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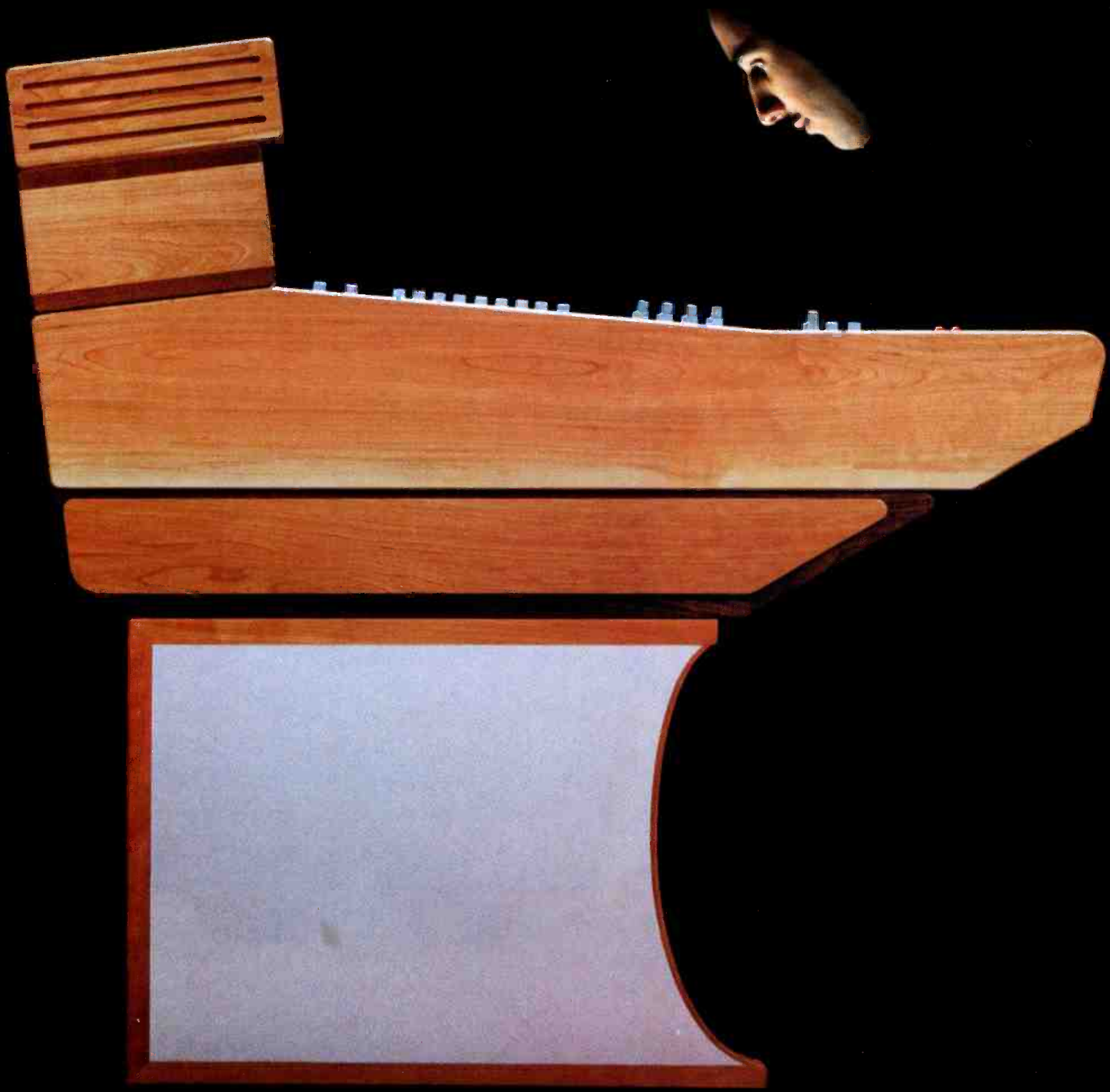

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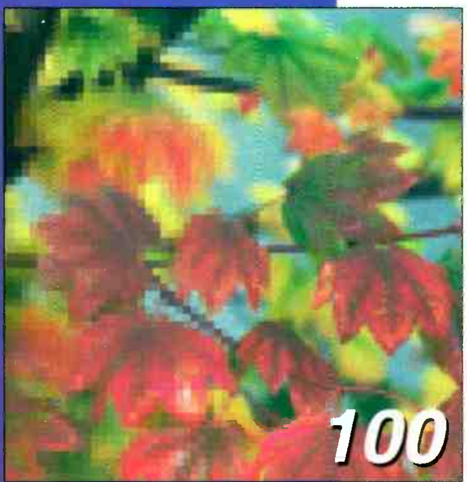

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913/967-1905 fax

FREEZE FRAME

A look at the technology that shaped this industry.

Do you remember?

How far we've come! In February of what year was this ABC engineer shown operating a "new" device for sports coverage, and what was it?

Answer: The year was 1969 and the "new" device was the Ampex HD-100 disc recorder. Record time was 1 minute on a 16-inch disk. Cost was $100,000. (that's about $500,000 today!)

Marching to the DTV drummer

Ever heard the line "If you build it, they will come" from the movie *Field of Dreams*? Recently it's been uttered by a variety of pundits from Wall Street to Sesame Street when referring to HDTV, but they have added a new twist, "If you build it, *will* they come?" Trouble is, after it's asked, few seem willing to answer the question. Well, I think the question has been answered.

I recently spent several days at the January Winter Consumer Electronics Show (CES). I attend the show infrequently, but when I heard that Harris Broadcast was going to host a special DTV event, I decided it was time once again to check it out.

What I learned was more than a little surprising. Although it's no secret that TV set makers need something new to sell, I didn't expect as much excitement and visible support for HDTV from them as I saw. From the set makers to DirecTV, to broadcasters, everyone's onboard the HDTV train, and this baby is ready to roll.

The show had plenty of set makers showing off their new TV sets. In the past, we mostly saw recorded clips of flowers or fish, much of which wasn't even real HDTV. However, this time, the images were live, off-air HDTV feeds from two Las Vegas stations, KLAS and KLVW. There was lots of material, some designed to stress the receivers, but all of it looking great. There were plenty of flat-panel displays, new projection systems and lower predicted prices. Sets will be available by the third quarter of this year. And, if you think all this won't matter because there won't be any images to view on these sets at your local Radio Shack or Best Buy, think again. DirecTV announced that it will soon begin delivering two channels of HDTV programming.

Before concluding, I want to give a "Well done," to the folks at Harris. I've been to a lot of press events (most could have been neglected without missing anything), but this one was different. The company hosted a session the day before CES opened to highlight its research supporting the conversion to DTV. Although you might question the research the company conducted, Harris also had independent sources there presenting their own data on the subject. Company officials promoted HDTV and the technology; they did not promote their products.

Later that evening, Harris hosted what had to be the most upbeat, no-holds-barred, rousing kick-off for DTV (or any other broadcast technology) ever. While I expected a typical snoozer, complete with company talking heads spouting the advantages of "their" solutions, what I, and more than 200 others, got was a fantastic evening's entertainment, in addition to some great facts and demonstrations of HDTV and DTV.

Congratulations to Harris for supporting DTV at CES. It helps not only broadcasters, but also our partners in this endeavor, the consumer electronics industry.

So to the question I first posed: Will they come? Well, I've seen it and when you build it — they will come.

Brad Dick

Brad Dick, editor

direct: brad_dick@compuserve.com
website: www.broadcastengineering.com

Reader Feedback

re: the October 1997 "Digital Basics"

Dear Paul,

Yes, the 2.4GHz digital wireless sender really works! I just bought the Wavecom Jr. brand (it cost $95) from one of our distributors for video products (Petra) and frankly, I was skeptical. I am surprised to report that the quality is satisfactory and better than expected!

I needed to transmit a PrimeStar signal to another part of the house, approximately 40 feet away and downstairs. Yes, the receiving antenna must be pointed in the general direction of the transmitter, but the transmitter did not need to be pointed at the receiver. I have not noticed any interference due to other equipment operation, nor does walking between the units cause any signal degradation.

You might want to purchase one to experiment with and see for yourself all of its possible uses. I also plan to use it with my camcorder for times when I want the signal to transmit to a monitor or recorder at a close distance where wire would be impractical. It also transmits quality stereo sound and can be used for audio applications, as well.

I have also been trying some wireless speakers around my house with excellent results, solving some wiring problems with a simple solution.

Yes, it truly is a TV station for $150.

DONALD D. FLINT
PRESIDENT/CEO
DF&A WIRELESS
CORPUS CHRISTIE, TX

Another roadblock for DTV?

Brad Dick wrote in his December 1997 Editorial: "In November, I again reminded readers how stupid rules seem to be the normal course of action by elected officials (and bureaucrats)." Here is yet another example:

Dear Brad,

I know most *Broadcast Engineering* readers are more concerned, understandably, about having to implement ad-

vanced TV and how to finance advanced television, however . . .

The Copyright Royalty Tribunal recommended increasing direct-to-home (DTH) network copyright fees by 900%, more than cable's fees for the same network signals. When the Library of Congress approved that raise, I realized that whether intentional or not, another roadblock had been put in place to block the road leading to smooth growth, development and implementation of ATV-DTV in the one area of program distribution that can most easily embrace network ATV-DTV technology, the DTH industry!

Can anyone provide a detailed explanation of either the Copyright Royalty Tribunal's or the Library of Congress' logic and reasoning for the disparity between past and new DTH copyright liability vs. cable's copyright liability?

Cable advertisements compare (promote) their service vs. DTH. The ad touts cable's ability to carry multiple channels (multiplexed) on one coaxial cable. Each TV connected to cable in one dwelling, can display any of 20 to 45+ channels all at the same time — while DTH receivers can only tune and output one channel at a time. So, without multiple DTH receivers (and modulators), off-air broadcast reception, cable, or other signals (modulated onto channels other than 3 or 4) DTH owners must watch the same channel on any/all TV sets in the dwelling that are connected to the DTH receiver.

To date, no one in Congress or the broadcast or cable industries can explain the logic. If you can, I'd like to hear it.

ROBIN ADAIR, CET
THE VIDEO LADIES
DULCA SCENES
2471 MONTPELIER RD.
COLUMBIA, KY 42728
DULCA@DUO-COUNTY.COM

re: the November 1997 Editorial "Stupid Rules"

If you want to know about DTV or HDTV ask your Congressman or Senator! (Particularly those on the Communications Committee, i.e., former Senator Hank Brown from Colorado — "I can't answer that question, but I will certainly ask my office advisor about that issue." My answer was — Wait a minute, I didn't ask about an issue, I just asked a simple question.

JACK E. MCKAIN
ITELCO
DENVER, CO

READER FEEDBACK
INTERNET: ***brad_dick@compuserve.com***
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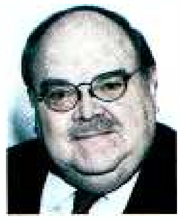
News

TCI has "different" HDTV



BY LARRY BLOOMFIELD

"*TCI May Deny HDTV to its Subscribers*" and "*TCI Cable Service May Provide Only Low-Resolution Digital Television*" were headlines that blazed across the wire services recently.

Last month, while speaking to the National Association of Television Production Executives (NATPE) in New Orleans, Consumer Electronics Manufacturers Association (CEMA) president Gary Shapiro said, "Manufacturers and broadcasters have committed to bringing Americans the astounding picture resolution of HDTV, but now TCI's 14 million customers may never have the chance to see it. This is a huge tragedy for the American consumer."

TCI plans to downconvert broadcaster transmission of 1,080 interlace (1,080-I) HDTV and then pass it on to its subscribers in a lower resolution, 480 progressive (480-P) format. Under these circumstances, TCI's subscribers may suffer a loss of more than 80% of their spatial resolution when compared to the 1,080-I signal were they to receive it directly.

Gary Shapiro

Leo Hindery, Jr.

"This highlights the importance of the FCC's upcoming must-carry proceeding," continued Shapiro. "The FCC must ensure that if broadcasters transmit programming in high-definition, cable companies are required to pass the programming through to the consumer in the same manner. Otherwise, cable subscribers will be involuntarily downconverted to a picture resolution no better than today's TV."

Although the next generation of TV receivers will be able to receive and decode the lower-resolution 480-P as one of the 18 formats available, the lower-resolution 480-P, just isn't HDTV. "Any effort to label 480-P as true HDTV is an attempt to fool American consumers, who want the highest level of resolution they can get. HDTV could have a wonderful future, but it won't if Americans aren't allowed to see it," Shapiro concluded.

The cable industry has always had the charter to pass along to their subscribers exactly what they received from their various sources. Case-by-case exceptions have been made when it has been impractical to pass on some program material in stereo.

To present the other side of the story, Leo J. Hindery, Jr., president of TCI, said, "CEMA's information is incorrect and it was extremely irresponsible of them to mislead the public. The truth is, TCI has provided for additional choices and flexibility for all involved. The technology in TCI's advanced digital set-top devices allows a TV signal in any HDTV format to be transmitted to a customer's high-definition TV set. Second, customers who do not own a high-definition TV set can receive 480-P HDTV signals, translated into a standard-definition format, with the set-top device as currently configured. As the market for HDTV evolves, TCI will continue to respond to the needs of its customers. Any accusation that we are impeding this process is dead wrong."

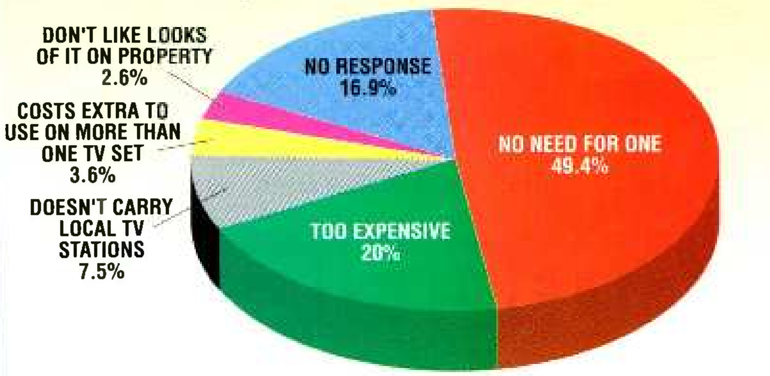
Hindery continued, "We believe strongly that the marketplace will drive this business and determine which HDTV format will be used. The dialogue continues in the broadcast indus-

FRAME GRAB

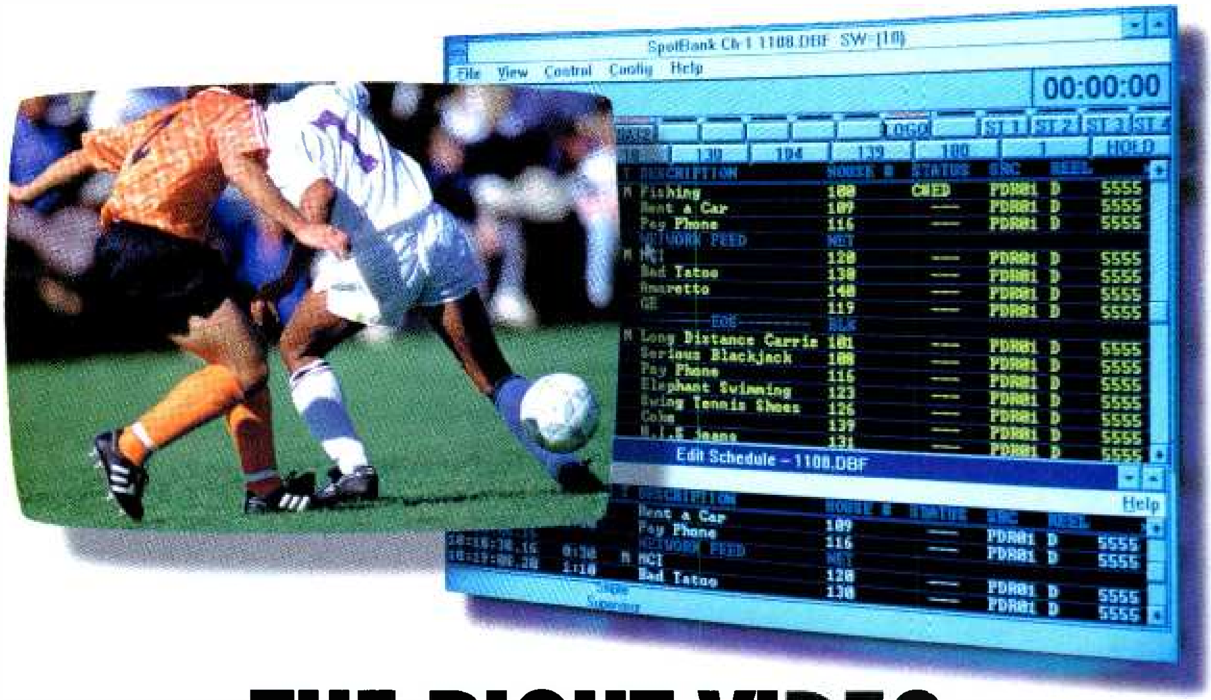
A look at the issues driving today's technology.

Why won't you buy a satellite TV dish in the next 12 months?

Broadcaster's greatest friend may be DBS-equipped homes. A Yankee Group's survey on satellite TV dish ownership showed that relatively few consumers cited the fact that DBS does not carry local TV stations as a reason to not buy a dish.



Source: SCRI International. For more information on broadcast and production industry trends, contact www.scri.com or e-mail: scri@scri.com.



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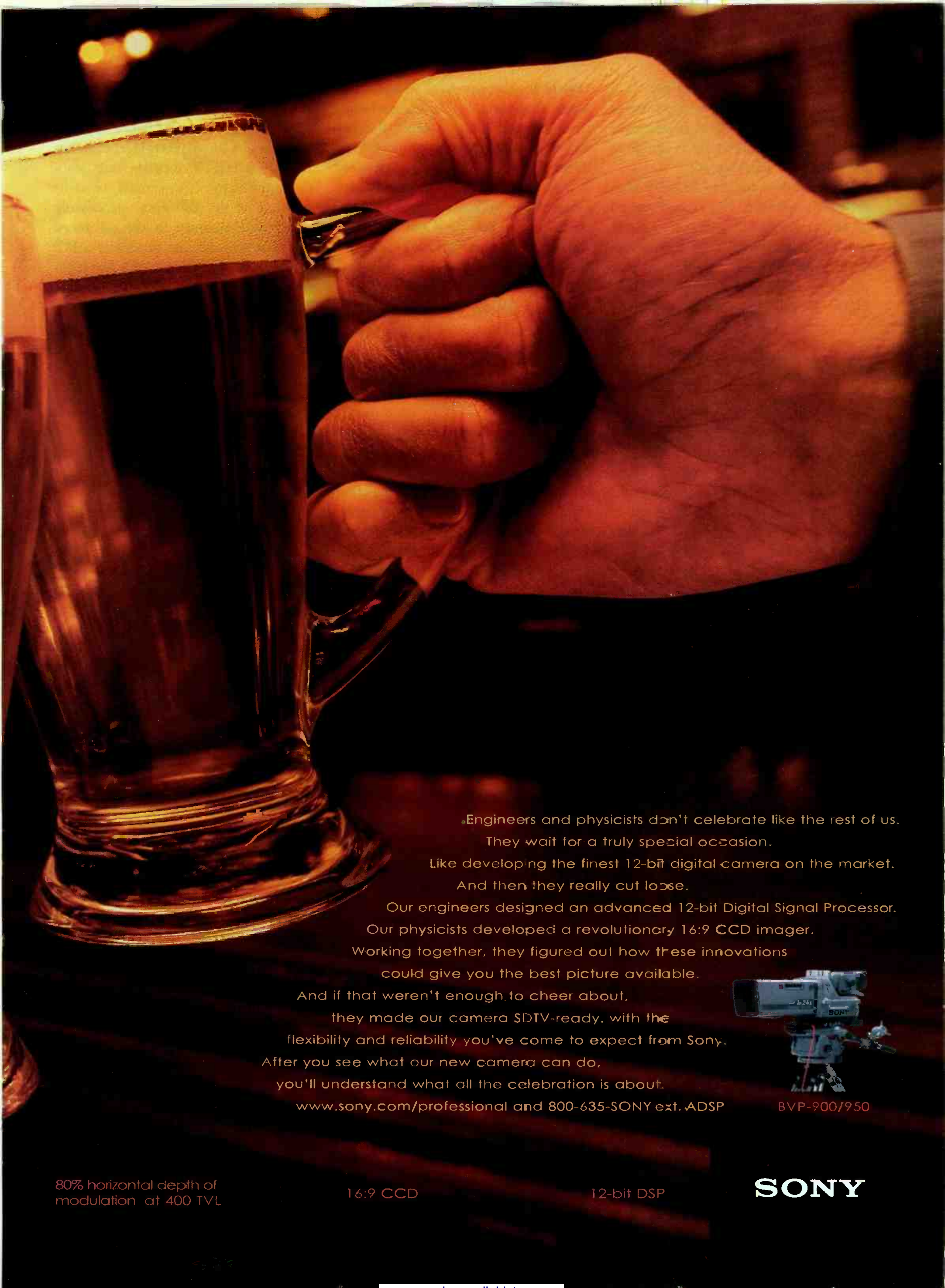
Engineers and physicists don't celebrate like the rest of us.
They wait for a truly special occasion.
Like developing the finest 12-bit digital camera on the market.
And then they really cut loose.
Our engineers designed an advanced 12-bit Digital Signal Processor.
Our physicists developed a revolutionary 16:9 CCD imager.
Working together, they figured out how these innovations
could give you the best picture available.
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try surrounding HDTV formats and digital multiplexing. The outcome of this dialogue will help determine the HDTV product ultimately available in the consumer marketplace."

A few days after CEMA's Gary Shapiro addressed NATPE, TCI countered by saying, "TCI unequivocally affirms that its advanced digital set-top devices will indeed have the capability to pass through, to high-definition TV sets, HDTV signals in the 1,080-I format or any other proposed HDTV format that may be selected by broadcasters and the consumer marketplace. Furthermore, since the introduction of high-definition TV sets into consumers' homes will happen over time, TCI has taken the extra step of incorporating the ability to translate *480-P HDTV* signals into the standard NTSC format for display on consumers' standard-definition TV sets."

It is my understanding that only the 720-P and the 1,080-I have ever been referred to as high-defination television." TCI also stated, "Based upon the demands of the marketplace, translating other HDTV formats into standard-definition TV signals remains possible with additional processing speed and memory in the advanced digital set-top devices. In no way is TCI planning to "downconvert" any higher-format HDTV signal to a lower HDTV format." ■

Is lip sync in HDTV going to be a problem?

Much space has been given to the 18 different video formats that are part of the new DTV standards, but not much has been said about audio. You need to look at what you'll be working with, because there may be potential problems, if you are not aware of what's going on.

Dolby Digital AC-3 is Dolby's third and next generation of surround sound and is the audio system adopted for HDTV. AC-3 is also the digital film format and is used on the audio tracks of the latest-generation digital video disc (DVD). That's not all. With the recent changes to the PAL DVD specification, the AC-3 encoders are used in most parts of the world, including Europe, making it, for the most part, the worldwide format on audio tracks. This makes the techniques for encoding/decoding the same for DTV, DVD and HDTV.


Louis Fielder

AC-3 provides five full-bandwidth channels and a 120Hz bandwidth low-frequency effects channel (hence the 5.1 channel term) that provide extra headroom for special effects. The full-frequency range channels consist of right-front, center-front, left-front, right-surround (rear) and left-surround (rear).

The trick comes in carrying 5.1 channels of audio information, which would normally require close to 5Mb/s of data in a 384kb/s stream. Perceptual coding methods that take advantage of the human ears' tendency to respond to only the loudest of several closely spaced components of a sound are used to do this trick.

AC-3 also includes provisions for sending information about the audio in multiple auxiliary datastreams, such as language identifiers, copyright protection, time stamps and control information.

According to Louis D. Fielder of Dolby Laboratories in San Francisco, in a technical paper published by the Audio Engineering Society entitled Collected Papers on Digital Audio Bit-Rate Reduction: "A distinguishing feature of the AC-3 is that it processes multiple channels as an ensemble. It uses an oddly stacked TDAC transform and is designed primarily for single-point to multipoint consumer applications."

With that in mind, what do we do with AC-3 when it gets to our station? There could be some potentially undesirable side effects lurking in the corners ready to bite you when you're not looking.

It will help to understand the impending quagmire if we approach this from the standpoint of a station getting a feed in HDTV. The station will receive encoded AC-3 along with normal network HDTV video feeds. Dolby addressed this issue and said, "Most of the networks, except for PBS, are planning to distribute a mezzanine level rate-reduced datastream to their affiliates. The audio and video will run at a high enough data rate to allow several decode-re-encode processes to happen without losing any significant amount of quality. The final rate-reduction process that produces the 384kb AC-3 datastream and the video data that will be combined to make up the 19.39Mb/s ATSC transport stream, will happen at the transmitter." Now that should put some minds to rest.

But what about the network or other feeds that may be distributed, like PBS will be doing. According to Dolby, "PBS will distribute the 19.39Mb/s per ATSC transport stream to all affiliates just to get a system-wide HDTV presence from day one. The company realizes that for the HD programming, it won't have the freedom to brand its programs, but is willing to forego this to get the service started. I'm guessing that it will also go to the intermediate level of compression that will allow them the operational freedom it has now in the future."

There is some concern that decoding delays in AC-3 may raise their ugly heads. Dolby reassured me that "normally, the video is processed, when it goes through master control and has to be decoded and re-encoded in the same manner as the audio would have to be to add a voice-over." The saving factor here is that the video decoding, processing and re-encoding takes longer for the video than it does for the audio. The result is that we will still have to delay the audio to match the video, as we do today."

It appears that any station, especially the PBS affiliates, will have to decode the AC-3 back into all six channels, add what it needs to and then re-encode all six channels back to AC-3. According to Dolby, AC-3 decoders will have the ability to decode and reproduce any of a number of different configurations "from one to 5.1 channels from a com-

mon 5.1 channel bitstream." The channel playback configuration is the X/Y mode, X being the number of front channels and Y the number of surround channels. Thus, the AC-3 coding algorithm supports 3/2, 3/1, 3/0, 2/2, 2/1, 2/0 and 1/0 playback modes.

Also keep in mind that it takes time to decode and encode digital signals.

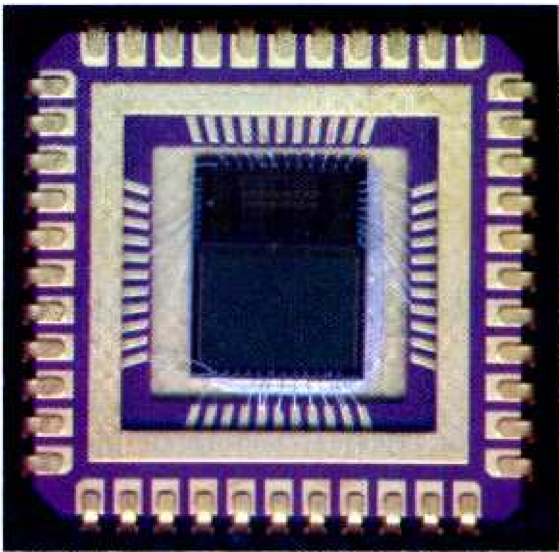
Fielder said, "AC-3 is a single algorithm with a high degree of flexibility with regard to data rate and other operational details."

In speaking with Brink's Intasys's Peter Burinskas who was involved with the audio codec concept and associated compression issues said, "Where the Grand Alliance's selection of the AC-3 scheme gets dicey is in live feeds that need to be VO'd. The problem, even when sending the original 5.1 signal out as 2/0, is the encoder delay. If you are feeding a digital transmitter with an uninterrupted compressed digital signal, and all of the boxes along the way "speak" AC-3, all is wonderful in TV land. The moment the signal is decoded for enhancement of any kind, it must be fed to the transmitter as uncompressed or recompressed using AC-3. The encoder/decoder chain total processing delay averages 100ms. Most of this is in the encoder, with only 5ms to 27ms delay resulting from the decoding process. This means that at best, 'walking up to the post' is gonna be tough.

Two questions. Is there a simpler way of doing it? How can we do our local audio business, such as inserts without screwing up the incoming signal? If you think about it, we're sure you can think of several more concerns. ■

A new chip for cameras

Looking to buy new cameras in the not too distant future? Well hold on to your hat and those budget dollars too. It looks like you could get much more for your money and better pictures to boot from a new generation of cameras, if they use a recently developed chip from the Sarnoff Corporation. Sarnoff, the former RCA Laboratories, has developed an image sensor based on complementary metal oxide semiconductor (CMOS) technology. The new CMOS active pixel sensor (APS) has a dynamic range that is nearly 100 times that of standard charged-coupled device (CCD) sensors, at comparable resolutions. This means better shadow and highlight detail. What's more, the APS-CMOS can control exposure without the need for a mechanical iris. The onboard electronics also eliminate the need for external analog-to-digital converters and other circuitry normally required in CCD-based cameras.



The chip is designed to give full TV resolution with video output in analog and 12-bit digital form. The temporal noise is as low as 10 elec./pixel for demanding applications, with a dynamic range better than state-of-the-art CCDs (more than 110dB), to preserve image detail in highlights and shadows. APS-CMOS chips have lower power consumption than CCDs, making it attractive for battery-powered applications. The chip is also compatible with color filter technology.

The design incorporates breakthrough technology that virtually eliminates the performance limitations associated with previous CMOS-based image sensors. The design of the internal circuitry reduces fixed pattern noise to <0.01% of full signal, below the threshold of visibility.

Michael Ettenberg, senior vice president of Sarnoff's solid-state division said, "The CMOS APS is virtually a 'camera on a chip,' and we believe it will revolutionize the way cameras are made and used. Not only can it replace CCDs in many current camera applications — it will help create new applications. Its low cost allows engineers to add vision capability to products where it would once have been too expensive. Complete cameras based on the CMOS imagers will be cheaper right from the start, because they'll need fewer electronic parts and consume less power."

It came as no surprise when Ettenberg commented, "We expect the quality of the resolution to eventually overtake what you can do with film. As we move forward and improve the technology, we'll be able to have the same quality as pictures from high-definition TV sets and beyond."

The cost of the chip is low enough to make the digital camera as inexpensive as a computer mouse and just as common. Ettenberg predicts that the CMOS APS chips will start at prices comparable to those of equivalent CCDs and then drop as volume increases. Unit costs for the chips could be in the $6 to $10 range.

The company will license the technology to camera makers and provide engineering support to modify the sensor's design to fit specific cameras and applications. The company has already approved two foundries to fabricate the chip, and will supply design tapes for manufacturers who wish to produce it in other foundries.

For additional information, check out www.sarnoff.com. ■

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The goal of NBC and SGI was to present complex statistics in a way never before seen on network television, while providing an informative, entertaining interpretation with a new look

As the football game progressed, several on-site engineers used SGI's O2, desktop workstations to input data, play by play, so it could render the results live on the Onyx2 systems when needed. An NBC spokesperson said, "There was a separate machine for every category or separate graphic they built. This SGI equipment and software and a live set where the commentator made his presentation were all housed in a separate trailer near the remote truck.

At the conclusion of each quarter, Randy Cross, NBC Sports commentator used statistical charts created by the Silicon Graphics Onyx2 systems to provide viewers with a live, 3-D animations of key game elements from the graphics trailer. "Statistics are a necessary part of football, but numbers are boring. Pictures excite people. The capabilities of real-time live, instead of a pre-made packaged piece made my job as a commentator much easier."

The 3-D model of the stadium was created by MultiGen, Inc., using its real-time, 3-D modeling tool, MultiGen II Pro. Also working with Silicon Graphics was Boston Dynamics who had developed Football-Guy, a special version of its DI-Guy (software which was created to visualize football defense formations).

The equipment was, for the most part, off-the-shelf SGI gear, but the software was a joint effort custom modified or designed specifically for this particular event.

The current price tag for this "solution," including the custom software and hardware, is pretty stiff. The approximate cost for everything in this particular solution was about $250,000. However, like everything else, the price should come down for these packages as they come into more common use.

For more information, check out **www.sgi.com**. ■

CEMA unveils new logo

At the International Consumer Electronics Show in Las Vegas last month, the Consumer Electronics Manufacturers Association (CEMA) and the Advanced Television Systems Committee (ATSC) unveiled a new logo for the DTV Receiver Certification program.

This new logo will be displayed on TV sets, computers and other consumer devices to signify to consumers that the product they are about to purchase will be capable of receiving and presenting for display all ATSC video formats.

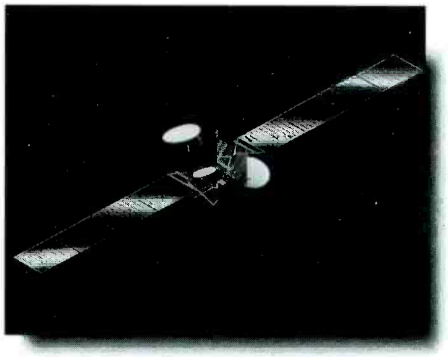
The CEMA/ATSC certification program, which will be administered by CEMA, will allow manufacturers to assess their products for conformance to the ATSC standard. ATSC will establish the conformance standards and compliance testing procedures.

For more information, contact CEMA at www.cemacity.org or ATSC at www.atsc.org. ■

Blazing trails in DTV

When you want to do a job right the first time, you start by getting the best people you can. That is what Hughes did when it put together its subsidiary, DirecTV. To lead the team, the company nabbed Dave Baylor, NBC's Skypath wizard.

Because DirecTV delivers TV programming digitally, it might give us some insight as to what terrestrial broadcasters will be getting into. My first step was to get a direct broadcast satellite (DBS) receiver. If there were any faults, I'd see them on my 50-inch TV set. The difference in picture quality over any of the cable services or off-the-air signals exceeded my expectations.



Step two was to give the engineers at DirecTV a call. I asked Jeffrey Crosby, senior vice president in charge of engineering, what DirecTV had planned. He said, "There are 18 different formats all separate from NTSC. Given the large established market, we will continue to transmit NTSC for many years to come. DirecTV will most certainly want to offer digital TV formats to the consumer that will be consistent with these (other) new formats."

DirecTV broadcasts from satellites some 22,300 miles out in space. "We currently have three satellites flying in close formation. Each satellite has 16 transponders. DirecTV uses 11 transponders on DBS-1 and USSB uses the remaining five transponders. DirecTV operates all of the transponders on each of the other two satellites." DirecTV's uplink site is in Castle Rock, CO, and a second site is being built in southern California.

To get the number of channels to the viewer's receiver, I was curious about

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DTV. ADAPT OR DIE?

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GUIDE TO HDTV

Is it time to transfer my facility to a 601 type production at the very least?

Maybe. 601 isn't HD and will still require upconversion, but the output quality will be much better than upconversion from other sources. If your NTSC quality is good, you could use a high grade decoder and an upconverter to output HDTV in the short term. If it isn't, you should fix it because upconversion reveals poor quality and MPEG encoders don't like noise.

Can I pass through an HDTV signal if I'm not doing any local HD production?

Yes. The HDTV signal you pass through will be MPEG encoded and provided you don't modify it in any way, it's a cinch.

my archive material?

Careful noise reduction and pre-processing of these SD signals prior to upconversion will tackle each of these problems and enable you to maximise the value of your archives.

What kind of quality can I expect when I upconvert my local production for transmission in HD?

Best results are from a 601 digital source. Then analog component is the next best, finally the least good results come from a composite NTSC source. When you have no choice but to use composite, you will need the best decoder. With less than excellent decoding, residual NTSC color subcarrier can remain in the decoded video signal. This is then treated as video by the MPEG encoder, wasting valuable bandwidth.

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what kind of compression it used. When pressed, Crosby said, "We're using MPEG-2. The world of digital video compression is similar for everyone right now. We're dealing with the same issues trading off the number of channels vs. the image quality for those channels."

Crosby went on to indicate that when it comes to formats, the consumer will not decide. It will be up to the broadcasters. Ultimately, Crosby felt that if the broadcast industry narrows down to just a few of the 18 formats, they would become de-facto formats. ■

Harris and Lucent form DTV alliance

On Jan. 21, Harris Corporation and Lucent Technologies announced the formation of a strategic alliance to provide digital TV encoding equipment for broadcasters. The Harris FlexiCoder (tm) will use MPEG-2 encoding technology developed by Bell Labs, the R&D arm of Lucent Technologies.

The FlexiCoder is an expandable, modular, ATSC-compliant digital video and audio compression system. It will allow flexible, transparent switching between multiple channels of standard-definition video or a single channel of high-definition video, each with Dolby stereo digital audio. A data input module will accept EIA708 captioning data and will support an external Dolby Digital encoder. All video modes and formats in the original ATSC Table 3 will be supported, subject to ongoing standard-setting issues.

Four SD channels in a single ATSC transport stream (one TV channel) were demonstrated, with a target of six HD programs or one HD program to be available by NAB '98. For the target HD operation, six encoding engines are combined for increased horsepower. Of the six encoder engines used in the HD mode, four are required and two are configured as redundant standbys. For additional reliability, multiple modules of the same type can be installed as redundant pairs, with automatic change-over. The modules are hot-swappable, although redundant units must already be installed to allow seamless replacement of a failed unit.

ATSC transport stream outputs are available in a variety of formats, including ATM and SMPTE 310M. (310M is the new SMPTE standard for the link between the ATSC encoder and the 8VSB exciter. It is in the final stages of standardization.) A unique feature of the FlexiCoder and 8VSB exciter combination is a transport stream frame synchronizer. This decouples the timing reference of the transmitter from the transport stream clock rate, allowing the transmitter frequency stability to be determined by an external frequency reference (GPS, WWV, etc.) if desired. ■

Larry Bloomfield is a former chief engineer, industry consultant and author, located in Bend, OR.

Reallocating TV Channels 60-69

BY HARRY C. MARTIN

In a year-end action, TV Channels 60-69 (the 746-806MHz band) were reallocated to other services. Specifically, 24MHz at 764-776MHz and 794-806MHz were allocated to the fixed and mobile services for public safety use. The remaining 36MHz at 746-764MHz and 776-794MHz were allocated to the fixed, mobile and over-the-air DTV broadcasting services.

A proposal has been issued to develop rules for the public safety services that will operate in the Channel 60-69 spectrum and includes criteria for protecting analog TV and future DTV stations against interference.

Channel assignment update

In December, broadcasters responded to filings by the Association for Maximum Service Television (MSTV) and the Association of Local TV Stations (ALTV), which asked the FCC to revise the DTV table of channel allotments.

MSTV requested 357 changes to the table saying they were designed to reduce projected adjacent-channel interference among stations operating on the DTV channels and alleviate interference to existing NTSC service and new DTV service. MSTV changes included 32 additional allotments on Channels 60-69.

ALTV addressed the disparity in authorized power between UHF DTV channels assigned to stations operating on UHF channels and UHF DTV channels assigned to stations operating on VHF channels. ALTV suggested allowing DTV stations to increase power to 1,000kW if they use beam-tilt antennas or other technologies to prevent additional interference.

Fees for ancillary DTV signals

The FCC plans to impose fees on stations that use digital spectrum for non-broadcast services and other uses that are supplemental to stations' over-the-air DTV signals. In an NPR, the FCC asked what methodology should be used to determine the fees. The rationale for imposing fees on ancillary use of DTV spectrum is that the commission does not wish to provide a competitive advantage to broadcasters over wireless licensees who purchased their spectrum at auctions.

The FCC proposed three alternatives to calculate the fees: 1) a percentage of gross revenues, 2) a percentage of net revenues or 3) a combination of both.

Harry Martin is an attorney with Fletcher, Heald & Hildreth, PLC., Rosslyn, VA.


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DTV Update

DTV: Broadcasting or datacasting?

BY LOUIS LIBIN

There are now more opportunities for broadcasting data and it is the new catch phrase for those who want to take advantage of the digital capacity of the new DTV channel. According to some estimates, the potential revenue from datacasting will ultimately run a close second to broadcasting revenue. In the beginning of the DTV era, however, datacasting has an even higher potential for stations to earn money than even broadcasting premier HDTV programming. To date, there is no conclusive research or evidence to prove the business model of the various datacasting schemes and plans that broadcasters are currently evaluating.

The new digital transmission technology will allow broadcasters to deliver high-definition pictures, CD-quality audio and additionally, data transmissions. The FCC adopted the standard, leaving open the video formats. This means that full flexibility is available to broadcasters for different video formats, all the way from high-definition pictures to low-resolution images. The digital broadcaster will be transmitting only data through its network, leaving it to make the choice of services to occupy the almost 20Mb/s. The use of data broadcasting will allow broadcasters and others to apply part of the 6MHz channel for other services, and these uses may prove to be a significant revenue stream, even at the beginning of the DTV service.

The DTV system owes much of its power and flexibility to the packetized transport technology employed for the broadcast delivery of the multimedia service.

Along with packetization, the transport technology provides two other important functions: multiplexing and synchronization of the services that comprise a program. The transport technology creates a stream of fixed-length information packets from a variety of elementary bitstreams. Each packet contains only one type of data: video, audio or ancillary. Because there is no fixed mix of packet types, the transport mechanism can dynamically allocate the available channel bandwidth for complete flexibility. Each transport packet consists of a four-byte packet header followed by 184 bytes of payload. The header includes means for synchronizing packets and identify-

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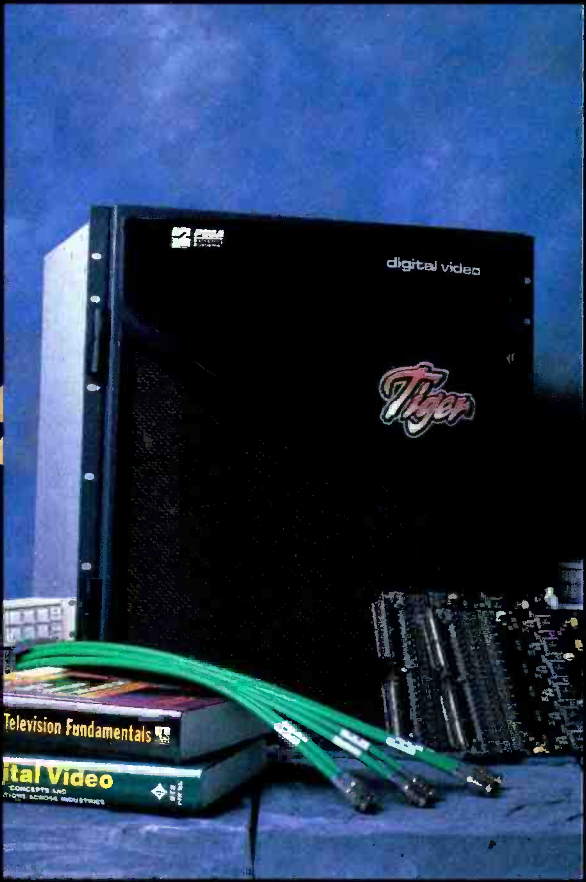

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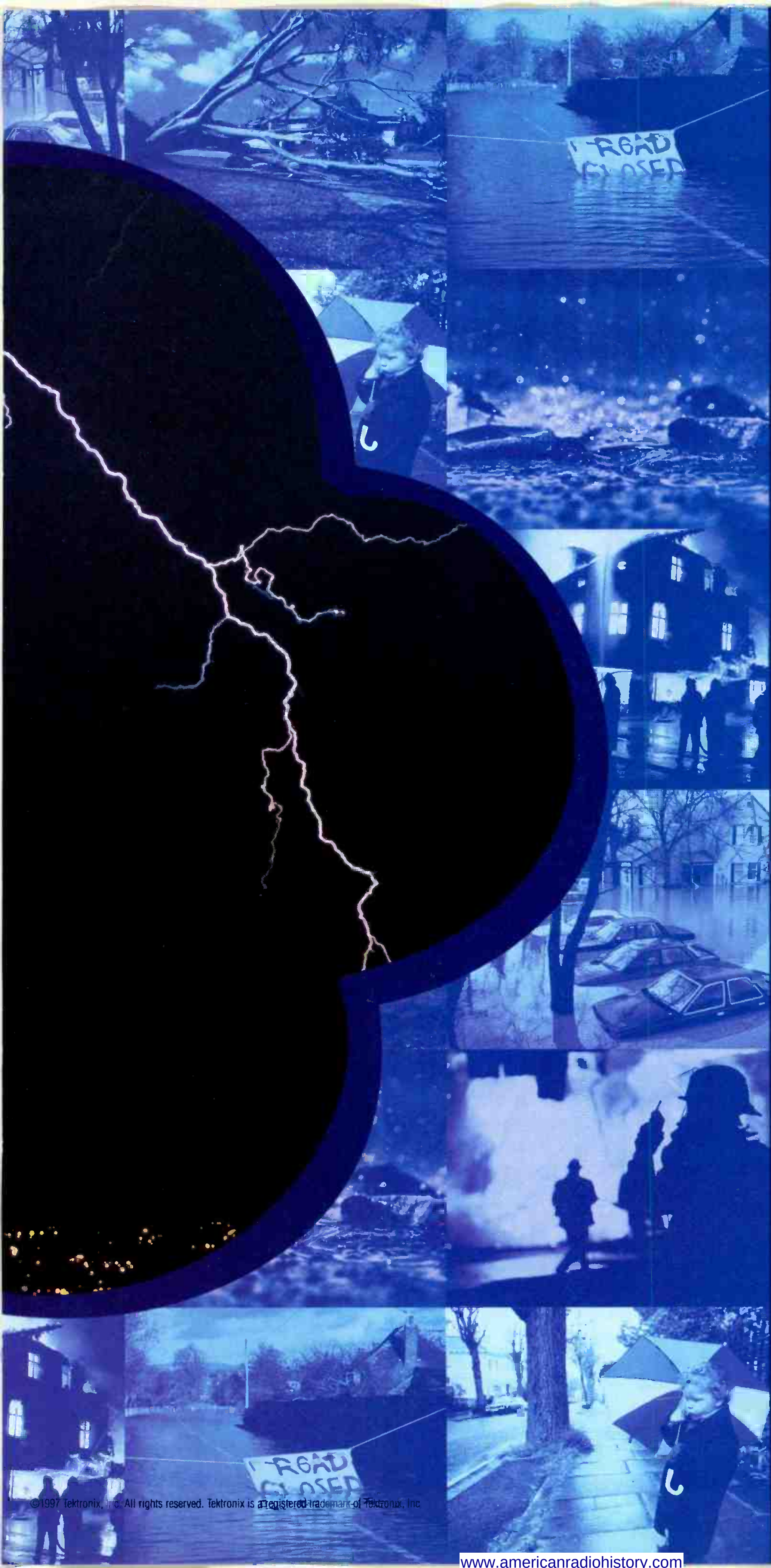

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ing payload service. The sync byte, always the first byte of the packet header, contains a fixed, pre-assigned value. A 13-bit field called the packet identifier, also found in the packet header, affords a way of multiplexing various elementary bitstreams. Because the location of the packet identifier field is fixed, packets corresponding to a particular elementary bitstream are simple to extract once packet synchronization has been established. The simplicity of this approach is extremely significant.

An example of a solution for the multiplexing/datacasting problem can be seen with the Philips 4.0+1 DTV compression system. This is a modular system, capable of flexible designs. A station may choose to transmit four SDTV signals in one ATSC datastream. HDTV programming may be added by using an HDTV encoder. External data sources can be inserted, even replacing an SDTV source. One of the primary purposes for this device is an STL replacement, to allow the NTSC and the HDTV or multiple DTV channels to be multiplexed together for transmission on a single channel. This is but an example of the types of equipment we will see in the coming months and years. ■

Louis Libin is a broadcast consultant in New York and Washington.

Expert's Corner/Vendor Views

Planning for DTV

Within any facility, there are infrastructure issues that once implemented are difficult to change. As stations move toward DTV broadcasts, these infrastructure issues must be revisited. *BE* contacted two readers and two vendors and posed the following questions:

1) What type of infrastructure would you recommend stations build if they have to convert within the next two years? Is a mezzanine approach adequate today, how about for tomorrow?

2) What if stations don't have to convert until five years from now? Would the answer be different?

EXPERT

Charlie Goode, vice president of engineering, Smith Broadcasting, St. Petersburg, FL.

Group perspective:

All of our stations are in the 30+ tier and do not need to convert until the end of the FCC's timetable. Therefore, we will be doing only minimal conversion over the next two years. Our facilities consist of a composite analog infrastructure, however, within that infrastructure are other formats, made necessary by color-under and component tape equipment and RGB-based graphics systems. These signals are converted to the house format (analog composite) as needed, and we expect conversion to the house format to remain a staple of our operations. What will change will be the house format.

Facility upgrades and purchases are made with an eye toward a serial digital infrastructure. For example, we are no longer installing 8281 cabling. Wiring is being done with true 75Ω connectors and cabling that supports data rates in excess of 270Mb/s. Fiber is not used unless it is required. Routing switcher frames compatible with serial digital are used, but are being configured with analog crosspoints. As our complement of serial digital equipment grows, so too will the router crosspoints to support it. As our existing cameras are replaced, we are providing them with switchable aspect ratio cameras. In this manner, we hope to preserve our current investment and extend the equipment's useable lifetime.

The concept of local pass-through of network signals is unworkable. Local branding, EAS and local commercial insertion are all required in our current and future operations. A mezzanine level of some type might be supportable, but our anticipation is that incoming and locally produced signals will be converted to a serial digital house format and handled accordingly. We do not expect to support a high-definition infrastructure, but rather to upconvert standard-definition as needed. It does not make economic sense to invest $4 or $5 million in a station that is only worth $4 or $5 million. ■

EXPERT

Scott G. Griffin, principal and director of engineering, The Systems Group, Hoboken, NJ.

