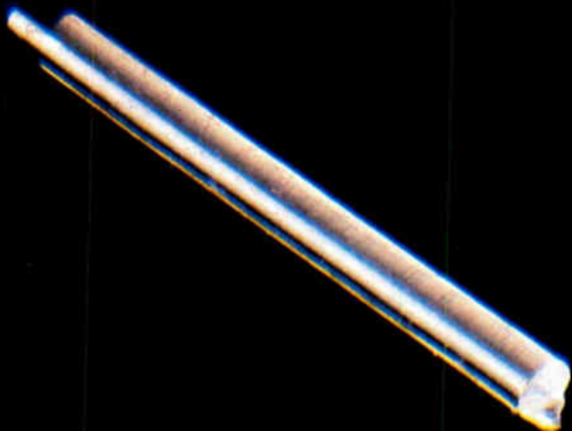
COMMUNICATIONS TECHNOLOGY

Official trade journal of the Society of Cable Television Engineers



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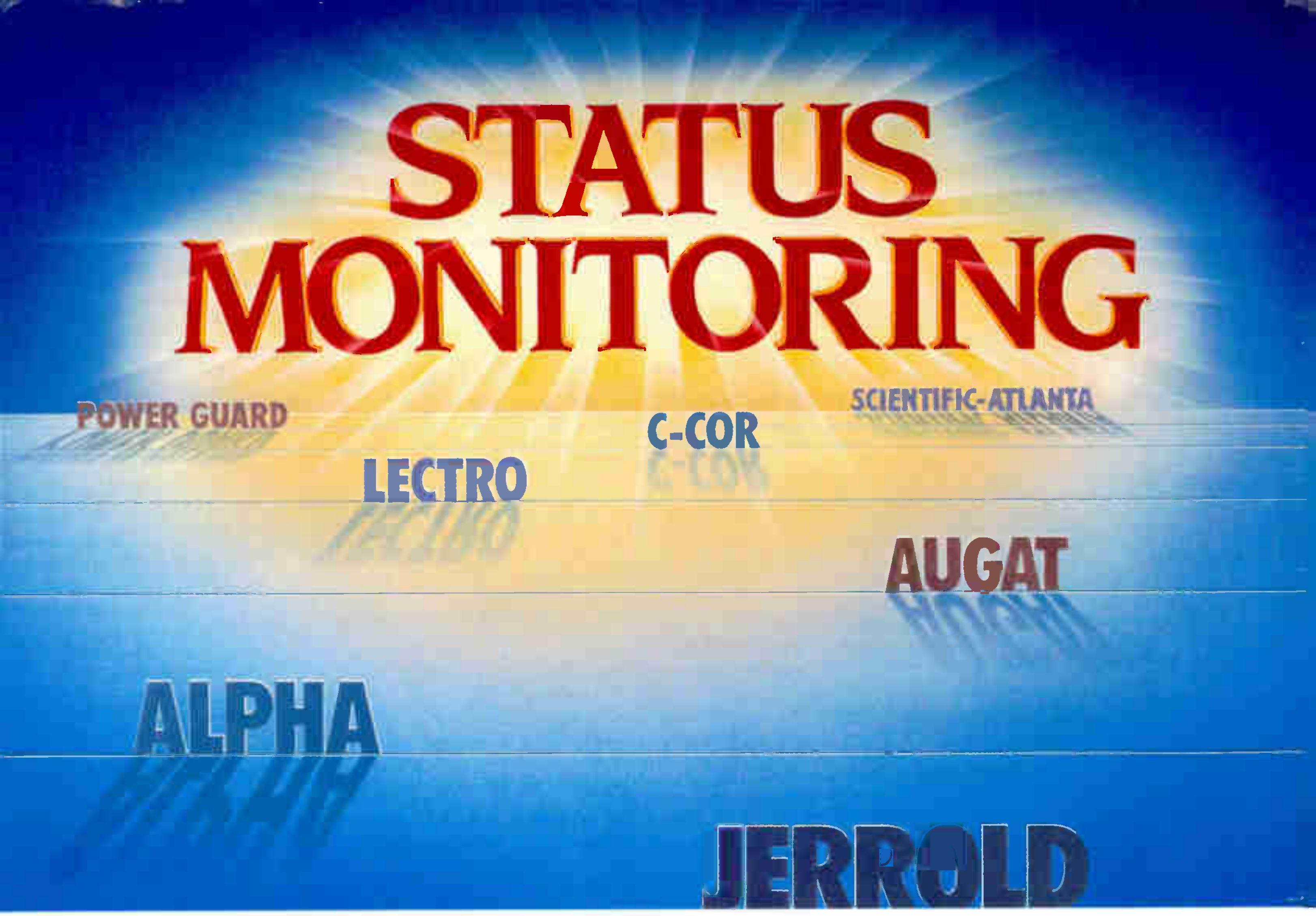
May 1991



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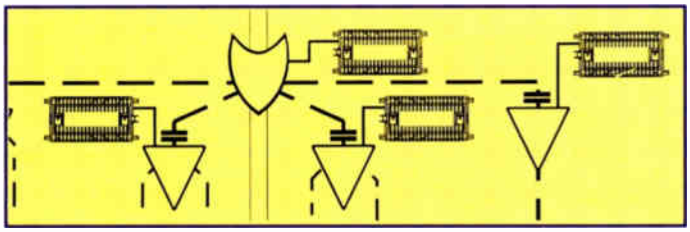

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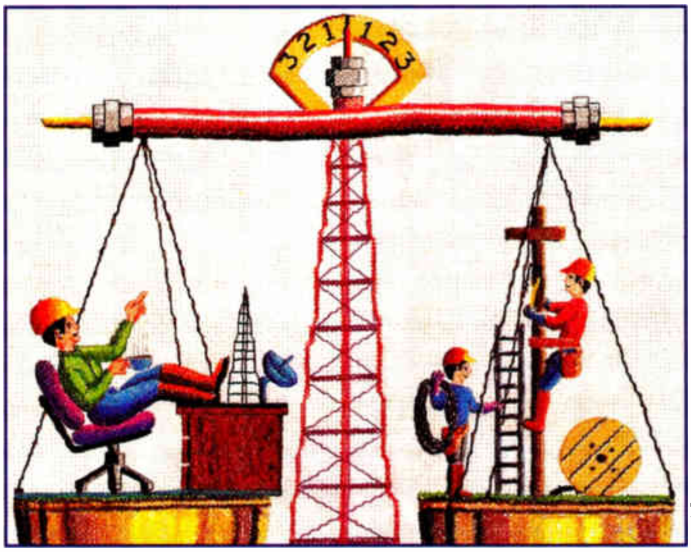

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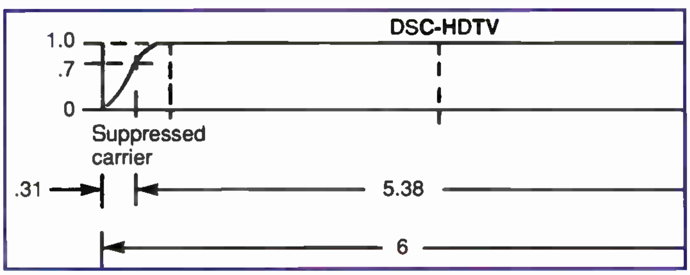

Correspondent's Report 64

Features

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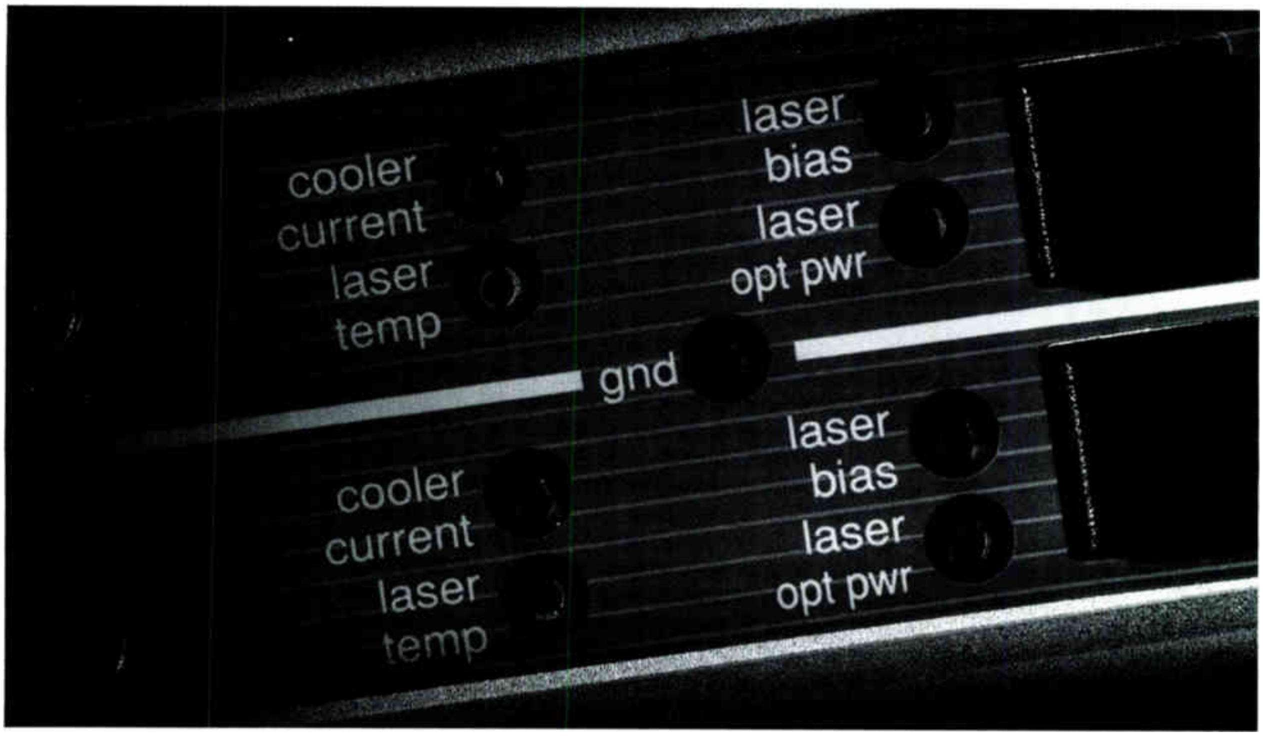

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Reader Service Number 5

EDITOR'S LETTER

Technology takes limelight

For the first time in several years, technology overshadowed programming/operations/finance/marketing at the annual NCTA convention. While floor traffic appeared to be down somewhat from previous years (final attendance figures were not available at the time I wrote this), most exhibitors I spoke with said that the quality of floor traffic was better than usual. Furthermore, international attendance was probably the best ever!

What brought technology to the forefront? Fiber was certainly part of the equation, as was the introduction of 750+ MHz active equipment. But what really stole the show was without a doubt digital video compression. And I think we've been blindsided by the latter, gang.

It wasn't that long ago that video compression was a laboratory curiosity, with expectations that we wouldn't see working technology until the end of 1991 or perhaps sometime in 1992. I think compression sort of sneaked in through the back door while we weren't looking: Jerrold, S-A and SkyPix all had some very impressive demonstrations in New Orleans.

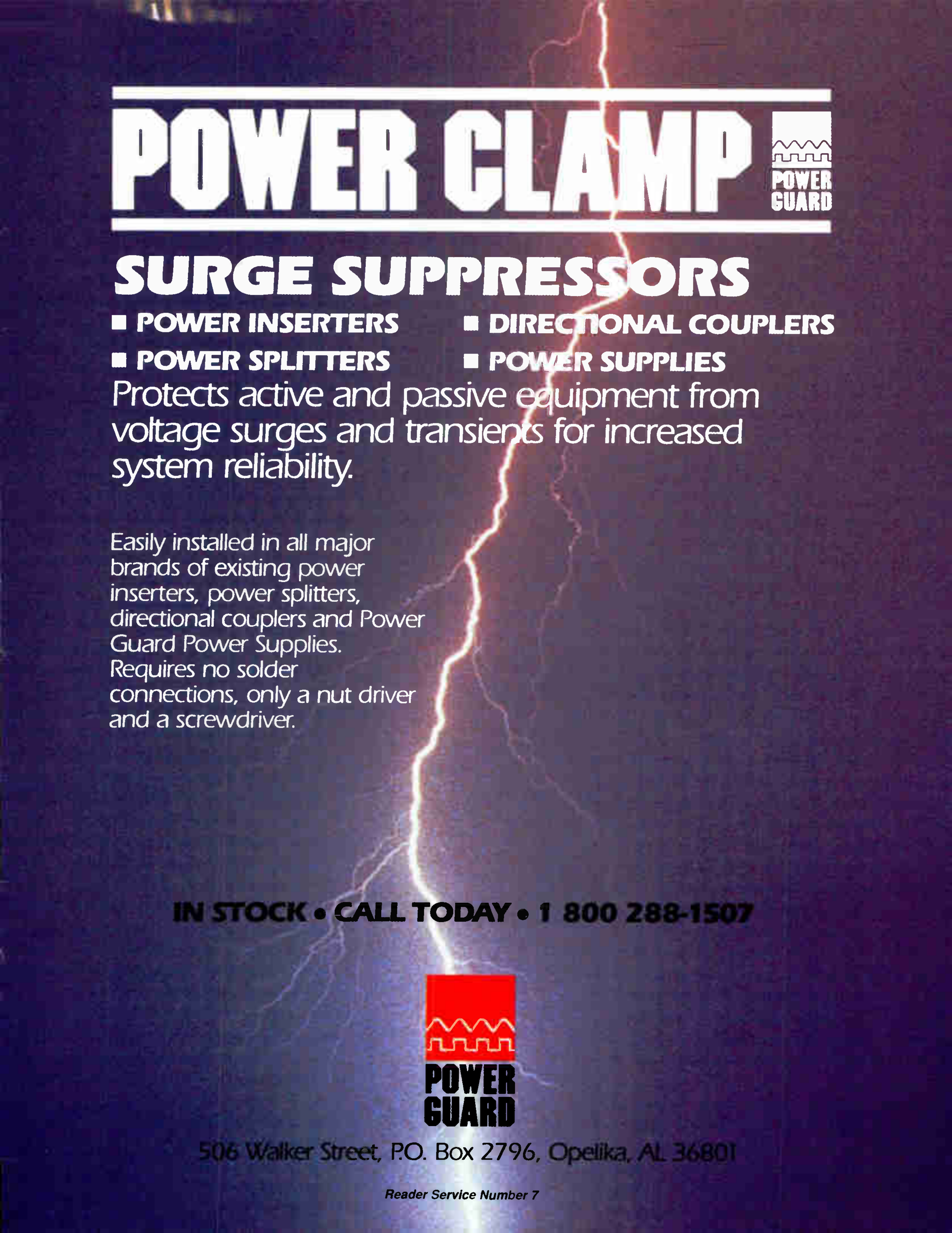
Since late 1988 fiber has been cable's gee-whiz technology. It's certainly going to continue to play a vital role in the evolution of our industry, but I think we now have a new gee-whiz kid: digital video compression. I also think it has the potential to be much more than evolutionary; I predict that compression is going to be a revolutionary part of the business, perhaps even surpassing the importance of satellite technology in the 1970s.

Not only will compression allow us to substantially increase the efficiency of spectrum usage (how about three or four channels in the space of one 6 MHz analog channel?), but it paves the way for real pay-per-view: near video on demand. On an even bigger scale, there's potential for impacting the consumer electronics industry. We already have CD and laser disc players, and in the last year or so have seen the introduction of DAT (digital audiotape) players and recorders. All of these are digital technologies, and many of the devices have not only analog inputs and outputs, but digital inputs and outputs as well. I bet it won't be too long before we see TV sets and VCRs (DVTs?) with digital inputs and outputs next to their analog connectors. Quite a distance down the road we may even see all-digital equipment. (Hmmm ... all-digital cable systems?)

During the next 12 to 24 months we're going to see substantial improvements to video compression technology, and maybe even some standards! No, the demos at NCTA weren't perfect. Take SkyPix for example. Eight compressed channels — each about 2 MHz wide — from *one* satellite transponder were block converted down to the VHF spectrum and mixed in with a local cable system feed. Part of the demo included adding noise and distortion to the system feed to simulate a 500 (not a typo!) amplifier cascade. The analog signals on the system looked pretty bad — definitely in the objectionable category — but the SkyPix compressed video looked exactly the same as it did with no noise or distortion added to the spectrum. And the SkyPix channels were quite acceptable (yes, there were some digital artifacts visible); certainly better than the movies you rent at the local video store. I think a lot of consumers would be willing to pay for the picture quality I saw.

Maybe NCTA officials should have had someone dressed as Paul Revere riding a horse through the convention center shouting, "compression is coming, compression is coming." Without question, the future of our industry was on display in New Orleans. Let's make sure we welcome it with open arms, just like we did satellite technology, expanded bandwidth operation and fiber optics. I think video compression will be more than just another tool in our CATV toolbox, though; it may well become the toolbox!

Ronald J. Hranac
Senior Technical Editor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Reader Service Number 9

Cable pioneer Richard Schneider will be missed

The cable industry suffered a tremendous loss with the passing away of Richard Schneider on March 29, 1991, in Casper, Wyo. Richard, along with his brother Gene Schneider (both executives of United International Holdings) are two of cable's original pioneers; their first system turned on in 1953.

Richard had been in the technical arena since he entered the University of Texas Engineering School in 1942. He entered the Navy in 1944 and attended its Technical Schools, advancing to a Special Research Service Squadron.

In the winter of 1952-53, after more tech schooling and short stints with Texas Instruments and the Kwick Kafe Co. (in which the Schneiders were partners), Richard, with Gene, became interested in a new prospect — community antenna TV. Along the way, they met Bill Daniels. With Daniels' help and financial support from four Texas oilmen, they formed a company to construct the Casper system.

On Christmas Eve, 1953, Richard and Gene played Santa Claus to the town of Casper. Instead of a sleigh, they delivered their gift via cable. Although the system could only deliver one channel (they chose Ch. 2 from Denver) it sure beat nothing.

In Daniels' eulogy at Richard's memorial service, he said, "Everybody loved Richard Schneider and even more admirably, he never uttered an unkind word about anyone."

Under Richard's technical guidance, the Casper system was not only the first operating cable system in the Rocky Mountain area, but also had the distinction of being the first system in the United States to utilize both common carrier and private microwave facilities to deliver signals to the system.

Richard was an engineer's engineer, and was not about to quit after building the Casper system. He had caught the cable bug. What began as one system eventually grew to be the 9th largest MSO (United Cable) in the country before its merger with United Artisits in 1989 (The combined company is ranked #3.)

Stated Frank Hickey of General Instrument, "Richard was perhaps more farsighted and open to technical innovation than many knew. As example," he stressed, "Richard became convinced after thorough evaluation by himself and colleagues at United that addressable cable systems were an important advancement in operating efficiency and customer service. He was not an undemanding customer in technical matters, but he was among the most fair minded and reasonable men with whom I have ever dealt. His intelligent and commonsense judgement will be missed, as will his friendship."

Another of Richard's long-standing friends was Pat McDonough of United International. "Richard Schneider was one of the best engineers I ever met. Those who had the privilege to work with him learned two things: that total honesty in dealing with others and the

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Reader Service Number 37

technical quality of the systems he built were the real bottom line. He never spoke badly of another person," McDonough said, "never compromised his engineering standards and never played games for his own benefit. He demanded the same integrity from those around him. I worked with Richard for over 10 years and every day I stay in this business I will think of him and try to live up to the standard he set for all of us."

Our industry will miss his presence and expertise. He is recognized as being an outstanding pioneer in the cable engineering community. He also had been active in the NCTA as a member of its Standards Committee and as an active member in the Wyoming CATV Association where he was secretary-treasurer.

Satellite update: Are you ready for 2° spacing?

By Rex Gunnison
Headend Technician, Continental Cablevision

In less than two months the spectre of 2° spacing will be a reality. The cable industry will be forced to deal with the problem when Hughes relocates G1 to 133° in late June. This is only a move of 1° but it may mean trouble for many operators. It also is the first in a series of changes to the satellite arc that will affect us all.

Besides the relocation of G1 by Hughes, General Electric is scheduled to launch C5 and position it at 139° to replace the recently retired F5. Once this is done, GE plans to move C1, which is temporarily handling the F5 traffic, over to 137° to resume service to most, if not all, of the recently displaced C1 services. The last change this year will be the launch of G5 scheduled for November. G5 will be placed at 121° and will turn on after W5 is retired. Programming on G5 is expected to come primarily from the move of G1 services.

In mid-1992 GE is scheduled to launch C4 and place it at 135°. C4 is expected to be the new home for most of the programming now on F4, but exact plans are not yet finalized. It also should be mentioned that C4 is expected to be about 2.7 dB stronger than its neighbor G1, which means that sidelobe performance of any dish looking at G1 will need to be good enough to compensate for this increase. Shortly after the launch of C4, GE will send up C3 to replace F1R at 131°. This also is a 2.7 dB "hotter" design and may increase the sidelobe pickup problems with G1 on marginal dishes.

The first group that will have to worry is the one with dual-beam feeds. Will your feed work at 2° spacing? If you can't move the feeds closer to each other by about one-third of their present center-to-center distance, they probably won't work. The second group is those with smaller (under 4-meter), warped or older dishes with poor sidelobe performance. These dishes may need replacement if they can't discriminate between the desired bird and its neighbor. If you have even the slightest doubt, check it out now.

Announcements and innovations spring from NCTA show

NCTA elects new board members: Jim Robbins of Cox Cable was elected chairman; vice chairman is ATC's Joe Collins and secretary is Amos Hostetter of Continental Cablevision. The executive committee comprises outgo-

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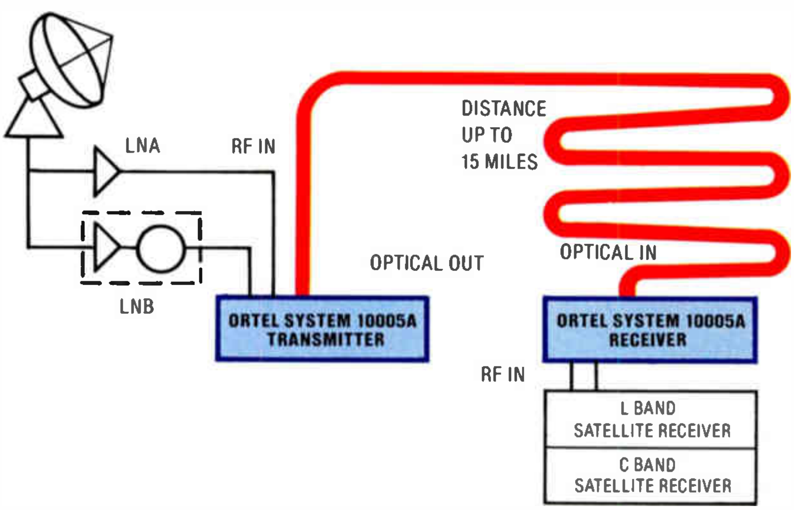

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ing NCTA Chairman Jerry Lindauer, as well as Jim Mooney, Tony Cox, Glenn Jones, John Malone, Bob Miron, Brian Roberts and Larry Wangberg. Other new board members include Alan Gerry, Cablevision Industries; June Travis, Rifkin & Associates; Jerry Lindauer, Prime Cable; Timothy Robertson, The Family Channel; Tony Cox, Showtime Networks; and Maggie Wilderotter, CableData.

New corporate umbrella for Anixter, ONI, Regal: Based in Skokie, Ill., ANTEC consists of two functional groups, each focused on addressing specific market needs. The product and technology group is comprised of Optical Networks International and Regal Technologies. The distribution group is comprised of Anixter Cable TV, Anixter Cable TV Canada and ANTEC International. Also announced was Regal's new president, S-A veteran Stephen Necessary.

Comm/Scope inks deal with AT&T: Comm/Scope will manufacture fiber-optic cable under license from AT&T. According to Comm/Scope, the cable is especially designed for CATV, allowing longer pulls and the easiest fiber access in the industry. Comm/Scope's Optical Reach fiber-optic cable is available this year through an AT&T private label agreement; beginning first quarter 1992 Comm/Scope will manufacture Optical Reach at its Catawba facility for sale to the CATV market.

Superior expands Cheetah capabilities: The firm will offer power supply monitoring for one-way plant as an option to its Cheetah system that is 100 percent compatible with Alpha hardware It also has adapted the Cheetah system to international applications. It was introduced to the United Kingdom by Omnitest during the London show in April. The system allows full conversion of both electrical and channel specifications to a variety of countries. In other news, Superior signed an agreement with RF Technologies to represent the Cheetah product line in the Northeast.

Magnavox and Oak team up: They will jointly support development and marketing of a new interdiction product line that marries Magnavox's new AXIS addressable external interdiction system with Oak's ACS network control system. Production is scheduled for early next year.

CableLabs, Jerrold and Nexus sign PCN pact: The three will engage in joint research in PCN technology. CableLabs established this relationship to explore both the technical and economic feasibility to validate the concept that the cable industry's infrastructure can play an integral role in the eventual development and deployment of PCNs. The agreement provides for exchange of technical information relating to interfacing PCNs in cable networks.

NCTA presents Vanguard, President Awards: In the technical arena, Dan Pike (Prime Cable) took the Vanguard Science and Technology Award for his leadership in focusing industry attention on phase noise and its effect on TV picture quality. Bob Miron (Newhouse Broadcasting) and Ruth Otte (Discovery Channel) received the Distinguished Vanguard Awards for Leadership. Others receiving Vanguard accolades included Brian Roberts (Comcast) for Young Leadership; John Hendricks (Discovery Channel) for Programmers; Hal Krisbergh (Jerrold) for Associates; Dean Deyo (Memphis CATV) for State/Regional Association Leadership; Matt Blank (Showtime) for Marketing. President's Awards go to Ralph Baruch (National Academy of Cable Programming), Jim Chiddix (ATC) and June Travis (Rifkin).

Scientific-Atlanta demos compression technique: Conducted in association with the CableLabs Digital Transmission Consortium (comprised of CableLabs, S-A and General Instrument), this was the first time S-A showed its approach to this subject. The technique, based on a process known as vector quantization, features real-time digital compression that provides headend-quality, full-motion video. The result of two years of analysis and development, the technique will allow programmers to deliver multiple TV channels to headends in one transponder; multiple TV signals, and eventually advanced TV or HDTV, will be possible in one 6 MHz cable channel. In other news S-A received a turnkey fiber-to-the-serving area contract from St. Joseph Cablevision for its London Bridge Cablevision rebuild/new-build in Lake Havasu City, Ariz. The contract includes system design, 36-channel headend, 450 MHz PT distribution amps, taps and passives, Model 6450 AM fiber transmitters and Model 6901 AM fiber receivers. The project will cover 366 plant miles.

ONI debuts communications infrastructure: Jointly developed with

AT&T, Optical Networks International debuted its network model for CATV's entry into residential and commercial voice and data services. The model illustrates SONET-based digital transmission and PCN equipment as it will likely be integrated into today's fiber systems. The enabling architectural element is the optical transition node, depicted as a curbside cabinet that houses the necessary equipment to handle wireless voice, video and wireline voice and data traffic. It is located at the fiber termination point for each node site in a cable system. According to Andy Paff, ONI president, the only part of the network that depends on future technology is the PCN element, which is not far off. In other news, ONI recently activated a complete fiber upgrade for Jones Intercable's Naperville, Ill., system. The CAN architecture was employed. The system used five optical receive sites to reduce amp cascades from 30 to a maximum of eight, and delivered picture quality measuring 47 dB C/N at the tap. Ample dark fiber also was placed for future use.

C-COR presents flexible networking concept: It is based on the premise that operators want to rebuild or upgrade their systems today using FTF or fiber backbone type architectures. The three main principles of flexible networking are applied to these proven fiber architectures as follows: 1) Home run fiber paths allow easy upgrade of the AM fiber portion of the system, allowing operators to use 1,550 nm and optical products as they are developed, and providing for further segmentation of the subscriber base. 2) Neutral networking, developed by Adelphia, allows for additional fiber use and further subscriber segmentation without any redesign or reconstruction of the system. This is accomplished through drop-in upgrades at existing amp locations. 3) Superdistribution feeder, developed by Rogers, allows for drop-in upgrades to 1 GHz while improving performance and reliability.

ConTec offers converter repair guarantee: The company has instituted a converter repair guarantee that all converter repairs will be fulfilled with a 3 percent or less failure rate of the entire order, or rebate its customers $10 per unit above this rate. ConTec customers can have the rebate in cash or use it as a credit on account. Also, all failed units returned will be repaired and shipped at no additional charge.

Members elect national directors

Over 2,250 ballots were received from members of the Society of Cable Television Engineers during its 1991 national election for seven open seats on its board of directors. Re-elected to their current positions on the board are At-Large Director Richard Covell, Texscan; Region 2 Director Ron Hranac, Coaxial International, serving Arizona, Colorado, New Mexico, Utah and Wyoming; Region 9 Director Jim Farmer, Scientific-Atlanta, serving Florida, Georgia and South Carolina; and Region 11 Director Diana Riley, Jerry Conn Associates Inc., serving Delaware, Maryland, New Jersey and Pennsylvania. Newly elected to the board are At-Large Director Wendell Bailey, NCTA; Region 1 Director Tom Elliott, Catel Telecommunications, serving California and Nevada; and Region 6 Director Rich Henkemeyer, Paragon Cable, serving Minnesota, North Dakota, South Dakota and Wisconsin.

These individuals join the eight existing board members who are currently serving the second year of their present term on the board, including At-Large Director Tom Elliot, CableLabs Inc.; Region 3 Director Ted Chesley, Rock Associates Inc., serving Alaska, Idaho, Montana, Oregon and Washington; Region 4 Director Leslie Read, Sammons Communications, serving Oklahoma and Texas; Region 5 Director Wendell Woody, Anixter, serving Illinois, Iowa, Kansas, Missouri and Nebraska; Region 7 Director Victor Gates, Metrovision, serving Indiana, Michigan and Ohio; Region 8 Director Jack Trower, WEHCO Video Inc., serving Alabama, Arkansas, Louisiana, Mississippi and Tennessee; Region 10 Director Michael Smith, Adelphia Cable Communications, serving Kentucky, North Carolina, Virginia and West Virginia; and Region 12 Director Walt Ciciora, Ph.D., ATC, serving Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island and Vermont.

