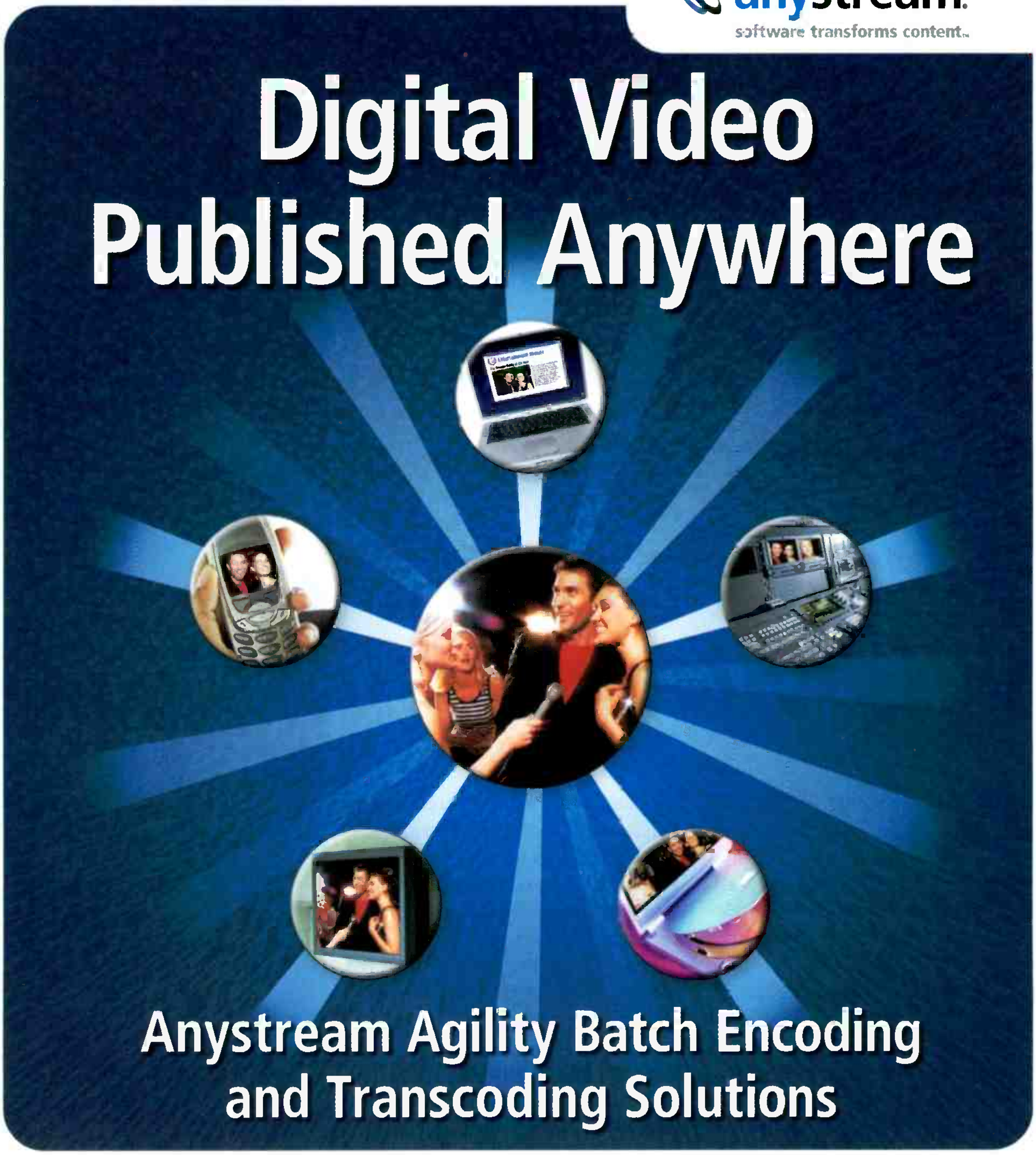
The camera truly becomes a lens accessory.

This approach also makes available the full feature set of a studio camera in all applications. Return video loops, intercom, tally, prompter outputs and other features are no longer excluded from applications that require a small (but not handheld) package, which increases production flexibility greatly. Lastly, this approach is clearly the best solution for technicians because now they can focus on the technology of fewer products. It also reduces repair time and parts inventory. Counterbalancing this is the long-held opinion of some camera operators that the low mass of buildups makes high-quality camera moves more difficult. Perhaps this is true. You might remember when RCA sold a TK-76 portable camera and a TK-760, which was nothing more than a TK-76 with a big case around it to make it feel big. That might not satisfy the market today, but the issue is one you must consider when specifying studio cameras.

Finally, with zoom ratios extending beyond 100x, the stability of the camera-lens system is a serious consideration. When the camera's mounting platform cannot prevent vibration — for example, on a scaffold at a stadium — the mass and inertia of a large camera can help produce a more stable picture. Even with modern lenses that have internal image stabilization, this total body mass may be an important supplement in some applications.

Editor's note: For a full discussion of imaging and critical human visual system capabilities, see the April 2004 article, "HDTV displays: How good do they need to be?" by Jukka Hamalaien, available at www.broadcastengineering.com. **BE**

John Luff is senior vice president of business development AZCAR.


Digital Video
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Anystream Agility Batch Encoding
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IT moves Olympic graphics forward

By Michael Grotticelli

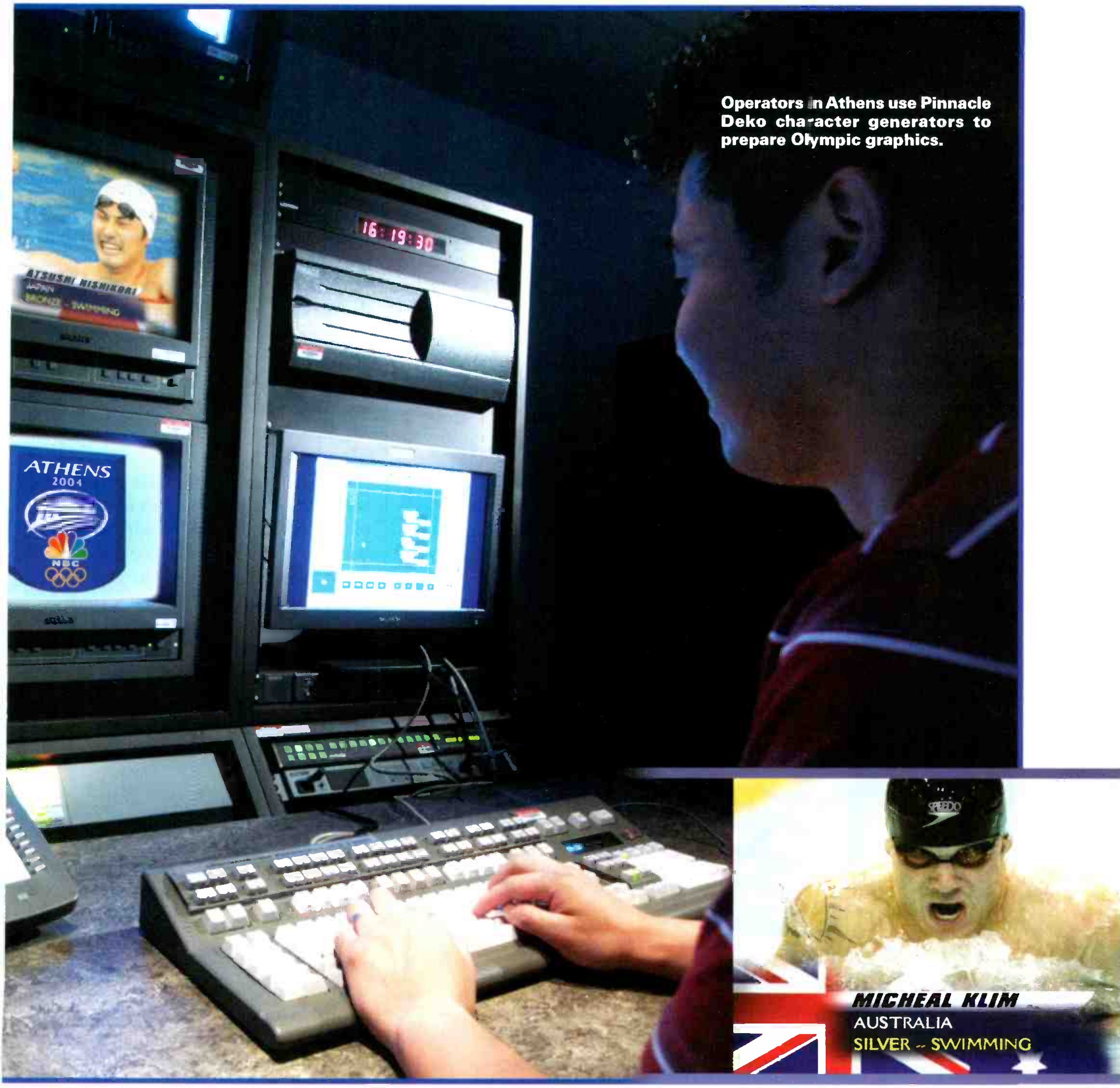
As director of graphics engineering and operations for NBC Olympics, Philip Paully has almost seen it all. Over four consecutive Olympic telecasts that span back to the 1992 games in Barcelona, Spain, Paully has seen NBC's Olympics graphics production department progress from a logistical nightmare to this year's well-oiled machine. It's been a gradual learning experience, making the transition in technology from large, dedicated hardware boxes to open, IT-based networks and production devices that streamline the creative process and get elements to air faster than ever before. For example, in 1992, it took NBC from 45 to 60 seconds to produce a frame of animation. Today, with significantly improved processing machines and networked efficiency, the network can produce 30fps video.

After manning the ninth floor of 30 Rockefeller Center at NBC's New York headquarters for about a year, Paully supervised the transportation of his 25-person team and all of its related equipment to Athens, Greece, to set up NBC's graphics at the International Broadcast Center on site. His team created most of the complex, prebuilt, 3-D graphics clips with subtly animated backgrounds and uniquely styled statistics in New York well before the August start date of the Summer Olympic Games.

Behind the scenes

To create the majority of the clips and animations in New York, the graphics team used a variety of paint/compositing systems, including a Discreet flame compositing system running on an SGI Octane2 workstation and an SGI Tezro system running Alias Wavefront and Maya software. They needed this horsepower to create the multiple layers and 3-D elements that make up this year's vibrant, eye-catching colors and subtle background changes. Because these systems are format-independent, they allow the team to produce graphics in both SD and HD to feed the network's dual video-distribution platforms. This multiformat design also enables NBC technicians in Greece to crossconvert between PAL and NTSC, and convert from analog to digital and SD to HD. All of the graphics production equipment can share AVI, Targa and QuickTime files.

A significant amount of footage for the graphic elements originated as 720p HD masters from international freelancers using Panasonic's AJ-HDC27 multiple-frame-rate VariCam HD camera. NBC's HD format of choice is 1080i, so crossconversion to 1080i/50 and 60fps will play a big part



Operators in Athens use Pinnacle Deko character generators to prepare Olympic graphics.

in this year's Olympics coverage. Sony's HDCAM VTRs will also play a big role. Most of the graphic elements were shot in HD for clarity and will be downconverted for the SD telecast.

The infrastructure set up this year between New York and Athens is decidedly different in that there will not be a full-time, dedicated LAN between the two sites. This time, the team will create graphics locally.

Gigabit networking

Figure 1 shows the entire graphics workflow, from creation to playout. This is the first Olympics for which the network has established a 1Gb network, sometimes transporting 18K jumbo packets at 6x to 8x real time. At this speed, a 60-second clip will arrive in 10 seconds. For this year's Athens network, several NBC departments are using and sharing Cisco 3750 and Cisco 6505 switching/routing equipment. Once the team has completed the graphics elements, they will upload them onto the network and send them to multiple networked Pinnacle Systems Deko character generators — FXDeko II for SD and HD Deko500 for HD — which will electronically fit the files into custom templates. Pinnacle Thunder servers will store some of the graphics before they travel to Athens for real-time playback. The team will play the majority of the graphics in real time with live data from the Dekos. NBC uses Deko's file-association and macro capability to display customized graphics without having to physically create each separate file, saving both creation time and operator training. The team plays out animations and over-the-shoulder graphics directly from the Thunder broadcast servers.