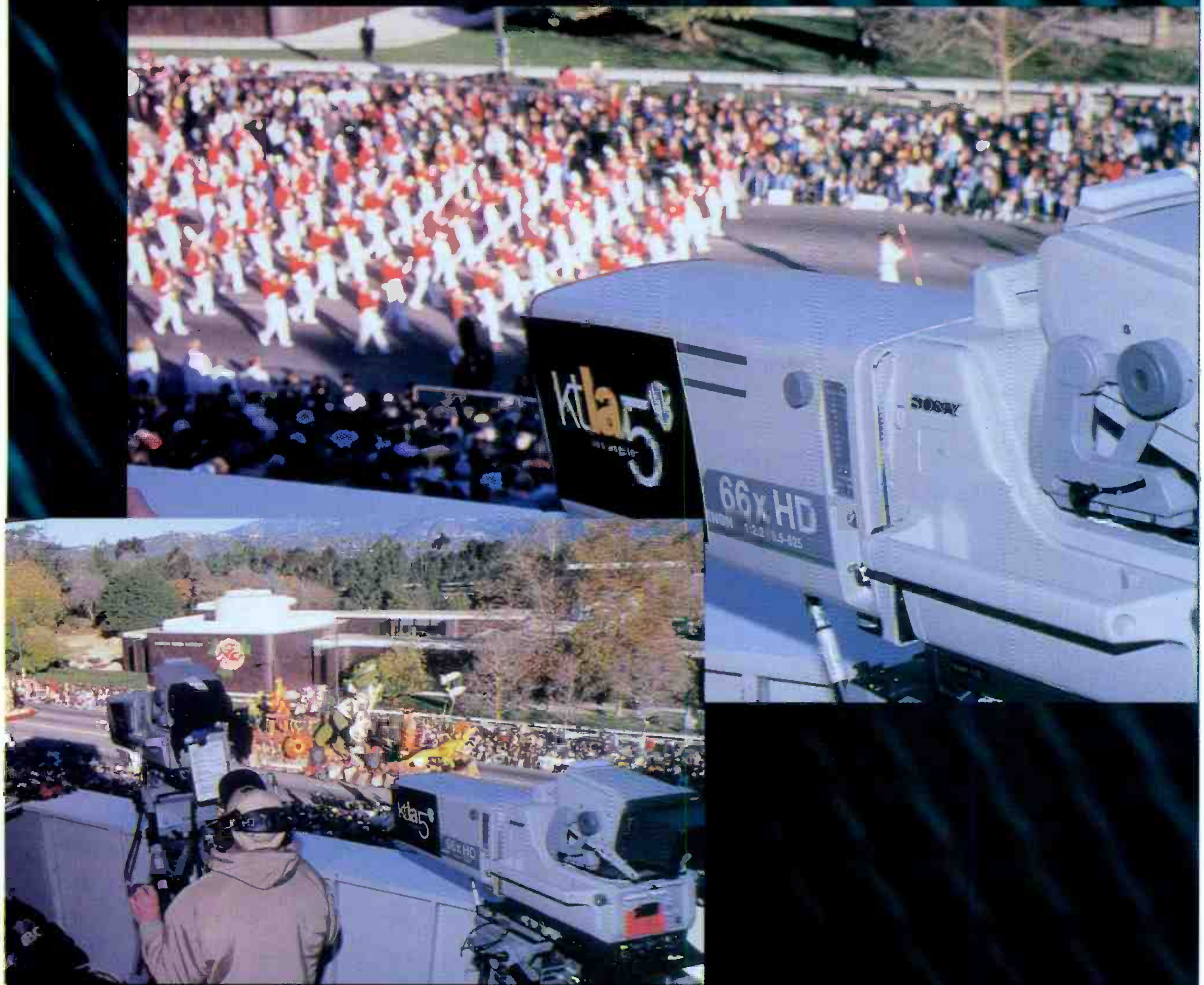
System integrator perspective:

The choice of infrastructure needed to support DTV programming is primarily a business decision. It is based more on a station's market competition, network affiliations, fiscal capacity and programming content than on a subjectively chosen transmission or production standard. The mezzanine approach of a 270Mb/s routing and distribution scheme, with upconversion and "mole"-aided bitstream splicing for network insertion, is the most cost-effective approach for most stations that need to convert within two years. Once transmitting in DTV, a close monitoring of the competition, and an assessment of the *actual* financial impact of the new technology will lend clarity to a prudent next step, whether it be further technological upgrade or expanded programming. ■

SONY

Business and Professional Group

Technical Brief: Studio Camera Technologies and Systems for the DTV Era



By Laurence J. Thorpe

Vice President, Acquisition Systems, Business & Professional Group
Sony Electronics, Inc.

The era of DTV has arrived. A gigantic private sector undertaking has finally forged its way through a long and sometimes difficult process to shape the new American broadcasting landscape. Television is about to change dramatically, and it will change for the better.

All facets of the gigantic television "food chain" are already being touched. From program origination through post-production, distribution, and traversal of the broadcast network infrastructure, to the local station's final program preparation and—finally—transmission to the home, the new DTV agenda is affecting every element of the television system. And, it is affecting the system in ways we would not have dreamed of only a short five years ago.

The DTV agenda of the United States encompasses a new freedom never before known through all of the decades of analog NTSC transmission. DTV can be a digital HDTV (high-definition television) service, or it can be a digital SDTV (standard-definition television) multichannel service. Perhaps most important, it can be any combination of these two. In other words, broadcasters have been assigned a new and separate 6 MHz RF channel through which they can transmit a single channel of HDTV, or multiple channels of SDTV, or any combination of these two services—throughout different portions of a given day or night. The "payload" carried by the mandated digital transmission standard has been effectively deregulated.

It is probably true to say that the new freedom broadcasters now have, in terms of the DTV service that they might ultimately offer, is presently a cause for some confusion and anxiety. The difficult decision of how to start the service, and then how to evolve it to a successful new broadcast business, confronts every broadcaster.

The leading edge of this total television system, namely, the camera or camcorder that originates the DTV pictures and sound, will play a major role in the system that follows. Just the decision of whether to start with digital HDTV, or one, two, three or more widescreen or 4:3 digital SDTV services, poses a basic question as to the appropriate camcorders for the news crews, the cameras for the news studio, and cameras for a production studio or mobile outside broadcast (OB) truck.

In this Technical Brief, Sony will examine the central technical issues confronting the producer and broadcaster when acquiring the program origination equipment that will support their first venture into an embryonic DTV service, while facilitating further flexible migration. What is unique about this DTV era is that different broadcasters may elect to pursue quite different migration strategies to their final service. This poses special challenges to the studio/OB camera manufacturer. Sony's design strategies underlying the new BVP-900/950 digital SDTV studio/OB cameras and the new HDC-700/750 high-definition cameras will be outlined as contemporary solutions to these challenges.

DTV Requirements in Studio Camera Systems

What are the key requisites for acquisition systems supporting program origination in this looming era of DTV? What are the essential technical imperatives, in contrast with those of the former analog-only NTSC period? There are four such requirements, given below:

- **Aspect ratio management.** The need to service both the standard 4:3 aspect ratio and the new 16:9 widescreen image format introduces the most difficult challenge of all for the program originator. Aspect ratio conversion entails difficult choices in terms of preserving or discarding precious picture content.

- **Highest picture quality.** In anticipation of DTV, an entirely new yardstick of picture quality will soon be appearing in the living room. This will be propelled by a plethora of new digital delivery media that bring MPEG-2 digital component video directly into the home.

- **Highest signal/noise performance.** There is now an entirely new industry need for the very lowest in picture source noise. Noise is the enemy of compression. Television program masters will henceforth be subjected to increasingly frequent digital compression in order to service distribution via DTV broadcasting, digital satellite and cable, and digital packaged media ranging from CD-ROM to DVD. A formerly benign noise interference (in the analog NTSC context) can, in an era of heavy digital compression, be easily translated into new and disturbing picture artifacts.

- **System flexibility.** The diversity of services that any given broadcaster may ultimately deliver, coupled with the still unclear migration to a full widescreen DTV operation (while still maintaining an ongoing standard 4:3 analog NTSC service for some years), augur for particular care in the choice of program origination equipment that is suitably flexible.

The implications of each of these issues are complex, and need to be carefully evaluated against the contemporary technologies available to camera equipment manufacturers. In particular, the ability to deliver full HDTV and a choice of either the 480I or 480P SDTV formats will become more important.

Section I: Camera Technology for SDTV

HDTV and SDTV are both usually distinguished from current analog NTSC by their aspect ratio. HDTV is always presented in a widescreen 16:9 aspect ratio, compared to the standard 4:3 of NTSC. SDTV, on the other hand, while expected to be largely 16:9 widescreen, *can* also be standard 4:3.

As shown in Figure 1, the very essence of the future simulcast broadcast operation will dictate a great deal of program material flow between the ongoing analog 4:3 NTSC service and the new DTV service. Archive 4:3 material will be regularly accessed for the developing digital DTV channel; new material specifically originated for the widescreen DTV channel may well also be used at times on the analog NTSC channel; widescreen film-originated programming may sometimes service both channels; and so on. There are many variations that will constitute a normal daily programming dynamic in the multiple DTV scenarios that will surely evolve in the anticipated competitive and innovative DTV marketplace.

The management of aspect ratio is a significant new production issue, dealing in a world that will encompass two quite different image formats: the widescreen 16:9 format and the standard 4:3 format. Here we are dealing with the very troublesome issue of *picture content*, as illustrated in Figure 2. The 16:9 image has 33 percent more horizontal picture content than the 4:3 image.

There is no good way of moving program material in a bidirectional manner between two such formats. Simply put, you can derive an often-times excellent (or at least satisfactory) 4:3 image from a 16:9 original, but there is no way of deriving a satisfactory 16:9 picture from a 4:3 original.

Figure 3 summarizes a novel Sony approach to the entire issue of implementation of dual 16:9 and 4:3 aspect ratios in a studio/OB camera (the BVP-900/950). The essential point the illustration conveys is Sony's recognition that this implementation would vary considerably between customers. No one implementation would meet all the needs of a broadcast and production industry that will see different approaches to both the initial start-up and the ultimate migration of DTV services. There are a number of primary variables, including:

- The timetable of the end-user. Being able to upgrade to 16:9, in *their* time frame, can be very important.

- Some innovative users will start immediate production in 16:9, but would still like to have the ability to also produce in 4:3 if the need arises.

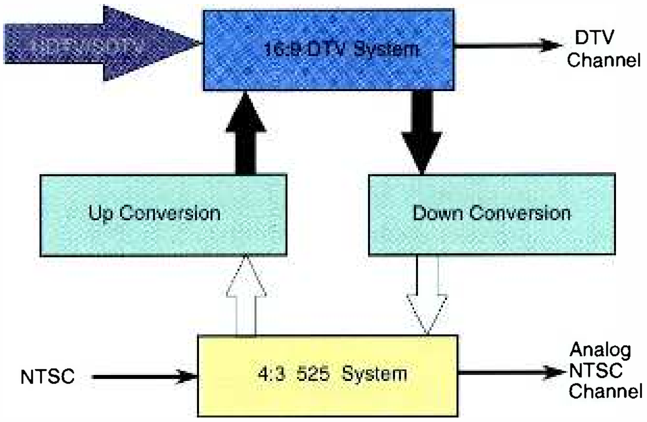


Figure 1. The flow of program material between the existing analog NTSC service and the new DTV service.

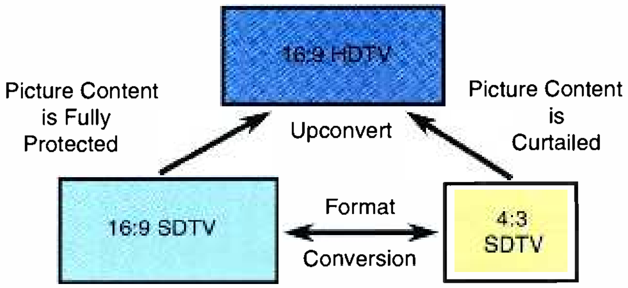


Figure 2. Exchanging program material between two different image formats is not symmetrical in terms of protecting picture content.

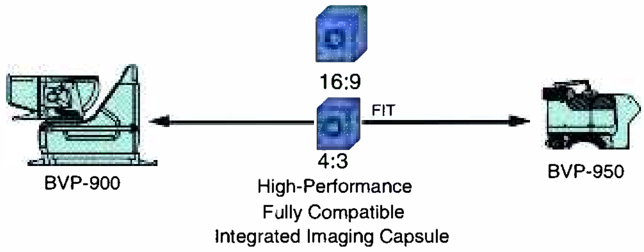


Figure 3. The *Integrated Imaging Capsule* allows rapid configuration of a camera with a 16:9 or a 4:3 CCD imaging system.

At first glance, it would seem that the switchable 16:9/4:3 camera would meet all requirements. That is not, however, the case in the real world.

Widescreen is fully expected by the marketplace to produce a picture that can be clearly distinguished from traditional 4:3 images, and for that reason alone there can be no short-changing the initial 16:9 image capture. It is for this reason that Sony always employs a full-format, true widescreen 16:9 CCD imager, whenever it images for widescreen.

The suggested approach of using a basic 4:3 imager and electronically altering the vertical spatial sampling structure to implement 16:9—in Sony's view—is, unfortunately, badly flawed. Sony disagrees with the concept of attempting to synthesize any form of credible widescreen image from switching a 4:3 imager into a 16:9 mode, for the following reason.

Spatial sampling can only be optimized for *one format* or the other. The all-important optical low-pass filter is a fixed entity that *cannot* be optimized for two different vertical spatial sampling formats. Vertical aliasing is inherently troublesome in the 525-line SDTV domain, and this is worsened by such an approach. Sony strongly favors the use of a true 16:9 imager and the employment of DSP signal processing to derive a quality 4:3 video format from the widescreen original.

For a television station today, three approaches to dual 16:9 and 4:3 camera operation are useful:

- Configurable
- Simultaneous
- Switchable

We will look at each in turn.

Configurable

This approach exploits the innovative Sony concept of the plug-in *Integrated Imaging Capsule*. It uses two optimized CCD Integrated Imaging Capsules—one being a full-diagonal 2/3-inch standard 4:3 format, and the other a full-diagonal widescreen 2/3-inch 16:9 format.

This approach works exceedingly well for those customers who, by the very the nature of their business, are regularly reconfiguring studio/OB and companion portable cameras. Mobile truck operators, who alternate between different sports coverage and high-visibility entertainment events, are a classic example of this type of user.

They also fully expect to be reconfiguring their cameras for different events that will be defined by widescreen or standard 4:3. Having an appropriate pool of 16:9 Integrated Imaging Capsules will readily facilitate the transformation of the appropriate mix of studio/OB and portable cameras to 16:9 operation.

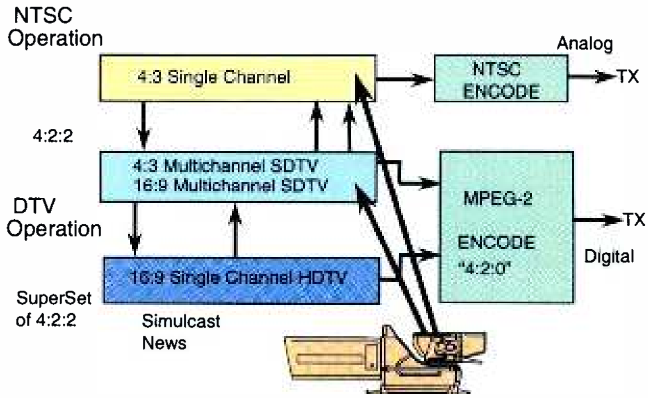


Figure 4. The evolving simulcast broadcast plant and the servicing of NTSC and DTV with multipurpose studio/OB/EFP cameras.

Simultaneous

This is a very important operational situation. Figure 4 depicts a macro-view of the evolving broadcast station (or production facility) of the near future. Depending upon the agenda of the customer, they will ramp-up some form of DTV while continuing to broadcast 4:3 NTSC. It is expected that these agendas will be widely variable. HDTV may or may not figure into the agenda in the early years. Widescreen 525-line SDTV surely will play a role for most.

Within the dual simulcast NTSC/DTV operation, there will constantly arise the need to service *both* channels from a single live source. Broadcast news is a prime example. Here, a widescreen camera will directly originate the live 16:9 pictures for the new DTV service, but those same images may also be required for the analog 4:3 NTSC news program.

Sony's novel (and still unique) ARU-701 aspect ratio converter can take an analog component video output, or the serial digital component video output, from the widescreen 16:9 camera CCU and *simultaneously* deliver the two required live feeds—each via serial digital interfaces. (See Figure 5.) A switchable camera alone cannot do this.

Switchable

As DTV broadcasting becomes more routine, the need to deploy cameras between 4:3 and 16:9 operation will, for many customers, become almost a daily event during the simulcast years (at least until NTSC goes away, many years from now). Now, the switchable camera becomes more attractive.

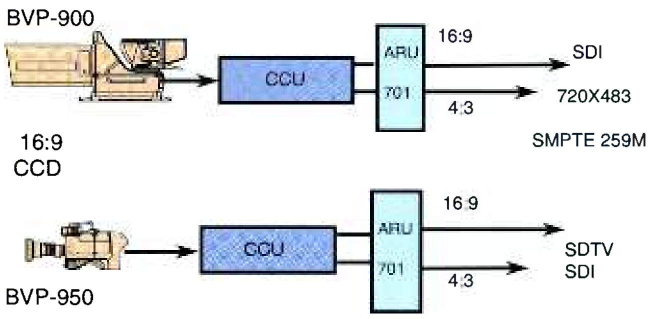


Figure 5. Use of the ARU-701 digital processor produces simultaneous 16:9 and 4:3 outputs.

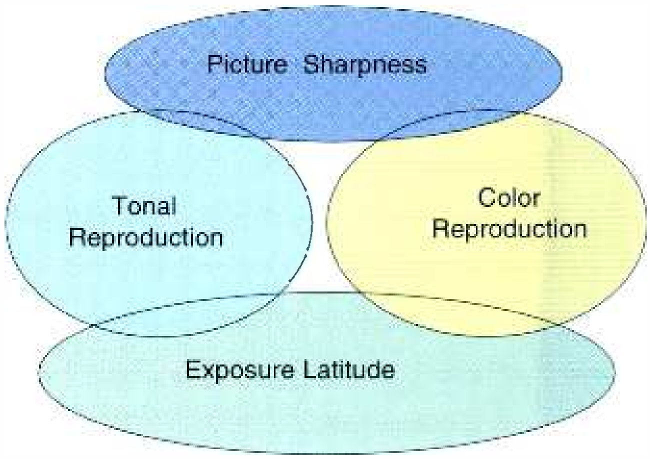


Figure 6. The multiple dimensions that contribute to image quality.

The switchable camera will require a DSP camera head and a true 16:9 Integrated Imaging Capsule. This provides the high-performance true widescreen image origination, delivered via a serial digital interface of 16:9 at the output of the CCU. Alternatively, via a remote control switch at the master setup unit, a 4:3 derivative can be digitally created from the widescreen capture and provided as a serial digital stream at the CCU output.

Highest Picture Quality

The overall performance of a television camera can be divided into two distinct categories:

- Those separate imaging attributes that collectively contribute to overall picture quality (that is, the aesthetics and beauty of the picture).
- Those separate artifacts of the camera system that collectively detract from the overall picture quality.

The name of the game in high-end television camera design is to optimize *all* of the picture quality factors while minimizing *all* of the picture artifacts.

The New Importance of Picture Quality

As the transition begins to digital component video origination and post-production—and all-digital transmission to the home—it is very important to take stock of how we specify the true overall performance of picture sources. Widescreen MPEG-2 digital 4:2:0 component 525-line video that is virtually artifact and noise-free will look dramatically different from analog NTSC when viewed in the living room. As a consequence, new criteria for source picture quality will invariably emerge.

In describing the overall aesthetics of the DTV picture, it is essential to re-examine the multidimensional aspect of image quality and to reassign some priorities to the contribution of each of those picture dimensions.

Quantifying the Separate Dimensions of Picture Quality

There are four core attributes of picture quality, as illustrated in Figure 6. They can be separately considered (and separately specified) as the key contributing dimensions of picture quality:

- ***Picture sharpness***—the overall resolution of the image.
- ***Tonal reproduction***—the accuracy of reproduction of the gray scale.
- ***Color reproduction***—the total color gamut that can be captured, and the accuracy of reproduction of the luminance, hue and saturation of each color.
- ***Exposure latitude***—the total camera dynamic range, or the ability of the camera to simultaneously capture picture detail in deep shadows and in areas of the scene that are overexposed.

The overall performance of a camera is largely determined by the front-end imaging system, namely the combination of optics and imager. These elements predetermine the four core attributes, earlier defined, of a television picture. The image quality must be fully retained and—where possible—en-

CCD Imager		Video Processing
Pixel count Super EVS	Picture sharpness	Detail enhancement system Skin tone detail system
Sensor design	Tonal reproduction	Video dynamic range management system - Gamma precorrection - Black gamma
	Exposure latitude	Variable overexposure - Knee control
Manufacturing quality control	Color reproduction	Linear matrix Variable linear matrix Secondary color vector

Table 1. System linkage between the CCD imager characteristics and the video DSP processing in determining overall camera performance.

hanced within the complex RGB video processing system that follows the imaging system.

Thus, the operational picture performance of a camera is totally determined by the combination of the CCD optics, the imaging system and the RGB video processing system. Table 1 shows the relationship between the CCD imaging parameters and the associated video processing that together contribute to each of the four primary dimensions of picture quality.

Achieving the Highest Picture Quality: The Pivotal Technological Linkage of a New CCD and ADSP

What is different about the Sony approach to *Advanced DSP* (ADSP) is that it was not born of an isolated technological advance in RGB video signal processing. Rather, Sony's ADSP was part of a larger *advanced imaging* strategy that carefully coordinated two important, but separate, development programs. It comprised no less than a strategic mobilization of the separate technologies of CCD imaging and DSP processing to enhance the multidimensional aspects of a number of important imaging parameters.

The specific goal was to advance digital video imaging simultaneously, on two fronts, with the intent to produce the highest performance SDTV camera in the industry. These two development programs included:

- The introduction of an advanced new CCD imager that would simultaneously improve dynamic range and S/N.
- The move to the long-sought 12-bit DSP, which would simultaneously facilitate a better match with the high dynamic range of contemporary CCDs, and higher S/N.

The New CCD Imager

We unceasingly refine the core technologies of CCD imaging. These refinements are not merely isolated advances in semiconductor physics. Rather, they constitute carefully planned development programs targeted at improving specific picture attributes that have been clearly identified by Sony's camera design teams. These engineers are a formal part of design reviews for any new CCD development programs.

The award-winning *Hyper-HAD*™ technology was spawned from this synergistic coordination of a focused program to make a significant breakthrough in television camera dynamic range, actually thrusting its imaging capability—in this respect—beyond the legendary capabilities of motion-picture film. Sony did not stop there.

The company, some time ago, elevated the priority of sensitivity, S/N, and dynamic range as a system "imaging troika" that Sony would optimize *in concert.* This imaging troika is illustrated in Figure 7. Equally important, when Sony attempts to optimally reproduce the superb CCD imaging capability at the lower end—toward optical black—as well as the overexposed signal ability, it speaks of a total imaging dynamic range in excess of 70 dB! As much priority needs to be assigned to this crucial lower region of the exposed signal as to the higher signal level region. Clearly then, care must be exercised in the priorities assigned to the A/D amplitude scaling applied to this unprecedented level of video signal [1]. This is the very essence of the Sony strategy to significantly improve overall picture quality.

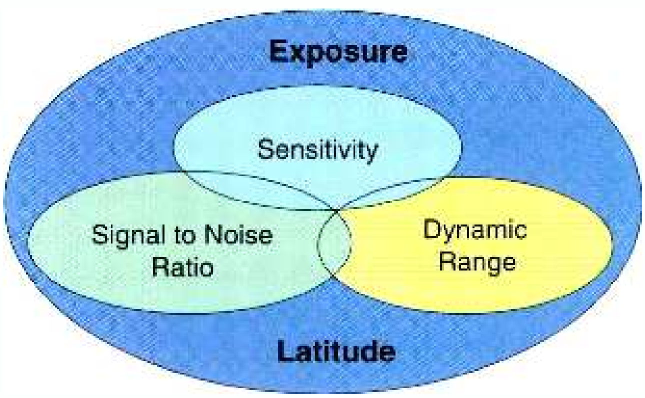


Figure 7. The three core performance attributes of the CCD imager that combine to expand the *exposure latitude* of the studio camera.

Sony's Approach to 12-bit ADSP

The analog-to-digital (A/D) quantizing levels have a direct bearing on the S/N performance of the DSP processing circuits in a camera system. Over the linear video A/D output range from black to nominally exposed reference white level, the video S/N is given by the well-known formula,

$$S/N = 10.8 + 6\,N \text{ (dB)}$$

Where N = the number of bits assigned to that range.

Table 2 summarizes the quantization S/N ratios of various levels of DSP amplitude sampling.

The significance of this DSP S/N quickly emerges when the concatenation of this S/N with that of the CCD itself is examined. Sony set as a central design target, for the new BVP-900/950 cameras, that the amplitude sampling of the video representation of a nominally exposed signal (capped black to nominal 100% exposed reference white) must be *at least* 10 bits. The remaining bits would be delegated to handling the overexposed signal.

To ensure the highest S/N camera for the era of SDTV, it is essential that the *CCD imager* be the defining element of that noise level. This demands that the DSP quantization noise be of a far lower level than the CCD imager noise. In this respect, a rule of thumb is that the DSP quantization noise will have less than a 1 dB effect on overall camera S/N if the DSP S/N is about 6 dB higher than that of the CCD. Figure 8 illustrates this critical issue by examining two cases: one where the CCD and the DSP have the same S/N, and a second where the DSP has an S/N approximately 10 dB higher than that of the CCD.

The 12-bit DSP Camera: The New BVP-900/950

It is in recognition of this major S/N system optimization that Sony's design approach to 12-bit digital video processing is markedly different from that of some competitive 12-bit DSP cameras. This difference is significant. Figure 9 shows the contemporary approach used for the assignment of the 12 bits to the full CCD linear output signal. Here, priority has been given to a *linear* quantization, based upon a plausible argument that handling the compression of the overexposed signals entirely in the digital domain constitutes the achievement of a goal of the true digital processing camera [2].

The resulting 9.2-bit amplitude scaling applied to the nominally exposed signal produces a DSP quantization noise in the vicinity of 65 dB, which, if concatenated with a 62 dB CCD, would produce an operational S/N of about 60.5 dB.

Number of Bits	DSP Quantization Levels
8 bits	S/N = 10.8 + 6 x 8 = 58.8 dB
9 bits	S/N = 10.8 + 6 x 9 = 64.8 dB
10 bits	S/N = 10.8 + 6 x 10 = 70.8 dB
11 bits	S/N = 10.8 + 6 x 11 = 76.8 dB

Table 2. The quantizing S/N associated with various DSP quantizing levels.

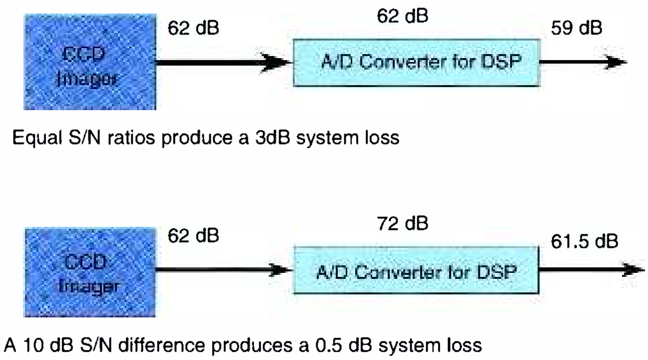


Figure 8. The critical separation required between the CCD and the DSP S/N contributions.

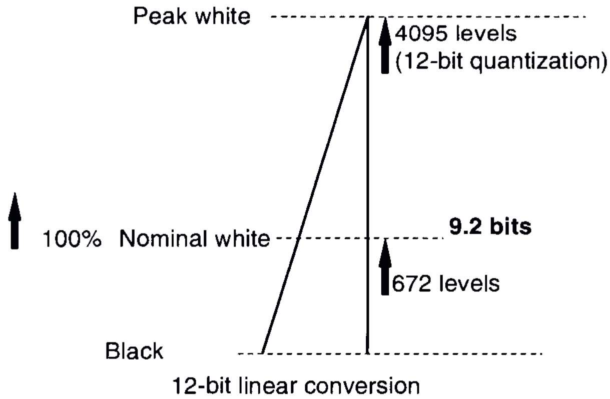


Figure 9. 12-bit linear quantization of the total CCD output signal capability results in a 9.2-bit amplitude scaling for the 100% nominally exposed signal.

In the case of the BVP-900/950, Sony has a new CCD producing a remarkable *66 dB S/N*, so it was important to elevate the DSP S/N as far beyond this point as possible. The starting premise was an unequivocal assignment of at least

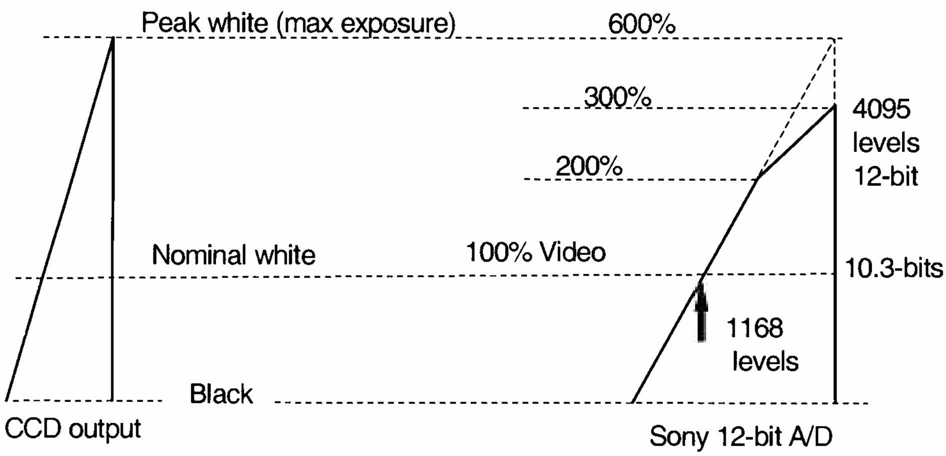


Figure 10. The amplitude scaling of the BVP-900/950 DSP cameras, which uses a fixed analog pre-compression to optimize the bit allocation for both maximum S/N and preservation of a wide exposure latitude.

10 bits to the nominally exposed (reference white chip of gray scale chart at 100% video level) signal.

Accordingly, Sony uses an analog *pre-knee* processing technique before the 12-bit A/D converter. This is a careful compromise—a fixed and accurate analog compression of highlight information—one that facilitates unique and sophisticated downstream digital processing of the important over-exposed highlight information. The results of this approach are shown in Figure 10.

This scheme produces an effective operational S/N performance for the camera of 65 dB, a number that sets a new yardstick for the industry and assures the requisite ultra-low noise source that will be important in the era of compressed SDTV transmission. Table 3 shows how this S/N is produced, being a concatenation of the 66 dB of the new CCD and the 10.3-bit allocation to the quantization of the nominally exposed video.

The issue of S/N, however, is only the first key performance issue. The second is the effective dynamic range of the CCD/DSP combination, which—in turn—will determine the operational exposure latitude of the camera itself.

It must be emphasized that 12 bits are still not sufficient to properly quantize the extraordinarily high *linear* dynamic range signal that a contemporary CCD can produce. Today, Sony typically talks in terms of overexposed CCD linear signal output capabilities in the vicinity of 600 percent! At least 16-bit *linear* quantization is required to do justice to such an extraordinary signal range if it is to be handled entirely in the digital domain, as shown in Table 4.

Unfortunately, 16-bit high-speed A/D and video processing is beyond today's technology. Various techniques for pre-processing the linear analog output from the CCD imaging system have, therefore, been utilized to optimally match this extraordinarily wide video signal dynamic range to the capabilities of a given A/D converter. Given this limitation, Sony carefully deploys the 12 bits to optimize *both* S/N and dynamic range. True optimization of exposure latitude (this is bound up in issues of CCD sensitivity, dynamic range, and noise floor) is the primary goal.

Signal to Noise Ratio and Bit Sampling S/N = 10.8 + 6N dB
BVP-900/950 = 10.8 + 6 x 10.3 (ADSP) = 10.8 + 61.8 = 72.6 dB
With a 66 dB S/N FIT CCD imager Camera S/N = 66 dB + 72.6 dB = 65 dB

Table 3. How the new CCD and 10.3-bit quantization of the nominally exposed signal combine to produce an operational S/N of 65 dB.

Video Control Function	Number of Bits
Nominally exposed video (100% reference white)	9
Gamma correction (X4 gain at black)	2
White balance gain (color temperature adjustment)	1
Black gamma (X2 gain)	1
Overexposed signal handling (600% of nominal white)	3
Total	16

Table 4. The allocation of minimum bits to each of the core functions of the DSP camera.

Section II: Camera Technology for HDTV

The nature of the U.S. DTV agenda suggests that the majority of broadcasters will inevitably become involved in providing *both* digital HDTV and digital SDTV services. This duality poses a serious dilemma to the broadcaster and program producer in terms of planning their capital outlays over the early years of DTV. In recognition of this fact, and of the quite unpredictable nature of the overall migration from 4:3 analog NTSC to widescreen DTV, Sony has adopted a core strategy to make HDTV program origination equipment as *multipurpose* as possible. Multipurpose, meaning the flexibility for one studio/OB camera system to deliver *both* HDTV and SDTV outputs. The latter one available as a choice of the ubiquitous ITU R601 4:2:2 480I standard, or the new 480P version of that basic format.

A flanking strategy was to design that camera to be as cost-effective as possible, so that the HDTV premium paid above the typical cost of a present-day, high-end, 525-line equivalent camera system would be well-justified by this dual format capability. The center of the strategy was to firmly embed the new HDVS (*High-Definition Video System*—the logo used by Sony for its line of products to support HDTV program production) cameras within the existing BVP series of SDTV/NTSC studio and portable systems. Maximum system compatibility would be maintained; lens interfaces (optical, mechanical and electrical) would be maintained; and—to the degree possible—all physical components would be common between the two camera families.

The HDC-700 is a full-featured studio/outside broadcast camera utilizing Sony's two million pixel Hyper-HAD *frame-interline transfer* (FIT) CCD imager. The HDC-750 is a companion portable HDVS camera that perfectly matches the performance and operational features of the HDC-700. It can, however, be used in a stand-alone portable configuration for highly mobile field acquisition. It can also be configured for full studio operation with the same CCU and control panels as the HDC-700. Figure 11 illustrates the integrated camera HDTV/SDTV system.

The cameras utilize the same housings and chassis as the contemporary BVP-900/950 and BVP-500/550 SDTV camera families. The unique high-speed digital control sys-

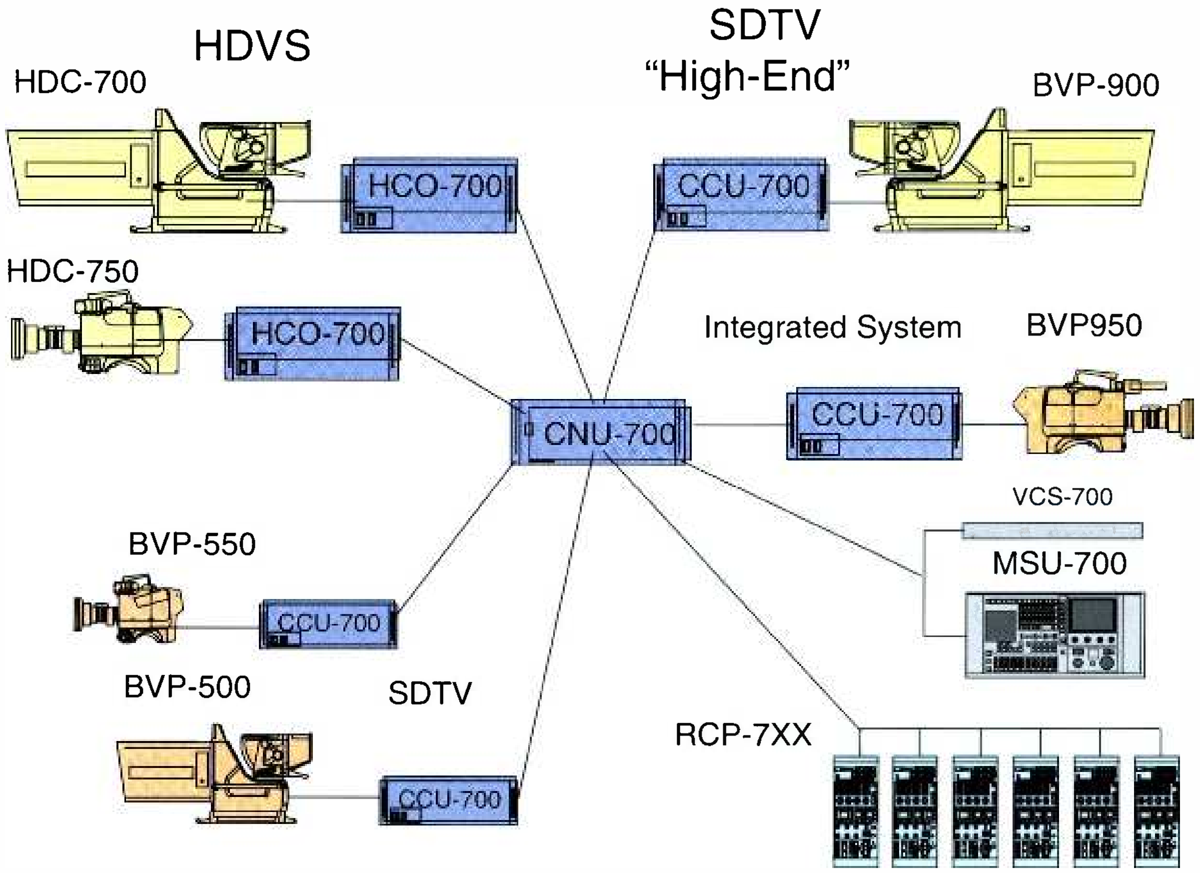


Figure 11. The master design strategy to integrate SDTV and HDTV studio and portable camera systems.

tem is common to all of these HDTV and SDTV cameras. They also share the same remote video control panels and the same master setup units.

The benefits of this master design plan are twofold:

- Migration from the present analog 4:3 525-line world to widescreen digital SDTV or full HDTV is made easier with a variety of transition paths.
- Important manufacturing economies of scale were gained that dramatically lowered the price of the new HDTV camera systems.

Having set the stage for the transition to HDTV, the HDC-700 studio camera and its portable companion HDC-750 will next be outlined in terms of the four key criteria earlier defined for DTV.

Management of Aspect Ratio

The HDC-700/750 cameras originate in 16:9 widescreen HDTV. Both of the cameras also provide a simultaneous feed of downconverted 525-line SDTV. The cameras are, thus, *multipurpose* in that they simultaneously deliver serial digital outputs of both HDTV and SDTV. This "two for one" capability offers broad operational flexibility in that it enables the servicing of both forms of DTV (for those who will offer both HDTV and SDTV), or it allows a paced migration from an initial SDTV program service to full HDTV at a later time.

The troubling conversion of widescreen SDTV to a standard 4:3 format can be a creative decision requiring some production flexibility. The HDC-700/750 provide remote control (from the MSU or the RCP video panels) of a variety of aspect ratio conversion choices. These include:

- *Widescreen* 16:9 525-line SDTV.
- *Standard* 4:3 derived from the 16:9 downconversion, with remote variable control of pan-and-scan.
- *Letterbox* version of the full widescreen image within the standard 4:3 format.

Picture Quality

Just as with the SDTV camera, the front-end CCD imager goes a long way toward the ultimate determination of the HDTV camera picture quality. And again, the criteria of picture sharpness is directly related to the pixel sampling structure, while the remaining key criteria of tonal reproduction, color reproduction and exposure latitude are all largely bound up in the quality of the individual CCD sensor.

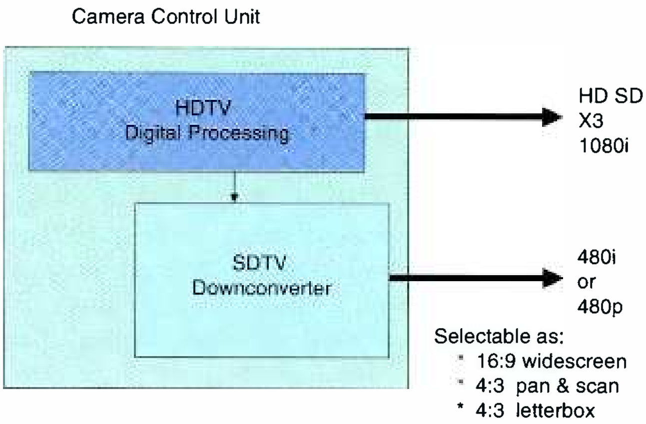


Figure 12. A built-in downconverter within the CCU makes the HDTV camera multipurpose in delivering both HDTV and one of the SDTV alternatives.

Sony expended enormous resources in perfecting the HDTV CCD imager. It first introduced the 1920 x 1035 pixel CCD to the U.S. market in 1992 with the HDC-500 camera [3]. Refinement of the HD CCD technology has been ongoing since that time. At NAB in 1997, Sony introduced the 2/3-inch, two million sensor CCD using Hyper-HAD and FIT technologies.

A distinct advantage of such a multipurpose camera is that the downconverted SDTV video is of a highly technical quality. The original HDTV imaging effectively constitutes a "super-sampling" system in both the horizontal and vertical domain (with a 1920 x 1080 sampling lattice), both of which are subsequently interpolated down to the 4:2:2 SDTV structure of 720 x 480 samples using very sophisticated digital techniques. In the vertical direction, this means a higher overall *modulation transfer function* (MTF) and much less aliasing than that created by a 525-line camera. In the horizontal direction, it also allows a higher MTF and less aliasing for the downconverted SDTV signal.

As illustrated in Figure 12, the CCU delivers three outputs of serial digital HDTV and two outputs of serial digital 525-line SDTV. In the case of the progressive scan SDTV output, each 540-line *Field* of HDTV is digitally converted to a high-quality 480-line *Frame*.

Signal to Noise

The HDC-700/750 cameras employ a new 2/3-inch, two million pixel CCD for each of the RGB video channels. These Sony-developed CCD imagers (FIT technology) are the culmination of a decade of technical development. They utilize the latest in Hyper-HAD techniques in the sensor design, which yields a high luminance S/N performance of 54 dB (measured unweighted over a 30 MHz bandwidth). While it is difficult to directly relate this specification to contempo-

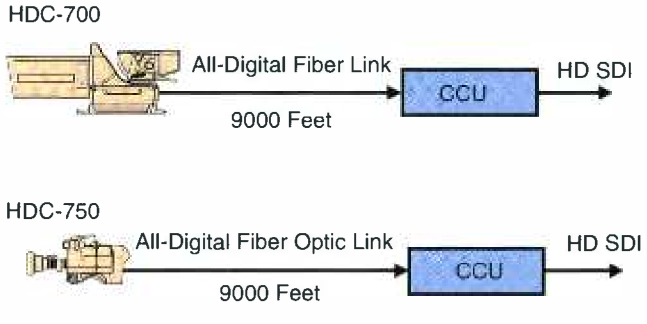


Figure 13. The all-digital fiber link for the HDC-700/750.

rary S/N specs for 525-line cameras (which are measured over the much more restricted 4.2 MHz bandwidth), suffice to say that it subjectively represents an extraordinarily low noise level. This greatly depressed noise floor contributes to the extended dynamic range that endows these cameras with an operational exposure latitude in excess of 10 *f*-stops.

System Flexibility

The HDC-700/750 cameras were designed to meet all needs for outside broadcast in HDTV. In particular, long cable connections between the camera heads and their CCUs are the key to system flexibility for large sports and entertainment event coverage. Both cameras utilize two-way, *all-digital* transmission of video, audio, intercom, control and status signaling. These are 1.5 Gbits/s serial digital transmissions (both directions), according to the SMPTE 292M standard. Such transmission data rates negate the possibility of multicore or triax cable. Accordingly, a new fiber-optic interface has been developed to facilitate this transmission over a 3,000-meter (>9,000 feet) length, as shown in Figure 13. This camera fiber interface is presently in the final stages of standardization by SMPTE.

The technical advantage of this approach is enormous, providing a digital link of high signal integrity, which ensures that the full quality of the HDTV image created in the camera head is made available at the CCU output interface. Perennial problems associated with triax transmission on long cable lengths are a thing of the past in HDTV: no more electromagnetic or RF interference, no timing skewing, and minimal equalization problems.

A New Era for Camera Technology

The dawn of DTV, and especially HDTV, promises to reshape the television industry in short order. New digital devices and systems are rapidly replacing important elements of the NTSC-based analog past. Cameras are, of course, a crucial element in the chain that will bring crystal-clear images to consumers. New advances in imaging and digital signal processing developed by Sony have given broadcasters, content producers and production houses the tools they need to succeed in the DTV revolution.

The Sony HDC-700 HDTV camera in action. Designed for studio and OB use, this camera features simultaneous HDTV and SDTV outputs.

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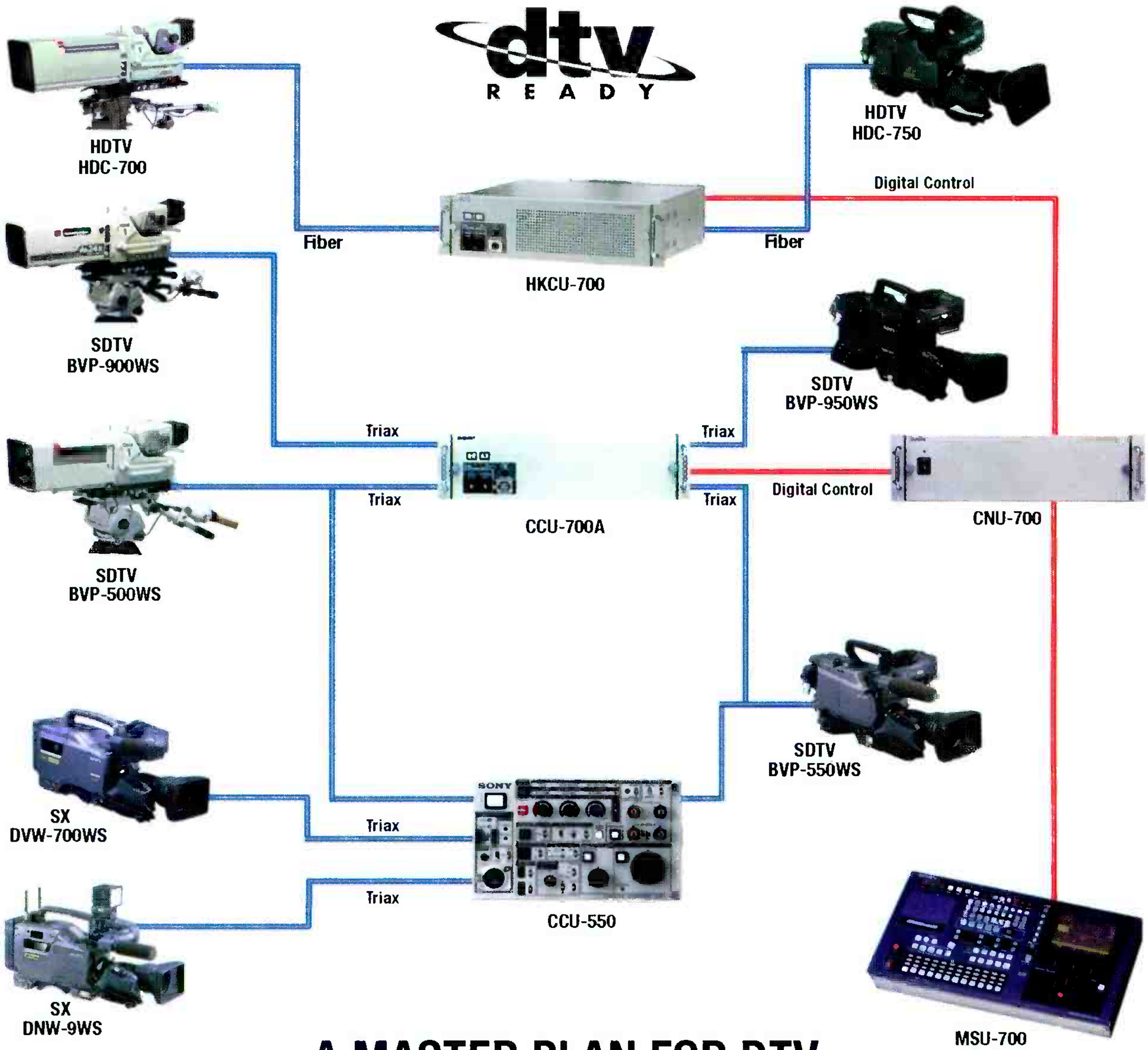

A MASTER PLAN FOR DTV

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The same two questions were posed to vendors familiar with infrastructure issues.

VENDOR

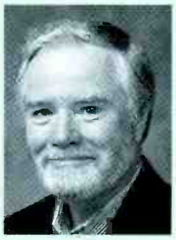
Bruce Penney, Tektronix, Inc.

One of the most basic questions a broadcaster faces in planning for DTV is whether to go single-program high-definition or multiprogram standard-definition. Many broadcast stations still have analog NTSC facilities. If broadcasters elect to jump all the way from NTSC to HDTV, but consumers don't buy into HDTV, they could find themselves sitting on a high-tech elephant. If, on the other hand, broadcasters bet on multichannel SDTV and convert their NTSC facility to component digital 601, they might be at a competitive disadvantage if HDTV is a hit. What's needed is a strategy for converting an analog NTSC facility to digital, while preserving the flexibility to later use the facility for either HDTV or SDTV.

Proper application of compression in a DTV facility can provide this flexibility. If we use 270Mb/s or 360Mb/s serial digital routing and distribution within a facility, we can support lightly compressed HDTV or non-compressed SDTV. Broadcasters can safely convert to digital now, implement 16:9 widescreen operation at the appropriate resolution for their market and know that the basic infrastructure is future-proofed to handle SDTV or HDTV.

But what if a broadcaster doesn't have to convert to digital until five years from now? Because 16:9 widescreen is a key part of DTV, the sooner broadcasters convert to 16:9 digital, the sooner they can start building their library. By choosing the right balance of 16:9 SDTV, lightly compressed HDTV and full 1.5Gb/s HDTV, broadcasters can be sure that their investment in digital television has immediate and long-term value regardless of whether DTV means SDTV, HDTV or both. ■

VENDOR



Larry Thorpe, vice president of Acquisition Systems, Sony Electronics' Business and Professional Group.

The DTV infrastructure will inevitably encompass the *duality* of routing/distributing and networking. This duality includes routing and distributing uncompressed baseband SDTV and HDTV video and multichannel audio, in addition to networking digitally compressed SDTV/HDTV/audio signals. For high-definition production, the baseband network will encompass digital "islands" largely using the SMPTE 292M HD SDI interface.

Sony has embraced the international MPEG 4:2:2 P@ML compression standard as the basis for production, transmission and distribution (via the new SMPTE SDTI transport interface standard) of SDTV. An extended family of MPEG levels will serve the HDTV applications.

Four imperatives form the underpinnings of the approach being taken by Sony: 1) highest possible picture quality based upon the 4:2:2 digital component set for all broadcast applications — *adequate data;* 2) highest possible storage efficiency on disk (realize cost-effective DTV servers) — *minimum data rate;* 3) utilization of the installed base of digital routers — *attempt to maintain the maximum DTV data rate below 270Mb/s;* 4) utilization of existing digital VTRs for tape streaming — *data rates commensurate with those VTRs.*

An 18Mb/s implementation of such a system has already been brought to the marketplace. ■

ON AIR
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Transition to Digital

Testing CCIR-601 serial digital distribution

BY MICHAEL ROBIN

The need to satisfy the complex signal distribution patterns typical of large teleproduction centers led to the development of the bit-serial distribution concept. For this type of distribution, 10-bit parallel data is read out sequentially, starting with the least significant bit (LSB) and ending with the most significant bit (MSB). The resulting signal can then be transmitted on a single coaxial cable. This signal has a high bit rate (270Mb/s) and an associated spectrum on the order of 1GHz. When properly installed, this system can provide unambiguous and error-free signal regeneration at the end of long coaxial cables. Lengths up to between 200 and 300 meters, depending on the cable loss equalization capability of the receiver, are typical.

Figure 1 shows a block diagram of a bit-serial digital signal distribution model. The source encoder is a conventional group of three A/D converters whose outputs are multiplexed into a 27Mword/s bit-parallel datastream. The channel encoder transforms the bit-parallel datastream into a bit-serial digital signal suitable for transmission through the chosen medium (e.g., coaxial cable). The receiver channel decoder deserializes the received bit-serial signal and recovers the bit-parallel digital video signal, which can be converted back to analog, if necessary, by a set of three D/A converters. Problems can arise due to excessive cable losses, that result in a low signal-to-noise ratio (SNR) and a high bit error rate (BER). Additionally, interference caused by thermal noise contributed by the receiver input stage, can corrupt the signal.