The participation of more than 2,200 members in this year's election represents an increase of 700 people, or more than 33 percent, over the 1,500 who voted in the 1990 election.

The first 1991 board of directors meeting was held in conjunction with the NCTA show in New Orleans. The three new members officially take their seats May 1, and the board will elect the Society's officers for the coming year at its next meeting, to be held in June at the Cable-Tec Expo in Reno, Nev.

Expo exhibit floor sold out, events planned

All exhibit space has been reserved for the 1991 Cable-Tec Expo, to be held June 13-16 at the Reno/Sparks Convention Center. This marks the fifth year in a row that the exhibit hall has sold out. Cable-Tec Expo '90 showed a significant increase in attendance over the previous year, and SCTE is confident that Expo '91 will be another record-breaking event.

Sponsored by SCTE, Cable-Tec Expo is a fully technical conference and trade show offering an instructional exhibit floor featuring all types of cable industry hardware, as well as a wide variety of educational programs, hands-on training sessions and technical workshops.

Almost 200 exhibiting companies — displaying all types of products, services and equipment used in the operation of cable TV systems — have rented space on the exhibit floor for Cable-Tec Expo '91. The exhibit hall has been carefully coordinated to provide industry suppliers with the opportunity to present live technical demonstrations of their products in a relaxed atmosphere. An added feature on the floor will be the Technical Training Center offering additional equipment demonstrations. SCTE has expanded the floor space available to exhibitors 25 percent over last year's exhibit floor.

People planning to attend the expo are advised to seek lodging at the official headquarters hotel, the Bally's Reno, by calling 1 (800) 648-5080. Detailed information on accommodations at the Bally's Reno, as well as a reservation form, are included in the Expo Registration Packet that was recently mailed to all SCTE members. If you wish to receive a registration packet, contact SCTE at (215) 363-6888. Also note that the complete registration package appears in the April issue of *Communications Technology* magazine.

Cable-Tec Expo '91 will offer attendees countless educational opportunities, as well as an exciting and entertaining stay in "The Biggest Little City in the World," Reno.

Besides numerous training opportunities, Expo '91 will offer a variety of activities and special events planned to make this the most special expo yet.

The expo will feature the Society's first golf tournament, as well as the first national Cable-Tec Games event. Contestants will compete in four events: RG-59 cable and connector preparation, .750 cable and connector preparation, a written exam and "Name that Distortion."

Also planned is the second annual "Classic Cable Equipment Competition." Co-sponsored by the National Cable Television Center and Museum (NCTCM) and SCTE, expo attendees can participate in this contest by bringing with them what they consider to be a classic piece of cable TV equipment. These pieces will be judged on the basis of historical value and uniqueness by a panel of experts. Winners will receive cash prizes, and the equipment will be considered for possible acceptance into the NCTCM collection for display in the SCTE room at the NCTCM center.

For further information on Cable-Tec Expo '91, please contact SCTE national headquarters at (215) 363-6888.

ID badges sent to certified installers

The Society recently sent personalized badges to all members who have been fully certified in the SCTE Installer Certification Program. These badges are sent as a means of saluting successful candidates in the program through the promotion of their accomplishment.

"We hope all certified installers will proudly wear this badge on the job," states SCTE Executive Vice President Bill Riker, "to indicate their training to new subscribers and to encourage their fellow installers also to become certified in the program.

"It also is our hope," Riker says, "that the more than 1,000 candidates currently enrolled in the Installer Program will soon follow the example of those wearing these badges and also seek full certification."

Contest Rules: No purchase is necessary. Entries accepted from authorized representatives throughout the United States faxing their names, title and phone number and the phrase "Please enter us in the Midwest CATV Vegas Contest" on his/her company letterhead to 1 303 643-4797. Contest entry is limited to cable television systems companies only. The prize will be awarded in the company name. The winning company will determine the individual to be given the prize. Midwest CATV, its suppliers, parent companies, subsidiaries and ad agency are not eligible. This contest is void where prohibited by law. Only one entry per company is permitted. The odds of winning will be determined by the number of entries received. Contest entries will not be accepted if received by Midwest CATV after May 31, 1991. Total value of the prize is $1,132. Prize includes airfare from anywhere in the Continental United States to Las Vegas, hotel accommodations for three nights at the Flamingo Hilton, hotel taxes and transfers from the airport. No cash or prize substitutions. For more information contact Midwest CATV at 1 800 MID-CATV or write: Midwest CATV Sweepstakes, Fairways II at Inverness, 94 Inverness Terrace East, Suite 310, Englewood, CO 80112. The winner's name may be obtained by writing Midwest CATV after June 20, 1991.

Tap into a Free Trip to Las Vegas from Midwest CATV and Antronix.

This month's Midwest CATV Customer Incentive Contest is featuring a trip to Las Vegas.

You can enter the contest two ways. First, place your Antronix order during May, and write the phrase "Please enter me in the Midwest CATV Vegas Contest" on the bottom of your purchase order, and your company is entered.

It's a win win situation! Antronix is the largest tap manufacturer in the world, offering backward compatible standard and patented Cam-Port™ taps as well as Millenium taps, which offer a universal housing for 2-, 4- and 8-way applications. All Antronix taps have double polyurethane coatings for durability, color coded tap values for easy identification, and are easy to mount on strand or pedestals. So you get the quality of Antronix taps, quick service from Midwest CATV, and a chance at winning a free trip to Vegas!

The second way to enter the contest is for you, the company's authorized representative, to send us on company letterhead, via fax machine, your name, title, telephone number, and the phrase "Please enter me in the Midwest CATV Vegas Contest," and your company will be entered. It's that easy!

Only one prize will be awarded. The prize includes roundtrip airfare from anywhere in the U.S., hotel accommodations for three nights at the Flamingo Hilton, hotel taxes and roundtrip transfers from airport to hotel.

The winning company will be selected by June 20, 1991.

So don't fold on a great deal! Enter today.

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Reader Service Number 18

A cable perspective on digital transmission

The discussion of digital transmission in cable systems has rapidly grown within the past year. Digital audio services have been introduced in cable and digital transmission has become an integral part of all of the high definition TV (HDTV) proposals except MUSE. The potential for multiple NTSC-quality digital channels within 6 MHz has virtually overshadowed the HDTV applications. Some of the reasons for the shift toward digital transmission will be discussed before moving to a review of the methods of digital transmission.

By Gerald H. Robinson
Principal Engineer
Scientific-Atlanta Broadband Communications Group

The most commonly stated advantage of digital transmission over analog is the ability to deliver a "perfect" replication of the original signal at the receive point as long as the carrier-to-noise ratio (C/N) remains above some threshold. A more accurate description would be that constant quality is delivered above the threshold. When the original signal is a string of symbols such as numbers or letters, perfect replication is achieved. Each letter or number is encoded into digital form with no loss of information.

In cable, the original signal is generally analog in nature whether audio or video. This analog signal first must be digitized then transmitted and restored to analog form for perception by the audience. The process of digitization and restoration of this analog signal cannot be exact and will set the quality of the received signal with no degradation by the transmission channel above the C/N threshold. There will be no ghosts, no noise and no distortions of the restored analog signal due to transmission channel impairments.

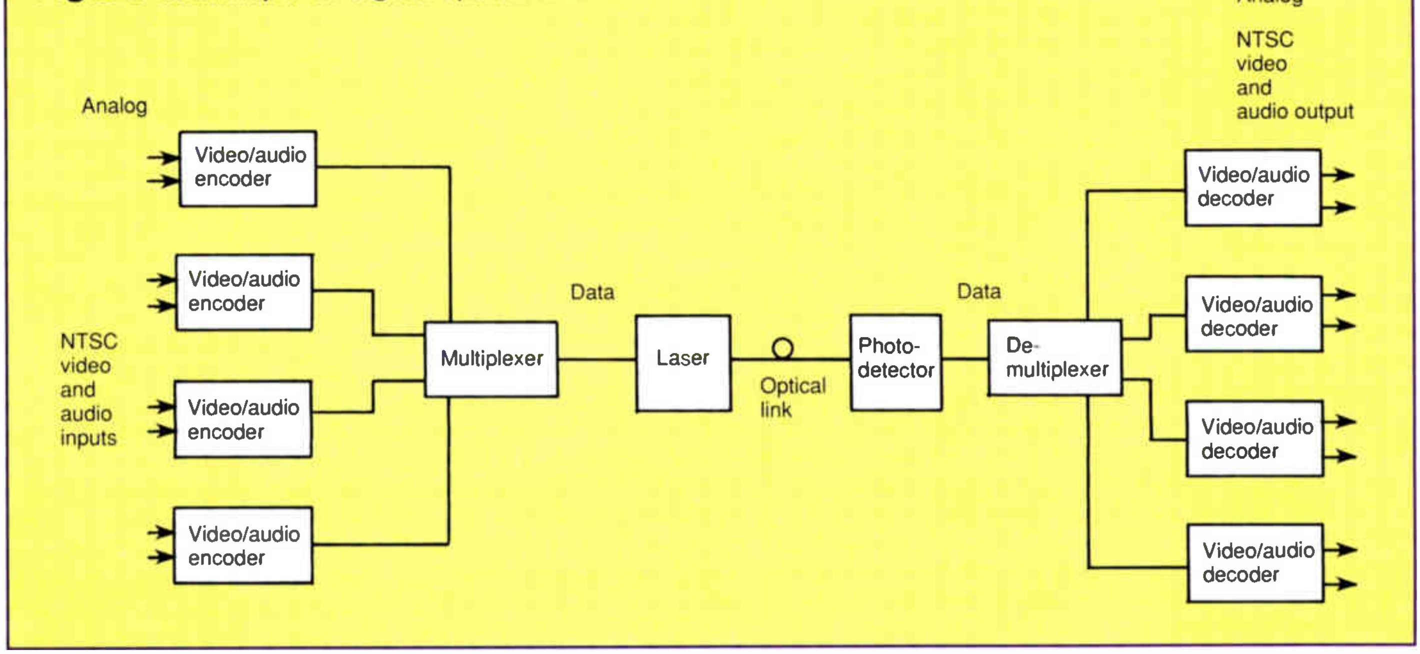
Greater advantages

The advantage of digital transmission becomes greater when multiple steps of processing are required. For example, carrier amplification is required in a long transmission path such as long distance telephone service. The carrier amplitude of digital signals can be restored by repeating the signal rather than simply amplifying the modulated signal. That is, the digital signal is demodulated and remodulated onto a higher level carrier. Since the digital bit stream can be recovered perfectly above threshold, the repeating process can be carried out as many times as necessary without loss of quality.

The same advantage is realized when the signal is passed between media. For example, many cable signals are received by satellite link. These signals are FM demodulated to baseband and re-modulated into the VSB-AM format for cable transmission. Noise in the satellite link adds to noise in the conversion process and the cable transmission. Distortions also are cumulative. A digital satellite signal could be received and retransmitted (repeated) with no loss of quality.

These advantages are certainly important but do not seem to provide sufficient reason to change from the present process. The conversion from FM to AM is not the limiting factor in delivered signal quality and there are no TV sets capable of directly using a digital signal. The signal eventually must be encoded into NTSC (RF or baseband) or Y/C baseband format. This requirement caused a focus on AM fiber for cable delivery rather than other modulation alternatives and would seem to argue against digital modulation for the near-term. Also, dig-

Figure 1: Example of digital optical link



ital advantages are not free. Digital transmission of NTSC signals requires a data rate on the order of 90 Mb/s. Even with bandwidth efficient digital modulation formats, which we will discuss later, this would require at least four or five standard 6 MHz channels.

Considering these points, why is there such great interest in digital transmission for television? The answer stems from the rapid growth in digital signal processing (DSP). An image can be digitized and then processed digitally to reduce the data required to reproduce the image. Even analog HDTV systems use digital processing to eliminate unimportant information and reduce the bandwidth required for transmission[1].

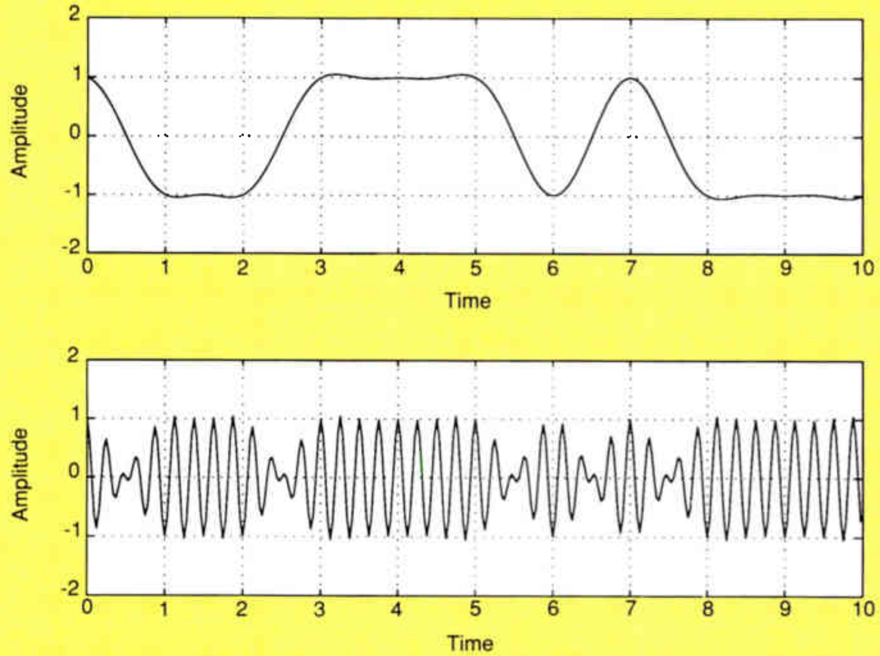
Techniques based on processes such as the discrete cosine transform (DCT) and vector quantization (VQ) have been used to dramatically reduce the data within an image. Standards for image compression based on DCT have been developed for both static and moving pictures. These are the Joint Photographics Experts Group (JPEG) standard for still pictures and the Motion Picture Experts Group (MPEG) standard for full motion video. Development also is proceeding on other techniques such as wavelet transforms and fractals.

Large compression ratios have been demonstrated with high quality reproduced images leading to proposals for transmission of two or more NTSC channels within 6 MHz using bandwidth efficient digital modulation. Indeed, all the HDTV proponents except NHK (MUSE) are proposing digital transmission of HDTV within 6 MHz.

We can conclude that the primary reason for increasing interest in digital transmission for cable is — rather surprisingly — reduced bandwidth. The focus on digital transmission has been driven by compression technology. Success will depend largely on the implementation of digital modulation methods, particularly in terrestrial transmission.

The video image must be converted to digital form before DSP and transmission. This involves the sampling and quantizing[2] of the source image so that the image can be represented as a sequence of numeric values in the form of a sequence of bits. We will concentrate on the transmission of the bit stream and will not discuss the analog-to-digital conversion or the details of DSP.

Figure 2: Data waveform and BPSK modulated carrier



Bits and symbols

Most are familiar with bits and understand how numeric values are often represented as a sequence of bits. Each bit has a value of 1 or 0 multiplied by a power of 2 depending on the position of the bit in the sequence. Each bit can be represented by any two-state condition such as two voltage levels or two amplitude levels of an optical or RF carrier. The data stream at baseband could be represented by voltage level. The value of each bit determines the voltage level at specific instants of time. While we usually think of data as having a square shape, the transitions need not be abrupt. When the data waveform is to modulate a carrier, a sinusoidal shape is preferred because a large bandwidth is required to transmit abrupt transitions.

We also could consider other representations of the bit stream. More than two levels could be used, for example. With four levels, each level would represent two bits. Various modulation schemes may result in four or more modulation states as we will discuss. These states now represent multiple bits and it becomes convenient to think of these states as symbols. The value of a symbol determines the modulation state. The value of a symbol is determined by one or more bits depending on the modulation method employed. Data are transmitted as a succession of symbols (modulation states) at a rate called the symbol rate. Since the symbol may represent more than one bit, the symbol rate may be less than the bit rate. The symbol rate and bit rate are equal only when each symbol has just two states.

Media and modulation types

Digital modulation can be employed in a variety of media. Satellite, RF coax and optical fiber are all part of the cable system today and probably would be used in any digital transmission.

Digital transmission of digitized NTSC composite signals via fiber is available today. These systems employ direct two-level (two-state) amplitude modulation of the laser. Multiple bit streams are time division multiplexed (TDM) into one high rate data stream, which modulates the laser as shown in Figure 1. Here, each symbol is equivalent to a bit.

Wavelength division multiplexing (WDM) also can be used to increase the number of channels by adding a second laser operating at a different wavelength. The modulation method is rather simple to understand. The baseband data stream consists of a single bit stream that amplitude modulates the laser between full on and full off. The output from the optical link is essentially a replica of the input waveform. The complexity lies in the multiplexer that must operate at a data rate,

Spectral efficiency and C/N requirements

Modulation technique	Theoretical efficiency bits/sec/Hz	Practical efficiency bits/sec/Hz	C/N (dB) required at $P_e = 10^{-8}$
BPSK	1	0.6-1	12
4-QAM	2	1.2-2	15
16-QAM	4	2.3-3.5	22.5

which is the sum of the rates of the individual channels.

RF transmission via satellite or coax uses a wider range of modulation types. We will see in later discussion that modulation methods may be selected to be efficient in the use of bandwidth at the expense of power or vice versa. A few fundamental concepts can provide a general understanding of all of these methods.

We have said that symbols are transmitted as a succession of modulation states. The modulation employed can be amplitude (AM), frequency (FM) or phase (PM) or can be a combination of these. The modulation types that will be more commonly encountered in cable can be described in terms of double sideband, suppressed carrier amplitude modulation (DSBSC-AM). The following equation[3] describes amplitude modulation in general:

$$M(t) = a(t) \cos(\omega_c t) \quad 1)$$

Where:
$M(t)$ = the modulated carrier
$a(t)$ = the modulating waveform
$\cos(\omega_c t)$ = the carrier

This equation simply says that the carrier is multiplied by a signal that varies with time. It can be used to describe NTSC luminance modulation as an example. In that case, a(t) is directly related to the luminance. The value of a(t) at sync tip (-40 IRE) is 1 and at peak white (+100 IRE) is .125. As you can see, a(t) has only positive values in NTSC VSB-AM. The carrier level varies from the peak value at sync to 87.5 percent (1 - .125 = .875) depth of modulation at peak white and is never fully turned off.

The equation also can be used to describe DSBSC-AM. In that case, the value of a(t) ranges from +1 to -1. We can see that as a(t) varies between the value of 0 and +1 the carrier amplitude varies from off to full on, but what of the negative values? Negative values simply mean a phase reversal of the carrier. In other words, between the values of 0 and -1 the carrier amplitude varies from off to full on but with a relative phase of 180°.

When DSBSC-AM is used for transmission of digital information, discrete values of a(t) are used to represent digital values. For example, two states +1 and -1 could be assigned. One state would represent a logical 1 and the other a logical 0. The carrier would be at full amplitude in both states but would have 180° difference in phase. A modulation scheme of this type is often called binary phase shift keying (BPSK). Here, the two modulation states represents "one" and "zero" states of a single bit. Actual data will consist of a stream of "ones" and "zeroes."

Figure 2 shows a typical modulation waveform and modulated carrier. The bits occur at regular intervals (clock periods) and the change between states follows a sinusoidal shape. In Figure 2, the sample time for each bit is at the grid line (10 bits are displayed). Note the relative carrier phase between sample points where the data is at -1 and +1. These two states represent bit values of one and zero (e.g., +1 = one and -1 = zero). It is interesting to note that this modulation can be described as DSBSC-AM although one might view it as phase modulation as its name, BPSK, implies.

BPSK transmits one bit per symbol, so the bit rate equals the symbol rate. We can increase the number of levels to three or more. With four levels, for example, each symbol represents a two-bit sequence. There are four states representing 10, 01, 11 and 00. Note that the carrier is not at full power for all symbols as in the two-level case. As you might expect, the four-level case will be more susceptible to noise and interference.

We should note that suppressed carrier modulation requires a local carrier to be reinserted at the receiver. This carrier must have exact phase relationship to the original carrier. Fortunately, the local carrier can be recovered from the transmitted signal since the carrier is present in each symbol with only the 180° phase difference.

We have established an understanding of the basic digital modulation format that will be encountered in cable. We must add the concept of quadrature modulation. Simply stated, two carriers at the same frequency, but in quadrature phase (90°), are modulated separately and then combined. Each carrier can be modulated DSBSC-AM as outlined previously.

It is easy to see how the carriers are modulated and combined but it is not as simple to see how they can be separated and demodulated. Synchronous detection, sometimes called coherent detection, must be used to separate the two quadrature channels. Synchronous detectors are occasionally used in NTSC reception. A synchronous detector essentially multiplies the received signal with a local carrier. To see how this works, we recall a trigonometric identity:

$$\sin(x)\sin(y) = 1/2[\cos(x - y) - \cos(x + y)] \quad 2)$$

We can use this identity to see how the synchronous detector recovers the modulation waveform and rejects the quadrature signal as shown in the following equation:

$$A(t) \sin(\omega_c t + \theta) \sin(\omega_{cr}) = 1/2[A(t) \cos(\theta) - A(t) \cos(2\omega_c t + \theta)] \quad 3)$$

Where:
ω_c = transmitted carrier frequency
ω_{cr} = recovered carrier frequency
$\omega_{cr} = \omega_c$
$A(t)$ = transmitted carrier amplitude
θ = transmitted carrier phase

The first term on the right contains the desired low frequency baseband information. The second term can be filtered out since it is at high frequency.

Now consider the BPSK waveforms in Figure 2. The carrier level is given by the absolute value of the data waveform. Carrier phase, on the other hand, will be either 0° or 180° as determined by the sign of the data. We can see from Formula 3 that the demodulated waveform is proportional to the product of the carrier amplitude and the cosine of the carrier phase (θ). The cosine will be +1 when q is 0° and -1 when θ is 180°. From these facts, we see that the recovered waveform will be a replica of

(Continued on page 34)

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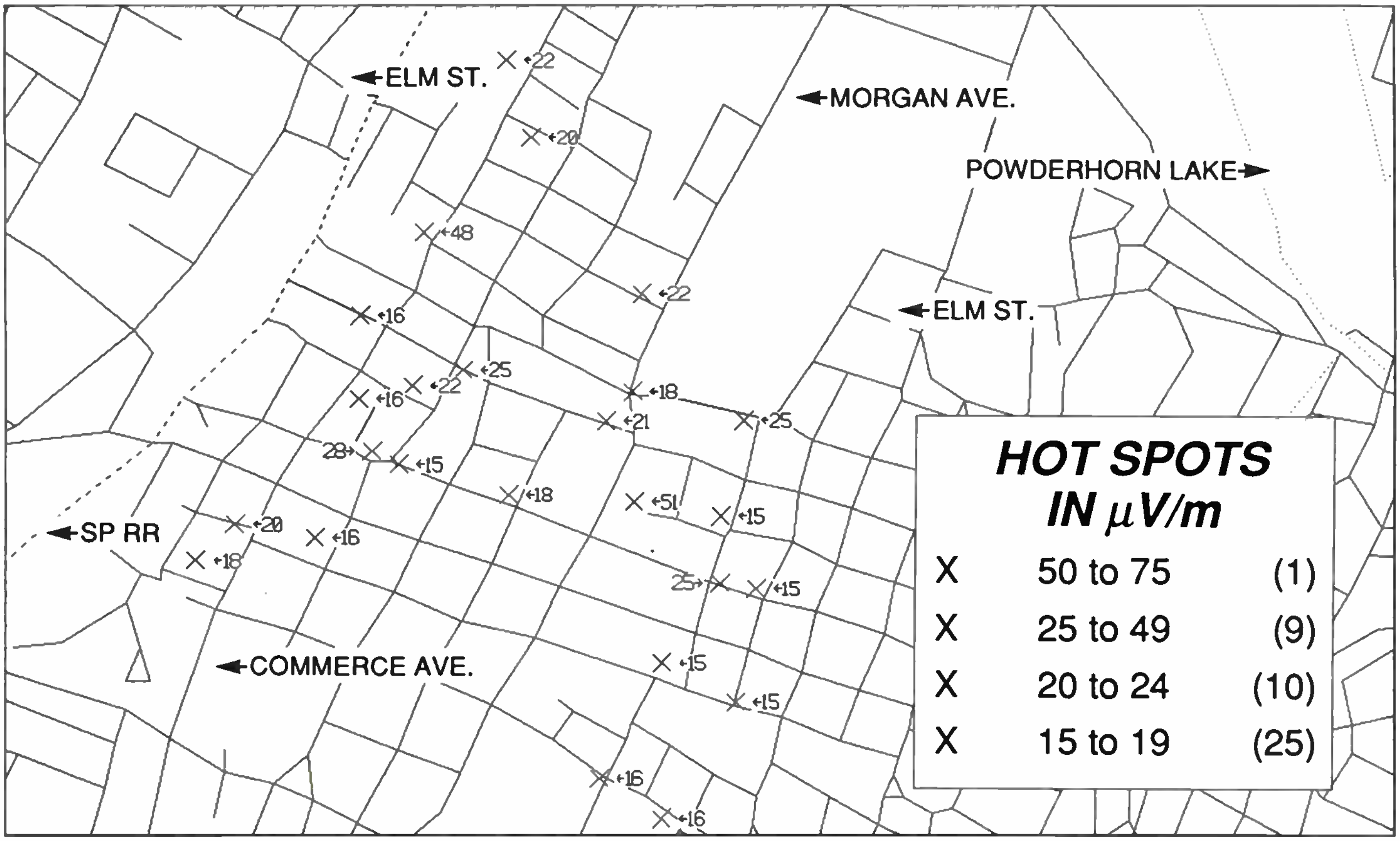

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Reader Service Number 59

Digital video for CATV

By Clyde Robbins
Senior Staff Scientist
Jerrold Subscriber Systems Division
General Instrument Corp.

Digital data has been transmitted over cable systems for many years. Common examples include closed-caption information, teletext and converter authorization data. Recently, digital transmission over cable has taken on a more glamorous role with the advent of digital audio services. For the first time, cable systems can provide audio for premium video and music services that have the full impact of the original recordings.

In the not too distant future, digital transmission will allow the delivery of video into the home with studio-quality pictures totally free of any transmission artifacts. Combining digital compression techniques with spectrum-efficient data modulation will result in systems where both analog and digital video delivery methods can coexist on the same cable.

Potential advantages

Compressed digital video transmission offers the following potential advantages:

- Uniformly excellent picture and sound quality at all drops throughout the cable system.
- Efficient use of bandwidth allowing more than one video channel per 6 MHz channel allocation.
- Efficient access control through built-in digital encryption.
- Extended cable system reach.

A list of goals for a digital video system for CATV applications should include the following:

1) Reconstructed pictures acceptable to experts as studio-quality for any motion or still picture. Test patterns need not be accurately reproduced. The compression should not be overdone to the point where artifacts become noticeable. Data compression

(Continued on page 40)

Table 1: Data modulation methods

Type	Description	Maximum efficiency	Practical rate in 6 MHz
BPSK	Two data levels, one carrier phase	1 bit/Hz	5 Mb/sec
QPSK	Two data levels, two carrier phases	2 bits/Hz	10 Mb/sec
16 QAM	Four data levels, two carrier phases	4 bits/Hz	20 Mb/sec
64 QAM	Eight data levels, two carrier phases	6 bits/Hz	27 Mb/sec
256 QAM	16 data levels, two carrier phases	8 bits/Hz	32 Mb/sec

Table 2: Distortion readings with and without QAM signal

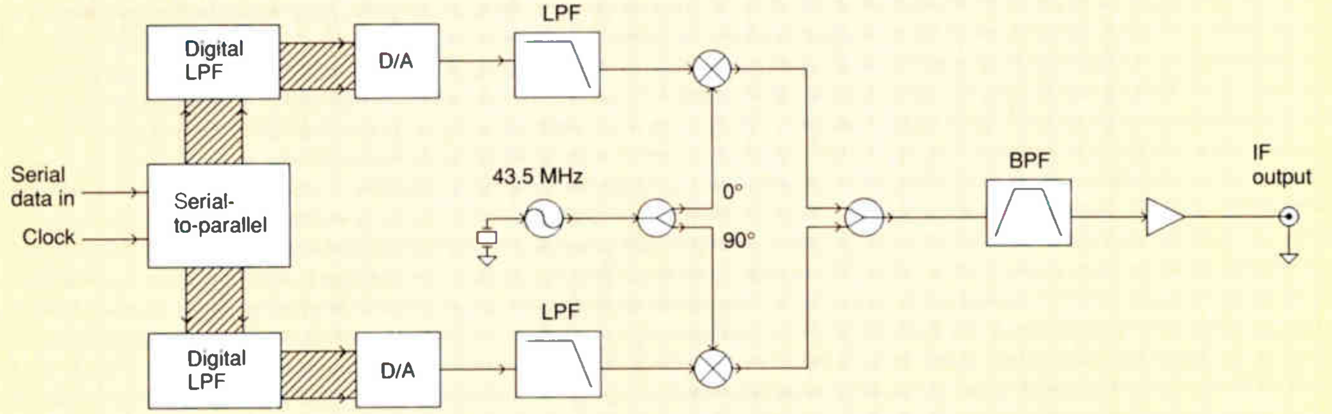
Ch.	Number	Composite second order		Composite triple beat		Carrier-to-noise ratio
		With QAM	Without	With QAM	Without	
38	307.25 MHz	66.0	53.5	53.5	53.5	51.3
39	313.25 MHz	16 QAM	16 QAM	16 QAM	16 QAM	41.3
40	319.25 MHz	72.5	72.5	53.0	53.0	51.3
41	325.25 MHz	72.9	72.9	53.0	53.0	51.3

Note: The test cable distribution system consists of:
- 20 Jerrold SXTA-450C trunk amplifiers at +34 dBmV with 6 dB tilt and two diplex filters
- One SXBA-550Q bridger amplifier at +48 dBmV with 9 dB tilt
- Two JLC-7-550 line extenders at +43 dBmV with 9 dB tilt

Table 3: Eye closure percentage

	I	Q
Mod-demod only	20.5	20.1
Upconverter-downconverter	23.3	22.6
Full system	23.3	22.6

Figure 1: QAM modulator



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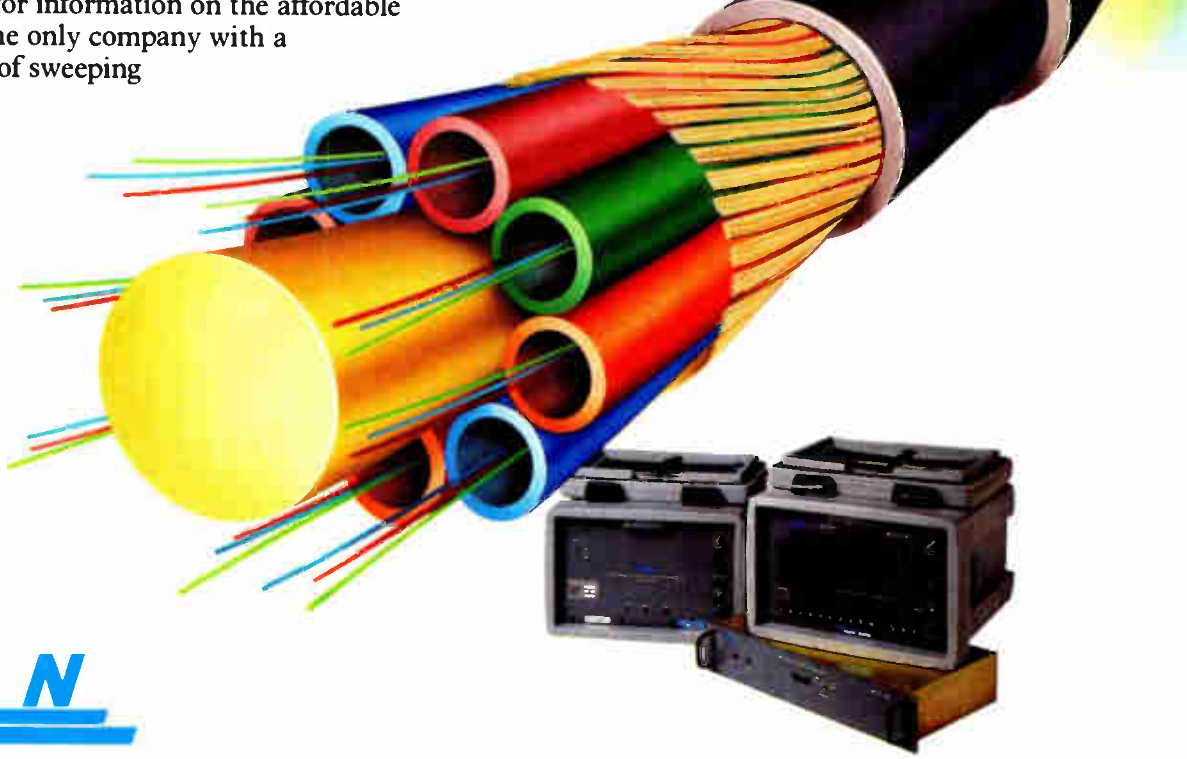

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Testing compressed digital video signals: A case study

It wasn't all that long ago that we read about a proposed new direct broadcast satellite service — SkyPix — that was going to deliver as many as 108 channels to Ku-band DBS subscribers in the early 1990s. The technology to deliver 108 channels would by compressed digital video, which was under development and expected to be available for this application around 1992 or 1993. Well, it's 1991 and the technology is here now; in fact, it was demonstrated at this year's NCTA show.