In Athens, a large Blue Arc 8300 server with 2TB of storage and a sustained 45Mb/s throughput serves as an on-site graphics library. The team sends finished graphics to the server and places them in a specific folder dedicated to individual pieces of equipment on-site in Athens. Every member of the Olympics graphics team has a customized mailbox togo to whenever he or she needs something related to the graphics production.

"We've gone from pushing and FTP'ing files, recording stuff in real time, and 'sneakernetting', to a more simple drag-and-drop workflow that serves the interests of the network so much better," Paully said. "We don't have the delays that we used to get."

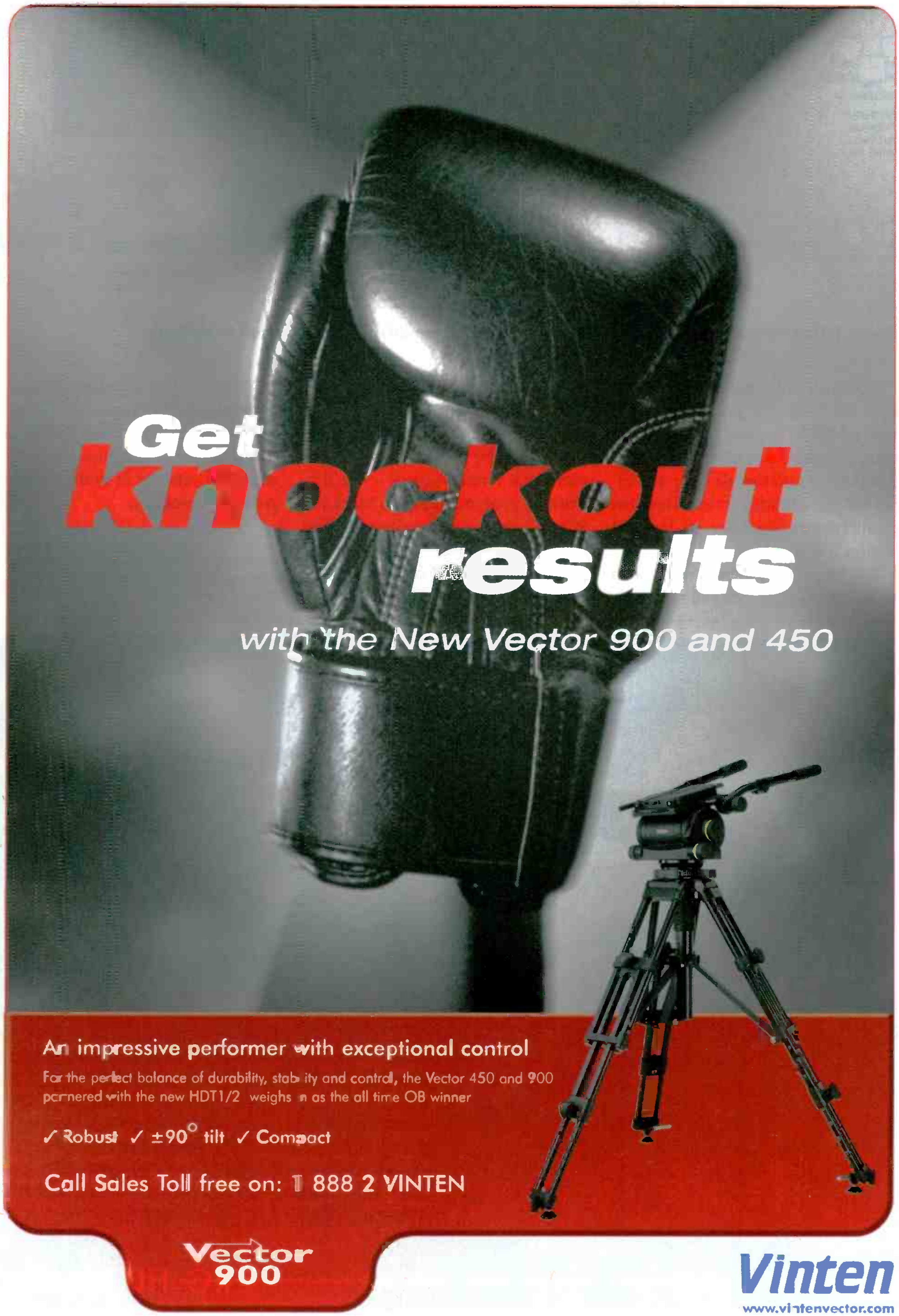
To ensure against system failure, the network has set up three methods for moving graphics files around. It can route to a device with live video, network it between two individuals, or use the old standby sneakernet with files burned on a CD or saved to videotape.

To save space on the main server, where 20GB equals about 30 minutes of HD material, NBC is spreading material across several different storage devices. Storage consists of two Sony AIT drives linked to two Quantel EQ systems, and several Apple Xserve servers tied into a 3TB Xraid array. The system allows editors and graphics artists to begin working on a project as soon as the first frame of new full-resolution material uploads onto the server.

Streamlining the build process

NBC has also streamlined its operations to the point that it now transports 10-RU, prewired systems, called short rack-in-the-box (RIBs) to Athens. These RIBs are more compact than the 20RU RIB systems that were carried to the past five Olympics. The new RIBs slide into 40-foot containers for ocean shipment to Athens. Each RIB contains a specific production subsystem, such as routing, distribution, transmission, videotape and communications.

The team is doing more work this year with a smaller budget and less equipment than ever before. Paully decided to use off-the-shelf Macintosh and PC platforms, not necessarily because of cost, but primarily due to the functionality and flexibility they offer. The platforms allow the staff to use a variety of Adobe, Apple and other common graphics programs, because the Deko and Thunder on-air systems can easily import and play back those files.



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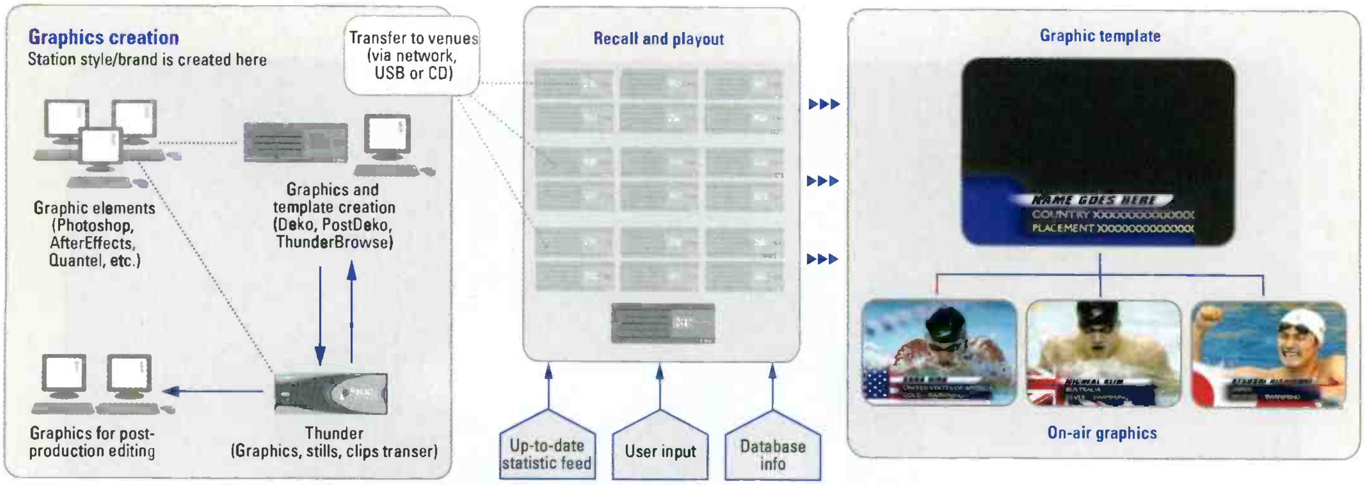


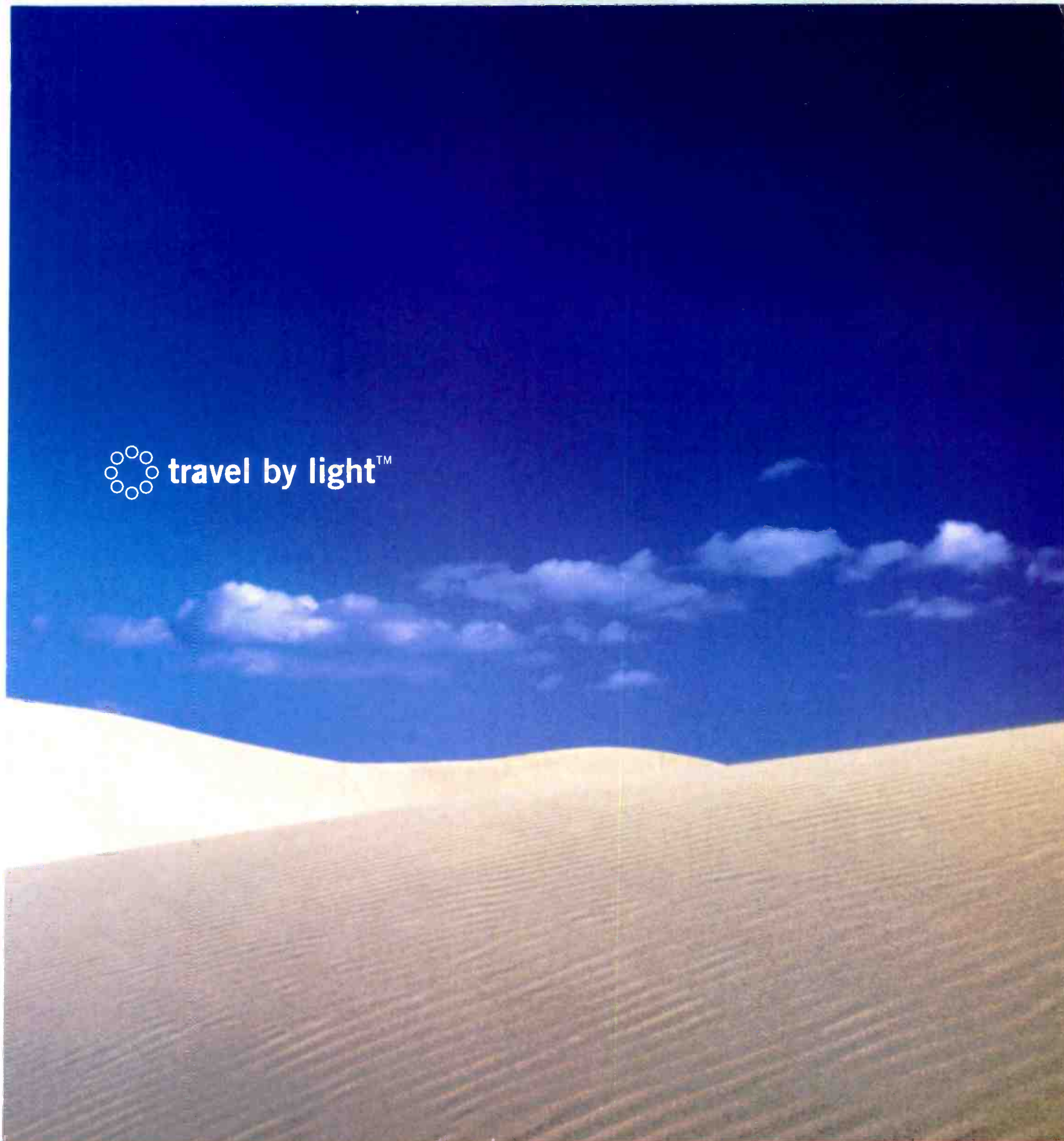
Figure 1. This diagram show the workflow of the Olympic graphics, from creation to playout.

In Athens, NBC has replaced a traditional $350,000 graphics system with a $40,000 SuperMac workstation equipped with a dual-processor G5 computer, Xraid storage array and Final Cut Pro editing software. The team created most of the bumpers, tags and station IDs on a Mac.

