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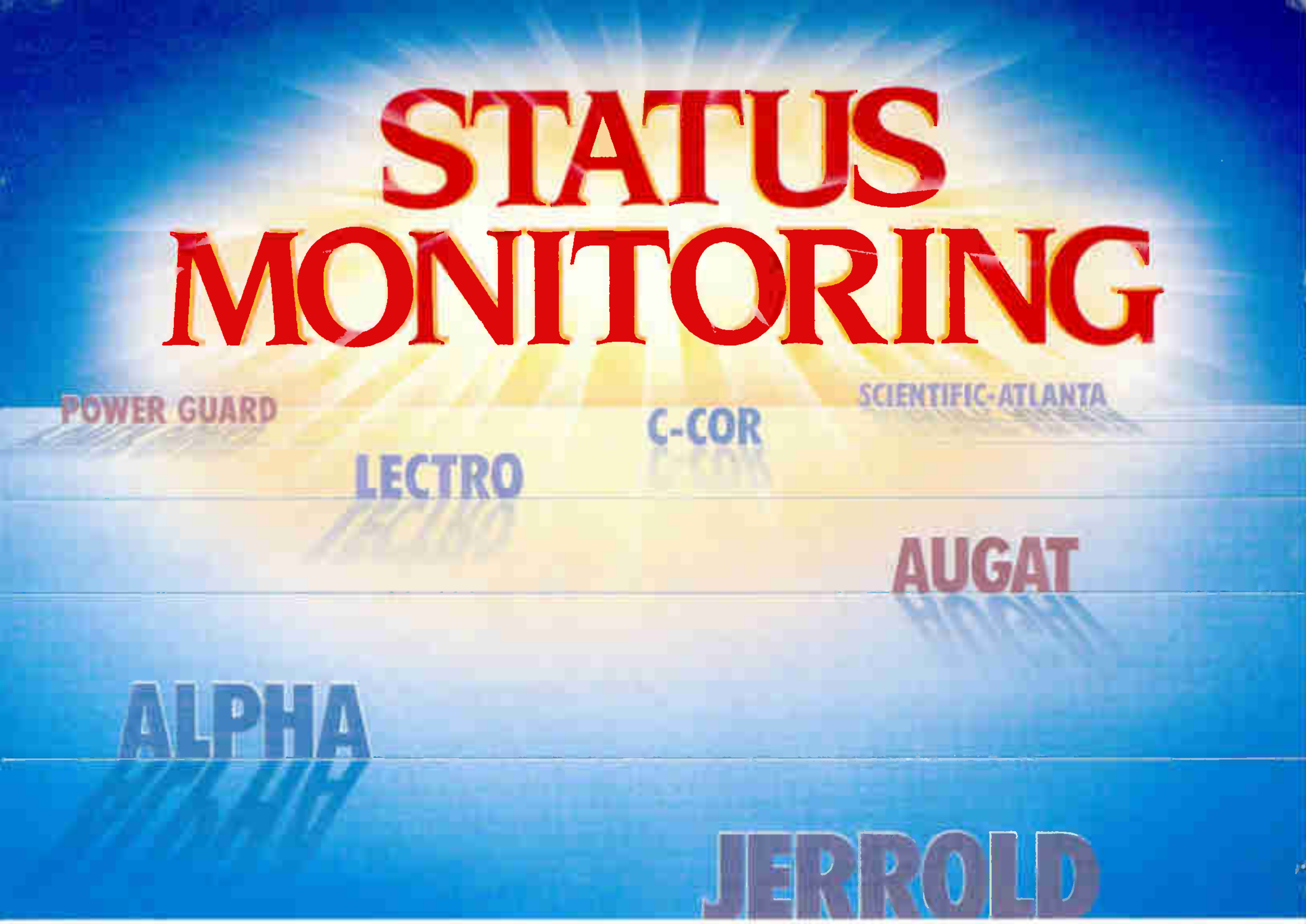
November 1991



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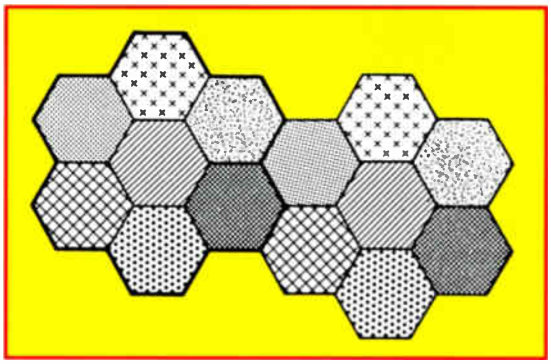

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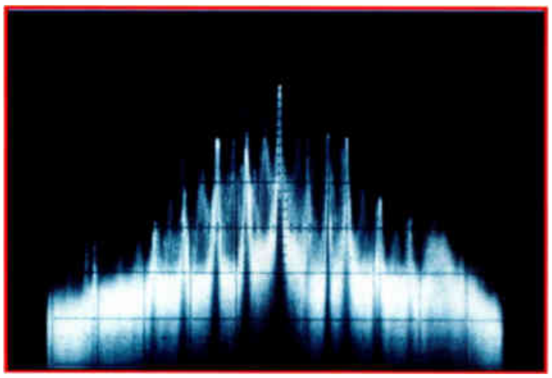

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EDITOR'S LETTER

Taking competition seriously

Over the years cable TV has faced various types of competition, each claimed at the time by our detractors to be the death knell of our business. There's no question that many of them have had an impact, in some cases significant. Even so, CATV's still here — and doing pretty well.

Multipoint distribution service (MDS) delivered one or two premium channels over-the-air at microwave frequencies. Subscription TV (STV) did much the same thing, except in the UHF broadcast band. Innovative for their time, both all but disappeared when cable systems were constructed in metropolitan areas.

Backyard dishes, DBS, VCRs

The popularity and growth of the backyard dish industry was really our own fault. First of all, our programmers did not secure their transmissions, and when they did, it was a case of too little, too late. Remember the howls of protest from the cable industry when we were told that really secure descramblers would cost about $2,000 per channel? If only we had heeded that warning. Today it's estimated that 50 percent or more of the backyard dish owners are using illegal "rubber chip" equipped descramblers to receive cable programming directly from satellites. (I suspect it's a higher figure. Not one of the dish owners I know has a legitimate descrambler.) There's no question that the backyard dish business has taken a chunk or two out of our revenues.

Direct broadcast satellite (DBS) has been more successful overseas than here in North America. That can always change, though. As DBS matures in other markets, the technology can be imported for less than the cost to create it from scratch here. Also, the development of digital video compression could allow multichannel DBS delivery comparable to or better than the best cable systems. This one's still a "wait-and-see."

Our biggest competition to date has probably been the VCR and corner video rental store. This formidable combination provides the consumer with a fairly early release window on recent hit movies, good choice (depending on the video store's inventory) and convenience. Until we have near-video-on-demand and related technologies, this will continue to erode our revenues.

New competition on the block

But there's a new competitor looming on the horizon. Multichannel multipoint distribution service (MMDS) — also known as wireless cable — has the potential to do some serious damage. I attended that industry's annual convention in Denver earlier this year. Record attendance, an upbeat atmosphere and generally good news from Washington, D.C., kept the pulse high. While Congress is trying to reregulate CATV, the wireless industry is enjoying the favors of Capitol Hill.

How successful can MMDS be? The operation in Corpus Christi, Texas, is a good example. Run by Bob Bilodeau (cable veteran and Society of Cable Television Engineers past president) the wireless system boasts 13,500 subscribers, some 7,000 of whom are claimed to be former unhappy subscribers of local cable systems. MMDS systems carry many of the same programs that are available on cable, although the channel capacity isn't as great. Still, if you were a disgruntled cable sub, would you consider paying $15 a month for 20 or so channels that don't have to pass through "unreliable" cables? Combine that with a VCR and who needs CATV?

The point I'm trying to make is that while we've weathered the storms for more than four decades, we can't let our guard down now. I've said it before and I'll say it again: quality, reliability and good service have to be our buzzwords. Otherwise our competition really will ring our death knell.

Ronald J. Hranac
Senior Technical Editor


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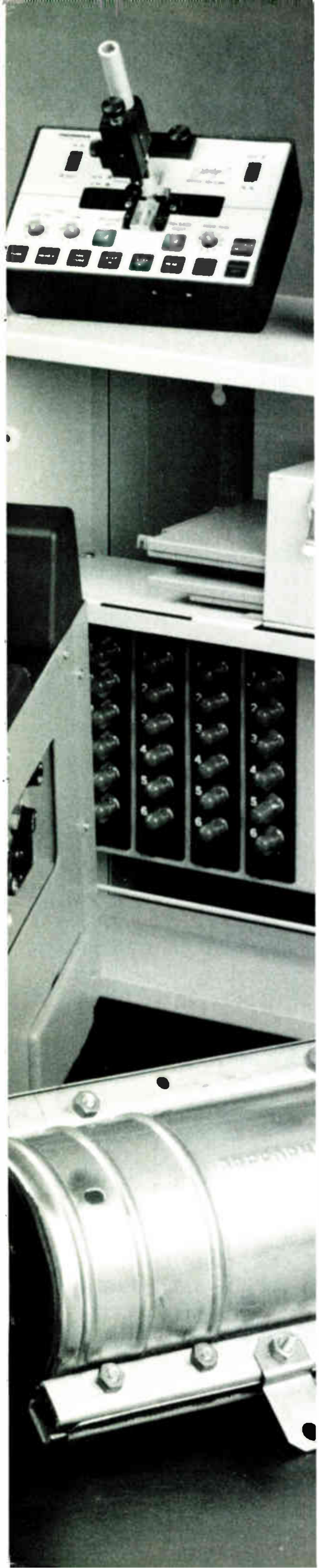

Challenges for CATV

For the past 19 years I've been working in CATV industry and I've seen a lot of changes. At the same time some things never seem to change.

A cable system can deliver more data than any other system. When we stop to think of a small system carrying 40 different channels to 10,000 homes that's a lot of power to reach people ... With that small fact in mind, we trust the system to our technical staff who in many cases never set out to be in cable and to a large degree may have had no formal training in electronics.

I'd like to propose these challenges to the CATV technical community:

1) Each of us (especially SCTE members) should try to improve our technical skills every day and pass this knowledge on to someone else. It can only make our jobs easier and improve our image with our customers by making service better.

2) Each SCTE member should recruit at least one new member a year. Subsequently, we can connect more people who are on the technical side of the fence with the latest in technical information.

3) Learn about the business side of cable. When we better understand were the money goes, it may help us to understand our part in the overall picture.

4) Start testing in the SCTE's BCT/E program. Use the testing as a learning tool. It will show your boss you are interested in improving yourself and it won't hurt when it comes time for a raise. It also is good for the old resume.

5) Don't be afraid to ask questions of others. Most manufacturers have active customer service departments and by using this service not only can you learn, but you can give them feedback on problems with their products.

6) Attend at least two SCTE chapter meetings a year. Not only are there good speakers, but you get to meet others in the industry.

7) Read at least two books a year. They don't need to be about cable. Some of the best ideas I've come up with in cable have really come to me from non-cable sources.

8) Try to help others understand what you do. I find I can only teach others what I really know. If I have a problem teaching it, it's more than likely because I don't understand it and I have work to do on myself.

Dane Walker
Torrance, Calif.

Strap safety

In the cover picture on the July issue, I could not help but notice that the tech has his meter strap around his neck. From personal experience, I know this can be very dangerous because prolonged usage can lead to nerve damage.

A safer technique would be to loop the strap over one shoulder, making sure to keep it positioned by the "knob" where the collarbone meets the shoulder. Don't allow the strap to slip toward the neck, although that is less damaging than looping it.

Robert A. Wanderer
United Artists Cablesystems

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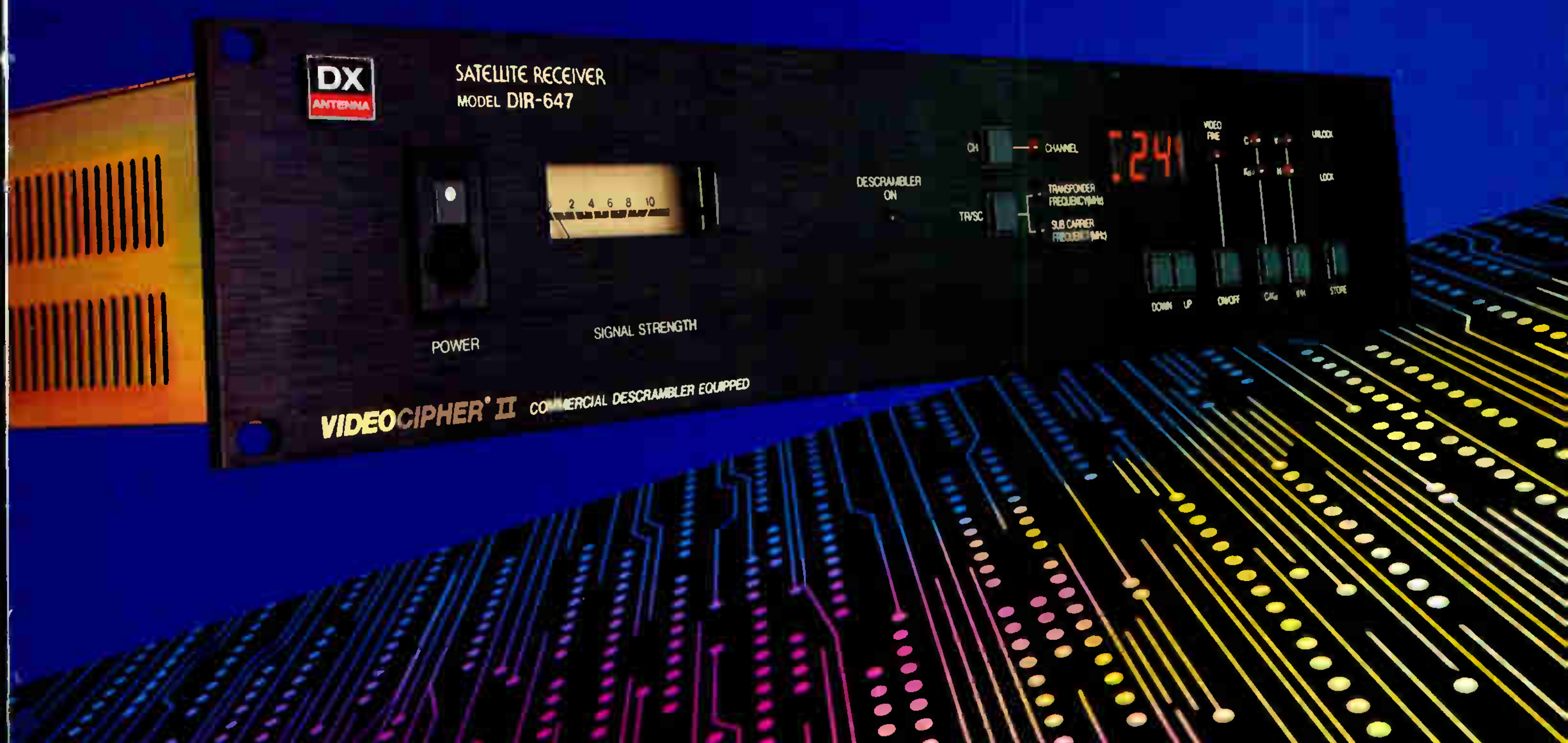

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S-A to unveil FSA variation

ATLANTA — Scientific-Atlanta announced it will introduce at the Western Cable Show a variation of its fiber-to-the-serving area (FSA) architecture to apply the advantages of FSA to fiber upgrades. The FSA-variable forward intermediate terminating trunk (FITT) will let systems with existing coaxial cable in place to gain the benefits of systems that have installed the FSA star architecture, according to the company. These benefits are said to include express feeder, super distribution and neutral network. The technology allows upgrades to 550 MHz bandwidth with minimal downtime, minimal new cable and minimal splices and jumpers.

In other news, IDB Communications said it will convert its satellite audio transmissions to S-A's spectrum efficient digital audio technology (SEDAT) from S-A's digital audio transmission system (DATS). As well, S-A is supplying $5.5 million in fiber receivers and new dual output amplifiers for Continental Cablevision of Ohio. Finally, Scripps-Howard ordered two fiber upgrades of 400 nodes for its Chattanooga and Knoxville, Tenn., systems from S-A.

In-home cabling subcommittee forms

ATLANTIC CITY, N.J. — The first planning meeting for the Society of Cable Television Engineers In-Home Cabling Engineering Subcommittee was held at the Atlantic Cable Show. One order of business was a vote to change the former "in-home wiring" portion of the name of the subcommittee (which was established at the SCTE board meeting at Cable-Tec Expo '91 in Reno, Nev.) to "in-home cabling." The subcommittee's purpose is to establish an industry standard and document it.

Wendell Woody, president of the SCTE, said the next meeting will be held Nov. 19 in Anaheim, Calif. (the day before the Western Show). Volunteers for working group chairmen within the subcommittee were taken at the Atlantic Show, but more volunteers were requested (especially from the operational side of the industry). Anyone interested in joining may attend the meeting in Anaheim or contact Woody c/o SCTE, 669 Exton Commons, Exton, Pa. 19341, (215) 363-6888 or FAX (215) 363-5898.

Great Lakes, great tech sessions

DETROIT — The Great Lakes Cable Expo provided a receptive forum for the four technical workshops and a panel discussion co-sponsored by the SCTE, under the guiding eye of its Region 7 Director Vic Gates of Metrovision. In addition, BCT/E exams in all categories and at both levels were offered.

The workshops ran concurrently in two back-to-back sessions on the first full day of the show, enabling attendees to chose two topics from the four. The fiber-optics workshop with Siecor's Steve Karaffa covered everything from the early beginnings of fiber's use in Bell's Photophone to today's manufacturing processes, specifications and applications. Surge protection by Marty de Alminana of Lectro examined problems and solutions associated with power transients, grounding and protection for equipment in the field.

Modulation schemes and their effects on data quality were covered in the workshop on digital video compression, where Scientific-Atlanta's William Woodward emphasized, "It is *not* true that the quality of cable systems carrying digital video can be much worse than those carrying analog." Rounding out the workshops was Louis Delannoy of Perfect Sync addressing audio and video in the headend.

The panel, "Rebuilds: Back to the basics where the customer lives," moderated by Gates, included panelists Dick Amell of Metrovision, Ron Jones from Orchard Communications, Advanced Communications' Dan Kanaan and Wendell Woody of Anixter and president of the SCTE.

Gates led off the panel with the question: "Which is our biggest threat — telcos or regulators?" The answer: Since we've been regulated in one form or another for years, it's the telcos (they've got all the money). He also stressed that whatever the cable industry does to improve reliability and service, "do it for the customers' sake." Amell, presenting the operator side of rebuilds, examined the three main reasons that make it necessary for operators to rebuild/upgrade: 1) channel capacity, 2) reliability/performance and 3) franchise requirements/commitments. He emphasized that whatever your plans are, keep an eye on the future and look at fiber use.

Offering fiber architecture applications to upgrades, Jones began with laser developments and went through end-of-line distortion achievements using new laser techniques and the ability now to serve many receiver nodes deeper into the system. Kanaan, who discussed problems and solutions from the contractor's viewpoint on how to work with active plant, explained what operators need to do to lessen problems: First is good communications — both in-house and with the contractor. Second is a good PR effort — let the subs/city know what to expect and why. And lastly, thorough planning is a must.

Woody ended the panel with a presentation on operators promoting the benefits of fiber improvements and upgrades to subscribers and franchise authorities alike. Noting that fiber will have a much greater impact on the total system than did satellites, he stressed promoting the fiber aspect because subs already perceive it as good (thanks to the telcos' promotional efforts).

Labs focus: Ghosts, FO, in-home wiring

BOULDER, Colo. — Cable Television Laboratories made several announcements recently concerning ongoing projects including ghost cancelling tests, a forum on fiber, a Laser Link donation and recommended practices for in-home wiring.

CableLabs is participating with broadcasters in conducting field tests to help in efforts to determine a voluntary guideline that may be used to eliminate ghosting from TV pictures delivered via over-the-air broadcast TV. Several cable systems and broadcast stations in the Washington, D.C., area are assisting in the testing with the CableLabs' evaluating performance at cable headends and at subs' homes.