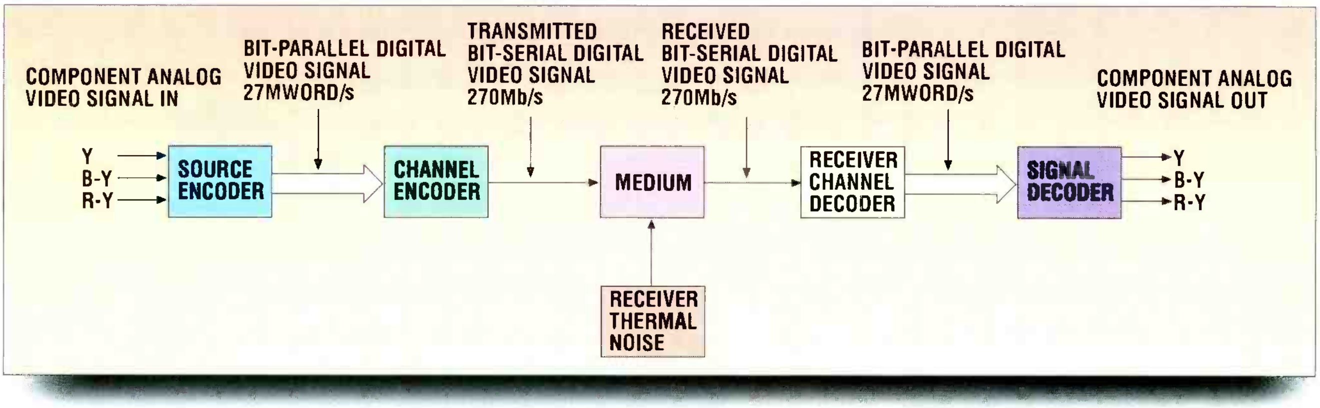
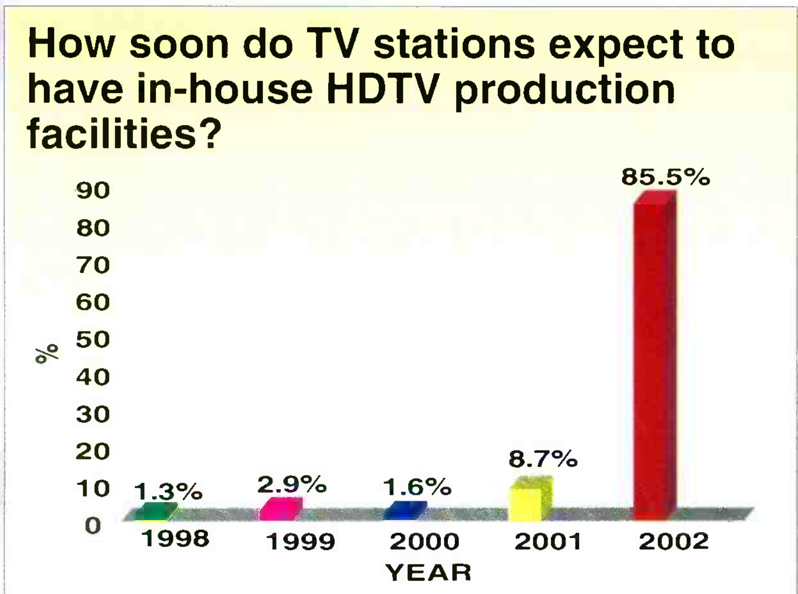


Figure 1. Bit-serial digital video signal distribution model.

FRAME GRAB

A look at tomorrow's technology.



Source: SCRI International. For more information on broadcast and production industry trends, contact www.scri.com or e-mail: scri@scri.com.

Standard interface characteristics and performance

SMPTE 259M describes the bit-serial interface for 525/59.94 and 625/50 equipment. It has applications in video facilities using coaxial cable. Cable lengths must not exceed the amount specified by the equipment manufacturer (typically 300 meters). A signal loss of 30dB at the clock frequency is normally acceptable. The interface characteristics are summarized in Table 1. The typical eye diagram of the bit-serial digital signal and some significant characteristics are shown in Figure 2.

Figure 3 shows a classification of bit-serial performance indicative of parameters related to the transmitter, distribution medium and the receiver of the bit-serial signal. Three areas of performance-related engineering concerns are as follows:

1. evaluation of equipment and technology;
2. post-installation acceptance tests; and
3. maintenance tests.

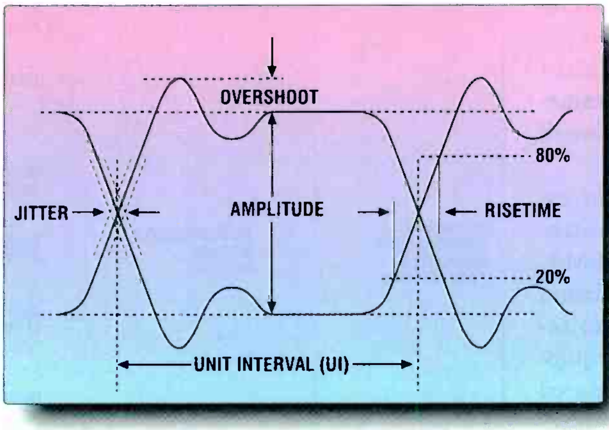


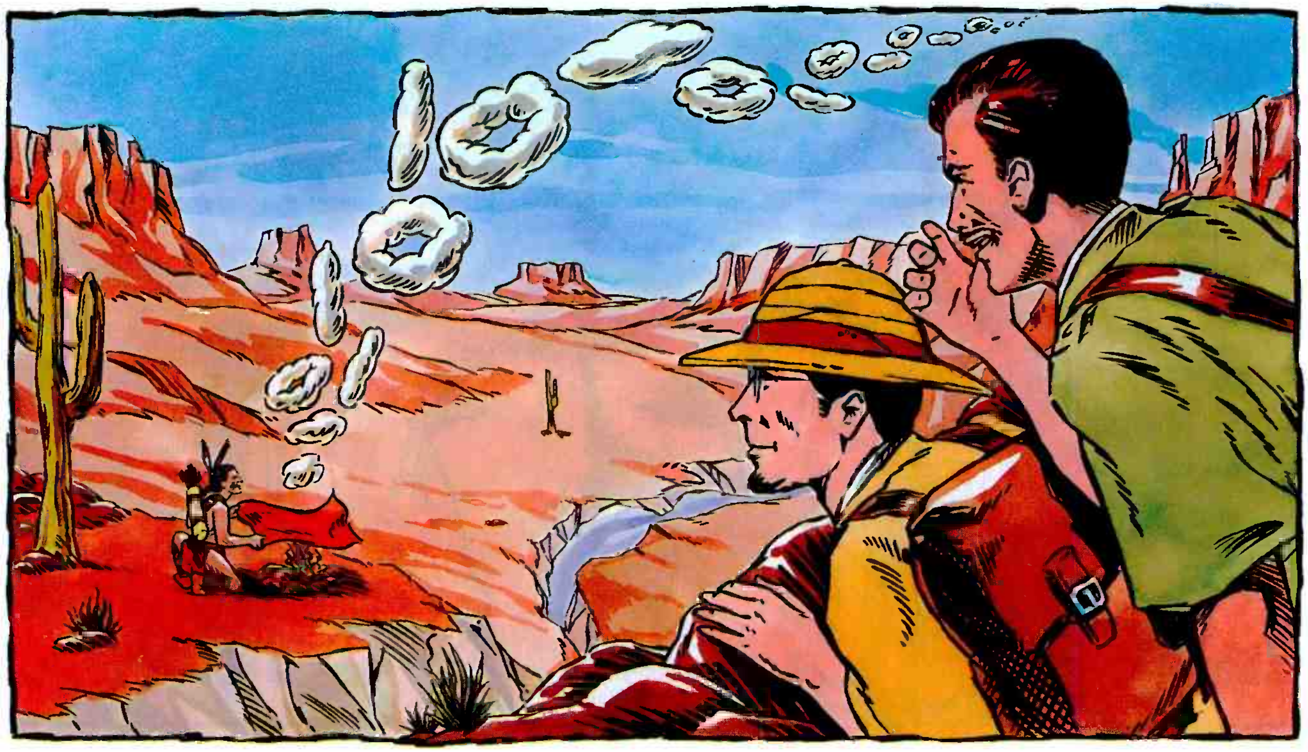
Figure 2. Eye diagram measurement dimensions.

Measuring signal parameters

For SDI, measuring signal characteristics requires accuracy, speed and reproducibility. It is advantageous to use a digitizing oscilloscope with a bandwidth on the order of 2GHz, which can be programmed to measure a set of parameters and display the results. Parameters to be measured include amplitude, rise time and fall time, jitter, overshoot and undershoot.

Jitter measurements require a suitable reference. The reference can be external to the equipment to be tested, resulting in absolute jitter measurements, or derived from the signal to be measured, resulting in relative measurements. The bandwidth of the relative jitter measurement depends on the clock recovery method used, because the recovered clock signal will contain some of the signal jitter characteristics. A jitter measurement bandwidth of 10Hz to 27MHz yields *timing jitter values*, whereas a measurement bandwidth of 1kHz to 27MHz yields *alignment jitter values*. When measuring jitter, it is important to mention the reference clock source.

Waveform monitors belonging to the Tektronix WFM601 family can be used to carry out signal characteristics measurements. However, many of these instruments have a measurement bandwidth on the order of 300MHz, which affects the rise time/fall time and overshoot/undershoot measurements. This requires the use of a correction formula (check with the



manufacturer) to obtain credible results. Some waveform monitors offer a choice of derived reference clock bandpass allowing the user to determine the dominant frequency of jitter.

Transmitter output return loss is an important performance indicative parameter, especially for relatively short cable runs. Measuring this parameter, however, requires special network analyzers.

Bit-serial digital video equipment, especially large-capacity routing switchers, may generate high levels of EMR. Equipment design and safe installation practices can help reduce EMR to acceptable levels. EMR levels of equipment and installations can be measured using a calibrated antenna and a spectrum analyzer.

For receivers, in addition to the input return loss, several other characteristics should be measured. These have to do with the receiver's ability to extract the original data from a noisy and jittery input signal. Two special test signals have been developed to meet

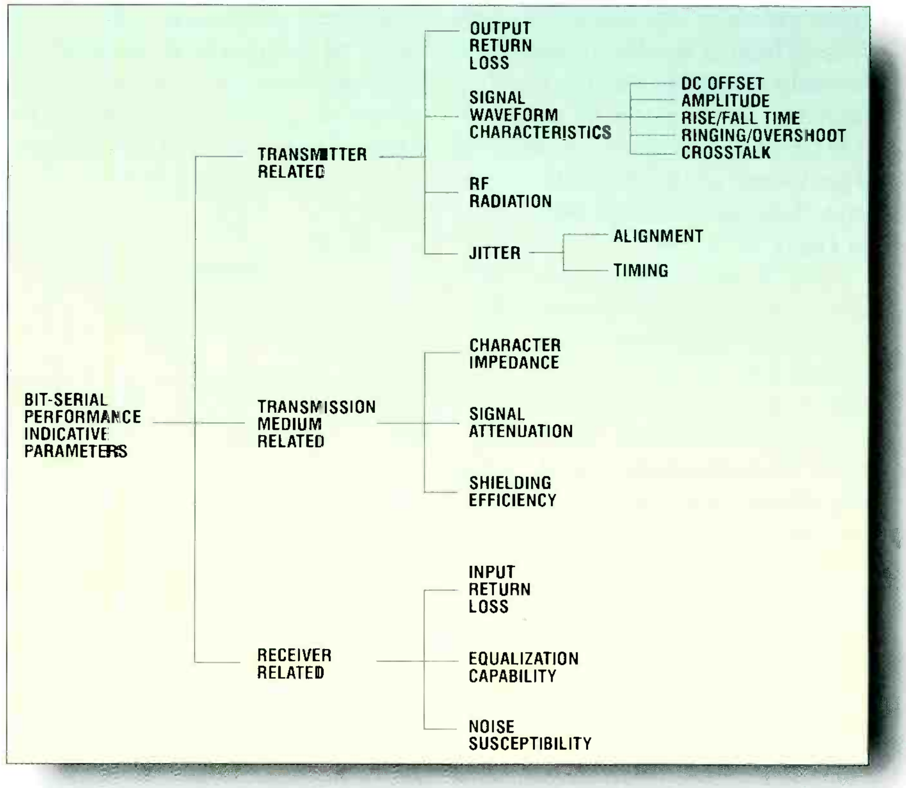


Figure 3. Classification of bit-serial signal performance indicative parameters.

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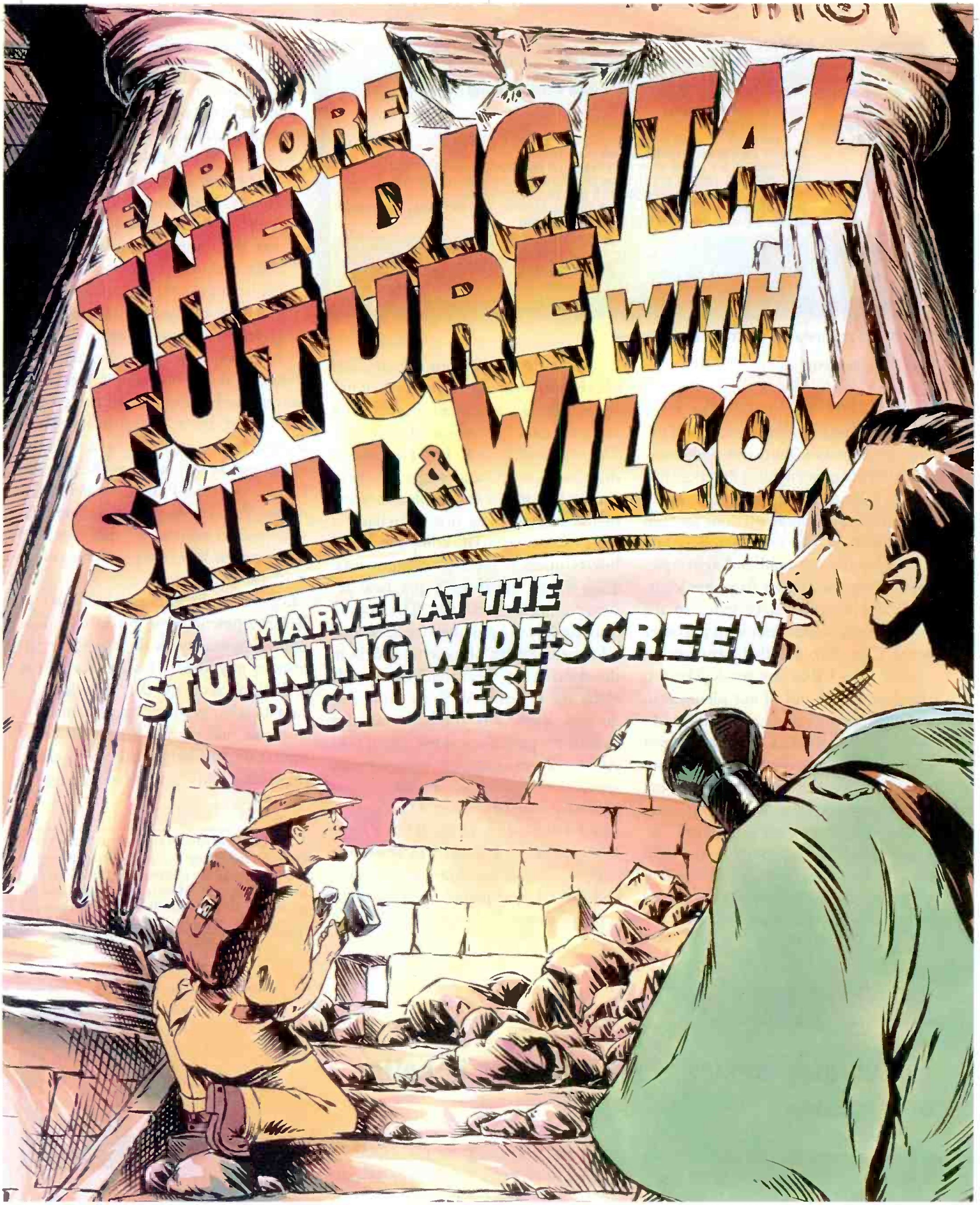

SNELL & WILCOX

Engineering with Vision

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CHANNEL CODING	SCRAMBLED NRZI INPUT SIGNAL POLARITY: POSITIVE LOGIC DATA WORD LENGTH: 10 bits TRANSMISSION ORDER: LSB OF ANY DATA WORD TRANSMITTED FIRST
TRANSMITTER CHARACTERISTICS (see figure 2)	UNBALANCED OUTPUT SOURCE IMPEDANCE: 75Ω NOMINAL RETURN LOSS : ≥ 15dB (5MHz TO CLOCK FREQUENCY OF SIGNAL) OUTPUT SIGNAL AMPLITUDE: 800mV p-p ± 10% DC OFFSET: 0.0 V ± 0.5V WITH REFERENCE TO MID-AMPLITUDE OF SIGNAL RISE AND FALL TIME: 0.4ns TO 1.5ns BETWEEN 20% AND 80% OF SIGNAL AMPLITUDE POINTS. DIFFERENCES NOT TO EXCEED 0.5ns OVERSHOOT OF RISING AND FALLING SIGNAL EDGES: <10% OF SIGNAL AMPLITUDE JITTER: 0.2 UI (0.74ns) BETWEEN 10Hz AND 27MHz
RECEIVER CHARACTERISTICS	UNBALANCED INPUT INPUT IMPEDANCE: 75Ω NOMINAL RETURN LOSS: ≥ 15dB (5MHz TO CLOCK FREQUENCY OF SIGNAL) OPTIONAL CABLE-LOSS EQUALIZATION: 30dB AT CLOCK FREQUENCY OF SIGNAL

Table 1. Characteristics of bit-serial interfaces.

this requirement.

1. *The EDH test signal:* The error detection and handling concept (EDH) was developed by Tektronix and issued as SMPTE Recommended Practice (RP) 165. It is based on making cyclic redundancy code (CRC) calculations for each video field at the serializer. Separate CRCs for the full field and active picture, along with status flags, are located in the ancillary data space of the vertical interval and sent with the other serial data through the transmission system. The CRCs are recalculated at the deserializer and, if not identical to the transmitted values, an error is indicated. EDH is used as an in-service test to pinpoint automatically and electronically any system failures. Depending on the sophistication of the EDH monitoring and measuring equipment, errors can be indicated as a warning light or as a complex report of errors and their sources. Each flag is set or cleared on a field-by-field basis.

2. *The pathological test signal (SDI checkfield):* Proper performance of bit-serial digital equipment depends on accurate data recovery at the receiver. The interface signal has two major drawbacks that require special attention in the design and implementation of the receiver. The first drawback is the existence of a DC component and low-frequency spectral components. This makes designing a practical receiver equalizer difficult. The second drawback is the possible occurrence of a long run length of logic 0s and 1s in the datastream. This requires a stable clock regenerating VCO to avoid frequency drifts. The fundamental idea behind the pathological test signal is to stress the transmission channel and assess the effects. Two special test signals have been developed. One consists of a 1 followed by 19 0s. It has a large DC content and is used to stress the cable-loss equalizer. The second signal consists of a sequence of 1s and 0s repeated every 20 bits, that provides a minimum number of crossings for clock extraction. SMPTE RP 178 describes a recommended pathological test signal called the serial digital interface (SDI) checkfield. It consists of one half field of each of the two stress signals described previously. This test signal is fed to the input of the equipment under test and the output is monitored on a color monitor. Bit errors affecting the top of the picture are a result of equalizer malfunction. Usually, this is due to excessive lengths of coaxial cable. Shortening the cable can eliminate the problem. Bit errors affecting the bottom half of the picture are caused by a malfunction of the receiver clock regenerator and could indicate a condition where the free-run frequency of the PLL-controlled VCO in the receiver has drifted from the specified frequency. In this case, readjusting the VCO frequency may eliminate the problem.

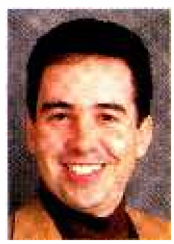
Because of the high reliability of digital equipment using bit-serial ports, many organizations do not carry out tests of any kind. This creates a false feeling of security that can lead to catastrophic results. Implementing a program that verifies proper bit-serial operation can help reduce and eliminate bit errors and avoid complete failure. ■

Michael Robin, former engineer with the Canadian Broadcasting Corporation engineering headquarters, is an independent broadcast consultant located in Montreal, Canada, and the co-author of "Digital Television Fundamentals" published by McGraw-Hill.

Computers & Networks

Networking basics, Part 2: Faster is better

BY BRAD GILMER



If you are building a network from scratch, you might be asking yourself, "Should I be looking into something faster than 10Mb/s?" "How much more will it cost to install a faster network?"

The cabling, connectors, patch panels and wall plates will cost you exactly the same for 100BaseT as for 10BaseT. The labor cost associated with installing these components is the same too — about $125 per desktop. The pieces at the ends of the cable — the network interface card (NIC) and the hub — are the only price difference. The NIC plugs into your PC. The hub is at the center of the star and serves as a central connecting point. (See Part 1 in January.) Even the NIC and hub costs are similar between 10BaseT and 100BaseT. A six-pack of 10BaseT NICs can be purchased for about $200 — about $34 per card. A totally dumb

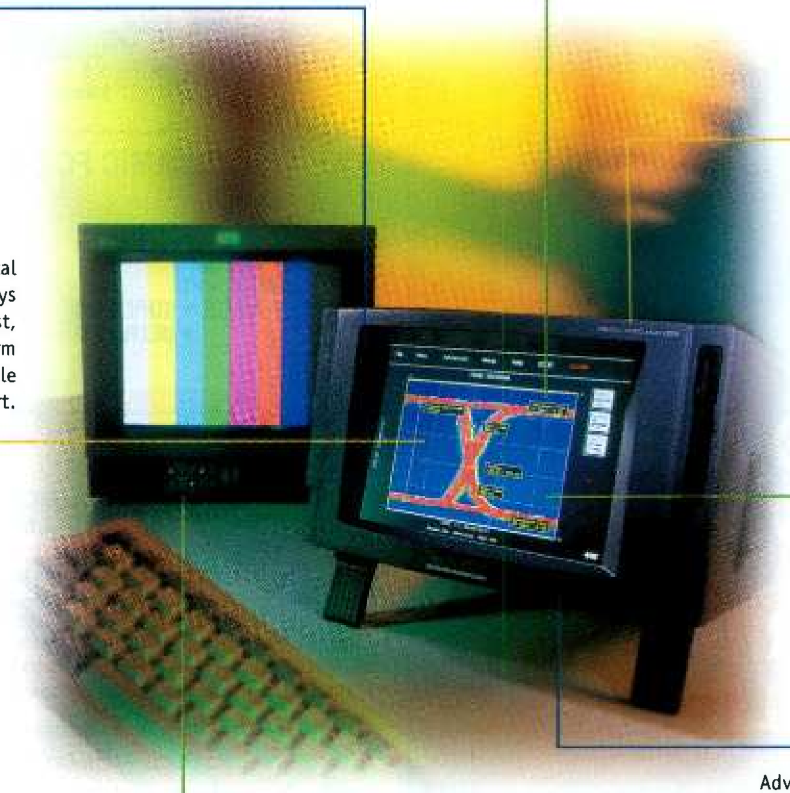
Serious SDI Testing

Tests both active video and auxiliary data portions of SDI signal and displays embedded audio stream numerically or as a waveform for easy recognition of proper test tones. 'Stop on Error' trigger catches auxiliary data embedding errors and embedded audio errors.

Jitter injection, amplitude attenuation, and error injection tell you if interconnections have enough headroom.

Confirms strict compliance with SMPTE and EBU standards.

Edge diagram of digital waveform. Clearly displays waveform shape and jitter. Fast, automatic eye-diagram waveform measurements are readable from remote control port.



Long-term digital error logging can grab 400 complete errored frames for unattended burn-in and overnight testing.

Advanced jitter features include FFT analysis with automatic measurements, output BNC connectors for demodulated jitter and reference clock to identify 'fingerprints' of jitter sources.

The DVA184C

Built-in test pattern generator provides stimulus and analyzes results conveniently. You get 32 test patterns and the ability to grab, create and store up to 400.

It's all here. Complete digital SDTV and widescreen testing at 270 and 360 Mbps, all in one very serious instrument that's also easy to use. The DVA184C is so accurate, fast and conclusive, you can bring systems up in much less time, ship product on schedule, and nail equipment incompatibilities before they nail you. Plus, the DVA184C has been well-proven, with demanding folks like HBO, ABC and SGI. Give us a call at 650-364-1853, or hit our web site today.

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10BaseT hub will cost about $100. A six-pack of 10/100 cards that will run either 10BaseT or 100BaseT costs $350, and a dumb 100Mb hub costs approximately $400.

Dumb hubs or smart hubs?

Hub prices vary greatly, ranging from $400 to $2,500 for a 10/100 Ethernet hub. So, why is there such a big difference in price? Quality of components may have something to do with it, but the larger reason is differences in functionality.

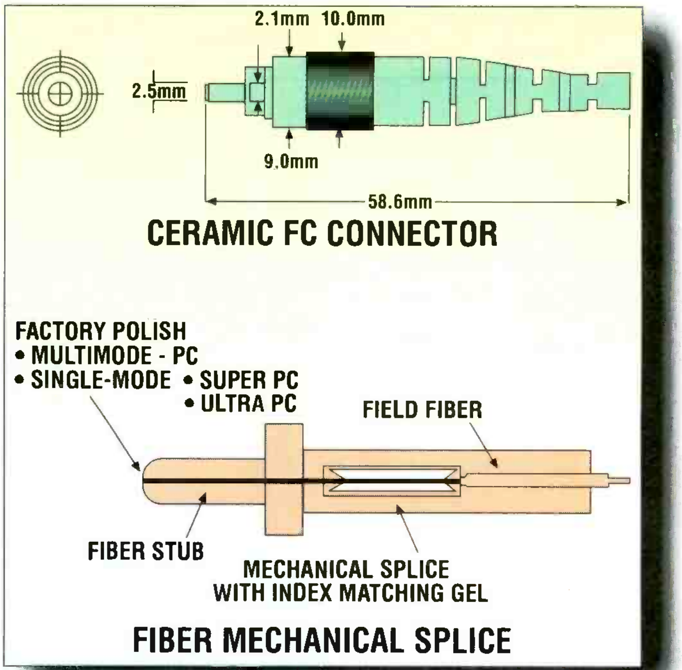

Figure 1. Fiber connectors are becoming more common and easier to use. Terminating a fiber cable into a connector typically involves a mechanical splice at or near the connector.

Dumb hubs serve as a central connecting point for the network — and that's it. Smart hubs serve that function, but many also perform protocol conversion and allow connection to a backbone running at a much higher speed. Most also contain network management software that tracks the network performance and reports this information to a central point. The decision of a dumb hub vs. a smart hub depends on the criticalness of your network, its size and your personal preference. When it comes to connecting a small group of computers together, both hubs will work fine.

How can I go even faster?

One way to go faster is to purchase faster cable. There are cable technologies on the horizon that promise connectivity over wire at rates up into the gigabit range. Standards for some of these technologies have not been set, and equipment availability is constantly changing. One thing is certain — faster wire-based technology will be available soon. The best thing is to speak with someone knowledgeable about networking when you are ready to begin work, and purchase the fastest wiring available at that time. Once the cost of installation, NICs and a hub are considered, cable cost becomes much less significant.

What about fiber?

What about running fiber to the desktop for the ultimate in speed? Fiber connectivity provides the greatest potential for high-speed networking to the desktop. But, fiber has found its true niche in connecting hubs together behind the scenes. Here are some of the reasons. The first is installed cost. It costs about $250 per line for fiber line, terminations, wall plates and jumpers. A fiber hub costs anywhere between $1,500 and $3,000, depending on the features. Fiber NICs are also more expensive — a six-pack of FX fiber NICs is about $2,000. Second, fiber media can be easily damaged. The cables are better than they used to be, but it is difficult to protect a fiber cable in an office environment. The big killer of fiber cables is not crushing, it is bending the fiber too tightly. Third, fiber terminations are sensitive to dirt. If you leave a fiber termination uncovered and reconnect the cables before you clean both surfaces, you may end up with a connection that is noisy at best. On the positive side, gone are the days of the old biconic fiber connectors where alignment was a real problem. The new FC connectors always mate correctly with little problem. Once you connect the fiber, dirt is no longer a problem. Taken together, these three issues have relegated fiber to the back room where it is a better fit in the computer network environment.

Fiber has a big advantage over wire in areas of high electromagnetic interference, impulse noise and lightning. If you continually have a problem with lightning destroying the NICs, you might try switching to fiber. Another advantage is distance. Fiber can be used in runs up to 412 meters. 10BaseT and 100BaseT are limited to 100 meters.

If you have ever tried terminating fiber cables in the past, you probably still have nightmares about sanding little figure eights. All that has changed. 3M, Siecor and others now make crimp connectors and splices for fiber that allow you to terminate fiber easier and cheaper. (See Figure 1.) If you were not all that great at making splices in the past, you can probably do better with these. Losses will be in the one-half to one decibel per connector range. A connector kit costs about $350 and connectors are about $6 each.

Although it is difficult to make a single recommendation that is right for everyone, here are some thoughts. Let's assume that you are going to install a small network with 10 workstations. Given that the cost of 10BaseT and 100BaseT is about the same, and given that you can purchase equipment that runs at 10Mb and 100Mb, then you should probably purchase 10/100 cards and wire your facility with the fastest wiring system available. Minimize your initial hub investment and plan on replacing it in a few years as your network grows. ■

Brad Gilmer is president of Gilmer & Associates, Inc., a technology and management firm.

FURTHER READING

The following sites on the web contain more information on 100BaseT and fiber:

- "Data Communications Cabling FAQ" compiled by readers of the comp.dcom.cabling newsgroup.
- www.hostots.utexas.edu/ethernet/descript-100quickref.html
- www.cis.ohio-state.edu/hype-test/faq/usenet/lans/cabling-faq/faq.html

Brad Gilmer left a 14-year stint at Turner Broadcasting Systems, Inc. to start Gilmer & Associates, Inc. Brad's consulting company specializes in designing and implementing multichannel and DTV broadcast facilities — especially those facilities that employ high-speed video networking. You can reach Brad at 770-414-9952 or on the Internet at bgilmer@atlnet.com.

Ask Dr. Digital

Bringing a scope back to life

BY STEVE EPSTEIN

As promised last month, we're here to help. Along those lines, one of my assistants recently received a plea for help from Brian Hoover, chief engineer at WNIT, the PBS affiliate in Elkhart, IN. It seems Brian was in the middle of rebuilding a Tek 529 and needed some information that ran many years back in *Broadcast Engineering* magazine.

Well, we dug deep in the archives and it turns out that the article Brian was looking for was written by Ken Dixon and ran in our December 1978 issue. It discussed modifying the 529 to replace the 7788 tubes (yes, tubes) used for vertical output with 2N3439 transistors. Now, I've repaired a few 529s in my time, and most of them had already been modified. Why anyone would want to keep one of those beasts alive is beyond me, but hey, I just spent my entire weekend rebuilding/restoring a 50-year-old micrometer (ACE Hardware sells them for $29.95, but it was my wife's grandfather's). So, who am I to say? Regardless, we sent Brian the information he needed.

Shortly thereafter...

Received your fax with the magazine article and schematic diagrams. Repaired the scope and it works great. Please have lunch on us grateful WNIT engineers!

Brian L. Hoover, Chief Engineer
WNIT-TV, Elkhart, IN

Enclosed in the letter were some fast food lunch coupons (hint, hint).

Thanks, Brian.

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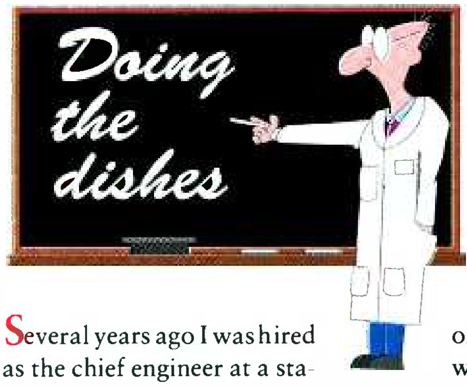
Well, I don't think that Tektronix has to worry too much about a warranty claim on that scope. We're here to help you. So, if you've got a technical problem, complaint or question, send it to dr_digital@intertec.com. Include as many pertinent details as possible, such as what you've done already and who you have talked to at the manufacturer and I'll see what I can do.

Steve Epstein



Several years ago I was hired as the chief engineer at a station in southern Illinois. Included in the station's equipment complement was a 10-foot satellite dish that was used daily for a variety of feeds. Apparently, it was designed for use at a cable head-end because it was not motorized. Two hand-operated jacks allowed it to be aimed at the desired bird. Sometime before I arrived, one of the hand jacks was replaced with a motorized unit. After I was on board several weeks, I found out the dish could only be aimed at the birds in the center of the arc. It seems that once the dish was moved too far east or west, the motor (which was basically designed for a six-foot mesh dish) was not strong enough to lift the dish back up.

After doing a little research, it became apparent why a larger (stronger) jack wasn't used; it simply wasn't available in the necessary size for a reasonable amount of money. For the most part, there were consumer units and models for five-meter and larger dishes — but nothing that was in between. Another solution was needed. Because I couldn't use a bigger jack, maybe I could lighten the dish. Counterweights are fairly common in many applications, I figured one could help here as well.

A series of calculations led me to believe that 150 or so pounds of counterweight on about a five-foot lever arm would offset the weight of the dish. Luckily, the metal and fiber-glass dish assembly had a metal frame that provided support for the rather massive counterweight. Using mostly two-inch pipe, a local machine shop fabricated the "iron cross" and the necessary mounting hardware. The end of the long pipe was threaded to accept a standard pipe cap. Removing the cap allowed the counterweights to be added as necessary.

The counterweights (two large and one small) were made from six-inch steel sleeves large enough to fit around the two-inch pipe. Four "spikes" (three-inch carriage bolts) were welded to the outside of the sleeve to provide some additional grip for the concrete. The spiked sleeves were placed in the center of a wooden form and the concrete was poured around them and allowed to harden.

The counterweights were mounted on a five-foot lever arm and provided enough weight to offset the weight of the dish.

When everything was assembled (except the jack) and the counterweights adjusted, the dish could be moved from horizon to horizon with little more than finger pressure. The jack was then remounted and with some adjustment, provided full coverage of the arc. At that point, the dish could be aimed at any satellite. However, one small problem became obvious over the next few weeks. It seemed that when the dish was pointed nearly due south, the signal strength would bounce around a bit. Looking at the dish, I noticed it was being blown around by the wind! The problem was mechanical "slop" in the jack. Re-adjusting the counterweights added some load (25 to 50 pounds) to the jack, eliminating the dish blowing in the wind.

Manufacturing the "iron cross" ran about $300, but it eliminated the majority of the wear and tear on the motor/jack assembly. It also improved the functionality of the dish by more than 300%. Other than an occasional tune-up, that dish required no additional maintenance the rest of the three years I was there. ■

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- Enhanced signal within the broadcast coverage area
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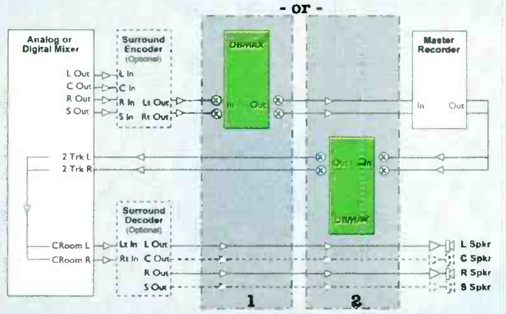

TV or Radio Production & Transmission Emulation

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Systems Design & Integration

Transmission & Distribution

Predicting DTV coverage

BY DON MARKLEY

Some months ago, this column touched on filing requirements for DTV. In part, the procedure described was correct, but more needs to be added to fully cover the filing requirements and the ability to predict the DTV service area. The problem comes about as the result of the commission's determination of a new antenna pattern that is meant to duplicate the NTSC Grade B service area.

The table of allotments that was contained in Appendix B of the FCC's sixth Report and Order identifies a maximum ERP and HAAT for each DTV allocation. What isn't clear from that document is that the ERP is the maximum allowable using the directional pattern determined by the commission. In preparing a DTV application for a construction permit, it is necessary to refer to that directional pattern and to propose an antenna that will not exceed the limits of that pattern at any azimuth value. This is discussed further in documents that can be found on the web page for the Association of Federal Communications Consulting Engineers (AFCCE) at www.afcce.org. In particular, the comments filed by AFCCE concerning petitions for reconsideration in that docket are of interest as is an excellent paper by Oded Bendov concerning the construction permit process.

A standard "omni" antenna will fit by simply checking the actual pattern for the antenna and rotating it.

More on directional patterns

Of particular concern are the new directional patterns. The patterns are available from the FCC web page at www.fcc.gov. An easier way is to use the link through the author's web page at www.dlmarkley.com. That page also includes a link to the AFCCE. The actual file is "dadb" and contains all of the notified patterns for all manufacturers, the directional antenna patterns as filed by all existing or proposed stations and the calculated DTV patterns. The DTV patterns are at the end and are identified by the city, state and channel number. Here is where the first of the problems lies.

For many stations, the DTV patterns are near non-directional. Many are sufficiently close to non-directional that a standard "omni" antenna will fit by simply checking the actual pattern for the antenna and rotating it as needed to keep it under the limits. It must be realized that no antenna is truly omnidirectional. They all have a little variation from a perfect circle. It may be possible to use that variation to meet the commission's requirements. In such a case, the simple check list application is a reality. In addition, an application for an ERP less than that shown in the allocation table will often work with a simple omnidirectional antenna as the maximum ERP values of the DTV directional antenna will not be exceeded. The problem comes with trying to file for the maximum permissible ERP.

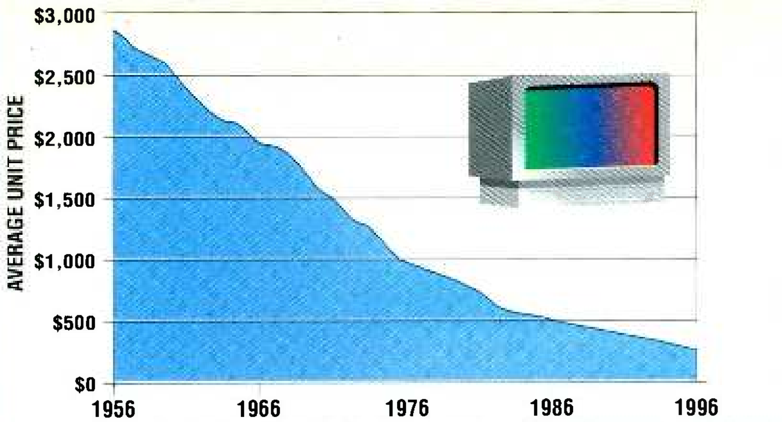
The directional antenna patterns for many stations are unrealistic. Some of the patterns are simply unobtainable in the real world. In fact, some of the antenna patterns don't even comply with the commission's rules. The rules

FRAME GRAB

A look at the consumer side of DTV.

So what's a set gonna cost?

This chart shows that in today's dollars, the first color TV sets were very expensive. However, as quantities shipped increased and technology improved, prices dropped dramatically. Experts believe that a similar, but far more rapid, price drop will be evident with HDTV sets.



Source: Consumer Electronics Manufacturers Association market research department. www.cesweb.org

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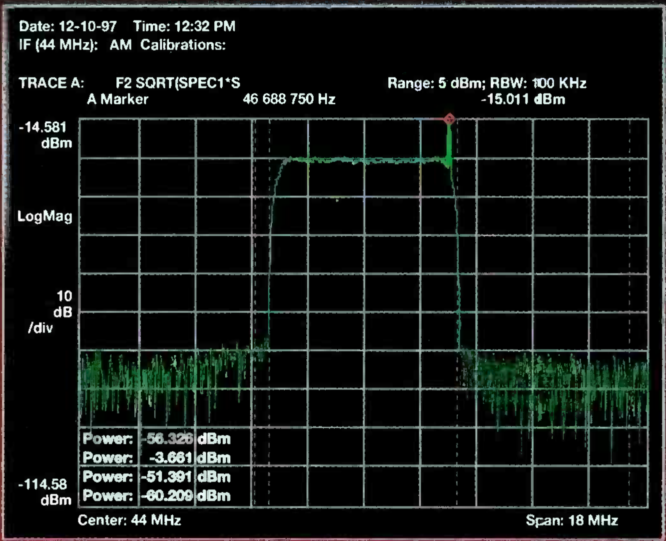
Why risk your future with any other DTV transmitter company?



ACRODYNE's DTV Modulator IF Output

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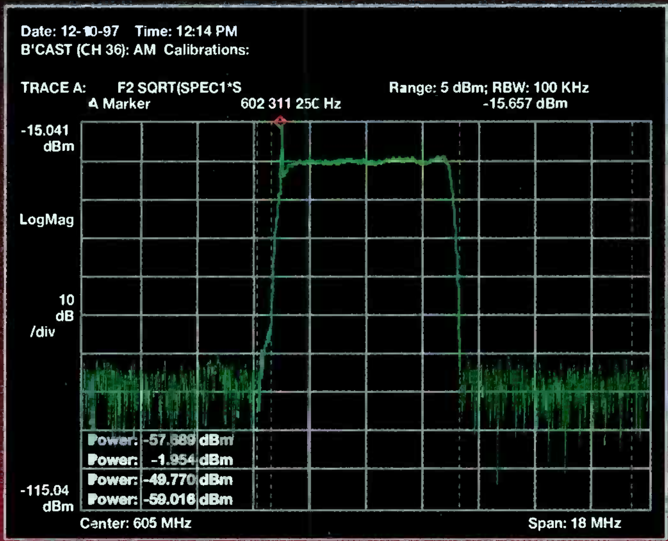

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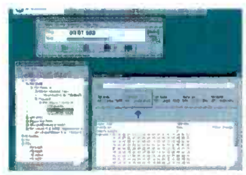

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for directional antennas limit the ratio of the maximum to minimum value of the pattern to 15dB for UHF stations and as little as 10dB for VHF stations. Although waivers of those limits have been granted on a case by case basis in the past, it seems unusual for the commission to specify patterns that do not meet their own rules. A brief study of the patterns reveals max to min ratios of as much as 32dB. Get serious. That ratio is difficult to achieve with a dish, let alone a TV transmitting antenna. That really means that the maximum ERP shown on the table is a joke. Even if a ratio of 20dB could be achieved, the maximum ERP would have to be reduced by as much as 12dB to have an application that would be acceptable by the FCC.

Let's look at some real numbers. WGBO-TV is licensed to Joliet, IL, on Channel 66. The station is located on the John Hancock Building in downtown Chicago and operates with a directional antenna and an ERP of 5,000kW. The null on its DTV pattern ala the commission's computations is -32dB from the peak. The authorized DTV ERP is 128.7kW. Let it be assumed that an antenna with nulls 20dB down could be reasonably built and further assumed that the commission would grant a waiver for that antenna. That would limit the station's maximum DTV ERP to 9.89kW to avoid exceeding the commission's pattern at any azimuth. The commission's tables indicate that the station's DTV/NTSC coverage match is 100%. Let's see now. That would mean that 9.89kW for DTV will provide the same service area as 5,000kW for NTSC at the same height. Those pigs must be flying again.

In addition, the lobe shapes themselves are a little bit strange. Rates of change on the side of lobes of as much as 10dB over a 10° azimuth change are shown for some stations. That can't be realistically done in the real world. Therefore, it won't be possible for some stations to duplicate their existing NTSC Grade B contours. In some cases, they can't even come close. You wonder if anyone actually looked at the DTV patterns before they were published or if the output of the computer was treated as the mouthing of some great deity as untouchable and absolute.

It won't be possible for some stations to duplicate their existing NTSC Grade B contours.

Now, on to the height above average terrain. The value shown in the allotment table is a maximum HAAT. Unless the DTV operation is to be on the same antenna as the NTSC station, which should be possible for some stations, the two stations cannot operate with the same HAAT unless a candelabra structure is used. There is no provision in the DTV rules for reducing power with an increase in HAAT. For example, some manufacturers propose stacked antennas with, usually, the DTV antenna on top of the NTSC antenna. That would call for a decrease in the HAAT for the NTSC system so that the height for the DTV antenna doesn't exceed the limit. In the past, the commission has allowed the ERP to be reduced to compensate for an increase in height. That is still acceptable for NTSC stations as well as for FM broadcast stations. An equation is contained in the rules for each band of DTV stations for new allocations, but no provision exists to modify the limits in the allocation table.

Revisiting the contours

So, what will the DTV service area look like for a given station? To start the calculation, the maximum ERP and HAAT can be obtained from the table contained in the sixth Report and Order. Then, the transmitting antenna must be designed to provide the best match to the commission's directional antenna for that station without exceeding the directional pattern at any azimuth. Then, the distance to the noise-limited contour can be determined from the F (50, 50) curves modified to F (50, 90). Even better, an improved propagation model, such as Longley-Rice, can be used to obtain a more accurate evaluation of the service area based on actual terrain.

With luck, this will change. Numerous petitioners have requested the commission to revisit this process and to correct some of the obvious problems. It is felt by many that the problem results, at least in part, from using one model to calculate the location of the NTSC contour, a different model to determine the location of the DTV contour and a third method to determine interference. This is not comparing apples and oranges — it is comparing apples and cows. The commission's staff has indicated that changes are coming — perhaps some by the time this article is published. In the meantime, to answer the question of what your DTV coverage will be — who the hell knows. The answer concerns what model you want to believe and how much you have to give up to match the commission's patterns. ■

In the meantime, to answer the question of what your DTV coverage will be — who the hell knows.

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

WEB SITES

- www.afcce.org (Association of Federal Communications Consulting Engineers)
- www.fcc.gov (Federal Communications Commission)
- www.dlmarkley.com (Don Markley web page with links to the above)


in the television
industry's race toward
digital transition,

Field accessories

BY BENNETT LILES

When a shooter grabs a camera bag and heads for the field, he or she can always count on one thing. That is, that you can't count on anything. A camera, a microphone and a batt light will equip you for home movies, but today's field shoots demand a toolbox full of widgets to instantly convert a number of tasks from impossible to easy. When selecting gear for a field package — *accessorize*!

There is a virtually endless array of small tools that are forgettable until the moment you need them. Clamps and C-stands can hold lights, masks, goboes, reflectors and shades. These are best kept in good condition with all three pads on the stand legs. One missing pad can cause the clamped equipment to sway back and forth in the wind like an annoying restaurant table with one short leg. Before the equipment goes out, always check the tripod for loose legs. One that slowly lets go can cost you a camera and a lens. A frequent question asked as the smoke clears and the damage is cleaned up is — "Why weren't those light stands sandbagged?"

Lighting gear can fill a large truck, but if you carry a batt light, at least have a barn door, some scrims, diffusion material and a solid stand and a sandbag for it. Still on the mechanical side, one item that no shooter should ever walk out the door without is gaffer's tape. It is used everywhere for everything. Take plenty.

If you get lucky and AC power is available, extension cables with adapters will be needed. The adapters should include stage/Edison and pigtail/Edison. Although they are heavy and cumbersome, AC power isolators can cure headaches for you *and* others using common power on the shoot; especially when that mysterious audio hum gets into everything like sand on a beach trip. Although Nickel/Cadmium (NiCad) batteries still rule the roost, the newer Nickel Metal Hydride (NiMH) batteries are the heir apparent, with greater capacity per size and without the memory effect commonly found in older NiCads not allowed to fully discharge before recharging.

That brings us to the fleet of audio adapters. Isolation transformers with ground lifters can help cure hum situations when you can't select another power source. Splitters of every kind are also a must. RCA, XLR, quarter-inch, mini and even submini splitters are good to have. There are still occasions when a 70V PA feed is all that's available. That's one more audio transformer to throw in.

The Tektronix WFM 90 is a hand-held video monitor that can show audio and video waveforms, vector displays and picture-in-picture.

Every kind of connector including last-resort alligator clip leads have a place in the well-stocked field kit. Line/mic pads with adjustable levels are also useful as are adapters to mix and match all of these various connectors. Turnarounds should also be included in every connector type. You never know when you'll have to take a feed from a high-impedance source so add impedance-matching transformers to the list. The type of connector that you encounter on the source will give you a clue to the characteristics of the signal. The high-impedance sources will usually have mini or RCA connectors while 150Ω to 600Ω sources will be XLR. Even binding posts for banana connectors are sometimes found at the rear of a PA mixer or pre-amp. One frequently home-made item is a phase reverser housed in an XLR audio turnaround. Just make sure that these are clearly labeled "phase reverse."

Extremely long audio cables can attenuate the sound signal until it is far below the originally advertised level. One little black box that's worth its weight in gold is a battery-powered pre-amplifier. Many of these have a selectable amplification level calibrated in power decibels and sport a range of 3dB to 64dB of amplification. Among other places, these have been used in cramped skyboxes at political conventions to boost individual mic lines to much higher levels so that they can be sent downstairs and across the street to the production truck in the press area and mixed there. The closer to the microphone that these pre-amps are located, the cleaner the amplified signal will be. A stereo field mixer is worth the extra money. The post people may want three mics on three separate tracks and a mix on the fourth. If you are mixing mics onto a common track in the field, a stereo mixer can allow you to easily mix any combination of sources to any combination of sound tracks. This is valuable because producers may not consider these options until things are hooked up and tape is about to roll. The stereo field mixer gives you maximum flexibility at a moment's notice.