"For the more complex work, with up to 100 layers, there's still no substitute for the high-end Dicreet Logic Flame or Quantel eQ systems," Paully said. "However, in the next few years — probably by the Turin, Italy Olympics [2006 Winter Games] — we'll be working predominantly on Macs and PCs and creating even more work than we are doing now."

Paully said that all of the graphics-equipment vendors involved in this year's production have been helpful in customizing their respective devices to fit NBC's workflow model. To NBC, its entire Olympics graphics production team and veterans of multiple Olympics, that's progress. BE

Michael Grotticelli regularly reports on the professional video and broadcast technology industry.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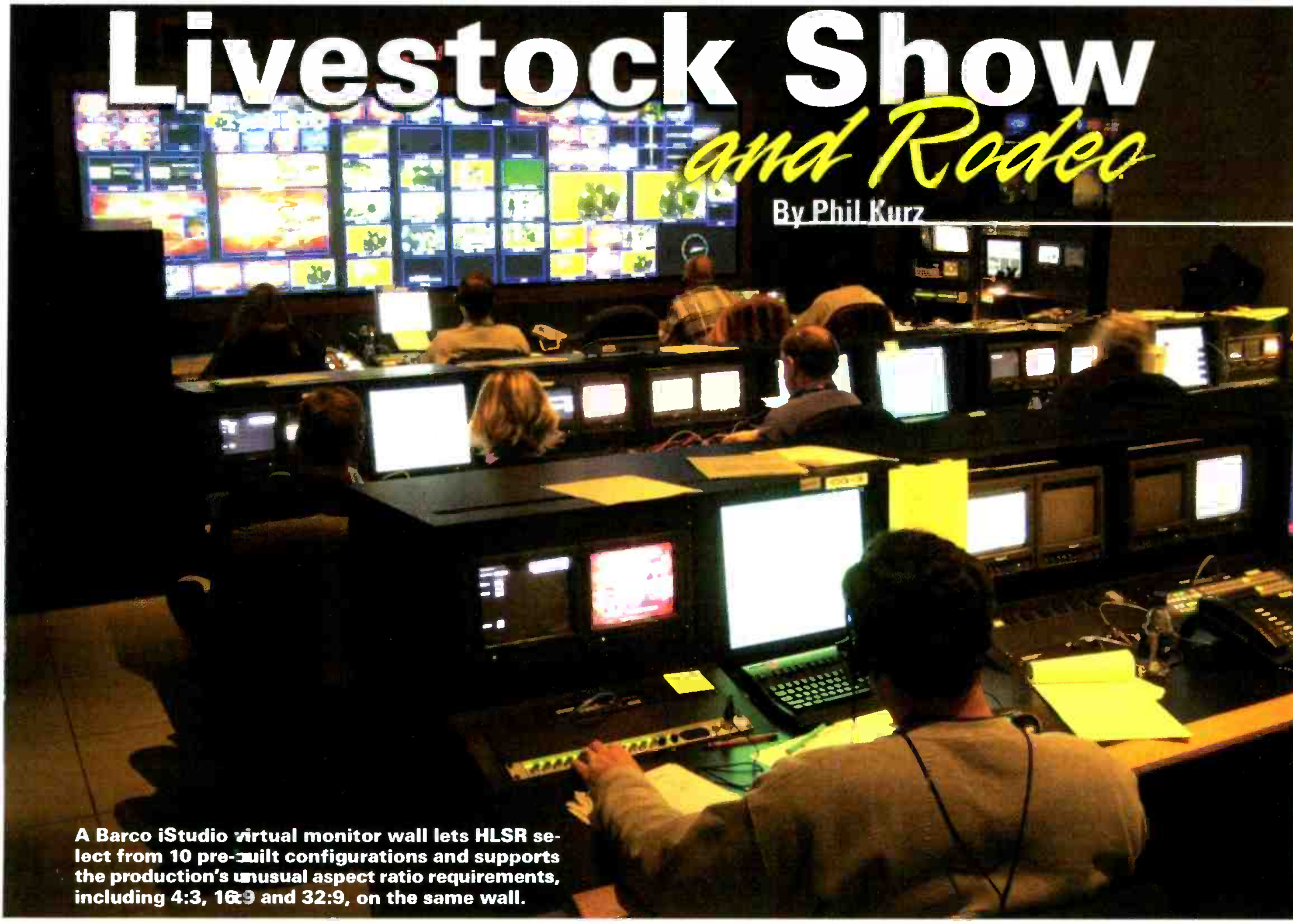
The Houston Livestock Show *and Rodeo*

By Phil Kurz



A Barco iStudio virtual monitor wall lets HLSR select from 10 pre-built configurations and supports the production's unusual aspect ratio requirements, including 4:3, 16:9 and 32:9, on the same wall.

The contrast couldn't be more striking. Out there in the cavernous expanse of Houston's Reliant Stadium, amid the dust and the din, are the broncs, the bulls, the cowboys and the crowd. In here, behind innocuous security doors at Reliant Center, is a cool, clean, modern video production facility where directors, TDs, CG operators and a variety of other production personnel work in unison, far removed from the chaos.

These two disparate worlds collide for 20 days each year and co-mingle to produce the Houston Livestock Show and Rodeo (HLSR), one of the largest rodeo events in the world.

Video is critically important to the success of the event — a charitable undertaking that has awarded more than $100 million in scholarships to area students since 1957. HLSR, the sole AV contractor for Reliant Park, has invested about $8 million in video and audio production equipment and $3 million in cabling and engineering. It's invested another $75 million in the construction of Reliant Stadium, becoming partners with the NFL Houston Texans' franchise in the building.

HLSR feeds 72 closed-circuit video channels throughout the complex. Eight are the company's original programming, including rodeo action, information channels with livestock-show scheduling and a sponsorship channel. Fifty-two come from partner DIRECTV. The others are used as needed.

Besides producing Rodeo Houston coverage to feed Reliant Park's closed-circuit system and stadium display, the AV contractor distributes rodeo coverage as live pay-per-view events on DIRECTV and other taped action on ESPN. This year, three nights of rodeo action appeared on DIRECTV.

After each day's rodeo, a mobile, self-propelled stage creeps from one end of Reliant Stadium to the center of the floor, where country music stars perform nightly concerts. HLSR provides video and audio support for the concerts as well.

But the most important thing video does for the rodeo is provide a narrative and context for the casual rodeo fan seated in the stands. Few have little more than a passing familiarity with the sport. Providing narrative and context is a big point of focus for the video presentation — an estimated 95 percent of the people watching the event are not into rodeo. It is the HLSR broadcast and audiovisual services division's job to make it as easy as possible for them to watch and have fun.

Easy and fun

Easy and fun aptly describes the fan experience, but there's nothing simple about the production. It takes 55 people, 15 cameras, thousands of feet of triax, four video switchers, a sizable wideband routing switcher, multiple character generators and digital effects units, more than a dozen digital videotape machines, linear and nonlinear editors, audio production equipment, and a bevy of other gear to pull off the production. Rodeo Houston requires 100 percent of the contractor's technical and production capacity. By contrast, a Houston Texans game requires 30 percent.

Reliant Stadium is awash in video display. Suspended from the stadium's retractable roof are six 28x16-foot Lighthouse LED indoor displays for larger-than-life views of the action. At either end of the stadium are 96x27-foot, 32:9 aspect ratio display walls that display standings and statistics as well as sponsorship messages.

Elsewhere in the stadium, video is a little more intimate. In the four main quadrants of the concourse, 16x9-foot rear projectors keep wandering fans apprised of what's happening on the show floor. At the clubs located around the stadium, fans can watch in HD while stopping by for a beverage. And, in the boxes surrounding the stadium, four monitors are tuned to HLSR coverage while a fifth is suspended above the seating outside the box. Another 1500 4:3 displays scattered throughout Reliant Park display rodeo action, livestock coverage and scheduling information.

The centerpiece of the studio is a Barco iStudio virtual monitor wall that fully supports the 32:9 display requirement of Reliant Stadium. The contractor chose the virtual monitor wall for its ability to display 4:3, 16:9 and 32:9 at the same time. The only alternative would be to use masked-off CRTs, which were considered much less appealing. The studio has 10 prebuilt monitor-wall configurations that can be called up with the touch of a button to support work related to Rodeo Houston. Three modules, each capable of displaying 30 SDI sources, make up the wall.

A Thomson Grass Valley Kalypso switches rodeo action coverage and a Zodiak drives sponsorship fulfillment on the two 96x27-foot video displays. Pictured are Bill Bradley and Zoli Vajda.

HLSR relies on Thomson Grass Valley Kalypso and Zodiak production switchers in the main control room and an Accom Abekas 8150 and Sony DFS700 in offline suites that can serve live production if needed. Operators use the Kalypso switcher to switch rodeo action coverage, and the Zodiak for sponsorship fulfillment on the 32:9 end-zone displays.

Reliant Center's mixed 4:3, 16:9 SD, 16:9 1080i HD and 32:9 (two side-by-side 16:9 SD channels) display requirements are reflected in the studio. The facility's primary emphasis is 16:9 SD, which is upconverted for HD display where needed and cropped for the 4:3 displays scattered throughout Reliant Park. Ninety-five percent of everything appearing on the 4:3 monitors comes out of 16:9. There are times the AV contractor needs to put in a 4:3 insert, like a sponsor-supplied message. In those cases, it will actually switch to a playout of that and cut back to the 16:9 being produced.

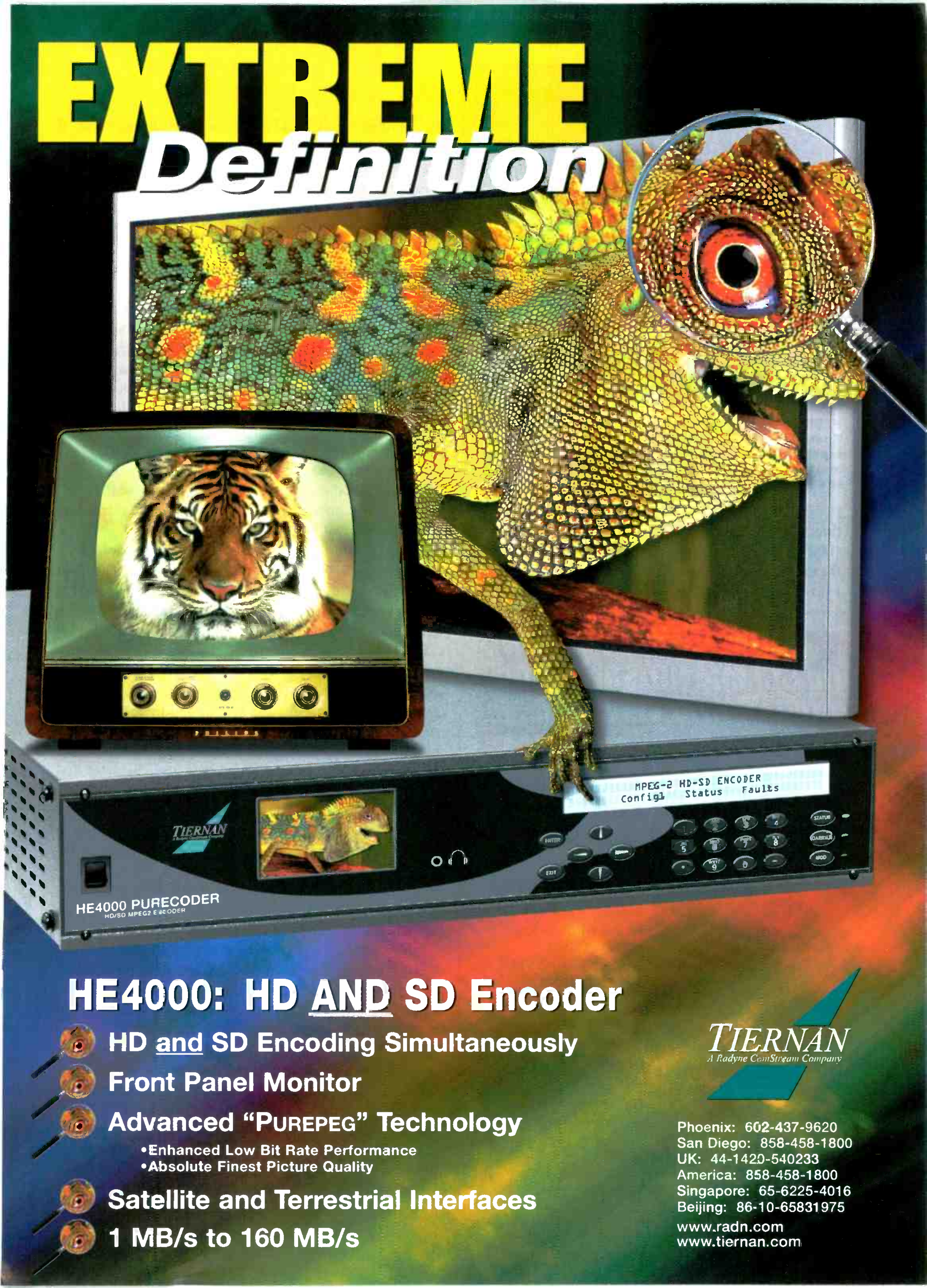
HLSR feeds 72 closed-circuit video channels throughout the complex.