A recent roundtable forum hosted by CableLabs had about 80 cable operators and equipment vendors discussing the deployment of fiber links and other fiber issues. Participants focused on the next generation of fiber links, the role of optical amplification, and cross-compatibility of transmitters/receivers of different vendors. In other fiber-related news, Optical Networks International and AT&T donated a Laser Link II transmitter and receiver for CableLabs tests involving the transport of digital and analog signals over an AM link to find effects of digital transmission on the analog portion of a system.

Finally, CableLabs and Square D Co., an electrical distribution equipment manufacturer, agreed to exchange information on the development of in-home wiring practices for cable TV signal distribution. CableLabs wants the information to explore ways that the quality of in-home installation can be improved. The end result of recommended practices would be coordinated with similar efforts by the NCTA and the SCTE subcommittees on in-home wiring.

SCTE offers tech sessions in AC

ATLANTIC CITY, N.J. — The SCTE sponsored several technical sessions at this year's Atlantic Show and offered exams in its BCT/E and installer certification programs (which boasted one of the best turnouts ever for candidates wanting to take tests at a convention).

• *Interdiction* — Prior to the "Interdiction and signal security" session, SCTE President Wendell Woody announced that two Society meeting groups had been elevated to chapter status. Woody presented the Penn/Ohio and South New Jersey groups with plaques to commemorate their elevation.

The session then started with moderator Robert Dickinson of Dovetail Systems introducing Zenith's Vito Brugliera who expounded on interdiction's place in CATV as the industry moves toward increased channel capacity, tier melt-up, compression and high definition TV. Jerrold's Dan Moloney went next and "interdiction is not being accepted by the market" was his bottom line. He said the industry has not been able to overcome obstacles in interdiction's way such as the lack of true cable-ready TV sets and compatibility with digital compression systems. Steve Necessary of Regal continued the session with, "Most consumers will prefer to have their multichannel needs met via a broadband supply/deny technology and only interdiction and traps meet that need," but added, "Clearly there is an economic impediment ... If history is repeated, we will not see massive deployment until prices drop or revenues increase." Scientific-Atlanta's Angela Bauer recommended that target deployment of interdiction was the best way to improve operational savings with off-premises technology for now, with system pockets that have high churn and theft being an ideal area for the technology. Interdiction's benefits and limitations from an operational view came from George Gardner of Raystay who concluded, "The technology never went through a good beta testing stage."

• *Fiber* — Performance and reliability techniques were the topics in the fiber-optics session, which was moderated by Siecor's J. David Johnson. Billy Pyatt, also of Siecor, quipped, "We don't know where we're going but we're on our way" and thusly pointed out the importance of documentation in fiber maintenance and restoration for future reference. Paul Armbruster of Fitel General highlighted the importance of the fiber emergency restoration kit and recommended that system techs build the kit themselves for extra hands-on experience with fiber (rather than the system buying a pre-made kit). Headend and field installation of optical couplers was the subject of Corning's Doug Wolfe's talk while Thomas Staniec of NewChannels gave a detailed example of how to put together a good training program for fiber restoration.

• *CLI* — As has been the case at past shows, the SCTE tech session on cumulative leakage index attracted heavy attendance and vigorous responses from the audience. Dovetail's Robert Dickinson moderated over the lively "CLI — Fine tuning the process." Intercontinental Cable Services' Jerry Caddy discussed his company's automatic measurement system, giving both the benefits and the "warts." CaLan's Alan system was the next measurement technology scrutinized by the company's Jerry Green, who gave beta test results. Next, the NCTA's Roger Pience warned of the common errors made by operators on FCC Form 320. Those included not signing the form, using a community mile figure instead of the cable plant mile figure in CLI calculations, and not fully completing the form. The FCC's Ron Parver injected the commission's view on leakage into the session by saying despite that it has a table of fines for CLI transgressions, "We're not here to put notches on our gun," but rather it considers CLI "a safety of life issue."

The question-and-answer portion of the session had Biro Engineering's Steven Biro (an audience member) donning the devil's advocate role by throwing out the argument that CATV signal leakage's potential to interfere severely or overpower aviation radios is perhaps being overplayed. Panelists and audience members responded that while, yes, one small leak probably isn't going to obliterate aeronautical radio communications, combined leakage levels could be very dangerous. Others praised the FCC's CLI program because now system management allows the technical department to get the test equipment it needs to run a tight system not just for CLI reasons but from an overall engineering standpoint.

• *Competition* — The session "Positioning for future competition" had the NCTA's Pience as its moderator and was kicked off by Dan Craig, also of the NCTA. Craig gave a concise overview of what is going on in reregulatory matters in Washington (including S-12 in the Senate) and said since rereg would "basically choke the industry" that operators need to publicize the good things cable is doing (like Cable in the Classroom) and get on with doing business right to prove the industry's worth. Tom King of Vyvx considered the industry's options for ancillary revenues and expansion — including interactivity, addressability, fiber, PPV, alternative access and "peeling off a small percentage of the telco business." Finally, Ericsson GE Mobile Data's William Frezza explained his company's technology designed to improve customer service and reduce operational costs by allowing tracking of a system's truck fleet. It's a multichannel 900 MHz radio system that can "tell you where your truck is for 4 cents." Frezza said it wasn't a product, but an enabling technology and his company is seeking CATV partners to put the technology into action.

☛ C-COR recalled and/or rehired 43 workers recently (bringing its total callback number to 98 since July 8). As well, the company hired six new technicians.

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Three meeting groups elevated to chapter status

Three SCTE meeting groups were officially elevated to chapter status within the Society at recent industry events. The former Bluegrass Meeting Group, which is based in Elizabethtown, Ky., was recognized as an SCTE chapter at its meeting held Sept. 17 in conjunction with the Kentucky Cable TV Association yearly meeting in Lexington, Ky. SCTE Eastern Vice President and Region 10 Director Michael Smith presented the plaque to the chapter officers and members in attendance.

Two SCTE meeting groups were officially elevated to full chapter status at the 1991 Atlantic Cable Show in Atlantic City, N.J. Region 11 Director Diana Riley was joined by SCTE President Wendell Woody to present chapter status to the former South Jersey Meeting Group, based in Vineland, N.J. Chapter officers Rich Cunningham, Phil Dente, Kevin Hewitt, Horacio Maiorino, Dave Pharo and Tom Young accepted the presentation of chapter status.

The former Penn-Ohio Meeting Group, based in Lake City, Pa., which serves SCTE members in Pennsylvania and Ohio, also was elevated to chapter status at the event. Riley and Woody presented the chapter plaque to the group's president, Bernie Czarnecki, and his fellow officers George Caramico, Sam Colletts, Ed Hassler Jr. and Roger Hughes.

The Society currently has 55 chapters and 13 meeting groups for a total of 68 local groups.

Marvin Nelson appointed director of chapter development

The Society is pleased to announce the appointment of Marvin Nelson in the newly created position of SCTE director of chapter development. His responsibilities previously fell under the title of director of chapter development and training. Due to the continued growth of the organization, that position has been split in half, with Nelson assuming the chapter development duties and Ralph Haimowitz continuing his work with the Society in the position of SCTE director of training.

A chapter officer for the past four years, Nelson currently serves as second vice president of the Great Lakes Chapter. He is a 12-year veteran of the cable TV industry and has been an SCTE member since 1986. He also holds certification in the BCT/E Program at the engineer level.

In his position as director of chapter development, Nelson will provide chapter support services, both at SCTE national headquarters in Exton, Pa., where he will be based, and through personal visitation to the Society's 68 chapters and meeting groups nationwide. He will work with the groups to ensure their success and will act as a liaison between the national and local organizations. His additional responsibilities will include supporting SCTE's certification programs through tutorial presentations and candidate manage-

ment. His full certification in the BCT/E Program will greatly aid him in his work with BCT/E candidates.

Nelson comments, "I hope to use my experiences as an SCTE chapter officer to support the efforts of the over 500 volunteers who make local technical meetings possible."

Member devises TV switch for paralyzed man

(Submitted By H. Brooke Duncan, Memphis CATV Inc.)

Is the thought of watching one TV channel for over eight hours daily without the ability to change the channel or even turn off the set maddening to you?

That's the predicament Tom McElfresh, an ATC Memphis Cablevision subscriber of nine years, found himself in after health problems left him paralyzed from the neck down. If he wanted to watch television while his wife was at work, she would tune his TV set to a channel that became his only companion for the next eight hours. He could neither change the channel, nor turn the TV off.

McElfresh's plight was a form of TV bondage until his good friend Frank Forrester enlisted the aid of Cablevision System Engineer and SCTE member Scott Young. Forrester learned of a device called a Puff-Sip dual switch that controls electronic switches with the use of air pressure. Switch operation is done by puffing or sipping air through a straw attached to the switch.

Young assumed the Puff-Sip switch could be adapted to control a remote control unit. In conjunction with a converter, the Puff-Sip adapted remote could be used to turn the TV set on and off, as well as change the channels one at a time in ascending order.

"I certainly couldn't ignore the customer's request," Young said. "It was rewarding and challenging to help a special customer receive the full benefit of his service. It gave him a lot of independence."

McElfresh agreed, "The greatest benefit the switch gives me is control over the TV set. I can watch what I want when I want, without being forced to watch something I don't enjoy just because I can't control the TV," McElfresh said.

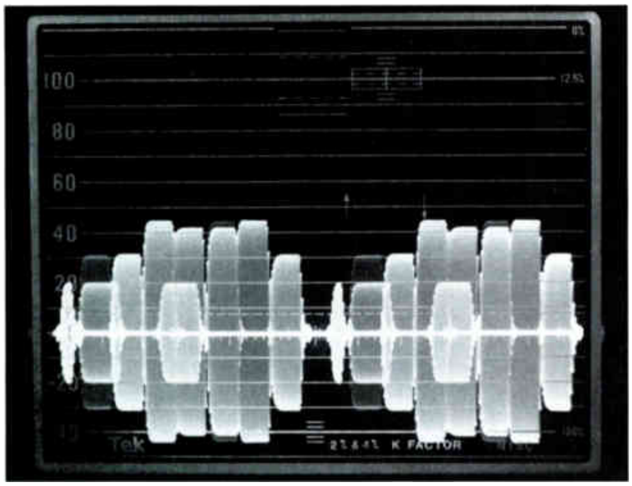
McElfresh hopes others in his situation will discover this new freedom source and take advantage of it. "I'll certainly tell everybody I know in Memphis about how Cablevision helped me. I just hope others across the country hear about it," McElfresh said.

The Puff-Sip unit is a pneumatic switch intended for use with any device operated with low current switching (20 ma max). The switch consists of a switch housing, flexible gooseneck and mouthpiece that allows switch operation with very slight positive or negative change in air pressure.

Combining the Puff-Sip switch with the remote allows a physically disabled person like McElfresh to operate two controls on the unit. In this case, he controls the on-off button and the channel increment button with the switch, giving him freedom to view any channel he chooses or turn the TV set on or off as he pleases.

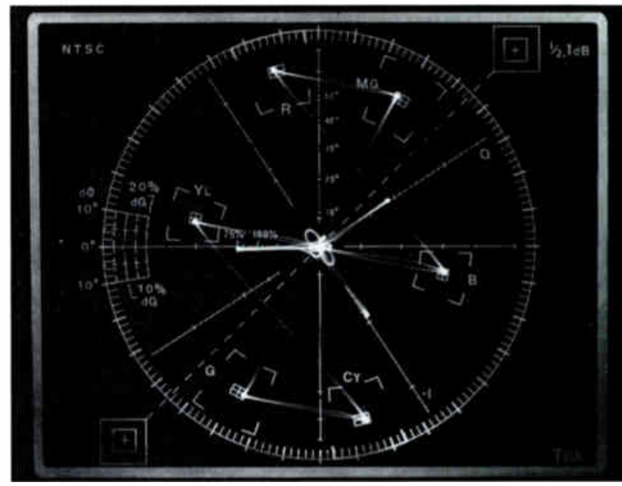
There's a final twist to this customer service saga. While Young was installing his newly created Puff-Sip remote, he noticed that McElfresh was experiencing ingress and generally poor picture quality. Although McElfresh didn't broach the service problem, Young returned to the office and arranged a service call. A Cablevision technician solved McElfresh's signal problems. **CT**

Figure 7: SMPTE bars — 2H, chroma



The chroma filter removes all luminance from the display. It is used for measuring chrominance levels and distortions.

Figure 8: SMPTE bars — screen only



A properly adjusted vectorscope display will have the color burst in the nine o'clock position. Color bars signal amplitude is correct when all dots are in their boxes.

chrominance (which together indicate saturation), the vectorscope indicates the amount of chrominance and its hue (color). Only the vectorscope can indicate the color represented by the chrominance signal.

Perhaps the most significant piece of video test gear in a headend is the precision demodulator. Using a standard cable demodulator or a set-top converter to extract the baseband signal for measurement is counterproductive. These devices often add significantly more distortions to the video signal than are actually present in the signal. Virtually no distortion is introduced by a measurement-quality demodulator.

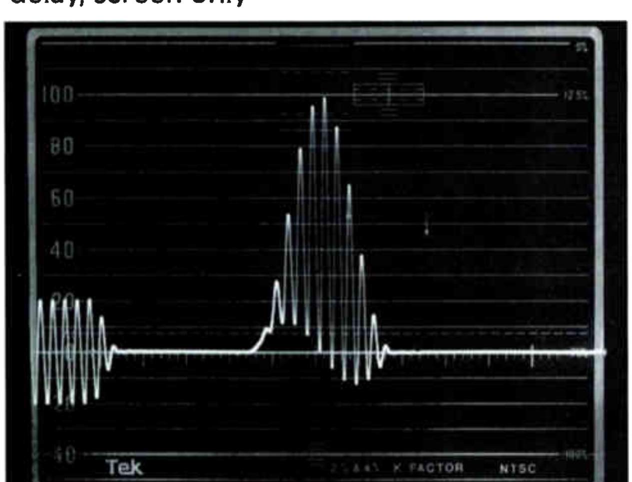
Baseband basics

The baseband video signal is a highly complex entity. However, understanding the excruciating details is not at all necessary for basic signal monitoring and system testing. The baseband video signal can be more easily understood by breaking it down into the fundamental concepts of synchronizing signals, active video, luminance and chrominance.

Figure 3 shows a common 2H (two horizontal lines) display of the SMPTE color bars signal. To understand this display, you should know that the NTSC TV picture consists of 525 horizontal scan lines. These lines are drawn or "scanned" across the screen from left to right and top to bottom. While Figure 3 appears to show two lines of video, it actually shows all 525 lines at once — half of them overlaid on the left and the other half overlaid on the right. In the center of the display (between each line) is the negative going horizontal sync pulse. The horizontal or "H" sync pulse causes the electron beam drawing the picture on a TV set or picture monitor to jump back to the left side of the screen.

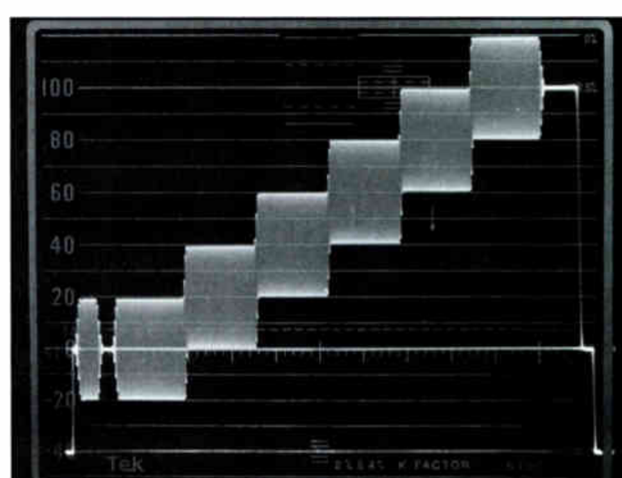
(Continued on page 50)

Figure 9: 12.5T modulated pulse — 250 ns delay, screen only



The sinusoidal distortion in this pulse's baseline indicates 250 ns chrominance delay.

Figure 10: Modulated staircase — screen only

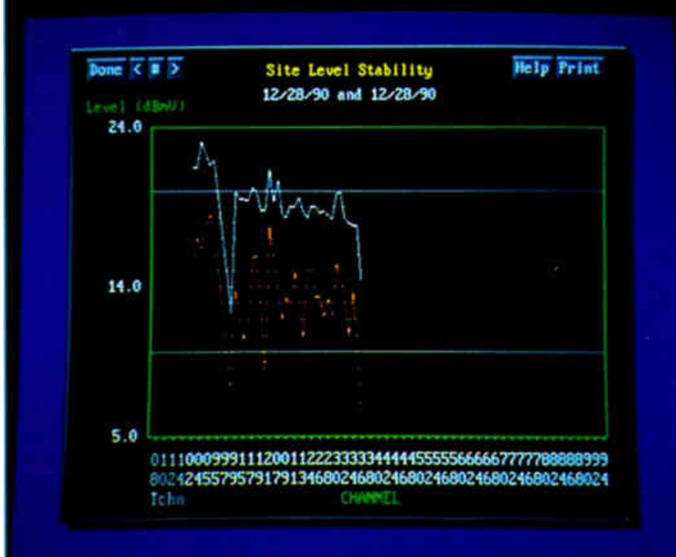


The modulated staircase signal is used for checking differential gain and differential phase.

Reader Service Number 21

Figure 1: Modulator in an HRC system

Figure 2: Site level stability



Beyond status monitoring

By Chris Krehmeyer
President, Superior Electronics Group Inc.

Cable operators have continually envisioned a product that would automate, document and standardize measurements in the cable plant. This concept traditionally has been referred to as *status monitoring*. What goes beyond status monitoring is a product that can automate the testing process of the cable system, inform the operator of specification errors and provide a method to clearly analyze developing trends. The ability to focus on a problem as it develops, document the activity and systematically target the areas being affected, adds a dimension of useable information that is currently available in today's products. The enhancements and development of today's monitoring systems provide the tools to make that vision a reality.

The concept is a simple one — being able to monitor and poll multiple locations and get quick, accurate information that allows the operator to compare, store and evaluate cable plant data as a physician would monitor a patient or a pilot the instrumentation of an aircraft. As any industry develops, the level of sophistication within that industry parallels in growth. The majority of products that have been developed have been based purely on necessity. Whether it is knowledge, efficiency or financial data, the need to make and implement informed decisions is essential to any industry's growth. The operation of the cable plant — its performance and its characteristics — have to be clearly defined and readily available.

"To go beyond status monitoring is to automate the testing process of the cable system, utilizing repeatable, accurate equipment polled and accessed by computers."

Then and now

When status monitoring was first introduced and promoted in the mid-1980s, it generally required a major investment in activating the return path of the cable system to receive data that was both uninformative and unreliable. In most cases it actually required more work to maintain the return path, interpret the data and react to the associated problems created by the monitoring devices than was cost-effective or practical. Many of the systems were

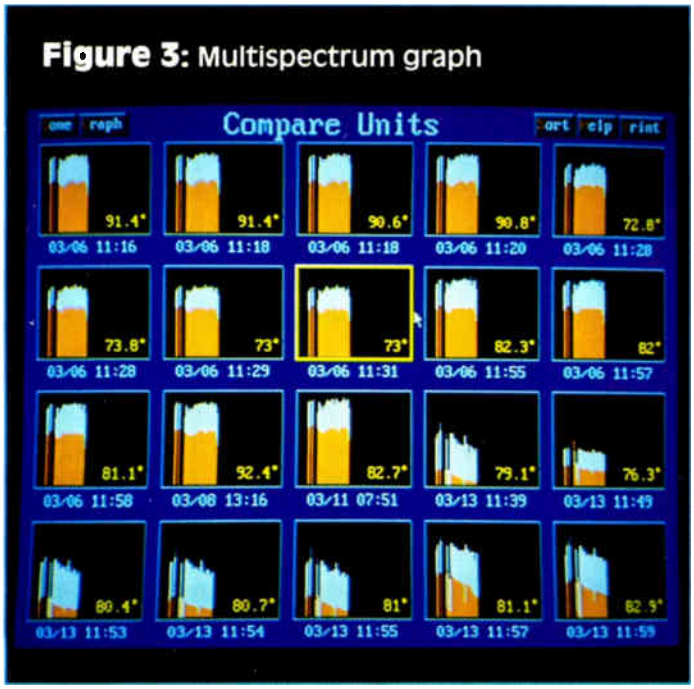


Figure 3: Multispectrum graph

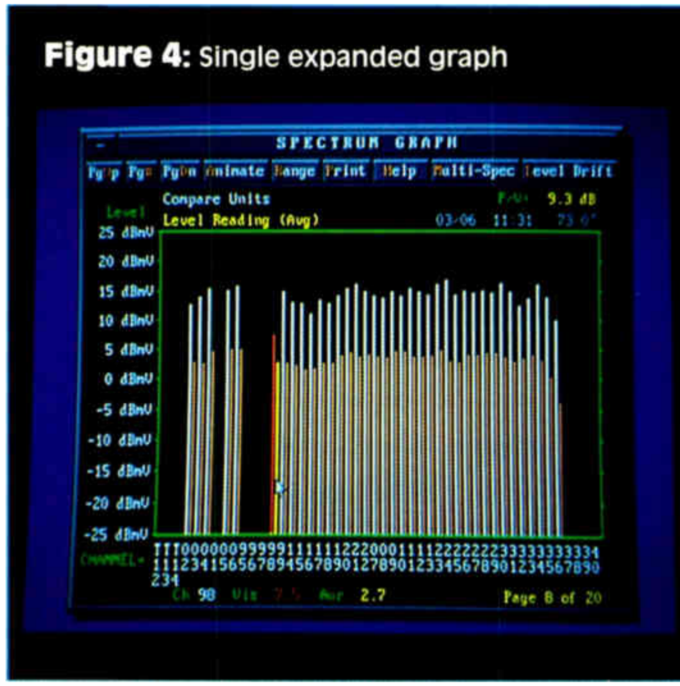


Figure 4: Single expanded graph

removed from operation and the skepticism created from this era was well-deserved.