As many surmised when SkyPix was first announced, almost any bandwidth efficient technology suitable for satellite communications also would work on cable systems. The demo at the NCTA show stressed "the natural marriage between cable delivery and the SkyPix entertainment system," and results of successful tests by Rock Associates in its Coeur d'Alene, Idaho, cable TV system were announced. This article is a summary of those tests, which were supervised by Rock Associates' Ted Chesley, who also is SCTE's Region 7 director. — Ron Hranac, senior technical editor.

By Theodore R. Chesley
Director of Engineering, Rock Associates Inc.

The primary purpose of the tests has been to determine the feasibility of overlaying SkyPix digital signals directly on top of the Coeur d'Alene system's existing 37 channels of analog cable programming. We can now report some definitive results of those tests.

A viable technology

The performance of this technology, with some considerations to be addressed later, is exceptional. The results of these tests show the SkyPix video compression to be a viable technology, especially for use over cable, and with some modifications, has excellent potential for our industry.

Initial activation of the SkyPix receiver at the headend allowed measurement of basic operational parameters off

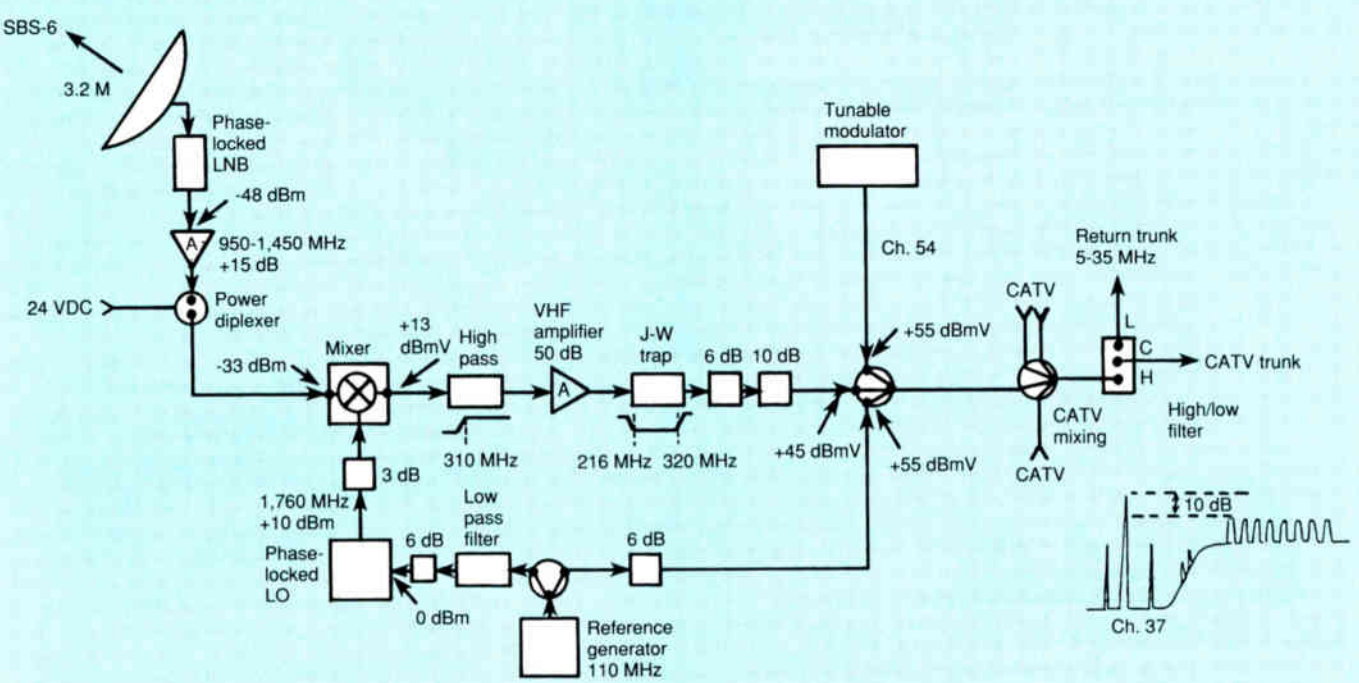
(Continued on page 46)

Table 1: Receiver input measurements at the headend

Input level threshold: -75 dBm (-27 dBmV)[A]
Acquisition time (T/H): 1.5 minutes = flag; 2.3 minutes = menu
Minimum C/N (to breakup): 8.5 dB[B]
Movie acquisition time (from selected menu): 3-5 seconds
Movie refresh time (from interruption): 6-9 seconds
Video S/N unweighted: >55 dB

Notes:
[A] Levels given are converted from dBm to dBmV using a 48.75 dB conversion factor.
[B] C/N of the satellite received signal was determined by aligning antenna off bore sight.

Figure 1: Headend configuration for SkyPix insertion



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Headend must be aligned to manufacturer's specifications. Units that are damaged by shipping are excluded from this guarantee. Units that are originally deemed "beyond economical repair," are excluded from this guarantee.

Reader Service Number 21

Don't mix lightning and cable

By Bob Rapp
Vice President, Marketing
Lightning & Grounding Systems Inc.

Lightning is one of the most beautiful sights on this earth, yet it is one of the most damaging acts of nature. Life and property must be protected. First and foremost is the protection of life. We are all aware of the dangers of lightning to life itself. Such force cannot be handled by the human body. Statistical data has shown that lightning-related deaths and injuries on commercial properties rank third.

The commercial properties of the cable industry are susceptible to lightning discharge. Large towers, headends, main office structures and remote antennas seem to be very attractive targets for the bolts from the sky. Among 1,000 lightning-related casualties, 14 percent of the deaths and 21 percent of the injuries were in commercial or industrial locations.

The cost of lightning-related damage recorded has risen drastically in the past few years from millions of dollars annually to billions per year. Why such a drastic increase in dollars lost? The answer: The more sophisticated the equipment the more prone it is to lightning damage. Electronics and computers run the industry and these delicate pieces of equipment are fair game for lightning.

The cable industry also must educate itself about the dangers of not protecting its structures from lightning. The legalities of the situation have changed drastically in the recent past. Lightning deaths and or related injuries while on the job were considered an act of God. Fundamentalists of the law argued that there was not a legal recourse from a lightning-related injury or death, and won. Now, with lightning protection systems that have proven capability, cases have been fought and won in the opposite direction. A precedent has been set that the owner of the structure or its lessee now has the responsibility to protect employees and visitors located on or around the structure from lightning-related injury or death.

Outages are one of the main causes of customer dissatisfaction and, consequently, disconnection of the service. Lightning plays a big part in this interruption of service. Protection from lightning must be weighed against the consequences of downtime and loss of revenue. Every part of the cable industry is feeling the business downturn. Most cable companies have put in place an austerity program to save money and help cash flow. Don't put the protection of employees, equipment and customer satisfaction on the option list.

Three different areas must be dealt with to assure the protection of all the cable industry's concerns: 1) grounding, 2) surge protection on electrical and telephone lines, and 3) lightning protection. This discussion will be limited to main office structures, headends and towers.

Grounding

Grounding is the first and foremost concern in the protection of structures. Without an adequate grounding system, surge and lightning protection do not properly function. What is a good ground system and how do you get it in place? A good grounding system consists of a low-resistance ground with all grounded mediums connected for equal potential of all grounds. Equal potential of all grounded mediums requires bonding the electrical and telephone grounds, water pipes (if they are of a metallic material only) and all other grounded metallic systems that enter the structure.

Bonding assures that all grounded mediums' potentials rise and fall at the same rate. This process protects life and property during fault situations and lightning strikes. In the case of a lightning strike, equal potential protects against a "side flash." Side flash is the lightning strike seeking a better and easier path to ground and "jumping" to and/or through some other object to reach the easiest path to ground. Side flash is the most damaging reaction of a lightning strike, with the most potential to cause death, injury, explosion, destruction and fire.

Low-resistance grounding is for the protection of life and sensitive equipment. A low-resistance grounding system helps every minute of every day to dissipate static buildup, fault conditions and lightning strikes. A 5 ohm resistance is a good example of where your grounding system should be. The problem is how to get to 5 ohms and keep it there.

Very simply, a ground loop of lightning protection conductor consisting of 28 strands of 14 gage copper conductor should be installed around the structure or structures and connected together. This ground ring also should have a series of either copper-clad ground rods or electrolytic grounding electrodes. (The latter is recommended for its consistently lower resistance in all soils, including bed rock.) The

(Continued on page 49)


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The powering of fiber-optic systems

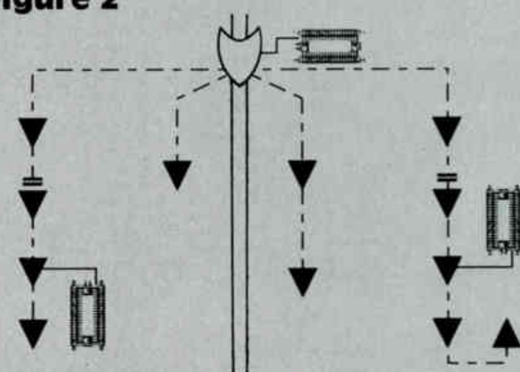
By Jerry Schultz
President, Power Guard Inc.

In the early days of planning fiber systems it was very difficult to determine just what the powering requirements might be. Some engineers thought that only small power supplies with ratings of 5 amps or less would be needed, others felt that supplies of 15 amps or even higher would be necessary. As actual fiber-optic system designs begin to emerge, it is apparent that more than one powering scheme will be used. The only thing that appears certain is that most if not all fiber transmitters and related equipment will be utility line powered at the headend, generally using the existing powering system. From the node (fiber receiver) on out, however, powering requirements will be significantly different.

Node powering

The node is the point at which your powering choices really begin. As you might expect, feeder design will vary from system to system and engineer to engineer, and will be based on system requirements as well as the designer's preference. Some systems will employ maximum use of fiber with no broadband distribution amplifiers, just line extenders and splitters, such as in fiber-to-feeder or star architectures. (See Figures 1 and 2.) This type of design minimizes the number of RF amplifiers in cascade, thus providing the best possible signal to the customer's home. Systems that already have good quality RF distribution systems in their outlying areas may find this type of system financially unacceptable.

Figure 2



Symbol legend

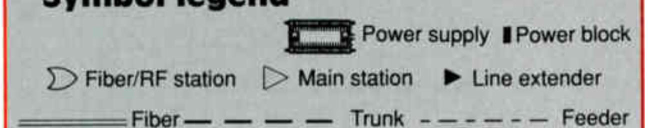
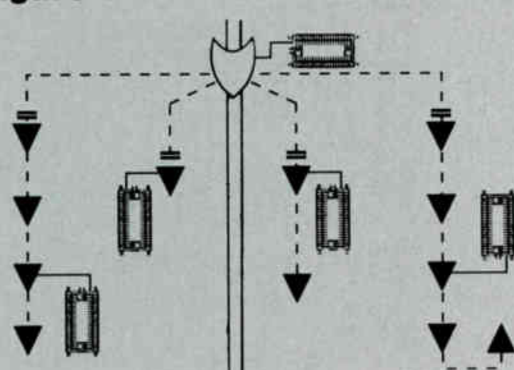


Figure 1

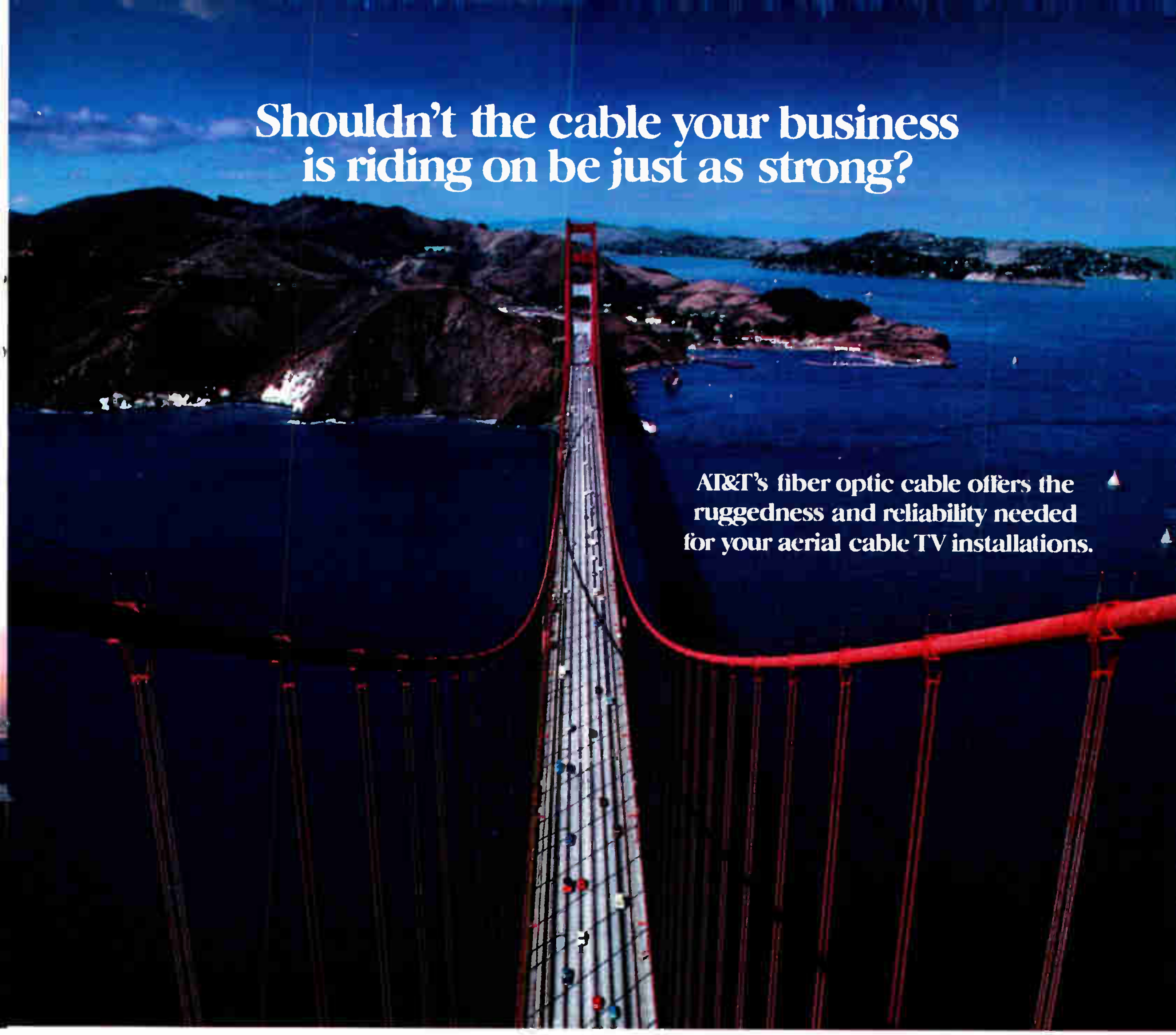


To maximize the use of existing equipment and still make major improvements in the signal quality, a combination of fiber trunk and RF distribution (fiber backbone architecture) may be used. (See Figures 3 and 4.) Many combinations and variations of these systems also may be used to achieve maximum utilization of the existing plant. So then what will determine how a feeder network should be powered? When should standby power be used in a node?

"No supply with an output rating of over 15 amps should ever be used in any distribution system."

Before we attempt to answer these questions a few general comments are in order. One of the main advantages of a fiber system over RF is the high reliability. Since there is nothing in the trunk runs other than the fiber, the primary limitation on fiber reliability is the fiber itself. The use of standby power in a fiber system does not automatically guarantee you better reliability than non-standby for the following reasons.

(Continued on page 53)



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Digital transmission

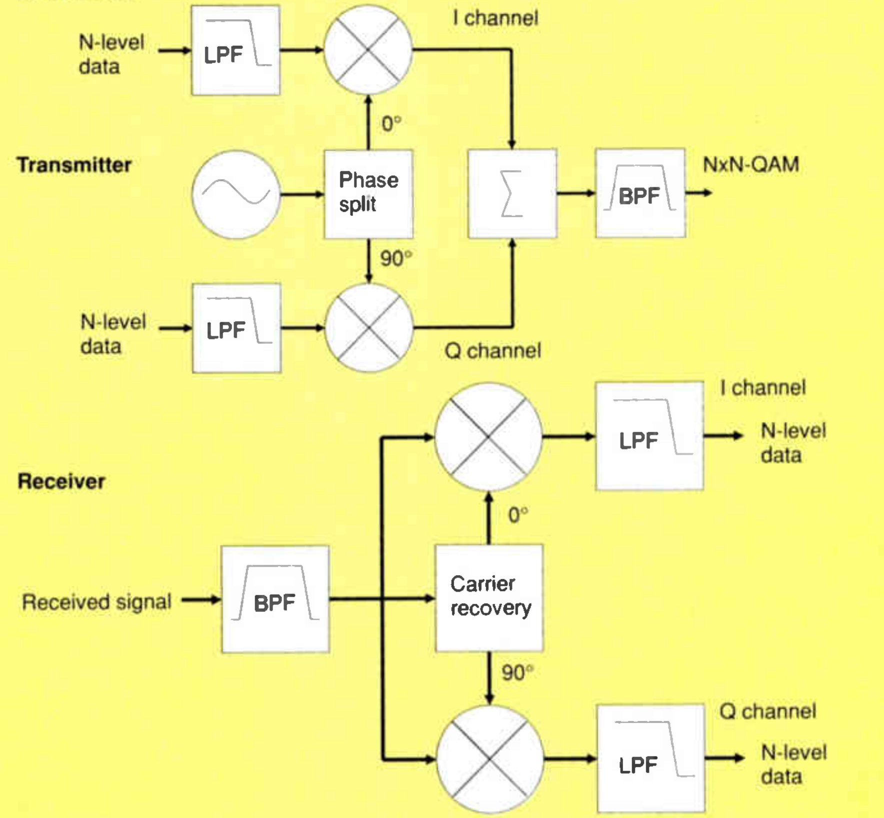
(Continued from page 24)

the data waveform.

What happens if we introduce a second carrier in quadrature phase but modulated in the same manner as the BPSK case? The two phase states for this new carrier will be 90° and 270°. Since the cosine has a value of zero for both 90° and 270°, our detector produces no output. We can, therefore, discriminate between the two carriers. A diagram of our digital transmission system is shown in Figure 3. By providing both an in-phase and quadrature carrier at the receiver, we can demodulate both transmitted carriers. The two channels are commonly referred to as I (in-phase) and Q (quadrature-phase).

You will often see diagrams of modulation formats that show the discrete modulation states. These diagrams are convenient for gaining an understanding of different modulation types. A diagram for the case we have just discussed is shown in Figure 4a. In this constellation diagram, carrier level is represented by radial distance from the origin and carrier phase is represented by the angle. The plotted points represent each modulation state for various combinations of data input. We have added the constraint that the bits in the I and Q channel are time coincident. That is, the time at which each bit value is sampled is the same in both channels.

Figure 3: Digital transmitter and receiver simplified block diagrams



There are four states that depend on the bit values in I and Q. When I and Q are both "1," for example, the I channel phase is 0° and the Q channel is 90°. The resultant of the combined wave is an amplitude of 1.414 and a phase of 45° (the upper right "dot" in the diagram). The combined wave will be separated by the synchronous demodulator into I and Q as we already have discussed. This modulation type is 4-QAM (quadrature amplitude modulation) or QPSK (quadrature-phase shift keying).

Other modulation formats can be used as well. We can simply add more discrete levels to each channel so that more bits can be represented by each symbol. Another format using four levels in I and Q (16-QAM) is shown in Figure 4b. With 16-QAM, we can represent four bits per symbol. These added bits do not come without penalty, however, as we will see in the following section. →

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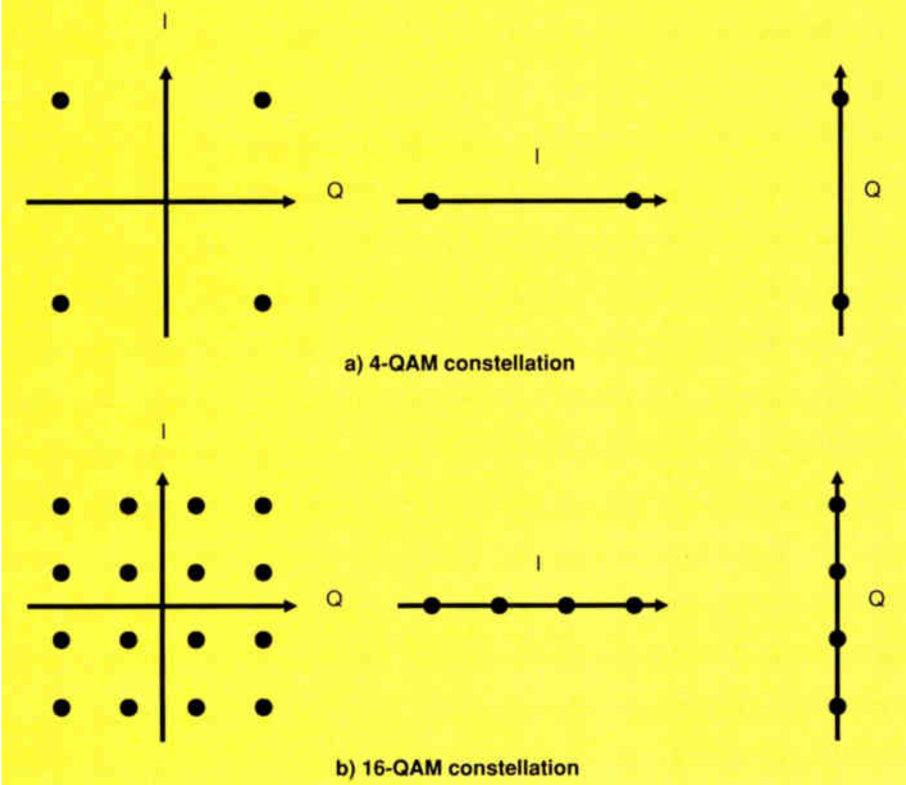
Figure 4: Constellation diagrams



Bandwidth and power

We stated at the beginning that getting more TV pictures within a given bandwidth (or a much higher quality picture) is a major objective for digital TV. While compression reduces the amount of data required, the modulation format must be efficient in the use of bandwidth as well. Consider the BPSK case with two levels and only one carrier. If we modulate a carrier with a sinusoid of frequency F_m, a sideband is produced above and below the carrier frequency by F_m. The channel bandwidth must then be at least $2F_m$. Since one cycle of the sine wave can represent two successive bits, we can transmit data at a rate, $2F_m$, or one bit per hertz of channel bandwidth. Adding a quadrature carrier does not increase the bandwidth requirement but doubles the data capacity to two bits per hertz of channel width. If we know the number of levels in I and Q, we can further increase the number of bits per hertz. We can achieve four bits per hertz of channel bandwidth with 16-QAM, which has four levels in I and Q. This is, of course, a simplified view. The actual channel filters that can be realized and their effect on inter-symbol interference (ISI)[4] must be taken into account. There is also the matter of power to be considered.

As we increase the number of levels in the data, it seems intuitively apparent that we will have more difficulty in distinguishing between levels[3]. Carrier power is usually limited by factors such as interference, linearity, etc. We are not free to increase the carrier power as we increase the number of modulation levels and thus the power difference between levels decreases. The accompanying table[5] shows how power requirements vary with the increase in number of modulation levels.

Expressing the level as C/N in decibels is familiar to cable TV engineers. The filters used in digital systems can vary depending on design trade-offs and practical constraints. C/N can become ambiguous when the noise bandwidths of systems are not the same. Because of the ambiguity, one often finds a less familiar term, E_b/N_0 in digital systems. The relationship between these two expressions follows[6]:

$$E_b/N_0 = C/N\ B_n/f_b = C/N_0\ 1/f_b \qquad \textbf{4)}$$

Where:
E_b = energy per bit
N_0 = noise power density
C = carrier power
N = total noise power
B_n = noise bandwidth
f_b = data rate in bit/second

It is convenient to express performance of a system as a function of E_b/N_0, particularly in theoretical comparisons, since the specifics of system realization need not be considered. The relationship described previously provides a means for conversion to (or from) C/N, which is generally the parameter that can be measured.

Clearly there is a tradeoff between data rate and power in digital transmission. We can increase the data rate transmitted if we can achieve the needed C/N. The second form of Equation 4 expresses the E_b/N_0 in terms of C/N_0. That form makes it clear that the required carrier power is dependent on data rate regardless of the bandwidth used.

Forward error correction and error concealment

The performance of an analog system such as NTSC is usually expressed in signal-to-noise (S/N) or signal-to-interference ratios and various channel impairments. These impairments include linear and non-linear distortions. The performance of a digital system is usually expressed as bit error rate (BER). BER is the ratio of error bits to total bits. A BER of 10^{-8} means there is an average of one error bit for every 10^8 total bits transmitted.

In analog systems there is a direct relationship between the S/N or other impairment and the visible effect. There also is a continuous range of degradation of the signal. As S/N degrades, the picture becomes worse but there is no sharp change at some S/N level. In digital systems there is no direct relationship between the channel performance and the visible effect. There also are threshold effects in digital transmission that cause error rate to increase dramatically when the C/N falls below some specified value. How this BER will affect the picture will depend on the type of compression algorithm used, among other things. While we cannot relate the channel impairment to a visible effect, we can measure the effects of channel performance on BER[4].

In any case, it is desirable to have the link operate to as low a C/N as possible. Forward error correction (FEC) often is employed to allow operation at lower C/Ns. An FEC code adds bits that allow errors not only to be detect-

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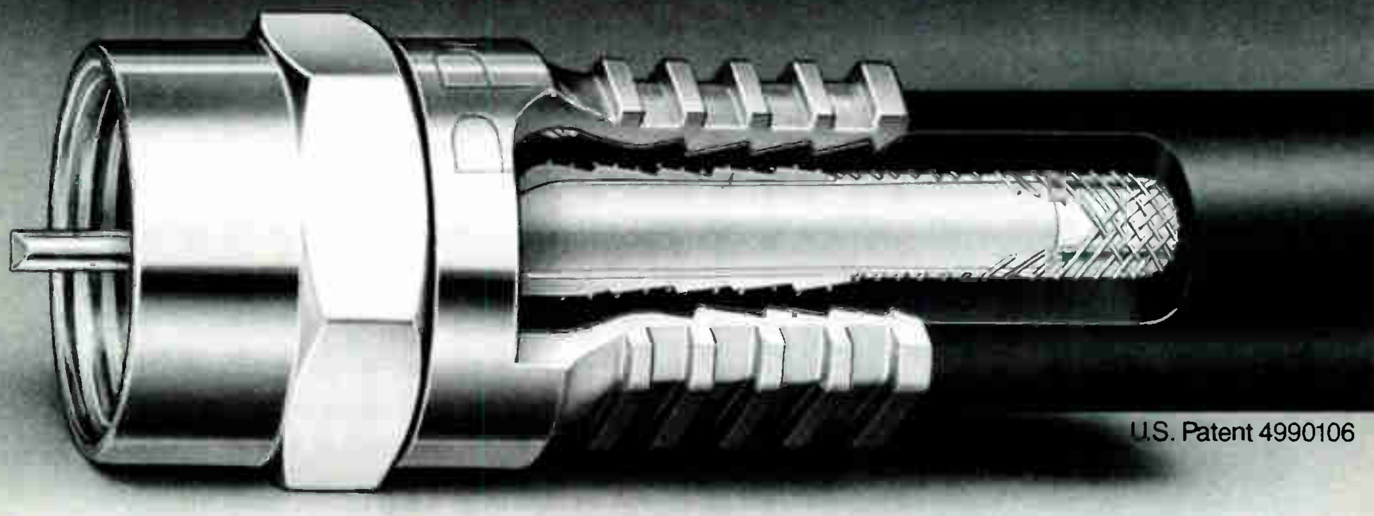

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ed but also to be corrected. There are several different FEC methods that are employed such as block codes or convolutional codes. These can be complicated in their detail. They all involve a process of systematically adding bits based on systematic combinations of data bits.