A Thomson Grass Valley 250x250 7500WB wideband digital routing switcher feeds any source to any production switcher over CAT-6 cabling. The facility's routing switcher, patch bays and cables are all HD-capable, although the facility is strictly SD. The routing switcher operates in a 192x128 configuration but is prewired for easy expansion. Additionally, HLSR uses Thomson Grass Valley modular signal conversion products and DAs, the Encore router and facility control system, and the NetCentral software application to monitor the health of the entire system from a PC. The company chose Thomson as a single-source vendor for major pieces of equipment to achieve seamless integration.

Four Pinnacle Systems Dekocast character generators play a prominent role in the main studio. Each is responsible for a specific task, including creation of the statistics channel, rodeo timer, rodeo scoring and internal InfoNet channel. A fifth serves as a backup. Two FXDeko IIs feed lower-thirds from the main studio, while two DVEXCELs deliver effects. Two Pinnacle Systems Lightning 1000s assist the FXDekoIIs by delivering preproduced graphics.

Adjacent to the studio is a rack room that is home to the routing switcher, tally control, signal converters, DAs, DIRECTV receivers, modulation equipment for closed-circuit distribution, CCUs and triax terminations from 28 camera stadium positions.

In another area, a Thomson Grass Valley Profile video file server, an EVS LSM-ST networkable production server, 16 Digital Betacam machines and a four-channel Pinnacle Systems Thunder combo still/clip store serve up the features, promos and commercials seen in the stadium, as well as most of the video seen on the information channels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HLSR uses three separate audio studios to support its Rodeo Houston production; in the main room is a 64-input Amek Recall console used to control all live feeds, and Yamaha DM2000 consoles are the centerpieces of the surround and concert audio rooms.

throughout Reliant Park.

Three audio control rooms handle sound for HLSR. In the main audio room, a 64-input Amek Recall console controls all feeds leaving from and arriving at the facility. Here, the contractor mixes and monitors the stadium's audio. It also uses the main audio room to create all of the mixes and submixes stored on tape.

In the surround audio room, a Yamaha DM2000 creates a surround mix of the show that's tracked to tape. It also mixes program sound on the nights the rodeo is broadcast. During the rest of the year when there is no rodeo, the room serves as a ProTools workstation-based audio production room.

The concert audio room has two functions. It tracks all concert sources to multitrack recorders and creates the stereo mix that is stored on tape, modulated and then fed to Reliant Center's closed-circuit monitors. The key equipment in this room includes two Yamaha DM2000s, 48 channels of Tascam DA88 and a 48-channel Radar hard-drive recorder.

In the stadium

Few in the audience at the rodeo could imagine the complexity and technology necessary to display the video, data and graphics that keep them informed.

In the stadium are 15 cameras, including six Sony BVP 550s, a single 570, two 790s, two 950s and three D30s. Add to that a Giraffe Cam mounted to a rodeo clown's helmet to provide up-close-and-personal shots of riders and animals, and there's no possible angle left uncovered.

But staying informed at a rodeo requires more than pretty pictures. It takes facts — lots of them. There's information on the riders, their scores, standings and history; there's the rider history of the bulls and broncs, and there's the clock. All of that information must be conveyed and displayed for fans to stay informed.

This year, HLSR pushed rodeo data and character display to the next level with a little help from the facility's IT department and Pinnacle Systems. The problem the contractor faced was an incompatibility between Daktronics and the Trans-Lux scoreboards the Houston Texans specified for the stadium.

Most people don't know there's a subtle difference between the typical stadium scoreboard and a rodeo scoreboard, but the score clock is specific to rodeo.

Reliant Stadium is dual use — football and rodeo. Football and soccer won out in the selection of the scoreboard. Reliant Stadium settled on a Trans-Lux scoreboard.

But Daktronics has the rodeo-oriented scoreboard and associated timekeeping equipment. The challenge was to get Daktronics' support equipment to feed the Trans-Lux scoreboard. In rodeo, scoring is done on the field. A computer located on each end of the field generates a clock over the network. Custom software created by the IT department looks for the clock feed from the Daktronics scoring device, strips out all extraneous data and allows replacement clock data to be inserted and fed to the scoreboards. The scoreboard server relies on custom data formatting to feed the display, so an XML file was created

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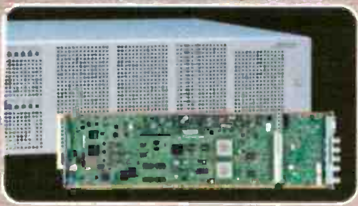

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that corresponds to the template that the Trans-Lux scoreboards need. With the XML template in place, a Pinnacle Systems Dekocast in the studio can map replacement clock information in the right spot.

But the three-quarters of a mile distance between the stadium floor and the Trans-Lux scoreboard — via the studio — introduced unacceptable latency in the clock display. In a sport measured in tenths of a second, a delay of several seconds could not be tolerated. The biggest challenge in the project was working with tenths of a second because it allowed less time to refresh data. The solution involved relying upon a fiber connection and speeding up the baud rate to spit out reconstituted clock information faster than what was coming in. The result is an imperceptible delay from the clock and what shows up on the board. The same XML file that corresponds to the Trans-Lux template allows the Dekocasts to insert other information, such as rider name and number, standing, and score for display on the scoreboard.

Another critical piece of custom code was a self-refreshing browser that updated whenever data changed. High above the stadium floor, this piece of code running on the announcers' computer screens keeps them informed of changing scores for up-to-the-second commentary.

Although Rodeo Houston signal routing and machine control is fully automated, James Davidson, HLSR managing director of broadcast and audiovisual services, likes having the ability to monitor status with the flip of a switch. Photo courtesy Phil Kurz.

Fade to black

By nearly any measure, Rodeo Houston is a resounding success. This year, more than 1.1 million people attended the event — the tenth consecutive year of drawing more than one million paying spectators. On March 17, the rodeo set a single-night attendance record of more than 70,668.

HLSR and its video production of Rodeo Houston play a large part in that success. It has supplied the people, effort and technology needed to engage a large stadium full of spectators and keep them coming back for more. Not too bad for an event where 95 percent of the spectators are not into rodeo. BE

Phil Kurz authors several Broadcast Engineering *newsletters, including "News Technology Update," "RF Update," "IBC Update," and "Sports Technology Update."*

Maintaining an IOT cooling system

By Rolin Lintag

An IOT's lifeblood is its cooling system, so keep it healthy.

Perhaps the most expensive single component in a TV broadcast station is the transmitter's inductive-output tube (IOT). Therefore, it is imperative that the station's engineers operate and care for this tube properly. Aside from improper tuning and mishandling, the biggest threat to the IOT's health is poor cooling. It can be a subtle but real cause of early failure in an IOT or, for that matter, any vacuum tube. Most, if not all, IOTs employ both air and water cooling systems that require regular care.

Air cooling

The air cooling system filters and blows air past the outer parts of the IOT assembly to remove heat. The IOT assembly includes the input cavity, where most of the tube connections are located, and the primary and secondary output cavities. Dirt and dust should not get into the cavities for any reason. Check the blower fan's intake air filter regularly; clean or replace it as necessary. It is a good policy to keep the floor surrounding the transmitter clean either with a wet mop or a shop

The power amplifier cabinet fan cools the top of the IOT's input cavity.

vacuum cleaner. Sweeping the area with a broom will only transfer the dust from places you can see to places you can't; the best place to use a broom is outside the building. You'll be surprised at how long you can keep the intake air filter clean just by keeping the building floor free of dust.

To make sure that the air cooling system blows sufficient air through the IOT assembly when the IOT is operating, regularly verify that the air blower interlock operates correctly. Check the interlock by shutting off the blower's circuit breaker and verifying that it shuts off the transmitter power amplifier (or puts it in standby mode). Of course, you don't want to unnecessarily stress the IOT during this test, so it's best to turn off the high-voltage (beam voltage) at the same time. Otherwise, with the blowers off for a minute or so, the tube may become dangerously hot.

Inspect cooling fans daily, or every time an engineer is on site, to make sure they are operating properly and not making any unusual noise. A noisy muffin fan, for example, probably has damaged bearings and blows less air than it should. Replace it as soon as possible. It's good policy to keep a spare fan in stock, just in case. The next time you inspect the fans, find out their model numbers and availability.

Air pollution can cause the IOT's high-voltage arc-protection circuitry to malfunction.

Poor air filtering can become a serious problem, especially in an urban area where air pollution can cause the IOT's high-voltage arc-

The primary and secondary output cavities of the IOT are air-cooled and should be kept clean to keep the high-voltage arc detector working.

protection circuitry to malfunction. The pollution can cause a buildup of soot in the internal output cavities (both primary and secondary), darkening the cavities and preventing the arc detector from functioning properly. This is a serious problem that can only be addressed by dismantling the IOT assembly, cleaning the inside of the cavities and, thereafter, permanently preventing polluted air from entering the air cooling system.

Water cooling

Most water cooling systems for transmitters employ a mixture of ethylene glycol and water, typically in equal parts. In its warranty requirements, the IOT manufacturer should specify the proper mixture. The major reasons for using ethylene glycol are to keep the solution from freezing in cold weather and to prevent corrosion on the copper piping and IOT collector. If the station uses the solution as an electrical part of the transmitter dummy load (i.e., impedance), monitor and maintain it.

To keep the IOT collector at the proper temperature, make sure to maintain the proper coolant flow. Monitor the level of the coolant inside the make-up tank or reservoir and add some coolant if the level falls near the minimum. Refer to the IOT manufacturer's data sheet to verify the minimum coolant flow — usually expressed in gallons per minute (gpm) — and the maximum inlet temperature. Take note that most IOT manufacturers advise an increase of 20 percent in minimum gpm if you use anything other than 100 percent demineralized water as a coolant. For example, using coolant composed of equal parts ethylene glycol and water with a 64kW-rated IOT (sync output power) requires a minimum collector coolant flow of 12 gpm instead of the 10 gpm specified for water-only coolant.

Also, the freezing point of the coolant depends upon the concentration of ethylene glycol. For example, a 50 percent concentration by weight of Dowtherm's SR-1 has a freezing point of -28.9° Fahrenheit. Increasing the concentration up to 80 percent by weight decreases the freezing point down to -52.2°F. Work

With the removal of the pump module's side panels, the coolant's reservoir tank is ready for visual inspection.

with the transmitter manufacturer to determine what concentration you should use depending on the climate and winter weather in your station's particular location.

The coolant pump pressure — monitored at the transmitter in pounds per square inch (psi) — determines the coolant flow. This meter usually is

Flow regulators maintain the correct coolant flow into the IOT. The red LEDs indicate that the flow is above the minimum allowed.

located in the pump module near the main and standby pumps. Monitor this pressure meter and log the measurements in the transmitter's operations log so that you can detect any gradual drop in pressure. Inspect the pumps and repair them as needed. Valves and connections should be inspected for leaks. The main and standby pumps should take turns operating on a monthly basis so that, if one fails it will be detected on the next change cycle and not be discovered only in an emergency.