However, not unlike other related technical products under development (such as computers and TV sets), the technical growth of system monitoring has been enhanced to meet expectations and requirements. This brings us to a major question: What is needed to know in order to maintain the integrity of the plant? A balance must be achieved between what is essential information and what is a convenience. This is all reduced to how cost-effectively it can be implemented into a system without causing the plant to change technically or operationally.

Today's operator is dealing with mandates of both technology and service that require automated testing and monitoring to have accuracy and reliability. This investment has to be justified — but what usually is focused on is replacing labor, which is a misinterpretation of better utilizing labor.

Applications

Most cable operators have developed a formula that is somewhere between $35 and $50 per truck roll. Whether it is a scheduled task or a reactive response to an outage condition, a truck is sent out. This can easily amount to a compounded cost of $70,000 to $100,000 a year per man in just keeping up with daily activity. How much of that truck time could be reduced or better directed by having the right information before the truck rolls?

Rick Scheller, vice president of engineering at Coral Springs Cable in Florida, who is an avid supporter of automated remote testing, has approached the subject like this: "I have the multiple monitors in this system reviewed every morning before the trucks roll and every night before they return. This allows us to focus our personnel in an informed manner before they go into a situation, and lets us reassign personnel before they return at the end of the day. This has a positive impact on relieving both overtime and aggravation. I can see a snapshot of the system performance in seconds, on demand. This will be the first year I have not had to add personnel and still maintain our projected growth rate as an operation."

"One of the most cumbersome but necessary measurements to the cable TV environment is distortion measurements. The automation of this process allows consistent, standardized readings that can be taken in under 60 seconds."

Scheller went on to say, "In the past, service was scheduled by reviewing customer logs to determine the problem areas. Now, with remote testing the necessary maintenance can be identified and performed while it is still transparent to the subscriber."

Depending on how a monitoring system is utilized, an operator could save 20 to 30 percent of an individual's time. This time can easily turn the investment into a quick payback while resolving additional issues within the operation.

Two of the most demanding issues placed on any operator are standardization of measurement and documentation. By placing fixed, mounted units in strategic plant locations that are polled and controlled by a computer system, both of these areas are addressed. Standardization of measurement is achieved by polling a repeatable measuring device that is not subjected to movement or interpretation. As long as conditions of temperature, time and circumstances are factored, you have introduced a device that other devices can be correlated and calibrated to.

Documentation is achieved by storing the extracted data from the monitoring device(s) into a software program's file or data collection area. The only issue here is how the program is written and arranged that allows the data to be stored, categorized and accessed for future review. Simple tasks like printing graphs and columnar data become easy and effective in identifying trends and documenting problems.

The basics first

The first basic requirement of what to monitor is to identify what is essential. The basics will always be frequencies and levels. Even with the sophistication of today's technology, routine problems will develop that continually affect these basics. Doing frequency checks on an annual or a semiannual basis is just not sufficient. Simple mechanical problems related to modulators and processors such as loose or poor connections literally can cause a ripple effect throughout the entire system.

The type and vintage of the equipment will dictate how much attention is required. You can easily develop your own trend analysis on individual pieces of headend equipment. Figure 1 shows a modulator in an HRC system that was not phase-locked. After a simple adjustment of reseating the output drawers, the frequency responded correctly. By automating frequency measurement, what once took hours and days to complete and required channels to be shut down, can now be performed in minutes, without signal interference or system disruptions.

Mike Gorin of Cable Oakland in California monitors multiple headends over considerable distance and obstacles. One of the obstacles was the Bay Bridge and the related traffic problems

(Continued on page 56)

Figure 6: Power supply monitoring in one-way system

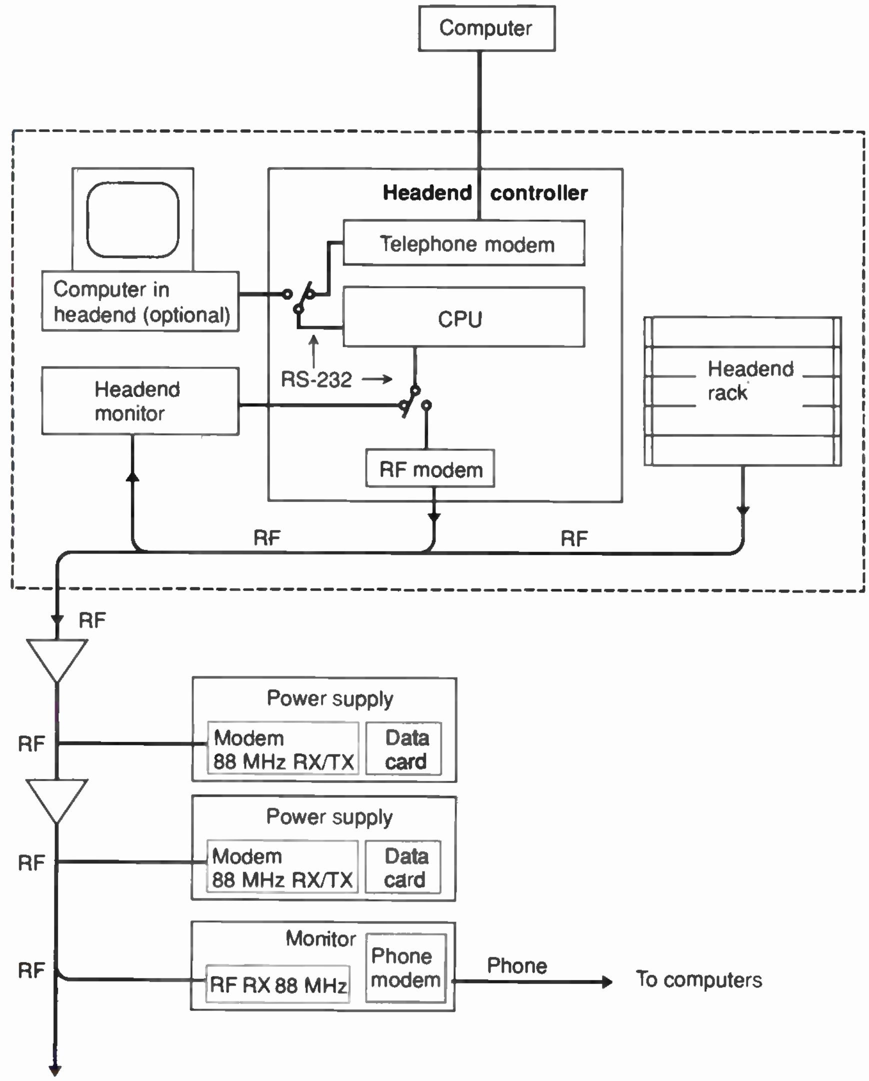


Figure 5: Distortion measurements

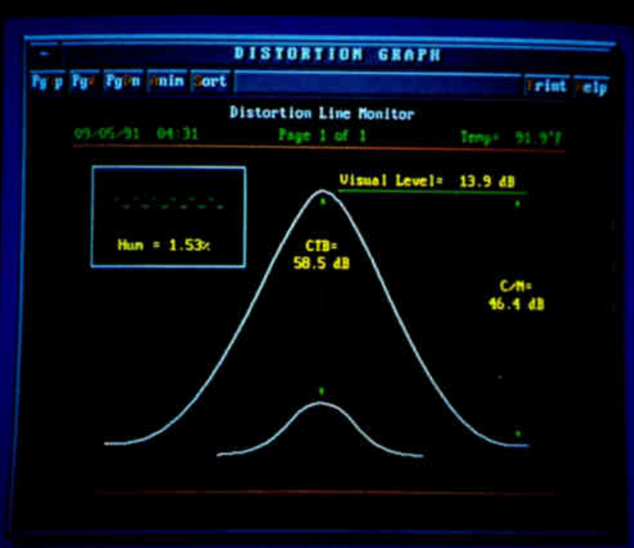
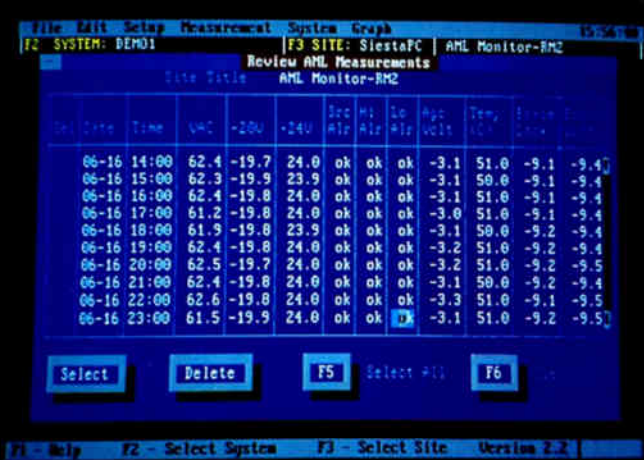


Figure 7: Chart format for AML



The effect of high chrominance levels in satellite-delivered video

By Paul F. Beeman
Vice President of Engineering, TVN Entertainment LP

Have you ever watched satellite-delivered video program material and noticed black streaks or an abundance of white dots in areas of the picture that are highly saturated with color? This video artifact is known as *chroma truncation*. During the infancy of satellite transmissions to cable systems this video artifact was never present. Why has it reared its head now?

History

The IF filters of satellite receivers of the earlier era had a bandwidth of 36 MHz. As the industry (satellite transmissions to cable systems) matured, IF bandwidth filters in the satellite receivers became increasingly narrowed. The receiver industry gradually narrowed the filter bandwidth to 32.4 MHz and then to 30 MHz.

This was not done blatantly and without cause. Calculations showed that most of the *video* information was contained in 30 MHz of bandwidth on the transponder. When the consumer satellite receiver marketplace started to develop and mature, the typical IF bandwidths became 27 MHz or less. It will be shown later that this narrowing of IF bandwidth improves the calculated carrier-to-noise ratio (C/N). However, over-deviation will be present as far as the receiver's concerned. Because of the majority of the video information being 30 MHz wide with peaks greater than 30 MHz, receivers with this narrower IF bandwidth will introduce some artifacts into the demodulated video signal.

Recently, even syndicated material transmitted by the broadcast networks has fallen victim to chroma truncation. The cause again is excessively high frequency chrominance information within the satellite transmitted/demodulated signal. "Excessive" means (in this scenario) substantially more chrominance level — and therefore peak deviation — on the video signal than the satellite receiver's IF filter bandwidth can pass without truncating the signal.

Point of origination

The program source, playback and uplink facilities strive to ensure the maximum signal strength (C/N) and signal quality (video and audio signal-to-noise ratios) to recipients of their program material. The programmer typically uses Type "C" 1-inch videotape machines or the new digital format "D2" ma-chines as their program source for playback. Depending on program format, often live studio cameras and electronic graphics also serve as program material.

Table 1: Receiver IF vs. loss

Receiver IF bandwidth (MHz)	Loss (dB)
36.0	15.56
32.4	15.11
30.0	14.77
27.0	14.31

Table 2: Antenna diameter vs. gain*

Antenna diameter (feet)	Antenna gain (dB)
12	41.12
11	40.40
10	39.54
9	38.64
8	37.60

*Based on Equation 1

For uplinking and transmitting the signal to the desired satellite, a 10-meter antenna (54 dB gain at 6 GHz) is typically utilized to ensure maximizing of the signal to the desired satellite. This size antenna also minimizes "spill-over" to adjacent satellites and minimizes to a practical level the amount of RF energy that must be generated and delivered to the feed point of the transmit antenna. Secondly, the program source desires to run as close to the power saturation point of a satellite transponder as possible. Maximum downlink power is achieved at the point of transponder saturation.

It is common for the uplink antenna to be used to monitor the downlink signal. This is possible via a four-port feed on the antenna. Two ports are used for the uplink signals. One port is used for each polarization. The receive side of the four-port feed also follows the same polarization configuration. Because of propagation properties and frequency selectivity of waveguide used in the feed along with isolators or transmit reject filters, the transmit signal does not interfere with the downlink signal though the transmit and receive feeds are adjacent to each other on the four-port feed. However, a 10-meter class antenna has approximately 6 dB greater gain at 4 GHz than a 4.5-meter antenna typically used in the larger cable systems. Therefore, for a given satellite downlink power (EIRP — effective isotropic radiate power) and for the type satellite receiver, the 10-meter earth station will have a C/N 6 dB greater than a 4.5-meter earth station and nominally 9 dB greater than a 3.2-meter (10-foot) earth station.

The uplink earth station also utilizes commercial-grade or cable-grade receivers to monitor the downlink signal. On occasion, the uplink earth station also may monitor the downlink with a consumer-grade receiver if the uplink earth station also serves the home TV receive-only (HTVRO) market. In the latter scenario, the uplink provider also may monitor the downlink on a smaller aperture antenna (10-foot class).

Transponders and receivers

Each C-band transponder on a satellite is 40 MHz wide in

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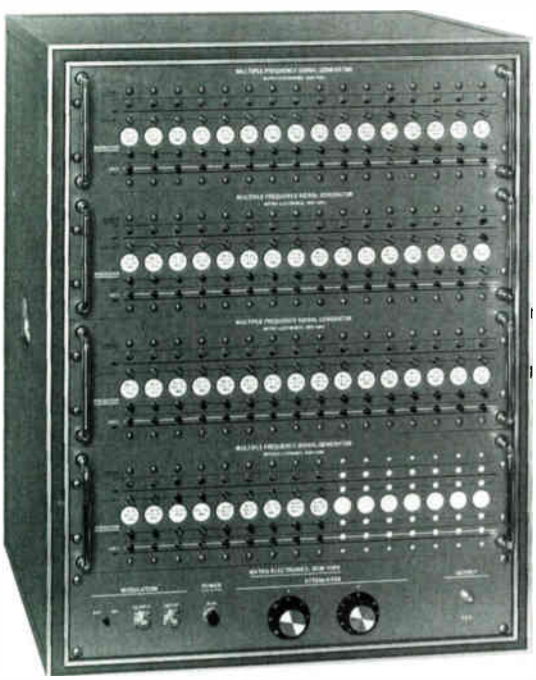

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Table 3: Saturation levels vs. color

Color	Phase relative to burst*	Chroma amplitude	P-P chrominance**
Burst	0°	0.286 V	
White	-	0 V	
Yellow	12.9°	0.319 V	62 IRE
Red	76.6°	0.451 V	88 IRE
Magenta	119.2°	0.423 V	82 IRE
Blue	192.9°	0.319 V	62 IRE
Cyan	256.6°	0.451 V	88 IRE
Green	299.2°	0.423 V	82 IRE
Black	-	0 V	

* As viewed on a vectorscope clockwise rotation from burst
** As viewed on a video waveform monitor, 7.5 IRE setup

Table 4: Pre-emphasis characteristics per CCIR 405-1

Modulating frequency (MHz)	Relative deviation (dB)
0.01	-10
0.10	-9
0.7616*	0
1.0	1
3.58	3.16

* Bessel null test tone frequency at -13.127 dBm with modulation index for first carrier null of 2.4048

bandwidth. The maximum useable bandwidth by the uplink service is 36 MHz. The remaining 4 MHz is reserved for guard bands. These regions of 2 MHz above the lower frequency limit of the transponder and 2 MHz below the upper frequency limit of the transponders are used to ensure that there is no appreciable energy that would affect adjacent transponders. Remember, that the adjacent transponders are not 40 MHz apart but only 20 MHz apart. However, the adjacent transponders are on the opposite polarization. Cross polarization isolation through the path (uplink, satellite and downlink and antenna feed) is typically greater than 25 dB. Energy from the adjacent polarization will be reduced to at least 1/316 of the level on the correct polarization.

The uplink exciters used to deliver C-band satellite programming still have an IF bandwidth of 36 MHz today. Therefore, the uplink provider, and the satellite both have or use the same active passband bandwidth.

Commercial satellite receivers, typically ones used at uplink earth stations sites, have an IF bandwidth of 36 MHz. This is effectively the full useable portion of a transponder. Cable-grade receivers typically have an IF bandwidth of 30-32.4 MHz. Consumer-grade receivers and integrated receiver descramblers (IRDs) typically have an IF bandwidth of 27 MHz.

If one was to watch any satellite program material long enough on a narrow IF bandwidth receiver, one would notice that in cases of chroma truncation when the video level is reduced or the scene changes, the truncation vanishes as the video level and chrominance level is reduced.

System analysis

Many subsystems of the receive earth station contribute to the overall system performance. C/N, video and audio signal-to-noise ratios (S/N) are all dependent on antenna gain, system noise temperature and receiver IF bandwidth. The following will illustrate the contribution factor of each subsystem.

Antenna diameter vs. antenna gain and G/T

For a fixed efficiency rate of a parabolic antenna, the antenna gain is a function of the diameter of that antenna. Antenna gain can be calculated via the equation[1]:

$$\text{Antenna gain (dB)} = 20\log(D) + 20\log(F) + 7.5\text{ dB} \qquad (1)$$

Where:
D = diameter in feet
F = frequency in GHz
Efficiency = 55 percent

According to Equation 1, since the receive frequency is centered at 4 GHz (3.70-4.20 GHz), the gain of an antenna will vary with 20log(D). The figure of merit of an earth station (G/T) is *approximately* equal to the following equation[1]:

$$G/T = Ant_{gain} - 10\log(Ant_{noise\ temp} + LNE_{noise\ temp}) \qquad (2)$$

We can see then as the antenna gain changes dB for dB, the G/T and, therefore, the C/N also will change dB for dB.

In Equation 2 system noise temperature has been simplified to be noise temperature of the antenna ($Ant_{noise\ temp}$) plus the noise temperature of the low noise electronics ($LNE_{noise\ temp}$). In fact the equation is more complex than presented. Contributions of the noise figure of the receiver, feed gain, etc., are taken into account in the expanded equation. However, the overall noise temperature of the system would typically change less than 2°K.

Receiver IF bandwidth and C/N

To summarize where our analysis is to this point, the C/N of an earth station is equal to[2]:

$$C/N = G/T + EIRP - L_p - L_a - K - 10\log(RX_{IFBW}) \qquad (3)$$

Where:
L_p = path loss (196.6 dB at 4 GHz)
L_a = atmospheric loss at 4 GHz, 5° elevation, clear weather (0.3 dB)
K = Boltzmann's constant (-168.6 dB)
RX_{IFBW} = receiver IF bandwidth (MHz)

We can see empirically by this equation that if we reduce the "loss" in the portion of the equation as described by 10log(RX), the C/N will increase if all other variables (G/T and EIRP) remain unchanged. That is to say, receivers with a wider IF bandwidth contribute more to this portion of the equation, which is considered a loss.