Live from anywhere

In recent years there has been a new remote shoot animal added to the zoo — the ENG satellite uplink live shot. When your video and audio signal is

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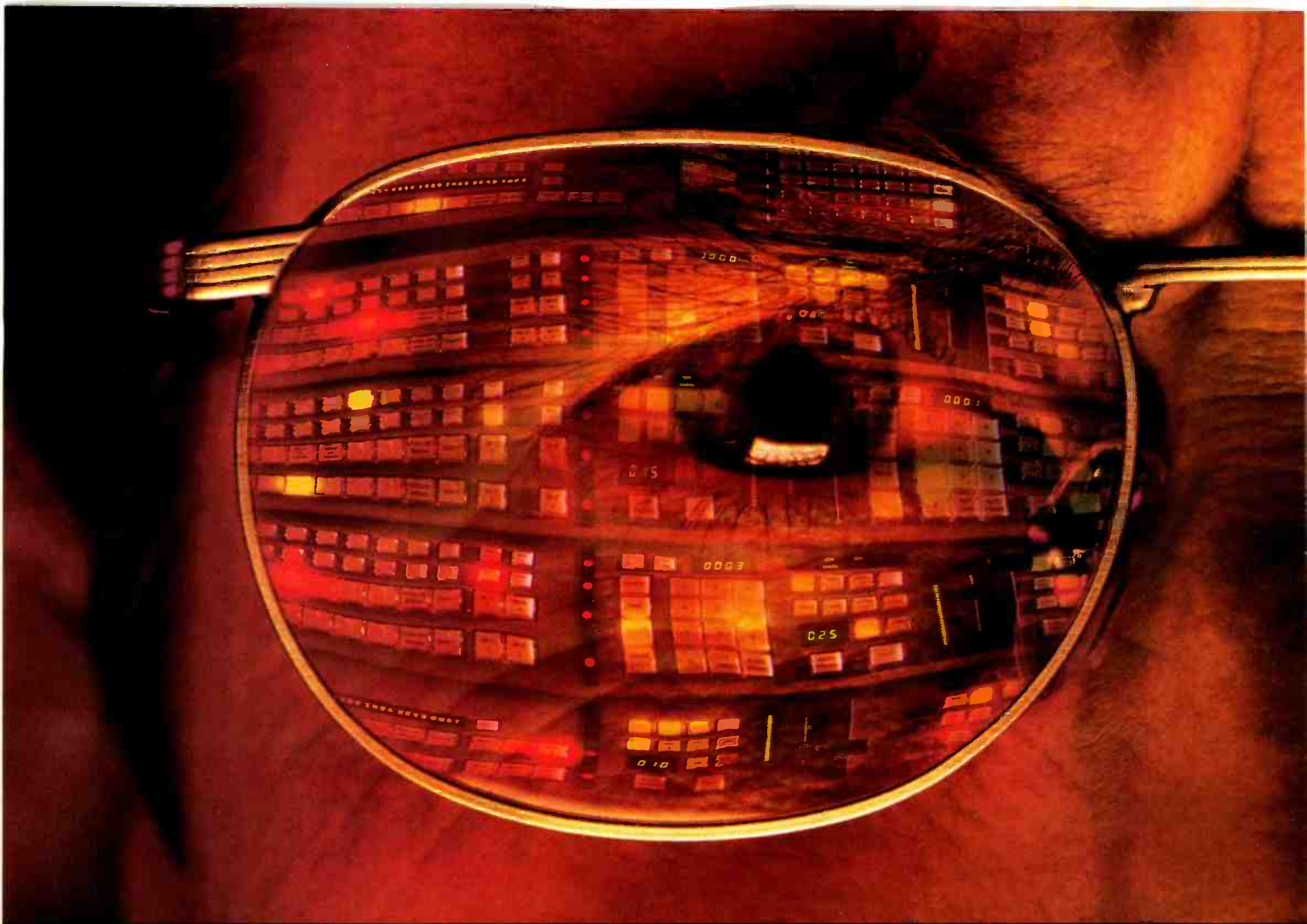

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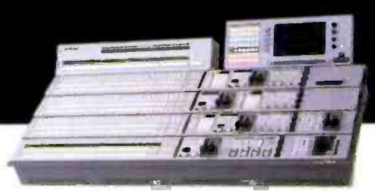
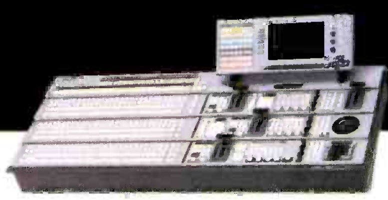
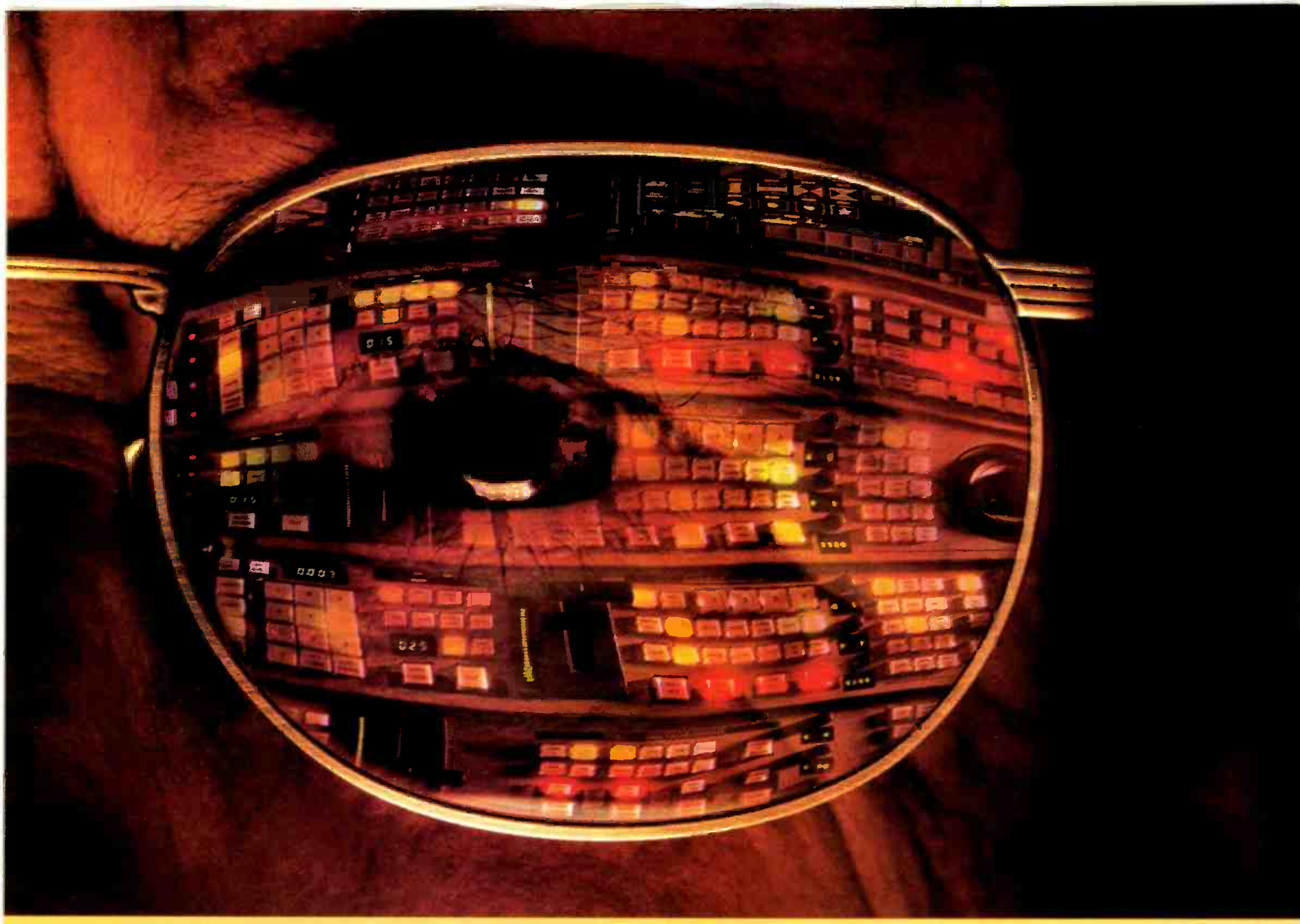


DVS-7350 System



DVS-7250 System



being uplinked as part of a program originating elsewhere, several new tools are needed in the field kit. These items interface the telephone line with the IFB earpiece and the shooter's communication headset.

Typically, one side of these telephone couplers will have an RJ-11 jack and a loop-through RJ-11 for connection of a standard handset. The other side will have an XLR and/or quarter-inch jack to connect the IFB earpiece or the camera op's high-impedance headset connector. Many now sport dialer pads and some even have an auto-answer feature. Of course, there have been telephone sets around for years that have parallel headset outputs incorporated into the case, but these are generally too bulky for a field kit.

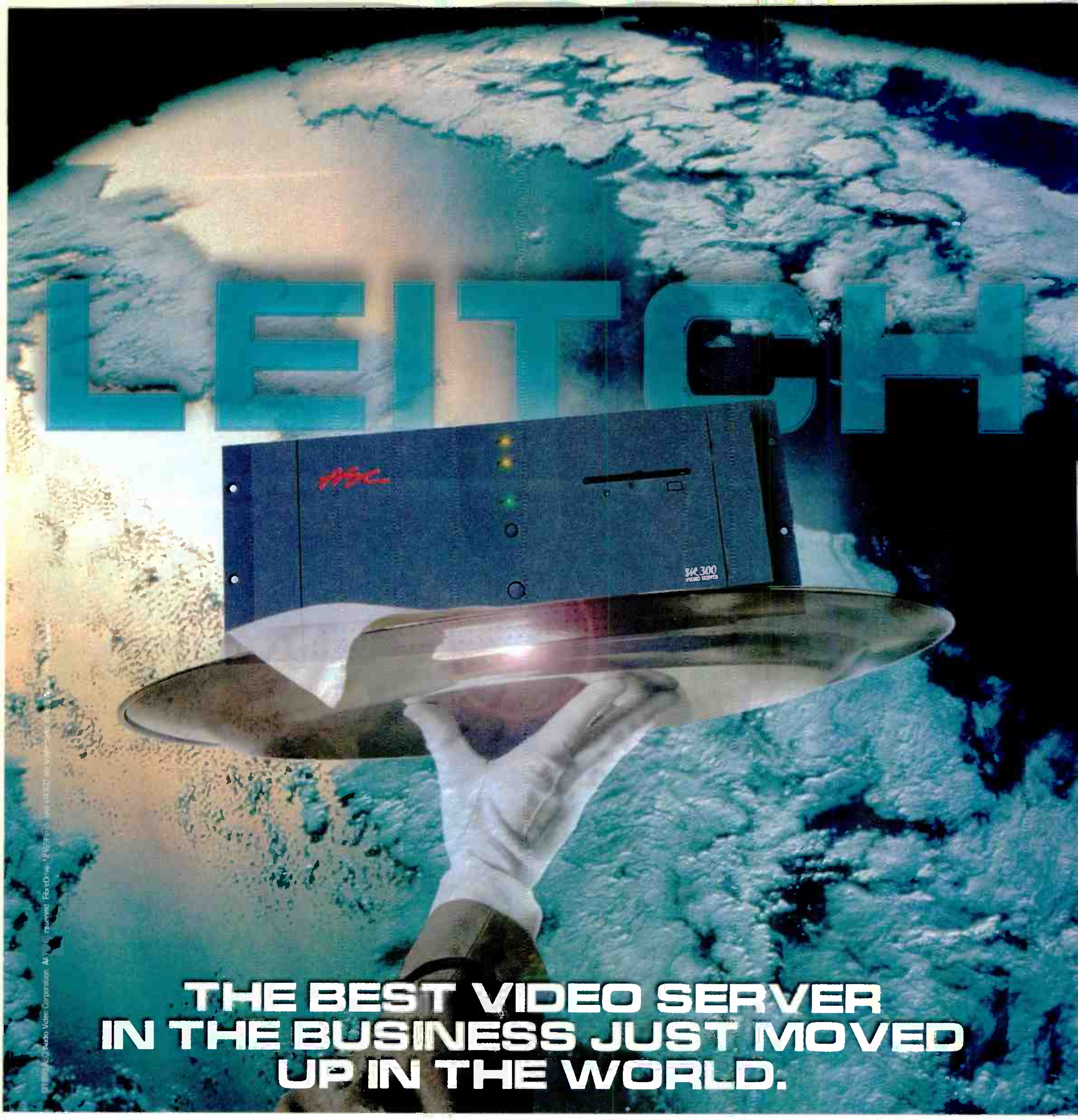
Here again, the stereo field mixer can be used to mix mics on one channel and monitor mix-minus program sound on the other, by way of a pair of stereo headphones so that the camera op can hear both sides of the conversation. One channel carrying the mic mix is fed to the uplink, while the other channel carrying the mix-minus is fed into the talent's IFB earpiece by way of the second output channel on the mixer. Some of these telco interface units are powered by the wet phone line, but some use 9V batteries or external power in the range of 15-24VDC at around 50mA. Lately, cell phones have begun to augment telco interfaces for connecting to remote intercom and IFB.

Check that cable

Bad cables are a fact of life on field shoots and the task is to diagnose and replace them quickly. Many new tools have surfaced to help spot sick lines. Some consist of nothing more than small, mic-to-headphone amplifiers that can be clipped to a belt and worn for instant line monitoring. Others tell a more complete story, with LEDs that light to show which if any conductors are carrying DC. This will identify phantom-powered mic lines and IFB cables.

The nicer boxes have built-in microphones, speakers and tone oscillators with selectable output levels at -50dB, -20dB and +4dB. With one at each end of an audio cable, an instant intercom is created and powered on a 9V battery in each unit. Microphones can be handily checked at the mic end of the line. On the video side, new hand-held multifunction monitors have made field video measurements and monitoring easier than ever. Some of these units enable adjustments to video, sync and blanking levels anywhere along the signal path while displaying a vectorscope or waveform in the corner of the picture. All vital video and audio parameters can be checked at any location along the line, allowing the field operator to quickly isolate a trouble spot and make corrections. As field accessories have gotten smaller and smarter, jobs that used to take an hour or more can now be done in seconds. Using these tools more, the modern field shooter may use his running shoes and antacids less. ■

Bennett Liles is audio engineer at Georgia Public Broadcasting, Atlanta.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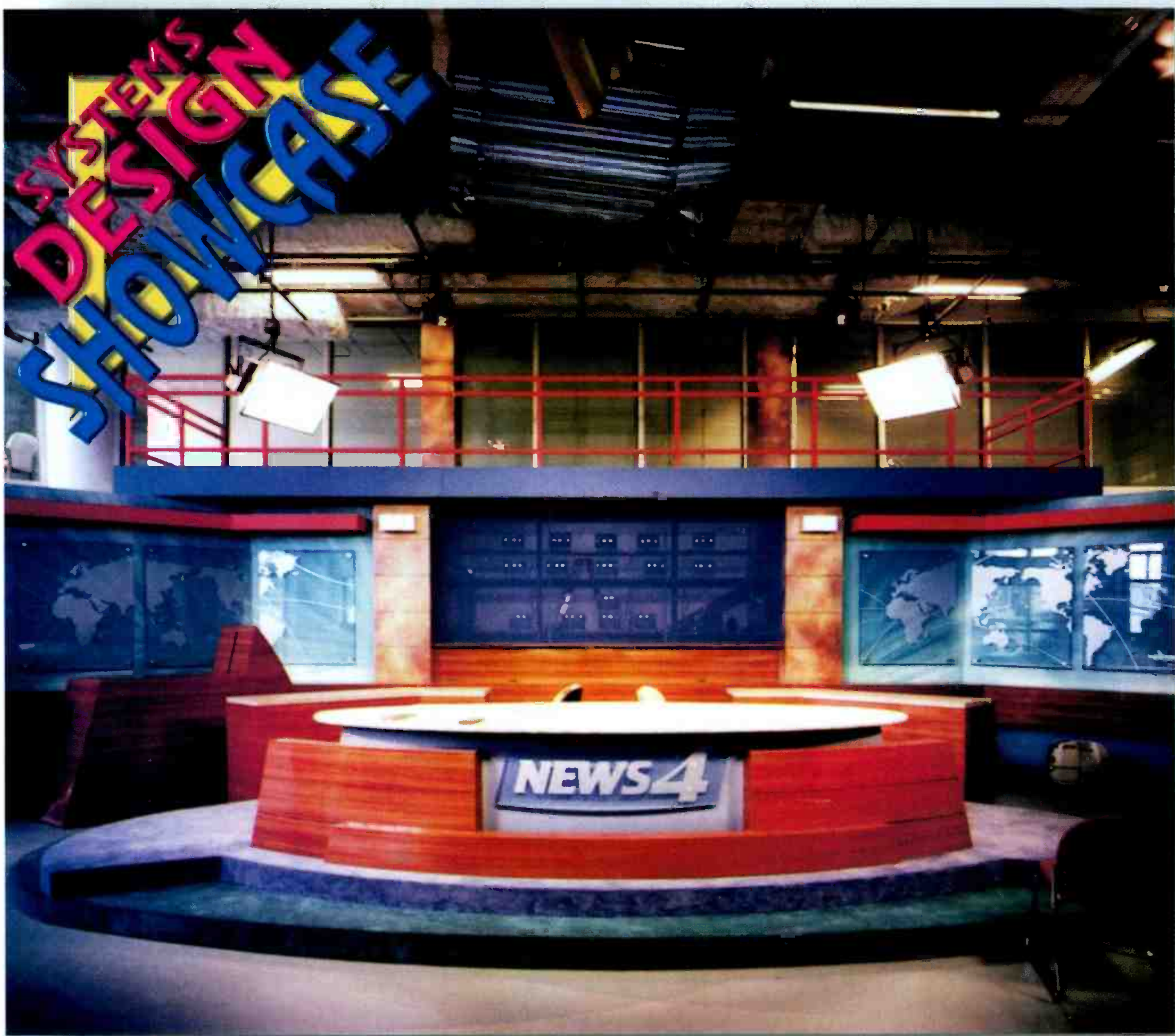
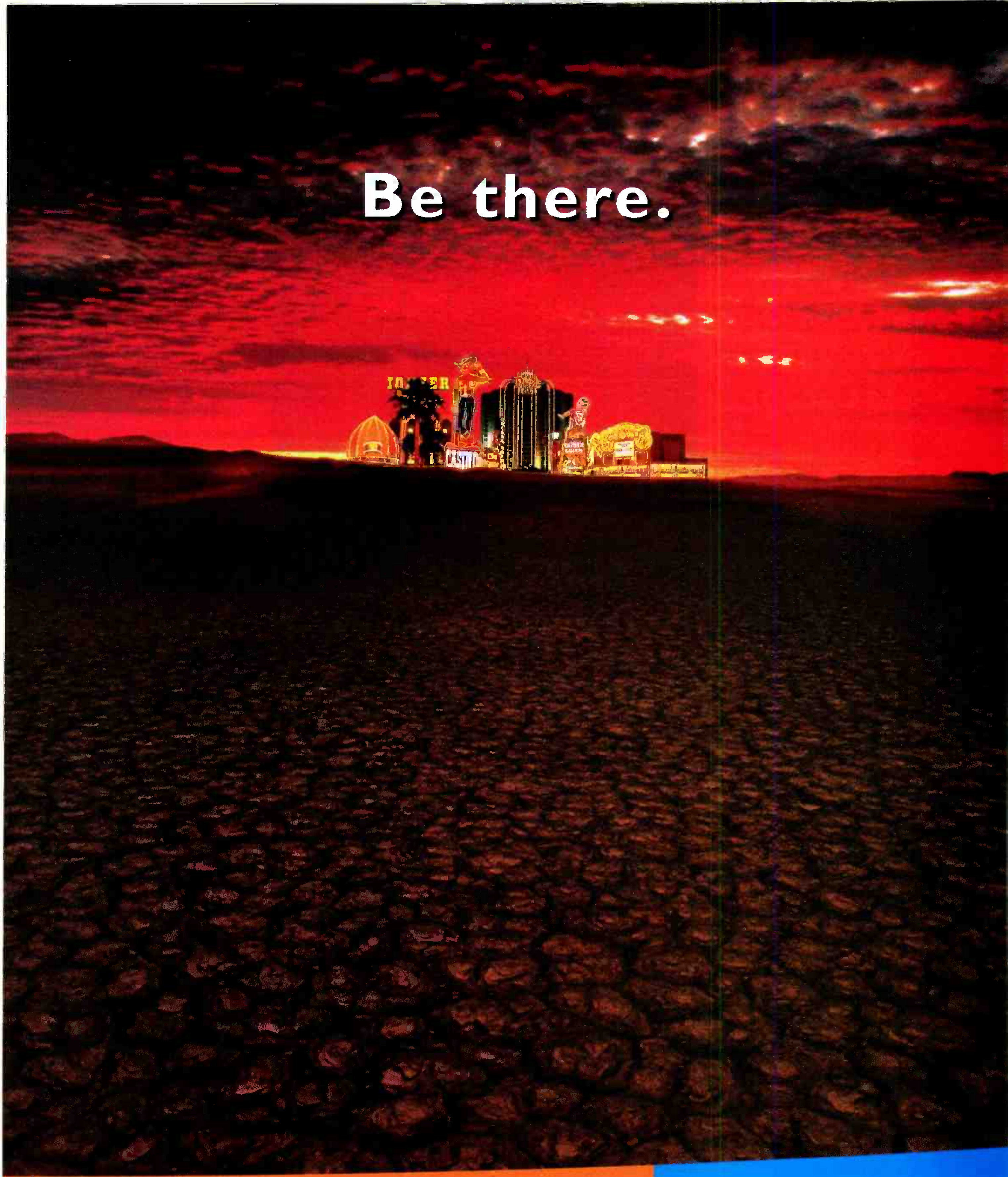


KITV: First on-air DTV station

BY JT DUGGIN

When Argyle Television did its due diligence inspection visit at KITV in Honolulu in December 1994, Tom Mann, then Argyle's vice president for engineering and new technologies, discovered that upon purchase, the company would have to begin a fast-track plan to find and equip new studio facilities for Channel 4. The present building was an owned building on leasehold land, with the lease expiring in three years. The old facility was extremely crowded, contained in just 15,000 square feet. Preliminary space planning studies by the previous owner revealed the need for double the space. A 35,000-square-foot commercial space at the One Archer Lane condominium complex was selected to be the site of KITV's new facility.

The technical facility was straight out of the early 1970s with poor growth planning and insufficient technical capital. Almost no equipment would be valuable enough to move and the rest was in questionable repair. A facility would need to be designed from the ground up. Although no regulations were on the books to require ATV and no technical standards existed for ATV, it was to be a reality within the next several years. An analog design, whether component or composite, would be a poor choice for new construction.


Be there.

Putting the system together: Invention

KITV did not have a large engineering staff. The goal was to efficiently construct a new station without adding to the station's engineering staff. John Duggin Sr. and Digital System Technology, Inc. (DST) presented a unique solution. We had supplied routing switchers, master control and machine control systems packaged pre-wired to Argyle Television for other stations in the past. Duggin and Mann had coined the term *palletization* several years prior, to describe a process that wasn't stick-built and wasn't turnkey.

The master control room with a Philips Media Pool that is used for spot playout.

Digital System Technology, Inc. assembled multirack modules pre-wired to patch panels, configured and tested. The racks were bolted together on a shipping pallet so that the installation team could drop it in place, connect the inputs and outputs and let it fly. The station gets a finished, tested system, ready for implementation into its existing technical fabric. Digital System Technology, Inc. extended this modular design and packaging of palletization to larger more complete systems, including the entire technical facility at KITV. Because of its modularity, the palletization process is particularly suited to the ATV conversion of TV stations. Many stations will not need a complete redesign of their facility, just a conversion in key areas.

Working closely with Mann and KITV station chief, Greg Johnson, Dwight Crumb engineer at Digital System Technology, Inc. began the task of designing KITV's new digital facility. Once the technical design was completed DST's president John Duggin Sr. oversaw the procurement of the specified equipment for the project. Simultaneously, DST began pre-building the core of the station at its facility in Irwindale, CA. The

equipment was pre-wired in five rack modules, powered up and tested prior to shipment. Taking into consideration the high cost of on-site labor, everything that could be completed prior to shipment was addressed. On Sept. 10, 1997, 3.2 million dollars of crated and palletized equipment was sent via air cargo to Honolulu. Digital System Technology, Inc. remained on site for 14 weeks with its installation crew. The entire install took place at KITV's new home, One Archer Lane, while the building was under construction. This alone presented some interesting challenges. In order to meet the specified deadlines for transmission we began the install under temporary lighting with no air conditioning or windows in the middle of a construction zone. Painstaking efforts were taken to protect the equipment from dust and damage.

The master control room with an Itelco transmitter remote control shown in the background.

The newsroom area under construction.

Technical islands for island television

It might be said that the station has three separate technical islands:

1. master control and the core technical facility;
2. production system; and
3. news gathering and editing.

The Philips Venus digital routing switcher, Jupiter router and machine control, Saturn digital master control and Diamond digital production switcher system were chosen as key core technical equipment, principally because the components all work together as a system. KITV's master control was specifically designed to do HDTV and SDTV multicasting. It is designed to originate up to eight program streams simultaneously, and is presently equipped to output two SDTV streams. Additional SDTV streams are largely a matter of plugging in cards. Insofar as possible, HDTV is also a plug-in. Although KITV is not automating as part of the move, automation is part of the design and will be implemented as soon as it is necessary to originate additional program streams.

Hawaiian TV stations have a unique problem in that the network (ABC in KITV's case) has to delay two or three hours (depending on the season; Hawaii does not have daylight savings time). KITV was a pioneer adopter of Philips Media Pool disk-based storage system for this net delay back in 1994. A second Media Pool has been added for spot playback in the new technical facility. The great advantage of Media


Power
up

The newsroom area under construction.

Pool over competing products for spot applications is that it inherently has variable compression as part of its original design. Figuratively, a K-Mart spot could be compressed 10:1 or even 22:1 if there was no motion, but a Rolls Royce spot could be stored in uncompressed form. The Media Pool is the short-form storage engine for the station. There is planning for the addition of near-line storage to the Media Pool this year.

The long-form storage engine for KITV is JVC Digital S tape. This format was chosen after evaluation of Digital S and DVC PRO, both of which got high marks for quality in subjective tests. The following factors carried the most weight in the decision-making process:

Digital S is 4:2:2 with a 50MB/s data rate from inception.

The half-inch tape in the Digital S format was thought to be more physically stable than the 8mm tape in DVC PRO in the high humidity environment of Honolulu, because tape is hydro-


Color Pattern Generator
16:9 Pattern Generator
Digital Sync Generator
Waveform Monitor
Vectorscope
Digital Video Analyzer
Color Analyzer
VITS Generator
OFDM
TV Digital Sound Modulator
NICAM Monitor
TV Monitoring Receiver
TV Modulators
Central Test Transmitters
Distribution System
Quality Control System

scopic and there had been reports of problems with hi-8 tape in humid environments. This was circumstantial, but Hawaii is a unique, tropical environment.

The station had been using JVC SVHS for news gathering, had a good maintenance and support history with JVC and could retain the KY-27 cameras for a couple more years of use in the news department field service.

Shown on the right in the master control room are the JVC Digital S decks, the station's house format.

The production studio system was designed to be SDTV component digital 16x9/4x3 aspect ratio switchable, based on Philips LDK-10 cameras, the Philips DD-30 production switcher and a Neve 55S analog audio console. This straightforward control room/studio pair provides daily service for the production of news shows, as well as special production for the unique identity of the station's trademark, Island Television.

Post-production editing is accomplished on three Avid Media Composer 8000 systems, one of which is exclusively dedicated to station promotion production to keep KITV's image and programs fresh in the Hawaiian public's eye.

News footage is shot on Digital S with JVC KY-27 cameras, then transmitted or carried back to the station and spooled into six Avid News Cutters. Ninety percent of the station's news product is non-linearly edited. The edited product is streamed to an Avid Air Play, which also stores interstitial components of the news and serves the station's affiliation on local cable with CNN 24/54 news. News stories are played out of Air Play into the 5:00 newscast from the production control room. Long-form news programs (specials, series pieces, etc.) often start out in News Cutter and migrate to the Media Composers via Avid's Media Dock docking hard drives.

Transmitting advanced television

On April 2, 1997, the FCC authorized the commencement of digital TV broadcasting and assigned channels for that purpose. In June 1997, Argyle Television made a strategic decision to be first in the Hawaiian market to actually transmit ATV signals. Thus, began a fast-track project to license, provision and construct KITV-DT, KHVO-DT and KMAU-DT (Honolulu, Hilo and Maui, respectively). They became the first commercial TV stations to receive an FCC construction permit to build digital TV transmitters.

The DTV transmitters were the longest lead item in the RF group. After discussions with most of the major transmitter manufacturers, Itelco S.p.A., was selected because it was the only manufacturer who could deliver a solid-state design before the third quarter of 1998. Itelco-USA was able to deliver two 800W DTV transmitters and one 7.5kW transmitter in late November 1997. The transmitters are, in at least one aspect, unusual for a solid-state design, because the power amplifiers are liquid cooled. The liquid is distilled water, although other liquids could easily be used. This cooling method allows the transistors to operate 20°C cooler than air-cooled designs. Thus, allowing much greater linearity and stability in conventional bipolar transistor designs, without having to resort to bleeding-edge technology before it may be ready.

The Honolulu transmitter began transmitting on Nov. 28 at 3:34 p.m. Honolulu time. Hilo followed several days later on Dec. 3 at 8:00 p.m. As far as is known, this was the first commercial digital TV transmission in the United States. ■

JT Duggin is the vice president of Digital System Technology, Inc., Irwindale, CA.

Equipment list

JVC 22 BRD-85U Digital S VTRs; 19 BRD-750U Digital S VTRs; 11 BRD-40U Digital S docking recorders; KY-27 cameras; 70 racks from GKM; ADC audio/video patch panel; Philips Venus 128x128 SDV router; Venus 128x128 analog audio router; Jupiter control system; Saturn digital master control; DVS Token mux and multiplexer; three LDK 10 studio cameras; Media Pool eight-channel video server; Diamond Digital DD30 production switcher; $300,000 of Leitch Digibus conversion and distribution equipment; five Ikegami 32-inch 16x9 color monitors; 40 Link D-to-A monitor converters; RTS intercom system; Chyron Infinit with Liberty paint system; six Nigel B edit consoles; Pinnacle Extreme DVE; Neve 55s audio console; Tektronix test and measurement equipment; Hewlett-Packard test and measurement (ATV).

Power quality and grounding

Many of the older methods of grounding, bonding and shielding must be abandoned for reliable operation of today's digital equipment.

By Warren H. Lewis

Times change, and so does equipment. Analog power supplies and electronic circuitry have been steadily giving way to digital switching and logic-based designs. Although most of us have noticed this progress, are we aware of what this change means regarding the reliable operation of digital-based equipment? Also, what happens when newer equipment is connected into the typical AC power and signal wiring systems used for the old analog equipment?

To begin with, most analog audio mixers used potentiometers to directly vary the input signal level. The potentiometers could be rotary or slide types, and either type could get noisy over time. Newer digital-based circuits use the same types of controls, but with a difference. Channel gain is step-variable in accordance with the binary value of the number produced via A-to-D conversion of the potentiometer's resistance. Noise is filtered out prior to and during the A-to-D conversion process.

Some controls for mixing and gain are no longer even potentiometer-based. Optically or magnetically coupled digital encoders are used. Shaft rotation or slide position is directly converted to digital pulses and hence, binary numbers. Then, of course, there are systems such as audio and video mixers controlled via a digital link to a laptop or desktop personal computer. Links are often of the RS-232 or RS-422 type, although fiber-optic links with even better performance are coming on strong. Wireless systems also exist, and they may also use control and signal links involving infrared (IR) or radio frequency (RF) for the wireless portion of the path, but still wind up using wiring to get the signal into and out of the equipment to which these links are connected. The wired portion of these devices may use these types of digital-format signal protocols or other proprietary types.

Once we get to the actual control, audio and video signals that newer equipment deals with, we find the signals are fully digital. They are no longer neatly phase-shifted or amplitude-varied AC waveforms or DC-referenced sine or analog-shaped waves. Rather, they are streams of square-wave-shaped, pulse-width-modulated (PWM) signals or packets of encoded binary numbers representing a fully digitized control, sound or video signal. Even looking into AC-to-DC power supplies, there are typically only two places where DC exists (the input filter capacitor and the logic or utilization voltage output buses); the rest of the circuit handles square waves of one sort or another. Frequencies into the tens of kHz and PWM schemes are now encountered inside power supplies. In contrast, analog power supplies had only 50Hz or 60Hz AC on the line input to the rectifier and everywhere else was either pulsating 120Hz DC or some "pure" level of DC — stable or changing, but nevertheless DC.

Power quality and grounding

Ground rules

In the analog equipment world, we typically lusted after the much-discussed single-point ground (SPG) system and quiet earth-grounding electrode, usually of a mystical 1Ω character and not connected to anything except our equipment. This practice has been and remains a serious NEC violation per Article 250 — Grounding. All earth-grounding electrodes on the premises are required for fire, shock and lightning safety purposes to be made by means of bonding conductors, electrically common to all other electrodes and to the building's electrical systems equipment (safety) grounding conductor (EGC) system. The system consists of metal conduit raceway, metal equipment enclosures and the famous greenwire on the power cords.

This situation has changed completely. The modern recommended practice for grounding analog and digital-based equipment is to use a multipoint grounding (MPG) design, accept connection to the AC power system's equipment grounding greenwires and ignore special connections to earth of all types.

For example, where we have rooms full of equipment in racks and where this equipment is interconnected by signal-level cables, a signal reference grid (SRG) is used to ensure that broadband grounding capability is achieved and common-mode noise is attenuated among interconnected units. A diagram of an SRG and related equipment is shown in Figure 1. We will cover the SRG in detail later in this article.

Digital equipment is different and also immune to some of the problems associated with analog equipment. However, new problems have emerged relative to digital equipment. Some old rules of installation used with analog equipment must be thrown out and new rules applied. Luckily, these rules generally apply to analog equipment as well. For example, some equipment grounding rules have undergone significant revision. Some cable shielding rules have been similarly affected. Lightning and electrical surge-protection requirements have also emerged as being poorly understood and more important than ever when using electronic load equipment and, in particular, digital-based equipment.

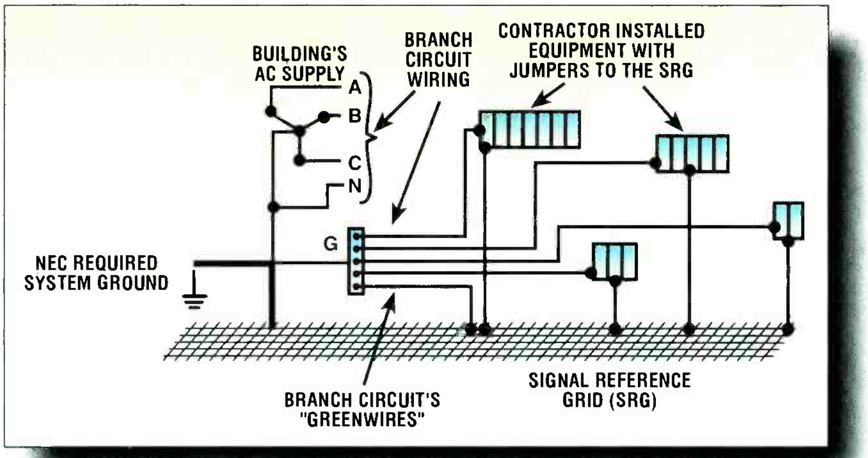


Figure 1. Diagram of a typical signal reference grid (SRG) and equipment grounded or bonded to it for reduction of common-mode noise.

Power quality and performance problems

No practical difference exists between a logic circuit used in a computer system to represent a numerical bit value (0 or 1) and that used in digital circuit-based sound and video equipment. Therefore, a lot of information that has been successfully developed for use in the computer world is directly applicable to digital audio and video equipment. Don't forget this also involves computer equipment. Nowhere is this more true than when considering the CBEMA curve.

CBEMA (pronounced See-B-Mah) stands for an old mainframe computer manufacturer's organization called the Computer Business Equipment Association. The curve developed by CBEMA's Power Interface Subcommittee No. 3 (SC-3) can be used to characterize the general relationship between AC power quality and the reliable performance of most digital logic-based equipment. (See Figure 2.)

The x-axis is constructed in terms of time and the related number of cycles per second of the standard U.S. 60Hz power-line frequency. The y-axis is constructed as a plus-and-minus reference for voltage. The reference point on the y-axis is set to equal 100% of the chosen nominal rms voltage of the AC line being considered. For example, 120VAC is at the 100% line; when the voltage increases, go up on the curve's y-axis (marked by double, triple and so on increments of the AC line's nominal voltage as set to 100%). When the line

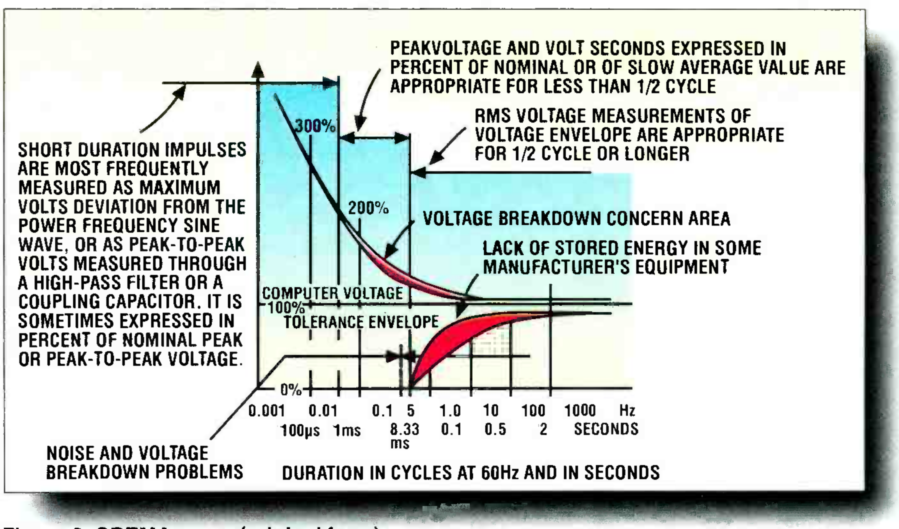


Figure 2. CBEMA curve (original form).

voltage goes down, go down the y-axis all the way to zero, as in a complete power loss. The logarithmic x-axis determines the duration of the event being tracked. For example, if the AC power line went to zero voltage for one minute (in addition, the y-axis line would be drawn along the bottom of the curve from the far left and at 0V until the one minute point (3,600 cycles) was reached on the x-axis, then it would be restored to the 100% line. This assumes the voltage did go back to 120VAC and, therefore, 100%. If it did not, then the line would be restored to whatever level to which it returned.

The CBEMA curve has an overlaid funnel-shaped set of lines on it. The inside area represents that set of time periods and voltage levels over which typically well-designed digital logic-based equipment should operate reliably with respect to the quality of the AC line's input power. However, if the conditions on the AC power line find themselves outside of the funnel, an increasing level of trouble will occur. Ultimately, the equipment will fail, and component damage is possible. The area above the funnel's top line represents the area of increased line voltage for whatever reason, while the area below the funnel's lower line represents the area of decreased line voltage.

Note the AC line voltage is shown as reaching zero at the 8.33ms point. All this means is that once every half cycle, the 60Hz voltage waveform passes through the zero voltage point on its way to the next half cycle and a polarity reversal. We all hope that our equipment will continue to work while the AC line does this; otherwise, we will have to provide for a DC power distribution system.

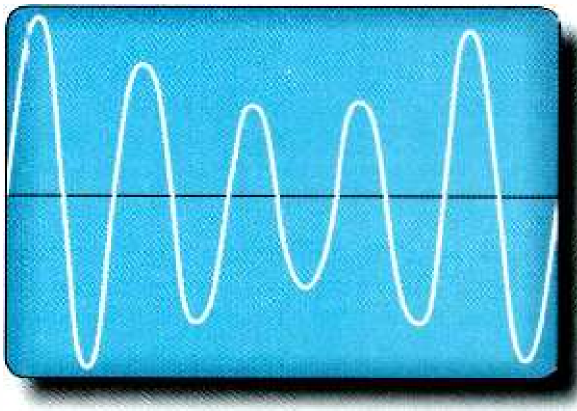


Figure 3. Simplified illustration of an AC line voltage sag.

To the left of the 8.33ms or half-cycle point is the subcycle, impulse or transient-surge voltage realm. To the right, is the longer-term or rms voltage event realm. For example, voltage swells or voltage sags are found here if these events last only a few cycles. After that, we might be discussing problems such as a long-term, high or low nominal rms line voltage or loss of voltage. In general, impulses are to the left and high or low rms voltages are to the right of the 8.33ms mark. The former lasts for less than one-half cycle; the latter lasts for more than one-half cycle and can continue indefinitely.

Sags

One of the most commonly encountered power-quality problems is called a sag. The sag has been variously described as being a dip, dive or something similar, but sag is the official term, according to the IEEE's Emerald Book (Std. 1100-1992). An idealized view of a sag is shown in Figure 3, where a nominal voltage exists before and after the sag event. A sag event results in a noticeable decrease in rms voltage for more than one and over a period of several cycles.

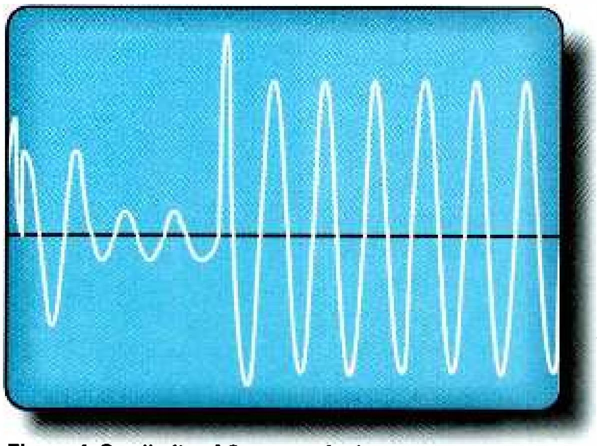


Figure 4. Swell after AC system fault recovery.

The typical sag event is often caused by the sudden application of loads that have a high momentary starting or inrush current. Such loads are typically represented by whole panel boards, motors, large rectifiers and AC-DC power supplies that have an internal large-value input capacitor. The capacitor is charged directly across the line via a rectifier. With a big, empty capacitor, a large charging current can exist on the first half cycle, with progressively lessening currents on subsequent half cycles until the capacitor is charged to near the peak line voltage.

Swells

As might be expected, the swell is the exact opposite of the sag condition. The swell has also been called a surge voltage, but this phrase is not correct. The term surge is more properly applied to shorter-duration events involving momentary high voltages, such as those produced by lightning. The term swell is the IEEE's official description of the described event. An idealized view of a swell is shown in Figure 4, where a nominal voltage exists before and after the swell event, which resulted in a noticeable increase in rms voltage for more than one and over a period of several cycles.

The typical swell event is often caused by the removal on an electrical system or circuit of large loads that have a high running current. Such loads are typically represented by panel boards, motors, rectifiers and large groups of AC-DC power supplies that can be disconnected at the same time by a single power-off control.

The impulse voltage condition

The typical impulse event has many names, such as glitch, spike, notch, whisker, zot, transient and, of course, impulse. These events are characterized as being subcyclic events of either polarity and any amplitude. They are generally of a singular nature, but can occur in trains or strings of impulses that may or may not all be related to a single cause. The impulse may be synchronous or asynchronous with the amplitude of the AC line's voltage or current with which it is being compared. The impulse will typically appear in that portion of the CBEMA curve to the left of the 8.33ms point and in the subcyclic area. The impulse may remain fully above or below the 100% line or part of it might be above and part below that line. It may also be of a decaying oscillatory nature.

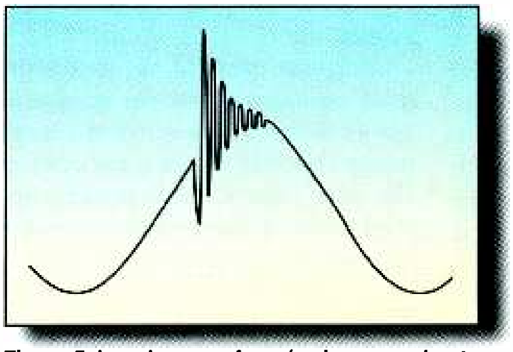


Figure 5. Impulse waveform (as impressed onto AC voltage waveform).

A fast transition time is also typically associated with an impulse event, but the term fast is not always clear except in comparison to the rate of change for the AC power system's fundamental frequency. Generally, impulses have a transition time expressed in terms of less than a millisecond or several microseconds. Faster transition times are typically seen only when the source of the impulse is close to the point at which the measurement is being undertaken. This is because at high frequency, AC power circuits are lossy transmission lines and tend to attenuate signals rapidly with distance. An idealized impulse is shown in Figure 5.

Decaying oscillatory voltages

The impulse event may also involve a decaying oscillatory current or voltage waveform, depending upon how it was generated and transmitted through the AC power system. AC systems contain reactances and are LC circuits resonant at a fundamental frequency and harmonically related ones. Therefore, oscillatory events are common. The degree of damping of these oscillations is variable, but in general, only a few decaying repetitions of the higher-frequency impulse will be seen. Lower-frequency events may take longer to damp out and can be propagated over longer wiring paths. The typical decaying oscillatory event is found to the left of the 8.33ms point on the CBEMA curve and in the subcyclic disturbance area. However, sometimes the 8.33ms line is crossed by the oscillatory waveform's tail.

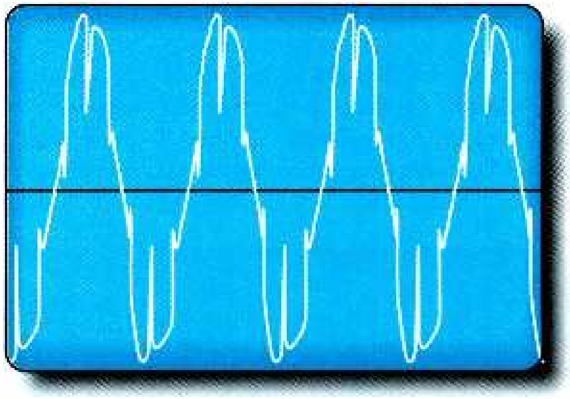


Figure 6. Waveform notching (typical commutation notches caused by rectifiers).

An example of this type of event is when banks of power factor capacitors are switched in (and sometimes out). These events have some energy behind them and contain a lot of low-frequency content. Together, these things allow the resulting disturbance to be propagated without much attenuation up to several miles. Generally, the closer the capacitor bank is to the affected electronic equipment, the worse the potential disturbance will be and vice-versa. Most power factor correction capacitor banks are installed on three-phase distribution circuits for the electrical supply system itself, within a facility on its main feeder system or at both locations. In either case, their unwanted effects reach down the building's secondary feeder and branch circuit system to electronic load equipment.

The commutation notch

Voltage waveforms on the AC line are also sometimes seen to exist with what is best described as one or more notches having been taken out of the waveform. (See Figure 6.) These notches may appear anywhere along the time base and may move around in starting time and duration. They are called commutation notches and are generally caused by the momentary short circuit placed across the AC line during the time that one controlled rectifier is turning off and another is turning on. With SCRs that are phase-shift fired, it is easy to see the notches move around on the x-axis. Notches generally stay on the left side of the 8.33 ms line on the CBEMA curve and in the subcyclic area.

Multiple zero crossings on the voltage waveform

In the extreme case of a capacitor's decaying oscillatory event, the zero-voltage line may be crossed multiple times.

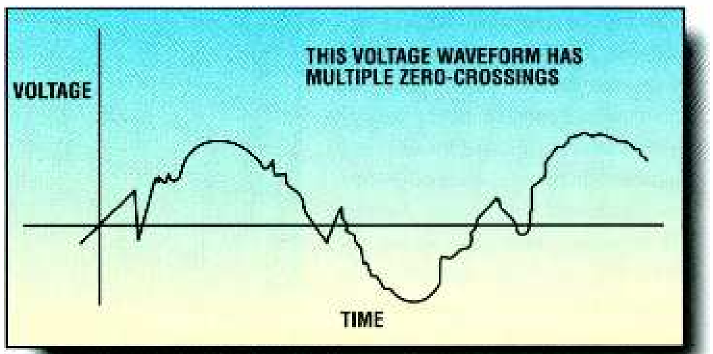


Figure 7. Voltage waveform distortion from rectifier-type load on an alternator.

(See Figure 7.) This can also occur if some oscillation exists on a deep notch's edge and crosses the zero-voltage line. In either case, the result is multiple zero crossings. This can significantly affect any equipment that depends upon the 60Hz line voltage's zero- crossing point for timing, SCR commutating or both. Some SCR-based lighting control systems are seriously affected by this kind of problem. Also, some digital clocks and timers that count zero crossings on the voltage waveform can really speed up if they get more than one voltage zero crossing every 180° on the 60Hz circuit.

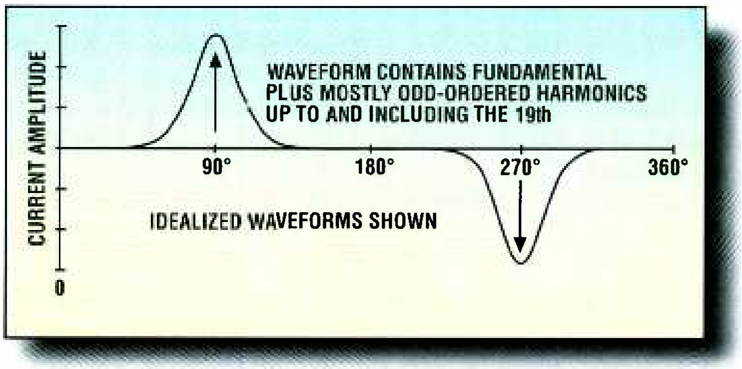


Figure 8. Typical high-peak current waveform for switch-mode power supply input on 120VAC circuit.

Harmonic voltage waveform distortion

With non-linear loads, such as rectifier power supplies of all types (linear and SMPS), current is taken from the power line at frequencies harmonically related to the 60Hz fundamental. In general, all current is taken in the form of an impulse near 90° and 270° as opposed to being linearly taken all along the applied voltage waveform. A typical input current waveform for a switched-mode power supply (SMPS) is shown in Figure 8. This waveform can involve a high peak current on the affected circuit with a concurrently large voltage drop occurring across the AC supply circuit's impedances. These impedances include the wiring, the impedance of the supply transformer and an alternator's windings or any other AC power source's internal impedance.

Of special note and interest, the above impedance can be largely provided by the flexible power cord sets used with temporary AC power distribution systems. Long branch circuits are another contributor, and if they are used in conjunction with an extension cord, good luck! Also, placing a power-conditioning device, such as a line voltage regulator, between the non-linear load and the AC supply can sometimes make things worse. This is because the typical power-conditioning device has considerable internal impedance, adding directly to the voltage waveform distortion problem.

The typical non-linear load, such as an SMPS connected to a 120VAC line, requires fundamental frequency current and harmonic currents up to about the 19th order (19x60Hz or 1,140Hz). Mostly, the currents are drawn from odd-ordered harmonics (3, 5, 7, 9 . . .) and from the lower orders (particularly the third, fifth and seventh harmonics). Once a harmonic current is demanded by the non-linear load, it produces voltage drops across any of the impedances in the series path. Thus, if a third-harmonic current of a given amount produces a 10V drop in the upstream circuit, this condition will be seen as 10V at 180Hz algebraically added to the 120V, 60Hz fundamental voltage. (See Figure 9.) It is important to understand that because of the total amount of inductive reactance $X_L=2\pi fL$ in the current's path, 1A at 180Hz (third harmonic) produces three times the voltage drop that would be produced per amp at the current's fundamental frequency of 60Hz. This relationship also holds true for each higher order of harmonic current because the inductive reactance increases proportionally with frequency.

Harmonically distorted voltage waveforms typically have less total area under the curve than an undistorted sine wave and the peak voltage may also be lower. This spells more trouble for a connected linear power supply than for an SMPS design. The former loses regulation headroom and runs hotter. It sees what it interprets as a low-voltage condition on its input and reacts accordingly. The SMPS has more headroom available and compensates by drawing a higher peak-charging current for its main energy storage capacitor at 90° and 270°. With enough distortion, both supplies will eventually lose regulation, but the linear supply will almost always go first and by quite a bit.