Like your car's cooling system, the IOT's heat exchanger has a fan and a radiator. The radiator has a coiled coolant path with fins that radiate the coolant's heat to the outside environment. These fins need to stay clean and free of dust and oil deposits to allow efficient thermal transfer of heat from the coolant. Clean them regularly with an industrial-grade solvent. Clean them more often during the summer and autumn months when lawn clippings and dead leaves are likely to clog the fins. Industrial-grade solvents can contain corrosive chemicals like sodium hydroxide, so handle them with care. Wear the appropriate safety goggles, and chemical-resistant gloves and clothing. Make sure to read and comply with the material safety data sheet (MSDS) that accompanies the cleaner. Mixing the proper concentration of cleaner into a portable pressure sprayer can make the job easier. Approach the cleaning procedure with care. Before attempting to clean the heat exchanger, before you even remove the heat exchanger's guard screen, turn off the power to the fan. And beware! The fact that the fan blades aren't turning doesn't necessarily mean that the power is off; it may just mean that the thermostat hasn't kicked in. Verify that the fan's AC power switch is off.

Pumps can be used alternately on a monthly basis. Valves and connections should be inspected for leaks.

This IOT shows corrosion on the collector. The compressed air tank in the background is for drying the collector body after it has been cleaned with water and light brushing with a copper brush.

Regularly check for coolant leaks. Any short or arcing on the focus coils can result in costly replacements. Ethylene glycol, like Dowtherm SR-1 and the older Ucartherm, is available with fluorescent color to aid in detecting leaks. Inspect the pump module for coolant leaks, especially at the output of the pumps and the drain valves. Also check the IOT collector coolant connections. Leaks on the collector near the magnet frame can disturb transmitter operation by showing up as increased body current or can trip the circuit's breaker.

IOT manufacturers recommend flushing the system and replacing the coolant after each winter season. But you can choose the less expensive option of closely monitoring the system's health and using the coolant for more than one winter. If you choose the latter option, use a pH tester to check the coolant for its acidity. The pH should be somewhere between 8 and 10. If it drops to less than 8, then the coolant is starting to become acidic and it will start to corrode the copper piping and the collector of the IOT. You can mitigate this problem to some extent by adding heat-transfer fluid (HTF) inhibitors. Perform the pH test monthly and send a sample of the coolant to a laboratory for the standard corrosion testing at least once a year.

This photo shows the heat exchanger with the pump module at the back. Air is blown upwards by the fan, and the radiator is underneath the enclosure at the air intake. The AC power switch for the fans is at the upper left corner.

A proactive program of maintaining the cooling system for the IOT power amplifier requires a fair amount of effort. But, in the long run, it will save time and effort and avoid the perils that a damaged IOT can bring to the engineering department. **BE**

Rolin Lintag is an RF engineer with the Victory Television Network in Little Rock, AR.

HD production

BY JOHN LUFF

It's all about resolution...or is it? During the last year, HD production volume has exploded. Literally hundreds of HD cameras have been sold, many to the live entertainment market. New cable networks seem to come online almost weekly, and an all-HD DBS provider is trying to make a go of it in an SD world. Driven by market forces in consumer electronics, as well as a desire to grab market share early and hold it for the long term, programmers are increasing cost and quality in the expectation of future returns on investments. Turner Entertainment recently launched an HD version of TNT. ESPN gave its infrastructure an HD makeover and will broadcast more than 100 live HD events this year (see *Broadcast Engineering*, June 2004). FOX and CBS plan to commit to HD sports for the fall of 2004 — with FOX building out an HD affiliate distribution system for the first time this fall.

Is resolution the driver? From a marketing perspective, it is. With ESPN and FOX joining the 720p camp in 2003, the 720p vs. 1080i argument continues unabated. Also, several other factors have proved to be defining issues for those making the leap from SD to HD production systems. Interestingly, graphics, which one might think could be created cheaply in software-based systems, have lagged behind cameras and other more complicated electronics.

It's all about resolution...or is it?

Aspect ratio is one of the most critical core issues. The good news for SD program services is that 4:3 aspect ratio content will continue to drive revenue. The bad news is that mixing any two aspect ratios can get messy. Think about a service that wants to distribute a live event such as the 2004 British Open. For North American HD consumption, as well as the Japanese, 16:9 HD is preferred. For European distribution, PAL Plus (625/50i 16:9, sometimes converted from 4:3 as 14:9 aspect ratio) is needed. For the North American SD market, 525/59.94i in 4:3 aspect ratio is a mandate. This means that standards conversion, frame rate conversion and aspect ratio conversion all must be done while preserving high technical quality. Even more importantly in this context, no less than three aspect ratios are required (4:3, 16:9 and perhaps 14:9). If graphics are added in the normal production process, they will be compromised in at least two of the three aspect ratios. As a result, productions are done with separate switching of 4:3 and 16:9, with 14:9 being a compromised subset of the 16:9 broadcast if derived by the end user from the 625/50i 4:3 broadcast.

For instance, lower thirds, which are left-justified and end at the right side of the frame, must be reframed for two additional uses. Perhaps a single format can be agreed upon that has different appearances in the three potential output formats. But adding moving graphics with sound effects, and trying to get the effect to appear correctly in two (or more) aspect ratios is not so simple. Timing the au-

Turner Entertainment recently launched an HD version of its TNT channel to coincide with its newly upgraded HD facility. Photo courtesy Turner Entertainment and AZCAR

dio to have the right “motivation” in two different screens can also be dicey.

Consider the technical complications of switching two programs from one panel. First, all of the sources must be available in the respective chassis and, most likely, must be mapped to the same physical inputs. This includes POV cameras, graphics and key channels, any still stores or other fixed graphics, and specialty graphics. The next step is to get the moving graphics and the DVE channels lined up and timed to appear on screen perfectly (a left push on in 16:9 might arrive earlier than a left push on in 4:3, with audio out of sync). Then deal with the fact that the two switchers and DVE channels might have different electrical length, which can affect the overall sync of the program's audio.

The production control area of the Center for Disease Control's HD press room in Atlanta is equipped with all-HD equipment including Evertz's conversion and signal processing systems, and Panasonic's AK-HC900 720p cameras and AJ-HD1700 archive video recorder. Photo courtesy Digital Systems Technology.

Flat-screen displays create another pernicious effect. They are not “real-time devices,” and have in fact had a frame delay built in as well. What then is the right audio sync? What the director sees? What the viewer receives? Consider that the camera signals are a frame late on the monitors, the switcher is a frame or two long, and the output plasma is perhaps a frame later still. What is the correct audio sync for the control room? Will it bother the production staff that the camera on the line monitor is out of sync with the camera direct monitor? Probably not, because it is a problem that cannot be fixed easily.

One might think that the control room should have the exact audio from the output broadcast. Consider the fact that almost no control rooms are the shape or dimensions of the home listening environment. It is not trivial to create a sound field in that space that works for the full production staff. Most production teams have settled on perhaps a stereo feed for the control room, maybe augmented with the LFE channel. It is much easier to create a broad sound field that is uniform in stereo than in 5.1, especially in wide rooms that are not very deep — mobile unit control rooms, for example. After decades of experience designing and working in control rooms, we are in need of new experience to turn the capability of HDTV into reality. Understanding the features the technology offers can offer insights into implementation and the best use of the considerable power of this relatively new medium. BE

John Luff is senior vice president of business development for AZCAR.

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

VIDEO CLIP SERVER

Video Technics NewsFlow: Staff members can work simultaneously from a common pool of digital media; anyone can browse, log or edit material in real time even as it is being captured; offers the Apella VCS, central NAS/SAN storage, proxy editors/browsers and online/offline edit workstations with an open architecture.

404-327-8300; *www.newsflow.tv*

MULTIVIEWER

Zandar Predator HD4: Is 1RU; accepts HD or SDI inputs; displays in quad or full-screen mode; selectable output resolutions include XGA and SXGA, in addition to widescreen resolutions common to plasma and LCD displays; features input source auto-detection, embedded audio monitoring via in-picture bargraph display and alarms, video fault detection and alarms for loss of sync, frozen picture, and black picture detection.

321-939-0457; *www.zandar.com*

SHOULDER-MOUNT MINIDV CAMERA

Panasonic AG-DVC60: Is 3CCD; employs a wide-angle, 16x optical zoom lens; has 12-bit A/D and RGB gamma processor; features infrared nighttime shooting, movielike recording and 16:9 recording modes; has optical image stabilizer (OIS) and a focal length of 39.5mm to 632mm; has low-dispersion glass to reduce chromatic aberration, flare and ghosting; includes IEEE 1394 interface.

201-392-4127; *www.panasonic.com/broadcast*

PROMPTING SOFTWARE UPGRADE

BDL-Autoscript +WinPlus+: Operates in any language supported by Windows and Unicode; output as data for closed captioning; PCI PromptCard has full NTSC or PAL color capability with optional genlock; use with a laptop; XBox USB provides the same facilities in an external mains/battery-powered enclosure; can be controlled by an unlimited number of local or remote desk/foot speed controls using the BDL ControlNet system with standard coax video cable connectivity.

516-799-3869; *www.bdlautoscript.com*

ACTIVE BIAMPLIFIED MONITORS

Genelec 8000 MDE: Is comprised of three new models: the 8030A, 8040A and 8050A; enclosure features rounded edges and gently curved front and sides; has unsurpassed frequency response and minimized cabinet edge diffraction; models use an entirely aluminum MDE design with integrated Advanced Directivity Controlled Waveguide (DCW).

508-652-0900; *www.genelecusa.com*

WORKFLOW SOLUTION

Chyron and Proximity Lyricstore: Integrates connectivity between Proximity's Xenostore and Chyron's Lyric; search, transfer, convert and manage Lyric graphical assets; integrate Lyric software into graphics operations with legacy equipment from Adobe, Avid, Chyron, Discreet, Leitch, Omneon, Pinnacle, Quantel, Sundance and Thomson Grass Valley.

631-845-2000; *www.chyron.com*
800-433-2900; *www.proximity.com*

DATA COMMUNICATION MONITOR

DNF Controls The Analyst: Isolate, identify and resolve RS-422 and RS-232 interface problems quickly; simplifies the testing of cable runs between floors or between buildings; verifies RS-422 and RS-232 signal paths; detects RS-422-to-RS-232 adapter problems; is a compact, handheld device with a four-line-by-40-character display, eight-key keyboard, and RS-422 and RS-232 connectors.

818-898-3380; *www.dnfcontrols.com*

MPEG-2 DVR/PLAYER

LEIGHTRONIX TCD R/P: Drive size has been increased to 160GB in standard production models; TCD/IP network-managed video system controls the player; integrate into systems involving one or more TCD R/Ps, as well as DVD players and VCRs; uses variable bit rate MPEG-2 encoding; select a VBR encoding rate maximum limit between 1Mb/s to 10Mb/s.

517-694-8000; *www.leightronix.com*

SD/HD PRODUCTION SWITCHER

Snell & Wilcox Kahuna: Process selected mix effects on SD and HD outputs; simultaneously mix together SD and HD sources in one mix effect; provides macro and timeline features, 80 inputs, 2-D DVE effects per keyer plus an additional eight channels of 3-D DVE effects; mix SD and HD material on the same screen without an intermediate conversion step; is offered in 2M/E, 3M/E and 4M/E versions.

408-260-1000; *www.snellwilcox.com*

OPTICAL DISTRIBUTION FAMILY

Telecast Fiber Systems Mamba: Comprised of an integrated family of optical distribution products; features low-profile video and audio patch bays, using the mini-WECO and bantam jacks; fiber-optic interframe cables are smaller, lighter and easier to manage; features optical DA outputs, and electrical-to-optical media converters for HD/SDI, AES-EBU and analog audio; fiber cables are standard single-mode type.

508-754-4858; *www.telecast-fiber.com*

UNIVERSAL VIDEO AND AUDIO PROCESSOR

Miranda Imaging Series XVP-801i: Simplifies incoming feed processing with multiple SD and HD formats; offers up-, down- and crossconversion; includes HD/SD signal processing, frame synchronization and 16-channel audio processing using embedded audio or separate AES with the DAP-781i audio processing module.