Table 1 shows the results of $10\log(RX_{IFBW})$ for common IF bandwidths. According to this table, if we reduce the IF bandwidth from 36 MHz to 27 MHz there is an "increase" in C/N of 1.25 dB. Let's compare this 1.25 dB difference as the receiver IF bandwidth is reduced from 36 MHz to 27 MHz. The purpose is compare this gain change to the same gain change if the size of the antenna was changed instead (see Table 2). We will see that this 1.25 dB gain (less loss) from 36 MHz to 27 MHz IF bandwidth would be equal to reducing the antenna diameter approximately 15

Table 5: IF bandwidth vs. video S/N

IF bandwidth	$10\log(BW_{RF}/2BW_m)$	Difference
36.0 MHz	9.33 dB	0
32.4 MHz	8.87 dB	0.46 dB
30.0 MHz	8.54 dB	0.79 dB
27.0 MHz	8.08 dB	1.25 dB

percent while still maintaining the same C/N. This 15 percent diameter reduction scenario is given by the equation: $10^{(1.25/20)}$ (where the base 10 is raised to the power of 1.25 dB/20).

To summarize to this point, if antenna gain is changed, the C/N will change, and if we change the IF bandwidth of the receiver, the C/N also will change. The narrower the IF bandwidth, the less noise contribution. If "less loss" was traded off for antenna diameter, the size of the antenna could be reduced while reducing IF bandwidth and maintaining the same C/N. The alternate scenario would be an increase in C/N as the receiver IF bandwidth is reduced (if the antenna diameter remains unchanged).

Transponder signal analysis

For point of illustration we will analyze a transponder that is encrypted with VideoCipher II Plus with no audio subcarriers and transmitting the energy dispersal waveform (EDU). The following would be the signal analysis for the perspective of peak deviation on the transponder using the root-sum-square law (RSS)[3]:

Signal format	Peak deviation (PD)	PD^2
Video	10.75 MHz	115.56
EDU	1 MHz	1

Total: 116.56 MHz
Square root of the sums: 10.8 MHz

Carson's rule of bandwidth

This rule states that bandwidth (BW) is equal to[3]:

$$2(F_{vm} + FM) \qquad \textbf{(4)}$$

Where:
F_{vm} = peak deviation from RSS
FM = highest modulating frequency

Therefore, in Equation 4:
BW = 2(10.8 + 4.2)
BW = 30 MHz

In fact, as denoted in a satellite systems handbook[6], "the RF bandwidth to support broadcast-quality television via satellite is approximately 30 MHz." Naturally the preceding refers to the current analog FM format used on conventional C-band satellite transmissions.

In this illustration, the commercial and CATV satellite receivers would have ample predetection IF bandwidth to ensure against chroma truncation. However, the consumer-grade satellite receiver would not have sufficient predetection bandwidth and would display the visual artifacts indicative of chroma truncation in regions of the video that were highly saturated in color. These artifacts manifest themselves as horizontal streaking in highly saturated scenes or portions of scenes. These streaks are normally black in

Table 6: Peak deviation vs. bandwidth

Peak deviation	Bandwidth
(10.75 + 4.2) = 14.95 MHz	29.9 MHz
(9.30 + 4.2) = 13.5 MHz	27.0 MHz

nature and also can be exhibited as a "tearing" in the chroma sections of the scenes. In some cases where there is a higher degree of chroma truncation, a highly saturated chroma scene would exhibit almost a white dot mosaic within the high chroma region.

"But my white flag is at 100"

Colors are transmitted in "color bars" as yellow, red, magenta, blue, cyan and green. Table 3 shows the relationship the amplitude of the color signals referenced to chroma amplitude. According to this table, the colors cyan and red exhibit the most amplitude. In day-to-day operations, scenes with a high amount of these two colors also exhibit the most chroma truncation.

Video transmissions via satellite are frequency modulated (FM) in format. In FM systems the noise voltage spectrum is triangular, increasing in frequency. The color subcarrier with its sidebands resides at the upper part of the band (video) and therefore is subjected to high levels of noise. After demodulation, the high frequency channel noise becomes low frequency color noise.[4]

Chrominance levels in the region above the normal saturation level would cause chroma saturation in at least the consumer-grade receivers and possibly in the cable-grade receivers. Chroma truncation can and will occur even when the peak white level (white flag) is maintained at or below 100 IRE.

Oftentimes it is the operating practice of a production or playback center to allow for chrominance levels to exceed 100 IRE. And in theory, since this is typically only an instantaneous transition, little or no problems would occur. However, when this display period is a long interval (several frames) and the transition is with cyan or red colors, chroma truncation is most prevalent.

In an FM system, the peak deviation is a function of signal amplitude whereas the rate of deviation is a function of modulating frequency. Therefore, over-deviation can be caused by: 1) large black-to-white and white-to-black transitions, and 2) strongly saturated chroma regions of a picture (since the pre-emphasis network used in video boosts the chroma signal). Table 4 shows pre-emphasis characteristics per CCIR 405-1.

Why not just reduce peak deviation on the transponder to conform to narrower IF bandwidths? As previously mentioned, C/N has a direct impact on video S/N. The following equation can be used to calculate the video S/N:

$$V_{S/N} = C/N + 10\log(BW_{RF}/2BW_m) + 9\text{ dB} + 10\log(D \times 0.714/BW_m) + EW \qquad \textbf{(5)}$$

Where:
BW_{RF} = receiver IF bandwidth (MHz)
BW_m = maximum frequency of baseband modulation signal
9 dB = conversion from RMS/RMS to P-P/RMS S/N

(Continued on page 60)

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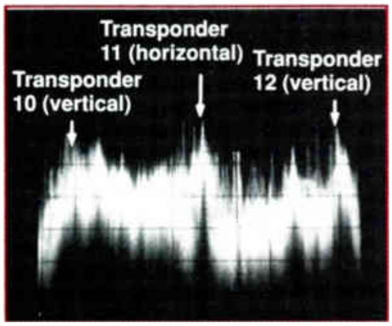
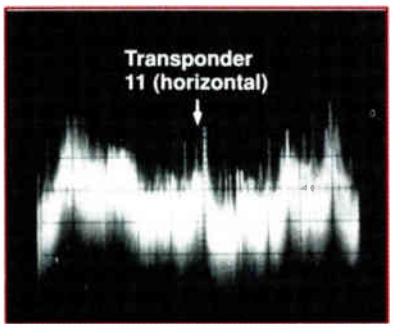
Figure 4: IF test point with feedhorn out of adjustment by 45°



In this example we are looking at an LNA that is used to receive the satellite's vertically polarized signals, and will rotate the feedhorn to minimize the amplitude of horizontally polarized signals.

Figure 5: As the feedhorn is rotated, the amplitude of the undesired transponder will begin to decrease



transponder, the analyzer display should resemble Figure 3. If you try to adjust the antenna's feedhorn to peak this signal, you'll find that it's possible to rotate it a considerable distance either direction before a noticeable amplitude change occurs. Instead, you should adjust the feedhorn for a null of signals on the opposite polarity.

In this example, let's assume that the desired transponder shown in Figure 3 is vertically polarized and is Transponder 10 on your receiver. To adjust the antenna's polarity for optimum performance, first tune the receiver to a horizontally polarized transponder, say, number 11.

Figure 4 shows what the analyzer display would look like with the receiver tuned to the adjacent transponder on the opposite polarity from the desired transponder. In this case, the feedhorn is 45° out of adjustment, so the amplitudes of both polarities are equal. At this point, received picture quality would be very poor. As you rotate the feedhorn, the amplitude of horizontally polarized Transponder 11 will begin to decrease (Figure 5). Continuing the adjustment, Transponder 11 will approach a null (Figure 6).

The cross-polarization isolation of your antenna and feedhorn will limit the amount of null you are able to achieve, but it should be possible to have a minimum of 20 dB difference between the desired and undesired transponder amplitudes (Figure 7). By now you will also have found that the feedhorn adjustment for a null is fairly critical, and that a very small amount of rotation will go right past the null.

Because very few systems have motorized antenna adjustments, this procedure will usually require that someone monitor the spectrum analyzer in the headend (unless you temporarily place a receiver outside at the antenna) while another person rotates the feedhorn. Communication can be on your system's two-way radios, although low-cost 49 MHz FM headsets (available from Radio Shack) will work well and not tie up a pair of radios. After the null has been achieved, be sure to tighten any clamps or bolts that were loosened on the antenna and feedhorn. When you tune the receiver back to the desired transponder, it should again resemble Figure 3.

This procedure also can be performed on installations that use LNBs at the antenna. With LNB installations, the 4 GHz satellite spectrum is block downconverted to an IF of 950 to 1,450 MHz (this frequency range may vary, depending on the particular IF that your equipment provides). An easy way to check isolation is to connect the spectrum analyzer to a spare port on your LNB splitters in the headend.

Analyzer settings will be the same as before, except that span per division can be increased so you can see all 12 transponders on the desired polarity. As before, rotate the feedhorn to minimize the amplitudes of the opposite polarity (Figure 8).

A spectrum analyzer is recommended for polarity adjustment because you can easily vary the analyzer's resolution bandwidth and other controls to provide the most useful display. A conventional CATV signal level meter will not work well because its IF is too narrow, and a power meter cannot discriminate between desired and undesired signals, especially if more than one transponder is present at the IF test point (the power meter should be used to peak the antenna on the desired transponder, however). **CT**

Figure 6: The opposite polarity is approaching a null in amplitude

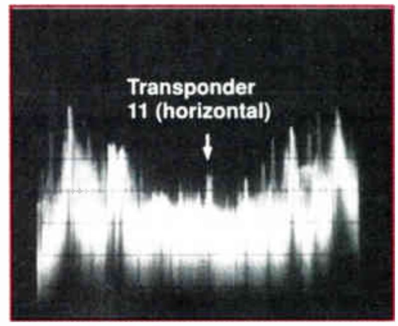
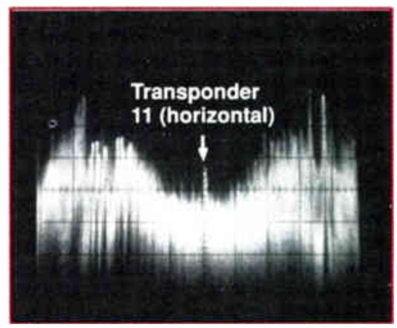
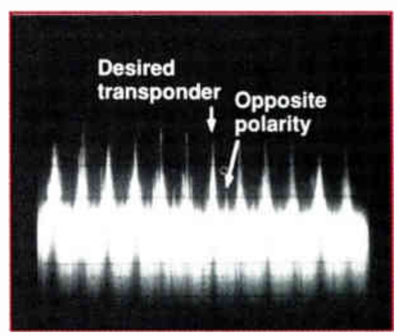


Figure 7: Lowest amplitude achievable with this particular earth station

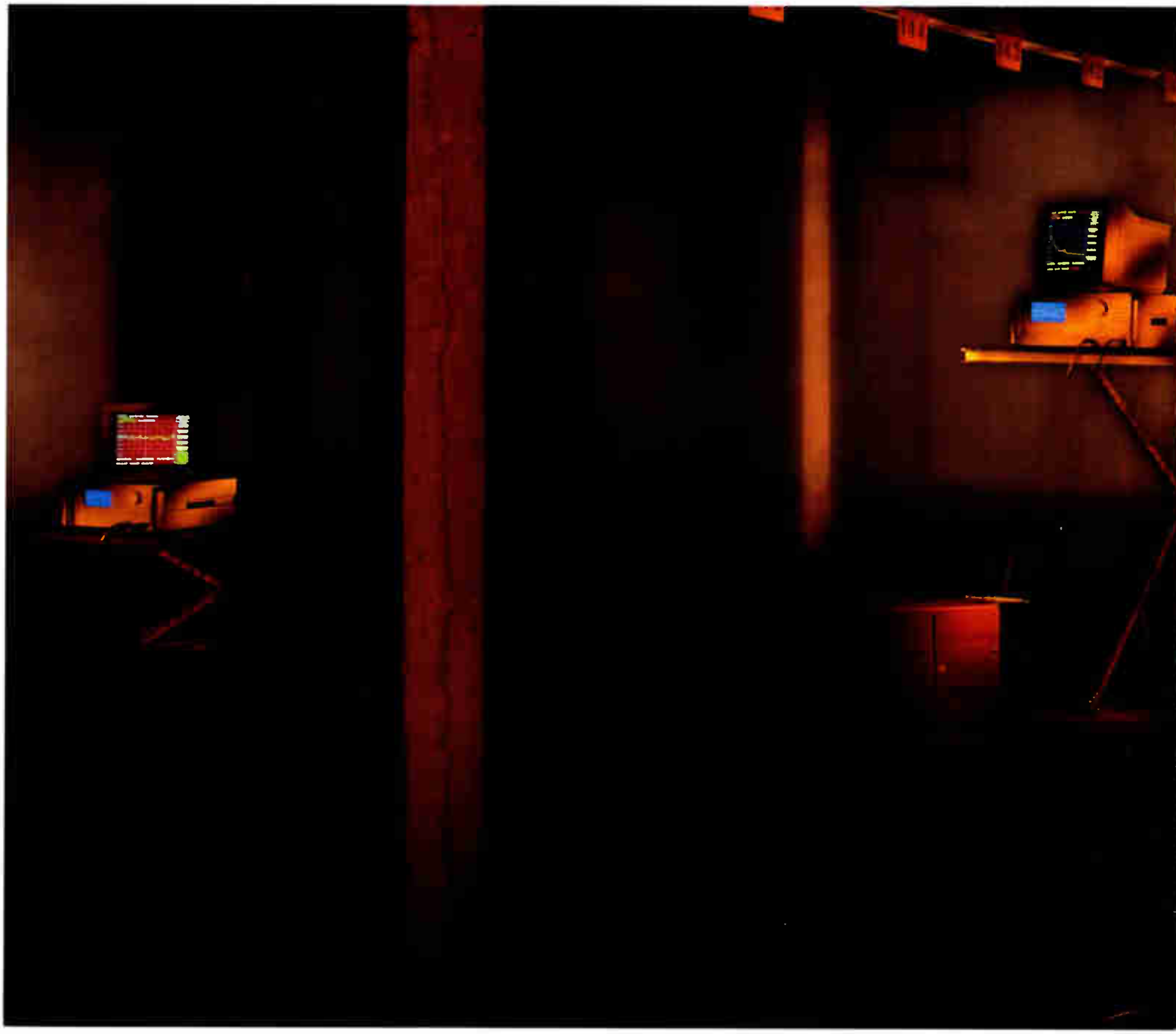


In this case, cross-polarization isolation is more than 20 dB.

Figure 8: Minimized amplitude of signals on opposite polarity with LNBs



For LNB installations, the same procedure can be used to minimize the amplitude of signals on the opposite polarity.



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The migration from analog to digital

By Neil Neubert
Engineering Manager
And Juan Martinez
Senior Field Sales Engineer
JVC Professional Products Co.

Video signal digitization started to become practical in the late 1970s with the introduction of 8-bit quantizing, wideband video analog-to-digital (A/D) and digital-to-analog (D/A) converter integrated circuits (ICs). The development of A/D and D/A converter ICs was key to the success and growth of digital video products. Implementation of converters utilizing individual discrete transistor circuits was not a practical possibility for useful products.

The early 1980s saw the introduction of unique digital video processing and manipulation products that accomplished tasks that could not be done in a practical manner in the analog domain. One such product was the digital video noise reducer, which employed field and frame digital recursive filters to comb noise from video signals. It did so without effect on, or reduction of, picture resolution. Such picture filtering could not be accomplished practically in the analog domain.

Other applications made possible by digital video processing are graphics-related products. Initial digital effects and video graphics devices became available to broadcast users in the early 1980s. Digital signal processing has made it possible to change and manipulate TV pictures in countless ways. Today, video graphics devices are key elements in broadcasting, cablecasting and even as plug-in peripherals for advanced personal computers.

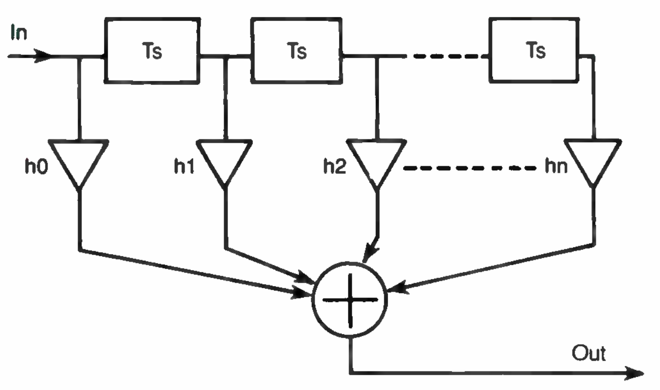
Digital video processing requires RAM picture memory as well as good A/D and D/A conversion circuits. At their introduction in the early '80s, digital video products could utilize only the small capacity digital memory ICs available at that time. As a result, a great deal of space and volume was required just to house RAM picture memory in early products. Power consumption and consequent heat dissipation also were quite great in early digital video products. Today, both conversion and RAM picture memory have been improved in performance, size and power consumption so that very powerful, yet small, cool and electrically economical products are available in all markets for a wide variety of applications and uses.

Digital video is no longer the sole domain of TV broadcasters. Today economical digital video products can be purchased and used by cablecasters, professionals, business and industry and, soon, probably even in modestly priced but very capable home computer systems.

Digital audio

While the technical challenges were not as great as for those of video signals, the digitization of much smaller bandwidth audio signals became popular at about the same time as video. However, fewer technical challenges permitted digital audio processing to mature more rapidly than video during the early 1980s. As an example, a means to serially transmit a digital stereophonic audio signal was standardized in the mid-1980s. This is known today as the AES/EBU serial digital audio interface. A standard method of serial digital video transmission is yet to become a reality, although a great deal of work has been devoted to such a method in recent years.

Figure 1: FIR filter configuration



> ***"Pictures and sound in digital form are precise, rugged and robust. Unlike analog signals, they are generally independent of the media that they're recorded and stored on."***

Today, the world of consumer audio boasts numerous digital products. Foremost of these is the compact disc digital audio recording, which has now surpassed the analog vinyl record as the most popular method of distributing recorded music and entertainment. Digital audiotape (DAT) recorder/players were introduced to U.S. consumers little more than a year ago, although the DAT recording format and technology have been standardized and available in other parts of the world for many years now.