Here's an important bit of advice. If you are attempting to make an accurate voltage or current measurement on an AC power conductor that is not carrying a sinusoidal waveform, you cannot use anything other than a true rms instrument. The typical analog or digital current or voltmeter is not true rms, but is an average-actuated, rms-calibrated device. In other words, it is a full-wave-rectified DC instrument that

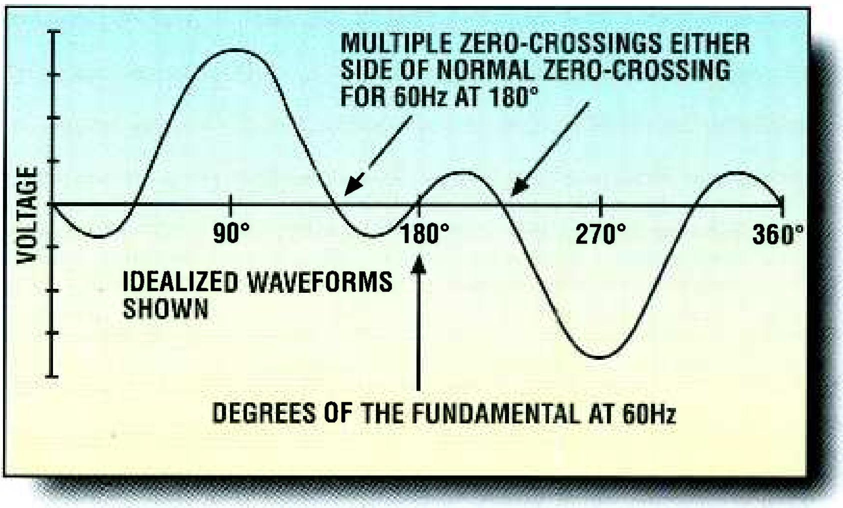


Figure 9. Multiple zero crossings of a 60Hz voltage waveform distorted by third-harmonic voltage (180Hz).

has its scale fudge-factored to make it agree with the rms value of 0.707 on a pure sine wave. On a typically harmonically distorted waveform, the area under the curve is insufficient to allow this kind of instrument to give accurate readings. The result is typically a reading that may be off as much as 50%, making a 20A rms current read around 10A. This could mislead the user into believing that the circuit is not heavily loaded. Similar problems occur on the voltage waveform, where the user is mislead into thinking the AC line voltage is too low and needs to be raised. Computations involving voltage and current are, of course, really fouled up by this situation.

Mitigating problems

Choosing the AC power source: Proper AC power for electronic equipment definitely involves more than just plugging it into the nearest available wall outlet. It also involves avoiding the common mistakes made when attempting to get special or dedicated AC power. The task of obtaining truly proper AC power, therefore, starts with the AC source itself.

Go upstream: The best advice to follow is to originate the AC power from a point on or as close upstream to the service equipment (SEQ) for the building as is practical. This means a dedicated feeder into the SEQ that is routed to the electronic equipment room, where it can be interfaced to one or more panel boards via an isolation transformer (IT) or another suitable power-conditioning device.

The rationale for this advice is simple. No matter where you get the AC power in the building, whatever affects the SEQ will similarly affect all

Switch mode vs. linear power supplies

Another perspective on the CBEMA curve is to view the area below the 100% line on the y-axis and to the left of the 8.33ms point as being the area where the lack of good energy storage in the typical SMPS' input filter capacitor comes into play. In well-designed SMPS units, this relatively large-valued capacitor is fed from a full-wave bridge rectifier connected directly across the input AC line, and can be charged to nearly the AC line's peak line voltage (169VDC on a 120VAC line). It can store a lot of charge (Q=CE), which can then be drawn off by the supply's inverter prior to use in the logic voltage regulation circuits.

SAG EVENTS

A poorly made SMPS or a good one that is overloaded, could be susceptible to a lack of stored energy in its main input capacitor once during a sag event. In an SMPS, this occurs anytime the peak AC line voltage out of the full-wave rectifier is equal to or less than the voltage level on the capacitor for that half cycle. In linear AC-DC supplies, the filter capacitors are operated at a low voltage obtained from an input step-down transformer. Not much voltage difference exists between what the capacitor is charged to and what the linear voltage regulators constantly work against. This difference is called head room, and there is no comparison between the two designs — the SMPS wins this contest hands down.

Because Q=CE, it can be seen that for the same size capacitor, the amount of available energy stored at 170 peak volts from a 120VAC line is a lot more than what might be stored at 40 peak volts from a 25VAC transformer secondary. Also, just think about the additional energy that could be stored in an SMPS that is operated at 240VAC input. In a linear design, there is no difference. The secondary voltage from the step-down transformer doesn't change, only the primary voltage does; hence no change in headroom results either.

The idealized effect of a typical line voltage sag on the DC output of an analog supply and SMPS of similar output rating is compared in Figure 1. (See page 96.) A line voltage sag does little to the connected SMPS when compared to an equivalent linear AC-DC power supply. The digital difference provides better performance in a less-expensive, smaller volume and lighter weight supply.

Not surprisingly, most AC power-quality studies (IBM, Bell, et al.) have identified the AC line voltage sag event as being the most commonly experienced power-quality problem by most electronic and computer equipment users. Even though the SMPS-based digital equipment type is better than analog equipment at ignoring AC line power-quality problems, there is still some point at which the sag can produce performance problems.

SWELL EFFECTS

When a swell arrives at the input to a typical SMPS, the result is predictable. It tries to charge the input energy storage capacitor after the full-wave rectifier as quickly as possible. The capacitance in the typical SMPS is fairly large, making the task difficult. Adding to the difficulty is the RLC time constant based on the input capacitor and the reactances and resistance of the whole upstream wiring system. It is hard to get the capacitor filled up; instead it just absorbs what is available and stores it for use. If it results in a voltage higher than the AC line's peak, the capacitor will not accept any new charge until after the SMPS' inverter load has depleted the capacitor's voltage to below the AC line's peak voltage.

SMPS inverters are high-frequency (usually in the tens of kilohertz) switched circuits involving alternately cut-off and saturated devices supplied from the main input energy storage capacitor. The inverter transformer's secondary is then full-wave rectified and used to charge a secondary energy storage capacitor at a voltage (with headroom) near that used by the connected loads. By pulse-width modulating the inverter (controlling its duty cycle), the capacitor's charge level can be precisely controlled.

The final result is a stable voltage on the inverter-served secondary energy storage capacitor, even though the main input energy storage capacitor may have considerable voltage variation across its terminals. The inverter may even be temporarily held cut off by the pulse-width modulation circuit if too much voltage begins to appear across the secondary energy storage capacitor. This automatically resetting protective action works quite well, keeping input line overvoltages from reaching the load.

In linear power supplies, swells often cause the main energy storage capacitor (on the input transformer's low-voltage secondary) to become overcharged. Ultimately, the

Continued on page 96

levels of power distribution in the building. For example, a momentary low voltage (sag) at the SEQ will also be seen at all electrical outlets in the building. However, if you are obtaining power from an outlet far downstream in the distribution system, then anything affecting the feeders or panel boards between the selected outlet and the SEQ can affect the power quality at the selected outlet. Statistically, power quality is best at the SEQ and becomes progressively worse as you move down through the distribution system, where the building's own loads can create problems.

Get a low-impedance power source: All power sources have an internal impedance. This is what limits the short-circuit current available across the terminals of a battery or a transformer, for example. Internal impedance is, therefore, unavoidable and beneficial unless you fail to account for it and get in trouble from its predictable effects.

Typical electronic load equipment power supplies involve rectifier inputs. These kinds of inputs require non-sinusoidal and high peak currents on each half cycle and cause a significant voltage drop across the internal impedance of a power source. This then causes a harmonic distortion of the available voltage waveform from the source. Harmonically distorted voltage waveforms thus created cause numerous problems with the basic operation of normal and electronic types of load equipment.

Harmonics on power circuits can be strong and, therefore, can usually get into telephone and electronic equipment's signal level circuits and cause a lot of mischief. For example, simple voltage waveform harmonics on the AC power system are serious because they also cause the involved AC power wiring to propagate wideband audio-frequency interference into nearby control or signal cables. For example, the interference from simple AC-DC power supplies may range from 60Hz to around 2kHz. Where higher-frequency notching is present on the voltage waveform, the available harmonics can extend upward into the tens and hundreds of kilohertz, potentially affecting video or digital switching processes.

Harmonic voltages are reduced to reasonable levels by ensuring that the chosen AC power source is of sufficiently low internal impedance. For the typical service transformer (ST), this correction is not a problem. But it can easily become a problem where dry-type transformers or other types of power-conditioning equipment are subsequently installed within a building, and from which equipment is being powered. Recommended practice is to employ building AC power sources of larger kilovoltampere capability than the load requires and with internal impedances in the range of 2.5% to 5% to avoid most of these problems.

The newest way to provide AC power system wiring and grounding is to use a 120VAC center-tapped AC system.

Note that most voltage regulators and UPS types of power sources cannot meet the foregoing internal impedance recommendations. This compromise is sometimes still acceptable. The trick is to make certain that the chosen regulator or UPS has an internal output voltage feedback circuit that looks at the output voltage waveform and sends an error-correction signal back into the control circuit. This signal will keep the output waveform distortion and rms voltage level under simultaneous control. Thus, an active method can be used to compensate for the high internal impedance.

If the power-conditioning equipment does not have good output voltage waveform control, then it is common for the distortion of the output voltage waveform to be significantly worse than when it is being supplied directly from the building's power system. Sometimes, this problem gets so bad that the electronic load equipment won't even work properly when connected to a power-conditioning unit, but will work when connected directly to building power. In the trade, this is known as an expensive lesson.

NEC wiring methods for electronic loads

Historically, the NEC did not allow much flexibility when wiring the AC power branch circuit supplying electronic load equipment. Only two ways were allowed: solid grounding (SG) and isolated or insulated grounding (IG). The AC system supplying the equipment typically could only be a solidly grounded system. (This means bonding the supply transformer's neutral to the equipment grounding conductor system and to the nearest NEC-acceptable earth-grounding electrode to the transformer for AC systems of 150VAC to ground. See Sections 250-5 and 250-26.) Anything else was not permitted on the branch circuit, even if it might be a good idea from an equipment performance standpoint, such as decreasing hum and other noise problems.

Because the product safety testing and listing services (such as UL) were completely aware of this point, it should be apparent that all of the equipment that they tested and the standard for safety to which it was tested had to meet the NEC's requirements as they were written, not as someone would like them to have been written. Together, the NEC and UL made it impossible to try anything else until the NEC was changed. This was done for the 1996 edition of the NEC.

AC system and branch circuit grounding

The two traditional ways of grounding an AC system and its branch circuits used to support typical installed electronic load equipment that is subject to noise and hum problems are shown in Figure 10 for the SG design and in Figure 11 for the IG design. Until the NEC's 1996 edition, these were the only two permitted designs.

There are two important points to be aware of relative to these grounding methods. First, on a typical 120Vrms branch circuit, the hot wire is at a

Power quality and grounding

potential of nearly 170 peak volts to anything grounded or to ground itself. Second, because of common-mode noise current flow in the grounding conductor system, an unequal common-mode (CM) noise current can occur on the neutral and hot conductors of the branch circuit. This unequal current subsequently gets partially converted to normal-mode current on the AC power wires to the load (the hot and neutral conductors).

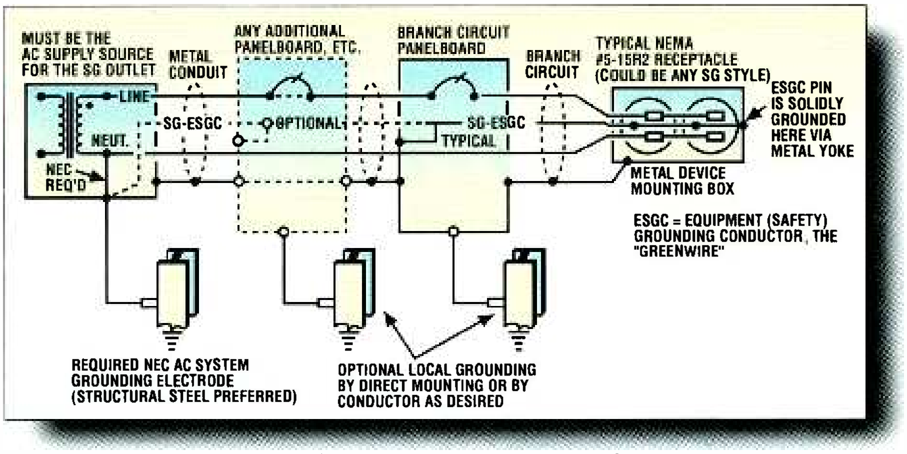


Figure 10. Solidly grounded (SG) AC system and branch circuits.

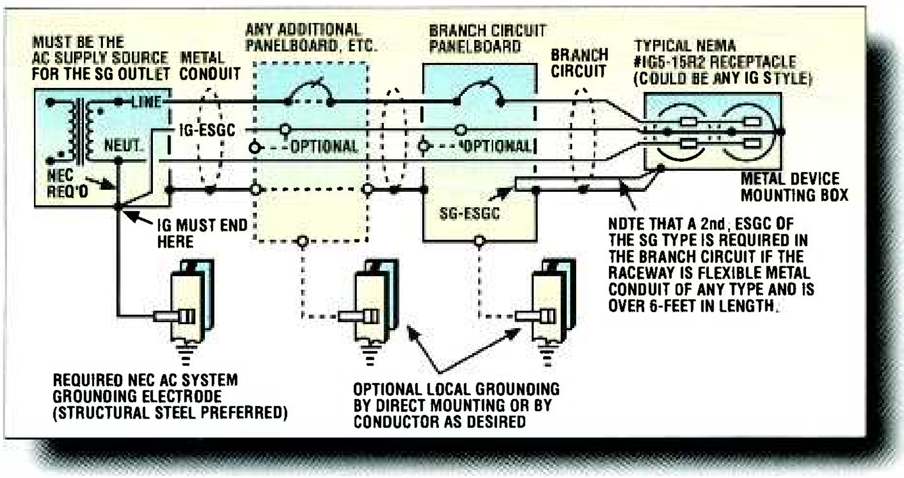


Figure 11. Solidly grounded AC system and isolated or insulated grounding (IG) of the served branch circuit.

The first situation means the electric field (e-field) is quite high nearest to the hot conductors and in relation to anything grounded, such as a shield on an audio cable installed near power wires. This high e-field maximizes the electrostatic coupling between the AC wires and the grounded shield, which then introduces hum and other noise into the audio cable. This point is important for high-impedance circuits because they are voltage driven. If the voltage to ground on the AC wiring was lowered, so would the amount of coupled interference from the e-field into nearby signal-level conductors. This is important because the e-field is a near-field phenomenon that is proportional to the voltage and tends to fall off rapidly with increasing distance between the involved conductors.

The second situation means that the normal-mode converted common-mode (CM) noise current becomes algebraically additive to the expected power current on the circuit and, after interaction with the circuit's impedances, becomes a normal-mode noise voltage impressed upon the AC voltage waveform. Thus, the load equipment must have an AC input circuit immunity to noise voltage across the entire audio frequency range and above, not just at 60Hz and 120Hz. This implies special considerations for the filtering system following the rectification process. These might include the use of low series-resistance leakage value capacitors and low-leakage inductors.

For example, a linear power supply might pass this noise voltage onto its DC output, where it could affect the regulation circuit's performance. The noise voltage might even pass through or around the regulation circuits and gain access to the final DC bus structure directly connected to the electronic circuits. This is especially vexing when these are low-level mixers or amplifiers that are analog in nature and have a bandpass that ranges across the audio range.

However, with the typical SMPS, this is not much of a problem because the interstage inverter transformer provides a sufficient amount of attenuation between stages and keeps the noise out of circuits, such as the regulator circuits.

The new way

The newest way to provide AC power system wiring and grounding is to use a 120VAC center-tapped AC system for a single-phase AC power source and to establish the branch circuit system with all of the conductors symmetrically arranged to ground. The nominal AC voltage to ground must be one-half of what it was before, for example, 60Vrms instead of 120Vrms. This type of AC system and the subsequent wiring and grounding requirements are called out in NEC Article 530 — Motion Picture and Television Studios and Similar Locations, Part G; Separately Derived Systems with 60V to Ground. A typical wiring design using the solid grounding (SG) method with the new AC system grounding method is shown in Figure 12; the design for the insulated-isolated grounding (IG) method is shown in Figure 13.

The operative section within the NEC for a 60VAC to ground system is

530-70, General, where it states that the "use of a separately derived 120V, single-phase, three-wire system with 60V on each of two ungrounded conductors to a grounded neutral conductor shall be permitted for the purpose of reducing objectionable noise in A-V production or other similar sensitive electronic equipment locations provided that its use is restricted to electronic equipment only and that all of the requirements in Sections 530-71 through 530-73 are met. The new requirements call for the addition of a ground-fault interrupt (GFI) on either the receptacle or the branch circuit breaker used on the new type of AC system grounding.

Three important changes occur when the new 120/60VAC system is used. First, the voltage to ground on the hot conductors is one-half of what it would be if it were a standard form of circuit. This drops the e-field to ground level proportionally. Second, the grounding system is fully symmetrical, limiting the ability of a common-mode noise current in the grounding system to be converted to normal-mode current and hence normal-mode noise voltage on the circuit. This change reduces the ability of the noise to get through the equipment's power supply and to the subsequent circuits. Finally, the requirements prevent the use of any equipment other than electronic equipment equipped with the required special connector. This prevents a great deal of unwanted interference from other types of equipment that might otherwise share the same AC system and branch circuit wiring.

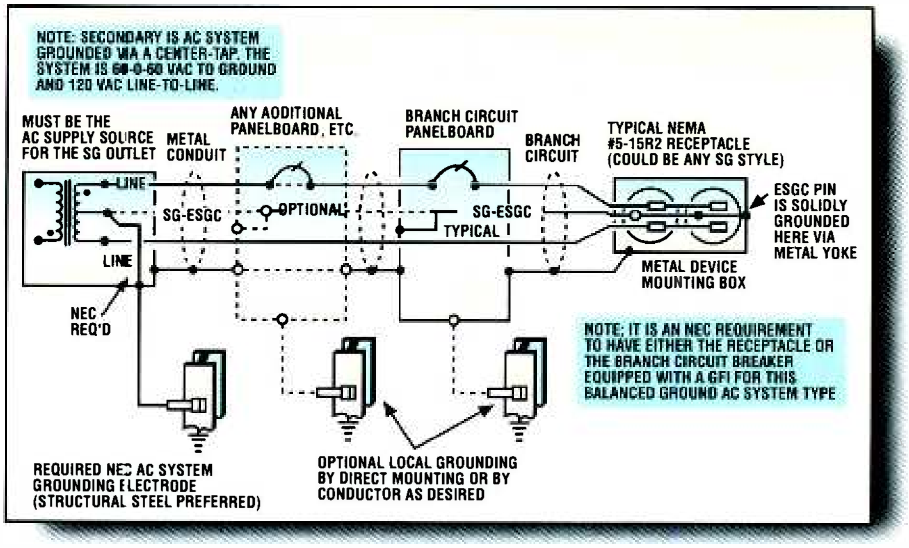


Figure 12. Article 530 — Motion Picture and Television Studios or Similar Locations, Part G; Separately Derived Systems with 60V to Ground (Solid Ground Receptacle).

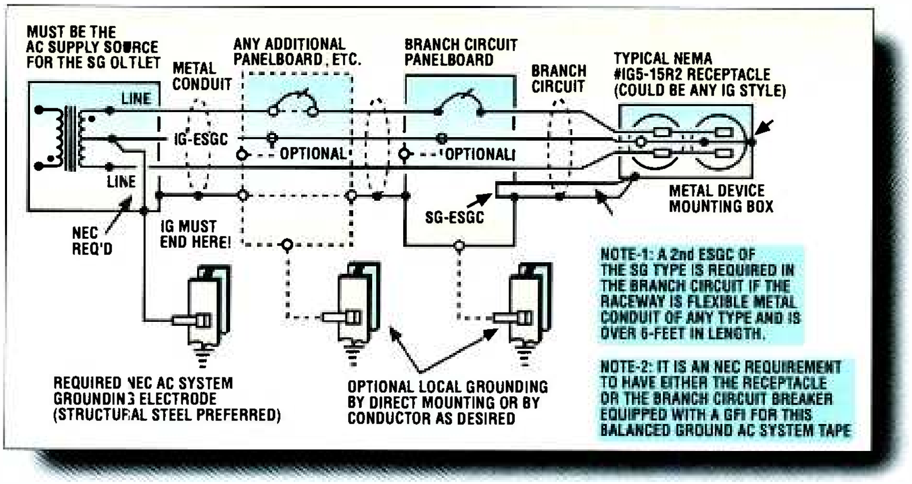


Figure 13. Article 530 — Motion Picture and Television Studios or Similar Locations, Part G; Separately Derived Systems with 60V to Ground (Insulated-Isolated Ground).

What to do?

For best results, install a separate transformer, secondary overcurrent and disconnect device, feeder and branch circuit — all at the new 120/60VAC level. This system needs to meet the requirements of the NEC for use on such a system. This will be a separate AC system from the building's other systems, but it will still need to be AC system grounded. This is done via a grounding electrode conductor (GEC) to an NEC-acceptable earth-grounding electrode that is electrically common to the building's normal earth-grounding electrode system used by the service equipment and other separately derived AC systems.

Please note that one small glitch exists in the whole process of using the 120/60VAC system arrangement. It involves locations that do not restrict access to qualified persons only. Per the NEC, when the 120/60VAC system is used in areas of general access, it will need to be uniquely configured and identified for use with this system.

The problem involving this unique configuration requirement is two-fold. First, you have to obtain the special receptacles and plugs, which are not necessarily in-stock at all suppliers; second, you must modify already product safety listed and labeled equipment by cutting off the existing 120VAC plug on its line cord and replacing it with one of the new plugs. This latter action makes for another problem: you generate another NEC situation because of the combined effects of Sections 110-2, Approval and 110-3, Examination, Identification, Installation and Use of Equipment; Paragraph (b), Installation and Use. For example, you cannot modify listed or labeled equipment in any way without invalidating its listing or label process. This then causes the equipment to no longer be in listed or labeled condition, which then creates a problem with the two sections just identified. The only out on this is to get the electrical safety inspection authority having jurisdiction at the location to provide a written waiver that permits the installation and operation of such modified equipment. If this is not done and a fire or shock occurs, the lawyers will have a field day in assigning liability to those involved in the modification process at all levels. A change in the NEC is needed in this area to permit equipment already listed and labeled for use on standard NEMA-5-15 or-20 types of receptacles to be so modified without losing either the listing, labeling or any other NEC compliance benefits.

Equipment grounding for hum and noise control

When equipment is installed together in a room, such as for audio or video editing, there are typically several racks of equipment involved with a number of signal-level cables routed among them. This type of installation often has hum and other noise problems, all originating in the common-mode (CM).

Common-mode currents and voltages on the equipment grounding system can cause operational problems with digitally based equipment when the impulses interfere with clocking and related set-reset operations of the logic elements. Once converted into normal-mode current or voltage by the circuit's impedance imbalances, it mimics the desired signals and can directly affect control, audio or video signal processes.

Common-mode currents and voltages classed as noise are problem areas usually addressed by marginally and randomly effective or hazardous practices. These generally involve creating electrical safety problems via equipment grounding methods that violate the NEC or employing grounding-bonding schemes that are based in unreliable art as opposed to predictable engineering practices. A good example of this is the use of the

Continued from page 92

linear voltage regulator circuit cannot withstand the applied voltage and regulation is lost. Too much DC voltage on the power supply's output can upset or damage the connected loads. Alternately, the regulator circuits themselves can become damaged. A DC level crowbar circuit is sometimes the only protection from this kind of problem. It is not an elegant solution, especially if it is not automatically resetting or can be triggered by electromagnetic interference (EMI).

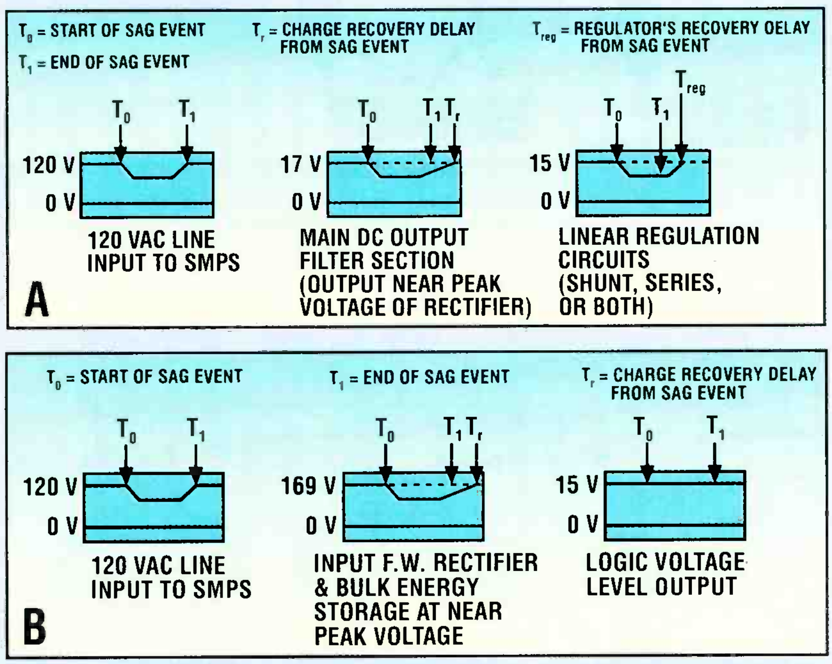


Figure 1. (A) Idealized effect of an input voltage sag on an AC/DC analog power supply, (B) Idealized effect of an input voltage sag on an AC/DC SMPS.

OTHER EFFECTS

Because impulses and most oscillatory events contain high-frequency components, they can affect the power supply that they are impressed upon because of EMI effects. EMI problems involving AC line propagated electrical disturbances generally involve power supply designs that provide unwanted coupling between the input and output. This is especially true when higher frequencies in the tens to hundreds of kilohertz are involved, and where small amounts of stray reactance can create significant coupling between circuits. The usual problem within a power supply involves H-fields as opposed to e-fields. This is because the currents are relatively high and circuit impedances and voltages are relatively low. Thus, most problems involve stray magnetic fields and the routing of, for example, wiring harnesses and PC board traces.

Regarding EMI immunity, the SMPS wins hands down because it is already a prolific generator of EMI in its own circuits. Thus, the SMPS must be well-designed from an EMI and electromagnetic compatibility (EMC) standpoint or it will not work and will also generate interference for the equipment with which it is being used. Making the SMPS immune to its own poison has the desirable effect of also rendering it pretty much immune to externally applied EMI. This is not the case with the typical linear power supply, which is fairly quiet by itself, but is often not well-designed from an EMI immunity standpoint.

As an example, often, when equipment with a linear power supply is being affected by AC line EMI problems, a compatible uninterruptible power supply (UPS) is placed between it and the offending AC line.

This change typically cures the problem, but how? Simple. The problem has been fixed by putting an SMPS between the AC line and the linear power supply in the "victim" equipment. After all, what's the real difference between an AC power UPS and the SMPS in equipment except that the UPS is higher power, doesn't have a rectified inverter output and supplies 60Hz instead of DC to its loads? The similarity between the UPS' battery and the SMPS' main input energy storage capacitor is pretty obvious, so I won't elaborate. ■

single-point grounding method. This produces marginal and unpredictable performance for analog-based equipment and is useless for digital-based equipment. In addition, it is a lightning damage-prone grounding design for the attached equipment, and an NEC equipment and AC supply system grounding violation when implemented in its classic form.

A ground plane is typically difficult to implement and somewhat costly in practical forms.

However, an effective methodology does exist to deal with all of these problems and also to keep the AC supply system and equipment grounding safe. This method is called a signal reference grid (SRG) and it involves AC power and signal-level surge protectors being employed along with some special rules for the termination of cable shields. Taking these items in order, let's start with the SRG.

The signal reference grid

It is generally agreed that if all the electronic equipment is grounded to an underlying ground plane (a flat, wide-area solid sheet of copper), then the best form of grounding available across the broadest range of frequency can be obtained. However, a ground plane is typically difficult to implement and somewhat costly in practical forms. If, instead of a plane, a grid is installed, all the benefits of the ground plane can be had except that the upper effective operating frequency limit will be lower.

Remember, topologically speaking, a grid is just a plane with some openings in it. For the typical grid installation, having openings in the plane is not a problem. The recommended practice designs for SRGs are effective from DC to approximately 25MHz to 30MHz. This is good broadband grounding effective across the entire frequency range needed by analog and digital logic-based commercial audio and video equipment.

The typical SRG consists of a network of bare copper conductors with bonded intersections every one or two feet, completely covering the floor area where the equipment is installed. The SRG is typically installed on the floor and all of the equipment is jumpered to and from it via grounding-bonding straps. All electrical conduits, the equipment ground and the isolation transformer (IT) serving the equipment room are grounded or bonded to the SRG, making it the commonly shared ground reference for everything. Yes, everything. The idea of isolation is long gone; it has too many problems, including electrical safety ones. (The neutral terminal on the secondary, the metal case or enclosure and the greenwires are all tied together within the transformer. The junction point for these items is then grounding-bonding jumpered to the SRG. The isolation transformer is typically placed directly atop the SRG and is not remotely installed.)

Typical construction

Generally, the construction of the SRG involves the use of a cellular raised floor (computer-room-style flooring) under which the SRG, electrical power and signal wiring can be routed. The underfloor volume is also often used for an air-handling space for the supply of HVAC process cooling air into the room above.

Cellular raised floors allow the SRG to be installed directly atop the structural subflooring or suspended just below the floor's pedestal post's top cap by SRG wire-holding and bonding clamps. Either way, it works well. Materials used generally involve bare copper wire AWG 6 or a copper strap about 0.1 inch thick and two inches wide. The crossover points where the junctions are made are typically at 2×2 feet. They can be made a little larger or smaller, because the differing effects are not too noticeable.

For carpeted or uncovered floor surfaces, a flat copper foil is generally used. The foil is typically 0.030 inches thick and two inches wide, with all of the crossovers soldered together. This type of SRG can be directly applied to a floor's surface and then either walked directly on or covered with an antistatic electricity carpet. (You do use this kind of carpet in equipment rooms, don't you?) T-shaped access slots cut into the carpet allow grounding straps or jumpers to be passed through and then soldered to the underlying SRG foil, after which the carpet's edges are folded back down.

Surge protection

The biggest threat to electronic equipment from a physical damage standpoint is from lightning-related transient voltages, commonly called surges. Although somewhat related to the geographical location of the equipment, surges are a real threat almost everywhere in the United States. How much of a threat can be estimated by consulting ANSI/NFPA-780, the National Lightning Protection Code 1992.

Common-mode currents and voltages classed as noise are problem areas usually addressed by marginally and randomly effective or hazardous practices.

A direct strike to the building or the incoming AC supply conductors is not necessary to create a damaging surge current and voltage for the equipment installed in the building. A cloud-to-cloud overhead or a nearby strike is sufficient to do the trick.

Because many typical installations involve routing cables throughout a facility, there is ample opportunity for damaging lightning currents to be near-field coupled into them. This is an e-field (electric-field, capacitive coupled) and H-field (magnetic-field, inductive) set of phenomena that is unavoidable. However, they can be mitigated by employing proper grounding, bonding, shielding and surge-protection techniques.

The surge is coupled into the building wiring system and the various control or signal process cables of the affected electronic load equipment. The amount of surge coupled is proportional to the amount of area enclosed by the affected wiring. Big areas mean larger surge currents and voltages are developed from the lightning discharge.

From the victim equipment's standpoint, there are two ports from which the surge threat arrives: the AC power input and the signal or control cable connectors. Therefore, a surge current arriving from one port's conductors is passed into the victim equipment and out the other port and into its conductors. The victim equipment is in the center of a loop into which a surge impulse has been coupled.

This explains why adding surge protection to only one of the two ports does not do much to protect the equipment from lightning-coupled damage.

With the increased use of computers, the control or signal-level port is generally configured to use one of the computer industry's standard protocols, and this is fortunate, as we will see. This is true unless problems arise because of some special interface plug-in card being installed, which may use a nonstandard signaling protocol or other configuration.

Proper surge protection needs to be installed on the equipment itself and on the AC power and control or signal cable ports using performance-coordinated surge-protective devices. Typically, this is a metal-oxide varistor-based form of protection on the AC power input port. The signal level port may use a combination of Tranzorbs, gas tubes, series resistances or impedances and common-mode chokes in a specially designed protection circuit particular to the signal port's characteristics and coordinated with the performance of the associated AC power port's protection.

For example, an RS-232 signal port needs a surge protector specifically designed for the RS-232 protocol. It must be used with an AC power port surge protector with which it has been performance tested and rated to work. Anything else will most likely fail to do the job, and the signal port will most likely be the one damaged. The best protection is provided when the AC power and signal protectors are mounted onto and grounded-bonded to the protected equipment's metal frame or enclosure. In most cases, using a rack's metal framework is adequate for this purpose, and this practice is necessary for larger groupings of equipment in any case.

A direct strike to the building or the incoming AC supply conductors is not necessary to create a damaging surge current and voltage.

Surge protector units are generally available for any industry-standard signaling protocol, but not for proprietary signal protocols. These need to be specially engineered for the specific application.

The building's AC power system also must be surge protected so that the level of the surge arriving at the electronic load equipment is as low as possible. The protection provided at the electronic load equipment is not usually capable of doing the whole protection job involving high-energy surges, but is rated to do a good job with lower-level surges. By today's means, you cannot provide top-notch performance and high energy level handling in the same package as installed at the victim equipment's level.

The recommended practice is to start with the building's SEQ and to install a device called a secondary lightning protector (or arrestor) on the service conductors. The metal frame or enclosure of the SEQ must be used for the surge current's reference point. Generally recommended practice is to parallel this protector with an AC capacitor connected from each line to equipment ground. This is often properly referred to as a wavefront modification capacitor. It is sometimes built in as a part of the overall protector chosen to do the job. Most of these protectors are rated for 600VAC systems and are available for single- and three-phase services.

Next, recommended practice encourages the application of surge protectors similar to the one used at the SEQ on each level of switchboard and panel board that exists between the SEQ and the victim electronic load equipment on the branch circuit. In each case, the protector is applied in shunt between each line and equipment ground, such as the metal frame or enclosure of the switchboard or panel board.

The final level of surge protection ahead of the equipment's port protection is applied at the end of the branch circuit itself. The recommended practice is to install a surge-protected receptacle or to plug in a protector to the normal receptacle into which the victim electronic load equipment is then plugged.

Taken together, all of these measures serially shunt and progressively attenuate the level of surge that arrives at the SEQ from the power distribution system. What is left is mopped up by the device-specific and coordinated protection applied at the AC power port for the electronic load equipment, coordinated with that equipment's signal port's protection.

Cable shield terminations

With analog circuits and lower-frequency signal processes, the golden rule was always to ground the shield at one end only. However, this is not recommended with digital signal circuits because of the higher-frequency nature of the circuits. It is not recommended for analog circuits either, if you are concerned with the shield attenuating H-field coupled interference, such as from lightning.

With digital circuits, the requirement is to ground the cable's shield at both ends to obtain H-field protection and to preserve the integrity of the high-frequency signal on the cable. Worries about cable shield current combining with the digital signal on the cable are minimized because, at the involved frequencies, the two currents are separated by flowing on the inner and outer surfaces of the shield with little or no overlap. This is an e-field and a skin-effect function. In fact, most digital signal cables, such as coaxial cables, can have the shield grounded at multiple points along the way with no ill effects and much improved lightning protection.

The telephone company has always grounded the cable shield at both ends between the subscriber loop station and the subscriber's premises. This was done for lightning safety reasons and is required under NEC regulations. A twisted-pair arrangement is used inside the telephone cable's shield, and each of the contained pairs is protected by a surge-protective device (SPD) connected from line-to-line and line-to-ground or chassis. Unwanted cable shield currents caused by conducted common-mode currents are typically dealt with by isolating one end of the shield from ground via a capacitor of a few microfarads. This blocks DC and most audio frequencies (including AC power system harmonics), but lets high-frequency surge-type currents flow with ease. As a result, the shield can function as a means of attenuating H-field-coupled noise and surge currents, but is relatively unaffected by DC and AC power system-related common-mode currents resulting from ground potential offset between the two ends of the circuit.

Shield current problems can also be dealt with via a number of other recognized techniques, such as using Tranzorbs between the shield and ground, opto-couplers at the cable's ends, common-mode chokes on the cable and transformer isolation of the signal.

Proper surge protection needs to be installed on the equipment itself and on the AC power and control or signal cable ports using performance-coordinated surge-protective devices.

Finally, if you simply must have the cable's shield grounded at one end only, you can still have the benefits of grounding the shield at both ends (for H-field protection) by pulling the cable into a grounded-at-both-ends metal conduit raceway. This practice provides a two-level shielding system. The design also improves the e-field shielding capability of the circuit. The best types of conduit or raceway to use in this role are electrical metallic tubing (EMT), intermediate metal conduit (IMC) and rigid metal conduit (RMC) in ascending order of effectiveness. Note that galvanized steel conduit is markedly better than aluminum conduit in attenuating common-mode noise currents and that tightly made joints and terminations are necessary for the best effect.

Digital logic and SMPS-based equipment is replacing or has replaced the analog circuit-based equipment of yesterday. These newer designs have great advantages, but are still somewhat susceptible to electrical noise arriving on the AC power input, the grounding system and the attached signal level cables used to interconnect items into a system. Equipment of the new and old design types are still susceptible to the damaging effects of lightning-induced surge currents and voltages that are impressed upon the equipment's AC power input wiring, the signal cables and the grounding system being used.

By understanding how AC power problems affect electronic load equipment, you can determine the types of power-conditioning equipment needed. The CBEMA curve was developed to aid in this process and is useful with the analog design equipment and digital logic-based designs.

When using the newer digital-based equipment, abandon many of the older methods of grounding, bonding and shielding. This means strictly following the NEC. Avoid the use of isolated earth-grounding electrode connections. Eliminate single-point grounding systems, instead use broadband signal reference grid (SRG) designs. Ground signal cable shields at both ends — a requirement for digital signals. Pay strict attention to providing proper surge-protective devices on the AC power and signal circuits if there is a risk of lightning damage at the location. Following these guidelines will ensure a ground system that is safe for the electronic equipment you install and for the people who will use it. ■

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For more information:

1. IEEE Emerald Book entitled "Recommended Practice for Powering and Grounding of Sensitive Electronic Equipment"

2. Federal Information Processing Standard Publication No. 94 [i.e.; Fips-PUB-94]

3. "Guideline on Electrical Power for ADP Installations," U.S. Department of Commerce, National Institute of Standards and Technology [NIST], National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161.)

NEC sections:
Grounding
250-5, 250-26

Balanced power systems:
530-70. General
530-71. Wiring Methods
530-72. Grounding
530-73. Receptacles

MPEG transmission issues

Concatenation, digital turnaround and interoperability are the keys to MPEG transportability.

By Keith Dunford

The use of MPEG-2 compressed digital TV signals is expanding rapidly throughout the world for terrestrial and satellite video networks. Although the digital technology does bring significant operation and cost savings to users, it also has created challenges for equipment manufacturers as the transition from analog to digital is implemented. The top challenges have been *interoperability* of MPEG-2 encoders and decoders from various manufacturers, *concatenation* of signals and *digital turnaround* of compressed video between satellite and terrestrial networks.

Interoperability

Compressed digital television has been around for more than a decade, bringing new capability and flexibility to TV program contribution and distribution networks. The past five years has seen an order of magnitude improvement in performance, efficiency and size of MPEG-2 compression products, largely brought about by the development of RISC technology.

Standards that were developed in the early 1990s for compressed digital TV signals have played an important role in the utility of the new technology. The International Standards Organization (ISO) MPEG-2 digital TV standard brought digital television closer to widespread use in network TV operations. This standard provides a degree of confidence that users can buy equipment from an array of manufacturers and know those digital encoders and decoders would interoperate. This was substantially proven in tests conducted by the industry, but they left the satellite modulation and demodulation standards open, reducing the chance for guaranteed interoperability. The European digital video broadcasting (DVB) standard developed quickly to help solve the problem. Because MPEG-2 and DVB standards have since been adopted by all manufacturers of compressed digital TV systems, interoperability has to a large degree been achieved. Even so, there remain isolated instances where a manufacturer's MPEG-2 encoder or integrated receiver decoder (IRD) does not interoperate with others.

Companies that tested their MPEG-2 encoders, DVB modulators and MPEG-2/DVB IRDs for interoperability at the Intelsat and ISOG trials include Tiernan Communications, News Data Systems (NDS), Scientific Atlanta, General Instruments, Divicom, Wegener, Thomson and Tadiran/Scopus. These companies proved their interoperability in accordance with parameters set by Intelsat and ISOG, designed to meet primary requirements of digital TV broadcast applications. Interoperability will be an ongoing issue as new products are released, such as the new high-performance encoders and IRDs supporting the MPEG-2 4:2:2 studio profile.

The issue of interoperability allowing exchange of digital TV programs between users of different manufacturers' MPEG-2 equipment is no longer a key issue in making the decision to convert from analog to digital technology. CBS Inc. was the first among U.S. networks to adopt the advantages of digital satellite news gathering (DSNG), when in 1995, it began with a single-channel MPEG-2 system for fixed and mobile applications. CBS went further when covering the 1996 Republican Convention in San Diego, by uplinking six channels of MPEG-2 compressed digital TV coverage on a single transponder. This provided extensive coverage of the event to CBS affiliates and international networks using other manufacturers' receiving equipment. European news networks, including the 25 member stations of European News Exchange (ENEX), were faster to adopt the benefits of DSNG and are considered ahead of U.S. deployment.

This is likely to change in 1998 as the major U.S. networks plan a significant increase in the use of MPEG-2 compressed digital TV technology for their contribution and distribution requirements. This demonstrates the increased confidence in MPEG-2 technology that has without doubt improved substantially over the past couple of years. This was clearly seen at NAB '97 when most of the leading players rolled out new and substantially improved products over those seen a year earlier, including some with the long-awaited 4:2:2 studio profile.

Concatenation

The need for concatenation or multiprocessing of MPEG-2 compressed digital TV signals must be considered in designing program contribution networks. Concatenation of MPEG-2 datastreams can generate unacceptable errors resulting in visual artifacts in the TV image. Signal jitter and timing problems can also be introduced in the multiprocessing environment. In networks where concatenation is necessary, the problem can be lessened by running the originating encoder at higher video data rates. The use of a 4:2:2 studio profile @ main level encoder offering video data rates up to 50Mb/s will improve digital post-production tools and provide a degree of protection in multiprocessing situations, above that possible with 4:2:0 encoding.

Experience has shown that broadcast-quality video can be achieved in single and multihop circuits using satellite or terrestrial links with video bit rates of between 5Mb/s and 8Mb/s (more on this in the next section). However, where post-production editing or re-encoding is necessary, artifacts are likely to overrun when more than three or four concatenations take place at these highly compressed data rates. Higher video data rates help protect against errors that can be

MPEG transmission issues

introduced in multiprocessing environments. In concatenated MPEG-2 applications, video data rates from 8Mb/s up to the 15Mb/s limit of MPEG-2, ML@MP must be considered. Unfortunately, higher data rates reduce the efficiency of a network and require more bandwidth, which results

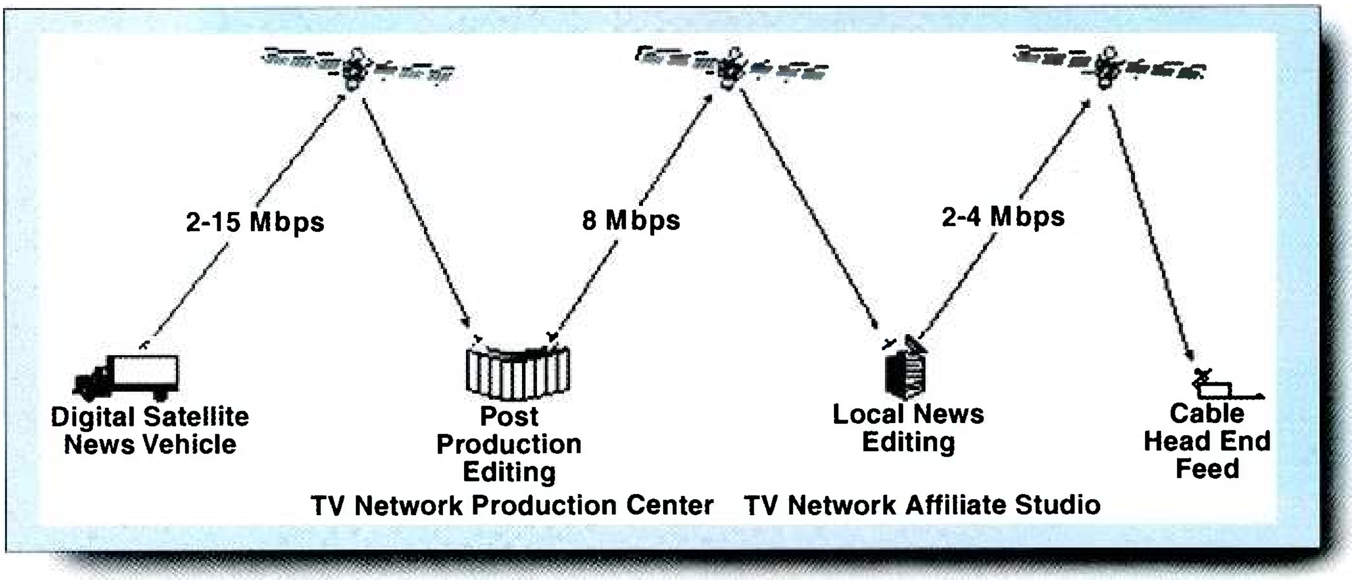

Figure 1. Concatenation of MPEG-2 encoding/decoding in digital satellite news gathering.

in fewer channels per transponder or terrestrial circuit.

MPEG-2 relies on high compression ratios, reducing the required video data rate by 90% or more. These high compression ratios and low data rates are inevitable for network efficiency, but data integrity is always of prime importance in digital TV networks. Specific attention must be directed to error-free decoded video and audio signals, comparable to uncompressed analog video, while still gaining the benefit of digital transmission. MPEG-2 has been proven adequate and sufficiently robust to render broadcast-standard video at around 8Mb/s. Lower video data rates in the order of 4Mb/s to 6Mb/s are possible with some less complex video, such as news interviews and other less aggressive video, resulting in only slight degradation of quality. However, low data rates are not advisable when heavy concatenation is likely.

TE6 encoder and the TDR600 decoder.

In adverse conditions, such as a satellite circuit operating at close to threshold, a low data rate video signal will be less robust than one operating at a higher data rate. This will likely result in disturbing artifacts being visible at an earlier state of link decay with low data rate video, than signals composed of higher rate video. The problem of possible decoded artifacts with high compression ratios must be balanced against the type of program material and the degree of concatenation expected in network operations.

Tests show that a high proportion of broadcast program material, including much with high motion, like sports events, can withstand at least two concatenations when coded at 8Mb/s or higher using MPEG-2 compression. There is no accurate measurement of the effect that concatenation is likely to cause, other than the measurement of errors in the datastream, which may not be consistent even within the same category of compressed program material. There is always the potential for a video signal to create processing problems in MPEG-2 compression and this gets more problematic in concatenated operations.

Digital turnaround and ATM networks

In the world of analog television, turnaround of network signals in program contribution and distribution networks was a relatively easy task. All you had to do was simply remodulate a baseband signal or even better, do it at the IF frequency. However, noise gets added at each turnaround and there will be signal degradation to varying degrees, which can reach the point where a broadcast-quality picture is not possible.

Many problems were encountered in the early days of multihop digital TV networking, largely caused by the continuation of analog network practices, such as IF turnaround. This technique often resulted in the generation of er-

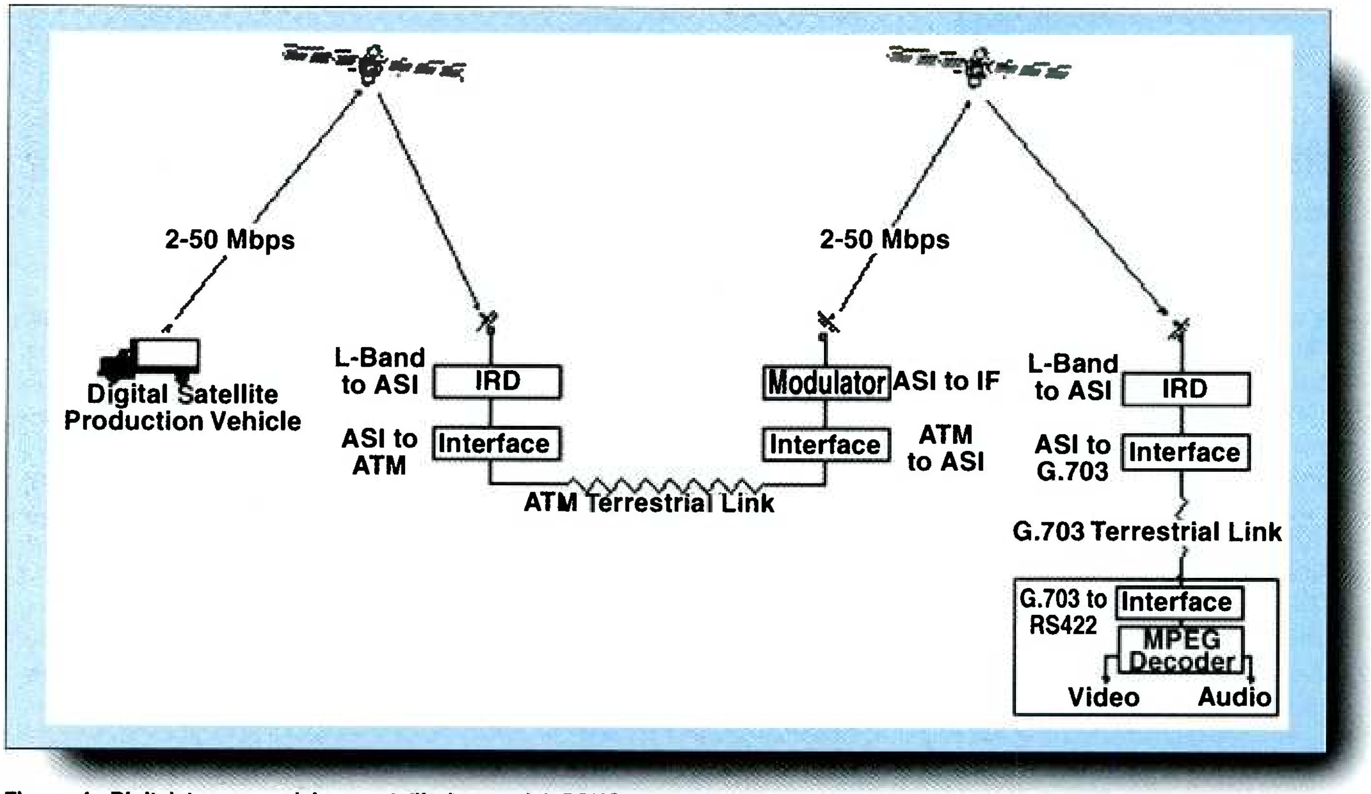

Figure 1. Digital turnaround in a satellite/terrestrial DSNG network.

rors and timing problems in the MPEG-2 datastream that were outside the MPEG tolerance. It was soon discovered that digital TV turnarounds had to be done at digital baseband and not involve multiple encoding.

Digital turnaround has now become commonplace with the major TV networks and common carriers. Global circuits can be used with MPEG-2 digital television offering little or no loss of video performance. British Telecom (BT) was among the early adopters of the digital turnaround technique. BT provides digital video transmission services to and from the main switching center at London's BT Tower over a standard G.703 terrestrial fiber and microwave link to the Madley satellite teleport. The G.703 link supports an 8Mb/s or 34Mb/s link to the BT Teleport where the datastream is converted from G.703 to the asynchronous serial interface (ASI) format required as input to the satellite uplink.