Take an extremely simple example. Suppose we wish to transmit three bits a, b and c. We add three bits, d, e and f such that $a + b + d = 2^1 = b + c + e = a + c + f$. When we receive the data, we perform the same operation. If we find that $a + b + d \neq 2^1$ and $a + c + f \neq 2^1$, then "a" is in error. If we find $a + b + d \neq 2^1$ and $a + c + f \neq 2^1$, then "b" is in error. If we find only $a + b + d \neq 2^1$, then "d" is in error.

Of course, larger numbers of errors, even though detectable, cannot be corrected. As the rate of errors increases further, even detection becomes impossible. The actual FEC codes used can improve BER by orders of magnitude. Sometimes more than one FEC method is applied sequentially. The improvement in BER is achieved at the expense of added bits that reduce the data capacity available for the signal. Even so, the improvement in C/N performance often outweighs the capacity reduction.

"The success of digital TV will depend as much on implementation of modulation techniques as on selection of compression methods."

Even after application of FEC we have a threshold effect. Below some C/N the system becomes unusable. Error concealment can allow more graceful degradation as the C/N drops below threshold. One method of concealing detected but uncorrectable errors is to interpolate between temporal or spatial samples that do not have errors.

Another approach would be a hierarchical coding where the image is formed from a basic image with levels of detail added. By coding the basic picture in a robust manner, the detailed information could be dropped when the error rate in that detail became uncorrectable. In fact, the interpolative and hierarchical method could be employed together.

Some compression techniques such as vector quantization can have an inherent hierarchical structure that causes errors in certain levels of data to be less noticeable. The objective of error concealment is to provide useable service in areas where noise and interference do not permit full quality in the same way analog services are used today.

Summary

Digital systems are the focus of much research and development today. A primary reason for this interest stems from compression technology. While much of the theoretical base for this technology has been available for some time, the ability to realize large scale integrated circuits permitting implementation has only recently become practical and has led to rapid growth. We have reviewed the fundamentals of digital transmission, particularly by RF modulation, to provide some insight for those unfamiliar with the subject. The success of digital TV will depend as much on implementation of modulation techniques as on selection of compression methods. **CT**

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[1] G. Robinson, "Selected Topics on HDTV," *NCTA Technical Papers 1989*, pages 5-12.

[2] G. Robinson, "Digital Video: Whatever Happened to Differential Phase and Gain," to be published, *NCTA Technical Papers 1991*.

[3] Members of the technical staff of Bell Telephone Laboratories, *Transmission Systems for Communications*, Revised Fourth Edition, Western Electric Co. Inc., Winston-Salem, N.C., 1971, page 97.

[4] Leo Montreuil and William Wall, "Performance of Digital Modulation Methods in Cable Systems," to be published, *NCTA Technical Papers 1991*.

[5] Dr. Kamilo Feher, *Advanced Digital Communications Systems and Signal Processing Techniques*, Prentice-Hall Inc., Englewood Cliffs, N.J., 1987, pages 329, 389.

[6] Dr. Kamilo Feher, *Digital Communications*, Prentice-Hall Inc., Englewood Cliffs, N.J., 1983, page 158.

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DMV

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Digital video for CATV

(Continued from page 26)

should be secondary to picture quality as the fundamental system determining factor. Note that once a system is selected it must satisfy everyone, from the videophile to the casual viewer, for many years to come.

2) The system should be flexible enough to support the various operation methods used with present analog video systems (e.g., satellite delivery with local addressability and billing control, commercial insertion on satellite feeds and off-air or studio-direct video feeds). Closed captioning must be accounted for, as well as second language audio.

3) Any large increases in home receiving equipment prices should be offset by decreased cable plant costs. The receiver must be able to process standard analog signals to allow for a

Figure 2: QAM demodulator

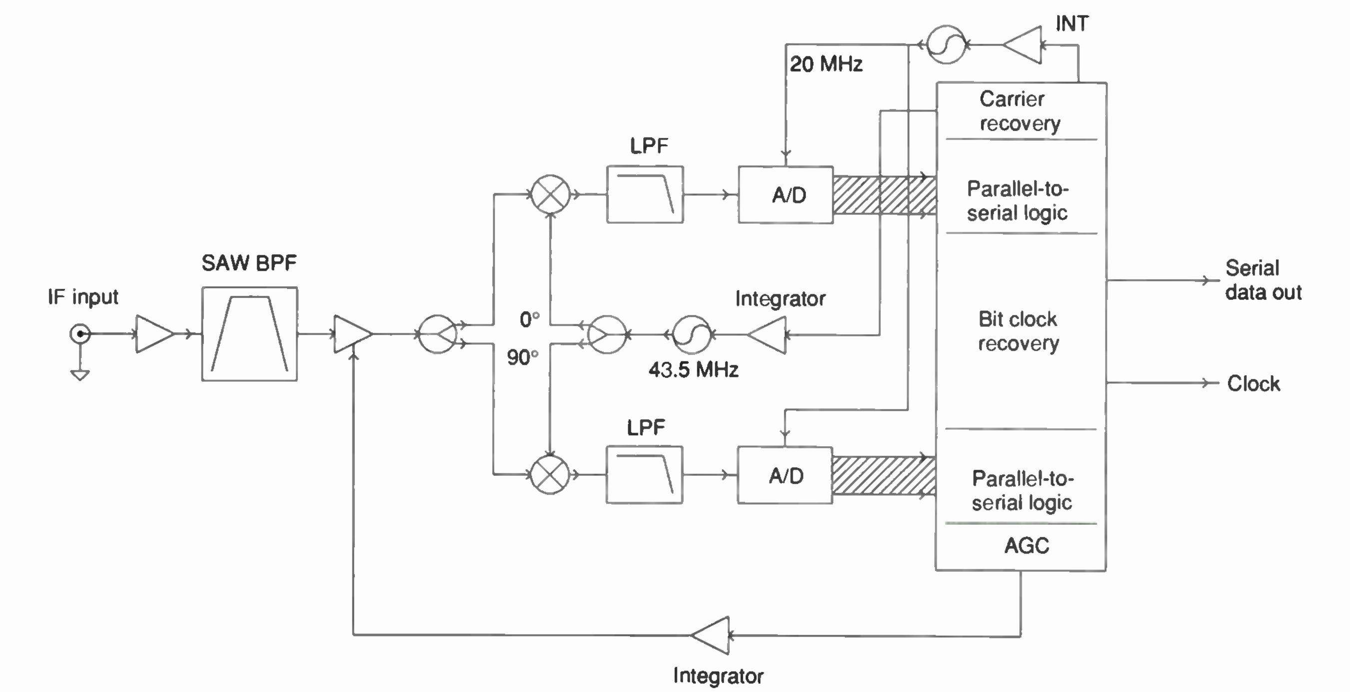
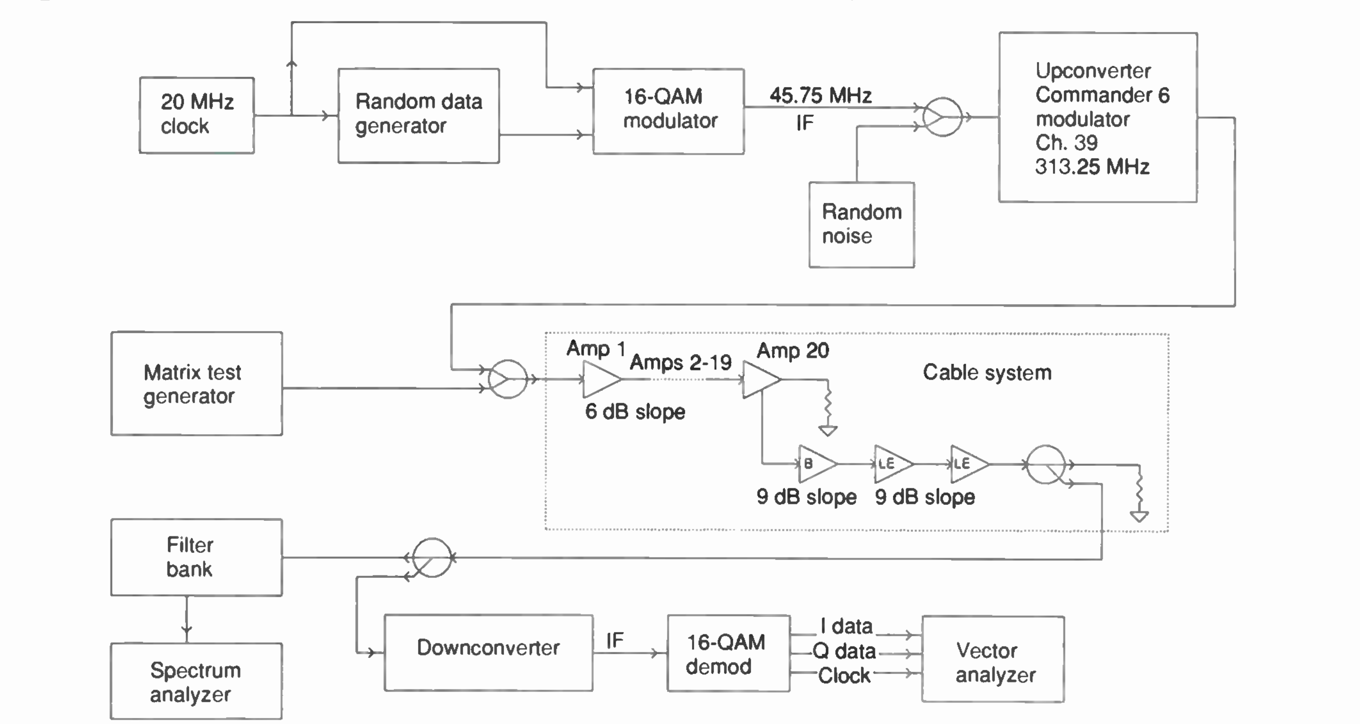


Figure 3: Combined AM-VSB and 16-QAM over cable test setup



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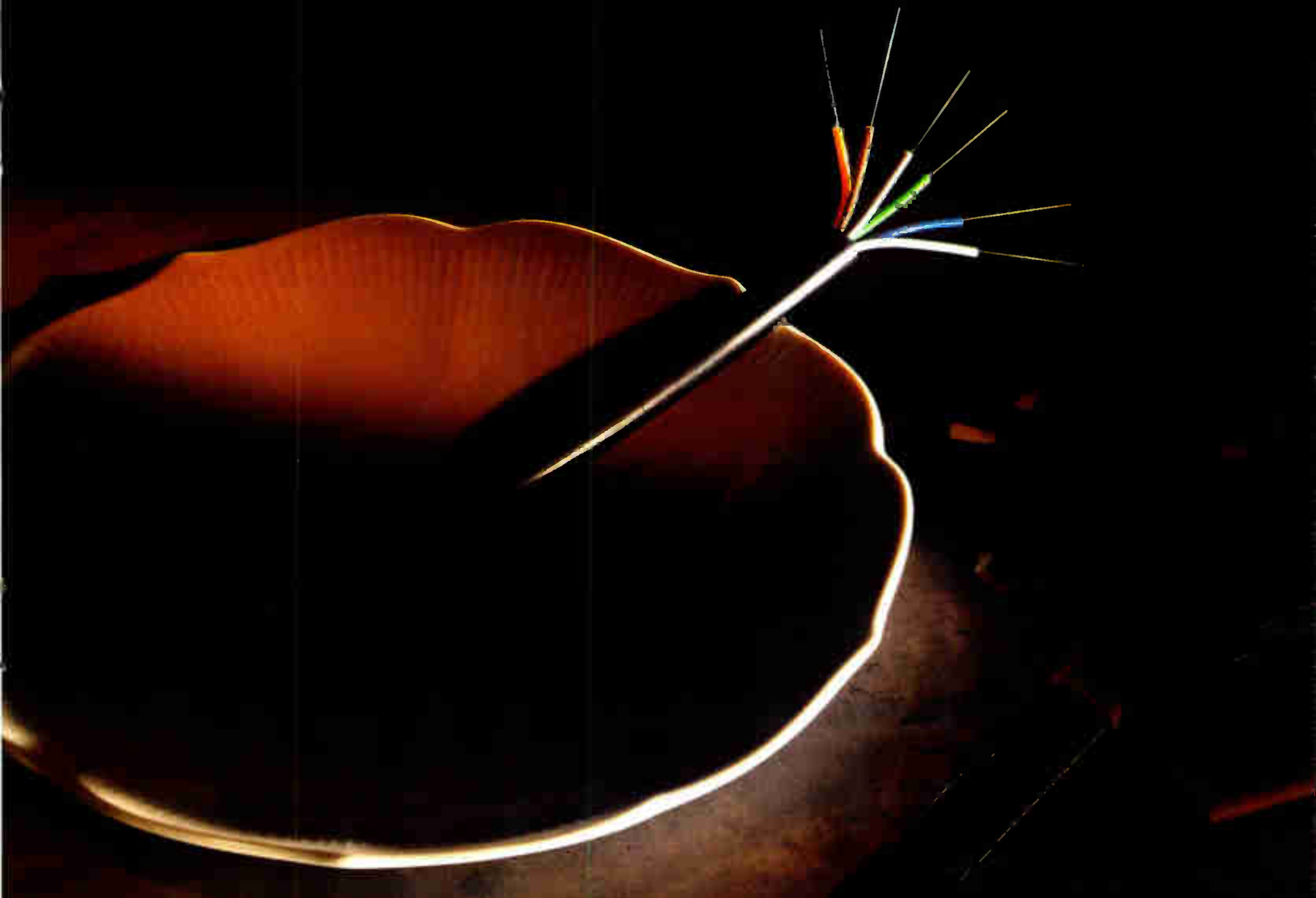

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Figure 4

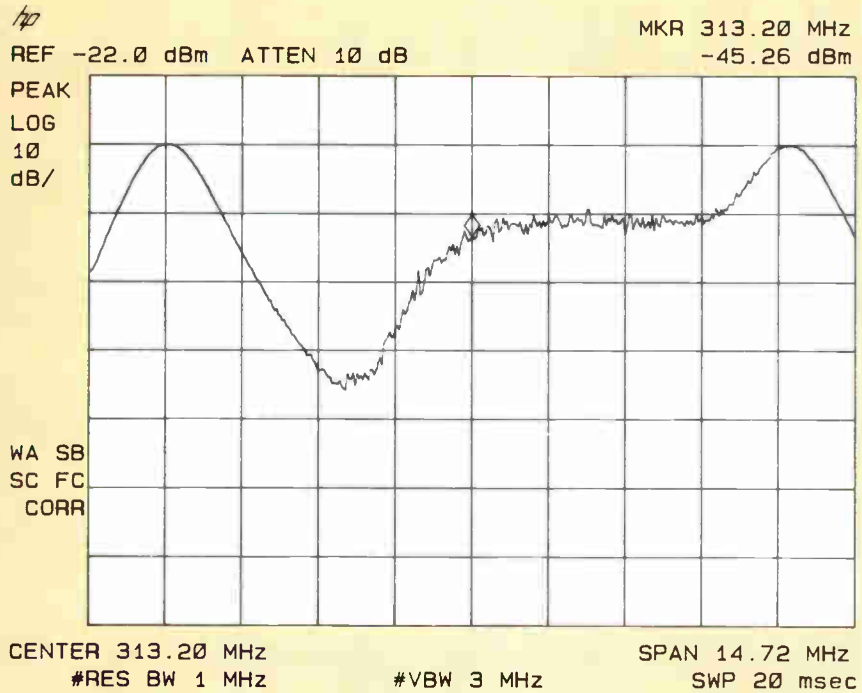
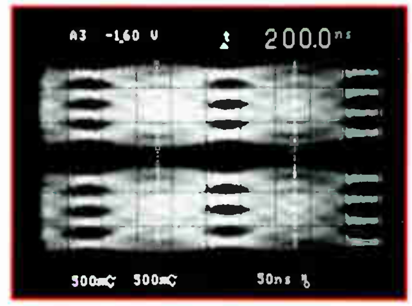


Figure 5



phase-in period for digital services.

Assuming these three goals will be met, there are two more requirements. They have been tested, and the results follow.

1) The chosen data modulation format, together with error detection and correction, should result in a somewhat more robust signal than the current AM-VSB video. In other words, the digital video should still be operating perfectly when the analog video has degraded to the point of generating service calls or customer complaints.

2) Carrying digital video should not have a negative impact on the picture or sound quality of analog channels.

Techniques

There are many different data modulation techniques. Table 1 shows a few of the commonly used methods. Moving down the table, we see

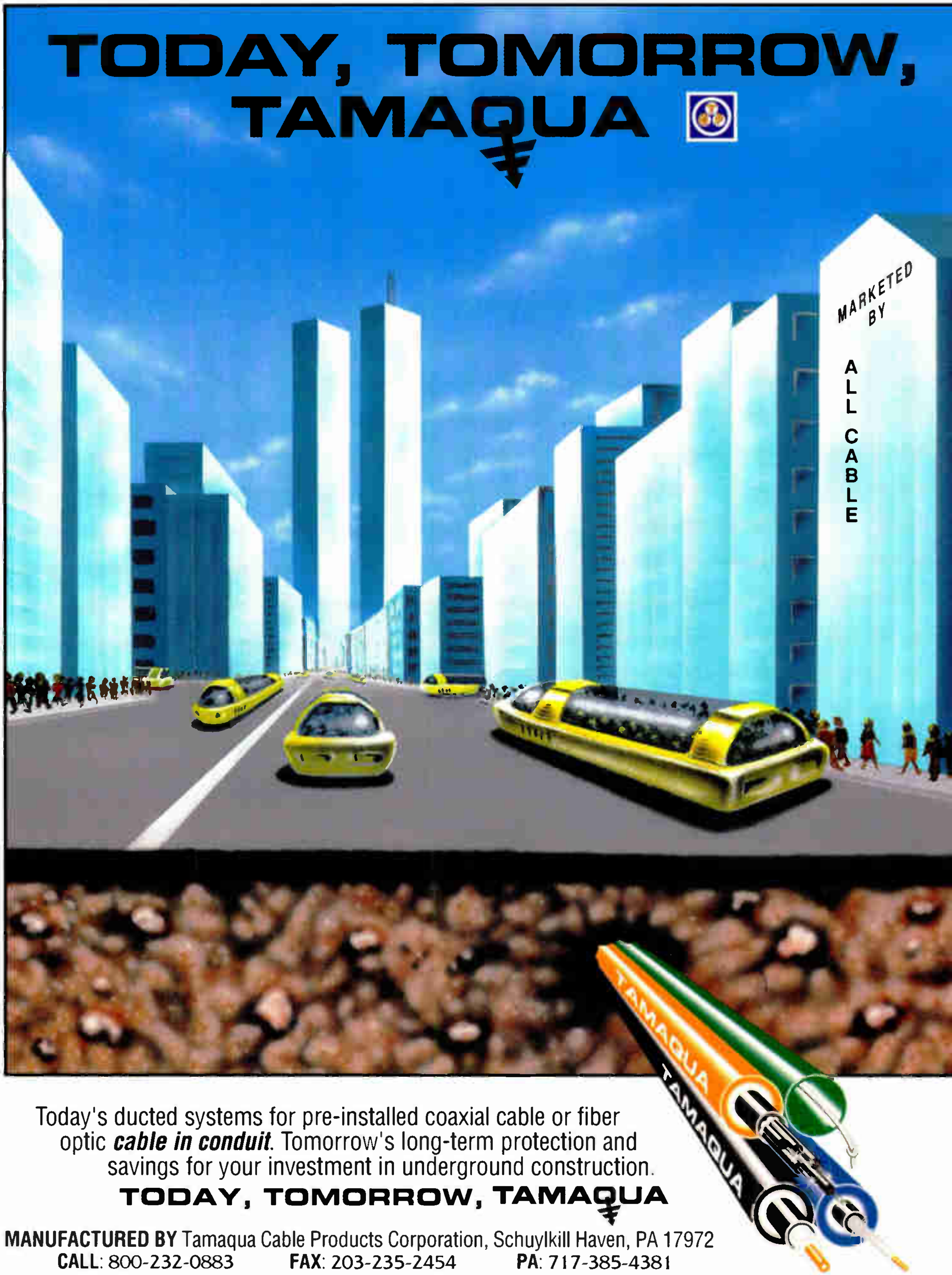

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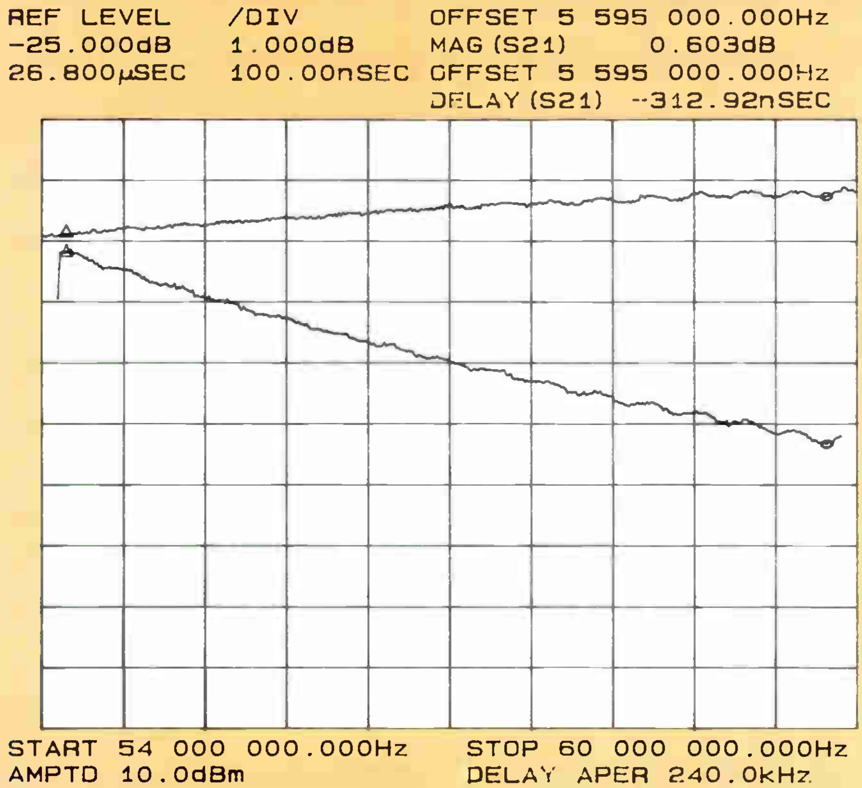
Figure 6



increasing spectrum efficiency, but the price paid for efficiency is a requirement for higher integrity of the received signal.

We selected the 16-QAM (quadrature amplitude modulation) method for testing over cable because it has reasonable efficiency with relatively high robustness (Figures 1 and 2). A 20 Mb/sec. random data stream was modulated using 16-QAM and upconverted to Ch. 39. The 16-QAM was combined on the test cable system with the Matrix multifrequency generator output (Figure 3). The QAM signal was carried 10 dB below video carrier level (Figure 4). Distortion readings were taken with and without the QAM signal present. There was no measurable difference in video distortion (Table 2).

Eye closure is a measure of the degradation to a data signal's eye pattern. The more closed the eye, the more susceptible the signal is to errors. The eye closures for the received I and Q data signals were measured. The cable distribution test system did not affect eye closure compared with the upconverters and downconverters connected back-to-back. (See Table 3 and

"In the not too distant future, digital transmission will allow the delivery of video into the home with studio-quality pictures totally free of any transmission artifacts."

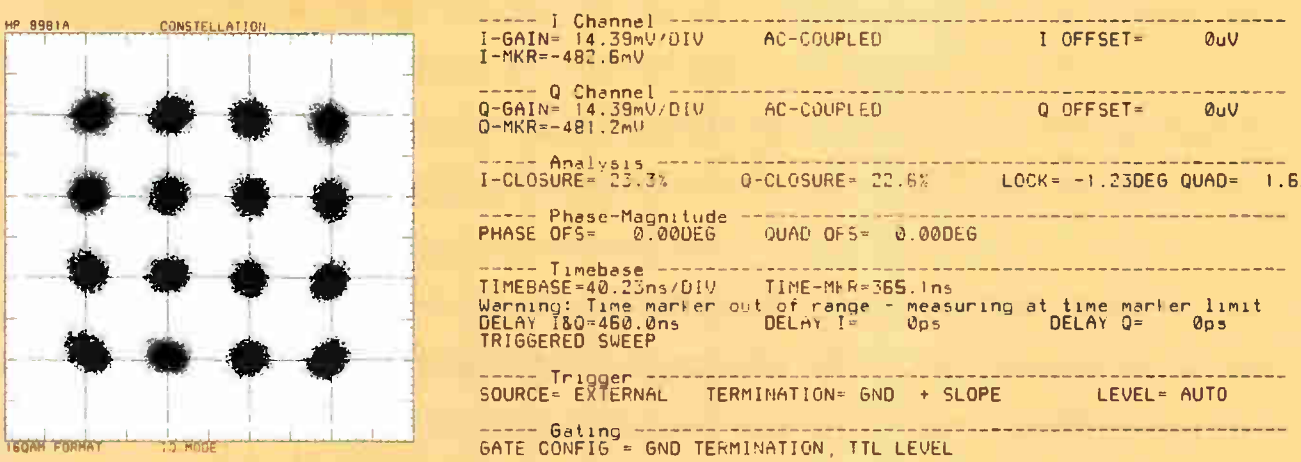
Figure 5.)

When the 16-QAM signal was tested on Ch. 2 it did not operate at all. A network analyzer plot indicates why (Figure 6). The group delay from the 40 sub-split diplex filters across Ch. 2 is longer than a bit period. This also makes Ch. 3 unusable. Beyond Ch. 3, the entire cable pass band is usable for 16-QAM transmission. Practically speaking, it is most likely that the upper frequencies, beyond existing channels, would be the first place where digital video channels are carried.

Since the test cable system had very good performance, random noise was intentionally added to simulate a poor quality system. At 35 dB C/N for the analog video channels (25 dB for the digital signal) no change in performance was visible. At 30 dB, errors became visible in the vector display (Figure 7), but at a rate that's correctable and still operational.

This short set of tests, although limited in scope, indicates that cable systems are very compatible with data transmission at speeds that will support compressed digital video. In addition, the digital signals will not degrade existing analog channel picture quality. **CT**

Figure 7



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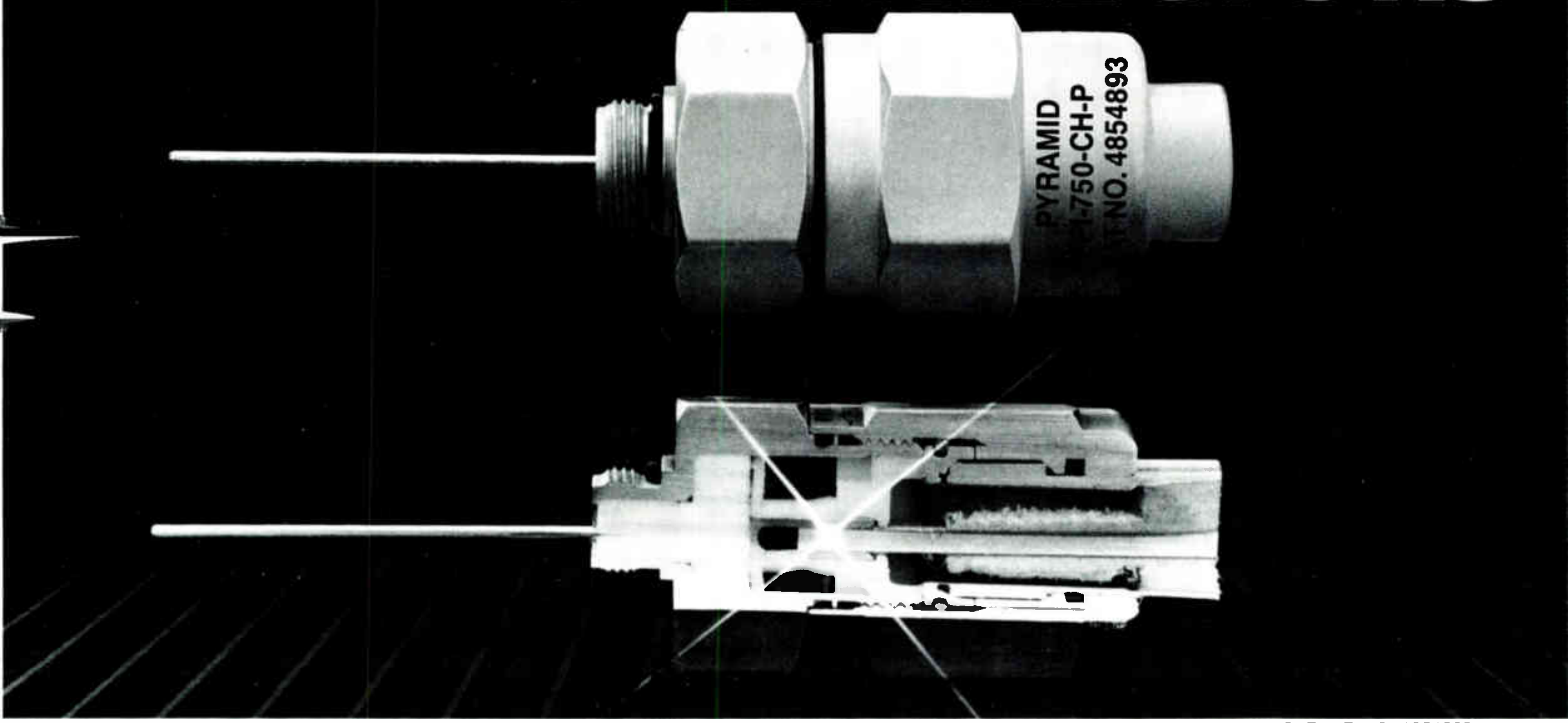

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SkyPix compression

(Continued from page 28)

the LNB. Since the receiver used is the standard SkyPix box, provision was made to block downconvert a portion of the 950-1,450 MHz spectrum (in essence Transponder 19, 1,400-1,429 MHz) to 330-360 MHz in the VHF range. This was accomplished by using a 1.760 GHz phase-locked local oscillator (LO) driving a stand-alone Minicircuits mixer (Model ZFM 2000) as shown in Figure 1. The LO is referenced to 110 MHz from a Wavetek RF generator, which also is added to the CATV spectrum to allow phase lock of an upconverter at the receiver. Measurements of the receiver input at the headend yielded the results in Table 1.