In the professional audio world, digital audio recording devices have been available and indeed used extensively since before the mid-1980s. The first digital audio recorders were videocassette recorders. A digital audio converter was used with them to convert the audio from analog to digital form, and then encode it such that it resembled, and could be recorded as, a video signal. The AES/EBU serial digital audio data rate is about 2.5 MHz for a stereo audio signal. In the early 1980s, only videotape recorders could accommodate such signal bandwidths. In perspective, 2.5 MHz is the equivalent of a TV picture with horizontal resolution of

(Continued on page 62)

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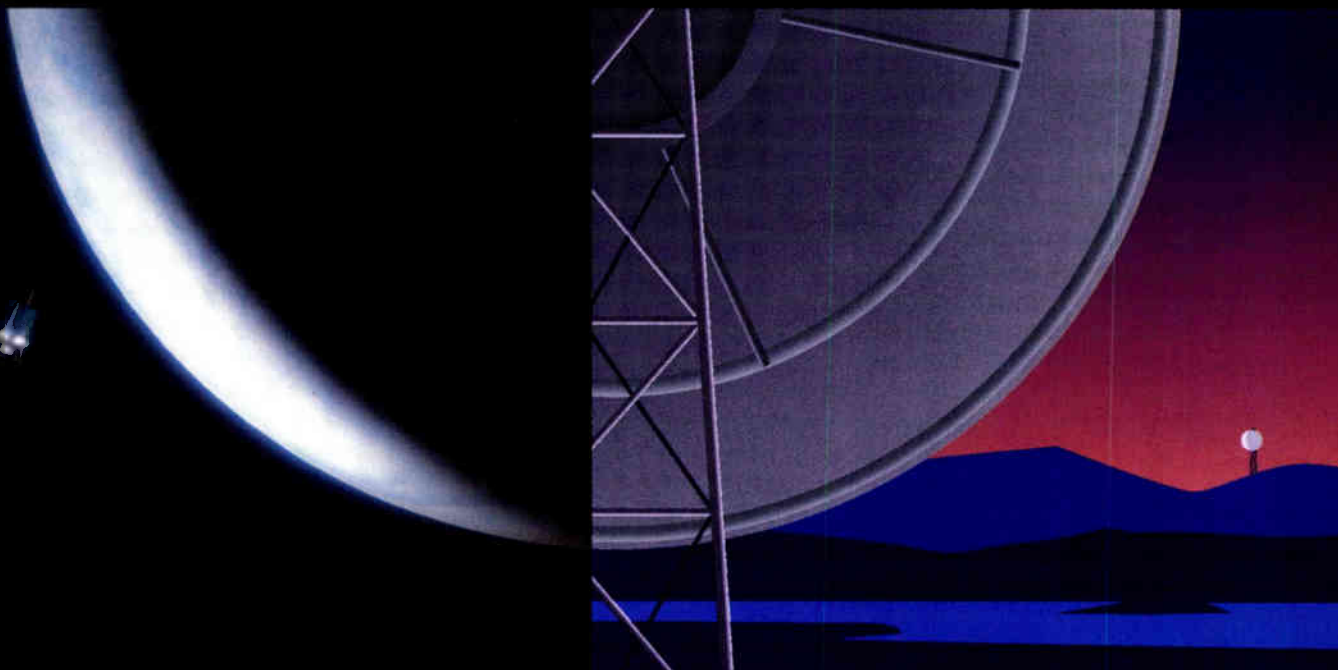

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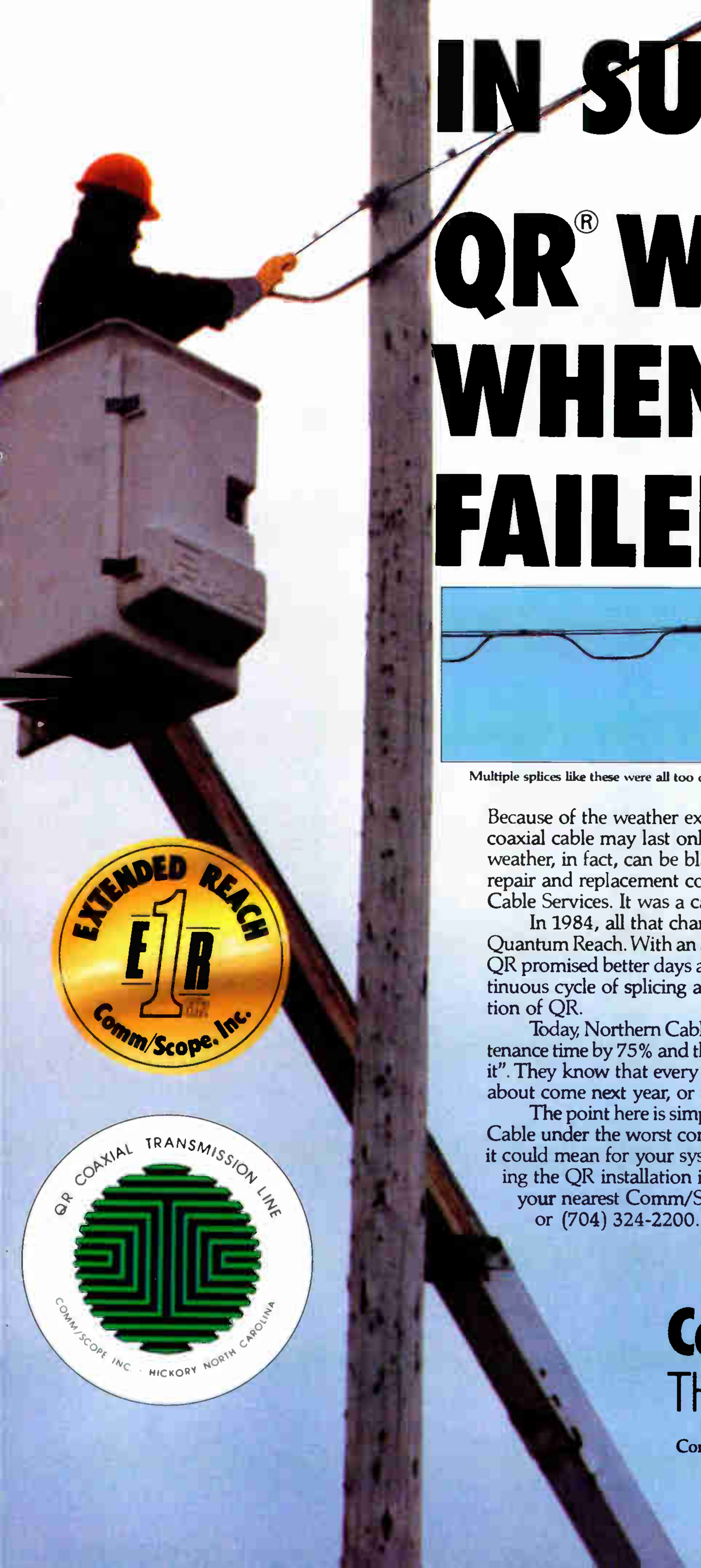

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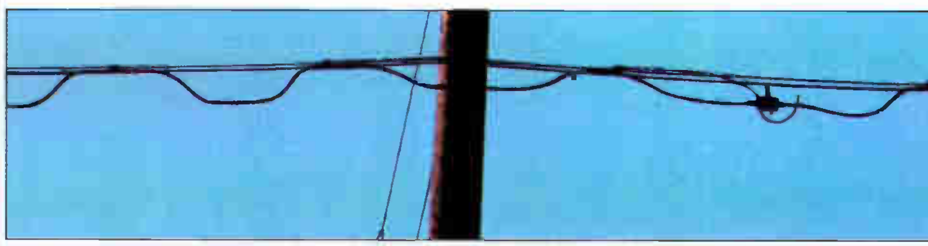

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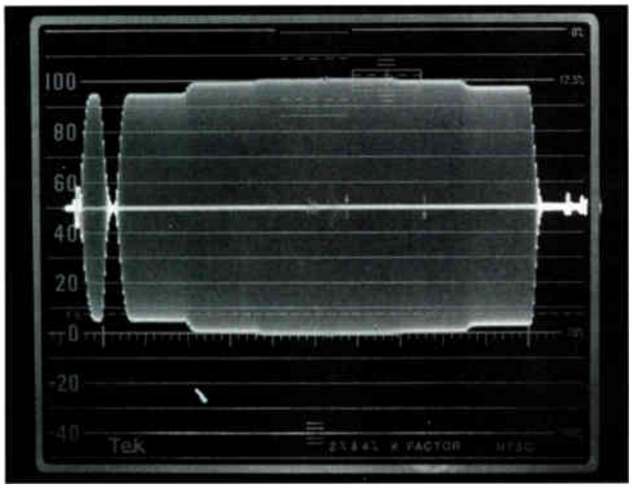
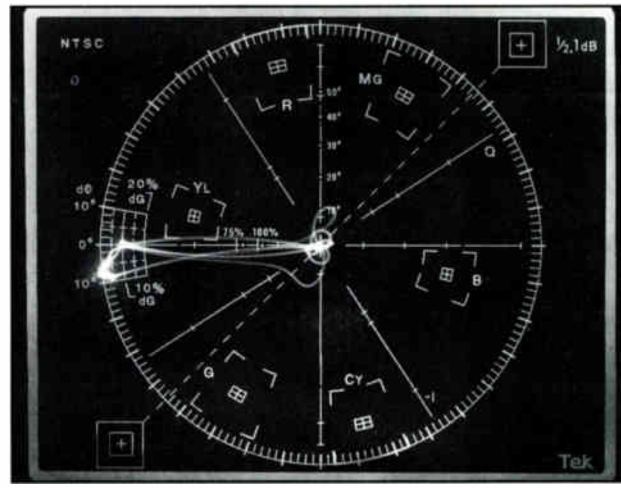
Figure 11: Modulated staircase — chroma filter, set for measuring differential gain, screen only



With the luminance portion of the signal filtered out, differential gain errors become obvious. This waveform has about a 10 percent differential gain error.

Figure 12: Modulated staircase showing 10 percent dG/9° dP, screen only



Some vectorscope graticules feature special markings for measuring differential gain and differential phase. This signal has errors of approximately 10 percent differential gain and 9° differential phase.

Video monitoring

(Continued from page 24)

Figure 4 shows a waveform expanded horizontally around sync and burst. Notice that just to the left of sync and to the right of burst the signal is at 0 IRE. This area of the video signal (the portions at 0 IRE and the sync and burst in between) is the horizontal blanking interval. The area between two horizontal blanking intervals is referred to as active video, the part of the signal that contains the actual picture information.

When the horizontal scanning process reaches the bottom of the picture, pulses in the vertical blanking interval cause the scanning to start again at the top of the picture. Figure 5 shows the entire vertical blanking interval on a waveform monitor. A two-field sweep and horizontal magnifier are used to obtain this display. With a two-field sweep, horizontal lines are displayed sequentially (not overlaid as in the 2H display).

Notice in Figure 5 that there appear to be blank or unused lines on the right side of the display. These lines are in the vertical blanking area and are not used to make part of the picture. However, vertical interval test signals (VITS) are routinely inserted on these lines. Most off-air signals have VITS, whether the signal source is conventional broadcast or a satellite downlink. It is these test signals that make it possible to monitor and measure distortions on a live feed.

Monitoring VITS requires a waveform monitor and vectorscope with a line selection feature. Rather than viewing hundreds of lines on top of each other, using a line selector allows you to view a single line (or two side-by-side) of video.

Immediately to the right of each H sync pulse is a color burst. The color information in an NTSC video signal is modulated onto a 3.58 MHz subcarrier (SC). It is the phase of the SC that actually conveys the color information. The color burst (or simply burst) is the phase reference used by the TV receiver when demodulating the color SC.

Figure 6 shows the SMPTE color bars signal on a waveform monitor with a low pass filter selected. This removes the chrominance (color) portion of the signal, leaving only the luminance levels. A chroma filter was selected for Figure 7, leaving only the 3.58 MHz chrominance signal. It is the combination of these two components that form the complete waveform, whether it is a static test signal or a live transmission.

Detecting distortions

In most discussions about video distortions, a few of the more common distortion types always seem to surface. This happened again recently in discussions among government officials. The Federal Communications Commission indicated that in the near future it would like to know how every system in the country is performing with respect to chrominance-to-luminance (C/Y) delay, differential gain and differential phase.

While not a part of those talks, insertion gain is another important item to monitor in baseband video equipment. In fact, correct insertion gain is often considered a prerequisite to making these distortion measurements. Detecting (and correcting) these distortions is helpful not only for producing clean video signals, but for verifying the quality of pass-through signals as well. The signals required to make the following tests are often transmitted as VITS, making it possible to perform these tests with off-air or satellite feeds.

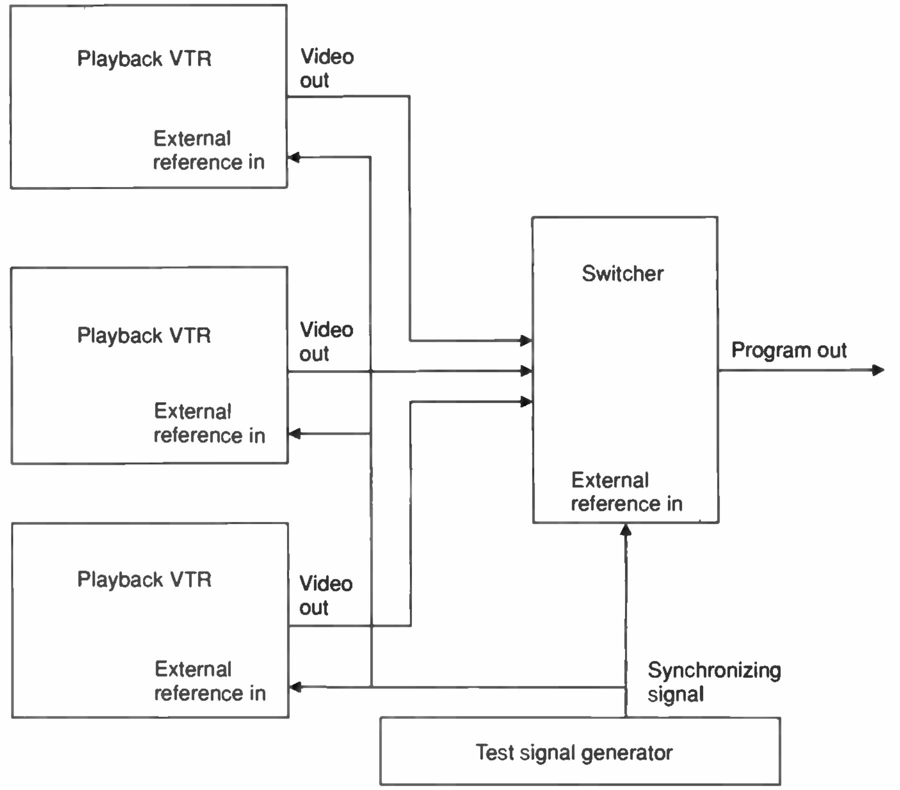
Any piece of baseband video gear in the signal path must accept a 1 volt (140 IRE) video signal at its input and be able transfer that same 1 volt signal to its output. Errors in this one-to-one transfer are called insertion gain (or loss). Each component in the system should be individually checked for insertion gain errors. If the amplitude of a 1 volt video signal is reduced by a piece of equipment, the signal-to-noise ratio (S/N) degrades and the picture will be darker than it should. An increase in gain could result in overloading distortions or clipping and will make the picture too bright. This error is expressed in decibels, IRE units or as a percentage.

While many test signals are suitable for measuring insertion gain, color bars are often used. Refer back to Figure 6. Notice that the highest luminance level is at 100 IRE. Also, the sync pulse extends down to 40 IRE, making the overall signal amplitude 140 IRE, or 1 volt.

Chrominance amplitudes must be checked as well. Figure 8 is a properly adjusted vectorscope display of the SMPTE color bars signal. Each dot of the vector represents one of the color bars and should fall into its box on the graticule. If the dots extend past the boxes, then chrominance gain is too high. If the dots fall short of their boxes, chrominance gain is low.

When luminance gain is correct but chrominance gain is not, your system is exhibiting either a frequency response problem (which can be measured at RF) or a C/Y gain error. A discussion of the C/Y gain measurement is beyond the scope of this article. The bottom line regarding equipment exhibiting an

Figure 13: Simple synchronous system



A simple synchronous system requires a common external reference for each component in the system.

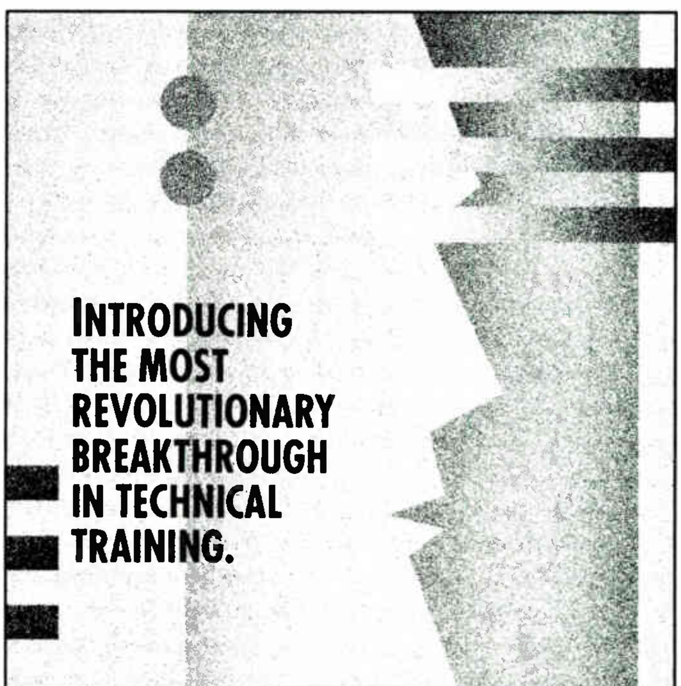
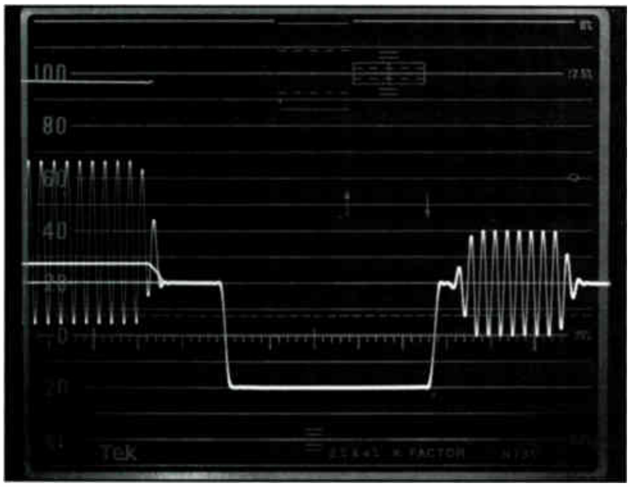


Figure 14: Sync pulse 50 percent point set to major timing mark



Sync timing requires establishing a reference position for the leading edge of sync on the reference signal.

insertion gain error is that it must be either adjusted or repaired.

C/Y delay error is present when a system delays or advances chrominance with respect to luminance. A 12.5T modulated pulse is required of this measurement. This pulse is one element included on several common "combination" signals, including pulse and bar, NTC 7 Composite and FCC Composite. The latter two are often transmitted as VITS. This type of error typically causes smearing or bleeding on the edges of objects in the picture.

When present, this error will cause a sinusoidal distortion to the normally flat baseline of the 12.5T modulated pulse. Figure 9 shows a 12.5T modulated pulse with approximately 250 nanoseconds (ns) of C/Y delay. If a C/Y gain error is present in addition to the delay, the sinusoidal distortion of the pulse's baseline will not be symmetric.

Pure C/Y delay is fairly easy to measure. Use the waveform monitor's variable gain and vertical position controls to set the pulse's baseline on the 0 IRE graticule line and adjust its amplitude to 100 IRE. Then measure the peak-to-peak amplitude of the sinusoidal distortion. With this vertical gain factor, every 10 IRE of peak-to-peak distortion represents approximately 100 ns of delay. If the first peak of the sinusoidal distortion is positive, chrominance is delayed. Delayed chrominance is reported as a positive number and advanced chrominance is reported as a negative.

To make the measurement with more resolution, select the X5 vertical gain mode. Remember that the pulse amplitude first must be set to 100 IRE when the waveform monitor's gain is set to 1 volt full scale. Then, in the X5 mode, every 10 IRE of peak-to-peak distortion represents approximately 20 ns of delay.

As previously mentioned, asymmetry of the sinusoidal baseline indicates the presence of both C/Y delay and C/Y gain errors. This condition requires a special nomograph to determine the amount of delay.

If varying the luminance level of a chrominance signal causes the gain of the chrominance signal to change, differential gain is present. On the picture monitor, you might notice differential gain, for example, on a red object that is partially in a brighter area and partially in a darker area. This error could cause the portion of the red object in the brighter area to appear somewhat pinkish compared to the portion in the darker area.

A modulated staircase signal (Figure 10) is used to measure this distortion. The chrominance packets on each of the five luminance steps of the staircase are nominally 20 IRE peak-to-peak. A differential gain error would change the amplitude of some of the packets.

Selecting the chroma filter on the waveform monitor removes the luminance portion of the signal and makes viewing differential gain much easier. Figure 11 shows the modulated staircase with the chroma filter engaged and the waveform monitor's variable gain control adjusted such that the largest packet is 100 IRE. Differential gain is then measured (in percent) as the difference in amplitude between the largest and smallest packet. The signal in Figure 11 has about a 10 percent differential gain error.

Differential phase occurs when changing the luminance level of a chrominance signal changes the phase of the chrominance signal. The picture impairment resulting from this distortion could be illustrated by a red object that is partially in a bright area and partially in a darker area. A differential phase error could cause the red in the brighter area to shift toward a more orange tone.

The modulated staircase signal is used for this test as well. Some vectorscopes provide graticule markings for direct measurement of both differential gain and differential phase. These graticule markings provide the advantage of making both measurements at once, but don't yield as much resolution for differential gain measurements as the waveform monitor.

Measuring differential phase on a vectorscope is very simple. It appears as a circumferential elongation or spreading of the dots representing the chrominance packets. First use the vectorscope's variable gain control to set the tip of the vector on the outer graticule ring. Then set the phase control as necessary to measure the differential gain. The display in Figure 12 shows a combined differential gain error of 10 percent and differential phase error of about 9°.

System timing

As mentioned in the introduction, local origination programming and commercial insertion are two major sources of baseband video in the headend. Both activities often involve multiple pieces of video gear tied together in some fashion. With the proper setup and hardware supporting this equipment, switching between sources can be clean and roll-free.