The attractiveness of asynchronous transfer mode (ATM) technology in digital turnaround of MPEG-2 signals is well recognized and offers another step in efficient bandwidth-on-demand circuits for a growing digital TV market. ATM will add another dimension to MPEG-2 digital TV networking in terrestrial and satellite media. The addition of this new networking tool has come just when global TV networks need added bandwidth and flexibility to meet the demand for program contribution and distribution.

Digital turnaround has become commonplace with the major networks and common carriers.

Teleglobe International was the first major carrier to offer digital TV service over an ATM terrestrial network using newly available MPEG-2 4:2:2 studio profile equipment. The service was inaugurated in December 1997. The ATM link was established between Teleglobe's Lake Cowagan, British Columbia teleport to Laurentides teleport near Montreal, terminating at Waterfront Communications New York teleport.

NHK was the first to use the new MPEG-2 4:2:2 ATM service from Teleglobe International. NHK was well satisfied with the video and audio quality of the service. Teleglobe is initially offering two levels of MPEG-2 ATM service to its users: 8Mb/s at either 4:2:2 or 4:2:0 profiles and 18Mb/s at 4:2:2 only.

Finally, trials by Intelsat and ISOG have convinced manufacturers and users that interoperability is no longer a major issue. It has been proven that any manufacturer's equipment conforming to the MPEG-2 and DVB standards can be made to interoperate with another manufacturer's similarly compliant product. Continued cooperation is needed between manufacturers to ensure that the new products, including those supporting the new 4:2:2 studio profile will maintain the required interoperability. ■

Keith Dunford is vice president of Tiernan Communications, Inc., San Diego.

Make it easier for others to reach agreements with you

BY KARE ANDERSON

Are you far enough along into the new year to find that you are already backsliding on your goals for 1998? Want to try on some bite-size "behavioral change" goals instead? These small habits may reap big rewards in reducing stress and friction when trying to reach better agreements more easily.

Tell me which of the following 12 habits you find the most difficult to adopt, the easiest or the most rewarding. E-mail me at kareand@aol.com.

1. *Anticipate what you want out of a situation before you go into it.* Before you enter into a conversation with someone, consider your main goal. The more you can keep your goal in mind, especially if you have strong negative or positive feelings about the person you are talking to, the more you will remain focused on what is being said and you will be less reactionary to issues that don't relate to your bottom line. In some cases, your main goal may change in mid-conversation, but having a goal gives you a context for the conversation.

2. *Demonstrate goodwill upfront.* Be willing to compromise and be genial, even if you don't like the person or the situation. This is the best way to keep the channels of communication open.

3. *Make the other people feel safe before you try changing their minds.* Being right or smart or good is often of no help in protecting your interests. Acting in mutual best interests is more valuable. All agreements involve asking people to change, which we initially resist. In almost every situation, people are first influenced by their fears more than their opportunities. Calm their fears, even if they may be unstated, and you will open people up to hearing your needs. Align your goals with their picture of positive possibilities and you may move them more quickly to agreement. Once fears are allayed, they can hear about others who have already done something similar to what you propose.

4. *Understand that problems seldom exist at the level at which they are discussed.* When you are involved in any argument lasting more than 10 minutes, ask yourself, "Are we arguing about what our disagreement is really about or is there a deeper conflict not being discussed?" Probe for the underlying concern and find a direct or indirect way to address it.

5. *Make it a habit to refer to other people's interests first.* Refer to the other person's interests first (you), then how the topic relates to your mutual interests (us) and finally, how the topic relates to your interests (me). Research shows that others will listen sooner, longer, remember more and assume you have a higher IQ than if you were to address your interests first.

6. *Honor commonalties more frequently than bringing up the differences.* It is a habit to bring up our concerns more than our agreements with someone else. Whatever you refer to most often and most intensely will be the center of your relationship. Keep referring to the part of them and their points that you can support and want to expand upon. If you want more from other people, wait until they have invested more time, energy, money or other resources to ask for it.

7. *Don't assume that other people see the picture you are presenting.* Do not presume that others recognize all the benefits of what you are proposing. Take time to describe them in their terms, relating your suggestions to their most pressing interests and situation. Many seemingly tough "negotiators" are simply acting to prevent looking foolish later on. The best peacemakers work hardest to allay the other people's worries.

8. *Use time, rather than letting it control you.* Plan and act early to avoid last-minute rushing and thinking. As you go forward in your discussions, remember that the allure of a successful agreement often clouds our perceptions of whether we can cover all the elements of the agreement in the time we have allotted to discuss it. Do not panic when you have unavoidable outside time constraints. Use the pressure to get more accomplished in less time.

9. *Look to your long-range interests and your better side.* Even though it is human to gloat in the face of imminent victory or vindication, do not make a victim of the underdog. You will never have their complete attention or trust again; some will retaliate and you will be diminished in the eyes of others who witness your behavior.

10. *Recognize your blind spots and your hot buttons.* When you get angry with someone, look first to your vulnerable points before you lash out.

11. *Be a "synthesizer leader" (SL).* The emerging synthesizer leaders have some behaviors in common. They listen to others before voicing an opinion. They ask probing and follow-up questions. They refer to the previous comments of other people with whom they agree as a way of prefacing the idea they advocate. They display consistent values. They offer and keep commitments, without being reminded. Consequently, even if others may not agree with "SLs," they are likely to respect and work with SLs more than others who may be closer to their beliefs, but who are unreliable in keeping commitments.

12. *Aim humor at yourself.* The best way to deflect is to poke fun at yourself. Make reference to a situation when you did something foolish. ■

Kare Anderson is a speaker and author. Visit her web site at www.sayitbetter.com.

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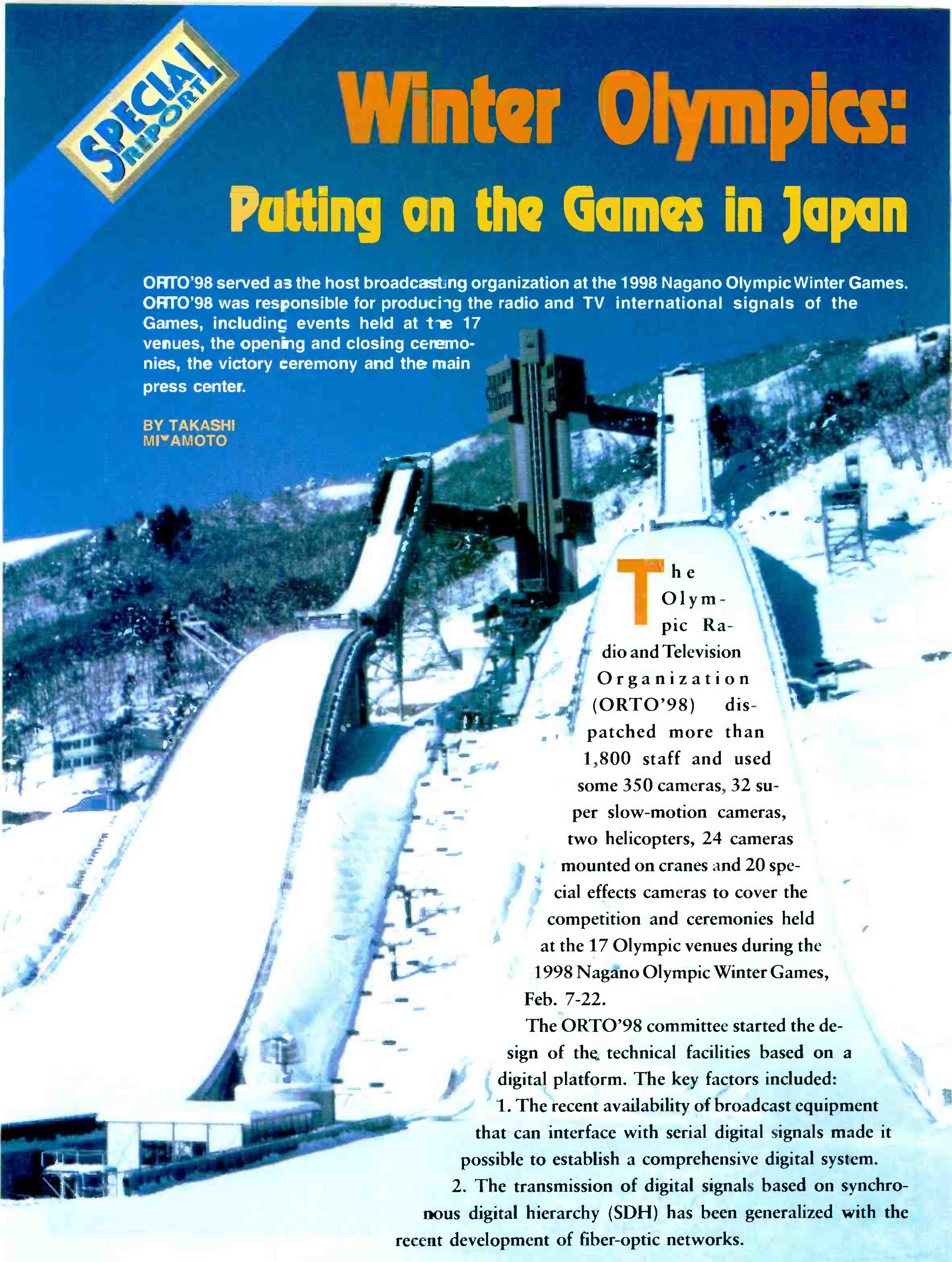
SPECIAL REPORT

Winter Olympics:

Putting on the Games in Japan



ORTO'98 served as the host broadcasting organization at the 1998 Nagano Olympic Winter Games. ORTO'98 was responsible for producing the radio and TV international signals of the Games, including events held at the 17 venues, the opening and closing ceremonies, the victory ceremony and the main press center.

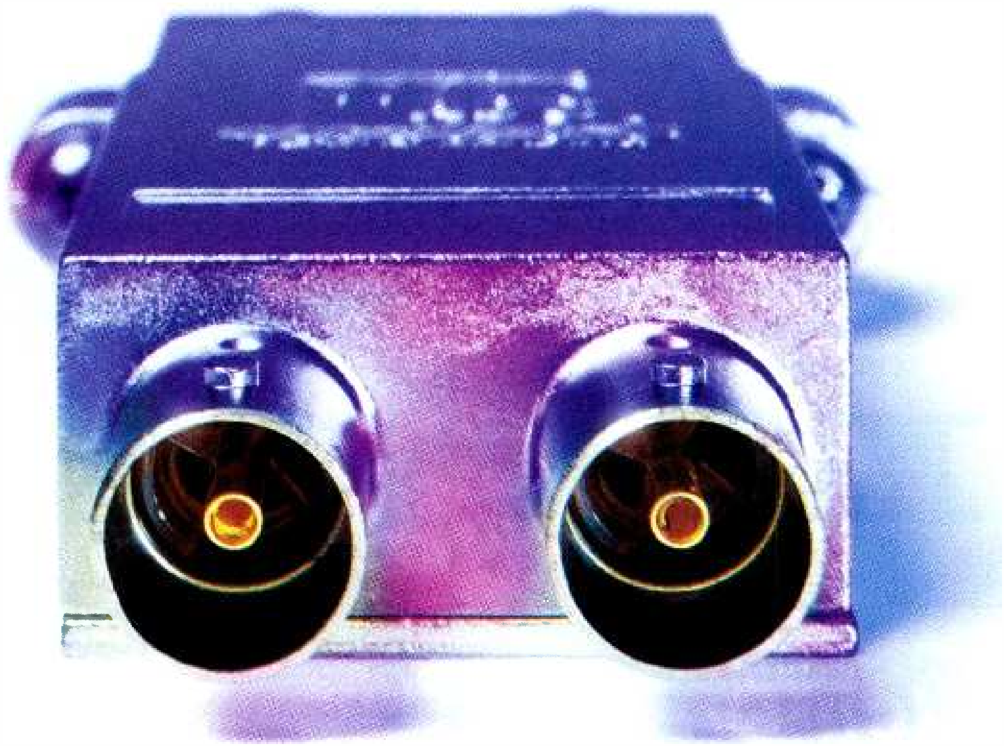
BY TAKASHI MIYAMOTO

The Olympic Radio and Television Organization (ORTO'98) dispatched more than 1,800 staff and used some 350 cameras, 32 super slow-motion cameras, two helicopters, 24 cameras mounted on cranes and 20 special effects cameras to cover the competition and ceremonies held at the 17 Olympic venues during the 1998 Nagano Olympic Winter Games, Feb. 7-22.

The ORTO'98 committee started the design of the technical facilities based on a digital platform. The key factors included:

1. The recent availability of broadcast equipment that can interface with serial digital signals made it possible to establish a comprehensive digital system.
2. The transmission of digital signals based on synchronous digital hierarchy (SDH) has been generalized with the recent development of fiber-optic networks.

Finally, a place to stick the FCC's DTV requirements.



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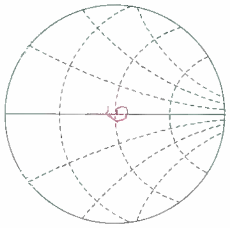

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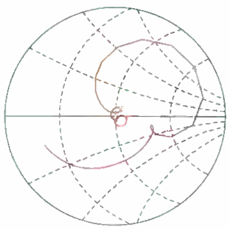

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Video workshop room for CG work at IBC.

3. In order to ensure superior signal quality, conversion from analog to digital and back was minimized.
4. Standard digital multiplexing techniques allowed digital video and audio to be combined on one coaxial cable, which reduced the amount of cables and work required when building large broadcast facilities.

ORTO'98 established a digital system that conformed to NTSC composite digital format SMPTE 259M/272M standard that specifies a serial digital interface with embedded digital audio. In order to secure the host broadcast equipment at the International Broadcasting Center (IBC), Panasonic was selected to be the key system integrator for the Nagano Games in September 1996. The Panasonic installation included digital broadcast equipment, including D-3 format videotape machines with serial digital (SDI) and embedded audio interfaces.

International signals

The international TV signals were handled by SMPTE 170M (NTSC, 525 lines/59.94Hz) with stereo audio in-

NOJC (Japan Pool) monitoring room using compact DVCPRO VTRs (AJ-D-230) IBC.

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terfaces. In order to transmit the digitized TV signals with a data rate of 143Mb/s through fiber-optic circuits based upon STM-1 (155.52Mb/s),


VTR room for archiving/library (IBC).

ORTO'98 introduced a codec with serial digital interface that was capable of carrying serial composite digital signals on SDH. The codecs, supplied by Grass Valley, accommodated two times AES3 channels in addition to one times serial digital video input. No bit reduction was used on any channel.

Technical facilities

ORTO'98 secured a space of approximately 1,800 square meters, with the IBC as the technical area, to perform the host broadcaster's responsibilities. Installation of ORTO'98 technical facilities at the IBC started in September 1997 in association with Panasonic. The technical area included the following facilities:

- distribution center;
- transmission center;
- codec room;
- VTR room;
- video workshop;
- quality control room;
- seven edit suites;
- RF communications control room;
- viewing/copying room; and
- radio studio.

As international signals were distributed to world broadcasters on an analog system, digital and analog facilities coexisted in the ORTO'98 central facilities. All video and audio signals transmitted through contribution networks from the Olympic venues were terminated at the distribution center in the IBC before being distributed to the world broadcasters' areas. The contribution networks consisted of 15 sports venues, a venue for the opening and closing ceremonies, plus main press center and a venue for the victory ceremony, the Olympic village and the panoramic camera feeds.

Distribution of the signals produced by ORTO'98 to world broadcasters at the venues and the IBC were NTSC composite analog with associated stereo sound. Signals were identified, equalized and synchronized in the distribution center. ORTO'98 also handled 73 permanent unilateral circuits from venues to the broadcast suites at the IBC.


Distribution center inside of IBC.

Transmission center

The transmission center served as a final supervising point of outgoing signals to be transmitted via terrestrial or satellite circuits in cooperation with telecommunications companies. ORTO'98 handled 51 permanent outgoing circuits from the IBC to overseas and domestic destinations.

Outgoing signals were transmitted via telecom KDD's uplink facilities as follows: Yamaguchi earth station accessible to Indian Ocean Region (IOR); Ibaraki earth station accessible to Pacific Ocean Region (POR), PanAmSat and Intersputnik; and IBC earth station accessible to IOR, POR and PanAmSat. In addition, a transoceanic fiber-optic link at Ninomiya was used.

VTR and post-production facilities

ORTO'98 was responsible for nonstop recording of all the international signals transmitted live from the venues. In the VTR room, all international TV signals were recorded in digital format conforming to SMPTE 259M/272M standard without any conversion to analog signals.

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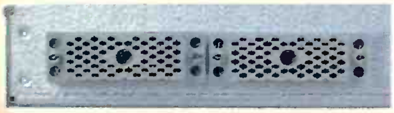

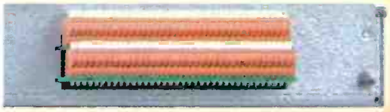

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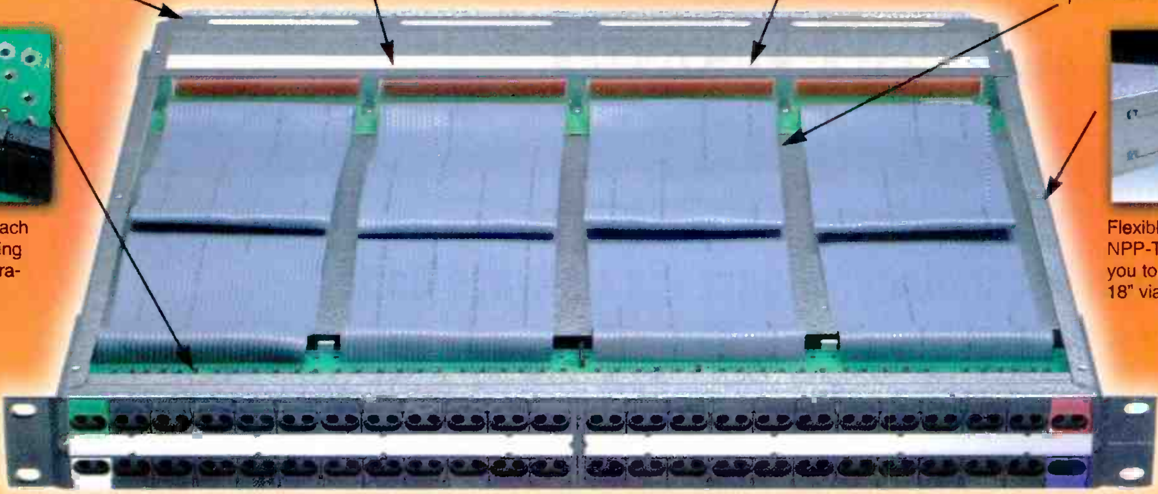

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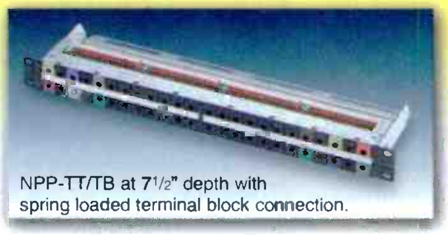

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chines were installed at the venues and at the IBC for recording and editing purposes. Also, DVCPRO machines were available at the venues for insertions.

Commentary switching center

In order to provide commentators with the best possible operational environment, ORTO'98 introduced a newly developed commentary system that incorporated advanced digital technology. The commentary equipment was supplied by Aplicaciones Electronicas Quesar (AEQ), which is headquartered in Spain.

Transmission of wideband commentary audio from the venues to the IBC were conducted via digital circuits equipped with codecs that featured short delay times. The source coding technologies were adopted to 7kHz transmission (G722) and 15kHz transmission (apt-X100).

Graphics

Taking into account the large and differing audiences that watched the 1998 Winter Games on television, ORTO'98 designed the graphics for the international signals to be simple and viewer friendly. In order to gain high-speed operations and uniformity of the international pictures, ORTO'98 installed the "Video Work Station" developed in cooperation with FOR-A Company Ltd. in Japan as a graphics/character generator. The graphics/character generator system was linked with data/result/timing systems at each venue.

The graphics information, such as the athletes' names, countries, starting numbers and running times, were always inserted and placed in an exact location on the screen, giving uniform and stable images to the viewers.

Takashi Miyamoto is director, IBC Operations, ORTO'98, Nagano, Japan.

New Products & Reviews

Applied Technology

Router technology: Bigger isn't always better

BY DAVE TEWEL

In today's world of rapidly evolving technology, stations and production houses need to make careful decisions when selecting new routers. No longer can it be assumed that one central legacy router is the best way to manage audio and video signals. Sometimes, bigger is not better.

This concept has been proved beyond a doubt in the computer industry. During the past two decades, the era of the mainframe computer as the only source of computing power has passed away. Today, every organization has decentralized its computing into a mix of smaller computer systems tailored for specific applications. This distributed processing approach has great applicability in the broadcast industry as well.

Advantages

There are some significant benefits to distributed routing configurations. They are compact in size and can be located in that new edit bay with only a limited number of cable runs back to the legacy router. In addition, these routers simply don't require the care and feeding of the products of old; no longer do you need a climate-controlled environment and raised floors.

However, the biggest advantage by far is the cost savings associated with buying only the capacity that you need. When large router configurations are installed or expanded, an enormous amount of capacity and costs are added to the system, while in all probability, the majority of this new capacity is simply not needed.

The effective cost of the distributed routers is much lower because the crosspoint use is so much higher. The larger the router, the more crosspoints, but the fewer of them in use at any given time. On the other hand, a decentralized design provides for a much greater utilization level, meaning the cost per crosspoint will actually be much less in smaller routers. This is true even though there is a natural economy of scale realized when building mainframe routers; if the crosspoints are never used, however, there is simply no cost savings to be gained by having them available.

The other similarity to the computer industry is that every year, routers get smaller, faster and less expensive. The lesson here is to buy only what you need to meet today's requirements.

The VersaFrame

Telect's VersaFrame products fit well into the distributed routing environment. The VersaFrame is a three-rack unit chassis and power supply into which up to 10 modules may be inserted. These may be scalable router input and output modules, as well as a number of other application modules. The routers are scalable by performance level, as well as by total configuration size.

The VersaFrame uses a building-block

approach of either eight-input x eight-output or 8x16, which provides a granularity sufficient for inexpensive expansion in cost-affordable increments. It allows the station to select more closely the actual router size required, knowing that expansion can be easily performed later. With the VersaFrame, a station no longer has to buy a router with enormous headroom, instead it can buy a router with the capacity to grow.

Room for growth

Each VersaFrame module is made of two components: the electronics portion for input and crosspoint on one module and the output on a second. Each of these is mated with an I/O card that attaches to the back of the VersaFrame. This provides the versatility to configure the router to fit the customer's needs. Signal isolation within the module is assured by the steel plate that backs each module, separating it from all others. The power supply, an optional redundant power supply and all other VersaFrame modules may be positioned in the VersaFrame for optimal access, particularly for cable routing. Output modules include gain adjustment pots for each output. An optional audio input gain adjustment module is available when working with a mix of balanced and unbalanced sources.

Telect's VersaFrame 2000.

All units may be hot-swapped for ease of maintenance. With Telect's building-block strategy, only a limited number of spare input and output modules are required to be maintained on site or in the dealer's location for quick repair. This saves cost and storage space.

Telect offers a variety of video performance levels, ranging from 50MHz to 150MHz to 400MHz. The 50MHz and 150MHz products target NTSC, YC and YUV applications, while the 150MHz and 400MHz products target mid- to high-end RGB applications. With Telect's ability to place various performance products in the same VersaFrame, a user can specify 50MHz video routers for managing external sync signals in combination with a 400MHz RGB router to reduce cost. Each router may have its own unique router address so that controllers to individual routers may all share the same daisy-chained cable. A router may be set up to run component, as well as composite, in order to accommodate a limited number of NTSC signals in a predominantly component environment without requiring a separate router. Each of the scalable routers can grow from their base size up to 72 input x 128 output. This same set of building blocks can be used in a number of sizes and applications within the station, all according to current requirements.

Those stations that installed Telect routers last year have a choice when expanding to meet this year's requirements. Last year's 16x16 router that needs to grow this year to a 32x32 router may be expanded with more of the 50MHz eight-input x eight-output modules that are currently installed. However, if users choose to upgrade with the new 150MHz eight-input x 16-output modules, their total configuration will be less expensive and require fewer VersaFrame slots, even though the performance level is greater. The same holds true for the audio router counterparts. If the new routers are backward-compatible with routers already installed, the justification to grow in small increments only gets stronger.

Analog audio and video routing are only a small part of how the VersaFrame can be used. In a distributed processing concept, space typically is at a premium, whether it's in the edit bay, the news room, in the production area or in a mobile unit. The VersaFrame leads the industry in configuration flexibility and packaging density. In addition to scaleable routers, Telect builds audio and video DAs, serial digital DAs, serializers and deserializers, stereo audio amplifiers, color bar/black/sync/tone generators, router controller modules for smaller configurations and 16x16 serial digital routers.

All of these applications modules may be positioned in the open slots not occupied by the routers. The combination of analog and digital, audio and video, routing and distribution, conversion and control provides the ultimate in space conservation.

Looking ahead

Digital transition appears inevitable, but the future of many stations is still uncertain. The strategy of distributed routing, which uses smaller routers like the VersaFrame, can be a valuable tool during this transition phase. As the migration begins, users can install the serial digital modules in the same VersaFrame next to their analog counterparts. By doing so, they'll be easing into the digital world while protecting their current router investment. ■

Dave Tewel is the eastern region account manager for Telect, Inc., Liberty Lake, WA. He can be reached at davet@telect.com.

Applied Technology

Digital video microwave systems for 2GHz applications

BY DR. JOHN B. PAYNE

The FCC's new rules on HDTV create new opportunities for TV broadcasters. Unfortunately, for some stations, even getting the signal to the transmitter may be a task. In addition, recent FCC actions reducing the amount of ENG spectrum have resulted in severe shortages of new channels for news operations. Fortunately, there are some new digital techniques that can bring solutions to these pressing problems.

Transmission architecture

The modulation and type of microwave radio required to transmit digital video information is considerably different from that used for analog video transmission. In a digital system, the encoder digitizes then compresses the video and audio signals, then multiplexes the compressed bitstream with the digital data inputs to produce a digital transport stream. The encoder output data rate is typically in the range of 1.5Mb/s to 34Mb/s, depending on the amount of compression and forward error correction (FEC). The digital modulator converts this baseband signal to a 70MHz RF signal.

Typical digital modulation techniques include QPSK, multiple-level PSK and QAM, which use a combination of phase and amplitude to modulate the 70MHz signal. The modulator's output is upconverted (heterodyned) to the RF microwave frequency, amplified in a linear-type RF amplifier and output to an antenna or diplexer with other microwave signals.

At the receiver, the reverse process takes place. The RF signal is received, downconverted to 70MHz and demodulated to produce the compressed datastream. The decoder then decompresses the signal to generate the final video, audio and data. The receiver, digital demodulator and decoder functionalities are generally combined into a single unit called an integrated receiver decoder (IRD). These units typically accept either a 70MHz or L-band RF signal.

The system is easily scaleable to compress and transmit multiple channels on a single carrier. To support multichannel transmission, only additional encoders and a multiplexer are added. The multiple encoder outputs are combined by a multiplexer that outputs a digital stream at a rate equal to the sum of the input datastreams. Thus, if two encoders output 15Mb/s and 10Mb/s respectively, then the multiplexer output will be 25Mb/s. The multiplexed datastream is fed to the digital modulator. In this manner, multiple channels can be fed on a single carrier, as long as the multiplexed datastream does not exceed the maximum data rate of the system.

NTSC/HDTV dual-channel STL

Figure 1 shows how an NTSC and an HDTV transport stream can be simultaneously transmitted over a single microwave link from the studio to the transmitter. The NTSC composite signal is digitized and compressed to the desired output rate, 17Mb/s in this example. The 17Mb/s compressed NTSC signal is combined with the 19.39Mb/s HDTV transport stream to yield a muxed output rate of 36.39Mb/s. Using a QPSK modulator, the required transmission bandwidth is approximately 22MHz. Using 16-QAM, the bandwidth is further reduced to 11MHz.

At the receiver, the signal is demodulated and applied to two decoders. The NTSC decoder decompresses and outputs the composite video and audio signal to be applied to the NTSC transmitter. The other decoder demultiplexes and passes through the HDTV transport stream to the HDTV transmitter. NUCOMM offers a complete turnkey system for this application that is available now.

DIGALOG — digital and analog microwave system

To meet broadcasters immediate need for continued transmission of analog signals, but to also be ready for the transition to digital, NUCOMM has developed the DIGALOG FT6/FR6 radio system for STL applications (and the DIGALOG MMPT6 for ENG applications). The DIGALOG radio is highly configurable and can operate in

either analog or digital mode. Depending on the existing system configuration, optional analog and digital modulators can be added to the 2RU unit. If the input is already a 70/140MHz modulated IF signal, the IF signal can be directly upconverted and amplified for transmission. Using a single switch located inside the front panel, the power amplifier can either operate in analog mode for maximum power output or in digital mode for linear power output. The corresponding receiver is the DIGALOG FR6 analog/digital microwave receiver. Two IF bandwidths, 30MHz and 45MHz, are provided in the IF amplifier. The 30MHz bandwidth filter is switched in for analog or low data rate digital operation. The 45MHz bandwidth filter is switched in for data rates of 45Mb/s or higher.

Data rate vs. bandwidth

The equation defines the bandwidth required to transmit an encoded bitstream at a given data rate. The transmission bandwidth is a function of input data rate (Za), modulation coding (M), FEC and spectrum shape factor (a).

$$\text{Bandwidth (MHz)} = \frac{(1+\alpha)\,\Sigma\,Za\ \text{Mb/s}}{FEC * M}$$

where ΣZa = sum of data rates from one or multiple encoders (Mb/s)
FEC = forward error correction = VC * RS; if no FEC is used, then FEC=1
VC = Viterbi coding: typical 1/2, 2/3, 5/6, 3/4, 7/8
RS = Reed-Solomon: typical 188/204, 192/208
M = coding level of the modulator
a = spectral shaping factor

Table 1 shows the spectrum efficiency in bits/hertz and carrier-to-noise level (C/N) for various modulation techniques. As M increases, the required transmission bandwidth for a given data rate decreases proportional to bits/hertz (assuming FEC=1) and the required receive C/N level must increase for a given bit error rate (BER). This is the trade-off for better transmission efficiency.

The most robust and common form of digital modulation is QPSK, which has a spectrum efficiency of 1.66 bits per hertz. In cases where more bandwidth reduction may be required, higher-order modulation, such as 16-QAM or 64-QAM, provides a spectrum efficiency of 3.33 bits/hertz or five bits/hertz, respectively. However, as the coding number increases, the modulation is less robust and becomes susceptible to RF interference and multipath effects. Also, system gain decreases substantially because of lower available output power and the requirement for higher receive carrier levels increases for a given bit error rate.

In an STL link where signal levels tend to be high and the transmission link reliable, the higher forms of modulation can usually be justified. However, in ENG links where multipath

Type of Modulation	M	Bits/Hertz M / (1+ a)	C/N (dB)
PSK	1	.833	10
QPSK	2	1.66	10
8-PSK	3	2.50	14
16-QAM	4	3.33	17
64-QAM	6	5.00	23
256-QAM	8	6.66	28

Notes: 1-Normalized C/N corresponds to a BER of $1X10^{-6}$.
2-Assumes No FEC and a = .20

Table 1. Types of modulation.

and weak signals are the norm, a robust modulation such as QPSK is needed. To fit the digital video data rate within the allocated bandwidth, the encoder data rate and FEC need to be adjusted according to the type of modulation technique used. Reducing the data rate with current encoders has little effect on the picture quality. Therefore, it becomes a judgment call on the part of the ENG management to assess the picture quality for given bandwidths. There may be no other option if the 2GHz allocated bandwidths are further reduced by the FCC.

Analog vs. digital performance

The analog link and a comparable digital link for those system configurations discussed earlier show a video signal-to-noise (S/N) ratio of 70dB for high receiver input signal levels. As the

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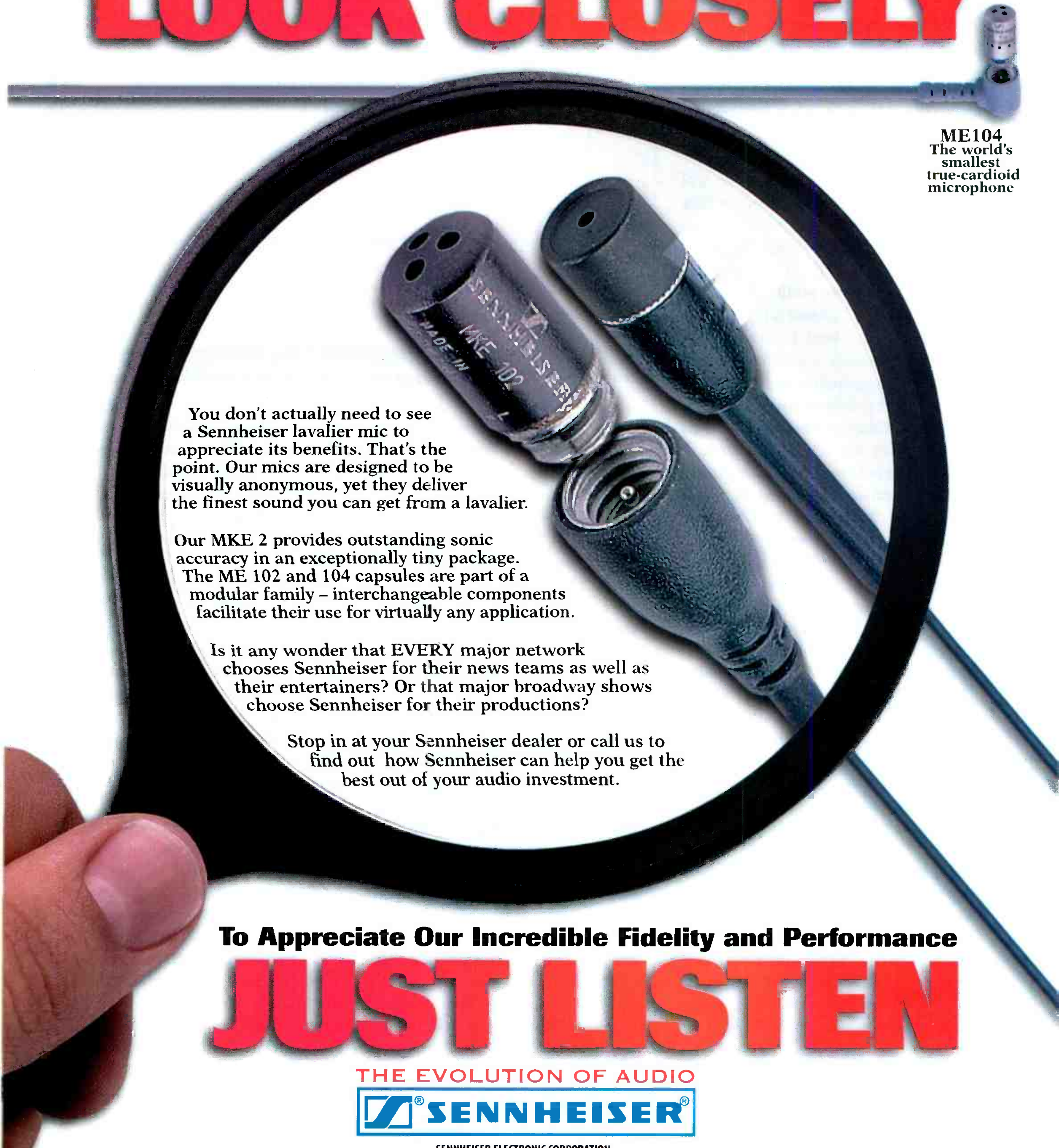

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signal level drops, the video S/N becomes linearly proportional to the input signal level. When the receiver threshold is reached (typically -85dBm at 7GHz in current video receivers), the video S/N drops much more rapidly than the receiver input signal level. In a typical analog system, threshold is defined when the video S/N reaches 37dB. At a receive level of about -82dBm, the audio channels become noisy and unusable.

The digital link shows a lower S/N than the analog link for strong receive signal levels. This lower S/N is due to the limitations of the digitizer in the encoder. Typically, a 10-bit digitizer gives a S/N of about 60dB. The advantage of the digital system is that even as the input signal level is reduced, the video S/N remains constant at 60dB. This S/N is maintained until the error correction capabilities are exceeded, at which point the transmission fails. This failure point for a QPSK system is generally at or below the analog threshold point and depends primarily on the amount of error correction and the type of modulation used.

A 45Mb/s QPSK digital signal with error correction was passed through the NUCOMM 7GHz FT6/FR6 DIGALOG transmitter and receiver. The digital threshold for QPSK (-89dBm) was 4dB lower than the systems analog threshold (-85dBm). Using 16-QAM, the digital threshold (-82dBm) was higher than the analog threshold by 4dB. This 7dB threshold increase using 16-QAM instead of QPSK essentially enables the transmission of twice the data within the same bandwidth.

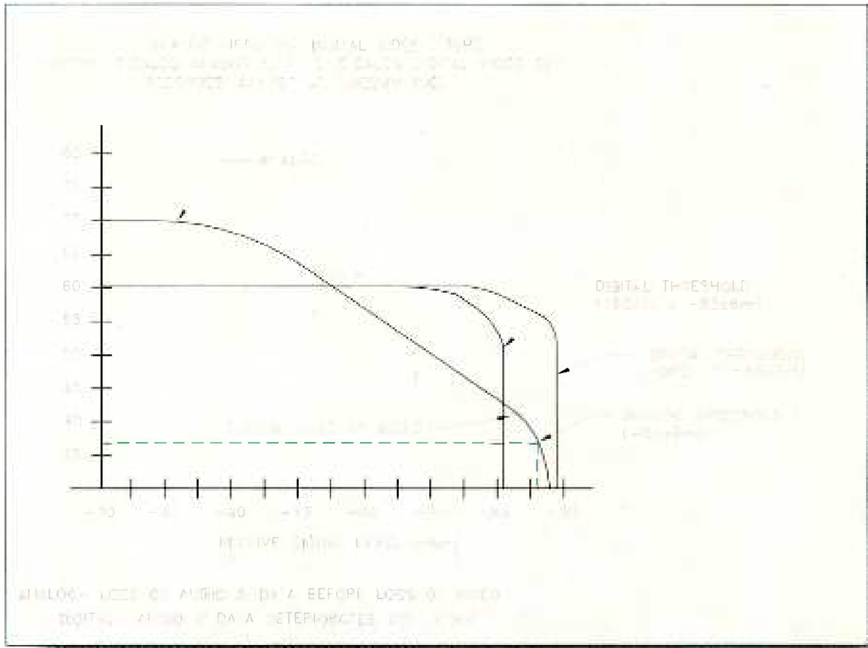

Figure 1. Video S/N vs. receiver signal level for analog and digital ENG/STL systems.

Field tests at 2GHz

When the subject of digital video being applied to 2GHz ENG microwave systems is suggested, oftentimes the response is that digital video will never work for ENG. Operators are typically faced with non-engineered paths where shots are made using multiple bounces in high multipath environments. We recently completed field testing of our 2GHz ENG digital video microwave system in New York City. This city was chosen because it represents one of the most severe and challenging environments for ENG operation.

For this test, the analog transmitter was a NURAD 10W model PT1 that was padded down for an output of 3W. The digital transmitter was a NUCOMM DIGALOG FT6. Its power output was 1.5W. The antenna was connected directly to the transmitters through 50 feet of Andrew half-inch flexible coax and had a measured loss of 3dB. The antenna was a NURAD silhouetta antenna mounted on a pan and tilt. To ensure stress testing the digital encoder, a difficult 2.5-minute video clip of a pre-recorded hockey game on Betacam SP was used as source material because it included fast camera panning, fast action, high color contrast and saturated colors.

At the Empire State Building, the output from a steerable Super Quad antenna was divided to feed the NURAD analog receiver and the NUCOMM DIGALOG FR6 digital receiver simultaneously. The 70MHz output from the digital receiver was upconverted to L-band for input into the IRD decoder. Each of the composite outputs from the analog and digital receive systems was transmitted back to the studio over an analog fiber link where the outputs were recorded on Betacam SP tape. Both transmitters operated on the same 2GHz channel.

The first three case tests compared the audio and video quality of the 2GHz analog FM signal with the quality of the digital MPEG-2 compressed and QPSK modulated signal under the following three environments:

1. direct line-of-sight transmission;
2. moderate multipath transmission; and
3. extreme multipath transmission.

The ENG truck was located at E. 90th St. and 5th Ave., and the receive site was the Empire State Building. The procedure for setting up each test was to first establish the analog shot geometry and picture quality. The resultant analog video picture was recorded for 2.5 minutes. Then, without moving the antennas, the digital transmitter was connected and the test repeated. Each digital case tested data rates ranging from 9Mb/s to 15Mb/s and two FEC rates of 3/4 and 7/8.

The first test was a line-of-sight shot to make sure that the system was working properly. Analog and digital transmissions produced overall good pictures for each configuration. Although the analog signal was strong, there were still some multipath and ghosting artifacts. The digital picture showed no sign of multipath or ghosting.

The second case, moderate multipath transmission, is representative of typical ENG operating conditions in major urban cities. The ENG truck was in the same location as in the first case, but

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the antenna was moved to 45°off true North so that at least one bounce was introduced in the path. The received signal measure was lower than the first case, but still quite strong. The resulting analog signal showed noticeable ghosting artifacts and color shifting. The quality of this analog signal was considered a borderline usable picture for broadcasting. The digital signal, on the other hand, had no problem locking up and performed perfectly with no ghost or indication of multipath in the picture.

The third case tested extreme multipath interference comprised of multiple reflections and scattering from buildings and possibly even moving vehicles. Here, the ENG truck antenna was aimed toward the west side of Central Park. The resulting transmitted analog signal was severely degraded to the point where it was not usable and was so bad that a frame synchronizer had to be used to receive the picture. The analog video had significant ghosting artifacts and the audio had severe break-up. The studio reported that the picture quality was too poor to broadcast. When the digital signal used an FEC of 3/4, the IRD decoder had no problem locking on the signal and it produced a perfect picture.

The results of these tests clearly showed that digital ENG video transmitted in the 2GHz band consistently produced a picture equal to and, in most cases, superior to the analog transmission system.

In the presence of extreme multipath, a 7/8 FEC was not enough and the resulting errors can be observed by occasional slow-picture motion, checkerboarding and drop outs. As predicted, an FEC rate of at least 3/4 was required to adequately recover from random errors induced by multipath interference, and in our tests, an FEC rate of 3/4 seemed sufficient to recover from most errors. This test shows the importance of forward error correction.

The results of these tests surprised all concerned and clearly showed that digital ENG video transmitted in the 2GHz band consistently produced a picture equal to and, in most cases, superior to the analog transmission system.

Applying digital video compression, QPSK modulation and forward error correction for STL and ENG systems can conserve frequency spectrum and yield superior quality and performance equal to and better than analog systems under fading and multipath types of environments. Although QPSK worked well for the STL and ENG tests, there are other digital modulation techniques available that can be used for these applications. For STL, higher-order modulation than QPSK can be applied because their transmission links are fixed and tend to be reliable.

The tests were performed without the use of adaptive equalization in the digital demodulators. Equalization was purposely not used so as to measure the uncorrected multipath effects on such a system. The use of adaptive equalization can only further improve the performance of digital video systems. ■

Dr. John B. Payne is president of NUCOMM, Inc., Hackettstown, NJ.

Acknowledgment: The author wishes to thank New York City FOX station WNYW-TV and Rich Paleski for providing the ENG truck and its Empire State Building central receive site, as well as studio recording equipment and personnel. I would also like to thank the WEGENER Corporation/COMSAT Labs, which supplied the encoder and IRD equipment.

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Adjacent-channel DTV/NTSC transmitters using Diacrodes

BY TIMOTHY P. HULICK, PH.D.

The FCC's new TV broadcast channel allocations have resulted in many TV stations being assigned a DTV channel adjacent to their NTSC allocation. In the case where the DTV channel is adjacent and below the NTSC channel (n-1), little guard band is present to design and build a channel-combining filter system enabling the user to pipe both signals to a common antenna. A second transmitter, a DTV transmitter, is still needed, however. For the n+1 case, the solution isn't simple. There is virtually no guard band between the channels, rendering the filter combiner solution impractical. Even where a filter combiner is to be used, in this case, the visual and DTV signals enter the combining filter, then go through a notch diplexer where they are combined with the aural signal. This means three transmitters are needed: visual, aural and DTV. Acrodyne has developed an alternative approach called *adjacent channel technology* (ACT).

Common NTSC/DTV amplification

The answer to both situations may lie in using a common high-power amplifier for the NTSC and DTV signals. If this can be successfully accomplished, a combiner will not be needed. However, this approach does require a linear amplifier and one that is capable of sufficient peak envelope power.

Common amplification of the entire NTSC signal became popular in the mid-1980s when UHF tetrodes were developed for higher power and the klystrode/IOT devices were introduced. The tetrode and its derivative, the Diacrode, along with the IOT, are the UHF choices today because all three offer sufficiently linear performance for amplifying the combined visual and aural signals. Properly designed intermodulation and cross-modulation correction circuits are used to prevent any one carrier from contaminating the other.

The specific circuit and technique used is tube-type dependent. If common amplification of the visual and aural signals is possible, what happens when a DTV signal is added to the mix? Surprisingly, it isn't all bad. This technique is only an extension of methods already used.

Only the tetrode and Diacrode cavities can be tuned wide enough to accommodate side-by-side channels, however. More than 12MHz of flat bandwidth is needed to allow both channels to be included. The TH-680 Diacrode cavity can be tuned for a 1dB bandwidth of 14.6MHz, putting the tuning bandpass sufficiently far enough away from the channel edges so that group delay is not a problem. Flatness is within 1dB across both channels. Input return loss is sufficiently low so that the driver sees an adequately matched load.

The amplifying device type must have sufficient bandwidth and be able to provide the desired power. The TH-680 Diacrode is capable of at least 104kW of unsaturated peak envelope

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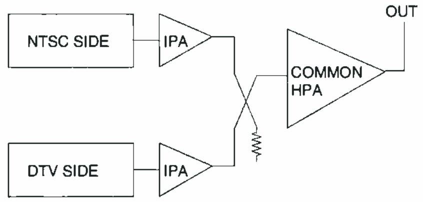

Figure 1. A simplified ACT system block diagram. By keeping the NTSC signal separate from the DTV signal until they are power combined, near-perfect clean drive is obtained.

power, giving it a rating of 60kW peak of sync along with simultaneous provision of 6kW of aural power.

The actual output power levels derived may be doubled, tripled or quadrupled according to need by using two, three or four Diacrodes. A single TH-563 tetrode offers half the power with a PEP limitation of 52kW.

Performance considerations

Peak envelope power limits and tuning bandwidth are not the only considerations in selecting a high-power amplifying device or method. Other considerations also include:

- linear distortion;
- non-linear distortion; and
- how to make the driver clean.

Of all of the types of distortion in all TV transmitters, regardless of tube type, only relatively simple correction for a Diacrode or UHF tetrode is needed to make the combined output signal competitive in the world of performance specifications. In-band intermodulation distortion, probably the most difficult one to achieve, is routinely recorded at -60dB from peak of sync across all picture levels. Uncorrected IM output from these tubes is about -49dB with a 10% aural signal.

Figure 1 illustrates the block diagram of the approach taken by Acrodyne to provide near perfect drive. The NTSC driver and all of its lower-level stages back to the modulator and video processor are kept separate from the DTV side. Likewise, the DTV side is kept separate from the NTSC signal. They are brought together only at the driver outputs through a 3dB coupler or hybrid combiner. Although half of the drive power is lost to the combiner reject load, this is a small price to pay for the resulting signal integrity. System details, such as input filters, circulators and correction circuits, are not shown for clarity.

Using a TH-680 or TH-563 tetrode in common amplification has the following advantages for the n+1 situation:

- It is not necessary to use a channel combiner, nor is it necessary to have a separate aural transmitter.
- Split drivers allow for generating the cleanest possible drive for the HPA.
- A single transmission line and antenna may be used for both broadcast channels.
- At a future date, the NTSC side may be turned off and its driver used to work with the DTV side to come to full DTV power.

Using a common amplification Diacrode or tetrode approach to solve the n+1 problem has these following disadvantages:

- If the HPA fails, the power output of both signals is reduced to the drive level in HPA bypass mode.
- The tube is not perfect and some additional intermodulation distortion products are introduced because of the presence of the added DTV signal. With a clean drive, it all happens in the tube, but these products are quite low in power and easily dealt with.

Test results

The following data represents test results acquired as of Nov. 21, 1997. Although not every idea has been exploited to date, the results indicate that the common amplification approach ACT works well.

The major equipment used for these tests included:

- An Acrodyne Au60D 60kW 10% aural NTSC transmitter on Channel 27 for NTSC and Channel 28 for DTV.
- A Zenith version 2 8-VSB modulator with *FIR* filter linear correction and supporting linear correction software. Non-linear correction software is not available as of yet.

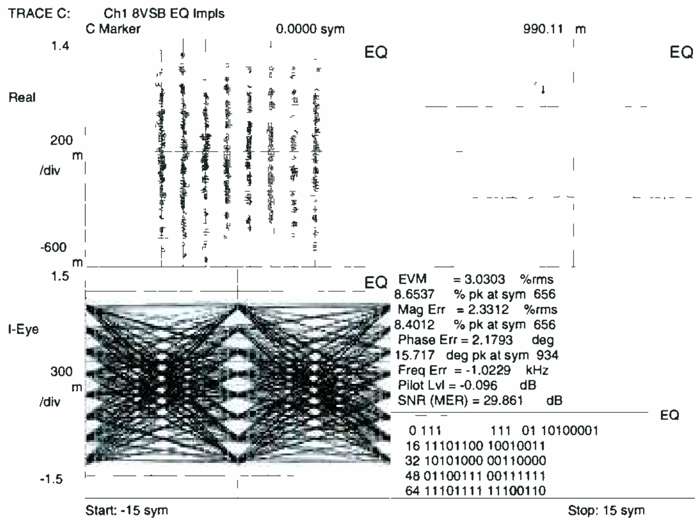

Figure 2. With the NTSC side off, the DTV results out of the HPA are shown. Eye opening is good with an EVM of 3.03%. SNR is 29.861dB. Power output is 2.5kW average.

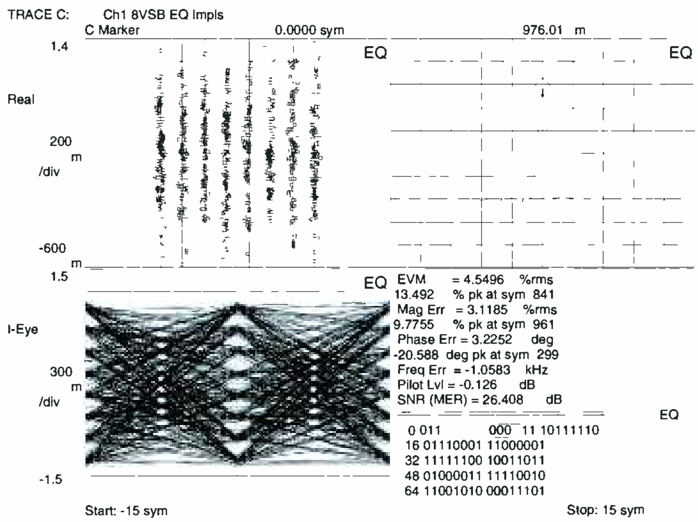

Figure 3. The NTSC side is turned on and brought to 25kW peak of sync with 2.5% aural power. DTV power remains at 2.5kW. Only slight degradation is seen in the EVM and SNR. The eyes are still widely open.