Two phase-locked LOs were obtained from Tampa Microwave. These were referenced to 110 MHz from the Wavetek generator. The stability of this arrangement assured positive receiver lock-up and signal acquisition.

The SkyPix spectrum and the 110 MHz reference were added to the system through the headend combiner. The data was inserted 10 dB below visual carriers and the 110 MHz reference at the visual level. The combined digital and CATV spectrum was transported to the Coeur d'Alene office through 15 trunk stations, a bridger and one line extender. Extensive testing of the system at the office location was conducted using the setup in Figure 2 with the results in Table 2 (applies to upconverted signal). The parameters in Table 2 held for all VHF input levels. Note that the noise performance and threshold levels are identical to those required directly from the LNB.

Since the system distortion required to affect performance would be far greater than tolerable in an analog system, there is no reason to expect to approach these levels even in a very long cascade. This also indicates that the receiver

Table 2: Test results

Parameter	Analog visual	Data
Threshold input level	-15 dBmV	-74 dBm (-26 dBmV)
Carrier-to-noise (dB)	15	8.5
Intermodulation (dB)	21	11
Acquisition time (T/H) min.*	1.5 flag, 2.3 menu	
Movie acquisition time*	3-5 secs	
Refresh time*	9 secs	
Video S/N unweighted	>55 dB	

*Average times

Figure 2: Compression test setup

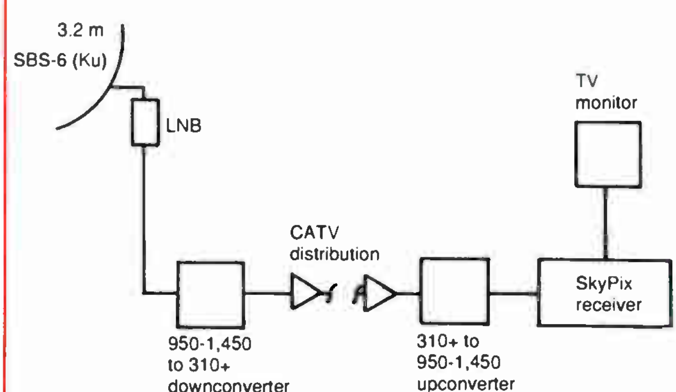


Table 3: Reference oscillator phase-lock tracking test

Deviation frequency	**400 Hz**	**1 kHz**
Peak deviation to:		
Intermittent breakup	±4 kHz	±1 kHz
Complete loss	±6 kHz	±2 kHz

input requirements are very tolerant of drop level. A -20 dBmV digital drop level simply could be amplified 10 dB and the receiver still would work fine through the upconverter.

To examine the receiver performance through a complex set of conversions, we looked at it through the broadband AML microwave system in Athol, an adjoining community. This is a 550 MHz microwave system feeding a 450 MHz plant. Since this is a collinear path and is down somewhat in receive level, it simulates about 13 trunk amplifiers in cascade; adding the five trunks after the microwave makes an effective total of 18. The microwave converts the VHF spectrum up to 12 GHz, and it is repeated at an intermediate point, Round Mountain, then received at the Athol receiver, which is phase locked to the transmitter via a 74 MHz pilot. With varying drop levels into the upconverter, the receiver performed exactly as at the office, which is identical to the performance at the headend. This leads us to believe the performance should be identical under varying CATV transport conditions.

Potential problems

Now to the source of potential problems. Two causes of unreliable operation have been identified: 1) carrier frequency stability and 2) signal integrity. As to carrier stability, we have found that by properly phase locking the up- and downconverted carriers, stable operation can be achieved. The two carriers don't necessarily have to be phase locked together, but by using the same reference this method works much better. We phase locked the up- and downconversion local oscillators to two separate reference 110 MHz generators. Although the receiver operated fine, it was more sensitive to slight changes in one oscillator or the other. However, it worked even better locked together.

Our experience confirms this significant fact: As long as the conversion oscillators are stable, the receiver input is above threshold, and system noise and distortions are normal, the receiver duplicates its performance observed directly off the LNB.

We conducted an experiment to see how much we could frequency modulate the reference carrier and still have reliable operation; the results of this test are shown in Table 3. This indicates the stability of the system with a phase-lock reference carrier on the CATV spectrum is quite good.

Another potential impact on reliability of the system is intermittent signal loss from poor connectors or cabling in the CATV system. We are all well aware of the intermittents caused by wind, radial cracks, poor fitting preparation, etc. An intermittent interruption can cause noise to appear in either analog or digital pictures. For digital, this causes a characteristic checkerboarding effect, and at the worst will cause a freeze frame and a refresh interval of nine seconds or so. Note that the preceding applies to active programming only; the menus don't react to noise. This is a problem with all forms of transmission. With the industry emphasis on system integrity for RFI and signal leakage control, most systems already should be pretty tight.

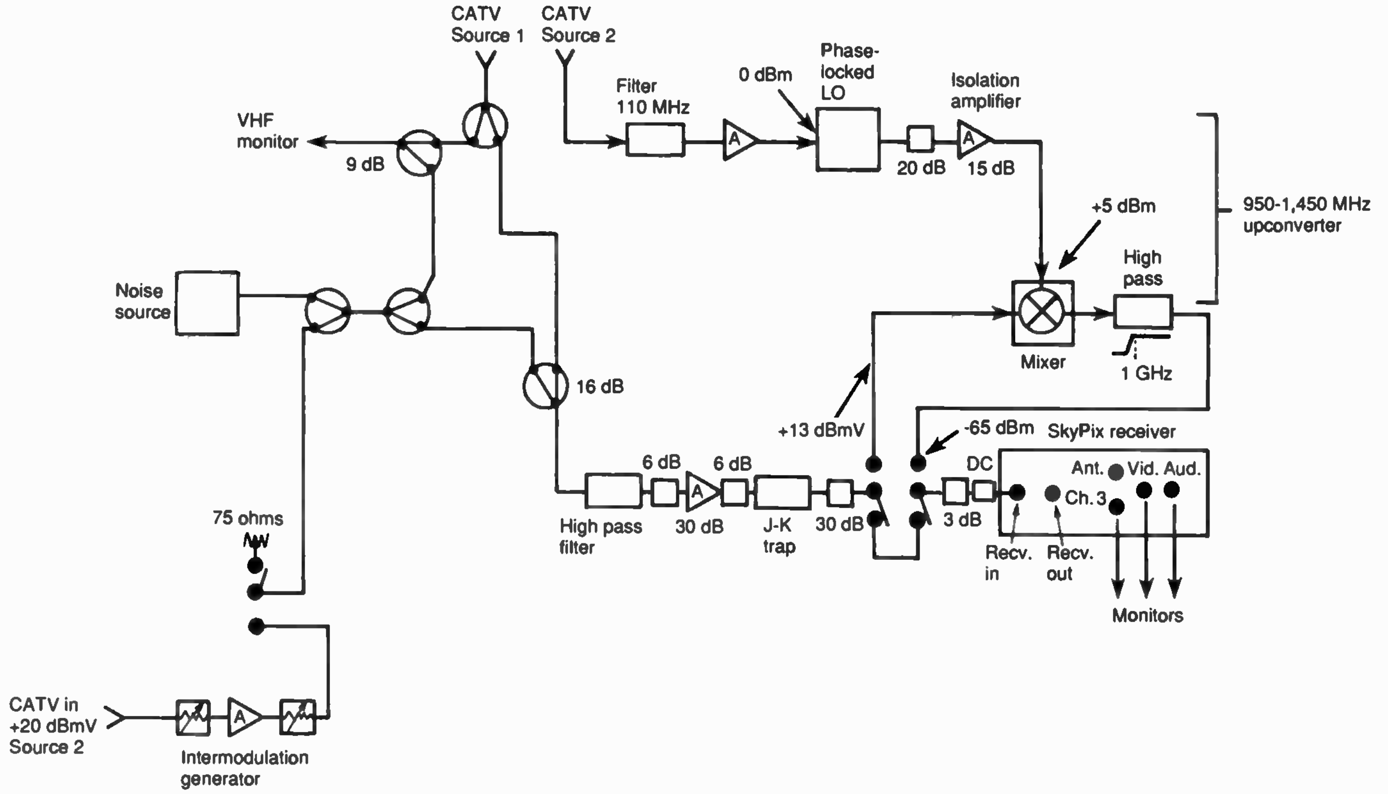
Another consideration with compressed video is the use of high level system sweeps. The receiver has difficulty with acquisition in the presence of these sweeps and, if acquired and on a movie, will break up to varying degrees. To operate high level sweeps with this system in place, we would have to either notch trap the sweep signal over the bandwidth occupied by the data carriers, or possibly use a non-interfering type of sweepless sweep, such as Tektronix or CaLan.

Equally important to eliminate are single frequency spurious carriers from the headend, such as local oscillator leakage, that overlay the digital signal. Headend "cleanliness" easily is obtained by adding a VHF notch trap to the cable spectrum prior to insertion of the compressed carriers. Although most leakage of this type is well below the inserted satellite noise floor it may be best to trap. In regard to the block converted satellite noise floor, it is obvious that we must carefully filter this spectrum to prevent satellite noise in the VHF cable spectrum. Again, this is easily and cheaply done with low cost filters.

Evaluating SkyPix

To allow us to evaluate the SkyPix system, we developed a test arrangement of stand-alone components and equipment to first get the signals on the cable, then reconvert them to a form (950-1,450 MHz) that the receiver could use (Figure 3). In actual practice, the equipment configuration would be greatly reduced in number of components by interfacing the receiver directly at VHF and using integral downconverters at the headend. We also used a high pass filter at the receiver upconverter mixer input to prevent overload

Figure 3: Compression test receiver setup



"As long as the conversion oscillators are stable, the receiver input is above threshold, and system noise and distortions are normal, the receiver duplicates its performance observed directly off the LNB."

from the 10 dB higher VHF carriers.

It is well understood what we must do to properly receive and process the SkyPix signals onto the cable system, giving attention to proper filtering to separate the bands of signals. Using separate LOs and mixers tied to a common reference, we can either block convert or channelize incoming satellite transponders to VHF slots. For CATV headend use I would recommend a phase-locked LNB referenced to an external VHF source, preferably to the same source we use for our downconversion oscillators. In this way we can ensure absolute frequency stability among all conversion sources. The reference frequency can be diplexed onto the same cable going to the LNB, or a separate cable can be used. For CATV use this is a practical option since these types of LNBs are available.

Having converted the satellite signals to cable, the type of receiver conversion is important. We would provide the VHF compressed band to the receiver and use the receiver's internal LO to convert directly to the required IF, very similar to the common CATV converter. We can, in fact, do this with the test receiver. The dynamic range of the receiver can be adjusted to work over a +15 dBmV to -10 dBmV range so no internal AGC circuitry would be required. If we do require AGC, a composite AGC would work fine.

Added distortion

As to the question of added distortion to the CATV system, we must look at these carriers differently than we do VHF TV carriers. Examining the spectrum containing the data carriers it is apparent they look like 2 MHz wide bands of noise. There is no coherent carrier energy as such, therefore they can't be plugged into conventional distortion formulas the same way we would calculate continuous energy carriers such as VHF signals. It is best to look at these as noise levels that we are turning on and off at a 2 MHz rate. Since we have filtered this band from the VHF spectrum, no interaction occurs between the two bands. If we look at the data as noise, a simple formula for noise addition can be used; since the amplifier noise is at a very low level in comparison to this, it doesn't appear that much degradation would occur with increased channel loading.

The characteristics of the digital signals also impact other areas of cable TV concern. Because these signals contain no coherent CW energy, the interference potential to other services is very low, improving the signal leakage criteria. And since these are compressed digital video signals, they are inherently scrambled, removing the necessity of the complex scrambling/descrambling schemes used with analog transmission. The receiver also is addressable and set up for impulse viewing, providing the desirable features of analog addressability.

In the Coeur d'Alene system we are continuing to pursue testing of this technology and are quite pleased with the repeatability of results. As we've found, the performance remains the same as long as the basic criteria are met. This easily should be achieved in all cable systems. **CT**

Lightning and cable

(Continued from page 30)

ground loop should be bonded to all legs of the tower and antennas, and a minimum of two inside common ground bars in the headend or office structure. Jumper bonding of all metallic equipment in the headend is required, with jumpers attached to the common ground bars.

To achieve the 5 ohm resistance goal is not just a matter of chance. Nor does it just depend on the amount of copper you install at the site. Someone with expertise in this field should calculate the material required and the installation procedures. This person can save money by comparing systems and their results to the monetary considerations of the project. Some grounding books are available that are very useful but lack the comparison of electrolytic grounds to copper-clad ground rods.

Surge protection

Protection from surges is the next consideration in your protection system. The electrical system is one of the easiest places for lightning to penetrate the defenses of the headend or main office structure. Not only can lightning invade via a direct strike, it can come in via the main electrical feeders. Burying the electrical cables does not protect from the intrusion of lightning into the structure. Induction of the lightning charge into the electrical cable below grade is quite common.

The best protection for the electrical service is a very strong surge suppressor at the service entrance. A metal oxide varistor (MOV) is the standard for this frontline protection. The MOV unit should be able to handle a 60 kA surge and react in less than 5 nanoseconds. The unit should have indicator lights to make checking its condition easier. Interior fusing should be utilized for added safety.

Replaceable MOV modules are recommended for reasons of economy. There is not a transient voltage surge suppressor made that can handle the largest known lightning strikes, and therefore replaceable modules are needed. This unit should be installed via a breaker on the main panel or a disconnect on the main bus. The reason for the breaker or disconnect is to allow servicing of the suppressor without shutting down the complete electrical service.

Along with the MOV a very fast suppressor should be included — one that will react in less than 1 nanosecond to protect the most sensitive electronic equipment. A silicone avalanche diode (SAD) is the standard for this application The weakness of the SAD is that it is not strong and can only withstand a 1 kA surge. Therefore, it must be used in conjunction with the MOV to protect the SAD from the strength of large surges. Again, inspection lights, interior fusing, replaceable modules, and breaker and/or disconnect utilization for installation are needed for protection required at the headend and main office.

The telephone and data lines also are a main source for lightning and surge introduction into the headend and main office. These lines service the most delicate equipment within the structure and must be protected. The standard for the industry is a SAD with the less than 1 nanosecond reaction time.

The installation typically is beside the telephone board. A metal junction box made specifically for the application is utilized along with a backboard made to install the SAD cards. These cards have a "dirty side" and a "clean side." The

"Large towers, headends, main office structures and remote antennas seem to be very attractive targets for the bolts from the sky."

incoming dirty side is hard wired to the incoming lines at the service entrance. The clean side is where the lines are connected to the equipment being protected. (All coaxial conductors that enter the structure also should be protected, but these applications won't be discussed in this article.)

The grounding system and the surge suppressors also should be bonded to a transient suppression plate consisting of a sheet of 26 gage (minimum) pure copper, measuring 3 feet by 4 feet. The plate acts as an "absorption cushion" for the larger surges and easy dissipation of the smaller static buildups.

Also check with the electrical utility company to ensure that it installs a lightning arrester on the pole or before your service entrance. The lightning arrester will help, but it won't be the only device required to protect the electrical equipment. The telephone company also may have gas tube protectors available for the service's main entrance. Check with the telephone company to ensure it installs this protection. Again, the gas tube is not the only thing required to protect the equipment but will help protect the SAD within the structure. Many utilities will install these protectors at little or no charge to the customer.

Lightning protection

The final link in the chain is the lightning protection system. Many are led into a false sense of security by having the grounded tower close to the headend. Thinking that this tower/lightning rod will protect all of the facility may lead to injury or worse. The lightning must be controlled and led to ground in the quickest and easiest way.

For years the only protection utilized was the typical lightning rod on top of the tower, using the tower's metal legs as the down conductors. Damage to a side-mounted antenna by lightning was common, if not by direct strike, by the induction of the strike being run through the tower's metal legs.

Now available are the early streamer-emitting air terminals to protect the tower and a wide area of the facilities. These "high tech" lightning protection systems are now being used in installations in more than 33 countries throughout the world. The units utilize an early and stronger emission of a streamer to capture the lightning strike and take it to the low-resistance grounding system. Insulated down conductors or bare conductors in PVC conduit should be utilized to help with the retardation of charge induction to the equipment along the tower. Surge suppression is a consideration on all equipment installed on the tower to ensure the best protection available.

These units are available through electrical distributors throughout the United States and worldwide. Design, installation and/or supervision are available from the manufacturer at a minimum charge to ensure a quality installation.

By using these lines of protection in your cable systems, your company is providing a safer and more consistent system to protect your employees, equipment and long-term customer satisfaction. **CT**

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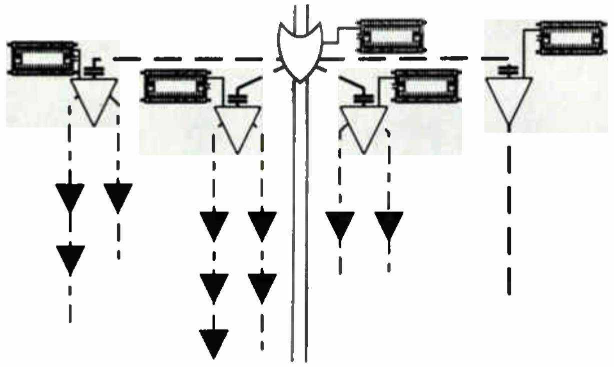
Figure 3



Fiber powering

(Continued from page 32)

All standby supplies are more complex than non-standby ferro supplies, therefore they may be more prone to failure. Second, all standby supplies must have batteries, which have always been the weakest link in the chain. Add this to the much higher cost of standby supplies and their associated batteries, plus the greater maintenance cost, and you may find that standby power isn't always the best solution to every powering situation. As this concept receives a broader acceptance throughout the cable industry we may see less standby in use, even in systems that have been traditionally 100 percent standby.

Another important factor that should be considered when choosing your power supplies is the output current rating, since ferro supplies operate far more efficiently and reliably at or near their full load rating. Matching the correct supply to the load should not be a problem since supplies with 3 to 15 amp ratings are readily available. Last but not least, it is my opinion that no supply with an output rating of over 15 amps should ever be used in any distribution system. This is due to the destructive nature of the higher short circuit current found in all supplies of 18 amps or more.

The first question to be answered when choosing power supplies for a fiber build would be: Should I use standby power on the node? Some designers will in fact use standby power on all nodes, while others prefer not to use standby power at all. The best approach would be to consider each node individually to determine the need for standby power. If a node serves a large section of plant that is to be powered from two or more power grids, standby power should be considered.

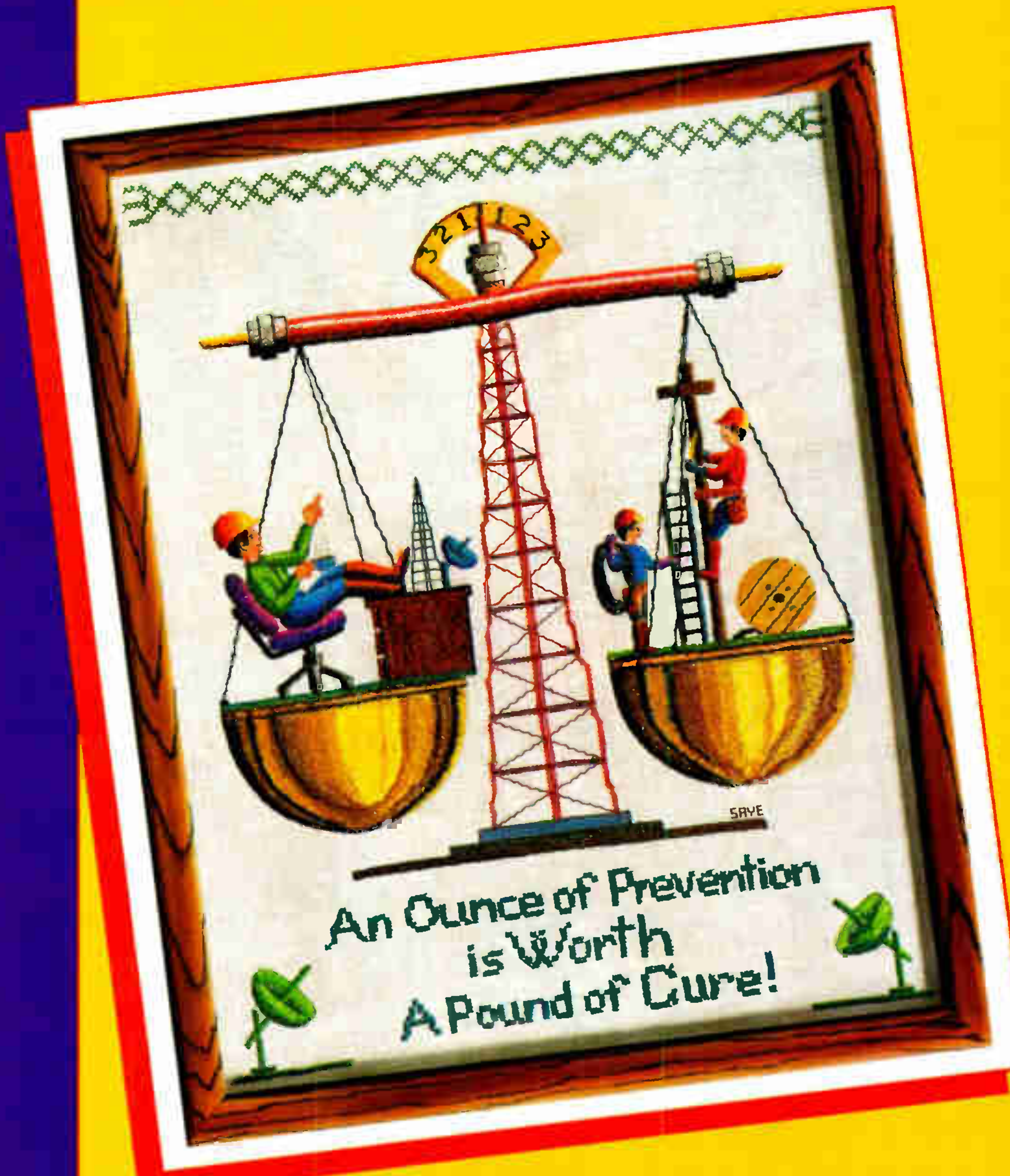
There also are two schools of thought on what should be powered from the node supply. One method is to power only the fiber receiver from a small 3 amp supply leaving the powering of all RF equipment to other supplies (Figures 1 and 3). The advantage is a short that occurs in the equipment connected to one port can't affect the operation of the other ports. Another method is to use a large power supply (12 or 15 amps) to supply the node, as well as the first one or two RF amplifiers out from each port. (See Figures 2 and 4.) This could reduce the overall number of power supplies needed in the system. If the node has standby power and the RF ports feed distribution amplifiers, the larger supplies also would provide backup power to these amplifiers. The larger node power sup-

May 1991

Preventive maintenance

BACK TO BASICS

The training and educational supplement to Communications Technology magazine.



Geri Saye

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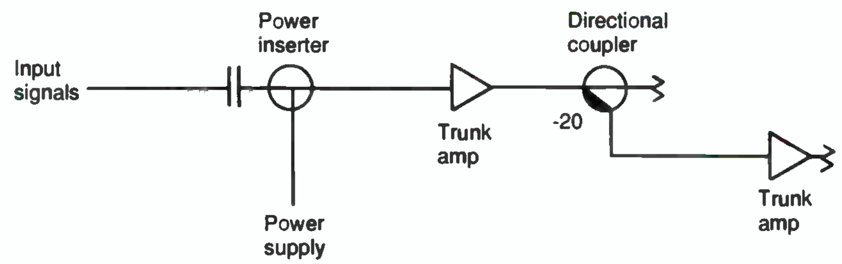
Formerly Installer/Technician

Comparing amplifier noise figures

By Tod D. Dean
Chief Technician, Alert Cable TV

Figure 1: Original test setup



Every amplifier adds a certain amount of noise to the signals it amplifies. The amount of added noise is known as the amplifier's noise figure. Obviously, the lower the noise figure the better. The noise figure for a specific brand and model of amplifier can be found in the specification sheets available from the manufacturer. A typical modern trunk amplifier will have a noise figure somewhere between 5 and 9 dB.

An interesting point is that if you were to take 10 sample amplifiers (all the same brand and model) and compared actual measured noise figures, you would find that some had lower noise figures than others. This is especially true of used amplifiers — not brand new equipment — even more so if some of the amplifiers have been repaired. You can use this information to your advantage.

Which is noisier?

Ideally, all of the trunk amplifiers of a given make and model should have the same, or nearly the same, noise figure. This will ensure optimum carrier-to-noise performance throughout the system. An excessively noisy amplifier anywhere in the system may degrade picture quality in spite of proper signal levels. Any amplifier that falls outside of the manufacturer's specs should be repaired.

There's an easy test to tell which amplifiers are noisier than others. It only requires a signal level meter and a test bench setup of two amplifiers in cascade. First set up the amplifiers as shown in Figure 1.

Make sure that the signal levels into the first amplifier are typical for your system. Balance both amplifiers. Next, get as many spare amplifier modules as possible. One by one, install them in the first amplifier location and balance them using the same pad and equalizer used in the first module. Now, change your test setup as shown in Figure 2.

Terminate the input of the first amp with a known 75-ohm terminator. →

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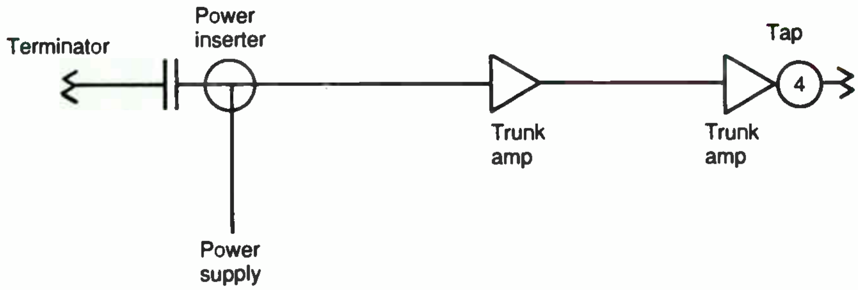
Figure 2: Second phase of test setup



By removing the directional coupler between the amplifiers and keeping the connecting cable short, we greatly increase the signal level into the second amplifier. This allows the gain of the second amplifier to directly add to the output level of the first amplifier, which gives us a noise level high enough to read using a typical signal strength meter. Do not use more than two amplifiers in a row for this test. The noise power present in three or four amplifiers configured this way may result in compression or possible equipment damage.

Test principles

To better understand what we are doing, let's look at the theory behind the test. The thermal noise produced by a 75 ohm impedance (the input terminator) at room temperature (68° F) measured in a 4 MHz bandwidth is -59.16 dBmV. Each amplifier in our test setup has 22 dB of gain. The noise figure of each amplifier is unknown (we'll estimate it at 7 dB each). The cable and connector loss between amplifiers is minimal, so we'll disregard it in this situation. The gain and noise figure of each amplifier will add to the thermal noise level.

If we add 22 dB of gain for each amplifier (44 dB total) to the input noise (-59 dBmV) we get approximately -15 dBmV. Even though the noise figure of each amplifier is approximately 7 dB, the noise level at the output of the second amplifier will be approximately -8 dBmV because the first of the two amplifiers will be the primary noise contributor. (Remember, this is using our specs. Actual results in your system may vary.)

Now back to the test. Install a terminating tap at the output of the second amplifier. Use the lowest value possible, typically a 4 dB two-port tap. Connect your signal level meter to one of the ports of the tap. Do not use the output test point or test probe; the signal level may be too low to accurately measure. Tune the meter to any frequency within the bandwidth of your amplifiers. (For example, between 50 and 330 MHz). The signal you are reading is noise. The level should be relatively flat across the entire bandwidth. Record this level.

Next, remove the amplifier in the first location and replace it with one of the spares modules. Since the spares all have been balanced to the same

(Continued on page 62)

Covering the basics

By Rickey Luke
Technical Manager, Storer Cable Communications

The cable industry has evolved from the five- and 12-channel systems of the past — which used single-ended gear — to the systems of today with 60 (and more) channels. Modern systems utilize TVROs, fiber, sophisticated solid-state electronics, AML (in some cases), power addition and feedforward technologies.

These systems carry tremendous amounts of video and data, which incidentally, extend into over-the-air boundaries set aside for other uses besides television. With all the technological changes our industry has gone through, we sometimes find ourselves so wrapped up in devising new complicated procedures to maintain our system we overlook the simple basic techniques that have always been the foundation of good quality system performance.

Important parameters

At the beginning of the system receive point (whether it is fed from a headend, a fiber node or an AML receiver), we are still concerned with at least three items. The first of these deals with the system parameters that determine the system response, the carrier-to-noise (C/N) and distortions — composite triple beat (CTB), composite second order (CSO), cross-modulation (X-mod).

The system response ideally should be equivalent to the number of amplifiers in cascade divided by 10 + 1. Maintaining properly designed input levels is crucial for good C/N specifications. Every dB that the input level is reduced at any given amplifier results in that given amplifier having a 1 dB worse C/N. Maintaining proper output levels for trunk and feeder is crucial for good distortion specs. Each increase in output level above your prescribed design level can have a 2 dB negative effect on your system CTB and 1 to 2 dB negative effect on your system CSO.

Installation and leakage

Another important basic area to consider is the installation. It needs to conform to good company specifications, the National Electrical Code and the National Electric Safety Code, and a quality connection all the way to the customer's TV set or peripheral equipment is a must.