The result of switching between two VTRs that are not synchronized will be ugly; vertical rolls, picture tearing or horizontal jumps are almost guaranteed. Today's viewer is steadily becoming more critical and demanding of picture quality, and these types of aberrations in the picture aren't written off quite as readily as they once were.

For clean switches, all baseband video equipment supporting a particular channel must be tied together to form a synchronous system. For example, a local origination channel might require two or more VTRs to play back program material and commercial spots. Some type of switcher must be employed to select the appropriate deck when necessary. All of this gear must be fed a synchronizing signal from a single source to operate to its tallest potential.

The system shown in Figure 13 outlines the basic con-

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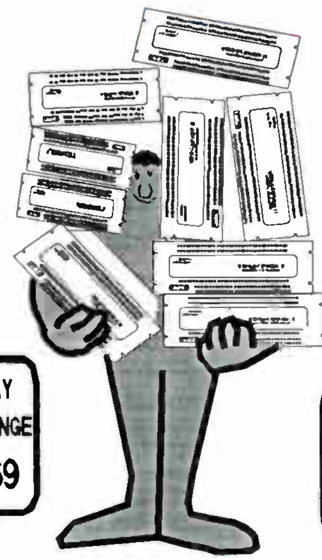

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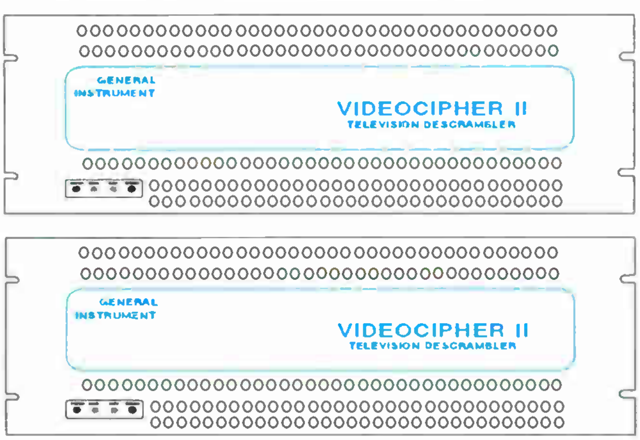

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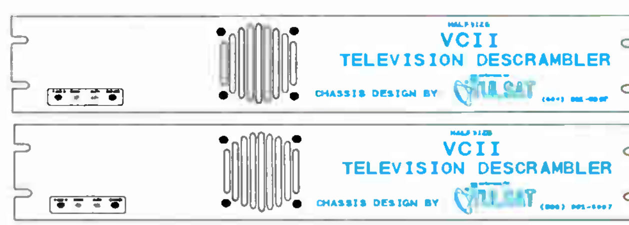

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"The Federal Communications Commission indicated that in the near future it would like to know how every system in the country is performing with respect to chrominance-to-luminance delay, differential gain and differential phase."

nections for a synchronous system. Notice that a test signal generator feeds an external sync signal to each piece of gear in the system. Making these simple connections is the first step.

Once an external reference has been fed to each piece of gear they must be "timed" to the system. This entails aligning the horizontal sync pulses and matching the color burst phase for every component in the system to the reference signal. Without such alignment, horizontal jumps and color shifts will occur in the picture when switching between video sources. Also, insertion gain should be checked (and corrected if necessary) before timing the system.

The waveform monitor and vectorscope must be connected to the output of the switcher, and the reference signal must be selected as the switcher's output. Make sure that both the waveform monitor and vectorscope are set to trigger on the external reference signal. Figure 14 shows the sync pulse leading edge horizontally expanded and vertically positioned so the 50 percent point falls on the 0 IRE line. Use the monitor's horizontal position control to place the leading edge on a major timing mark. Once this position is established, do not move the horizontal position control as this position will serve as the reference for all other inputs. On the vectorscope, use the phase control to position the color burst at nine o'clock.

At the switcher, select the output of one component in the system. Adjust the H (horizontal) phase control on that component to move the sync pulse leading edge back to the reference position previously established. Viewing the vectorscope, adjust the SC phase control of the selected component to set the color burst back to the nine o'clock position. Repeat this procedure for every piece of equipment in the system.

Notice in Figure 13 that each VCR is connected to a time base corrector (TBC). The output of a VCR is very unstable due to the mechanical process used to get video on and off the tape. The TBC replaces the video signal's synchronizing pulses and color burst with clean, stable signals. It is the TBC itself, not the VCR, that is timed to the system.

Getting started

The topics just covered are by no means a complete and exhaustive treatise on baseband video. But they do cover a number of critical areas that can make a noticeable difference in the quality of the product you provide. So add some room now in next year's budget for baseband test equipment or exercise the gear you already own a little more frequently. Your subscribers will appreciate it. The FCC may soon demand it. **CT**


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Beyond status monitoring

(Continued from page 28)

that made travel difficult and time-consuming. Gorin's headends were spread out across the bay area, and he needed a way to document and consistently be informed as to what was going on, without the time and expense associated with a visit to each headend.

By installing an automated remote testing device, Gorin was able to accomplish this. Through applications that this technology provides, he can preprogram times that measurements are to be taken and stored in the memory of his remote unit. This allows him to record analytical trends of frequencies, levels and temperatures without having to continually call the device to develop a log. Through a unique alarm feature, the unit's memory accepts a specification profile the operator desires the site to function within. If it exceeds the specifications, the unit calls the technician's beeper or a preassigned computer to notify and document a specification error. This allows valuable technician time to be focused on resolving problems while documentation and testing is automated by the system.

Levels are of equal importance; where you monitor these can be as critical as how they are monitored. Essentials like site level stability (Figure 2) and system sweeps can be automated and performed in minutes, instead of hours or days. Locating a remote monitoring device at a preselected location and tuning the device to the assigned channels and their frequencies allows the operator to compare headend activity to what is being transmitted into the system.

Figure 3 shows a multispectrum graph that displays 20 comparative graphs that were taken at a monitoring site over different time and temperatures. This allows the operator to review and analyze how that particular location is performing. By selecting the highlighted graph (Figure 4) and expanding for closer review, the operator can look at specifics like peak-to-valley and amplitudes of video and aural carriers and their relationship to the adjacent carriers.

This ability to review sites remotely, rapidly and accurately is an absolute necessity. The operator needs to know when, how, why and be able to document the activity.

Cost-effective solutions

One of the most cumbersome but necessary measurements to the cable TV environment is distortion measurements. The automation of this process allows consistent, standardized readings that can be taken in under 60 seconds. The graph shown in Figure 5 is an example of a reading that was programmed for 4:30 a.m. that required the preselected channel to be automatically shut down for less than one minute while CTB, C/N, HUM, level and temperature measurements were taken. This normally would have required two personnel: one in the headend to perform the shutdown, the other in the field to document the activity. The requirements of time, equipment and synchronizing the activity causes this event to be performed infrequently and sometimes inaccurately. The dimension of automating this process allows an operator to perform this function at will or at predesignated schedules that will not interfere with subscribers' viewing.

One of the biggest maintenance concerns in any cable plant is power supplies. The reliability and capability of these integral parts of the plant have been greatly improved by the utilization of standby power. This is a positive step in maintaining operation through power outages; in fact, it is done so well that operators are sometimes unaware that they are operating in standby until the battery discharges and an outage occurs.

Besides the physical inspection and maintenance that is required on these devices, it is necessary to systematically and routinely poll to determine the status and operation of each device. The operative words being *systematically* and *routinely*. Until recently, the option to automate this process was limited to cable systems that had fully activated two-way. With the majority of cable systems being operated as one-way plants, the alternatives to the majority were very limited.

The most obvious alternative was to activate the return path of the cable system. This first required you to have the type of equipment that supported a two-way system. If you did have this equipment, it then required the activation of these devices by purchasing and installing return modules in every unit in the plant. If you did not have two-way capable hardware, this required a costly upgrade.

After sweeping and setup, you could

now introduce the polling device, which is typically a modem and an interface card that provides functional controls and data collection from the power supply. This is an effective method but expensive to implement if you are not currently operating a fully active two-way system.

Another alternative and one that is in general practice throughout most cable systems is a manual maintenance program. This is a very labor-intensive task that requires a personal visit to every station, and a log of the activity at each location maintained manually. This makes routine maintenance checks possible without reorienting the technology of the entire cable system, but lacks efficiency and creates a time lapse as the technician or team makes their rounds to every location.

The third and universally unacceptable alternative was to allow failures to occur and react to outages as they developed. This approach is disastrous to the operation of the plant, not to mention the goodwill and image cable operations seek and promote for their communities. This is essentially a non-option.

With the resurgence of status monitoring, new alternatives have been developed, such as store and forward techniques, which do not require activating the return path. Figure 6 shows a block diagram of how this activity is implemented. This allows a consecutive group of supplies to be polled and data stored at a monitoring location in a one-way system. Another alternative being tested is technology that will allow direct polling of the power supply, independent of the cable system. In both circumstances, the computer or controller directly accesses the monitoring device without requiring activation of the return path.

Going beyond

The variety of different manufacturers, products and technologies functioning within today's cable operation requires a monitoring system to be versatile. The automated testing that is performed must be adaptable to the new technologies that are being developed, while managing the requirements that exist today.

With the current activity and interest in fiber, this becomes a prime candidate for monitoring. In the corporate hierarchy of the largest MSOs not only is fiber the most aggressively discussed subject, but how to monitor its reliability and performance is becoming of equal importance. The question of what to monitor has been focused to a commonsense approach. When the signal returns to RF, what is going on after the launch amplifier? By placing a monitoring device, capable of reviewing the entire RF spectrum, and providing that information accurately and expediently, you have the initial stages of monitoring fiber. It is not as much a mystery as it would seem.

"A remote monitoring device provides the convenience and accessibility to make multiple checks and measurements at will without expensive truck rolls and valuable personnel's time."

AML microwave receivers have been in operation for years. Often these are located at sites that are remote from the system office. The ability to monitor the performance of the receiver with data through a test box, like Hughes' RM-2 and RM-6, and the RF output at the receiver location is essential. The ability to do that through a remote monitoring device is efficient and cost-effective. In Figure 7, a chart format shows the trend of an RM-2 test box that is being monitored remotely and documented in a comparative columnar format.

The performance of this complex piece of equipment can be directly monitored through this data. A remote monitoring device provides the convenience and accessibility to make multiple checks and measurements at will without expensive truck rolls and valuable personnel's time.

To go beyond status monitoring is to automate the testing process of the cable system, utilizing repeatable, accurate equipment polled and accessed by computers. This allows a level of performance that is essential to the multifaceted cable operator. Today's products come in different concepts and forms, but are in pursuit of similar goals — they are a true representation of the industry's needs. **CT**

High chrominance levels

(Continued from page 34)

D = peak deviation of FM carrier
EW = emphasis improvement = 12.8 dB.

Therefore as the C/N increases or decreases, the video S/N also will change the same corresponding amount. However, if we evaluate the equation based on IF bandwidth of the receiver, we would see a change (see Table 5) in video S/N ratio as IF bandwidth is reduced from 36 MHz to 27 MHz, while monitoring video on a 36 MHz wide IF bandwidth receiver.

If the programmer or uplink provider reduces its peak deviation to fall within the IF bandwidth of the receiver, the reduction in video S/N shown in Table 6 also would be added to the reduction in video S/N of reducing the receiver IF bandwidth. (Per previous example, no subcarriers are accounted for in the peak deviation and bandwidth calculations.) Therefore, an additional reduction in video S/N would be realized equal to:

$$10\log(10.75 \times 0.714)/(4.2) - 10\log(9.3 \times 0.714)/(4.2) \quad \textbf{(6)}$$

or a reduction of (5.24 - 3.98) 1.26 dB. Therefore, a total of 1.26 dB + 1.25 dB = 2.51 dB reduction in video S/N would occur.

It is common practice to allow some over-deviation to occur in FM systems used on satellites. This over-deviation is caused typically by instantaneous transition. However, chroma truncation is caused by highly saturated colors for relatively long periods of time.

Remember that video is pre-emphasized during transmissions and it is the higher frequencies (chrominance) that are pre-emphasized. Therefore, it is the chrominance levels that determine the instantaneous peak deviation on the main carrier. Reducing uplink video deviation to totally comply with the narrower bandwidth IF filters in consumer receives would have a degrading effect to the overall system.

Things to remember

Color bars is one of the most frequently employed video test signals used to test a baseband video path or a transmission path. Therefore, a few definitions regarding color bars are of interest to anyone who is responsible for baseband or transmission level adjustments and thus some are presented here to further the understanding of color bars and their properties:

- *Color bars*: Consists of a color bar signal with 75 percent amplitude, 100 percent saturation and 7.5 percent setup. This signal is used for checking luminance, saturation levels and hue. It represents a scene with high brightness and saturation.
- *Luminance:* The signal that represents brightness or the amount of light in the picture. This is the only signal required for black and white pictures and for color systems it is obtained as a weighted sum ($Y = 0.3R + 0.59G + 0.11B$).
- *R, G, B amplitudes:* The 75 and 100 percent nomenclature regarding color bars specifically refers to the maximum amplitudes reached by the red, green and blue signals when they form the six primary and secondary colors required for color bars. For 75 percent bars, the maximum amplitude of the RGB signals is 75 percent of peak white level. For 100 percent bars, the RGB signals can extend up to 100 percent of peak white level. Both 75 percent and 100 percent amplitude color bars are 100 percent saturated. In the RGB format, colors are saturated if at least one of the primaries is at zero.
- *Saturation:* The property of color that relates to the amount of white light in the color. Highly saturated colors are vivid, while less saturated colors appear pastel. For example, red is highly saturated while pink is the same hue but much less saturated. In the composite signal, both chrominance and luminance amplitudes vary according to the 75 and 100 percent distinction. However, the ratio between chrominance and luminance amplitudes remains constant to maintain 100 percent saturation[6].

Summary

Program material containing high chroma saturation levels can cause chroma truncation. When color bars are transmitted (full-field) and viewed on narrow IF bandwidth receivers some degree of chroma truncation will be noticed. If program material containing movement and only momentary high chroma levels is viewed instead of color bars, little or no chroma truncation will be noticed. However, if program material contains high chroma levels and they are relatively long in duration, especially with red and cyan, chroma truncation is extremely pronounced.

Monitoring of chroma levels during postproduction or transmission by the programmer will ensure levels consistent with "normal" chroma levels. Secondly, if IF bandwidths of 30 MHz or more are used at the receiving earth station, chroma truncation should be minimal or nonexistent.

Monitoring the transmission and reception of color bars of proper level through the RF link will be an indicator of probability of chroma truncation in program material. If the color bars are highly truncated when received, then program material containing highly saturated colors also will be truncated. However, if the colors bars are received with little or no chroma truncation, the program material also should be free of major truncation artifacts.

When scenes of high red and cyan content are noticed with black streaking or a predominance of white dots in the picture, don't blame terrestrial interference (TI). (Although, normally, TI filters further reduce the IF bandwidth of a satellite receiver to some degree.) Using a satellite receiver with adequate IF bandwidth, and having the programmer monitor transmission levels within video, chroma truncation can be reduced to at least a "just perceivable" or "not noticeable" level. **CT**

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Videotape formats

(Continued from page 43)

benefits of each available format, you can make an educated selection of the best format for your use.

In production, U-matic provides high-quality video and audio performance. It has an established user base; in fact, it is the format of choice for the majority of professional and CATV operations. It offers a two-piece ENG configuration with 20-minute tapes for field recording. That tape size reduces wear in editing and limits the time spent in searching for scenes. In terms of compatibility, U-matic and U-matic SP are completely compatible.

Hi8 is becoming increasingly popular for production. It provides very good video and audio quality, and a wide range of tape lengths — up to 2 hours for recording events. Lightweight camcorders allow for one-person operation, and are available in professional as well as consumer models.

Hi8 is upward-compatible with 8mm, meaning that tapes shot in 8mm can be played on Hi8 equipment. Finally, 8mm is becoming more and more popular as a consumer camcorder format, meaning that many people are familiar with camera operations and may even have their own equipment.

Betacam SP is the definitive winner when it comes to video and audio quality, providing the best analog detail reproduction available. Equipment can be configured as a one-piece camcorder or two-piece ENG package. Although, it is more expensive than formats like Hi8, in professional circles it is the most common ENG/EFP format. If you ever need to rent additional cameras, chances are very good that someone in your area has Betacam SP equipment.

In postproduction, U-matic provides excellent multigeneration capability in simple-to-operate and full-featured editing systems. There are a number of manufacturers who offer editing controllers that are fully compatible with U-matic decks of all makes. U-matic has proven its durability and reliability over the years. Even though the basic format is almost 20 years old, there are still a wide range of products to choose from with optional features including address track (SMPTE) time code, plug-in time base correctors and digital noise reduction.

Hi8, which was once considered primarily an acquisition/recording format, is increasingly becoming a viable postproduction format. It features simple and full-featured editing and overall system compatibility. In its current products, it does not have the multigeneration capability of U-matic SP, but it is a relatively young format that is destined to see future growth as a post format. For instance, a new editing recorder that will be available next spring will greatly enhance Hi8's editing capabilities.

Again, Betacam is the best analog multigeneration system available today. It features built-in TBCs and time code, for automatic expandability from cuts only. There are various types of system connections allowing Betacam to interface with virtually any other format. However, the Betacam format is still the most expensive of those being discussed here and cost could well be an eliminating factor.

For on-air operations. U-matic provides reliability and a history of being the most widely used format in cable systems around the country. The tape is durable and withstands numerous passes, while parallel and serial interfaces allow the VTRs to be controlled for random access.

Betacam SP can be found in many broadcast TV and network operations as the playback medium. Tape quality and durability are major factors, along with the latest trend in station operations, fully automated cart systems. But, like Betacam for production or postproduction, cart systems are major investments.

For videotape distribution, VHS is the dominant format. Unless you are producing exclusively for an internal network that is dedicated to 8mm or another format, you need to provide VHS for tape distribution. The hardware is inexpensive and tape cost is low. Both equipment and tape are easy to find and purchase. If you are duplicating for your own presentation use, there are options like 8mm, which is very portable both in terms of the small tape and in the available playback equipment.

A good decision making process

Making a format selection must be a process that considers both overall market trends and personal demands. Don't think that the decision you make needs to be on a single format. Most facilities today are taking a multiformat approach, finding that different tape formats offer different benefits for acquisition, editing, transmission, duplication and storage.

"Most facilities today are taking a multiformat approach, finding that different tape formats offer different benefits for acquisition, editing, transmission, duplication and storage."

A good decision process takes into account the successes (and failures) of other operations. As well, your decision must take into account all of the specifics of your own operation. But that doesn't mean that you should make your decision in a vacuum. Video people are a generally friendly bunch. Before you dive into an equipment acquisition, spend some time talking with your peers. A quick phone call to a local postproduction facility, production company, or even other cable operations or broadcast stations can introduce you to people who will gladly show their operations and give you insight into their decision-making processes. Oftentimes you can find these folks at local trade organizations (SMPTE, ITVA, etc.) where engineers and producers regularly gather to exchange ideas. It could be your most valuable resource and one that should be fully explored.

Another resource is local video equipment dealers. Sure, they're in the business of selling you equipment, but they also can be a tremendous resource of information and advice. Good dealers know they do their job best when they sell you the right equipment for your application. To them, it means you'll come back for your next purchase and you'll also recommend them to other buyers.

If you're not sure exactly what you want, discuss your operation with them and listen to what they have to say. They also should be able to give you some hands-on demonstration time on the equipment in the showroom. And they might recommend some other users for you to talk to.

The more advice you can solicit, the better informed you will be. And you'll be in the best position to make the right decision for you. **CT**

Video migration

(Continued from page 44)

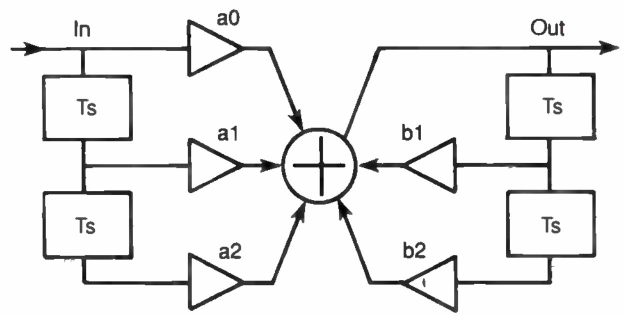
about 225 TV lines. Both 3/4-inch U-format and VHS VCRs were typically used to record and play back digital audio signals.