514-333-1772; *www.miranda.com*

ON-AIR BRANDING

Inscriber Inca Station: Create and streamline professional, custom layouts used for multilayer graphic insertions with new layout editor; seamlessly combine bugs, clocks, crawls, logos, graphics, clips, video and animations into simple or complex presentations; designed to maximize viewer impact and retention.

519-570-9111; *www.inscriber.com*

PROMPTING SOFTWARE

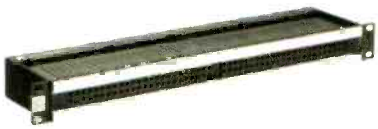
Autocue Qscript: Add hand annotations to scripts using a wireless touch screen or tablet workstation and stylus; instantly view multiple scripts in the rundown; runs as a front end to any newsroom system or any script source.

800-293-0118; *www.autocue.com*

DATA MANAGEMENT SOFTWARE

SGL FlashNet: Links video stored as files on video servers and network storage systems to libraries that serve as long-term repositories; move material from the server to the archive either manually or under the control of an application; tracks all video assets by a user or application assigned unique ID; use as a stand-alone system or integrate directly into the application.

+44 23 8023 3322; *www.sgluk.com*



PROGRAMMABLE PATCHING SYSTEM

ADC ProPatch: Combines the ruggedness and reliability of a WECO-compliant bantam jack, with a precision DIP switch, enabling users to change normalling and grounds quickly and easily; is a high-density system that fits in 1RU; modular design allows individual front jack access for circuit and ground configurations without having to take the entire panel offline or remove it from the rack; available in several termination options.

952-917-3000; *www.adc.com*

ROUTERS

Leitch Panacea and Integrator: Includes three new additions: the Panacea Clean Switch, which handles multiple SD/HD channels simultaneously; Panacea Lite 12x1 routers; and Integrator GOLD with analog, SD and HD in the same frame.

859-371-5533; *leitch.com*

ROUTING SWITCHER

PESA XD photonic switcher: Can switch any signal format, including video signals of any definition; delivers transparent connections between any of its input fibers and output fibers without converting light to electrical signals; switches video as laser beams between fiber-optic cables instead of as electrical voltages; integrates Glimmerglass' Brilliance microphotonics technology with PESA's 3500PRO control system.

631-845-5020; *www.pesa.com*

PLAYOUT SOLUTION

OmniBus HeadLine TX: Can be used in a simple form for Betacart-style playout; adapts to perform more advanced automation with graphics, timelines and secondary events; integrates with the latest version of MOS; is compatible with newsroom systems such as ENPS and iNews.

303-237-4868; *www.omnibus.tv*

CONTENT PROTECTION SOLUTION

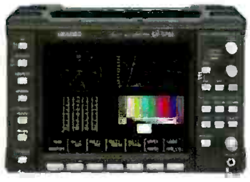
Irdeto Access PIright: Protects against the possible theft of premium video content deployed over DSL and FTTH infrastructures; features the Irdeto secure software client, which offers security protection without the need for a smart card; provides IP level encryption and supports unicast and multicast streams, as well as persistent encryption; secure storage is possible in video servers, edge servers or set-top boxes with hard disks.

858-668-4800; *www.irdetoaccess.com*

PRODUCTION SERVER

Accom Abekas 6000: Mix and match SD and HD channels with high-quality I-frame compression; features up to eight digital video channels, each capable of simultaneous recording and playback; includes improved networking with Gigabit Ethernet and Fibre Channel options and an updated content management panel.

650-328-3818; *www.accom.com*

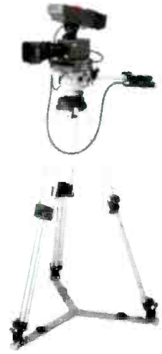


MULTISTANDARD WAVEFORM MONITOR

Leader Instruments LV5700A: Make accurate adjustments of color balance while shooting; includes DC-power, tripod attachment, embedded-audio headphone output and TFT LCD screen; has extensive error detection for SDI signal monitoring, individual or four-in-one multiple display of waveform, vectorscope, picture, status and embedded audio; supports 20 formats.

714-527-9300; *www.leader.co.jp*

MULTIROLE CAMERA



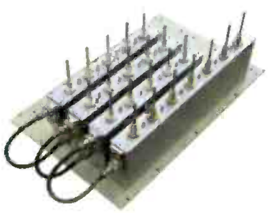
JVC KY-F560E: Has ½-inch bayonet lens mount, 12-bit ADC and 24-bit DSP; features ½-inch 3CCD color accuracy; can be expanded to include 26-pin connector and SDI compatibility with optional boards and studio kits; remote camera control via SDI interface is possible in conjunction with pan and tilt head and system controller; has horizontal resolution of 850 TVL and S/N of 62dB and full-time automatic operation; has RS-232C interface capability and JVC KY-F32 series compatibility.

800-582-5825; *www.jvc.com/pro*

STORAGE SOLUTION

Sony SONAPS: Is a fully managed environment for planning, ingest, production and publishing of A/V content; shared access to all material with full browse capability simultaneously; can work as a standalone solution or can be integrated within an existing infrastructure.

800-686-SONY
www.sony.com/professional



COMBINER

Radio Frequency Systems manifold combiner: Combines digital channels up to 250W; is tuneable over the entire UHF band (470MHz to 860MHz) for 6-, 7- or 8MHz bandwidths; exhibits low losses for its given filter sizes; features coaxial filters of up to seven poles; transmitter DTV masking is available.

203-630-3311; *www.rfsworld.com*

New Products

MPEG-4 ENCODER

Thomson Grass Valley ViBE: Combines encoding, decoding, MPEG processing, multiplexing and network adaption functions in a modular chassis; is available in 1RU and 5RU versions; features solutions for transport over IP/MPLS, ATM, PDH or SONET/SDH backbones; supports analog inputs, additional digital audio inputs, IP outputs, noise reduction and advanced pre-processing features.
530-478-3000; *www.thomsongrassvalley.com*

MULTIFORMAT VIDEO WAVEFORM MONITORS

Tektronix WFM700: Displays safe area graticules on the picture display to help editors correctly position action, graphics or text in the video image; has new automated measurement of six eye pattern parameters, including rise and fall overshoot, plus a histogram of eye pattern signal levels; for content monitoring, a new multi-axis display of surround-sound audio shows audio levels, total sound volume, phantom sound sources, and the dominant sound source to enable the efficient adjustment of surround-sound audio content.
800-426-2200; *www.tektronix.com*

AES AND DATC REFERENCE GENERATOR

Sigma Electronics SG5605: Track audio channels by generating AES tone/silence with eight audible channel identifiers; operate as a stand-alone reference generator or lock to a master video reference for complete system synchronization; generates digital audio time code and simultaneous outputs of tone and silence; features a user-selectable ID timing period.
866-569-2681; *www.sigmaelectronics.com*

HD MONITOR

ERG Ventures HDM-EV80D: Is 8.4 inches; includes enhanced color, gamma adjustment functions, additional framing markers and a convenient memory preset function; can serve as a rack-mount monitor; HD and SD inputs can be intermingled; has four input changes; features front-panel volume adjustment.
949-263-1600; *www.erg-ventures.co.jp/e*

STUDIO OPERATION SYSTEM

Sachtler Pilot System and Pilot Wing: Has luminaire, barndoors and motorized yoke; available in three versions with power capacities of 1kW, 2kW and 5kW; features a modular design that enables full automation of all luminaire functions; control via a DMX512 (unidirectional) or Sachtler's HelioCan studio control software; features direct access and status information via a full text status display; includes built-in friction clutches and electronic torque limiters on all axes.
516-867-4900; *www.sachtler.com*

HD, VOD RECORDER

SeaChange International Recording System 2.0: Has HD support; record and store HD and SD television broadcasts for on-demand viewing; data entry is minimized via point-and-click graphical user interfaces; captures the video content from broadcast sources, generates Cable Labs-compliant VOD metadata from television schedule information, and propagates files to servers; allocates video encoders to record incoming content from several sources; manages multiple HD and SD sources simultaneously; adds previously broadcast programming to VOD libraries continually.
978-897-0100; *www.schange.com*

MULTI-ROLE VISION MIXER

Eyeheight irisHD: Can switch between up to eight HD-SDI inputs under local control or via a standard iris control panel; switch incoming video feeds via an 8x4 crosspoint router and a dual input cut/mix/wipe unit with manual or user-controllable automatic wipe transitions, adjustable edges and variable-speed auto transitions; store settings in power-protected user memories; has four HD SDI outputs.

+44 1923 256 000; *www.eyeheight.com*

HEAVY-DUTY HYBRID FIBER-OPTIC CABLE

Gepco HDC120P: Is SMPTE 311M-compliant; features 12mm polyurethane jacket that is rugged, puncture-resistant and aids in the reduction of cable kinking; uses a nylon-based polymer, and a 16-gage steel strength member cabled at the center of the cable core; each fiber includes a Kevlar wrap and PVC jacket; electrical components consist of two 16-gage auxiliary conductors and two 24-gage signal conductors.

800-966-0069; *www.gepco.com*

SIGNAL INTEGRATION SYSTEM

Ensemble Designs Avenue: Is housed in a 1RU or 3RU frame; allows any combination of HD, SD, DVB-ASI and audio modules in the same frame; frames are 1.5Gb/s capable; control and monitor all modules in the system from one or many locations — locally or worldwide; can adjust video level, timing and audio delay parameters; features alarm generation and logging.

530.478.1830; *www.ensembledesigns.com*

SDI/COMPOSITE DETECTOR

Hamlet WhichWire: Is rugged and waterproof; battery-powered unit can be used in environments such as ungrounded bays, in pouring rain; case is sealed to the IP65 waterproof standards; with one BNC input socket automatic detection of SDI or CVBS input video signal is indicated on LEDS A BNC; indication of the SDI signal's nominal cable length on one of two LEDs for less than 100M or greater than 100M is provided.

+44 1494 729 728; *www.hamlet.co.uk*

RFS provides DTV to LA broadcasters

BY MIKE DALLIMORE

An innovative, shared broadcast system atop Mount Wilson, CA, provides four LA broadcasters with high performance and highly sculpted digital and analog television coverage.

The advent of digital television and simulcast digital/analog services has changed the face of global broadcasting. With real estate often at a premium, the escalating potential for interference and the considerable cost of deploying new infrastructure, many broadcasters are moving toward multiservice systems.

> **The advent of digital television and simulcast digital/analog services has changed the face of global broadcasting.**

For four Los Angeles broadcasters (KDOC-TV, KJLA-TV, KOCE-TV and KXLA-TV) seeking to add DTV to existing analog services, these considerations ultimately have led to the deployment of a shared broadcast facility at Mount Wilson. The solution incorporates a dual broadband panel antenna/combiner system from Radio Frequency Systems (RFS).

A shared system was imperative. Not only is Mount Wilson a highly congested site, but the existing analog services being moved there coupled with the new digital services—the whole involving adjacent channels—needed to be broadcast from the same location to prevent interference. A shared system also offered the advantage of economy of scale.

For channels 32, 44, 48, 49, 50, 51 and 56 to be broadcast, dual antenna/combiner subsystems were needed, for several reasons. The first of these was to simplify the combiner system, eliminating the need for adjacent channel combining. Dual subsystems also allow greater flexibility for main/standby services, as well as accommodating the stations' individual pattern-tailoring requirements.

Sculpting the signal

Accurate sculpting of the broadcast signal was one of the primary performance requirements of the system. A number of channels required signal restrictions over Mexico or toward San Diego, and it was desirable to reduce wasted power over the ocean for all channels, while ensuring premium coverage for Los Angeles and its western satellite cities. To achieve this level of pattern sculpting without compromising performance required the use of broadband panel arrays.

The dual, 10-level broadband panel arrays deployed at Mount Wilson were designed by RFS in close collaboration with broadcast consultant Merrill Weiss. Early in the project, it was decided to use panels arrayed on three faces of a five-sided column, with panels omitted on the two northern faces because coverage was not required over the nearby mountains to the north. Using sophisticated computer modeling techniques, the design team assessed the effects of electrically tilting the three faces individually, coupled with power distribution and phasing adjustments, to determine the optimum pattern for each antenna.