Finally, another basic consideration that has to be incorporated into system operations is leakage control. As I mentioned earlier, our systems now utilize frequencies allocated for other uses besides television. In order to eliminate potential interference to the cable system from those over-the-air frequencies, proper monitoring and immediate repair to correct such leakage has to be implemented. More importantly, the CATV system should not interfere or cause harmful interference to the over-the-air users of those frequencies — especially the air navigational frequencies.

"If something is loose enough in your system to create a leakage problem, it probably is affecting signal levels on some (or all) of the frequency spectrum."

Also consider that if something is loose enough in your system to create a leakage problem, it probably is affecting signal levels on some (or all) of the frequency spectrum. If this problem is in the trunk system it will have dramatic effect on the system technical performance. Additionally, this type of problem may be frequency-selective depending on varying temperatures and conditions. Therefore it would play havoc with a system's automatic gain and slope controls.

As a final thought, if you find yourself dealing with a unique system problem, unconventional converter problem, or other equipment problems, it is advisable to make sure that you have the basics covered. As so often is the case, we make a mountain out of a mole hill when all we should have taken was the simple perspective. About 99 percent of the time, a back-to-basics approach is all that is needed. It will prove very valuable if we stay on track with the basic techniques, which are just as valuable today as they were in the original five- or 12-channel systems. **CT**

Batteries vs. battery chargers

By Jud Williams
Owner, Performance Technological Products

A recent survey published by the Independent Battery Manufacturers Association reveals the major factor determining the life of an automotive-type battery is climate. In tests, batteries in Vermont lasted an average of 55 months, while in Arizona they averaged 31 months. The survey included inputs from 27 cities throughout the United States and found that the life expectancy averaged 44 months overall.

The report stated: "Higher temperatures, not cold, shorten the life of a battery." It went on to say: "If batteries can be protected from higher temperatures, longer life can be expected." Grid corrosion was the leading cause of battery failure according to the report.

Deadly heat/overcharge combo

Grid corrosion is for the most part caused by a combination of heat and overcharging. By overcharging, I mean subjecting the battery to excessive current during float charge. In many of the standby power supplies in use today, both excessive heat due to the design of the cabinets and overcharging of the batteries due to the use of so-called equalization voltages cause considerable problems in the field.

Sealed lead acid batteries (gelled and AGM) generate internal heat due to the recombination process during recharge. Those containing antimony seem to generate the most heat so when they are placed in an arrangement where three batteries are sandwiched together, the center battery suffers the most (since it is unable to adequately dissipate its heat and because the batteries on each side are radiating a certain amount of their own heat).

Power supply cabinets that locate batteries in the top section are compounding the problem due to the heating effect of the ferroresonant transformer. The batteries are literally being "cooked" from below. All this results in more grid corrosion and shorter battery life.

A new charger design

I was recently afforded the opportunity to design a plug-in battery charger to retrofit a quantity of existing standby power supplies. The major criteria for the design were to salvage the existing power transformers and to make sure the unit fit into the chassis the same as the original. An important aspect of the design was that it was to have a temperature probe reaching down into the battery compartment of the cabinet.

Since I already had an existing battery charger design — an integral part of my standby power supply, which has had extensive field use — I decided it would be the basis for the retrofit unit. My charger uses pulsating DC, which inherently limits the float current when the batteries reach full charge. At full charge, the peaks of the pulses are charging the batteries so that the current is limited to 40 mA. At that level, there is no possibility for internal heating or gassing. The peak voltage put out by the charging circuit is limited to the open circuit voltage of 12.8 V per battery. The output in the case of a two-battery system is between 25.6 and 26 V.

Special charger features

Chuck Beckham of Voltex Batteries suggested a charger would save batteries if it turns off when the temperature reaches a predetermined level. Others felt that the battery charger should be temperature-compensated. It was decided to incorporate a probe reaching into the battery compartment to monitor the ambient temperature at the battery.

The probe was designed so the charger automatically cuts off at 120°F but has an override if the batteries are discharged to below 25 V. The output is set to between 25.6 and 26 V at 77°F with temperature compensation of ±0.04 V per °C. The temperature compensation effectively boosts the battery voltage when the ambient drops below freezing and reduces the voltage when it is hot.

The power transistor that regulates the output voltage of the battery charger is mounted on a heavy-duty extruded finned heatsink for better heat dissipation and is designed to unplug from the printed circuit board to gain access to the components on the board. The transistor is protected from short circuits by a foldback current-limiting scheme.

One feature added to the device was a solid-state timing circuit that eliminates the use of a reed relay to control the transfer relays. A silicon control rectifier is triggered by a simple unijunction transistor timing circuit.

The final outcome is a design that answers many of the requirements for properly charging batteries and is universal enough so it may be adapted to most any type of standby power supply on a retrofit basis. Batteries are expensive and need not be abused by traditional charging schemes. **CT**

My thanks to Keith Hayes for fully testing the preproduction unit at his facility and Chuck Beckham for pointing me in the right direction.

Amp noise figures

(Continued from page 60)

output levels and the input level remains constant, any difference you read on your meter at the output of the second amplifier will be a difference in noise produced by the first amplifier. Test each spare module in the first location and record the noise level at the output of the second amplifier. Any amplifiers that produce exceptionally high readings should be tested by a qualified bench tech and repaired if necessary, or returned to the manufacturer for repair.

Understand that this is not a test to determine the specific noise figure of an amplifier. It is strictly a qualitative way of determining which are the best modules out of a group. By following the previous guidelines we have been able to make a definite difference in the quality of the pictures we are able to provide to the majority of our subs. **CT**

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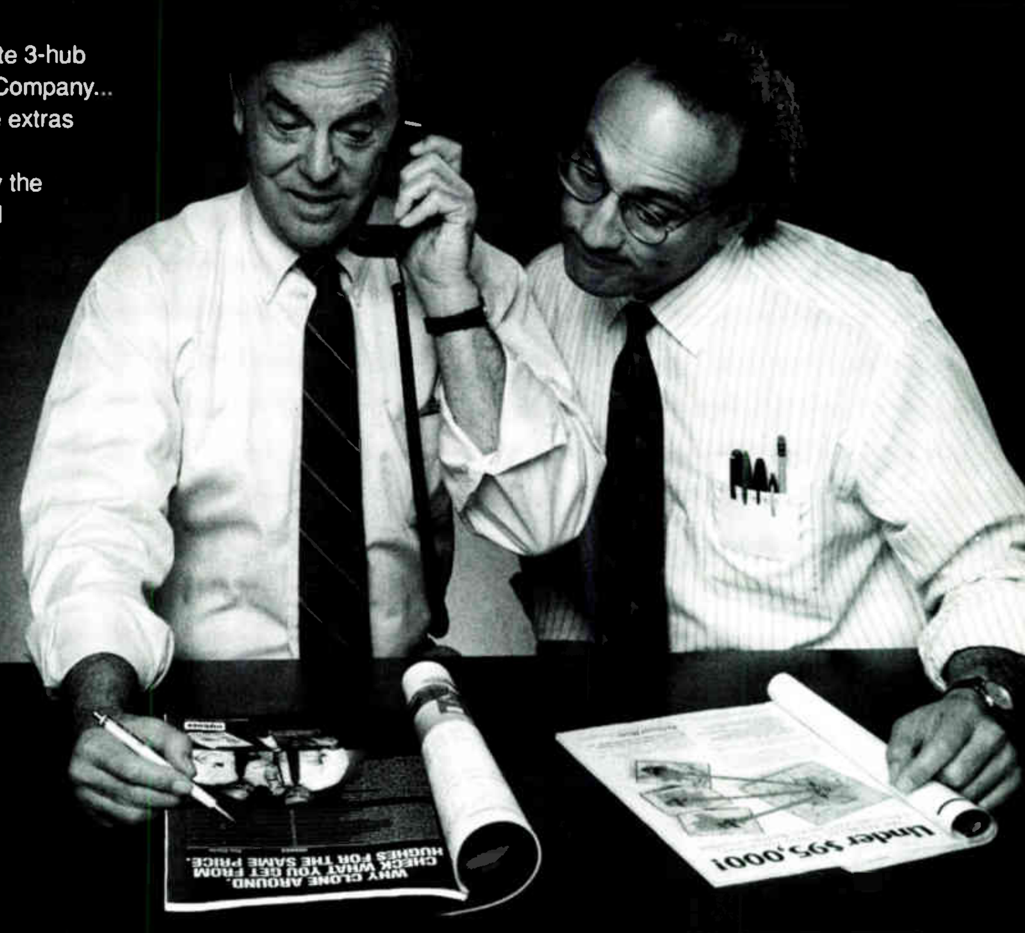

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The Zenith/AT&T all-digital proposal

By Lawrence W. Lockwood
President, TeleResources
East Coast Correspondent

In Washington, D.C., Feb. 28 was another milestone day in the endless saga of the HDTV standards search. On that the last day permitted by the Federal Communications Commission for submission, three organizations joined the all-digital high definition TV (HDTV) stampede with descriptions of their proposed systems. They are Zenith and AT&T, a consortium of NBC, Sarnoff Research Center, Philips and Thomson, and an alliance of General Instrument and Massachusetts Institute of Technology.

This move now makes a total of four all-digital HDTV proposals submitted to the FCC. GI started the ball rolling last summer with its system submission — DigiCipher (see my "Correspondent's Report," August 1990 *CT*, "General Instrument's HDTV proposal").

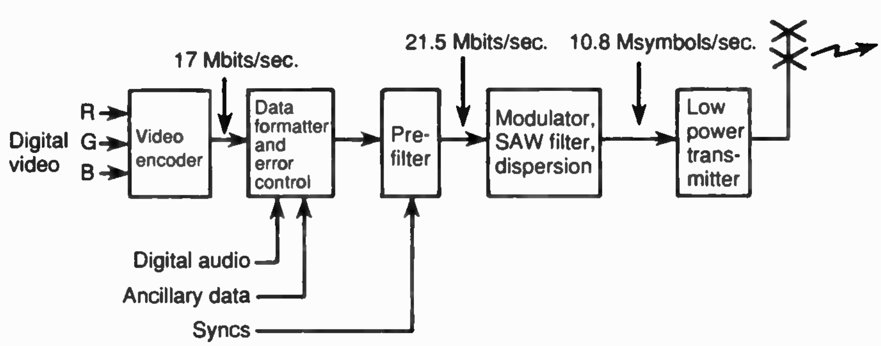
This month I will take a brief look at the Zenith/AT&T system, which they call the Digital Spectrum-Compatible HDTV system (DSC-HDTV). In succeeding months I will do the same for the other two. All the technical material presented is from their formal proposals to the FCC — with some occasional explanatory additions.

DSC-HDTV system parameters (From Zenith/AT&T proposal to FCC)

Video	
Aspect ratio	16:9
Raster format	787.5 lines progressive scanning
Frame rate	59.94 Hz
Bandwidth	
Luminance	34 MHz
Chrominance	17 MHz (U), 17 MHz (V)
Pixels	720 (V) x 1,280 (H)
Sampling frequency	75.3 MHz
Audio	4 channels at 125.87 kbits/sec. each
Data	
Video data	17 Mbits/sec.
Audio data	503.5 kbits/sec.
Transmission	
Data rate	21.52 Mbits/sec.
Symbol rate	10.8 Msymbols/sec.

"All HDTV systems under consideration — whether classified analog or digital — are ... all-digital in the picture compression. The differentiation ... applies only to the signal transmitted."

Figure 1: Transmitter block diagram



DSC-HDTV system overview

A most important observation must be noted: All HDTV systems under consideration whether classified analog or digital are — every single one — all-digital in the picture compression. The differentiation — analog or digital — really applies only to the signal transmitted. In some cases — the

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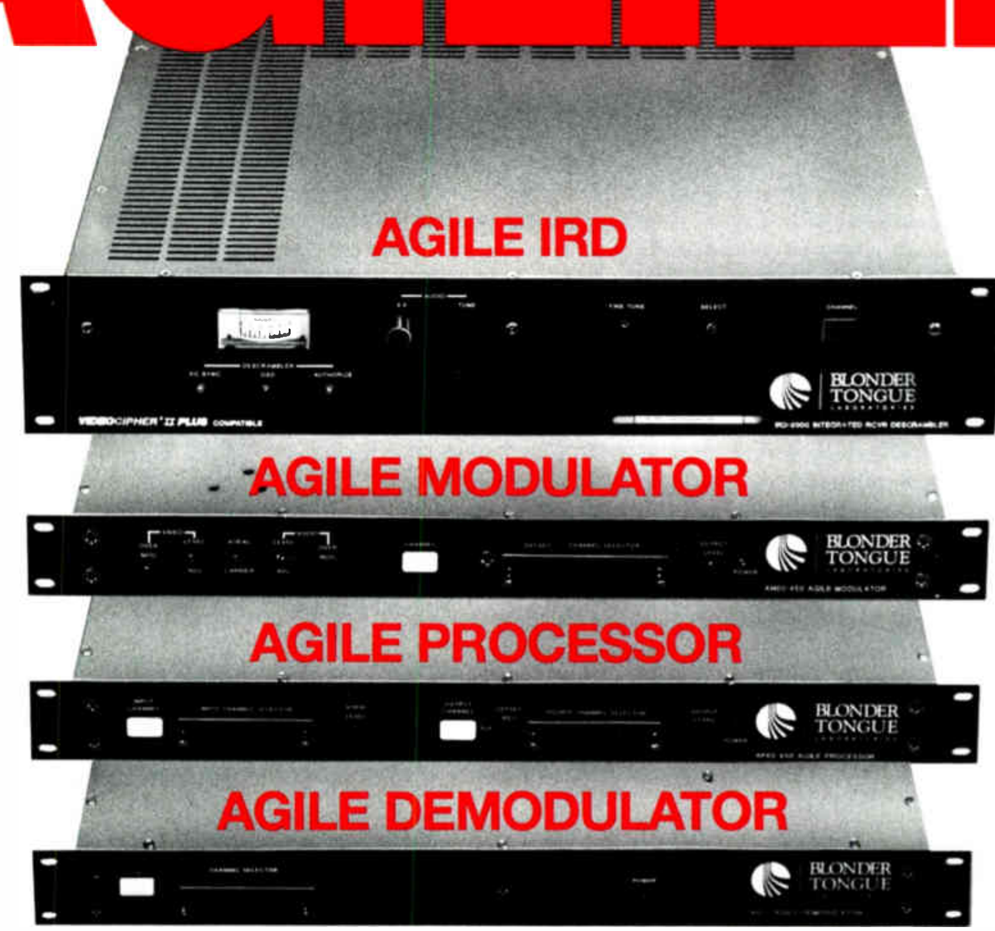

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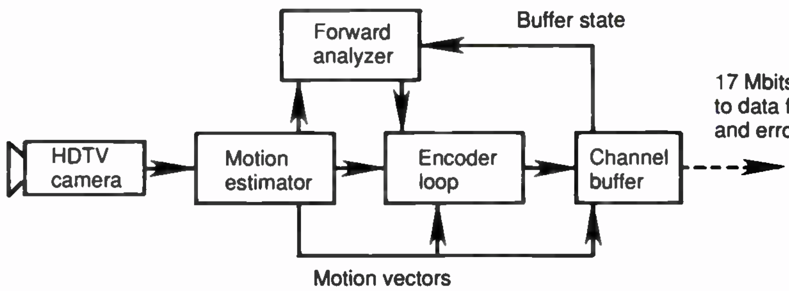
Figure 2: Video encoder



analog system — the compressed HDTV picture in digital format is transformed into analog for transmission. In other cases — the digital systems — the compressed HDTV picture in digital format is transmitted as a digital signal.

With that caveat firmly in mind the DSC-HDTV scheme may be examined. DSC-HDTV is a simulcast scheme (as are all the digital HDTV proposals) and can use a "taboo" channel. Taboo channels are the channels left empty between current TV broadcast stations to prevent adjacent channel interference. All the digital methods propose that they can use these channels with no interference to (or from) the current TV stations because the digital transmission requires much less power. DSC-HDTV claims an "HDTV service area equal to that of an NTSC broadcast station while radiating at least 12 dB less power. The (digital) transmission signal has a more noise-like character, which has further reduced the visibility of interference into a NTSC channel."

Zenith/AT&T note that "DSC-HDTV is very closely related to and is a natural extension of the previous analog/digital system" that Zenith proposed in September 1988 (see my "Correspondent's Report," November 1988 *CT*, "Zenith and compatible HDTV"). They stated that "Zenith is responsible for the system definition and transmission technology, AT&T Bell Laboratories for the design and implementation of a new video compression system, and AT&T Microelectronics for the semiconductor technology." They estimate that a DSC-HDTV receiver can be expected to sell for about $700 over prices for conventional TV sets.

The details of the digital techniques used in TV signal compression are beyond the scope of this short column. There are general texts and a number of recent papers addressing some of the latest procedures applied specifically to HDTV (and to NTSC) compression[1,2,3]. Suffice it to say they all use various methods of taking advantage of redundancy in any TV signal. There is a good deal of repetition of pixel (picture element) values within a frame and, of course, a great deal of repetition from frame to frame. Bell Laboratories has been active in TV compression since the early '50s and in DSC-HDTV it uses motion compensated transform coding that exploits both the temporal and spatial redundancy in the HDTV signal.

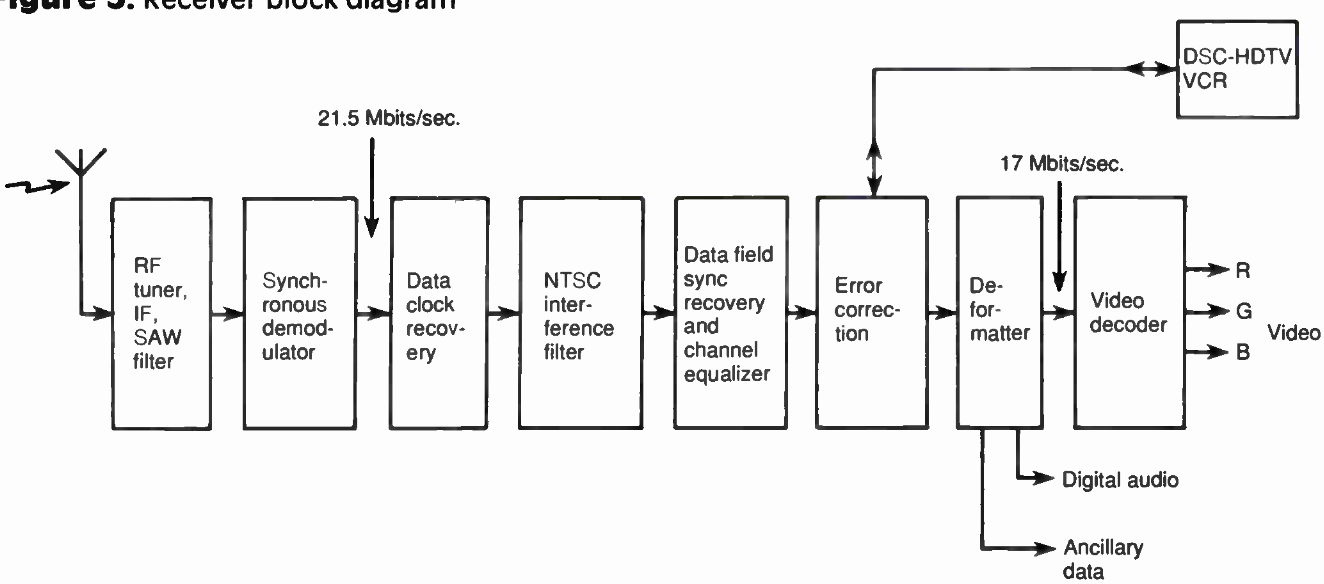
The key parameters of the DSC-HDTV system are listed in the accompanying table.

A key difference in the current DSC-HDTV and the previous Zenith proposal is that although the number of scan lines per picture is the same — 787.5 — the scanning is progressive rather than interlaced; i.e., 787.5 lines each frame of 1/60 of a second rather than 787.5 lines each 1/30 of a second interlaced in two fields. Another key difference is in the transmission method. The digital DSC-HDTV signal is changed into M-ary symbols that are PAM modulated by vestigial sideband (VSB) in a manner that they call "4-VSB" (more about 4-VSB later).

Digital video processing

Figure 1 shows the transmitter block diagram. Figure 2 shows the video encoder block diagram. The motion estimator compares blocks in two consecutive input frames to obtain motion

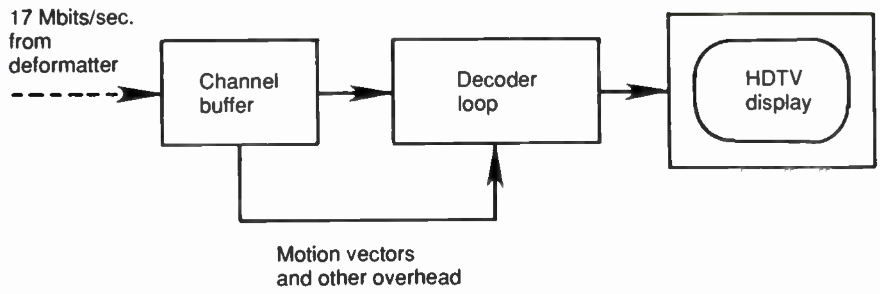
Figure 3: Receiver block diagram



vectors needed for the motion-compensated prediction. These vectors are compressed and sent to the output buffer. The parameters of the encoding are controlled in part by forward analysis. The data representing information like motion vectors, transform coefficients, etc., are seldom statistically uniform. Usually the data are statistically clustered (e.g., pictures with details separated by backgrounds with little detail, etc.). The use of variable length codes (Huffman coding) takes advantage of this statistical nonuniformity by assigning short code words to the most frequent values, and assigning longer words to less frequent values. The output buffer has a variable output rate of approximately 17 Mbits/sec. and has a varying input rate that depends on image content. After adding the data for four channels of audio, error control and ancillary data, the total data rate becomes 21.5 Mbits/sec.

Figure 3 shows the receiver block diagram. Figure 4 shows the video decoder block diagram. The compressed video data enters the buffer, which is complementary to the compressed video buffer at the encoder. The decoding loop uses the motion vectors, transform coefficient data and other side information to reconstruct the HDTV images. Channel changes and severe transmission errors are detected in the decoder causing a fast picture recovery process to be initiated.

Figure 4: Video decoder



DSC-HDTV digital signal format

The format of the 21.5 Mbits/sec. digital data stream that is sent to the "modulator, SAW (surface acoustic wave) filter, dispersion" block in the transmitter and comes out of the "synchronous demodulator" block in the receiver is shown in Figure 5. This is an illustration of the timing of the data of the data format. Different usage of the terms field and frame in data and television present great possibilities for confusion.

- *Data field* is a group of 262 or 263 data segments and has no relation to an NTSCTV field (except that the timing of both is the same).
- *Data frame* is two successive data fields and has no relation to an NTSC TV frame (except that the timing of both is the same).
- *Data segment* (DS) is a sequence of 171 bytes (containing video, audio, ancillary data, error correction and synchronization information) that is sent in the time period of one NTSC horizontal line.

Each data segment starts with one byte of data dedicated to synchronization of the receiver video data clock. Zenith/AT&T claim that the identical position of this byte for data synchronization in the successive data segments makes possible the reliable detection of data segment sync even under severe interference conditions such as ghosting.

As shown in Figure 5 each data segment also contains 20 bytes for Reed-Solomon (RS) code error control, which allows correction of a maximum of 10 errors per data segment. Each data field includes 1,300 error-protected bytes of audio data, which is sufficient to accommodate four audio channels of 125.874 kbits/sec. each. Each data field also allots approximately 1,200 bytes for ancillary data — e.g., test signals, cue and control signals, decoder box addressing and encryption, captioning, etc.

As shown in Fig-

Figure 5: One data frame

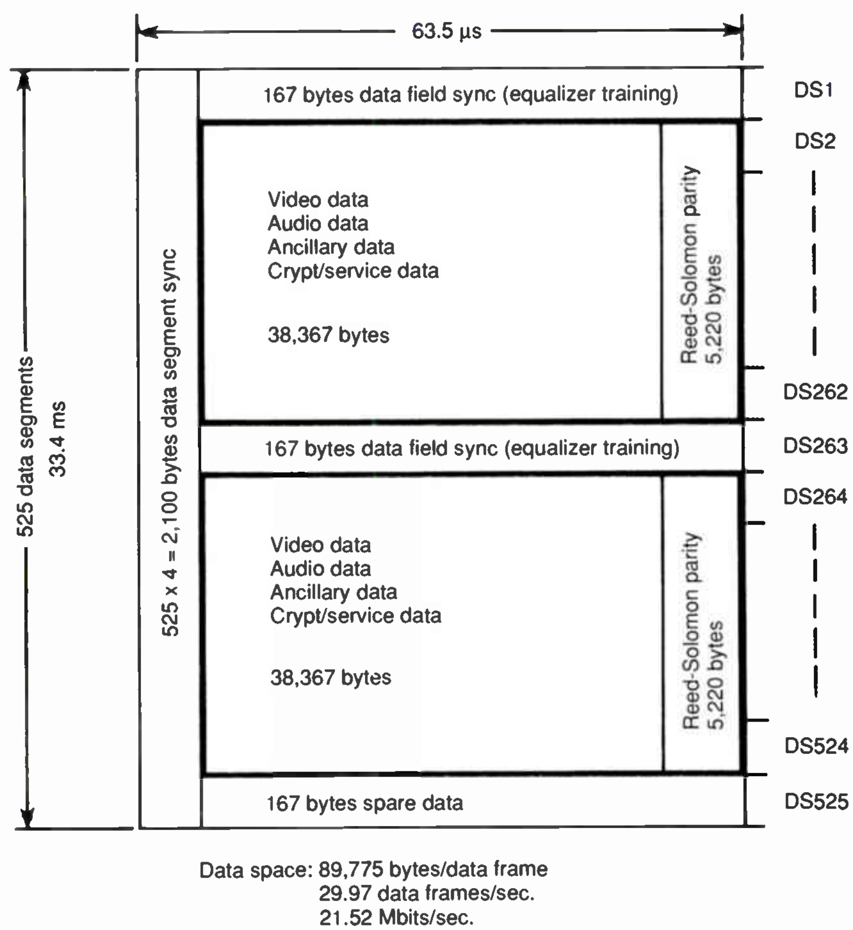
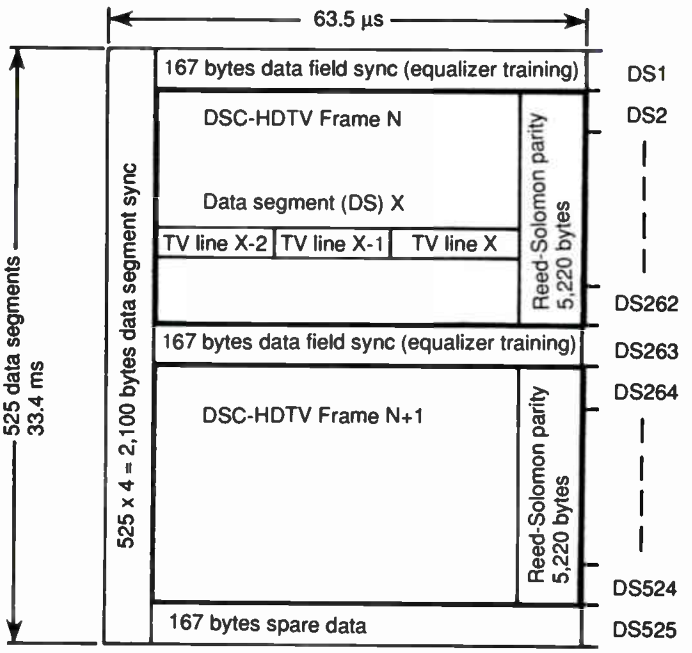
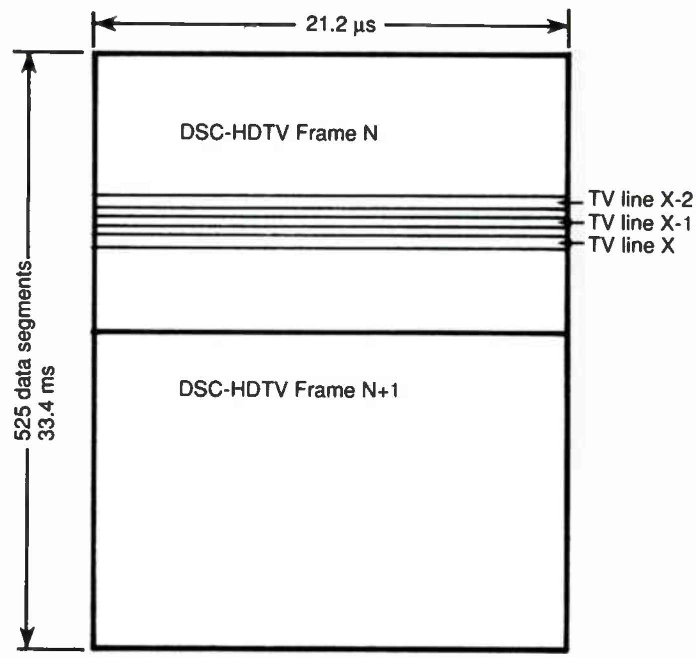


Figure 6a: Data segments in data fields



Data space: 89,775 bytes/data frame
29.97 data frames/sec.
21.52 Mbits/sec.

Figure 6b: Two DSC-HDTV TV frames



Data space: 89,775 bytes/data frame
29.97 data frames/sec.
21.52 Mbits/sec.

ure 6a each data segment carries the information for 3 DSC-HDTV scan lines, which when sequentially processed by the receiver decoder (see Figures 3 and 4) produces two progressively scanned DSC-HDTV frames as shown in Figure 6b.

4-VSB modulation

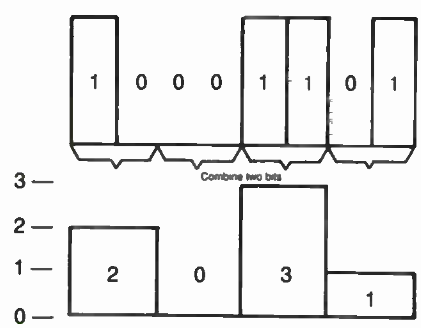
The block "modulator, SAW filter, dispersion" in Figure 1 accepts the data rate of 21.5 Mbits/sec. and prepares it for transmission in a 6 MHz simulcast channel. A key element in the process involves the fact that *two* binary bits can be represented by *one* symbol with four discrete levels as shown in Figure 7.