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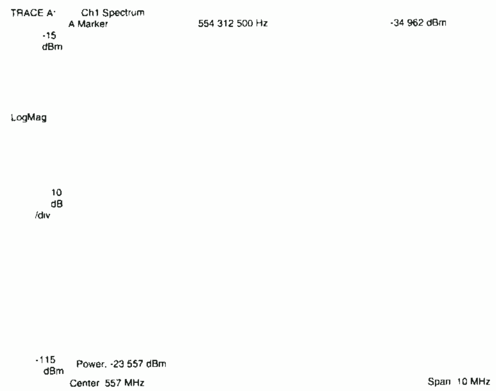

Figure 4. A spectral plot of the DTV signal with full NTSC (25kW) and 2.5% aural power is presented. Linear correction at the DTV modulator is on. The NTSC aural carrier is seen to the left of the DTV pilot with the color subcarrier at the extreme left.

- An HP-89441A vector modulation analyzer with adaptive equalizer.

Figure 2 represents the data as displayed on an HP-89441A for the driver output with the NTSC driver *off*. The important measurements to watch throughout this discussion are the *error vector magnitude* (EVM) and the signal-to-noise ratio (SNR), shown in the box at the lower right part of the display.

The EVM is a measure of all that is wrong with the transmitter because it indicates the relative magnitude of the vector at the tip of the desired one pushing it away from its intended position. The smaller this measurement, the less distortion of the DTV signal. Although SNR will be obvious to the reader, it's important because tests have shown that this number must be greater than 15dB at the receiving point for the signal to be decoded.

The eye opening is a qualitative measurement and it is shown that the eyes are widely open. The plot at the upper left shows the symbols lying generally on the eight I or in-phase levels. Departure from these levels is due to the error vector. Closing of the eyes is also a function of the EVM. It must be mentioned that the measured EVM and SNR for the modulator alone with the FIR correction off is 2.01% and 33.1dB, respectively.

Figure 3 shows the same results when the NTSC signal is on at 25kW peak of sync power with 2.5% aural power. DTV power remains at 2.5kW average. The EVM has increased slightly to 4.55%, while the SNR has decreased to 26.408dB. Eyes are still widely open.

The presence of the NTSC signal, even though the aural power is low, has only minimally affected the DTV signal. It must be remembered that for all of these tests, the FIR filter linear correction coefficients are determined by the HP-89441A and fed to the DTV modulator. Linear correction is on.

A spectral plot of the setup condition for Figure 3 is shown in Figure 4. The DTV pilot carrier is shown at the left edge of the upper channel, while the aural carrier is seen just below the pilot. At the extreme left is the NTSC color subcarrier. Closest to the DTV signal is the aural carrier. The high side band edge is awaiting a band edge filter from the vendor.

These results show the out-of-band performance of the Diacrode, without help. The flatness of the DTV spectrum shows the linear correction circuits of the DTV modulator at work. The cavity bandpass response has an upward tilt of 1dB toward the right side of the DTV channel. This is corrected by the linear correction of the FIR filter in the DTV modulator. The result is the flat DTV spectrum displayed.

A full two-channel spectral display is

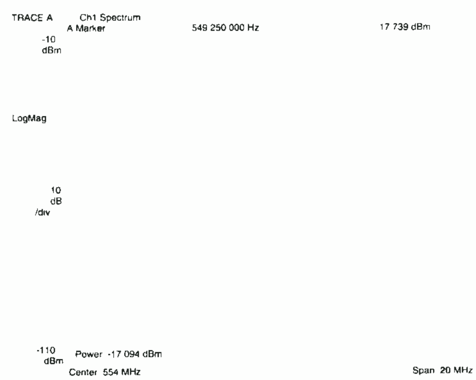

Figure 5. The spectral content of the two side-by-side channels with 25kW peak of sync power and 5% aural power on Channel 27 and 2.5kW of DTV power on Channel 28 is shown. The -4.5MHz and -3.58MHz components are easily taken care of with a conventional bandpass filter, while the upper DTV edge is fixed with a mask corrector circuit.

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shown in Figure 5, with the 25kW NTSC channel on 27 and the 2.5kW DTV signal on Channel 28. The -4.5 and -3.58 IMD components may be removed by a conventional bandpass filter, while the upper DTV channel edge will be suppressed by a mask corrector. Notice the close proximity of the DTV pilot and the aural carrier only 25kHz below the upper channel edge.

Figure. 6. The out-of-band intermodulation components at +9MHz and +8.08MHz, which lie under the DTV signal are responsible for the degrading EVM as aural power is increased. They are 31dB below the average power of the DTV signal.

Figure 6 shows the spectral output of the Diacrode operating at 25kW peak of sync with the DTV driver turned off. The +9 and +8.08MHz out-of-band intermodulation components, which lie underneath the DTV signal, are responsible for the decreasing EVM with increased aural power. The peaks of the +9MHz component is only 31dB below the average power of the DTV signal. These out-of-band components are easily taken care of with an anti-intermodulation component adjusted for best cancellation. The cancellation circuit under development is a modification of the +/-920kHz cancellation circuit in extensive field application. It will allow the EVM and SNR values to return to 3+% and 29+dB, respectively.

Conclusions and further work

This work shows common amplification of an NTSC and DTV signal at meaningful broadcast power levels may be accomplished using a TH-680 Diacrode for adjacent n+1 or n-1 situations. The secret is in knowing the PEP limits of the tube and the ability to tune a Diacrode (or tetrode) cavity wide enough to accommodate both signals.

This means that when station engineers are searching for RF solutions to an n+1 or n-1 configuration, the common amplification method presented should be considered. It is the only viable solution unless you have unlimited tower space and site resources. If common amplification works for combining aural and visual, why shouldn't it work for combining NTSC with DTV? The answer is that it does. ■

Dr. Timothy P. Hulick, Ph.D., is vice president of engineering, Acrodyne Industries, Blue Bell, PA. For more information on ACT, contact the company's web site at www.acrodyne.com or circle reader service number 180.

Field Report

Color my world

BY GARY FREEDLINE

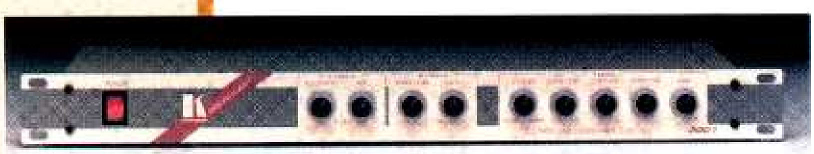
Until recently, only extremely expensive ($4,000 and up) component color correctors existed. For broadcast stations purchasing $70,000 BVW Betacam SP machines, these expensive add-on color correctors were already part of the budget. The introduction of the PVW and UVW series of Betacam SP decks and camcorders allowed budget-restrained production companies to enter the Betacam SP market. However, by running component, hue control was lost.

If the picture was green, it stayed green. If it was too red, it remained red. It was uncertain how hues could be adjusted when normal hue controls or subcarrier phasing controls wouldn't do the trick.

A component color corrector was needed between the Betacam SP decks and a switcher. Unlike composite devices, where the chroma signals are recorded together, component devices record and playback in a three-wire configuration. The Y (luminance), R-Y (red minus luminance) and the B-Y (blue minus luminance) are all recorded independently. There is no easy, one-knob control to adjust the hue or subcarrier phasing. A device that controls the Y, R-Y and B-Y levels independently is called a component color corrector.

At a glance

- Three looping component video inputs
- Nine outputs, three for each component
- Full-color control of component video signals
- Can also serve as component distribution amplifier
- Screen splitter for all channels



Color correctors can cost approximately half as much as a UVW 1600 machine. However, we could not justify spending thousands of dollars just to correct colors. At NAB '97, we discovered that Kramer Electronics was shipping a low-cost component color corrector, the 3001 component video processor.

It has a Y input, R-Y input and B-Y input, with individual unprocessed looping for each. The outputs are well-designed and incorporate a distribution center accommodating three independent outputs per color channel. In addition, the front

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panel has a variety of controls for processing independent signals, while all the inputs and outputs are in the rear of the unit. All of these features come in a unit that is only one rack space in height.

Although the documentation is sparse, the device is simple to use. There are gain and black level controls for the B-Y, R-Y and Y channels independently

The Y channel has an additional contrast and definition control. There's a front-panel splitter control that performs split screening, which allows comparison of the original picture to the processed signal. Once in the process mode, signal phase can be adjusted.

The R-Y and B-Y signals can also be adjusted via gain control and black level controls, maintaining level ratios. The Y signal can be adjusted to the correct IRE level. Another useful Y signal item is the definition control. In the middle position, the picture is processed normally. A counterclockwise rotation of this control allows the image to become soft or defocused and a clockwise rotation sharpens the image. Even though there was noise associated with sharpness control, it didn't negatively affect any products.

To create an image that looks like it was shot on film, adjust the contrast and definition controls. The definition control can sharpen a soft-focus camera shot and closely match the look of multiple cameras. An ideal situation for Kramer's 3001 component video processor is in a non-linear environment. By placing the 3001 between the source machine and the non-linear input, color correction can be done in real-time, before it is recorded on the hard drive.

This saves countless hours of color correction from software filters that need to be applied and rendered, especially when applying other effects to the clip. The 3001 can also be used to apply special-effect color filters and to detail clips in real-time before digitizing, thus cutting color-filter rendering time completely out of the non-linear process. The picture quality was clear with minimal signal loss in either the processed or unprocessed modes. ■

Gary Freedline is a director and editor at Virtual Studios in North Miami.

Technology In Transition

Wireless microphones

There's no doubt about it, audio equipment used for studio and field production is getting lighter and more compact. This advancement in equipment portability without sacrificing audio quality has created a steady acceptance of wireless microphones.

Wireless systems were fraught with complexity, dropouts and noise. For years, the complaint about wireless mic systems was interference, or unwanted signal reception caused by poor receiver selectivity or intermodulation distortion.

Manufacturer's have, for the most part, solved these problems. The solution was to move up in frequency. Higher radio frequencies mean shorter wavelengths, which mean smaller components and better filtering. Another solution was the development of diversity receiving circuits to address signal dropout.

Replacing an old system or adding a system where one didn't exist should be approached carefully. If you are adding a system in an area already congested with RF signals, check with the local frequency coordinator to determine which frequencies are available. When buying a system determine whether you need a hidden system or want to plug in a transmitter to a microphone. A hidden system usually relies on a lavaliere, in-the-ear or headset microphone and a bodypack transmitter. Receivers can be mounted in racks, on cameras or set on desks, depending on the length of use.

Diversity reception is one area that needs a lot of consideration. There isn't enough space to cover this area, however, refer to the following back issues for a discussion of diversity and wireless microphones:

"Unraveling the Mysteries of Wireless Mic Operation," 7/97; "Understanding Wireless Microphones," 10/96; "Wireless Microphones in the Studio," 5/95; "Solving Wireless Microphone Interference Problems," 9/94; "Using Wireless Microphones," and "Diversity Reception for Wireless Microphones," 1/93.

See summarized details of microphone features in Table 1 on page 138.

Special features

Azden:
Audio distortion of less than 0.1%@15k deviation; dynamic range of better than 100dB; an operating range of 100m under ideal conditions

Sennheiser:
Frequency range of 450-960MHz; switching bandwidth of 24 MHz; HiDyn Plus noise reduction system

Shure:
797 fully selectable, user-programmable frequencies; up to 20 systems can be used simultaneously; all Shure UHF components are interchangeable

Vega:
Microprocessor-controlled; 100 channel synthesis; controlled by embedded microprocessor

Telex:
Tone squelch

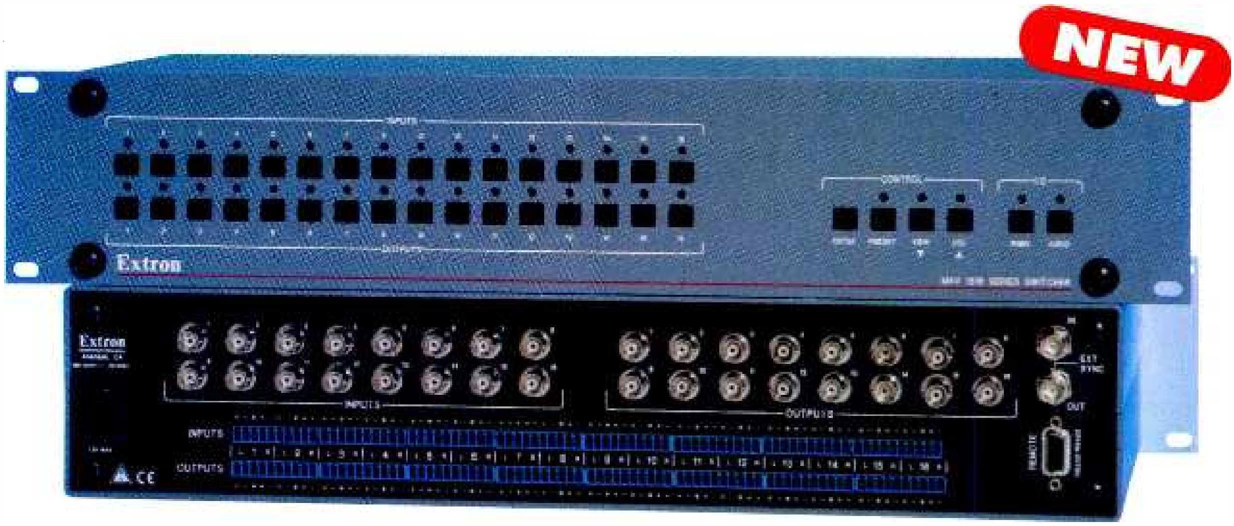
Systems Wireless:
UDR200B features PC control for selecting frequencies, monitoring system operation and performing spectrum analysis; can operate any one of 256 available frequencies; systems operate in UHF band 470-608 and 614-806

AKG Acoustics:
Multiple frequency bands available; simultaneous operation of up to 11 frequencies in WMS60; 16 in WMS300; and 40 in WMS800/900; in WMS800/900 two receiver sections provide true receiver diversity

Lectrosonic:
User-adjustable low-frequency roll-off; dual-band compandor; fit microphones with XLR jacks

COMTEK:
Switchable EQ circuit; dual-tracking preselector front end; helical resonator for front-end RF selectivity

Make the Switch



More 16 x 16 Solutions

Extron introduces the new MAV 1616 series matrix switchers. There are three switchers in this series: the MAV 1616 (matrix for audio and video); the MCV 1616 (matrix for composite video only); and the MSA 1616 (matrix for stereo audio only). Each of these models is capable of switching up to sixteen independent video and/or stereo audio sources to sixteen independent outputs.

All of the high performance features come standard. The MAV 1616s not only fit your large-scale matrix switching needs, they fit your budget: MAV 1616 $5,850; MSA 1616 $3,250; MCV 1616 $2,750.

The MAV 1616 series switchers provide:

- 16 x 16 configurations
- 80 MHz (-3 dB) video bandwidth, fully loaded
- Audio gain/attenuation settings for each input from the front panel (MSA 1616, MAV 1616)
- Stereo audio is standard and included in one 2U high enclosure (MSA 1616, MAV 1616)
- 16 memory presets
- Simple Instruction Set™ with basic ASCII commands for RS-232/422 controls
- Vertical interval switching
- QuickSwitch Front Panel Control™
- Internal 100-240 volt, 50/60 Hz power supply
- Windows® based control program software

Extron Electronics

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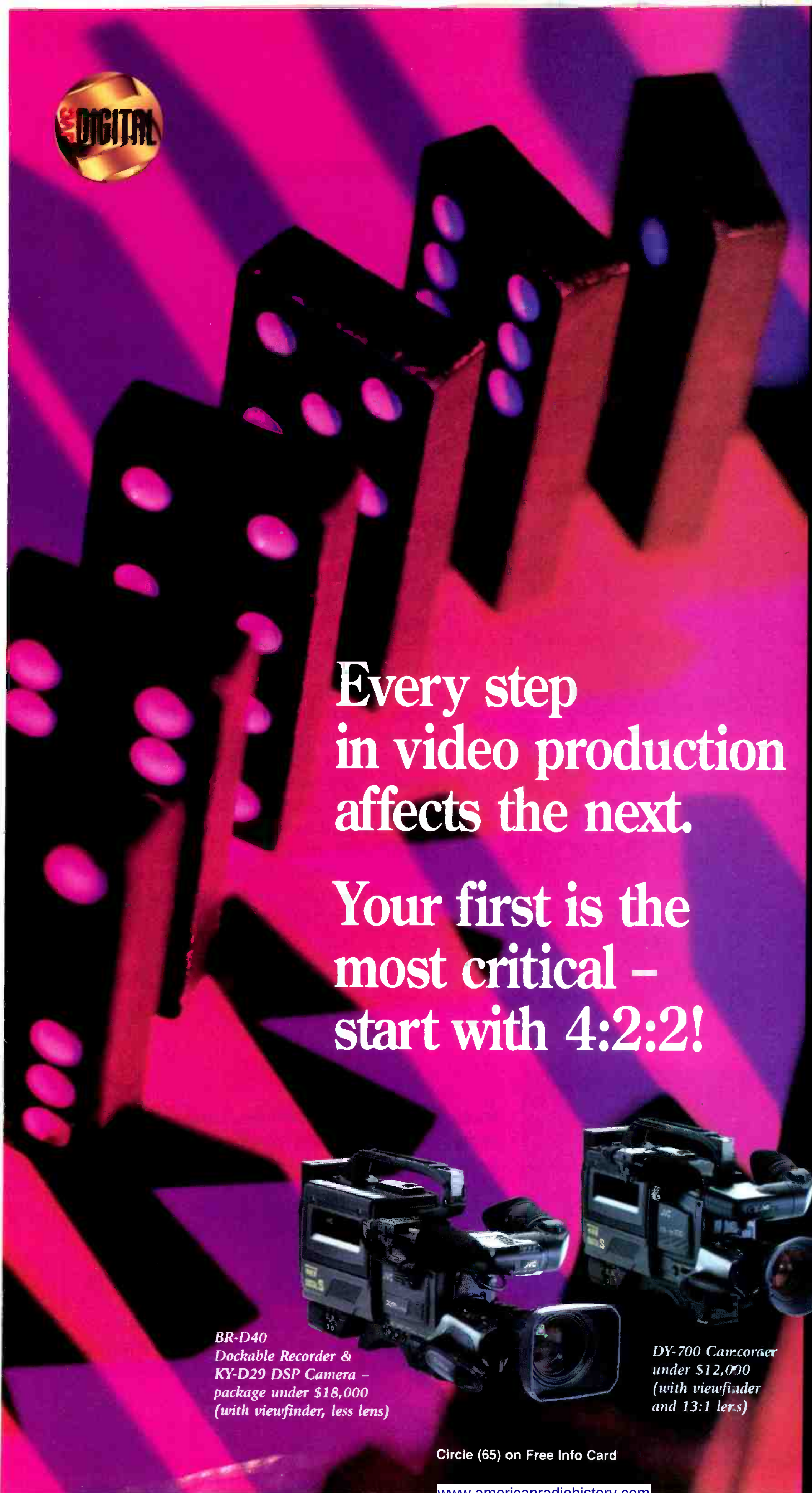
COMPANY	OPERATING BAND	CASE TYPE	TYPE OF DIVERSITY	TRANSMITTER OUTPUT	FREQUENCY POWER CONTROL	RS #
Azden (516-328-7500)						
411 systems	UHF	-	true diversity	10-15mW	PLL controlled	290
Sennheiser (860-434-9190)						
EM1046	UHF	multichannel receiver	true diversity	-	PLL controlled	291
EM3032	UHF	2-channel	true diversity	-	PLL controlled	292
EK4015	UHF	miniature receiver	true diversity	-	PLL controlled/ 32 switchable freqs.	293
SKM 3072-u	UHF	hand-held	-	50mW	PLL controlled	294
SKM 5000	UHF/VHF	hand-held	-	50mW	PLL controlled	295
5K50	UHF/VHF	bodypack transmitter	-	50mW	PLL controlled/ 16-channels	296
SK250	UHF	bodypack, transmitter	-	250mW	PLL controlled/ 16 channels	297
SHURE (708-866-2200)						
U14S/83 - 98	UHF	bodypack	-	-	-	298
U14S/16	UHF	bodypack	-	-	-	299
U14S58/87	UHF	hand-held	-	-	-	300
U14S/beta58/87	UHF	hand-held	-	-	-	301
Vega (800-877-1771)						
R-672	UHF	studio receiver	true diversity	-	synthesized	302
T-772	UHF	bodypack	-	50mW	synthesized	303
T-690 family	UHF	hand-held	-	50mW	synthesized	304
U2020 family	UHF	receiver, bodypack, hand-helds	true diversity	40-50mW	synthesized	305
Telex (612-884-4051)						
ENG-500/	UHF	portable	posi-phase	50mW	2 channel	306
ut-500		receiver & plug-in transmitter			crystal	307
USR-100L	UHF	lapel system	posi-phase	10/1 select.	100 channels	308
USR-100H	UHF	hand-held system	posi-phase	10/1 select.	100 channels	309
Systems Wireless (703-471-7887)						
UDR200B	UHF	receiver	true diversity	-	-	310
UT200	UHF	hand-held	-	-	-	311
UM200B	UHF	bodypack	-	-	-	312
UH200	UHF	plug-in transmitter	-	-	-	313
UCR200D	UHF	compact receiver	-	-	-	314
AKG Acoustics (615-360-0499)						
WMS60	VHF	hand-held, bodypack	antenna diversity	10mW	freq. agile	315
WMS300	UHF	hand-held, bodypack	true diversity	10mW	freq. agile	316
WMS800/900	UHF	metal construction, hand-held, bodypack	true diversity	10mW	freq. agile	317
Lectrosonics, Inc. (800-821-1121)						
UM200B/250b	UHF	beltpack	-	100/250mW	synthesized 256 freqs.	318
UCR200D	UHF	machined	antenna phase/switching	-	synthesized 256 freqs.	319
UH200	UHF	plug-in	-	100mW	synthesized 256 freqs.	320
UM195B	UHF	beltpack	-	70mW	crystal	321
UH195	UHF	plug-in	-	70mW	crystal, wide deviation	322
UCR195D/195	UHF	machined	antenna phase/ single antenna design	-	crystal	323
UM190B	UHF	beltpack	-	70mW	crystal	324
UH190	UHF	plug-in	-	70mW	crystal, narrowband	325
UCR190	UHF	machined	single antenna design	-	crystal, narrowband	326
COMTEK (800-496-3463)						
BST-25	VHF	metal	-	50mW	crystal	327
M-72	VHF	bodypack	-	50mW	crystal	328
PR-25	VHF	bodypack	-	-	syn. agile, crystal	329
MRC-82C	VHF	camera-mount	-	-	crystal	330
MR-182	VHF	base type	-	50mW	crystal	331
M-182	VHF	hand-held	-	50mW	crystal	332
Beyerdynamic (516-293-3200)						
V200/300	VHF	bodypack, hand-held	true diversity	50mW	freq. agile	333
U400/500/600	UHF	bodypack, hand-held	true diversity	50mW	freq. agile	334

Table 1. Summarized details of microphone features — (-) indicates missing information or that the category is not applicable. To receive more information, use the Reader Service Numbers shown in column 7.



BR-D40 Dockable Recorder & KY-D29 DSP Camera – package under $18,000 (with viewfinder, less lens)

DY-700 Camcorder under $12,000 (with viewfinder and 13:1 lens)

DIGITAL-S Acquisition

To get the most out of today's digital editing systems, you need to begin with the best raw footage possible. And that means shooting in 4:2:2. With DIGITAL-S, you get 4:2:2 color sampling with perceptually lossless compression. This produces an image that remains free of annoying artifacts that could build up through various steps in post production and digital distribution.

DIGITAL-S also offers superior chroma resolution, producing more well-defined colors, chroma keys and effects. In fact, all high-end systems, including the best non-linear editors, require 4:2:2 to achieve these benefits. The result is performance and quality that can stand up through each phase of digital video production. Shooting in a 4:1:1 DV format compromises your image, and you can't bring back the quality once it's lost.

COMPONENT DIGITAL
4:2:2

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www.jvcpro.com

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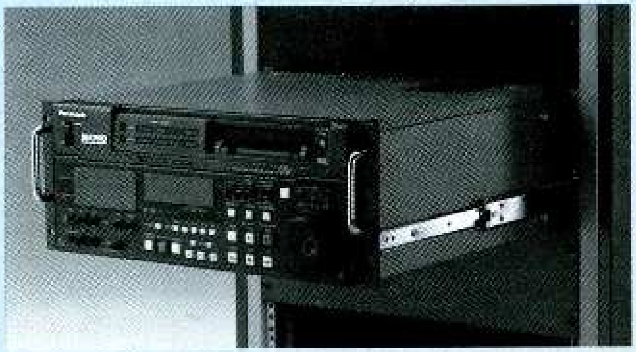
SERIAL DIGITAL INTERFACE OPTION FOR VIDEO MEASUREMENT SET

Tektronix VM700T video measurement set with serial digital interface (SDI) option: the VM700T video measurement set is a highly accurate, multiformat serial digital video analyzer; the SDI option is a comprehensive and affordable upgrade for professional video manufacturers and terrestrial broadcast engineers that are beginning the transition to full-bandwidth digital applications while still requiring precise analog testing; 503-627-7111; fax 413-448-8033. www.tek.com

Circle (273) on Free Info Card



DVCPRO RACK-SLIDE KIT

Winsted rack slide kit model F8203: this kit is the latest addition to Winsted's line of rack slide kits designed specifically for Panasonic, JVC and Sony VTRs (the line also includes models for Vicon and Barco monitors); model F8203 features heavy-duty chassis support brackets, Accuride ball-bearing slides for smooth pulling action, and pivoting rear finger brackets to allow mounting in sloping, vertical racks; 612-944-9090; racks@winsted.com

Circle (274) on Free Info Card

DIGITAL CAMERA SYSTEM

Thomson Broadcast's 1657D camera system: based on the portable 1657D, the Thomson Broadcast camera system provides many different configurations, such as Microcam and Sportcam; the 1657D is a digital camera with 12-bit quantization combined with intermediate processing stages of up to 20 bits providing the type of contrast ratio only previously available in film; it accepts a full range of accessories, including triax and multicore adapters, Betacam SP and Betacam SX recorders; other standard features include the switchable 16:9-4:3, dynamic pixel correction, video noise slicer, sensors, and shutter and clear scan; 201-569-1650; fax 201-569-1511

Circle (272) on Free Info Card

ONE- AND TWO-LINE VIDEO DISPLAY

Matthey Electronics 2550 broadcast-quality delay: the 2550 broadcast-quality video delay was designed for applications where one line or more of analog video delay is required; the 2550A delays the video signal and compensates for errors, such as large timing errors that can occur when new production equipment is installed; the Matthey 2550 has a fully variable range of two microseconds up to one or two lines, with two 75V outputs — NTSC or PAL; the 2550A also provides front-panel toggle switching of the delay range in 1ns steps; internal processing and Matthey filtering expertise to full CCIR-601 recommendation optimize all standard video measurements; 914-763-8893; fax 914-763-9158

Circle (275) on Free Info Card

Circle (66) on Free Info Card

HIGH-SPEED DATA TRANSMISSION OVER RING NETWORKS

ADC Telecommunications Fast EtherRing switch: ADC's first product based on its new EtherRing technology that enables data to be transmitted over fiber rings for the first time in native Ethernet format; the Fast EtherRing switch allows high-speed, high-capacity transport of data, Internet Protocol (IP) video and IP voice over telephony and MPEG digital video over fiber-optic rings of virtually unlimited distances; it initially uses a dedicated fiber or works in conjunction with ADC's DV6000 high-speed digital transport system; 800-366-3891 (ext. 3475); www.adc.com

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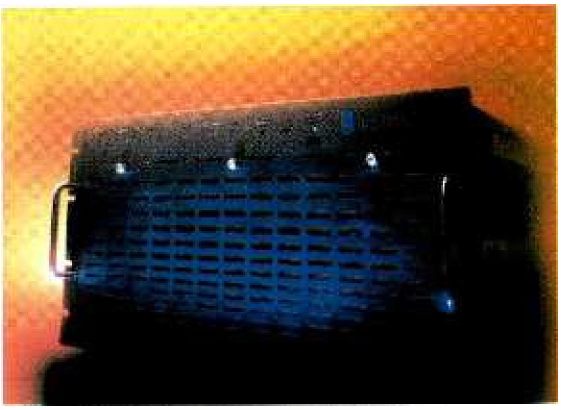

INTERFACE FOR BROADCAST MEDIACLUSTER AND OMNIBUS SYSTEMS

SeaChange International and OmniBus Systems broadcast development effort: SeaChange is developing an interface between its Broadcast MediaCluster video server and OmniBus Systems' broadcast network operation system; the interface will allow the Broadcast MediaCluster to be efficiently used in TV transmission systems that have selected OmniBus Systems as their broadcast vendor; OmniBus is a real-time network operating system that enables distributed control of a wide range of broadcast TV equipment from simple intuitive user interfaces; 508-897-0100; fax 508-897-0132

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PRODUCTS NOW SHIPPING

SADIE OWNERS CAN ADD PORTIA RANDOM ACCESS VIDEO

SADiE Portia NTSC: Portia, a random access video system, eliminates the need for a VTR during sound-for-picture processes by providing instant access to the visual elements; with the release of V3.03 software, all Portia functionality is now available in NTSC video format; when Portia is installed into a SADiE or Octavia DAW, video can be recorded into the EDL along with the audio; the video appears as a dedicated stream in the playlist, and audio and video can be scrubbed simultaneously; editing functions such as cut, copy and paste, can be performed on the video clips, as well as placement of the original recorded time code; 615-327-1140; fax 615-327-1699

Circle (287) on Free Info Card

ADVANCED VERSION OF EMULATOR OPERATING SYSTEM

E-mu Systems EOS 3.0: the latest version of E-mu software developed specifically for the Emulator 4 line of products is now available; EOS 3.0 has several new features, including 48-track sequencer with loop record and performance control features such as arpeggiator, split mode and layer mode; the advanced version also offers new modulation sources and destinations; EOS 3.0 ships with Emagic's EOS SoundDiver, a preset editor that is designed for EOS products; 408-438-1921; fax 408-438-8612; www.emu.com

Circle (288) on Free Info Card

INTEGRATION OF SEAGATE'S STORAGE TECHNOLOGY WITH ANDATACO'S APPLICATION-SPECIFIC ARCHITECTURE

Andataco GigaRAID Application-Specific Architecture (ASA) product line shipping with Seagate Technology's 10,000 RPM 9GB Cheetah disk drives: combining Seagate's advanced storage technology with Andataco's application-specific architecture (ASA) allows you to match the attributes of specific data structures to receive maximum levels of performance, availability and scalability in heterogeneous UNIX and NT computer environments; Andataco's GigaRAID high availability series offers extensive RAID and RAID-ready storage for ASA-targeted applications; new products in the series include Ultra SCSI and Fibre Channel solutions, as well as advanced new data sharing, remote mirroring and disaster recovery software that will soon be released; 800-335-9191; fax 619-453-9294; www.andataco.com; inquire@andataco.com

Circle (289) on Free Info Card

WIDE-POWER LENS

Fujinon A10X4.8B-10: this wide cine-style lens features a 90° horizontal field of view in the 16:9 format and over 85° in the 4:3 format with less than 1% distortion at a wide angle; it has a two-foot MOD that is measured from the object plane, unlike other TV production lenses that traditionally have measured MOD from the lens front; other benefits include a newly designed inner focusing system that reduces image size change to a minimum when focusing, zoom and focus gearing that accommodates most cine-style controls, and large orange numerals for focal length and "T" stop that are visible from both sides of the lens; 800-553-6611; fax 201-533-5216

Circle (259) on Free Info Card

MINI-M SAT PHONES FOR VEHICLES

LandSea Systems Mini-Ms: LandSea Systems is offering the latest of Thrane & Thrane's satellite communications products, the TT-3062A and TT-3062B INMARSAT phones for vehicles; both phones use spot beam technology allowing them to be more compact and use less power than their predecessors; the TT-3062A vehicular Mini-M Satphone uses a rod antenna and is fully omnidirectional; the TT-3062B model uses a stabilized disc antenna that uses steered beam technology and its internal components constantly move to locate the satellite as the vehicle moves; both antennas can be mounted to vehicles magnetically; 757-468-0448; fax 757-468-0625; www.LandSeaSystems.com

Circle (253) on Free Info Card

QUIET SWITCH AES ROUTER

Leitch ASR-16x16: this router includes the new synchronous quiet switch (SQS) process that guarantees quiet switching of AES digital audio; the SQS provides two processing steps — synchronous switching and user-selectable crossfade; the synchronous switching maintains AES framing during and after crosspoint switches, so that the downstream equipment does not lose lock during a switch; the crossfade guarantees a quiet switch between any two sources by fading the two signals near the switch point; the fade duration is user adjustable and the fade can be enabled or disabled; 800-231-9673; fax 757-548-4088

Circle (255) on Free Info Card

HDTV DIGITAL WAVEFORM MONITOR

Leader LV 5150D: a monitoring unit that handles serial digital and analog components for HDTV signals in the 1125/60 (59.94) format; it provides full waveform monitoring functions including line select, cursors and memory presets of test setups; picture display of the Y or G component, with a line select strobe provided; the unit offers a vector display of chroma component, as well as a Lissajous display for stereo audio; 800-645-5104 or 516-231-6900

Circle (254) on Free Info Card

PRODUCTS NOW SHIPPING

EDIT MPEG-2 FILES DIRECTLY

Applied Digital Technology ADnet MPEG editing station: Greenway Ltd. announced the release of the ADnet MPEG editing station from Applied Digital Technology that allows you to edit MPEG-2 files directly; it provides frame-accurate editing of first-generation MPEG-2 files, and in the edit mode, beginning and end points can be marked to create an EDL in the same manner that videotape is edited; edits can be previewed and modified and the final EDL, in industry-standard format, can be exported for further editing; this release allows simple cuts and dissolves, with additional functions scheduled for implementation later this year; +44 1635 528700; rcrosoer@greenway.co.uk

Circle (281) on Free Info Card

NEW VERSION OF ARGUS MPEG-2 ENCODING SYSTEM

Vela Research's Argus 3.0: now shipping, this Windows NT-based MPEG-2 encoder system is designed for a broad range of applications that need broadcast-quality digital video; the Argus 3.0 is a full-featured MPEG encoder on the Windows NT platform; new features include variable bit-rate encoding, caching FTP, improved API and inverse telecine; available as a rack-mount or desktop configuration, it creates streams at MPEG-1, SIF, MPEG-2 Half D-1, MPEG-2 D-1 (DOE) and MPEG-2 D-1 (AFF) resolutions; 813-572-1230; fax 813-573-2508; www.vela.com

Circle (282) on Free Info Card

WIDESCREEN CAMCORDER

Sony DNW-9WS: this widescreen digital Betacam SX camcorder is shipping to news operations migrating to widescreen digital TV production; it uses a new, high-performance widescreen Power HAD IT CCD designed specifically for ENG environments; the DNW-9WS offers superb video and audio acquisition, direct digital recording according to MPEG 4:2:2 P@ML, high-speed field-to-station transmission, networking within a nonlinear disk-based system; with the ability to switch between 16:9 and 4:3, the 13-pound camcorder features an extraordinary sensitivity capable of making full level in-scene illumination of only 0.7 lux (new Turbo Gain function); 800-686-SONY; www.sony.com/professional

Circle (283) on Free Info Card

DELAY CANCELLOR

Avocet Instruments delay cancellor: this product eliminates delayed audio or echoes of remote audio from the off-air return heard at remote sites; unlike the mix-minus systems that require a dedicated return path to the remote site, the delay cancellor allows the remote talent to use the air feed as their return audio from the station; a special DSP program compares audio that is transmitted to the studio with audio that is being received at the remote site via the on-air signal, satellite line or microwave path; the delay cancellor will compensate and correct for transmission delays of up to 800ms; 800-443-0728; fax 503-671-9626; www.avocetinst.com

Circle (265) on Free Info Card

DIGITAL CONSOLE

Studer D950 digital mixing system: featuring a fully scalable and configurable central DSP core, the D950 allows you to configure exactly the right console design for a given application; up to four control surfaces can share a single DSP core for maximum flexibility in multiroom installations; the maximum DSP configuration (20 hot-swappable DSP cards) allows for as many as 256 fully-featured channels, while a 40-channel console can be provided with as few as three or four cards; the console is controlled from a central PC-compatible system running on Microsoft Windows NT; 615-399-2199; fax 615-367-9046

Circle (262) on Free Info Card

TEST SOLUTION FOR DIGITAL TV TRANSMISSION STANDARD

Hewlett-Packard HP 89441V VSB/QAM signal analyzer: this analyzer tests 8VSB TV signals providing comprehensive radio frequency (RF) and modulation test capabilities in addition to powerful trouble-shooting features; it provides a visual display of VSB constellation and eye diagrams, allowing TV system designers to identify design errors quickly; TV broadcasters can conduct reliable transmission power-level measurements and generate accurate statistical measurements for peak-to-average power; this instrument also provides a statistical percentage of the time transmission power that exceeds a user-specified level; 800-452-4844 (ext. 5522); www.hp.com/go/tmdir

Circle (260) on Free Info Card

REAL-TIME VIDEO EDITING

Pinnacle Systems Reel-Time: a dual-stream desktop video capture card with on-board real-time special effects; ReelTime supports dual audio and video stream playback, and data rates as high as 13.4Mb/s (per stream) for lossless M-JPEG compression; with its dual-stream engine, ReelTime eliminates the performance limitations imposed by conventional video capture products, enabling Adobe Premiere to operate render-free in real-time editing; ReelTime allows for the playback and scrub of three tracks, including titles and keying at a lower cost; 650-526-1000; www.pinnaclesys.com

Circle (258) on Free Info Card

The GALLERY

PRODUCTS NOW SHIPPING

HIGH-PERFORMANCE STORAGE DRIVES

Avid's iS Pro Series: this powerful line of storage drives includes 9G and 18GB storage drives in a 3.5-inch format; ideal for digital video and audio applications, the iS9 Pro and the iS18 Pro are available in fixed and removable formats and offer increased performance, reliability and investment protection; these ultraSCSI drives are designed to work with Avid's MediaDock removable storage systems and in Avid MediaDrive fixed storage devices; using iS18 Pro drives in a fully loaded MediaDock (eight drives) allows storage of 140GB of digital media; 978-640-6789; fax 978-640-1366; www.avid.com

Circle (284) on Free Info Card

NEXT-GENERATION NEWSROOM COMPUTER SYSTEM

Avid's AvidNews Newsroom Computer System: the first component of AvidNews newsroom and control system, the AvidNews Newsroom Computer System, is now available; it streamlines news production with tools that enable text, video and audio management on your desktop; built on three core systems — AvidNews Newsroom Computer system, Media System and Broadcast Control System — AvidNews allows you to access and share video, scripts and rundowns; 800-949-AVID; www.avid.com

Circle (285) on Free Info Card

NT VERSION OF ITS IMAGING CONTROL PANEL SOFTWARE

Miranda Windows NT version of ITS ICP-S remote-control software: the Windows NT version of its ICP-S software control panel is now shipping; the Imaging Control Panel (ICP) software allows you to remotely control and monitor Miranda's line of digital encoders, decoders, converters, frame syncs and more from a software environment; ICP-S offers three menu levels that allow you to continuously monitor the status and control of all Imaging family modules connected to a particular workstation via a given RS-422 daisy chain; 514-333-1772; fax 514-333-9828; www.miranda.com

Circle (286) on Free Info Card

PROFESSIONAL MULTICHANNEL DECODER

Tandberg TT1100: a state-of-the-art, cost-effective multichannel IRD that simultaneously decodes one to six video channels in one unit; major CA systems are implemented, and the TT1100 receives and transcodes components of a digital TV signal into the preferred format; it transcodes to PAL/NTSC and offers MPEG-2/DVB conformance and interoperability; other features include closed captioning (NTSC), flexible conditional access handling, test signal (VITS) generation and automatic language selection for sound, subtitling and teletext; +47 67 11 62 00; fax +47 67 11 62 01; sales@tandbergtv.no

Circle (277) on Free Info Card

HDTV DIGITAL DISK RECORDER

Digital Video Systems' ProntoVision: new I/O features are now available on the ProntoVision HDTV disk recorder products; concurrent storage of virtually all interlaced and progressive HDTV and SDTV formats is provided in a single ProntoVision system; some of the enhancements include the ability to switch from HDTV to a multichannel SDTV server, record/play of the Panasonic HD360 compressed stream format and a frame doubler playout option that allows any material recorded in progressive-30 format to be played out in progressive-60 or interlace-60 formats; ProntoVision is compatible with all major edit controllers using the Sony RS-422 protocol and it easily emulates or replaces the traditional VTR in edit suite applications; 818-846-9444; fax 818-846-7444; www.digitalvideosystems.com

Circle (271) on Free Info Card

LARGE-CONFIGURATION MATRIX SWITCHERS

Extron Crosspoint 1616 series switchers: RGBS/RGBHV, 16x16 matrix switchers offer new options for large-scale routing; available in four models — 1616, 1616A, 1616HV and 1616HVA; each model has 16 memory presets and can switch S-Video and composite video for easy use with any large-screen projector and monitor currently available; when fully loaded, the switchers deliver 200MHz (-3dB) video bandwidth; the inputs and outputs are each isolated and buffered, allowing any single input or combination of inputs to be switched to any outputs with virtually no crosstalk; 714-491-1500; fax 714-491-1517; www.extron.com

Circle (266) on Free Info Card

The GALLERY

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Circle (77) on Free Info Card

Circle (76) on Free Info Card

Circle (80) on Free Info Card

Business

More than 14 Canon DIGI-SUPER 70 lenses were used in Superbowl XXXII. Canon's 70X zoom lens DIGI-SUPER 70 provides the longest telephoto and widest angle combination of any lens, and is engineered to incorporate internal focusing and IF+ technologies for long-range telephoto applications.

Already a fixture at sporting events, Canon's breakthrough DIGI-SUPER 70X lens is also gaining attention as a valuable tool in the entertainment business. Black Entertainment Network (BET), Washington, DC, purchased four Canon 70 lenses for use at entertainment productions, as well as sports events. Because the DIGI-SUPER 70 provides extremely high performance without regard to object distance, the cameras can be placed in the back of a concert hall or large theater and still get good close-ups, without obstructing the audience's view. At BET, the 70X lens has been able to get tighter shots from a greater distance, than they normally get with a 45X lens that is closer to the object.

Cinetel Studios, Knoxville, TN, installed an AMS Neve 24-fader Libra fully automated digital music console. The console will help in Cinetel's production of programming for networks, such as Home & Garden, The History Channel, A&E and The Nashville Network. The installation represents the final stage of a facility-wide upgrade to digital.

AMS Neve 24-fader Libra digital music console.

The Associated Press was awarded the contract for the new newsroom computer system at CBS-owned, KUTV-TV in Salt Lake City. KUTV-TV uses NewsCenter on 35 workstations to manage all areas of its news operations, including program management and timing, on-air control, prompting, captioning and assignment planning.

Boston University's College of Communication also awarded a contract for its newsroom computer system to The Associated Press. It will use NewsCenter on more than 40 workstations for production of local cable newscasts and for classroom training. Since its introduction, more than 160 stations, networks, cable programmers and broadcast bureaus have chosen AP's NewsCenter.

An Hitachi camera in use at the Daytona 500.

Hitachi announced that four of the CBS mobile trucks sent to Nagano, Japan for production of the 1998 Winter Olympics were equipped with Hitachi cameras. Three expandable units with a total of 18 SKF-710s, nine SKF-3s and three SKF-300 cameras were used to cover the games. This was the third time the expandable units (MU1, MU11, MU12) were used to cover the Winter Olympics and the units were also used at the Daytona 500.

Acrodyne Industries was awarded a contract to manufacture and install an adjacent-channel technology (ACT) transmitter at KBLR-TV, Las Vegas. The ACT transmitter enables KBLR to operate two channels, NTSC Channel 39 and DTV Channel 38, through a single transmitter, transmission line and antenna.

In related news, Acrodyne was awarded contracts by Pappas Telecasting Companies to manufacture and install Diacrode-equipped UHF transmitters at WSWS-TV in Opelika, AL, and Channel 63 in Merced, CA.

Panasonic announced that Warner Bros. will invest in high-definition recording systems from Panasonic Broadcast for high-resolution film-to-tape transfers of its movies. The initial purchase will be for two Panasonic AJ-HD2000 high-definition recording systems, but the station plans to buy several more over an 18-month period. Warner Bros. will standardize on Panasonic's D-5 format for high-resolution masters that will be used in creating products for DTV, NTSC and PAL delivery.

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QUICK DIAL 72

MILLER
Fluid Heads and Tripods

The silky, smooth action of each Miller Fluid Head is the product of the finest quality cast and machined parts functioning together in a fluid environment. They are engineering masterpieces, built to operate under extreme conditions. They're engineered to exceptionally fine tolerances and their mechanisms are protected effectively against ambient moisture and dust.

Miller 20 -Series II Fluid Head

- Dynamic fluid drag control
- Sliding/quick release camera platform
- Weighs 4 lbs. – handles up to 22 lbs.
- Counterbalance system compensates for nose heavy or tail heavy camera configurations and permits fingertip control of the camera throughout the tilt range
- Includes independent pan and tilt locks, bubble level, dual pan handle carriers and integrated 75mm ball levelling

Miller 25-Series II Fluid Head

- 100mm ball level fluid head • Robust, lightweight, low profile design
- Quick release camera platform • Weighs 7lbs –handles up to 25 lbs
- Multi-step fluid drag system and integrated counterbalance system provide ultra-smooth repeatable pan-and-tilt fluid control and finger-tip camer balance for ENG camcorders, industrial CCD cameras or small studio cameras

#601-Lightweight Tripod

- Weighs 4.5 lbs., supports up to 30 lbs
- Minimum height down to 24", maximum height to 57"
- Extremely portable, folds down to 33"
- Engineered from thermoplastic moldings, diecast alloy and hard anodized tubular alloy
- Fast, one turn, captive leg locks
- Includes 75mm (3") ball levelling bowl

#649-2-Stage Tripod

- Two extension sections on each leg. Operates at low levels as well as normal heights without the use of mini legs
- High torsional rigidity, no pan backlash
- Weighs 6.6lbs., supports 50 lbs • Very portable, folds to 27"
- Includes 75mm (3") ball levelling bowl

System 20 #338—Miller 20 Head, 601 Lightweight Tripod, On Ground Spreader
System 20 ENG #339—Miller 20 Head, 649 2-Stage Aluminum, On Ground Spreader
System 25 #500—Miller 25 Head, 611 Lightweight Tripod, On Ground Spreader
System 25 ENG #502—Miller 25 Head, 641 2-Stage Aluminum, On Ground Spreader

Vinten
Vision SD 12
Pan and Tilt Head with Serial Drag

The Vision SD 12 head features "Serial Drag" pan and tilt system. System consists of a unique, permanently-sealed fluid drag and an advanced lubricated friction drag. You achieve the smoothest pans and tilts regardless of speed, drag setting and ambient temperature.

- Patented spring-assisted counter-balance system permits perfect "hands-off" camera balance over full 180° of tilt.
- Instant drag system breakaway and recovery overcome inertia and friction for excellent "whip pans"
- Consistent drag levels in both pan and tilt axis.
- Flick on, flick off pan and tilt caliper disc brakes
- Greater control, precision, flexibility and "touch"
- Touch activated, time delayed illuminated level bubble
- Working conditions from as low as -40° up to +60°C.
- SD 12 weighs 6.6 lbs and supports up to 35 lbs.

Vision Two Stage ENG and LT Carbon Fibre ENG Tripods

The ultimate in lightweight and innovative tripods, they are available with durable tubular alloy (Model #3513) or the stronger and lighter, axially & spirally wound carbon fiber construction (Model #3523). They incorporate torque safe clamps to provide fast, safe & self-adjusting leg clamps

- "Torque Safe" requires no adjustment. Its unique design adjusts itself when required, eliminating manual adjustment and maintenance and making for a much more reliable clamping system.
- New hip joint eliminates play and adds rigidity
- They both feature 100mm levelling bowl, fold down to a compact 28", and support 45 lbs.
- #3513 weighs 6.5 lbs • #3523 CF (Carbon Fibre) weighs 5.2 lbs.

Vision 12 Systems

Vision 12 systems include #3364-3 SD 12 dual fluid & lubricated friction drag pan/tilt head, single telescoping pan bar & clamp with 100mm ball base.

SD-12A System
- SD-12 pan and tilt head
- 3518-3 Single stage ENG tripod with 100mm bowl
- 3363-3 Lightweight calibrated floor spreader

SD-12D System
- SD-12 pan and tilt head
- 3513-3 Two-stage ENG tripod with 100mm bowl
- 3314-3 Heavy-duty calibrated floor spreader

VIN-5ST and VIN-10ST

- Compact & lightweight, they maintain Vision performance and quality.
- Provide total stability and durability with payloads up to 33 lbs
- Ideal for the latest generation of dockable and one-piece camcorders.
- Compatible with all Vision accessories

VIN-5ST includes Vision 5LF head, single stage toggle clamp tripod, spreader and soft case.
VIN-10ST includes Vision 10LF head, single stage toggle clamp tripod, spreader and soft case.

QUICK DIAL 74

Canon
IF+ Series 1/2-inch & 2/3-inch Zoom Lenses

Canon's IF+ family of lenses are engineered to meet the needs of the next generation of broadcasting while meeting the standards of today. Besides having the widest wide angle lens available, the IF+ lens series have wider angles at shorter M.O.D. (Minimum Object Distance), provide higher MTF performance and incorporate Hi-UD glass for reduced chromatic aberration. In addition to superb optics they're all designed with Canon's "Ergonomic Grip" for fatigue-free shooting over an extended time. IF+ lenses are your assurance of unsurpassed quality and performance for today and tomorrow.

J15ax8B

A next generation internal focusing lens with the shortest MOD and widest angle of any standard lens, the J15aX8B IRS/IAS is a standard ENG lens that lets you shoot in tight or restricted areas at the closest minimum object distance ever possible and capture more of the subject. It incorporates all the great features of IF+lenses including a built-in 2X extender, high MTF performance, Hi-UD glass, square lens hood and Canon's "Ergonomic Grip".

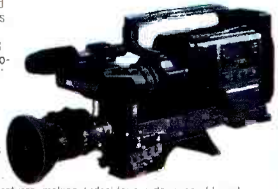
J20ax8B IRS/IAS

Excellent for ENG, sports and production, the J20aX8B IRS/IAS lets you squeeze in shots from 8mm and still take you all the way out to 320mm with its built-in extender. Incorporates all IF+ features, plus is the only lens (besides the J9aX5.2B IRS/IAS) with aVari-Polar lens hood, enabling rotation of attached filters.