This antenna pattern optimization process involves numerous variables. The act of changing the beam-tilt on individual faces leads to "transition regions" in the pattern that require careful analysis during the design process. Also, the effect of signal phasing on the pattern is tightly integrated — such that a change of phasing on one face has cascaded effects on other antenna parameters. Finally, due to the broadband nature of the antenna (580- to 756MHz), any adjustments for one frequency lead to follow-on effects across the bandwidth, so that the design is four-dimensional.

The process of ensuring optimum coverage for each of the services — and particularly, that the signal restrictions over Mexico didn't degrade the performance of those channels not requiring it — involved many iterations of the key design variables. Interference issues and the challenge of achieving the required gain within specified power limitations also were taken into account, with the ultimate result being two, separate stacked panel arrays (each capable of handling up to 195kW total average power input) that meet the stringent performance requirements of all four broadcasters.

Dual broadband panel arrays from RFS provide sculpted digital/analog signals for four Los Angeles broadcasters at Mount Wilson.

Crucial combining

A pair of parallel RFS directional waveguide combiner chains support the dual broadband arrays. The channel combiner subsystems comprise five directional waveguide filters and one blank section to allow for the introduction of additional channels. The system is designed to accommodate future channel reallocation; its compact nature offers space in the building for two additional combiner systems if required for future expansion.

In order to accommodate the high-transmitted powers of analog services on channels 50 and 56, the company developed a new full-wavelength directional waveguide combiner. The combiner incorporates resonators a full wavelength in height (instead of half wavelength), providing twice as much surface area to dissipate the greater heat generated by losses in the high-power, higher-frequency channels. Because of this, the system does not require forced-air cooling to ensure that the operating combiner does not exceed the design temperature rise.

Complementing the combiner system is a network of rigid transmission lines linking the transmitters, mask filters, combiners and flexible coaxial feeders, which are each in different locations owing to the crowding at the site. During the design phase, the team took care to minimize reflections that might otherwise have occurred due to the number of components in the rigid feed system. To do this, they developed broadband elbows that were tuned to optimize system performance. In addition, eight 5-inch RFS HELIFLEX flexible coaxial transmission lines were installed to feed the panel array — four for each sub-array.

The net result in the performance of the transmission line system was reflected power so low across all channels that several transmitters' reflected power indicators did not even move when the transmitters were energized.

Structural challenges

Owing to the congested nature and potential seismic activity of the site, installation of the combiner proved a challenge. A combiner room was built as a bridge suspended over an existing building, and the entire combiner and separate digital-mask filter systems were bolted onto steel frameworks suspended from groups of four vertical steel members. Seismic horizontal ties connect the steel frameworks to the building structure and prevent them from excessive swinging during seismic activity.

The internal cavity of the antenna column also needed to be expanded in order to maintain human access, as well as contain a large volume of equipment — including the eight flexible feeders, branch feeders and power dividers used for pattern sculpting. The result was an asymmetrical crosssection, which led to issues with the antenna/tower interface. This was solved in collaboration with the tower designer through the fast-track development of a unique multidimensional antenna-clamping mechanism.

An additional design consideration was the minimization of tower harmonics due to wind-induced vibrations. To provide dynamic stability to the antenna structure (two RFS panel arrays plus a third antenna mounted on top of these), the team introduced a tuned liquid damper at the top of the 20-level, panel-antenna column comprised of stainless-steel tanks filled with a specifically calculated volume of ethylene glycol that moves against the modes of vibration, potentially reducing the magnitude of oscillations by a factor of 20.

Final result

Conceived and designed over a period of more than four years, the final RFS combiner/antenna system at Mount Wilson can accommodate a total of 12 digital or analog services from channel 32 to 56. The combiner chains were installed in the first half of 2003, followed by the raising of the two stacked panel arrays that October, and rigid line optimization in early 2004. Currently configured for nine channels (including two standby services), the first services went on-air in April 2004 with the others joining in the following months. After extensive theoretical design and modeling, the physical realization of the individual components, and the ultimate installation and commissioning, the RF broadcast system has met all performance objectives. **BE**

Mike Dallimore is vice president, broadcast and defense systems, Radio Frequency Systems.

Rohde & Schwarz
DVM 100/120 transport stream monitors

BY ALEXANDER WOERNER

After transitioning to digital, many broadcasters are in the process of adding an active electronic programming guide by inserting full PSIP data into their transport stream. Or, they are upgrading an existing static EPG to dynamic with extended coverage into future programming schedules and data ingestion from traffic and automation systems. Different multiplex profiles during the day (several SD programs during off peak, and one HD or HD and one SD during peak hours) require diligent service announcements by PSIP metadata, as do the FCC-mandated closed-captioning services and the broadcast flag (more correctly called redistribution descriptor). Additional services, such as directed channel change or data broadcasting, are new ways to enhance the attractiveness of a single channel and to prevent viewers from zapping away.

All of these factors contribute to an increasing complexity of broadcast MPEG-2 transport stream multiplex signals. A broadcaster wants to make sure that all media and metadata are sent out properly and can be decoded properly by the DTV receiver or set-top box for continued viewer satisfaction. Thus, the requirements placed on the real-time monitoring equipment keep increasing with the complexity of the stream.

One system does it all

The MPEG-2 monitoring system from Rohde & Schwarz, R&S DVM 100/120, is compact and offers a scalable number of transport streams, up to 20 signals. It is used at transmitter locations, playout centers, central or regional distribution hubs, or cable headends. The 1RU base unit features an integrated system controller and up to four transport stream inputs, which can be switched electronically from DVB-ASI to SMPTE 310 as needed. Expansion units offer up to eight additional inputs.

The system controller provides a user interface and offers a detailed overview of all monitoring results for every signal. It includes access to optional drill-down analysis displays in case of trouble or questions. Monitoring options include service table (PSIP) decoding, PCR jitter analysis and record-on-trigger.

> The monitoring system uses a concept of distributed signal processing.

The monitoring system uses a concept of distributed signal processing. Highly integrated analyzer boards perform the basic transport stream analysis, each serving up to four inputs simultaneously. They are based on FPGAs, allowing for transport stream analysis up to the maximum ASI data rate of 216Mb/s. Processing power is shared between the four signals and can be allocated to provide power to each of the four inputs as needed.

A 100BaseT local Ethernet interconnects all analyzer boards with the system controller. Updated data on errors detected for all transport streams, as well as for the actual transport stream content tree, are exchanged on a continuous basis. The fast system controller collects all preanalyzed data, compares measurement values against the given limits, provides data logging and SNMP traps, and displays the results on the GUI.

Tailoring monitoring details

To avoid unnecessary alarms, it is crucial for a monitoring system to be capable of adapting all tests to the individual signals by adjusting measurement limits and excluding specific test elements. An indefinite number of monitoring configurations can be stored on the controller's hard disk.

Every input is assigned to one monitoring configuration stored on file. This allows different streams to use either the same or different configurations. These monitoring configurations also include the basic stream standard, which can be ATSC, DVB or SCTE (for U.S. cable systems). This way, the system is capable of checking ATSC-compliant streams and typical cable streams simultaneously.

The system includes the common set of tests — called first, second and third priority errors — as they are defined in ETSI measurement guideline TR101 290. Because some of the third priority tests verify service tables exclusive to the system, a modified version of those tests was used for the ATSC PSIP system. Besides the usual checks for tables, such as MGT, STT, TVCT and so forth, further tests are included that are beneficial for ATSC OTA TV.

Other checks include the verification of the transport stream ID against a given number. The transport stream ID is a unique ID that is assigned to every station by the FCC. Another test verifies that the bit rates of elementary streams (video/audio/data) are within given upper and lower boundaries. The monitoring system also checks when one of the services or multiplex elements disappears unexpectedly, a new one shows up or one changes its type (i.e. from video to audio or data), unless such modification is announced correctly. Verification checks include tables required for OTA supplementation, such as the DCC and LTST for directed channel change and the DET for data broadcasting to ATSC A/90.

Rohde & Schwarz's DVM 100/120 monitoring GUI can display the status of several details for each input.

Display guides the user through data zoo

The GUI provides instantaneous access to monitoring data of all stream inputs. It can be viewed and operated either locally or remotely through a LAN/ WAN connection. The default monitoring view offers three windows, of which the two left ones display hierarchical trees and remain on the screen at all times, with other in-depth windows. The upper window of the two (titled "Site") displays a hierarchical tree of all streams currently under investigation systemwide. The user can give all streams unique and easily identifiable names and group them into custom-named folders (i.e. "satellite feeds," "off-air," etc.)

The left lower window ("Input") shows details of the stream currently selected in the Site window above, with a hierarchical representation of all elements, such as video and audio elementary streams, service tables and other metadata. Both tree displays have a common coloring scheme used to indicate each element's error status (red dot = failure; yellow dot = failed before, currently without error; green dot or not marked = no error). If within any of the two tree displays a group of elements is collapsed, the remaining folder icon carries the summarized status of all elements with its color identification. This is valid over several levels and also for groups of folders, so that uninteresting details can be removed from the screen without losing the capability of monitoring any errors within. A red indicator with any folder icon leads the user to the troubled item underneath by a subsequent opening of tree branches.

The main window on the right side during monitoring mode is titled "Statistics and Log" and displays all monitoring errors observed by the system on the selected stream. The upper portion shows the error seconds per each error type, while the lower one lists all errors by time in a continuous log.

To interpret the displayed data, a system of context-related menu options is used. Depending on which error-indicating element is highlighted, further menu options are offered via right-mouse click.

Monitoring made easier

The DVM 100/120 can verify multiple transport stream signals simultaneously. It offers a large number of detailed real-time checks that can be easily tailored to the individual characteristic of each signal. To keep a clear overview, a specialized user interface not only unveils all monitoring details but also their interrelationships. **BE**

Alexander Woerner is the manager of market development for Rohde & Schwarz.

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Evertz MVP monitors KQED-TV

BY LEE YOUNG

KQED-TV serves the San Francisco Bay area and is the third largest PBS affiliate. The station has followed a steady path toward DTV beginning with the launch of its digital television 30 channel in 2000. Since then, the facility has migrated to a fully digital multichannel system that transmits four simultaneous SD channels at any time or one HD plus one SD stream during prime time.

The migration to multichannel was part of the facility's complete analog-to-digital upgrade, which features a tapeless environment with servers and other automation. To monitor the facility's multiple broadcast signals, monitor the quality of incoming synchronized satellite feeds, ingested archival material and QC competence satellite and ingest reach, KQED selected an Evertz MVP multi-image display and monitoring system.

One digital master control operator and one or two ingest operators monitor the displays at all times to ensure signal health.

In addition to monitoring video, the display system provides monitoring for closed captioning, analog and AES audio, as well as user-configurable analog and digital clocks for timing.

Evertz's MVP has 15 agnostic slots in a 6RU, front-access enclosure. It is a versatile multi-input signal monitoring and display solution.

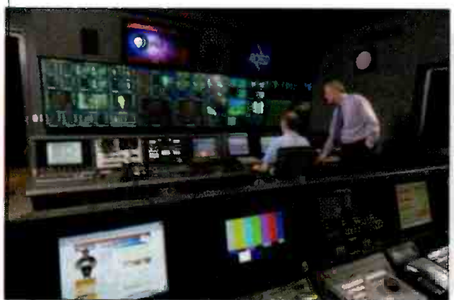
The system is installed in the digital master control room and two ingest stations, with five processors shared between the three rooms. Three processors are in master control, and one is at each ingest station. Digital master control monitors a variety of SD and HD signals on a full wall of Christie 60-inch cubes, including cable and off-air feeds, as well as satellite recordings and automation playlists. Meanwhile, ingest operators use MVP's multi-image display on Clarity 42-inch LCD screens to playbacks. Audio-level monitoring is important to the ingest process, while in master control it's only necessary to ensure the presence of audio.

Evertz enhanced its display with VistaLINK PRO, an SNMP monitoring and configuration tool that provides integrated signal monitoring and an open alarming interface to pinpoint signal problems. While some systems provide two to four simultaneous monitoring parameters for a single input, the MVP can provide extensive fault monitoring for up to 72 unique inputs per display. The system can present fault detection in in numerous ways, including user-configurable on-screen alerts and audible alarms.