This coding results in a symbol rate of 10.8 Msymbols/sec., which can be accommodated in a 6 MHz band (details of this process can be examined in References 4, 5 and 6). An intuitive (but far from rigorously correct) justification of the 6 MHz channel carrying 10.8 Msymbols can be visualized if each symbol were sent in each half of a cycle of a 5.4 MHz sine wave. The structure of a data segment showing the byte sequence and the symbol sequence is shown in Figure 8.

As long as the DSC-HDTV RF data stream is truly random, the co-channel interference into an NTSC channel has a random noise-like character and is of minimum visibility. The one exception to randomness of the data is the one byte of data segment sync that occurs every NTSC line at the same place and in the same format. As interference into the NTSC victim channel, it stands out because of its regularity. Dispersion is introduced to remove the repetitive character of the sync. This technique is not explained in detail in the FCC submission document. However, a Zenith spokesman said that the dispersion here is similar to that used in its previous analog submission; i.e., a variation of the radar modulation technique known as "chirping" (also known as time dispersion). This is a technique used to expand narrow pulses to wide pulses (while reducing their amplitude) for *transmission* and to compress the wide *received* pulses to the original narrow pulse width and wave shape (and restoring their amplitude)[7]. The dispersion is achieved in the transmitter SAW filter and complementary dispersion is implemented in the receiver SAW filter.

The modulation method is VSB with a suppressed carrier and the nominal band is shown in Figure 9. Figure 10 illustrates an NTSC co-channel on the same frequency scale as the DSC-HDTV channel. The NTSC nominal transmitted signal is drawn in a solid line; the dashed diagonal line repre-

Figure 7: Four-level coding



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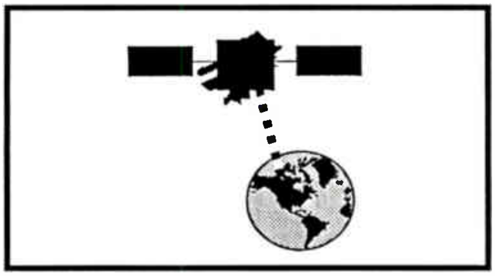

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sents the nominal NTSC receiver skirt selectivity (actually, the upper skirt at IF).

The claim regarding ghost cancelling in their FCC submission is: "The operation of a ghost canceler/channel equalizer for digital signals is less critical than one for analog signals. Just as a digital system can totally eliminate thermal noise as long as it is of a level below a certain threshold, ghosts in the transmission signal are unnoticed at the display, provided that they remain below certain threshold values. The canceler's function is to reduce ghosts and channel distortions below this threshold value." Since the digital information is carried in transmission by multilevel symbols, which perforce must have susceptibility to analog level interferences, a more thorough treatment of this claim seems to be required.

An incidental capability described in the submission is that VCR recording and playback may be accomplished with current consumer technology by recording the 6 MHz digital signal (see Figure 3). Of course the recording would make no sense if played back in the normal manner — it would have to be played back through the decoder before going to a display as shown in Figures 3 and 4.

Figure 8: Data segment

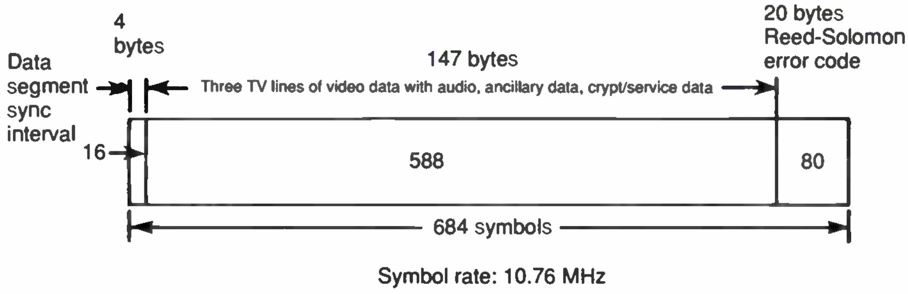


Figure 9: Nominal 4-VSB channel

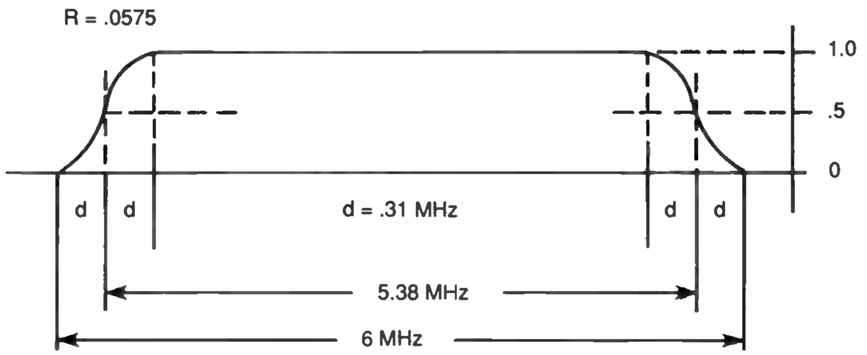
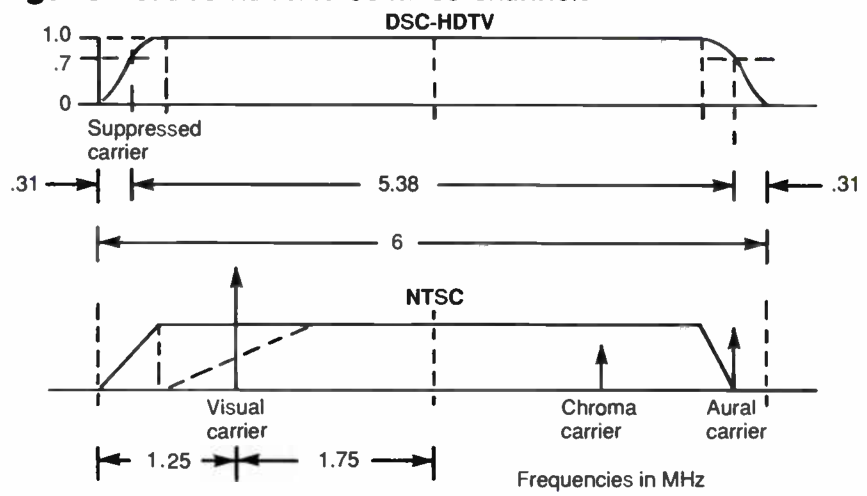


Figure 10: DSC-HDTV/NTSC RF co-channels



Conclusions

Now that there are four all-digital HDTV schemes in the hopper, comparisons are inevitable — even required. However, the task of comparisons faces insurmountable obstacles at this stage of the affair. At this point we have no hardware to test — only somewhat skimpy system outlines given in rather glowing descriptions.

In all the proposed digital HDTV systems, serious efforts were made to place greater complexity at the transmission end than at the receiving end (for obvious economical reasons).

The amount of memory required in the receiver in each scheme is:

- GI, approximately 17 Mbits or about 1.6 TV frames.
- Zenith/AT&T, approximately 12 Mbits or about 1.6 TV frames.
- Consortium, six to nine TV frames or about 66 to 100 Mbits.
- GI/MIT, a guess by proposer at 5 to 10 Mbytes (40 to 80 Mbits).

This is a limited hardware comparison but two main areas of each system that must he compared are 1) picture compression — how good is it?, and 2) the transmission method — how good is it?

In the case of picture compression it is interesting to note that all the systems end up with a data rate that is nearly the same — about 20 Mbits/sec. An interesting, but very rough evaluation of the effectiveness of a proposed compression is to examine the performance of existing TV compression hardware at or near the proposed TV compression ratio. The DSC-HDTV system uncompressed would produce a data stream of approximately 1.2 Gbits/sec; (75.3 + 37.65 + 37.65)8 = 1.2 x 10^9 bits/sec. This is compressed to 17 Mbits/sec., a 70-to-1 reduction. If an NTSC D2 signal, which is 114.5 Mbits/sec., is reduced by a factor of 70, a 1.6 Mbits/sec. (or approximately a T1 rate) results. This is one of the video teleconferencing rates — not satisfactory for entertainment purposes. As noted, this is far from a conclusive procedure but it does provide interesting directions for further more rigorous examination. Of course Bell Labs has had more years of experience in video compres-

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sion than any of the other contenders; unfortunately that alone is not evidence enough for superiority.

Computer people talk of "lossless" compression. FAX transmission of text is an excellent example. Since the only portions of the "video" of the FAX scan are the black parts of the text, run length coding can be used (see variable length codes/Huffman coding mentioned previously). Thus all the data scanned is reproduced with no loss in a compressed transmission. However compression of TV frames at a rate of either 1/60 or even 1/30 of a second is much more difficult and cannot be achieved in a totally lossless manner. Television can have enormous detail coupled with large gray scale variations (typically at least 256 levels) — not to mention color requirements. Thus in whatever compression scheme is used some of the original picture information will be discarded and or "massaged." "Lossy" compression will result in picture "artifacts," i.e., little differences in the displayed picture compared with the original before compression. It is impossible to predict for all artifacts how objectionable they will be to a human viewer. Ultimately any TV compression scheme must be evaluated subjectively — i.e., by having a great number of people evaluate it under controlled conditions. (These tests are part of the planned tests of the systems for FCC evaluation.)

Thus with only the information available now, comparisons of the picture compression schemes cannot be definitive.

Evaluating the efficacy of the transmission schemes presents equally formidable obstacles. We have no body of experience with terrestrial broadcast of high digital data rates. Several of the submissions (including Zenith/AT&T) have presented theoretical analyses of coverage, interference, ghosting, etc. However, experience in the real world of transmission amply reveals that nasty, unexpected conditions occur in abundance enough to invalidate a total reliance on an exclusively theoretical analysis not guided by experience in the areas of interest. Parenthetically it is interesting to note that for satellite transmission, Zenith/AT&T propose a different coding of the bits into symbols and a wider transmission bandwidth (20 MHz).

Since a great deal of the analog electronic world seems to be progressing inexorably into an all-digital one, and furthermore since the relation of the proposed digital HDTV to the computer sphere (particularly with respect to high definition displays) is becoming more significant politically, these four new all-digital HDTV systems are more than welcome — and important strategically. However, it is a safe prediction that the only credible evaluations will be in hardware testing, subjective testing and especially field testing. **CT**

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COMMUNICATIONS TECHNOLOGY DAILY

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National Show Product Wrap

ADS Inc. introduced its new outage location module. Combined with Lynx CADD, it records outages in dBase files for reports and recordkeeping. It also is said to help quickly locate outages on plant maps. **Reader service #129**

Alpha Technologies' recent addition of a 7.5 kVA uninterruptible power source (UPS) was on display. The company reports that designs for 10 and 15 kVA units are nearing completion. Applications for the products include PPV system protection (by protecting the event's revenues against a power outage) and headend protection (by isolating sensitive equipment from the power bump during switchover to generator during blackouts). The company's UPS products include cabinet and rack-mounted models with a wide range of battery packs for extended outage protection. Complete accessory packages also are available. **Reader service #188**

AM Communications presented new features for its LANguard TMC-8101 master control unit and system software. The company now offers dual protocol capability to control its own status monitoring transponders and **Jerrold** RMS monitors simultaneously. This enables Jerrold status monitoring users to upgrade with LANguard features without the concern of abandoning their present equipment. **Reader service #166**

American Lightwave Systems introduced an extended product family, LiteNET, that allows a combination of fiber-optic and RF products to be configured to satisfy the requirements of advanced CATV networks. LiteNET includes new products within the LiteAMp AM fiber family, 1,550 nm optical amplifiers, fiber switching and optical cable management equipment from parent **ADC Telecommunications**, and ALS network control software for fiber electronics and switching control. ALS unveiled a second model of its LiteAMp strand-mounted receiver that's been optimized for advanced CATV architectures and designed to be more cost-effective than alternate fiber systems for serving cells of customers. The Flexible Transport or FX Series receiver will support up to 1 GHz bandwidth and can be configured with up to four simultaneous high level bridger outputs, each 48 dBmV. A fifth output is available at trunk level. It supports one or two optical receivers and has three options for reverse path video and data transmission, plus status monitoring support. The system can be upgraded in place via simple plug-in modules. As well, ALS demonstrated, in a fully operational system, the initial results of its efforts to develop its own 1,550 nm optical amplifier technology. ALS is working on this effort with ADC and two major U.S. suppliers of optical fiber, components and fiber equalization devices. The goal of this effort is an optical amplifier product suitable for CATV and other applications requiring large numbers of video channels transmitted in AM format to many simultaneous receive locations. **Reader service #153, LiteNet; #182, receiver; #183, amplifier**

Anixter Cable TV showed its initial design of a complete 1 GHz integrated drop system (IDS). It includes products manufactured by **Raychem, Regal, Comm/Scope** and **Sachs**. An engineering committee has been formed between these manufacturers and Anixter's product development group to further develop the IDS. According to Anixter, the IDS will reduce maintenance costs, improve reliability and ensure signal integrity by integrating and standardizing all the components of a drop. In the same vein, Anixter presented its

Underground Plant System, designed with materials and products from Raychem, Comm/Scope, **Utility** and **Duraline**. It provides optimal integrity over a wide range of field conditions, according to the company. **Reader service #198, IDS; #165, UPS**

ARCOM Labs demonstrated its new Gaussian passive scrambling system. It employs distortion scrambling at the headend produced by a substantial Gaussian response pre-emphasis of the central portion of the video passband and gated carriers. The signal is decoded at the subscriber using a complementary passive filter, recovering a "class 1" picture quality signal. The system is said to provide comparable security to a positive trap without the associated picture degradation. **Reader service #157**

Arvis showed its 6742 downline insertion system that is said to provide interconnects the capability to inexpensively receive commercial insertions from one central headend to other systems' headends via microwave or fiber optics. It allows each system to insert its own system-specific and promotional spots within a given break. **Reader service #127**

Augat Communications demonstrated its OptiFlex AM 1000 optical-to-RF system that allows CATV operators to upgrade in a coaxial mode now and convert to fiber-optic capability when ready. System design flexibility is enhanced using RF amplifier technology with 1 GHz bandwidth potential. The optical portion of the system utilizes 1,310 nm laser and receiver technology. A single transmitter unit has the capability of six lasers and receivers with redundant power supply options. The optical trunk station has the capability of up to four plug-in receivers. Critical functions within trunk stations can be monitored in three distinct fashions. Local status monitoring provides access to this information via an LCD within the trunk station. Telemetric monitoring provides info within 100 feet of the trunk station via a hand-held remote receiver. Remote status monitoring provides global system information via fiber/coax from the headend for two-way systems. **Reader service #186**

Cable Security Systems presented the new Interdiction Beast designed to provide security for four-, eight-, 12- or 16-unit interdiction devices. The company says the mounting configuration provides 100% access. **Reader service #197**

C-COR Electronics showed a working 1 GHz amplifier that has the distortion performance to deliver 155 channels and provides performance at 750 MHz and 860 MHz. Built using C-COR's own gain block, the amp is used in one of the final phases of the company's flexible networking approach. It allows drop-in bandwidth upgrade of the superdistribution feeder system from 550 MHz to 1 GHz. The company also displayed the new C-COR/**COMLUX** 1.5 Gb/s optical transmitter and receiver. Models 3681/3682 allow the user to transmit 16 channels of video per fiber over distances greater than 50 km. As well, C-COR unveiled its AM fiber-optic receiver designed to suit a variety of fiber-to-the-feeder and backbone architectures. The product has flexibility for multiple output configurations combined with reverse path options. It can be configured for one trunk plus two high level bridger outputs or one trunk output plus four high level bridger outputs. It also supports single-fiber operation (450 MHz) or dual-fiber operation (550 MHz). C-COR also showed nine new models of its 550 MHz feedforward and power doubling minitrunk amps. The minitrunk's 1 GHz line extender housing allows for future bandwidth expansion as well as three output port capability for optimal signal routing. Both the feedforward and power doubling amplifiers feature automatic level control to ensure stable output levels. **Reader service #207, 1 GHz amp; #206 transmitter/receiver; #177, receiver; #176, amplifiers**

Channelmatic introduced V:base, a tape library management software program developed for the CompEdit 600A videotape compiling/editing system. V:base keeps track of all library reels and spot reels in inventory, storing complete traffic and billing information on each spot. Before compiling tapes, V:base automatically generates optimum library reel and spot reel organization plans designed to reduce overall tape preparation time, spot search time and the time it takes to rebuild damaged library reels. It also features DynaView, a dynamic viewing and editing tool that allows operators to visually browse the contents of any master spot reel on a PC, and modify or update its contents before making it into a physical tape. As well, Channelmatic displayed its SCU-1A system control unit that incorporates the error-detection and reporting features of the Adcart SCU-2A system control unit. Since error detection is now standard, rather than optional, the SCU-2A is being eliminated. The SCU-1A can monitor all channel control units in the systems and detect any of three errors: if a VCR fails, if a channels stops inserting, or if a channel stops sending cue tones. If an error is detected, the SCU-1A dials a pre-determined pager number to alert an operator. Channelmatic also showed its Auto Schedule Processing (ASP-100A) software, which was formerly an optional feature of its Adcart PC (APC-100A) software and is now standard. The ASP-100A enables interconnects to automatically retrieve logs and transmit ad insertion schedules at selected times between selected headends. A single operator can control up to 24 independent Adcart systems from a central location. **Reader service #193, V:base; #163, SCU-1A; #149, ASP-100A**

Computer Utilities of the Ozarks presented CableWorks, an in-house management information, billing and accounts receivable system designed specifically for the IBM PC, AT, PS/2 and compatible computers. Enhanced features and functions include full screen editing, on-line pick lists, pop-up anywhere inquiries, note pad, perpetual calendar and calculator. Industry standard dBase DBF files allow integration with data base and spreadsheet products, and an enhanced interface speeds up operation. There are no arbitrary limits on data workstations, and it will run on different platforms from the 8088 to the 80486. It also features an addressable interface. **Reader service #147**

Eagle Comtronics demonstrated its new Sideband Interdiction System (SIS) that will enable cable systems to bring the PPV Olympics to their non-addressable subscribers on any channels from 5 to 62. It is said to retain many of the desirable characteristics of the positive trap or decoding filter system while eliminating many undesirable traits. Any number of channels may be scrambled at the transmission site by a new IF scrambler and decoded at the subscriber's home by a passive device. Eagle says this decoder can operate to 450 MHz and beyond with little or no degradation of the channel's video information. SIS channels may by adjacent, upper channel interference doesn't exist and audio is scrambled. **Reader service #192**

Falcone International presented five new products, including its ADS desktop video production system that integrates standard industry components into a broadcast-quality edit suite. It uses an Amiga 2000 computer platform equipped with a NewTek Video Toaster card. The Playball random zone system is said to provide an affordable method of tapping into fixed-position ad revenues with ROS sequential insertion equipment. Each unit operates on four networks. The company's RACS units provides a means to deliver full random pod insertion on four networks using one dedicated VTR per network. It can be managed remotely from a central office including schedule changes, headend query and auto-check of VTR performance. The Autoleveler is an automatic stand-alone audio/video gain control. Installed in-line with Falcone's Comed ad compiler, it will process and correct audio/video levels during network tape production. Finally, the Access programmer is a rack-mounted, 256-color, high-resolution character generator built on a five-channel mainframe. The unit can provide the same or different messages on each channel, and full page displays or message crawls. Multiple pages for each channel can be stored preprogrammed. **Reader service #135, ADS; #134, Playball; #133, RACS; #132, Autoleveler; #131, Access**

France Telecom demonstrated its Visiopass technology, which the company says is personalized and interactive, allowing for "a la carte" TV (either subscription, reservation, impulse purchase, PPV, time-based, etc.). Using the D2-MAC standard and Eurocrypt.(the management access control via smart cards) Visiopass has been developed to meet all pay TV needs on a European scale. **Reader service #125**

Gilbert Engineering displayed its F-connector installation videotape. It includes proper installation techniques, tool selection/care and general product knowledge including detailed cross sections of installed connectors showing interrelationships of cable connectors. Gilbert also presented its connector/heat shrink package that includes one connector and one premeasured length of heat shrink tubing, providing a means of expediting connector installation. The sealed polybag is said to virtually eliminate contamination and damage to components. As well, Gilbert showed its KS interconnect cables, designed to join trunk and feeder cables to equipment in pedestals or other confined areas typical of underground plant. The assembly exhibits electrical specifications of 25 dB to 1 GHz typical return loss and is weatherproof. Any Gilbert entry pin connector may be installed in the KS female end of the cable assembly. The KS male end of the cable assembly has a built-in sealed swivel so the entire assembly may be installed on the trunk and feeder cables prior to connecting to equipment. **Reader service #194, videotape; #162, connector/heat shrink; #148, KS cables**

Hughes Microwave Products Division showed a new family of compact outdoor transmitters with 80-channel capability. The family is comprised of four transmitters, each one field-upgradable to the next higher power unit as system needs grow: HCOT-114, COT-113, MCOT-120 and LCOT-119. The HCOT-114 can transmit 40 channels over a single 20-mile link or four 10-mile links with 53 dB C/N and 65 dB C/CTB. The other units are each approximately 3 dB from the next higher model. A built-in pilot tone generator in each unit is compatible with all Hughes AML phase-lock receivers. The transmitters measure 19-1/2 x 13-1/2 x 10´´. **Reader service #187**

Integral introduced Tracer Duct, a detectable, non-conductive high density polyethylene conduit. Detection within inches to a depth of five feet is accomplished through a unique magnetic signature permanently incorporated into the conduit. Cable is preassembled in the conduit. The conduit gives a peak signal every six feet for telecommunications applications, with intervals for cable applications to be determined. **Reader service #158**

Jerrold Communications showed its Digicable digital compression and transmission system for cable TV. It featured end-to-end digital compression of a standard NTSC signal, starting with the VideoCipher facility in San Diego where it's digitized and compressed, then sent to a satellite dish at the convention center. It was then received by a DigiSat decoder in a cable headend, then processed and delivered through Jerrold's Starburst fiber-to-the-feeder architecture to a TV set. In addition, the demonstration also showed a compressed HDTV signal. Jerrold also displayed its new erbium-doped Starpower optical amplifier prototype. The unit, still in development, is said to have generated dramatic measurements in Jerrold's Applied Media Lab, including 1,550 nm AM video transmission over standard fiber with no dispersion-related noise/distortion, +15 dBm output power, CTB/CSO distortion-free operation and 4 dB noise figure. As well, Jerrold exhibited its Model ASR-1000 addressable satellite receiver and slimline commercial descrambler unit. Satellite programmers can remotely retune the ASR-1000 to receive up to six different satellite feeds when sports league rules or syndicated exclusivity create potential blackout situations. The unit supports local ad insertions and features a one-time operator installation. It stands 1-3/4´´ tall. The descrambler places GI's VideoCipher II-Plus commercial unit in a 1-3/4´´ stand-alone unit. In addition, Jerrold displayed its Olympian 2000 "un-converter" that allows operators to use advanced scrambling techniques to remotely control PPV event authorizations. Designed for the PPV Olympics it is ideal for systems that are non-addressable and those with limited addressability, according to the company. The converter automatically moves into a bypass mode to allow trapped systems to perform in a consumer-friendly manner, so subs retain all the features of their cable-ready TV sets and VCRs when not ordering PPV. Jerrold also demonstrated a concept called "ConverterEze" that's designed to make operating the converter as easy as possible. The parts include items like a simple remote control that handles multiple functions, on-screen programming and an easy-to-use "dumb" remote, according to the company. **Reader service #205, Digicable; #204, Starpower; #180, ASR-1000; #155, Olympian 2000; #154, ConverterEze**

Lectro Products introduced its dual output standby power supply specifically designed to power combination CATV/telephone switch nodes. Available in various output configurations, the unit produces regulated 60 VAC, 12 amp and 48 VDC, 8.5 amp outputs with a full UPS for eight hours on the DC output. The unit has built-in status monitoring and metered output power. Lectro also announced its compatibility with the **AM Communications** LANguard status monitoring system. Cable operators can now adapt the Sentry II line of power supplies to any of the major brands of status monitoring systems currently available. The AM system features the ability to monitor the following parameters: output current, output voltage, battery voltage, charging current, operational mode, cabinet temperature and tamper alarm. The following functions can be controlled: force to standby, force to return to AC operation and force to higher float voltage. The transponder module mounts beneath the center control module in the Sentry II. Replacement of a defective transponder is said to be easily accomplished without concern for interruption to the plant powering. In addition, the automatic transponder addressing feature of the AM system means that no switches or jumpers need be set in the field. All modules are interchangeable. **Reader service #189, dual output PS; #161, Sentry II**

Magnavox CATV Systems provided a demonstration of its 750 MHz amps and passives under development. According to the company, the distribution equipment will allow for greater channel capacity (up to 110 channels), which represents about a 50% increase over 550 MHz gear. This allows for more subscriber services, more flexible tiering, more PPV potential and the ability to offer near video-on-demand. As well, the new Axis addressable external interdiction system was exhibited by Magnavox. The addressable signal security device eliminates the need for set-top converters/descramblers and allows subs to use original remotes, view picture-in-picture and watch one channel and tape another without having to attach additional wires to their TV sets. It mounts on a strand, in a pedestal or on the side of a house. The unit is compatible with all existing RF signals, transparent to HDTV and ACTV technologies, and available in four- and one-port models. Masking up to 72 channels simultaneously, it has more than double the masking capability of other devices presently on the market, according to the company. The unit is offered with a choice of four, eight, 12 or 16 oscillators that provide a varying range of security options. **Reader service #185, 750 MHz units; #203, Axis**

Nexus Engineering demonstrated a prototype of its cordless interface for use in personal communications networks as part of a joint exhibit with **Jerrold**. It also introduced its SubManager for off-premise addressability. According to Nexus, it provides a totally flexible, fully upgradable and fully addressable system, ideal for MDU applications. **Reader service #191, interface; #150, SubManager**

Oak Communications demonstrated a new RF return option for its Cable Sigma addressable converter. The Sigma RF return features downloaded programmability of output carrier frequency and output power, and is capable of returning many types of information from the set-top converter, in addition to supporting PPV functions. This will allow operators to track statistics on message error rate at each hub site, or prior to or after a bridger gate, and locate smart RF receivers almost anywhere desired. **Reader service #169**

Orchard Communications presented improvements to its externally modulated fiber-optic system. Its AM5000-80 system, capable of transmitting 80 channels on one fiber using pump YAG lasers and external modulation techniques, now has higher optical launch power and reduced distortion. This makes trunking and distribution networks carrying 60 channels on one fiber practical over long distances. With 15 mW of optical power out of each two ports in the AM5000-82 dual output model, distances of 20 miles or more can be achieved without repeaters and with all distortion products at -70 dBc. If the signal is repeated for distribution, each port of the AM5000-84 four-port unit launches in excess of 10 mW of optical power — more than enough power for optical splitting and distribution to multiple receivers over distances of 15+ miles. After a total system length of 35 miles, typical C/N is better than 52 dB with all distortion products at -65 dBc. **Reader service #190**

Panasonic Communications showed its new addressable control system (PACS) that controls its TZ-PC300 addressable converter, which features volume control, on-screen display for programming of IPPV purchases and VCR timer programming. The system supports phone and RF return IPPV and is compatible with Jerrold equipment. Also on display was Panasonic's new AM fiber transmission equipment, which is available in a supertrunk package (TZ-NW501T rack-mount transmitter to TZ-NW501R rack-mount receiver) and rack-mount receiver to TZ-ANW500R strand-mount receiver. The equipment is capable of transmitting 80 channels over a single fiber with performance C/N around the mid-50s and distortion at -65 to -70 dB. The modular design can be configured with transmitter, receiver and status monitoring modules. **Reader service #140, PACS; #139, fiber equipment**

Radiodetection Ltd. showed its RD432 PDL precision directional locator that finds, traces and identifies buried cables and pipes in situations where locate accuracy and identification are critical. It provides a position pinpoint and depth measurement to a target line and has modes for searching for other nearby utility lines. **Reader service #126**

Regal Technologies introduced a complete line of 1 GHz system and drop passives. The splitters, multitaps and line passives achieve 1 GHz frequency by using microstrip printed circuit board (PCB) technology. The PCBs are enclosed in a corrosion-protected housing manufactured of nickel-plated zinc alloy, which is said to provide extended product life. EMI is shielded to 125 dB. According to the company, the full 1 GHz product line will be available by the second quarter of 1991. The two-, three- and four-way splitters are in production. The passives will consist of two-, three-, four- and 16-way splitters, multitaps and line passives. As well, Regal unveiled a new addressable interdiction system designed to give cable operators flexible control of viewable channels while maintaining a consumer-friendly environment inside the home. Designed to mount directly on the side of a home, the unit also is available in pole, pedestal or strand-mounted versions. The system may be line- or subscriber-powered. It provides complete control of service connect and disconnect, as well as remote addressable and interdiction control of specific channels. The system operates over 550 MHz bandwidth, with jamming capabilities between 50 and 450 MHz. Regal also introduced its RI870 Series isolators specifically designed for U.K. and European applications. The product is engineered to block DC and low frequency AC between the cable system and the subscriber's equipment, while passing CATV signals from 5 to 870 MHz with minimal insertion loss. It also provides a TV-FM split and minimizes loss to the TV port in the 88-108 MHZ band, particularly beneficial for addressable systems sending data carriers through FM band. The isolators provide electrical isolation in excess of 2,120 VDC. The design of the RI870-CASE accommodates drop cable from any direction. The entire isolator assembly may be positioned to any of four directions for direct cable access. **Reader service #195, 1 GHz passives; #160, interdiction; #151, RI870**

Reliance Comm/Tec displayed Corelink, a reusable and tunable mechanical fiber-optic splice. The unit can accommodate both 250 µm and 900 µm size combinations. Constructed from two precision aluminum plates and two transparent polymeric bodies fused together to form a single element, the unit allows the user to see, as well as feel, the fibers as they are aligned. **Reader service #124**

Sachs Communications showed its SC51 meter panel connector designed to provide a means of bonding the sheath of the cable TV drop to the metallic frame of a meter panel when alternative NEC bonding is inaccessible. This design allows a fixed and positive mechanical contact without interfering with the opening of the meter panel front cover. Applications include underground installations where the #6 copper wire is inaccessible or the conduit is PVC; in aerial installations where utility companies will not permit bonding to the mast or riser; or wherever alternate NEC bonding is inaccessible or cold water pipe has PVC in the system. Also, Sachs introduced its 1991 catalog, featuring new products, product design, technical applications and technical write-ups useful in day-to-day operations. **Reader service #159, panel connector; #130, catalog**