Digital audio recorders were soon developed and replaced the VCR for this purpose shortly after the mid-1980s. Stationary head digital audiotape (SDAT) recorders, followed quickly by rotary head digital audiotape (RDAT) recorders, became commonplace in recording studios and postproduction houses. Today, both varieties are being used extensively in the audio industry. Both have unique advantages and disadvantages. SDAT consumes a great amount of audiotape and is suitable only for use in fixed locations. Today, however, it is the only digital audio recording format that can record more than two audio tracks. In addition, it is superior to RDAT in edit convenience and capability. RDAT consumes very little tape and, consequently, RDAT recorders can be made small, lightweight rugged and portable. RDAT records only two audio tracks, and precise editing can be accomplished only if special circuitry and audio RAM memory are installed.

Over the last several years, bigger, better and cheaper personal computer processors, economical high capacity RAM ICs, and large capacity hard disc and magneto-optical disc drives have revolutionized the audio postproduction industry. Today, music is postproduced and edited on digital audio workstations that use Macintosh, MS-DOS and other personal computing equipment as platforms. These can directly store a very great deal of digital audio information, and rapidly access any part of it at random. Special software applied to these workstations permits greater audio editing capability than ever before and lets the editor see the music via graphical user-interface displays, as well as hear it.

As PCs continually become more powerful while remaining reasonably priced, we might speculate that in some homes they may serve as music, as well as data, processing stations some day. Just pop in a CD ROM disc and connect the computer COM port to your favorite power amplifier and speakers! While we're speculating, also consider that individuals who have a multicolor VGA display as part of their home computer system already have high definition TV in their home too!

Figure 2: IIR filter configuration



It's a digital future

During the 1990s, digital audio and video signal processing will predominate. Digital A/V products will proliferate at all levels, in all markets. There are numerous reasons why digital is a certainty in the future. Pictures and sound in digital form are precise, rugged and robust. Unlike analog signals, they are generally independent of the media that they're recorded and stored on, and can usually be recovered with great precision, even from aged and worn media.

Since recording and playback processes are very similar to transmission and reception methods, it is very likely that digital signals will withstand the rigors of modulation/demodulation and transmission/reception far better than their analog counterparts do today. Even from very poor media and over degraded transmission paths, a digital signal has built-in potential to correct itself, and restore even substantial amounts of erroneous and missing signal bits to the precision of the original. Analog schemes cannot cope well with even small amounts of missing signal. These can be improved only by substituting artificial signal segments fabricated from areas of good signal that immediately surround missing parts.

For broadcasters, cablecasters and professionals, digital offers virtually transparent re-recording capability through many, many edit generations. This is especially useful in video where original material must be dubbed numerous times for special effects to be added during postproduction.

Digital signal processing

While it is possible to speculate, as we have, about digital products and systems of the future, it is difficult to state or predict with certainty exactly what they will be and how they will function. Currently, the third broadcast grade digital video recording format, D3, is being introduced to join the already available (and in use) D1 digital component and D2 digital composite formats. D3 digital composite recording advances digital recording state of the art by utilizing smaller, 1/2-inch wide videotape to record a broadcast quality video signal. The earlier D1 and D2 formats use 19mm (3/4-inch) wide videotape. There is no "professional" grade digital video recording format available at this time. Such a format might be more economical than its broadcast counterparts, although it is likely to function at somewhat less picture performance. Even so, many of digital's advantages will prevail in a professional digital recording format.

Earlier, we speculated broadly about future digital audio products and systems. Since it is difficult to predict the future, perhaps it is possible to imagine products that might be available in the future by describing some of today's state-of-the-art digital processing systems, and how modern digital products can replace their analog counterparts, and be applied in broadcast, cablecast and professional applications. Discussion will concentrate on digital audio circuits and products.

Digital audio processing

Digitally encoded audio (and video) signals are numerical representations of samples taken from the original analog waveform. If sufficient samples are taken (Nyquist criteria) and each sample can be quantified to a value (number) great enough to accommodate all possibilities of signal level and dynamic range, then the analog waveform can be very accurately restored upon conversion of the quantified samples back to analog form. While in its numerical, or digital state the signal can be changed and altered (processed) very

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Video migration

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precisely by performing appropriate mathematical operations on the numbers that represent the signal. Often, these can be accomplished digitally without compromising other performance parameters, as analog processing might. One such application in digital audio processing is the implementation of finite impulse response (FIR) equalizers and filters. These permit audio signal equalization and filtering without change of phase characteristic of the signal over the filter's passband.

Digital filters can be classified into two types. One is called the FIR filter (Figure 1) and the other is the infinite impulse response (IIR) filter (Figure 2). A single FIR filter section is simple in circuit design, but effective FIR filtering requires numerous operations and, therefore, the commitment of a great number of circuit sections. The advantage is linear phase response because no feedback loops are employed in the FIR filter. An IIR filter requires fewer circuit sections but the application of feedback loops results in change of phase of the signal as the amplitude response is altered by the filter. Where many repetitive operations are necessary, such as the summing of numerous delayed signals in an FIR filter, digital processing is often the only practical method of executing these functions.

Digital audio recording

Digital recording and playback of both audio and video signals is commonplace today, especially (as we've already mentioned) for audio signals. The future is more foreseeable in audio. Hints of things to come, such as erasable/recordable audio discs, are often discussed and sometimes demonstrated today. For this very moment, however, the newest digital audio recording medium to arrive in the United States is digital audiotape.

DAT is a two-channel (stereo), rotary head digital audio recording system, and its format conforms to international standards that a majority of world users and manufacturers have agreed to abide by. Recently, a method of recording SMPTE time code on the DAT has been standardized, opening possibilities for numerous broadcast, cablecast and professional applications. Professional DATs that can record SMPTE time code also must be capable of synchronization to a video signal since the time code is firmly related to TV frames — 25 for PAL and 29.97 or 30 for NTSC color TV.

DAT synchronization is accomplished by connecting a black burst or other suitable video signal to the video sync input of the digital audio recorder. The same video sync signal must, of course, be connected to a time code generator as well, so that time code and video frame location are exactly related. Synchronization causes the DAT internal digital clocks to lock to the video signal as their reference, and assure that DAT recordings, played back at a later time, can be synchronized and maintain synchronization reliably to a videotape that is played back independently from a VCR.

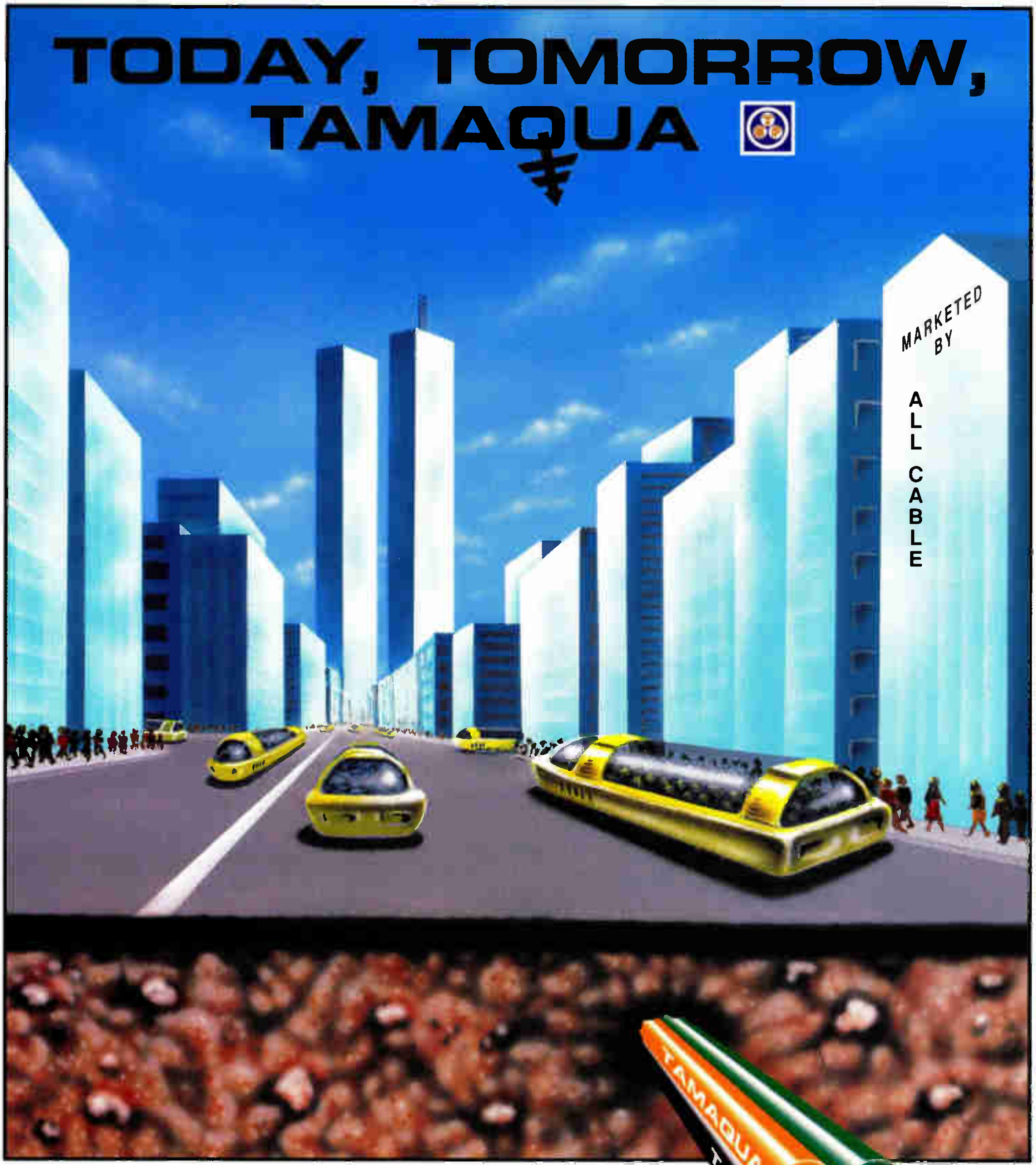
There are many video broadcast and postproduction applications that require synchronization of independent audiotape and videotape playback. For instance, audio is often edited and "sweetened" separately, in different locations and facilities, from its video counterpart. SMPTE time code capability makes it possible for DAT to be used in the audio postproduction process and for all other applications where it is necessary to accurately relate sound and pictures, and recombine them after they are postproduced.

In addition to possessing internal A/D and D/A converters for interface to analog systems, DAT recorders benefit from the advantages of direct digital signal transmission between machines by providing serial digital audio signal interface conforming to the AES/EBU standard.

DAT recording methods are the forerunners of disc recording systems that are visible on the horizon. DAT applications and interfaces we work with now will lead to better and more efficient techniques and interfaces for the new generation of digital audio recording products in the future.

1990s — The digital decade

Today, digital video recording and signal processing are maturing very rapidly. Digital audio recording is already mature, firmly established and commonplace in all of today's audio markets, from consumer to broadcast. Clearly, there is no turning back to analog, only great progress to look forward to for digital sound and vision. The 1990s will, without a doubt, come to be known as the digital decade. **CT**



Reader Service Number 46

PCNs — TDMA or CDMA

By Lawrence W. Lockwood
President, TeleResources
East Coast Corespondent

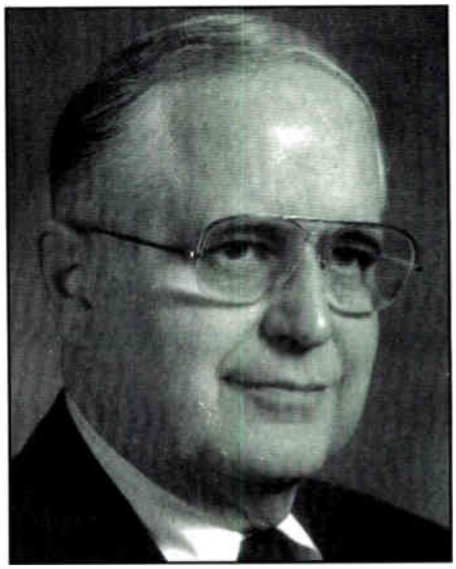
One of the most fascinating games in this government puzzle palace town right now is trying to make some sense of all the different definitions and descriptions from assorted experts of the anticipated new business of personal communications networks (PCNs) that are purportedly just over the horizon. (The Federal Communications Commission uses the umbrella term *personal communication services*, *PCS*, to include PCNs, cordless telephones, etc.) Even so, there's an impressive list of federal agencies, telecommunication networks, CATV MSOs and telecommunication manufacturers hip deep in various investigations of this far from fully defined area. Currently, one of the most significant items up in the air is the specification of the modulation method for PCNs — TDMA (time division multiple access) or CDMA (code division multiple access). More about these modulation methods later.

A broad definition of a PCN is that it is a microcellular system. Therefore a brief review of a cellular system is in order.

Cellular

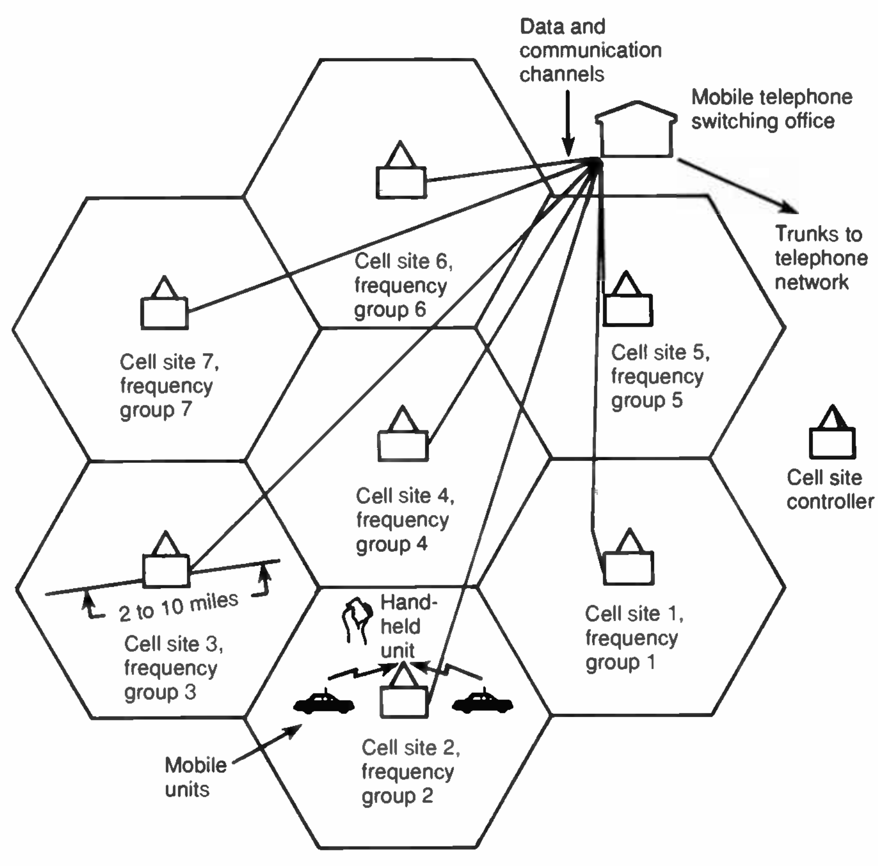
Today it is difficult to imagine anyone not familiar with the cellular phones that can be used in moving cars or portably from just about anyplace in a cellular service area. The fundamental idea in cellular radio telephone systems is frequency reuse. Because of frequency reuse, a limited number of radio channels can be made to serve many users. The capability of using only a limited number of radio frequencies is the key to the existence of a cellular service — without the limited number there would not be enough spectrum available to provide the extent of service cellular supplies. Figure 1 shows a general plan of a cellular radio system.

The number and size of cells are selected by the carrier to optimize coverage, cost and total capacity with the serving area and are not specified in FCC regulations. The cells are connected (usually by wireline) to an electronic central office that serves as a mobile telephone switching office (MTSO). The MTSO is the heart of the cellular mobile system. Its processor provides central control and cellular administration (cell switching, connection in and out of the telephone network, etc.). The mobile units are fre-



"The advantages of the use of CDMA spread spectrum techniques to increase the efficiency of use of the spectrum appears most attractive."

Figure 1: Components of a cellular system



quency-agile, that is they can be directed to shift to any of the 312 voice channels available on a cellular system.

The principle of frequency reuse is shown in Figure 2. Each cluster of cells (seven shown in this example) is repeated as many times as needed to provide coverage of the service area. The signals radiated from a cell in channels assigned to that cell are powerful enough to provide a usable signal to a mobile terminal within that cell, but not powerful enough to interfere with cochannel transmission in corresponding cells in adjacent clusters.

Currently there are at least six different, incompatible cellular standards employed in different parts of the world. All rely on analog frequency modulation for speech transmission. Second-generation cellular will conform to at least three different standards: one for Western Europe (Group Speciale Mobile, GSM), one for North America (an Electronic Industry Association Interim Standard, IS-54) and a third for Japan. IS-54 incorporates the first-generation standard, Advance Mobile Phone System (AMPS) and adds a digital voice transmission capability (D-AMPS). Some operating parameters of these standards are shown in Table 1.

Now about microcellular or PCN. There is no specific definition of cell sizes for either conventional cellular or PCN. But the comparison is miles to feet — say 5 miles for conventional cellular to 1,200 feet for PCN (perhaps a PCN cell every other block in a dense urban area). The required paths to a PCN MTSO for multiple PCN cells is one of the attractions of PCN to CATV.

At the time of writing there have been 93 PCS experimental applications filed with the FCC. Twenty-four of these are associated with CATV and are shown in Table 2 (page 84).

The use of microsized cells has a number of advantages. One is that obviously less power is required in the mobile PCN units permitting light weight, small shirt-pocket sized units and will permit longer use (talk and standby) before battery recharge or replacement than conventional cellular units. The size advantage is probably not important — Motorola has just announced a 7.7 oz cellular phone that is about the size of a TV remote control. No unit, PCN or not, can probably be much smaller — the distance from the ear to the mouth is not going to change. The lower power probably will remain a significant advantage. Another advantage of the microsized cell is that more users can be accommodated with the same set of frequencies. By having many more clusters of microcells in a system means more possible users. Based on cellular usage, it has been estimated that microcells will support customer densities of 100,000 customers per square mile — about 100 times greater than typical cellular systems in operation today.

Congestion in conventional cellular has forced consideration of a digital system and, as noted, interim standards incorporating digital signals have been established (IS-54). To permit more users per cell in PCN two different modulation techniques of the digital

Table 1: Operating parameters for three cellular standards

	AMPS	D-AMPS	GSM
Frequency band (MHz)	824-893	824-893	890-960
Associated bandwidth MHz)	50	50	50
Access scheme	FDMA*	TDMA	TDMA
Channel bandwidth (kHz)	30	30	200
No. of one-way voice ch./freq. ch.	1	3	8
Equivalent bandwidth per one-way voice ch. (kHz)	30	10	25
Channel bit rate (kb/s)	—	40	270

*Frequency division multiple access

Figure 2: Frequency reuse patterns

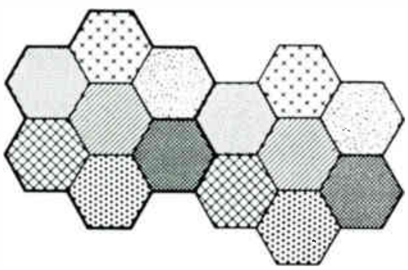


Figure 3: Example of time division multiple access

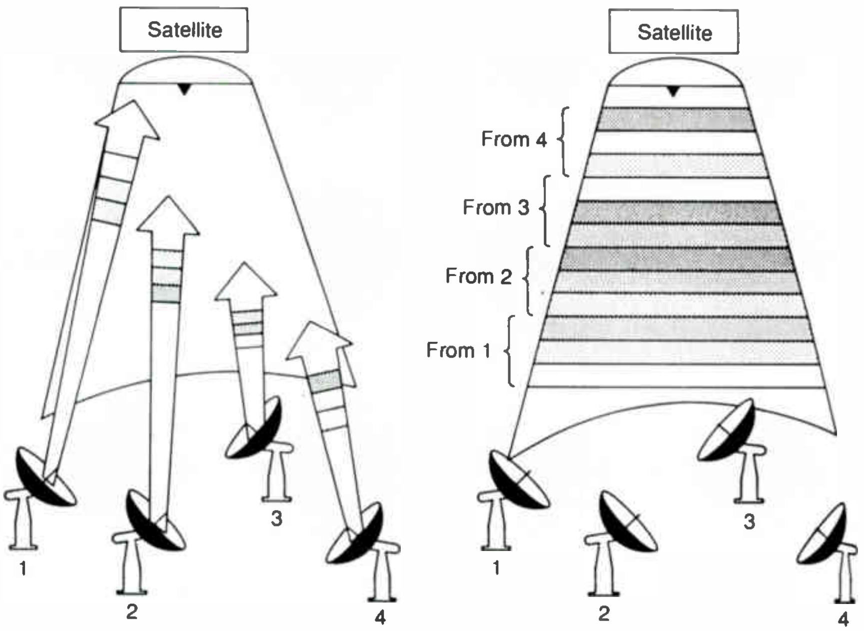


Figure 4: TDMA PCN waveform

signals have been proposed — TDMA and CDMA. (Actually IS-54 incorporates TDMA.)