The station also has purchased a second monitoring system, which is fed by multiple aux buses from the production switcher. Each processor provides single-card multiple outputs for both SD and HD signals. Unlike the on-air encoder, which switches between SD and HD formats, the MVP accepts feeds of both formats, plus composite analog, on the same BNC when ingest signals change between SD and HD.

While configurations can be altered easily, there hasn't been much need to alter the image displays. Changes to window size, aspect ratio (4:3 to 16:9 and vice versa), HD/SD integration, luminosity and other display aspects are made through a software interface and PC. The multi-image display layout is set up through templates. Preset selection and an intuitive drag-and-drop application allow the user to make changes and save them in the template.

The multichannel environment has streamlined station operations. The automation is in control of switching because a single operator cannot handle switching all channels and breaks. One digital master control operator and one or two ingest operators monitor the displays at all times for signal health.



The Evertz MVP multi-image display and monitoring system is used to monitor the facility's numerous broadcast signals, satellite feeds and ingest applications.

MVP provides a return on investment through the elimination of unnecessary system components, such as master control under-monitor displays. MVP accepts program information from the server and displays clip numbers, counts up- and down time and other playlist information. The display system decodes monitored signals for closed captions, so a separate decoder is not needed.

KQED will expand MVP within the next year to replace CRTs in the production control room, where it will add HD cameras and other HD equipment. While the production control room will be used as a separate feed from master control and ingest, the current system frames can be used and power supplies will keep expansion product costs to a minimum. The frames have swappable modules, so it's possible to replace a current single-output card with a dual-output card. This product design also addresses simple maintenance issues. Old modules can be easily replaced, and the entire system runs on redundant power supplies.

Evertz's MVP is a future-proofed monitoring system with features that should fulfill KQED's monitoring requirements for a long time. **BE**

Lee Young is manager of engineering facilities for KQED-TV.

Digital Vision helps Cablevision launch HDVOD

BY MICHAEL GROTTICELLI

As American consumers' appetite for HD programs continues to grow, stimulated by a significant reduction in digital HDTV set prices, broadcasters and multichannel system operators (MSO) are experimenting with a variety of distribution platforms and technologies to satisfy demand and help business grow.

With more HD sports and entertainment channels debuting in the United States all the time (there are currently about 30 HD channels available), cable and satellite TV operators have quickly begun to build out their infrastructures with sophisticated encoding systems that help operations engineers automatically manage and control the available channel bandwidth. The better the encoding system, the more digital channels operators can squeeze into new subscription TV services.

Launching HDVOD

Cablevision Systems, based in Bethpage, NY, has installed about one million digital set-top boxes to date, with roughly 25,000 able to receive and display HDTV signals. Last fall it became the first cable MSO to launch an HD video-on-demand (HDVOD) tier offering a collection of major motion pictures, independent films and IMAX titles for $6.95 each.

Facilitating the new pay-per-view service, Cablevision is using the Digital Vision BitPack-HD pre-mastering workstation. It's an HDTV offline signal encoding system that creates 1080i format digital files from D-5 videotape and 35mm film masters. The workstation also can generate 480i and 576i SD streams.

The cable company distributes these HDVOD titles with specialized encryption software that allows thousands of customers to individually rent the titles at their leisure and view them for a 24-hour period. While watching the programs, viewers have the full array of VTR-like functions — fast-forward, rewind and pause — at their fingertips.

Encoder hardware

The encoder is used for video file compression, which is critical for conserving channel capacity and maintaining a HDVOD business. The system is used for digital cinema, archiving and DVD applications, and it supports future HD DVD formats.

Cablevision was the first to launch an HD video-on-demand tier with the BitPack-HD.

The hardware behind BitPack-HD is based on a proprietary MPEG-2 compression engine. This provides picture quality and the flexibility to adjust bit rates as necessary. Also included with the workstation computer are integrated machine control functions that enable cable operators to perform automatic frame-accurate encoding and real-time playback. With an intuitive Windows NT user interface, the encoder enables comprehensive project management (using integrated EDLs), bit-rate encoding control and quality-of-service (QoS) monitoring via thumbnail pictures.

At Cablevision's headend facility in Bethpage, engineers can take a D-5 master tape and use the workstation system's sophisticated compression algorithms to reduce the size of the resulting audio and video data files. The result is two separate streams (one for SD and one for HD) that are distributed through several SeaChange VOD servers.

Looking ahead

The cable company currently transmits 1080i HD programs with a data transfer rate of about 14Mb/s, which produces an HD picture. However, this rate can be changed during different parts of the program as new services are added or as special live events (such as sports) require.

The BitPack-HD system is completely upgradeable. Users can purchase the SD version to get their digital program service off the ground, then migrate to HD channel programming with a software and hardware exchange. Cablevision operates two BitPack-SD systems and upgraded one to HD operation via a hardware-board swap to feed the new HDVOD service.

Though Cablevision was the first to launch an HDVOD tier, now many other operators are following suit. Using the Digital Vision BitPack-HD workstation, HDTV programming can be quickly developed into a profitable business. BE

Michael Grotticelli regularly reports on the broadcast industry.

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The cost of standards

BY PAUL MCGOLDRICK

Sometimes we hear but we don't listen to what we're told. Such is often the case with standards, and the costs of our miscommunications can be incredibly high. NASA recently learned this painful lesson because one of its teams was using metric units while another was using Imperial units. The misunderstanding led to the demise of the Mars Climate Observer. (Why are some NASA teams using Imperial units anyway?) Misuse of SI units is also a common error in the United States and can be very confusing. Consider, for example, a medical measurement of thyroid activity known as T4 that expresses units in μg/dL. Decilitres?

Some other international standards are neither international nor standard. The publishing world has adopted the International Standard Serial Number (ISSN) standard for periodicals and the International Standard Book Numbering (ISBN) standard for books. But when it comes to, say, paper sizes, the International Organization for Standardization (ISO) standard (ISO216) has certainly never caught on in the United States; nor do we use the ISO8601 standard for date and time notation (date in YYYY-MM-DD). ISO9000 standards have been forced on vendors who want to sell internationally, but it never ceases to amaze the author how American business shows its ignorance by neglecting — refusing — to conform to standards, thus hindering its ability to do business in the rest of the world.

Several decades ago, when the world felt a lot smaller — when international travel was rare and strawberries were available in your local markets only for a short period in June and July each year — there were reasons for independent direction in standards. The United States adopted 525-line 29.94fps monochrome NTSC television because it wanted more resolution than the British 405-line 25fps system and because it wanted to reduce the visibility of frame bars on the display caused by poorly engineered power supplies.

When it came to color standards, U.S. engineers made the common sense decision to provide a backward-compatible video signal for viewers with existing monochrome sets. Germany invented PAL to overcome what it considered a major design flaw in the existing color standards. But it was also a marketing issue, because European vendors believed PAL would keep the U.S. manufacturers out, and the emerging Japanese manufacturers would focus on the larger North American market. Japan pulled a similar trick after WWII by opting to drive on the left side of the highway to keep North American vehicle manufacturers out of their market — and it worked.

U.S. engineers made the common sense decision to provide a backward-compatible video signal.

In the PAL versus NTSC decisions, the British went a step further by insisting on using a higher video bandwidth and moving the sound carrier a further half-megahertz away from the video carrier to 6MHz. With other European vendors focused on manufacturing TVs with 5.5MHz separation, British manufacturers like Rank-Bush-Murphy expected to keep the domestic market, along with markets in countries such as Hong Kong and South Africa, to themselves.

With the exception of the Japanese motor industry, this protectionism hasn't worked. For example, the largest vendors of TVs in Britain turned out to be Philips and Sony. Rank-Bush-Murphy went out of business in 1980 after a failed venture with Toshiba. And as for SECAM, well, let's not even go there.

Recently, U.S. companies played a game of chicken with the Chinese. The Chinese proposed a unique security protocol, Wireless LAN Authentication and Privacy Infrastructure (WAPI), to replace the existing 802.11 security standards. They were going to ban imports of products that did not include WAPI, starting on June 1, 2004. In the U.S., two companies, TI and Atheros, caved in, while Intel and Broadcom said they would not go along with it. The latter two companies realized that agreeing with it would have opened up the floodgates for other cute little standards imported from China. And since when does China have any interest in its citizens' privacy?

Intel and Broadcom listened. They heard not just the message, but the future. Others listened but just heard their wallets shrinking. When it comes to the next generation of HDTV, which is not that far away, can we, as a planet, sit down, listen carefully and make some sensible decisions? BE

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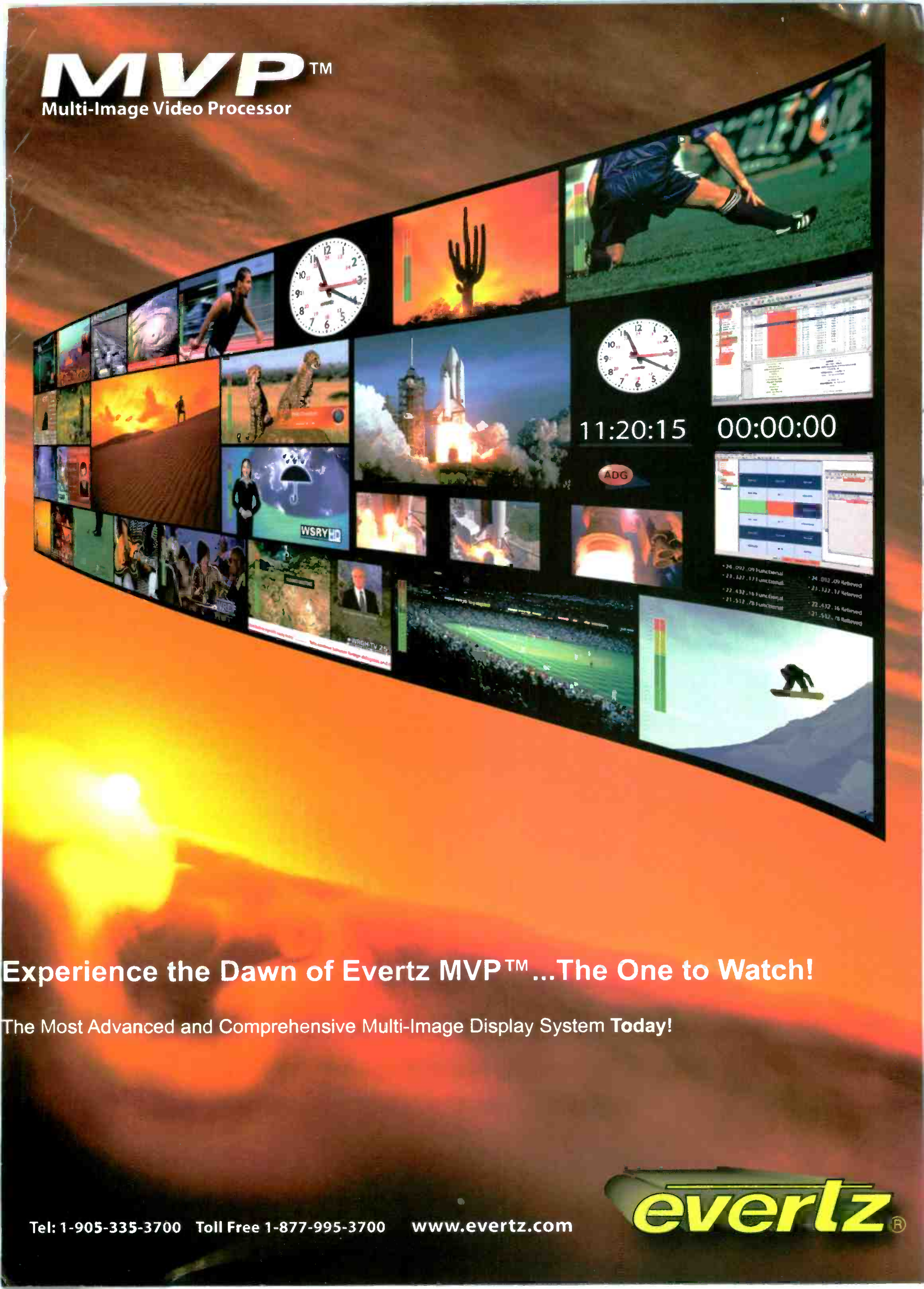
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