Scientific-Atlanta displayed the new System Amplifier product family, available in both dual- and single-output models. The amps are designed for integration with diverse fiber architectures and incorporate a fully functional 1 GHz platform. The dual unit provides higher output levels than a single hybrid amp, which the company says allows an operator to use fewer amps. It utilizes two output hybrid amps to provide 3-4 dB higher output than a single distribution amp, and is available in both 550 and 600 MHz versions. The single-output model is an enhanced version of S-A's current distribution amp. It is used in combination with the dual-output model in fiber-to-the-serving area architectures. Both products are designed to allow for future upgrades. Also introduced was the Model 8601 addressable set-top terminal, developed specifically to meet the requirements of the Japanese market. Highlights include Japanese character on-screen displays, the capability to send individual or group text messages to subs, stereo and bilingual decoder, three RF outputs, color-coded and easily identifiable keys, as well as other most often used subscriber features. **Reader service #142, amps; #141, set-tops**

SecaGraphics' outage and vehicle location system, demonstrated by **CableData**, is a field service management system providing outage detection and field service scheduling. It interfaces with CableData's DDP subscriber management and billing system, and is designed to give dispatchers the information they need to quickly and efficiently schedule crews and route vehicles. **Reader service #164**

Siecor displayed a new extension to its SCN fiber-optic closure family. The new design is said to better address the changing requirements of the outside plant environment including ease of assembly and reusable sealing material. The closure is designed for use in "butt" splicing applications where both cable entries are from one end. The new sealing system incorporates reusable end cap sealing gaskets made of silicon rubber. The gaskets are hollow and do not develop a "pressure set" that would compromise closure sealing. In addition, the gaskets are reusable and the need for re-entry kits is eliminated. The caps were redesigned to be installed with a common socket wrench and a throw-away gauge is provided to help ensure the cap is properly closed. Siecor also showed its restoration kits for fast, temporary repair of damaged single- or multimode fiber-optic cable. Kits include spare cable, two splice closures, two tool kits and all items required for bypassing a damaged section. This temporary repair allows transition later to a final repair without disturbing any fibers other than the ones being repaired. **Reader service #181, SCN; #128, restoration kit**

Square D Co. unveiled a new home wiring system that integrates and enhances telephone, video and audio services via a single, open wiring format. According to the company, the ELAN advanced home network will give homeowners convenient, immediate access to these services in virtually every room without having to upgrade the home's wiring later. Square D is working in association with **Regal Technologies** to provide video distribution products including Regal's broadband amplifier, and drop and subscriber passives. The hub of the wiring system is the ELAN distribution center and a Square D circuit breaker load center. These components help consolidate all telephone, video, audio and electrical services at the home's service entrance. From this hub, the necessary cables are routed to jacks and outlets in all areas of the home. **Reader service #167**

Standard Communications' Satcom Division presented its TVM450S frequency agile modulator. This model integrates Standard's CSG-60 BTSC generator into the modulator's chassis, creating an MTS stereo modulator compatible with all RF scrambling formats. The front panel video modulation, audio deviation and visual/aural carrier ratio controls have precalibrated center indentations. The user leaves the controls in their center indents and adjusts the VideoCipher or receiver to the correct output levels required for optimum BTSC performance. **Reader service #156**

Superior Electronics highlighted its Cheetah system, which provides a non-interfering status monitoring system for both headend and field measurements in CATV and LAN systems. The HE-4650 headend unit and PC-4650 standard field unit were in use, taking direct signal level and frequency readings, with the results available for immediate inspection. The Cheetah Pak software polled headend and field units throughout the country. The HE-4650 monitors signal levels, frequencies and temperature. It is rack-mounted and can be accessed by either direct connection or phone modem. Levels and frequencies are said to be measured in seconds without system disruption. The PC-4650 measures signal levels over an ambient temperature range of -40° to +140°F. Operators can monitor developing trends and analyze system operation because the controlling software package stores and represents the data gathered in both columnar and graphical form. Displays can be printed out for record keeping. Several new features also were demonstrated. Auto-Read allows unattended measurements over extended periods of time without operator intervention. Auto-Alarm logs, displays and notifies the operator of out-of-spec conditions as they occur. This feature allows alarms to be transmitted to various locations, including a pager if the operator so desires. In addition, Superior demonstrated an AML telemetry system on its Cheetah. The new AML option allows remote monitoring of the AML hubsite RM1 and RM2 parameters. This option provides instant AML receiver analysis of parameters such as fade, AGC voltage and other AML data that in the past had to be recorded on site. These parameters can now be monitored remotely, either by direct call up, Auto-Read, Auto-Alarm or any combination. **Reader service #203, Cheetah; #168, AML option**

Telecorp Systems showed an ANI interface module for its System 6000 ARU. The module is under development and will be available this summer. It automatically recognizes the calling party's phone number to facilitate a transaction such as PPV ordering. As well, Telecorp displayed its PPV windowing technology (also for the System 6000). With the product, it is said a cable system can offer more movie choices by providing a higher level of flexibility in creating event windows. Multiple menus of event/movie selections can be presented to the viewer depending on how many events are available at the time. **Reader service #179, ANI module; #178, PPV windowing**

Texscan unveiled the Model TLT-4000 AM optical transmitter. Features include full microprocessor control, digital status display, linear RF drive circuitry and status monitoring functions. According to the company, the unit's low profile fits well in areas where headend space is at a premium. It is available in both 1,310 and 1,550 nm versions and is specified for 40-, 60- and 77-channel operation on a single fiber. It accepts either 110/120 V 60 Hz or 220/240 V 50 Hz input. As well, the Glas-PAL AM optical receiver was shown by Texscan. It is capable of multiple "plug-in" optical receive options and return laser capabilities. According to the company, the product will further enhance the economics of fiber/RF distribution in domestic markets and directly serve the European requirement for "fiber-to-subscriber node" operation. It will be capable of both 1,310 and 1,550 nm operation. Also on display at the company's booth was a new AGC/ASC version of its PAL series line extender. This unit will "share" a common "plug-in" control card with the Flamethrower family of optical bridgers, distribution amplifiers and minitrunk stations. **Reader service #199, TLT-4000; #173, Glas-PAL; #172, line extender**

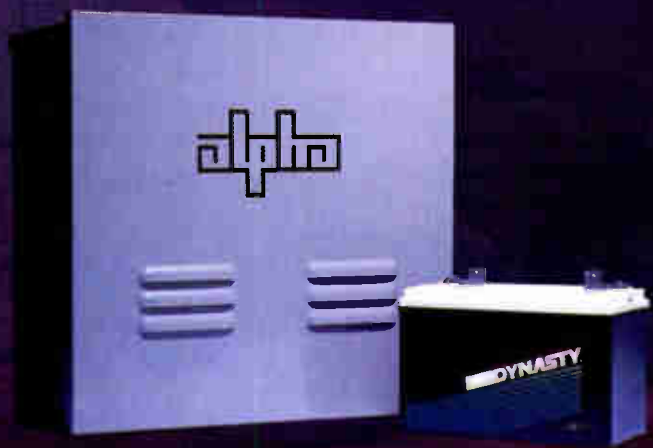
Viewsonics introduced a compact power inverter. The completely automatic unit operates on 12 VDC input and is designed to run equipment needing up to 1 kW of power at 115 VAC, 60 Hz. Features include a duplex outlet for easy plug-in, a carrying handle, automatic turn-on and turn-off from standby and overload protection. Dimensions are 10 x 7 x 4.5´´ and the weight is 30 pounds. The company also displayed its tubular amplifier, said to be the first remotely powered tubular amplifier and is tap-mountable to a female F 3/8 x 32 threaded port. It provides 10 dB of gain and has a 40-860 MHz response with excellent noise, cross-modulation, triple beat and second order figures with 77+ channel loading, according to the company. Also available is a tubular lock enclosure that surrounds the amplifier providing super RFI and security from theft. **Reader service #175, inverter; #174, amplifier**

Vyvx NVN, the nationwide switched broadcast-quality fiber-optic TV transmission network, was demonstrated at the show. The company's TV control center (TCC) routes TV signals from any point to any other point or set of points on its nationwide network. This remote routing function is carried out simultaneously and on demand and customers requiring occasional service contact the TCC, which is available 24 hours a day. System status and alarm readings are automatically reported into the TCC for monitoring and troubleshooting. If a circuit failure occurs, the TCC will manage rerouting of all necessary facilities in seconds, according to the company. Control of switching is carried out via a separate out-of-band T1 network that operates independently of NVN's DS-3 network for system reliability. **Reader service #171**

Wegener Communications unveiled its Series 2900 compact descrambler that is VideoCipher II Plus commercial descrambler equipped. It is available in basic Model 2900 or "switch and retune" Model 2901 (for automatic receiver control of ESPN feeds). It has a low profile (using only 1-3/4´´ rack space) and has the same interface features as existing full-size descramblers. The unit has front panel gain controls and indicators for ease of routine adjustments. **Reader service #138**

Zenith Electronics displayed the new Port Authority off-premise addressable technology, which was jointly developed with **AM Communications**. The system is built around addressable modules that can be strand-mounted. In addition, the system introduces a wide range of jamming and tiering techniques. Each four-port addressable module is driven by Zenith Command Series addressable system controllers, which provide expanded reporting capabilities, advance scheduling of PPV events, and the company's Phonevision ANI PPV system. Zenith featured new addressable products including the TAC 4000, a baseband addressable converter with almost unlimited pay-per-view capability, according to the company. The unit is compatible with existing Zenith sync suppression and active video inversion systems. It features on-screen display and full downloadable channel mapping. Also, new software features are available for Zenith's Command Series cable system controllers, including channel monitoring and opinion-polling in two-way systems, automatic impulse upgrades, season ticket marketing and advanced scheduling. **Reader service #170, Port Authority; #137, TAC 4000; #136, software**

BUILT TO STAND THE TEST OF TIME.



Few of the world's monuments withstand the test of time and the ravages of the elements like the pyramids. And no standby power system lasts longer than Alpha Technologies' equipped with Dynasty gel batteries. The pyramids were built with one thing in mind: endurance. Just like Alpha power supplies and Dynasty batteries.

Dynasty gel batteries outlive the competition in the harsh environments of cable television because they are designed to last. Unlike liquid-acid or absorbent glass mat technology, Dynasty batteries have real staying power over a wide temperature range. Although they can be stored longer prior to use, you can avoid costly battery warehousing by using Alpha's shipping service to put fresh batteries on your doorstep right when you are ready for them. Let's face it: a quality battery that lasts year after year costs less over time than a bargain battery that needs replacement every 18 months.

No battery lasts forever, but Dynasty gel batteries pass the test of time like no others. And that can make a monumental difference in the reliability of your cable system.

DYNASTY

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Reader Service Number 58

AD INDEX

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Leaming Industries' AGC432 audio AGC

By Ron Hranac
Senior Technical Editor

What would you categorize as the most difficult part of headend maintenance? How about keeping consistent audio loudness on all channels? If your system is typical, this is probably your biggest headend headache. How often do subs call to complain that some channels are louder than others? And how often do you find audio levels out of your satellite receivers apparently changing on a regular basis?

Seldom will you find this to be a problem with over-the-air TV and radio broadcasters, however. Most of them process their audio with devices known as compressors and limiters.

It would be nice if cable operators did the same thing, but the broadcast compressors and limiters are fairly expensive. Fortunately, CATV manufacturers such as FM Systems, Leaming Industries and Wegener Communications are among those that have introduced fairly inexpensive audio processing equipment to the cable industry. We obtained one of Leaming's AGC432 stereo/dual-mono audio automatic gain control (AGC) units and put it to the test in the lab.

The product

The AGC432 is an audio processor — Leaming calls it audio AGC — for either a stereo audio input (left and right) or two separate monaural inputs. It also includes alternate inputs for local commercial insertion or backup audio, as well as a built-in stereo synthesizer. Remote control operation is possible by grounding the appropriate terminal on the back of the unit. This provides the capability to remotely activate the stereo synthesizer, select the alternate audio inputs, activate or deactivate the AGC operation, or choose between stereo or dual-mono mode.

Performance summary

Frequency response (20 Hz to 15 kHz)	±0.23 dB
Distortion	0.103 % THD
Signal-to-noise (see text)	64.5 dB
A-to-B separation	80.2 dB
Left-to-right separation	78.5 dB
10-second release time	11 seconds
15-second release time	16 seconds
25-second release time	23 seconds

The AGC module itself is 1.6´´ H x 5.5´´ W x 10.5´´ D and is designed to be mounted in Leaming's PMU401 panel mount. The panel mount is 19´´ W x 1-3/4´´ H and will hold either three AGC modules or two modules and a PS420 power supply. Up to five AGC432s can be powered from the PS420. An external power supply also can be used; requirements are +24 volts DC @ 150 mA per module.

The front panel includes colored LED bar graphs for left (or mono Ch. 1) and right (or mono Ch. 2) audio levels. Each channel also includes toggle switches to manually select automatic, remote or bypass operation, as well as "A" input, remote selection or "B" input. Four level control pots are provided for adjustment of each channel's A and B inputs, and additional LEDs will show which inputs, A or B, are in use along with an indication of automatic operation.

The audio gain control itself incorporates three user-selectable modes. Internal jumpers allow the selection of 2:1 compression, constant-level, or adaptive slope operation. Three user-selectable release times (10, 15 and 25 seconds) also can be set with internal jumpers. As shipped from the factory, the AGC432 is configured for adaptive slope and a 10-second release time.

Mode one, 2:1 compression, is fairly straightforward. It operates over an input range of ±20 dB from normal. If the input were to increase, say, 6 dB, the output would increase only 3 dB. Going the other direction, an input decrease of 6 dB would result in an output decrease of only 3 dB. Thus, audio input changes of up to ±20 dB will change only ±10 dB at the AGC432's output. This means that a reasonable amount of dynamic range is maintained in the original audio program material. →

Mode two, constant-level output, will cause the output to vary only 7 dB over an input range of ±20 dB. This mode is suitable only for voice (such as a shopping channel) or music that has limited dynamic range (rock music is a good example).

The third mode is called adaptive slope. It actually is a combination of the most desirable characteristics of the first two modes. Most of the original dynamic range is preserved, since this mode makes a gradual transition from 2:1 compression at low audio levels to a constant-level output at high audio levels.

The AGC432's maximum gain increase is limited to 20 dB, and its maximum gain decrease also is 20 dB, for a total input dynamic range of 40 dB. Hard limiting is provided for additional protection against sudden peaks. In all three modes, should the audio level fall more than 20 dB below normal, the gain setting will be held for 10 seconds (this compensates for pauses in the audio). If the program audio has not returned to normal after 10 seconds, the unit will reset its gain to the bypass value in preparation for new audio.

Release time selection almost always results in some compromise to the processed audio quality. Too fast and the processing becomes obvious to most listeners, and too slow can result in excessive processor recovery time if different audio material at a much lower level is present. Leaming recommends the factory preset of 10 seconds for most TV program audio.

The rear panel connectors on the back of the AGC432 are a combination plug/screw type instead of the more usual barrier strip. The whole connector pulls off the back and all external connections can be made to the connector's integral screw clamps. After the connections have been made, just plug the whole connector back onto the rear of the chassis (the AGC432 has four such connectors).

The AGC432's list price at the time of the evaluation was $595. The optional power supply and panel mount are additional.

Lab tests

A single AGC432 mounted in the PMU401 panel mount was evaluated; it was powered by Leaming's PS420 power supply. For frequency response, distortion, signal-to-noise (S/N) and channel separation measurements (see accompanying table), the AGC432 was connected to a Sound Technology 3100A audio generator and 3200A audio analyzer system. Per Leaming's recommendation, all sine wave type tests were conducted with the input level 20 dB below normal peak levels and in the bypass mode (note: bypass mode only disables the AGC; it does not actually bypass the active internal circuitry).

Frequency response is specified at ±0.5 dB from 20 Hz to 15 kHz. We measured it at ±0.23 dB over this frequency range; in fact, the AGC432's response dropped only another 0.05 dB out to 18 kHz. Total harmonic distortion (THD) is rated at 0.3 percent maximum, but we measured only 0.103 percent.

Leaming's noise specification is stated as "-80 dB re PPL." Most audio S/N measurements are weighted (that is, made through a filter network with a noise frequency response comparable to the noise frequency response of the human ear). The Sound Technology 3200A audio analyzer indicated an A-weighted S/N of 64.5 dB. Keeping in mind that all sine wave tests were performed 20 dB below normal peak levels, this approximately equaled a noise level of -84.5 dB relative to peak.

In stereo mode, left-to-right separation is rated at 70 dB minimum. We measured a worst case of 78.5 dB at 15 kHz, and it was even better at lower frequencies. Separation at 300 Hz was near the measurement limit of the test equipment (about 97 dB). Channel separation in the dual-mono mode was measured at 80.2 dB (80 dB spec).

One of the more difficult things to measure in audio processing equipment is how it actually affects the loudness of program audio. Rather than relying on just subjective audible effects, we also connected the AGC432 to a Dorrough Model 40A loudness monitor. This instrument provides a graphic electronic display of perceived loudness.

The Dorrough was first calibrated so its "0 dB" level matched the AGC432's bypass unity gain setting. Actual program audio material that included a variety of music, voice and other sound passages was routed through an external audio attenuator that was connected to the input of the Leaming unit. The attenuator allowed simulating input level changes over a 34 dB range.

When the input audio was reduced to just above the AGC432's -20 dB threshold, it would slowly bring up the gain to within 1 or 2 dB of the unity gain setting in about 10 seconds. When input audio was quickly increased to 14 dB above unity (the maximum level we had available), the reduction to unity was nearly instantaneous. Leaming's spec for this is 5 milliseconds; we had no way to actually measure this, although every time the audio was increased the AGC432 brought it back as fast as we could turn the attenuator switch, and with no audible distortion.

The best performance was in adaptive slope mode. Most normal program audio sounded unnatural in the constant-level mode (this also was apparent on the Dorrough), and the 2:1 compression mode was similar to the adaptive slope mode except at higher audio levels, where adaptive slope provided better control.

The stereo synthesizer was not tested during this evaluation.

Comments

The AGC432 performed as it was designed to do. Proper adjustment of input levels is fairly critical, to ensure that normal audio is within the unit's window of operation. While it doesn't have the features and capabilities of the more expensive broadcast audio processors, it works well at maintaining *relatively* constant audio levels without sacrificing a lot of dynamic range.

The instruction manual is well-written and easy to understand, and it includes a good description of the AGC432's theory of operation. While no schematic is provided, the manual does include a major component location diagram to aid in identifying internal jumpers and controls.

The rear chassis connectors are a joy to work with. Should the module need to be removed from the rack, you won't find yourself having to disconnect every wire from the back. Just unplug the terminals with the wires still attached!

For more information, contact Leaming Industries at 15339 Barranca Parkway, Irvine, Calif. 92718; (714) 727-4144. **CT**

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May

May 15: SCTE Palmetto Chapter seminar on Installer Certification, University of South Carolina, Columbia. Contact Melanie Burbank-Shofner, (803) 777-0281.

May 15: SCTE Penn-Ohio Meeting Group seminar on interdiction/off-premises addressability, Cranberry Motor Lodge, Warrendale, Pa. Contact: Bernie Czarnecki, (814) 838-1466.

May 15-16: SCTE Big Sky Chapter seminars on fiber optics, May 15 in Missoula and May 16 in Laurel, Mont. Contact Marla DeShaw, (406) 632-4300.

May 16: SCTE Southeast Texas Chapter seminar, Warner Cable, Houston. Contact Tom Rowan, (713) 580-7360.

May 18: SCTE Cactus Chapter seminar on test equipment and its use. Contact Harold Mackey Jr., (602) 866-0072, x282.

May 19-20: SCTE Old Dominion Chapter seminar, Holiday Inn, Richmond, Va. Contact Margaret Davison-Harvey, (703) 248-3400.

May 20-23: Siecor course on fiber-optic installation and splicing, maintenance and restoration, Hickory, N.C. Contact Lynn Earle, (704) 327-5539.

May 20-22: SCTE and **New York State Commission on Cable TV's** Northeast Technical Seminar and Trade Show, Lake George, N.Y. Al Richards, (518) 474-1324.

May 21: Scientific-Atlanta seminar on headend and earth stations, Dallas. Contact Sylvia Rogers, (404) 925-6064 or (800) 722-2009.

May 22: Scientific-Atlanta seminar on distribution systems, Dallas. Contact Sylvia Rogers, (404) 925-6064 or (800) 722-2009.

May 22: SCTE Great Lakes Chapter seminar on interdiction and off-premises control. Contact Marv Nelson, (313) 553-2109.

May 23: Scientific-Atlanta seminar on fiber-optic systems, Dallas. Contact Sylvia Rogers, (404) 925-6064 or (800) 722-2009.

May 25: SCTE Golden Gate Chapter BCT/E exams in Categories I, II, III and IV, Pleasanton, Calif. Contact Mark Harrigan, (415) 785-6077.

May 29: SCTE Appalachian Mid-Atlantic Chapter seminar on sweep gear and test equipment, Holiday Inn, Chambersburg, Pa. Contact Richard Ginter, (814) 672-5393.

Planning ahead

June 13-16: SCTE Cable-Tec Expo '91, Reno/Sparks Convention Center and Bally's Hotel, Reno, Nev. Contact (215) 363-6888.

August 25-27: Eastern Show, Inforum Exhibit Hall, Atlanta. Contact Nancy Horne, (404) 255-1608.

September 24-26: Great Lakes Cable Expo, Cobolt Hall, Detroit. Contact (517) 484-4954.

October 1-3: Atlantic Cable Show, Convention Center, Atlantic City, N.J. Contact. Contact (609) 848-1000, ext. 304.

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Best cable hardware show in the world

By Wendell Woody
President, Society of Cable Television Engineers

This is the title being bestowed by many on SCTE's Cable-Tec Expo '91. A quote from a recent letter describing the expo states, "In fact, the SCTE-sponsored Cable-Tec Expo ... promises to (rival) the NCTA (show) as the most important (cable) hardware trade show in the world!" *CableFax* has been promoting the Cable-Tec Expo with the slogan, "Responding to the industry's needs ... the only hardware show in the industry!" Since this year's expo is in Reno, Nev., and we still look up to the big NCTA show with lots of respect, we say the Cable-Tec Expo is "the biggest little cable show in the world!"

The trend for this year's shows is a reduction in both exhibitor booths and attendance. However, our SCTE show manager, Anna Riker, has expanded exhibitor floor space by 25 percent over last year's show in Nashville. Also, every booth will be sold before opening day. Please join me in accepting the challenge to pack those aisles full with installers, technicians and engineers to equal the superb achievement in space sold.

This year's opening Engineering Conference encompasses speakers who range from the founders of our industry on up to current industry technologists. Our invited keynote speaker is Richard Smith, chief, Field Operations Bureau, FCC. The expo workshops carry the theme "Back to Basics." Subjects include fiber, test equipment, OSHA, technical speaking, technical calculations, proof-of-performance, CLI, system maintenance and troubleshooting, sweep techniques and house drops.

Welcome, new directors

Thirty-two percent of the SCTE national members voted in the recent election — a disappointing number to your president. However, that number represents the greatest achievement in the history of SCTE elections. Re-elected to seats on the national SCTE board were: Richard Covell, Texscan (at-large); Ron Hranac, Coaxial International (Region 2); Jim Farmer, Scientific-Atlanta (Region 9); and Diana Riley, Jerry Conn Associates (Region 11). New board directors to be seated at our June meeting in Reno are: Wendell Bailey, NCTA (at-large); Tom Elliott, Catel (Region 1); and Rich Henkemeyer, Paragon Cable (Region 6). Join me in welcoming these new directors aboard. Congratulations to all election winners.

Cable-Tec Games

The Cable-Tec Games are a competition among CATV system personnel centering around technical tasks and knowledge. After each event, points are awarded by the judges for each contestant based on speed, accuracy and performance parameters. First-, second-, and third-place Olympic-style individual medals are presented to the winner of each event.

The idea was originated by CT Publications Corp. and others. Coordinated by the SCTE Rocky Mountain Chapter, they simply called the event Cable Games and have held it the past two years at the Colorado cable show. The games have now been elevated to a national program and renamed Cable-Tec Games. The event is supported by a national SCTE subcommittee chaired by Ron Wolfe, ATC Training Center, Denver, (303) 753-9711.

The first Cable-Tec Games event was held in conjunction with the 1991 Texas Cable Show. The events were: RG-59 cable and connector preparation, .750 cable and connector preparation, written test and "Name that distortion." The cable and connector events were hosted by Gilbert and Comm/Scope. The written test was hosted by NCTI and "Name that distortion" was hosted by Jones Intercable.

Expo Evening will feature the first national Cable-Tec Games. The dedicated events hosts, sponsors and national subcommittee are significantly contributing to make this event technically meaningful as well as entertaining for all those present. Hone up your skills and sharpen your wits for the games! The number of contestants is limited, so contact your SCTE regional director.

Out and about

It was a pleasure meeting with Bob Johnson, president of the Wyoming Chapter, last month. I will be speaking at the chapter's Casper meeting later this year. I also met with Herb Dougall, president of the Great Plains Chapter, who is planning the SCTE program for the Nebraska state cable show, to be held in Scottsbluff this year. Additional travel and visits were with Pierre Cubbage, Gateway Chapter; and Don Gall, Ken Covey, Larry Douglas and Bill George with the Heart of America Chapter.

Most recently I met with the New York City Meeting Group; the morning session was devoted to a complete SCTE update on all activities and goals as well as a detailed review on the BCT/E training program. The BCT/E discussion continued on through a special board of director's luncheon arranged by their president, Jim Demetrius. Other officers present were Henry Schwabb, Richard Fevola, John Dallesandro, Paul Fucci, Lenny Muscato and Marvin Fields. Most gratifying was leaving the meeting with every pending document required to finalize its chapter status. They will be elevated and receive their chapter status plaque at the expo in Reno.

Next, I spoke to the "oldest SCTE chapter," Chapter #1, in Chambersburg, Pa. This is the Appalachian Mid-Atlantic Chapter, also known as AMAC. Following the regular meeting and BCT/E testing, its president, Lee Burkholder, called a board of directors meeting. I addressed the directors on ways to increase chapter membership and to advance technical sessions. Other officers present were Richard Forsyth, Gary Selwitz, Richard Ginter and Terry Appleby.

Additional travels and visits were with Tony Gauer, president of the Dakota Territories Chapter; Jeff Berg, director of the Dairyland Chapter; Bernie Czarnecki, president of the Penn-Ohio Meeting Group; and Rickey Luke, director of the Dixie Chapter. I'm very pleased to report all these chapter officers are very enthusiastic toward a good attendance at the Cable-Tec Expo. **CT**

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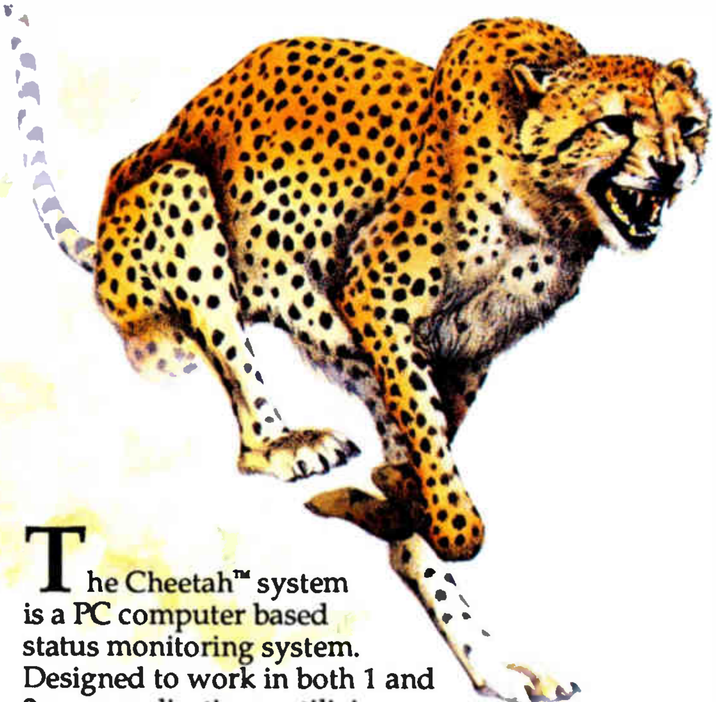

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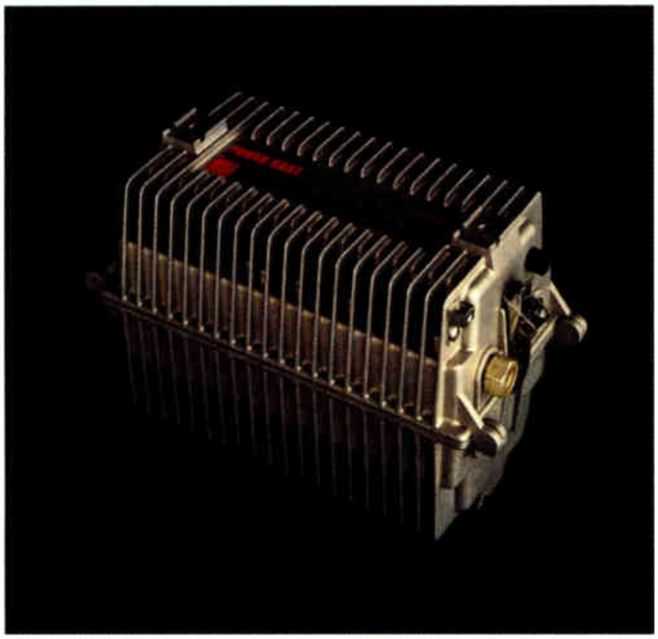

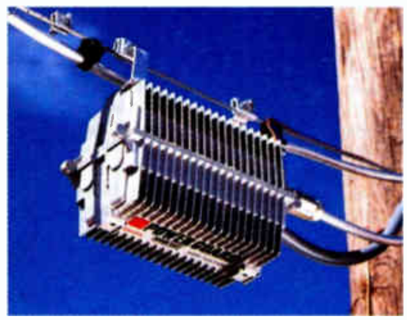

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