JVC GY-X2B 3-CCD S-VHS Camcorder

- Newly designed three 1/2" CCD image sensors deliver 750 lines of horizontal resolution and superb signal-to-noise ratio of 62dB
- Micro-lens technology provides exceptional sensitivity of F8.0 at 2000 lux and LDLUX mode lets you shoot with almost no light! Shoot superb footage with excellent color balance at a mere 1.5 lux
- Variable Scan allows flicker-free shooting of a computer screen
- Full Time Auto White circuit lets you move from incandescent to fluorescent to outdoor lighting without changing white balance or the filter wheel
- Quick Record Mode - when turned on the camera is set to the auto iris even if lens is set at manual. Also activates Automatic Level Control and Extended Electronic Iris which provides both variable gain and variable shutter. Shoot continuously from dark room to bright outdoors without having to adjust gain, iris or ND filter.
- Dual output system allows camera output to be connected directly to an external recorder

KY-D29 3-CCD Color Video Camera



One of the most sensitive cameras ever developed, the KY-D29 sets the standard for 3-CCD cameras and is also ideally suited for today's digital recording formats. With a sensitivity F11 at 2,000 lux, the KY-D29 can shoot in light as low as a remarkable D.35 lux. It also offers a signal-to-noise ratio of 65 dB (with its DNR function on), and delivers 850 lines of horizontal resolution. The exceptional resolution and sensitivity of the KY-D29 are achieved by three new 760,000 pixel 2/3" interline transfer (IT) CCDs, the highest pixel count in the industry.

All-New Digital Signal Processing
- Advanced 14-bit Digital Signal Processing (DSP) and 3-dimensional Digital Noise Reduction (3D DNR) circuitry make this camera ideal for acquisition with todays popular digital formats, especially JVC's revolutionary new Digital-S.
- DSP within the camera provides astonishingly crisp, high-quality images, while minimizing analog distortions and noise. DSP also makes the camera more flexible and easy to use. It even smooths the transitions between gain and white balance settings so that viewers won't notice sudden changes of settings while the tape is rolling
- Digital signal processing is enhanced with new 3D digital noise reduction circuitry to make it even more practical. By mixing multiple frames to cancel out random noise, then using motion detection to minimize lag, JVC's exclusive 3-D DNR produces dramatic results, far superior to any other DSP camera.

Super LoLux for Extremely Low Light Shooting
- Incredible new Super LoLux technology allows you to obtain a broadcast-quality picture in light as low as 0.35 lux. This extraordinary low light capability is the best ever achieved, and is made possible by utilizing JVC's exclusive LoLux dual pixel readout technology (increasing gain by 6 dB without introducing noise) while at the same time doubling the pixel readout integration time to 1/30 second.

Versatile Docking Capability
- Extremely high quality 4:2:2 digital recordings can be made by docking the KY-D29 to JVC's Digital-S BR-D40 dockable recorder. This digital combo produces recordings far superior to any component analog camcorder or 4:1:1 digital camcorder. The KY-D29 also docks directly to JVC's BR-DV10 DV-format and BR-S422 S-VHS dockable recorders andcan dock to Betacam SP recorders using an adapter.

Features for a Wide Range of Applications
- The KY-D29 is loaded with a wealth of high-performance features, making it ideal for a wide range of broad cast and professional applications. Built-in continuous auto black (CAB) continuously takes a black balance setting, and full-time auto white for continuous compensation of color temperature changes, balance the camera in real time all the time. This allows you to concentrate on getting the shot, and not on adjusting the camera.
- Because different shooting situations require flexibility, the KY-D29 offers selectable vertical resolution. In the Standard Mode, the camera produces 380 TV lines of vertical resolution. However, in the "V-Plus" high vertical resolution mode, the camera puts out 420 TV lines of vertical resolution, allowing you to increase vertical resolution without sacrificing sensitivity or lag, while maintaining 850 TV lines of horizontal resolution.
- Focusing is easier than ever with Accu-Focus. By momentarily decreasing depth of field, fast & critical focus is achieved instantly.
- Commonly used features can be activated without having to scroll through layers of menus. Features such as shutter control, variable scan, black stretch, black compress, CAB, iris modes, Accu-Focus, DNR and zebra are all menu-free. And for those times when events move so fast it prevents you from making any settings whatsoever, the KY-D29's Full Auto Shooting (FAS) mode controls all of the camera's requiring you control only the focus, zoom and trigger.
- Other camera features include a built-in time/date, built-in zebra level selection switch, an f-stop display in the viewfinder, and a "battery remaining" display for Anton Bauer battery packs. A special Black Stretch/Black Compression circuit is also included.

Panasonic
Broadcast & Television Systems

$500 Rebate thru 12-31-97

AG-DP800H SUPERCAM
S-VHS 3-CCD Digital Signal Processing Camcorder

- Three high-density 380,000 pixel CCDs with half-pitch pixel offset achieves 750 lines of horizontal resolution. S/N ratio of 60dB and sensitivity of f8 at 2000 lux. Additionally the Frame Interline Transfer (FIT) CCDs minimize vertical smear even in very bright illumination.
- Digital Signal Processing circuitry provides four valuable benefits
  1) Consistently reliable up-to-spec performance
  2) Fine adjustment of a wide range of parameters.
  3) Memory storage and instant recall of specific settings
  4) More flexible and higher quality image processing, easier maintenance
- Super High Gain mode allows shooting under illumination as low as 2 lux while retaining detail and color balance
- Synchro Scan function allows flicker-free shooting of computer monitors. Electronic shutter increments can be set variably from 1/61 seconds to 1/253 of a second
- Built-in internal time code generator lets you record with SMPTE LTC/VITC (Longitudinal/Vertical Interval) time code
- Two Hi-fi stereo audio channels with a dynamic range of 80 dB, as well as two linear audio channels with Dolby NR
- Has a 26-pin connector for convenient backup recordings using an additional VCR equipped with a 26 or 14-pin connector
- Phantom power can be supplied to an optional mic. Power can be switched off to prevent battery drain when not in use.

wDP-800H "LS" Package:
- DP-800H Supercam 3-CCD camera head with 1.5" electronic viewfinder and Anton Bauer Gold Mount battery plate
- Fujinon S14x7.5 BRM 14:1 servo zoom lens
- CC-S800 soft carrying case
- WV-QT700 tripod mounting plate

DP-800H "XL" Package:
- DP-800H Supercam 3-CCD camera head w/1.5" electronic viewfinder and Anton Bauer Gold Mount battery plate
- Fujinon S14x7.5 BRM 14:1 servo zoom lens
- CC-H800 Thermodyne hard shell carrying case
- WV-QT700 tripod mounting plate
- Two Anton Bauer Digital Trimpack 14 batteries
- Anton Bauer 2-position quick charger

QUICK DIAL 72

sachtler
VIDEO 14/100 FLUID HEAD

- Sachtler Touch and Go System
- Integrated sliding battery plate
- Strengthened dynamic counterbalance in 2 steps
- Frictionless leak proof fluid damping with three levels of drag
- Vibrationless vertical and horizontal brakes
- Built in bubble for horizontal leveling

HOT POD TRIPOD SERIES

Especially developed for use in ENG, the Hot Pod tripod is the fastest in the world. The central locking system is activated on all three legs at the same time, while the pneumatic center column easily makes it possible to have the lens at a height of over 7 feet. The elevation force of the center column is factory set and doesn't require any setup. When moving to another location it can be carried by its handle located at the center of gravity.

ENG TWO-STAGE TRIPOD SERIES

Sachtler two-stage tripods have an enlarged height range (lower bottom and higher top position) so they are more universal. Legs can be locked in seconds with Sachtler's quick clamping. There are also heavy duty versions for extra stability. The heavy duty aluminum has a 20mm diameter tube vs. 16mm and the heavy duty carbon fiber has a 24mm diameter tube vs. 22mm. All heavy duty two-stage tripods have a folding tripod handle.

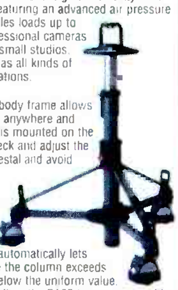
NEW! Sachtler CADDY systems

Now Sachtler quality is available to low budget users. The price of a CADDY system includes the new 7-step dampened CADDY fluid head, ultra-light but rugged carbon fiber tripod, lightweight spreader and either a soft bag or cover. The CADDY fluid head features an adjustable pan arm, 7 step adjustment for quick counter balance and the self-locking Sachtler Touch and Go System.

CAD 01 Single-Stage ENG Carbon Fiber System:
- CADDY Fluid Head • ENG Single-Stage Carbon Fiber Tripod
- SP 100 Lightweight Spreader • Transport Cover 100

CAD 2A 2-Stage ENG Carbon Fiber System:
- CADDY Fluid Head • ENG 2-Stage Carbon Fiber Tripod
- SP 100 Lightweight Spreader • Soft padded ENG Bag

Libec MATTHEWS
P100 Portable Pneumatic Pedestal



The P100 is a small size pedestal that offers great flexibility without taking up too much space. Featuring an advanced air pressure system, the P100 smoothly handles loads up to 66lbs., easily accomodating professional cameras used in a studio. Ideal for CATV small studios, event and wedding video as well as all kinds of industrial and institutional applications.

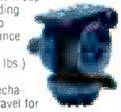
Air Pressure System:
- Air pump attached to the main body frame allows air to be pumped into a column anywhere and anytime – even while a camera is mounted on the pedestal. This allows you to check and adjust the air pressure while using the pedestal and avoid over-filling of air.
- Air pressure can be gradually adjusted by discharging air through a bleed valve when too much air has been pumped into the column. There is also a relief valve that automatically lets air out when air pressure inside the column exceeds the uniform value, bringing it below the uniform value.
- Large double wheel 5" casters allow the P100 to move smoothly and quickly. Wheels and caster axles are easily fixed by the double stopper system.
- A track lock mechanism locks the wheels of the pedestal so that it only moves in a desired position.
- Cable guards prevent the casters from rolling over and becoming tangled in camera cables when the tripod is moved around in a studio.
- Large steering wheel affords greater ease in handling when shifting columns up and down or when moving the pedestal.
- Maximum and minimum height is 31" to 61". By attaching the optional LA-100 Low Angle Adapter to the dolly for shooting at low angles (Height from the ground to mount is only 10").
- The column and dolly can be quickly disassembled for convenient transport. The column weighs 18 lbs. and the dolly 16 lbs.

H80 Professional Fluid Head

A premium fluid head, the H80 incorporates a patented drag control system that provides the smoothest pan and tilt available.

- Unlike conventional drag systems that have click stops at predetermined points, Libec's Continuous Drag Control System provides infinite control of drag tension allowing smooth, rapid movements as well as very slow movements.
- Continuous Counter Balance Control System provides optimum camera balance with tilt angles of + 90° or -90°
- Designed to withstand the most demanding environments, the H80 is fully operational even in temperatures as low as -22°F.
- H80 supports up to 37 lbs. and has a 100mm claw-ball to simplify camera leveling

H70 Professional Fluid Head



The H70's patented counter balance mechanism supports various operating configurations including stand-alone cameras, camcorders and studio cameras with large viewfinders. Perfect balance can be obtained with settings from 0 to 3, depending on camera weight (from 15 to 33 lbs.) and tilt angle

- Sliding balance plate features a locking mechanism and allow a total of 4" (100mm) of travel for camera balance. Has a 100mm claw ball.

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QUICK DIAL 74

NRG

POWER VEST SYSTEM

The Power Vest combines the comfort and convenience of a photo-journalist style vest with the power of NRG's high-est capacity power belt. Available in two styles, the **Field** model is designed for use in a field production environment, while the **Event** model is for shooting events where style is everything. The Field model is ruggedly constructed from black high density weatherized ballistic nylon and has an open-cut style that makes it comfortable to wear in a variety of climates. Also has a highly adjustable design to fit almost any physical proportion.

- Internal and external pockets for blank tapes and accessories, a clear insert window for a press pass or business card. D-rings for cables and microphones, and an integral padded camera rest on the right shoulder.
- Cleverly concealed inside the vest is your choice of 12-volt 86 watt hour or 13.2-volt 95 watt hour nicad cell packs.
- A control box on the front features dual power outputs (dual cig-arette, dual XLR or mixed).
- 7-stage "fuel-guage" charge status indication and auto-reset short/overload protection.

The Event model is very similiar to the **Field** except in place of rugged fabric and pockets it features shoulder to sternum black satin tux fabric. Worn under a suit coat, the **Event** model is indis-tinguishable from a formal dress vest and it still retains interior and low exterior pockets. Both vests include 300-series charger (12 hrs.) and can be used with the optional Intelliquick Fast Charger (2 hrs.)

POWER CAN SERIES

For powering single or multiple pieces of 12v DC equipment for extended periods of time, nothing beats the power and convenience of NRG's Power-Can Series. It integrates an ultra-high capacity, high-discharge-capable UPS type lead acid power cell, a world-wide fast charger, and computer-con-trolled monitoring system with display—in a single, rugged package. Connect up to four pieces of equipment simultaneously. From a midnight emergency scene to a wedding reception in the park, the Power-Can delivers ample power for extended running time.

- Recharge in 8-10 hours by simply plugging the Power-Can into any source of AC power (90-250v AC)
- LCD display shows discharge/charge status, voltage etc.
- An optional "Power Dolly" allows the Power-Can to be rolled for easy transport.
- Available in 18, 28 and 40 amp versions, each Power-Can has either four cigarette lighter connectors, four 4-pin XLR connec-tors or two of each.

HORITA

BSG-50

Blackburst/Sync/Tone Generator

The BSG-50 provides an economical means for generating the most common RS-170A video timing signals used to operate vari-ous video switchers, effects generators, TBCs, VCRs, cameras and video edit controllers.

- 6 BNC video/pulse outputs
- Now available, 6 blackburst, 4 sync, 2 subcarrier
- Each sync output individually settable for composite sync, com-posite blanking, H-drive, or V-drive.
- Separate buffer for each output–maximum signal isolation
- 1KHz, 0dB sinewave audio tone output, locked to video
- Outputs can easily be configured to meet specific user and equipment needs. **$269**

CSG-50

Color Bar/Sync/ Tone Generator

- Generates full/SMPTE color bars, blackburst and composite sync signals
- Built-in timer can automatically switch video out-put from color bars to color black after 30 or 60 seconds. Easy and convenient for producing tape leaders and striping tapes with color bars and black
- Front panel selection of full-field or SMPTE color bar patterns or colorblack (blackburst) video output
- Includes crystal-controlled, 1KHz, 0dB audio tone output
- Outputs: video, sync, ref frame, 1 KHz, 0dB
- Audio tone switches to silence and color bars change to black when using 30/60 second timer
- Fully RS-170A SC/H phased and always correct. No adjustment required. **$349**

WE STOCK THE FULL LINE OF HORITA PRODUCTS INCLUDING:

WG-50 -	Window Dub Inserter
TG-50 -	Generator/Inserter
TRG-50 -	Generator/Inserter/Search Speed Reader
TRG-50PC -	Has all of the above plus RS-232 control.
VG-50 -	VITC Generator, LTC-VITC Translator
VLT-50 -	VITC-To-LTC Translator
VLT-50PC -	VITC-To-LTC Translator / RS-232 Control
RLT-50 -	Hi8 (EVO-9800/9850)TC to LTC Translator
TSG-50 -	NTSC Test Signal Generator
SCT-50 -	Serial Control Titler "Industrial" CG, Time-Date Stamp, Time Code Captioning
SAG-50 -	Safe Area, Convergence Pattern and Oscilloscope Line Trigger and Generator

QUICK DIAL 72

GLIDECAM INDUSTRIES

V-16 AND V-20

Professional Camera Stabilization Systems

The GLIDECAM V-16 and V-20 Camera Stabilization Systems allow you to walk, run, go up and down stairs, shoot from moving vehicles and travel over uneven terrain without any camera instability or shake. Designed primarily for professional video and 16mm motion picture cam-eras, the Glidecam V-16 stabilizes cameras weighing from 10 to 20 pounds and the V-20 from 15 to 26 pounds. They are both perfect for shooting the type of ultra-smooth tracking shots that take your audience's and client's breath away—instantly adding high production value to every scene. With either of the "V" series stabilizers you'll be able to offer the type of profes-sional shooting techniques that were previously available only to clients with full budgets. Whether you are shooting commercials, industrials, documentaries, music videos, news, or full length motion pictures, the Glidecam "V" series will take you where few others have traveled.

The Glidecam Support Vest

The lightweight and comfortable Support Vest can be adjusted to fit a wide range of operators. High endurance, closed cell, EVA foam padding and integral T6 aluminum alloy create a vest which can hold and evenly distribute the weight of the Glidecam V-16 and V-20 msys-tem across the operator's shoulders, back, and hips. For safety, quick release, high impact buckles allow the vest to be removed quickly.

The Three Axis Gimble

A free floating, precision Gimble incorporating Integrally Shielded Bearings creates the super-smooth and pivotal connections between the front end of the Dyna-Elastic Arm and the Camera Mounting Assembly. The Three Axis Gimble provides the operator with finger tip control over fluid tilting, panning and rolling. A locking mechanism allows the Gimble to be placed at varying positions on the Central Support Post. Moving the Gimble effec-tively adjusts the Systems Center of Gravity. The upper portion of the Sled's central support post includes guide markings. These markings allow for accurate gimble positioning.

The Dyna-Elastic Arm

The Exoskeletal, Dyna-Elastic Support Arm is designed to coun-teract the weight of the combined camera and Camera Mounting Assembly by employing high carbon alloy springs. The arm may be boomed up and down, as well as pivoted in and out, and side to side. It is the combined booming and pivoting action of the arm which creates the shock absorption necessary for ultra-smooth camera movement and mobility. The spring force is field adjustable to allow for varying camera weights. For safety, a Dual-Spring design is employed to reduce spring failure damage.

QUICK DIAL 74

lowel

ViP Video Lighting System

Designed for video, ViP systems provide 55 to 500 watt capabilities, powered by AC or DC. Mount one on-camera, on-stand, or hand hold it. Some ViPs feature adjustable beam angles. All are light weight and convention cooled.

V-light

Efficient enough to light a small room yet small enough to fit in a large pocket, the V-light provides a broad key light, back light or fill light (with umbrella or gel)

- Extreme wide-angle multi-use halogen source
- Mounts on stand, clamps, boom, wall, window, door-top
- 500 watt, AC powered (lamps not included)

i-light

Battery powered light provides excellent fill light, eye-light, or high-lights, with good contrast control for news and documentary shooting.

- Small and lightweight (18 oz.) for on camera use
- Multi-use 6:1 focusing range with i-100 lamp (lamps not included)
- 55 or 100 watt (12/14 volts DC)
- Includes cig. lighter connector or optional 4-pin XLR

Pro-light

Can be used as a low-level key or accent light, fill light (w/diffusion), backlight or background light.

- Multi-use halogen, focusing/tilting controlled with one hand
- 125 or 250 watt AC, 100 watt 12 volt, or 200 watt 30 volt DC
- Optional cigarette, 4-pin and 5-pin XLR connectors
- Lamps not included

Complete line of Lowel lights, lighting kits and accessories in stock...Call

Tota-Light

Provides a base or bounce light, backlight, or background light. Use it with an umbrella or gel frame with a diffusion kit. It is an ideal fill light or small soft key or illumination for copy work

- Multi-use halogen source with 360° no-yoke tilting
- Choice of 300, 500, 650, or 750 watt AC lamps (not included)
- Gull-wing reflectors close compactly for storage and travel

Omni-Light

Produces the ideal key or back-light, and with diffusion or an umbrella, it becomes a great soft fill source. With accessories, hand-hold the Omni, camera mount it, or choose from a wide variety of mounting systems

- Multi-use halogen source provides a non-crossover beam
- Choice of optional quick-change Super-Spot Reflector for exceptionally long throws at all voltages
- Choice of lamps: 420 or 500 watt 120v AC; 650 watt 220/240v AC; 250 watt 30 volt DC; 100 watt 12 volt DC (lamps not included)

DP System

Only 3.9 pounds the DP Light offers a very powerful key, backlight or background light with or without diffusion. When used with its umbrella or diffusion it provides a soft key, fill, or side light. It includes a #1 reflector for an 8:1 focusing range and a large cool-operating hand grip and knobs.

- Multi-use halogen source with 170° no-yoke tilting
- Choice of 500, 750, or 1000 watts 120 volts; 650 or 1000 watts 220/240 volts (Lamps not included)

anton bauer

Logic Series DIGITAL Gold Mount Batteries

The Logic Series DIGITAL batteries are acknowledged to be the most advanced in the recharge-able battery industry. In addition to the comprehensive sensors integral to all Logic Series batter-ies, each DIGITAL battery has a built-in microprocessor that communicates directly with Anton/Bauer InterActive chargers, creating significant new benchmarks for reliability, perfor-mance, and life. They also complete the communications network between battery, charger and camera. With the network in place, DIGITAL batteries deliver the feature most requested by cam-eramen: a reliable and accurate indication of remaining battery power.

DIGITAL PRO PACS

The ultimate professional video battery and recommended for all applications. The premium heavy duty Digital Pro Pac cell is designed to deliver long life and high performance even under high current loads and adverse conditions. It's size and weight creates perfect shoulder balance with all camcorders.

- **DIGITAL PRO PAC 14 LOGIC SERIES NICAD BATTERY** 14.4v 60 Watt Hours. 5 1/8 lbs. Run time: 2 hours @ 27 watts, 3 hrs. @ 18 watts
- **DIGITAL PRO PAC 13 LOGIC SERIES NICAD BATTERY** 13.2v 55 Watt Hours. 4 3/4 lbs. Run time: 2 hours @ 25 watts, 3 hours @ 17 watts

DIGITAL TRIMPAC

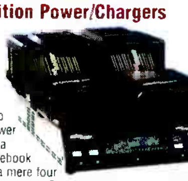
Extremely small and light weight, the Digital Trimpac still has more effective energy than two NP style slide-in batteries. High voltage design and Logic Series tech-nology eliminate the problems that cripple conventional 12 volt slide-in type batteries. The professional choice for applications drawing less than 24 watts.

- **DIGITAL TRIMPAC 14 LOGIC SERIES NICAD BATTERY** 14.4 v 43 Watt Hours. 2 3/4 lbs. Run time: 2 hours @ 20 watts, 3 hours @ 13 watts.

InterActive 2000 Power/Chargers

QUAD 2702/2401

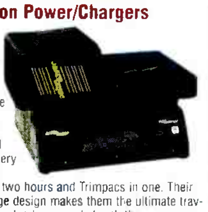
Four-Position Power/Chargers



The lightest (and slimmest) full featured four position chargers ever. They can fast charge four Gold Mount batteries and can be expanded to charge up to eight. They also offer power from any AC main: all in a package the size of a notebook computer and weighing a mere four lbs! The 40 watt 2401 can charge ProPacs in two hours and TrimPacs in one. Add the Diagnostic/ Discharge module and the QUAD 2401 becomes an all purpose power and test system. The 70 watt QUAD 2702 bundles all Power/Charger features in the ulti-mate professional power system.

Dual 2702/2401

Two-Position Power/Chargers



The DUAL 2701 (70 watt) and 2401 (40 watt) are sleek, rugged and economi-cal two position Power/Chargers that have all the features of InterActive 2000 technology including DC camera output and LCD display. The DUAL 2701 will charge any Gold Mount battery in one hour, the DUAL 2401 charges ProPac batteries in two hours and Trimpacs in one. Their compact, lightweight package design makes them the ultimate trav-el Power/Chargers. They can also be upgraded with the Diagnostic/Discharge Module and/or with the Expansion Charge Modules to charge up to six batteries of any type.

PROFESSIONAL VIDEO TAPES

QUICK DIAL 71

Fuji

Professional Grade VHS

PG-30	2.39	PG-60	2.59	PG-120	2.79

Superior Grade Double Coated VHS

SG-30	3.39	SG-60	3.99	SG-120	4.49

H471S S-VHS Double Coated

ST-30	6.99	ST-60	7.49	ST-120	7.99

M221 Hi 8 Double Coated

Metal Particles		Metal Evaporated	
P630HMP	4.99	E630HME	8.39
P660HMP	6.49	E660HME	10.49
P6120HMP	8.49	E6120HME	13.99

M321SP Metal Betacam (Box)

05S	17.95	10S	18.49	20S	19.95
30S	22.95	60L	31.95	90L	49.95

DP121 DVC PRO

12M (Med.)	8.29	23M	9.99	33M	12.99
63M	22.49	64L (Lg.)	23.99	94L	33.99
123L	43.99				

maxell

Hi8 Metal Particle (XRM)

P6-120 XRM	6.59

Broadcast Quality Hi8 Metal Particle

P6-30 HM BQ	5.39	P6-60 HM BQ	6.09
P6-120 HM BQ	7.99		

P/I PLUS VHS

T-30 Plus	1.69	T-60 Plus	1.99	T-90 Plus	2.09
T-120 Plus	2.19	T-160 Plus	2.69		

HGX-PLUS VHS (Box)

HGXT-60 Plus	2.69	HGXT-120 Plus	2.99
HGXT-160 Plus	3.99		

BQ Broadcast Quality VHS (Box)

T-30 BQ	5.49	T-60 BQ	6.19	T-120 BQ	7.39

BQ Professional S-VHS (In Box)

ST-31 BQ	7.19	ST-62 BQ	7.99
ST-126 BQ	8.39	ST-182 BQ	17.49

Betacam SP

B5MSP	15.75	B10MSP	17.75	B20MSP	19.75
B30MSP	20.75	B60MLSP	29.75	B90MLSP	46.45

Panasonic

Mini DV Tape

AY DVM-30	9.99	AY DVM-60	11.99

DVCPRO

AJ-P12M (Medium)	8.49	AJ-P23M	9.99
AJ-P33M	13.49	AJ-P63M	22.99
AJ-P64L (Large)	24.99	AJ-P94L	34.99
AJ-P123L	44.99		

SONY

Hi-8 Professional Metal Video Cassettes

P6-30 HMPX	4.59	P6-30 HMEX	7.99
P6-60 HMPX	6.59	P6-60 HMEX	11.49
P6-120HMPX	8.89	P6-120HMEX	15.49

Hi-8 Metal Evaporated Editor (HMEAD)

E6-30 HMEAD	10.49	E6-60 HMEAD	14.89
E6-120 HMEAD	20.19		

PR Series Professional Grade VHS

T-30PR	2.39	T-60PR	2.59	T-120PR	2.79

PM Series Premier Grade Professional VHS

T-30PM	3.49	T-60PM	3.99	T-120PM	4.79

BA Series Premier Hi-Grade Broadcast VHS (In Box)

T-30BA	3.59	T-60BA	3.99	T-120BA	4.79

MQ Master Quality S-VHS (In Box)

MQST-30	7.49	MQST-60	7.99	MQST-120	8.39

BRS 3/4" U-matic Broadcast Standard (In Box)

KCS-10 BRS (mini)	8.29	KCS-20 BRS (mini)	8.99
KCA-10 BRS	8.19	KCA-20 BRS	8.69
KCA-30 BRS	9.69	KCA-60 BRS	13.39

XBR 3/4" U-matic Broadcast Master (In Box)

KCS-10 XBR (mini)	8.79	KCS-20 XBR (mini)	10.19
KCA-10 XBR	9.29	KCA-20 XBR	10.69
KCA-30 XBR	11.99	KCA-60 XBR	15.69

KSP 3/4" U-matic SP Broadcast (In Box)

KSP-S10 (mini)	9.59	KSP-S20 (mini)	11.09
KSP-10	10.09	KSP-20	11.59
KSP-30	12.99	KSP-60	16.99

BCT Metal Betacam SP Broadcast Master (Box)

BCT-5M (small)	14.99	BCT-10M (small)	15.99		
BCT-20M (small)	17.99	BCT-30M (small)	18.99		
BCT-30ML	21.49	BCT-60ML	27.99	BCT-90ML	41.99

Mini DV Tape

DVM-30EXM w/Chip	15.99	DVM-60EXM w/Chip	19.95
DVM-30EX "No Chip"	12.99	DVM-60EX "No Chip"	14.99
DVM-30PR "No Chip"	9.99	DVM-60PR "No Chip"	12.99

Full Size DV Tape with Memory Chip

DV-120MEM	29.95	DV-180MEM	34.95

PVD Series Professional DVCAM Tape

PDVM-12ME (Mini)	24.95	PDVM-22ME (Mini)	26.95
PDVM-32ME (Mini)	29.95	PDVM-40ME (Mini)	31.95
PDV-64ME (Standard)	39.95	PDV-94ME (Standard)	44.95
PDV-124ME (Standard)	49.95	PDV-184ME (Standard)	59.95

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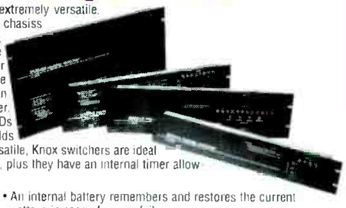
B&H
PHOTO - VIDEO - PRO AUDIO

QUICK DIAL 72

KNOX VIDEO

RS4x4/8x8/16x16/16x8/12x2

Video/Audio Matrix Routing Switchers



Knox's family of high performance, 3-channel routing switchers are extremely versatile, easy-to-use and very affordable. Housed in an ultra-thin rackmount chassis they accept and route (on the vertical interval) virtually any video signal, including off-the-air and non-timebase corrected video. They also route balanced or unbalanced stereo audio. The audio follows the video or you can route the audio separately (breakaway audio). Each of the switchers offers easy manual control via front panel operation. They can also be controlled remotely by a computer, a Knox RS Remote Controller, or by a Knox Remote Keypad via their RS-232 port. Front panel LEDs indicate the current routed pattern at all times, and an intenal battery holds and restores current apterns in case of power interruption. Totally versatile, Knox switchers are ideal for applications such as studio-feed control and switcher input control, plus they have an internal timer allow ing timed sequence of patterns for surveillance applications as well.

- Accept and routes virtually any one-volt NTSC or PAL video signal input—including off-the-air and non-timebase corrected—to any or all video outputs
- Accept and route two-volt mono or stereo unbalanced audio inputs to any or all audio outputs.
- Video and audio inputs can be routed independently (breakaway stereo audio), they don't need to have the same destination.
- Can store and recall preset cross-point patterns. (Not available on RS12x2.)
- Front panel key-pad operation allows easy manual operation.
- Can also be controlled via RS-232 interface with optional RS Remote Controller or Remote Keypad.
- Internal timer allows manual or automatic timed sequence of patterns —ideal for surveillance applications.
- Front panel LED indicators display the present routing patterns at all times.
- An internal battery remembers and restores the current pattern in case of power failure.
- Internal vertical interval switching firmware allows on-air switching.
- Housed in a thin profile rackmount 1" chassis.
- Also except the RS12x2 are available in S-Video versions with/without audio.
- Models RS16x8 and RS16x16 are also available in RGB/component version.
- With optional Remote Video Readout, the RS16x8 and RS16x16 can display active routes on a monitor at remote locations, via a composite signal from a BNC connector on the rear panel.
- The RS4x4, RS8x8 and RS16x16 are also available with balanced stereo audio. They operate at 660 ohms and handle the full range of balanced audio up to +4 dB with professional quick-connect, self-locking, bare-wire connectors.

NOVA SYSTEMS, INC.

StudioFrame

Modular Video Processing System

The Nova StudioFrame Series is a modular, flexible, digital/analog signal processing system. It is designed to efficiently and effectively combine a wide variety of individual function (or processor) boards such as A-D and D-A converters, video signal encoders and decoders, audio and video distribution amplifiers and frame synchronizers into more complex function groups, all in one equipment mainframe. The scalable nature of the StudioFrame design allows it to be easily reconfigured and/or upgraded as today's video standards and requirements continue to evolve. The system is based on two rackmount frame models (the SF-3 and SF-1) allowing up to thirteen front loading processor boards and thirteen rear mounted passive interface cards to be accommodated in a single chassis. Both the StudioFrame SF-1 and SF-3 chassis are designed to meet the most stringent broadcast requirements. The SF-3 is a thirteen slot, 3RU chassis while the SF-1 is a 4 slot, 1RU chassis. All studio cards as well as the two chassis' are backed by a two year warranty on parts and labor with guaranteed 24-hour turnaround service. The units are ruggedly constructed to endure studio rackmount, production van and OB (Outside Broadcast) mobile applications. A universal power supply operates at either 110 or 240 VAC, 50/60 cycle. DC operation is optionally available as is a redundant supply with automatic switchover. Dual exhaust fans maintain proper airflow and cooling. "Hot swappable" front card loading allows power-on removal/insertion of individual processing modules without disturbing others in the system. All cabling can remain in place while you service any module. An intelligent "centerplane" provides power, sync, timing and data distribution, facilitating expansion to more complex, more cost-effective signal processing functions.

NovaASD/NovaSDA

Analog to Serial Digital & Serial Digital to Analog Converters

Components of the Nova StudioFrame series, the NovaASD and the NovaSDA incorporate the latest digital video processing techniques for high speed A-D and D-A signal conversion. They are designed to meet the most stringent broadcast requirements and their "hot swappable" front card loading facilitates servicing without disturbing other cards in the system. The NovaASD is ideal for for interfacing analog signals with digital video formats and the NovaSDA for interfacing serial digital signals with

SDA-1 Serial Digital Component to Analog Component Converter
- SMPTE 259M 4:2:2: Serial Digital Component (D1) input,
- Equalized and reclocked serial digital component output
- Analog component video (Y, R-Y, B-Y/YUV), RGB or RGB/S outputs
- 10-bit D/A converters
- Output level control
- NTSC and PAL compatible

SDA-2 Serial Digital Component to Composite and S-Video Converter
- SMPTE 259M 4:2:2: Serial Digital Component (D1) input,
- Equalized and reclocked serial digital component output
- Dual composite & dual S-Video outputs
- Color bar output selectable
- 10-bit D/A converters
- Output level control
- NTSC and PAL compatible

SDA-3 Serial Digital Composite to Analog Video Converter
- SMPTE 259M Serial Digital Composite (D2,D3) input,
- Equalized and reclocked serial digital composite output
- Four analog composite video outputs
- Color bar output selectable • 10-bit D/A converters

ASD-1 Analog Component to Serial Digital Component Converter
- Analog component video (Y, R-Y, B-Y/YUV), RGB or RGB/S input
- Dual SMPTE 259M 4:2:2 Serial Digital Component (D1) outputs
- 10-bit D/A converters
- Picture positioning control
- NTSC and PAL compatible

ASD-2 Analog Composite and S-Video to Serial Digital Component Converter
- Analog composite and S-Video input
- Dual SMPTE 259M 4:2:2 Serial Digital Component (D1) outputs
- 10-bit D/A converters
- NTSC and PAL compatible

ASD-3 Analog Composite to Serial Digital Composite Converter
- Analog composite video input
- Dual SMPTE 259M 4:2:2 Serial Digital Composite (D2/D3) outputs
- 10-bit D/A converters
- Input gain adjustment

NovaMNR Median Noise Reducer

The NovaMNR is a StudioFrame card that eliminates impulse and transmission noise, cleans up satellite, microwave and fiber feeds and fills in CODEC and time-based corrected videotape drop-outs. It features full bandwidth, uncompressed 10-bit digital processing for ultimate video transparency as well as analog composite inputs and outputs.

- Eliminates "sparklies", those black and white dots that sometimes appear on remote video feeds. The NovaMNR incorporates a proprietary adaptive three-dimensional median filter that analyzes pixels from several fields of video and replaces the impulse noise with uncontaminated, clean video.
- Universal drop-out compensation replaces missing video information, whether it is from a time-base-corrected VCR source or the decoded output of a CODEC feed. The NovaMNR effectively fills in drop-outs with replacement video from the surrounding pixels and previous video field.
- Controls are accessible locally or remotely. A three position threshold switch (off/low/high) adjusts system noise sensitivity while a bypass/operate switch is also included. Both switches are remoteable via RJ-11 jack.
- Also available in PAL and PAL-M versions.

NC-8 RGB/Component to Composite/S-Video Encoder

- 10-bit processing, 8-bit D/A conversion
- Zero insertion delay, frame of memory
- Two composite and one S-video output
- Analog RGB (Sync on Green or all three), RGB/Sync and YUV (Betacam) inputs. Also available with looping inputs.
- Variable luminance notch filter
- Y and C pre-comb filtering for maximum encoding performance
- Remote serial control • Output level control
- Color bar output selectable
- Designed to meet the most stringent broadcast requirements.
- "Hot swappable" front card loading facilitates servicing without disturbing other cards.
- Available in PAL and PAL-M versions

VIDEONICS

PowerScript™

DIAL 74

Animated Postscript Character and Graphics Generator

The most advanced character generator ever designed for video production, multimedia and industrial applications, PowerScript delivers the huge range of titles and graphics supported by PostScript display technology, plus animation, effects, transparency and color keying. It features two GPI inputs, anti-aliased, 17.5 ns (nanosecond) pixel resolution and 4:2:2 broadcast-quality video. It also offers high-speed RISC processing to provide real-time Level 2 PostScript imaging and fast rendering—even with the most complex images. The PowerScript works stand-alone or with a computer, has a built-in TBC, offers a powerful and intuitive interface, and is suitable for the desktop or can be rackmounted.

Powerful Character Generator
- Choose from 35 built-in fonts or download PostScript fonts from your PC. PowerScript's high-speed RISC processor provides real-time PostScript imaging.
- Characters can be rotated at any angle, scaled to any size, stretched horizontally or vertically.
- Styles include variable bold and italic, underline and shadow (drop shadow, variable displacement and opacity). Each character can be adjusted separately.
- Text can be positioned anywhere on the screen or automatically centered, vertically or horizontally. Left, right, top, bottom and center justification is also provided.
- Characters are automatically kerned, using the font's standard kerning information. Spacing is highly flexible with variable word and letter spacing and line spacing (leading).

Intuitive User Interface
- Built-in real-time object-based drawing tool and text editor—no computer or software required. Design can be done ahead of time and displayed later, or can be done on the fly.
- Supplied keyboard and mouse are used with easy on-screen menus to place and modify graphics and text.
- Change fonts, colors, and other characters instantly.

Transparency and Colors
- Characters can be made transparent (0-100%) over video, other characters and graphics with 64 levels of transparency.
- Opaque characters can use over 4,000,000 colors, transparent characters can use over 8,000.
- Different colors can be used for fill and outline (variable width) as well as each letter and each graphic.

Roll, Scrawl, Animation, Effects
- Variable speed roll, crawl and push (slide) in all directions.
- Every text object, graphic and logo can be animated. Complex animations include having elements follow paths, bounce, etc.
- Elements can change outline and/or fill color, transparency, position as they move and results are displayed in real time.
- Move individual characters in different directions, make colors change; flash words; make letters and words bounce; spin a letter across the screen. Use fades and wipes to transition between titles and video or between two pages of titles.

Backgrounds and Graphics
- Titles can be placed on solid color, patterned or graduated backgrounds, or they can be genlocked to incoming video.
- Lines, squares, rectangles, ovals and circles can be created and placed anywhere on the screen. Each graphic object can use a different color, transparency, rotation, size, fill and outline.

Imported Logos and Graphics
- Accepts most PostScript or PCX format graphics without modification. Imported images can be any size and can be scaled, skewed, and rotated when placed on screen. Transparency and anti-aliasing can be defined when graphic is generated.

Expansion Capabilities

Although PowerScript operates on its own, you can still add peripherals and connect to a computer or network. Two PC-card slots allow the addition of non-volatile flash-RAM and Ethernet cards. RS-232 port allows connection to desktop computers for added storage and downloading of fonts or graphics from a PC.

QUICK DIAL 72

LEADER

Manufacturing test and measurement equipment for over 40 years, Leader Instruments is the standard which others are measured against for reliability, performance, and most important—cost effectiveness. Before a product is brought to market, an exceptional degree of energy and effort go into its design. Prototypes are built and tested to withstand environmental and other factors far exceeding actual operating conditions. These include high humidity, extremes of heat, cold, shock and vibration. Manufacturing quality is built in every step of the way and only the finest parts are used. At each production run, subassemblies are separately tested before they are integrated into the finished product, then each product is tested again. This is why less than half of 1% of all Leader products are ever returned for warranty repair or adjustment.

5860C WAVEFORM MONITOR

A two-input waveform monitor, the 5860C features 1H, 1V, 2H, 2V, 1 s/div and 2V mag time bases as well as vertical amplifier response choices of flat, IRE (low pass), chroma and DIF-STEP. The latter facilitates easy checks of luminance linearity using the staircase signal. A PIX MON output jack feeds observed (A or B) signals to a picture monitor, and the unit accepts an external sync reference. Built-in calibrator and on-off control of the DC restorer is also provided.

5850C VECTORSCOPE

The ideal companion for the 5860C Waveform Monitor, the 5850C adds simultaneous side-by-side waveform and vector monitoring. Featured is an electronically-generated vector scale that precludes the need for fussy centering adjustments and eases phase adjustments from relatively long viewing distances. Provision is made for selecting the phase reference from either A or B inputs or a separate external timing reference.

5100 4-Channel Component / Composite WAVEFORM

The 5100 handles three channels of component signals, plus a fourth channel for composite signals, in mixed component / composite facilities. Features are overlaid and parade waveform displays, component vector displays, and automatic bow-tie or "shark fin" displays for timing checks. Menu-driven options select format (525/60, 625/50, and 1125/60 HDTV), full line-select, vector calibration, preset front-panel setups and more. On-screen readout of scan rates, line-select, preset numbers, trigger source, cursor time and volts.

5100D Digital Waveform/Vectorscope

The 5100D can work in component digital as well as component analog facilities (and mixed operations). It provides comprehensive waveform, vector, timing and picture monitoring capabilities. Menu driven control functions extend familiar waveform observations into highly specialized areas and include local calibration control, the ability to show or blank SAV/EAV signals in both the waveform and picture, the ability to monitor digital signals in GBR or YCbCr form, line select (with an adjustable window), memory storage of test setups with the ability to provide on-screen labels, flexible cursor measurements, automatic 525/60 and 625/50 operation and much more.

5870 Waveform/Vectorscope w/SCH and Line Select

A two-channel Waveform/Vector monitor, the microprocessor-run 5870 permits overlaid waveform and vector displays, as well as overlaid A and B inputs for precision amplitude and timing/phase matching. Use of decoded R-Y allows relatively high-resolution DG and DP measurements. The 5870 adds a precision SCH measurement with on-screen numerical readout of error with an analog display of SCH error over field and line times. Full-raster line select is also featured with on-screen readout of selected lines, a strobe on the PIX MON output signal to highlight the selected line, and presets for up to nine lines for routine checks.

5872A Combination Waveform/Vectorscope

Models 5872A offers all the operating advantages of the 5870, except for the following: SCH is deleted from the 5872A (line select retained), making it ideal for satellite work.

5864A Waveform Monitor

A two-input waveform monitor that offers full monitoring facilities for cameras, VCRs and video transmission links. The 5864A offers front panel selection of A or B inputs, the choice of 2H or 2V display with sweep magnification, and flat frequency response or the insertion of an IRE filter. In addition, a switchable gain boost of X4 magnifies setup to 30 IRE units, and a dashed graticule line at 30 units on screen facilitates easy setting of master pedestal. Intensity and focus are fixed and automatic for optimum display. Supplied with an instruction manual and DC power cable.

5854 Vectorscope

A dual channel compact vectorscope, the 5854 provides precision checkout of camera encoders and camera balance, as well as the means for precise genlock adjustments for two or more video sources. Front panel controls choose between A and B inputs for display and between A and B for decoder reference. Gain is fixed or variable, with front panel controls for gain and phase adjustments. A gain boost of 5X facilitates precise camera balance adjustments in the field. Supplied with a DC power cable.

Designed for EFP and ENG (electronic field production and electronic news gathering) operations, they feature compact size, light weight and 12 V DC power operation. Thus full monitoring facilities can be carried into the field and powered from NP-1 batteries, battery belts and vehicle power. Careful thought has been given to the reduction of operating controls to facilitate the maximum in monitoring options with the operating simplicity demanded in field work.

CORPORATE ACCOUNTS WELCOME

Circle (69) on Free Info Card

Dielectric Communications signed an agreement with NBC for the purchase of DTV and NTSC TV station equipment. Under the agreement, Dielectric will be NBC's supplier for its current and future O & O TV stations nationwide. The agreement covers all passive RF components including, but not limited to, antennas, transmission lines, filters, combiners, switches and dehydrators.

Comark Digital Services (CDS) and the WGBH Educational Foundation are teaming up to develop strategies for the implementation of DTV. Comark and WGBH will develop plans for digital television, including HDTV, SDTV, multicasting and data broadcasting, as well as access services such as closed-captioning and descriptive video. WGBH plans to have a digital signal on the air by the end of 1998.

Avid Technology Inc. announced that FOX Television Stations, Inc. will incorporate its new AvidNews newsroom system in each of its 22-owned stations. The AvidNews newsroom system increases news production by streamlining all text processes. With the integration of Avid's newsroom computer system, Fox plans to have 200 seats installed by this June.

Avid also announced that WSB-TV, Atlanta's ABC affiliate, will also install AvidNews; the sale will involve the installation of 171 seats.

Sony announced that the Washington Redskins' home stadium, the Jack Kent Cooke Stadium, is now equipped with the TX-7 component triax system and DXC-D30 DSP cameras. Professional Products of Bethesda, MD, integrated and installed an advanced A/V system that is used to feed game action and crowd shots to the Sony JumboTron system during games and for the stadium's commercial and promotional video production. In addition to allowing for quick camera setup and multiple camera direction by a small crew, the triax system is designed for high-quality component video and extensive control of DSP functions.

More than 20 of its DV6000 Universal Digital Transport Systems from ADC Broadband Communications are being used by WorldCom in the United Kingdom. With the DV6000 system, TV stations no longer need an on-site truck to do post-production work, instead the signal is sent directly to the production studio to be edited and transmitted.

In an effort to consolidate regional operations, the WIC-Television Group in Alberta has chosen the Louth Automation ADC-100 to provide comprehensive solutions for automated satellite recording, program timing, media preparation and multichannel commercial and program playback. The two main centers, CICT Calgary and ITV Edmonton, originate the five signals. Calgary's CICT provides a second feed for CISA Lethbridge, while CITV in Edmonton provides a total of three on-air channels.

Hewlett-Packard installed eight HP MediaStream broadcast servers at the FOXTEL Management, Pty., Ltd. facility. Based in Sydney, Australia, the FOXTEL facility went operational with the new servers in October and presently is running more than 16 channels to air. The installation consists of seven HP MediaStream servers connected via a fiber channel network. Each server delivers one input channel and five output channels and will accommodate up to 15 hours of spot and promotional insertion material.

People

Dr. Yeshwant Kamath was appointed president of Videonics, Campbell, CA, and will serve on the board of directors.

Inscriber Technology, Ontario, Canada, has appointed Hugh Smyser as director of U.S. operations. Smyser will be responsible for strengthening the U.S. dealer network, expanding U.S. marketing and support systems and leading all operations in the U.S. marketplace.

Dan Ambauen was promoted to Harmonic Lightwaves' director of sales for the Western United States, Sunnyvale, CA. Ambauen will oversee the sales team responsible for servicing Harmonic's customers west of the Mississippi River.

Tan Yee Tiang was named director of operations and engineering at Asia Broadcast Center, New York.

Telemetrics, New York, has appointed James D. Wolfe to the position of sales director for the company's lines of camera control and robotics systems.

Romolo Magarelli has been named president and chief science officer of the Everetz Corporation, Burlington, Ontario, Canada. Everetz also announced Douglas A. DeBruin as chief financial officer and Alan Plaunt as technical director.

Harris Broadcast division, Richmond, IN, announced that Chuck Maines has added the role of radio and TV audio advisor to his other duties.

Rajnish Babbar has been appointed program manager, network management for the Broadband Communications Division, Meriden, CT.

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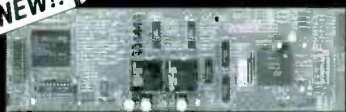

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EOM

When is an organization not an .org?

BY PAUL MCGOLDRICK

I was ruminating the other day about NAB; the annual event that some of us wish would never be repeated, and yet, we would be broadcasting hermits if we ignored it. Over the last 30 years I have been on the exhibitor side of the aisle for five companies and on the looking-in side with three organizations. Don't ask which is the most fun.

The change in the show over the years has been incredible; not just the growth, but the change in the people, the locations and the attitudes. It was decided years ago that the exhibition should always be in Las Vegas. Not a surprise. Although it is not the largest production in Las Vegas (CES and COMDEX are), it actually makes the utility meters run faster than any other show. There is no other show floor in North America that can provide the power needed.

NAB sells

It is also a practical show for the exhibitors. Visitors come to make purchasing decisions. Compare NAB with Montreux (a chance to spend a few comfortable days at the lake with your spouse) or SMPTE (where the papers and technology are wonderful, but you are prohibited from talking money) or some SBE shows of recent years (that were compared to bowling alley parties). Whenever I hear the phraseology quoted by an exhibitor in the show's press, "We were able to spend some real quality time with the visitors," I start to squirm. Broadcast is not the only industry with exhibitions and conferences that should be euthanized; I can think of electronics shows, like Wescon, which really died a few years ago, but people forgot to notice.

No, NAB has not been in those categories. The technical program has never been the centerpiece, but it is respectable. I always thought a five-day exhibition/conference with NAB running the exhibits and SMPTE running the papers would be a not-to-be missed show.

Although buyer and seller meet well at NAB, it is not a cheap way to go. Even the smallest company (a three- or four-person operation in a 10'x10' booth) will end up spending $15,000 for NAB. A 40- to 50-person company will have to budget about $75,000 and be committed to a custom-made booth on a 20'x20' space. "Have to" because if you don't look big in the broadcast business, customers won't believe you ever will be.

What does all this money buy? NAB '98 will cost exhibitors $29 per square foot — if you are a member of NAB — and $35 per square foot if you're not. Other costs include freight of the booth and equipment (and any booth refurbishing, new graphics, etc. since its last outing), drayage at the show floor, setup labor, power, special rentals, airfare, hotels and meals for the staff, special advertising, promotional and collateral pieces. Also, company sales people better be out there entertaining every moment while they have so many customers in one place.

I have watched the NAB exhibition go from being run marginally close to Mafiosi, to squeaky clean, to greedy.

Earning $75,000 to pay for such a mid-sized venture means having to sell about $750,000 of equipment or services.

As of the beginning of January, according to its web site, NAB had sold more than 750,000 square feet of exhibit space to more than 1,200 exhibitors with another 200 exhibitors expected. The "sold" space, if you assumed it was all sold at member rates, represents about $22 million of revenue. But wait, there is more.

Hype, glorious hype

Around Christmas, every NAB exhibitor and, presumably, every PR company involved with those accounts, received a box by Priority Mail from NAB. It contained a marketing extravaganza the likes of which I've never seen — a three-ring binder with laminated cover containing 74 sheets (148 pages) of "It's a Mad, Mad, Mad, Mad Advertising Rate Card." At least 50 sides were four-color, with a lot of special photography, and the remainder were at least two-color with spot varnish. For about a 2,000-piece circulation, my guess is this piece of work was upward of $40 a copy — that's exhibitors' money.

Some of the advertising is genuine; the remainder is covering NAB's costs of events, from the Amateur Radio Reception to the International Leadership Dinner where 300 of the world's finest — no doubt including the NAB board — get invited to a $60,000 bash that exhibitors are paying for! The granddaddy of them all is sponsorship of the Internet Theater on the floor of the Sands: A cool $150,000 . . . oh, plus expenses. What broadcasting equipment company do you think could afford that? Microsoft? Intel? H-P? Are we seeing a progressive image here?

I have watched the NAB exhibition go from being run close to Mafiosi, to squeaky clean, to greedy. As one of the most powerful lobbying bodies in the nation, NAB does not need this greed; if it feels it does, then it should change its web site from www.nab.org to www.nab.com. ■

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