TDMA

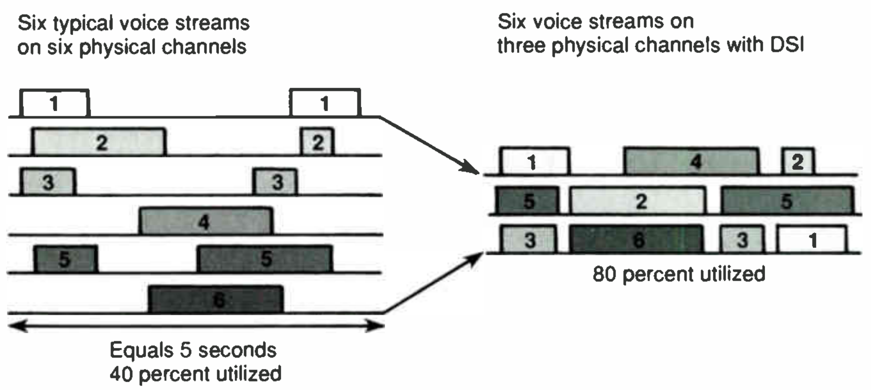
Time division multiple access has been used for some time in telephony and satellite communications. In TDMA users time-share a single channel. TDMA use in satellite communications is illustrated in Figure 3.

Use of TDMA in a PCN results in a waveform shown in Figure 4. In this system the cell sequentially probes all *k* users, each of whom use the same 30 kHz frequency band, but at different times. Using this system, the number of cells does not increase, but since there are *k* users per 30 kHz channel, the total number of users per cell has increased by a factor of *k*. To estimate *k*, we note that voice can be converted from an analog signal to a digital signal at a bit rate of 8,500 b/s without noticeable degradation of quality, or to a digital signal at a bit rate of 2,400 b/s with some degradation. For example, using a bit rate of 2,400 b/s and a digital modulation technique such as quadrature phase shift keying (QPSK) each digital voice channel requires a bandwidth of only 2,400 Hz. Hence there can be approximately k = 30 kHz/2.4 kb/s = 12 users per 30 kHz channel. Thus, there is a potential for the number of users per cell to be: 12 users per channel x 55 channels per cell = 660 users per cell vs. about 60 for conventional cellular using a seven-cell cluster. (However, a lower number of users per cell is planned to be implemented in practice.)

TDMA systems are very efficient if the *k* users have a continual need to transmit. If, however the users' need to transmit varies from time to time or if the users rarely transmit, the TDMA becomes inefficient since a user pays for the time-slot, even when he fails to transmit, since the time-slot is "wasted." During this wasted time an additional user could have been admitted to the system.

Hughes Network systems are promoting a version of TDMA they call Extended TDMA shown in Figure 5. This concept is a digital variation on a technique in long use in analog telephony called time assignment speech interpolation (TASI). As shown one line can support more than one conversation at a time since analyses of telephone conversations have indicated that a party is typically active about 40 percent of a call duration. Most inactivity occurs as a result of one person listening while the other one is talking.

Figure 5: Digital speech interpolation (DSI) concept



CDMA

Code division multiple access is an application of a spread spectrum technique originally developed for the military to ensure secure communications — i.e , hard to detect and even harder to jam. There are two generic methodologies used in spread spectrum — frequency hopping (FH) and direct sequence (DS).

FH spread spectrum utilizes the large spectrum provided for spread spectrum systems by periodically changing the carrier frequency of the transmitted signal. The changing is called "hopping." If the entire allocated bandwidth is, say, 1,000 times wider than the bandwidth of the transmitted signal, then during a given time interval the signal can be transmitted at any one of 1,000 possible frequencies. The result is reduced interference to any existing user. For example, if an existing narrowband user occupies one of the 1,000 frequency slots, then interference with the existing user occurs only 1/1,000 of the total time. During the remaining time, the transmission has hopped to different frequencies and, therefore, does not cause interference.[3]

DS spread spectrum achieves a spreading of the spectrum by modulating the original signal with a very wide bandwidth signal relative to the data bandwidth. (See Figure 6.) In this figure the message signal with the data to be transmitted is shown at the top of the figure — *d(t)*. The signal used to spread the spectrum is a pseudo-random (PN) binary sequence having the values ±1 shown at the middle of the figure — *g(t)*. The bit rate of *g(t)* is usually so much greater than the bit rate of *d(t)* that we say *g(t)* "chops the bits of data into chips," and we call the rate of *g(t)* the chip rate. It is necessary that the message bit duration t_m be an integral multiple of the chip duration t_1. PN means that the random sequence is

Figure 6: Direct sequence spread spectrum

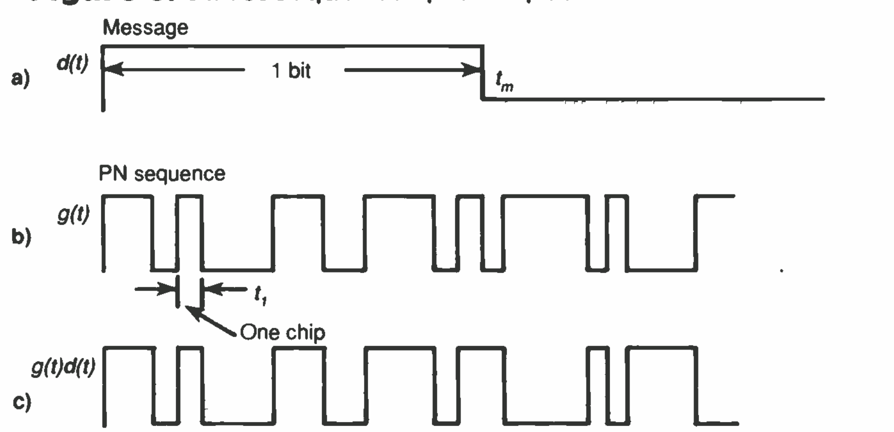


Table 2: CATV PCN applications

Business name	Licence Granted	Licence Expires	Test locations	Technical tests	Market tests
Cox	2/20/91	1/1/93	San Diego, New York City	X	
Cablevision	2/22/91	1/1/93	Cleveland, New York City, Chicago, Boston		X
Cable USA	3/15/91	1/1/93	Omaha, Kearney, Grand Island and Hastings, Neb.		X
Pertel Inc.	2/22/91	9/1/92	Philadelphia, Cleveland, Pittsburgh		X
LDH Int'l.	3/15/91	1/1/93	Greenville, N.C., Denver, Atlanta	X	X
Continental	2/22/91	1/1/93	Boston		X
Continental	2/22/91	1/1/93	Stockton, Calif.		X
Continental	2/22/91	1/1/93	Jacksonville, Fla.		X
Warner Cable	3/15/91	10/1/92	New York City, St. Petersburg, Fla., Cincinnati, Columbus,Ohio	X	
Comcast	Pending		Indianapolis, Baltimore, Philadelphia, West Palm Beach, Fla., Los Angeles	X	
Casco Cable TV			Brunswick, Maine	X	
York Cable TV			York, Pa., Pearl, Miss.	X	
Cable TV Providence			East Providence, R.I.	X	
Viacom Int'l.			Nashville, Tenn., Seattle-Tacoma, Milwaukee, Dayton, Ohio, San Francisco		X
U.S. Cable			Denver, Baton Rouge, La., Westchester, N.Y., Oakland, N.J., Tulsa, Okla.	X	
Buckeye Cablevision			Toledo, Ohio		X
General Instrument			Hatboro, Pa.	X	
Prime II Mgmt.			Anchorage, Alaska, Atlanta, Chicago, Las Vegas, Nev., Houston	X	
Wometco CATV			Lilburn, Ga.	X	
Media General			Fairfax, Va.	X	
Cencom Cable			Riverside and Alhambra, Calif., Olivette, Mo., Fultondale, Ala.	X	
Barden Comm.			Detroit	X	
Adelphia Cable			Pittsburgh, Miami, Tequesta, Fla., Buffalo, N.Y.	X	
TeleCable			Greenville, S.C.	X	

known both to the transmitter and receiver. The resultant spread signal with a wide bandwidth to be transmitted is shown at the bottom of the figure — *g(t)d(t)*. Since the PN sequence is known at the receiver the message is retrieved by removing the PN from the transmitted spread spectrum signal.

The goal of both FH and DS is to take the power to be transmitted and spread it over a very wide bandwidth so that the power per unit bandwidth (watts per hertz) is minimized. When this is accomplished, the transmitted spread spectrum power received by an existing user, having a relatively narrow bandwidth, is only a small fraction of the actual transmitted power. For example, if a signal having a power of 1 W is spread over a bandwidth of 100 MHz and an existing user employs a communication system having a bandwidth of only 1 MHz, then the effective interfering power, in the narrowband communication system, is reduced by a factor of 100, and is 1 W divided by 100, or 10 mW.

The feature of spread spectrum that results in interference reduction is that the spread spectrum receiver actually spreads the received energy of any interferer over the same bandwidth (100 MHz in our example) while compressing the bandwidth of the desired received signal to its original bandwidth. For example, if the original bandwidth of the desired signal is only 100 kHz, the power of the interfering signal is reduced by 100,000 divided by 100,000,000 or a reduction by a factor of 1,000.

CDMA is interference-limited; that is, the number of users that can use the same spectrum and still have acceptable performance is determined by the total interference power that all the users, taken as whole, generate in the receiver. Unless one takes great care in power control, those CDMA transmitters that are close to the receiver will cause the overwhelming interference. This is known as the "near-far" problem. In a mobile environment the near-far problem could be the dominant effect. Fortunately, it is possible to control the power of each individual mobile user so that the received power from each mobile user is the same. This technique is called "adaptive power control."[3]

Conclusions

The advantages of the use of CDMA spread spectrum techniques to increase the efficiency of use of the spectrum appears most attractive. Of the CDMA methodologies, FH and DS, the DS scheme is the one most suitable for PCNs and is the one being tested by those listed in Table 2.

Of course some conventional cellular systems are experimenting with both TDMA and DS spread spectrum techniques that, not surprisingly, they claim will make PCNs unnecessary. However, the increased customer capacities provided by the microcell structure cannot be achieved with conventional cellular cells. Realizing this, AT&T and Southwestern Bell demonstrated at a conference in May in St. Louis a TDMA microcellular system integrated into the existing Southwestern Bell cellular network in the area. The permutations and combinations of design appear endless.

Will CDMA prove better than TDMA? Will CATV find PCNs a profitable new business? Quien sabe? Only time and extensive experimentation will tell. **CT**

References

[1] *Mobile Cellular Telecommunication Systems*, W. Lee, McGraw-Hill, 1989.

[2] "Trends in Cellular and Cordless Communications," D. Goodman, *IEEE Communications* magazine, June 1991.

[3] "Spread Spectrum for Commercial Communications," D. Schilling et al, *IEEE Communications* magazine, April 1991.

[4] *Modern Communications and Spread Spectrum*, G. Cooper, C. McGillem, McGraw-Hill, 1986.

November 1991

BACK TO BASICS

Controlling signal leakage

The training and educational supplement to Communications Technology magazine.

Table of Contents

What is CLI?

Contestant #1 (General Manager): "It's a new regulation imposed on practically all cable systems by the Federal Communications Commission. Our people are required to file an annual report stating the results of a systemwide patrol where the technicians measure the strength of any signal leaks found in the system. The combined results of these measurements are used to determine if our system is leaking above the legal limit. This figure of merit for the system is known as its cumulative leakage index (CLI). As part of our systemwide extensive CLI program, every member of our staff receives continual training for maintaining plant leakage within allowable limits."

Contestant #2 (Chief Technician): "CLI is a figure of severity for overall cable system leakage. In order to operate on certain frequencies, the FCC requires us to maintain system leakage below a certain level and file the results of our leakage performance testing and CLI on an annual basis. CLI is based on the number and severity of leaks recorded during a ride-out of at least 80 percent of our total plant miles. Since leakage is caused by a fault in the cable plant, leakage repair not only maintains our system within legal limits but also increases our system's overall reliability. All of our field personnel have the equipment and training to monitor, log and repair leakage on a daily basis."

Contestant #3 (Installer): "It's a leakage thing. It will make planes crash if you don't take care of it . They gave us these (leakage detectors) last year but I don't know if the batteries are any good. I suppose they'll get it fixed if they want me to look for any of that stuff. Sometimes I think they use it (leakage) as an excuse to give me flack about my work."

"What would happen if everyone in your system were asked these four simple questions?"

To tell the truth

(Will the real CLI program please stand up)

By Rick Hollowell
Manager, Broadband Engineering
Lawrence Behr Associates Inc.
And James Kuhns
District Technical Training Manager
Continental Cablevision of Michigan

CLI has been talked about. CLI has been written about. CLI has been talked about. CLI has been written about. CLI has been ... well, you get the idea. What do the installers, technicians, line technicians, CSRs and others think and know about CLI? We spoke with a variety of people from both large and small systems, and in a totally unscientific survey here are some of the responses to the questions we posed.

Question #1: What is CLI?

- "I'm not sure. I'm just an installer so I don't have anything to do with leakage." — Installer
- "Why are you asking me? Is this going to get me in trouble?" — Installer
- "I don't know exactly what the letters stand for, but my supervisor starts talking about it every time he QCs a job and finds a loose fitting." — Installer
- "Cumulative leakage index. It's a picture of the health of your system. I've never gotten to work with it personally, what with being just an installer, but you read about it all the time in the trade magazines." — Installer
- "It's radiation patrol." — Technician
- "Signal leakage patrol. I didn't think I was going to like it, but it's really kind of neat. Sometimes you find a really hard one (leak) that no one else could find and it makes the pictures look better." — Technician
- "I don't know. That's technical." — CSR
- "It's the leakage index where you enter in all of your unrepaired leaks during a ride-out and find out if your system is going to pass or not. If it doesn't then you've got your work cut out for you." — Line Technician
- "Leakage." — Numerous Installers, Technicians, Line Technicians and Chief Technicians

Question #2: What does CLI stand for?

- "I don't know." — Installer
- "Cable line interference." — Technician
- "Calculated leakage index." — Line Technician
- "I personally couldn't tell you, but our chief tech will be in later today. Would you like to leave your name and telephone number? I'll be glad to give him the message and ask him to return your call." — CSR
- "Cable leakage information." — Technician
- "Cable loss index." — Technician
- "No idea." — Installer
- "Cumulative leakage index." — One Installer, four Technicians, six Line Technicians

Question #3: What has been the biggest problem you've encountered with CLI?

- "Beats me. I don't have anything to do with it, really. I'm just an installer." — Installer
- "Leaks. Leakage is all my chief tech ever talks about. You work all day on one street and everything is quiet and then you drive down that same street a week later and the damn thing (the street) is leaking again. It's depressing. You can't win." — Service Technician
- "Pure sloppiness. It runs the entire gamut, from missing signatures, failure to acknowledge channel offsets, you name it. Pure sloppiness." — John Wong, FCC
- "Keeping enough knowledgeable personnel on staff to do the job." — Line Technician
- "Money and people. My boss wants a lean operation and he doesn't understand the need for personnel that don't directly contribute to the bottom line. I've tried to explain that we could lose channel space and that would cost us money, but he doesn't believe it could happen to us." — Chief Technician
- "We don't really have any problems with CLI. All of our systems are pretty tight." — Area Engineer
- "We have to climb each pole at each

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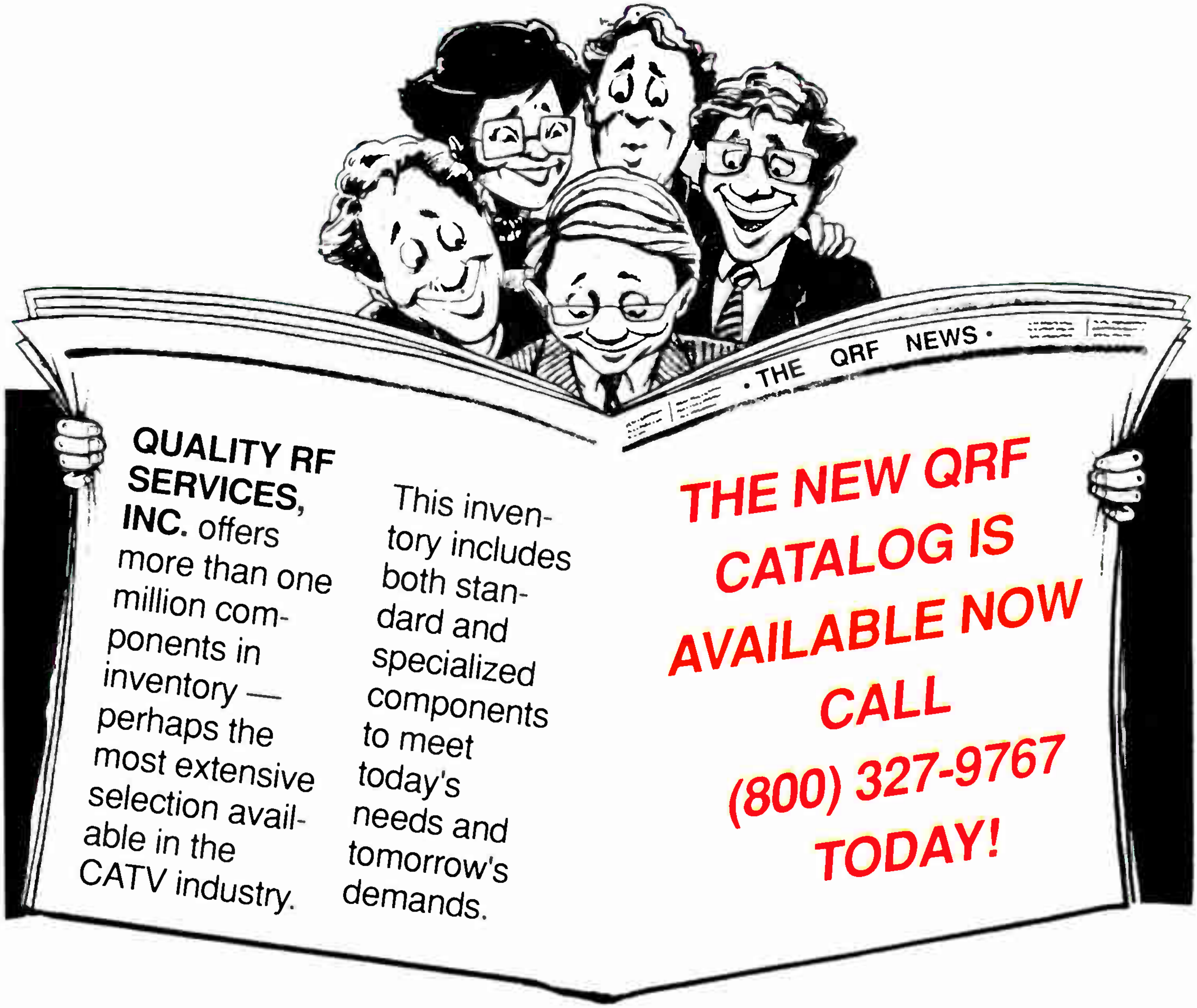

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job, even if it's just a bad box (converter), and check the tightness of the F-connectors. I don't know about the other guys, but I always do." (Laughter.) — Technician

• "Personnel, I guess. I'm still trying to impress upon my people just how important this is to all our jobs. We hold regular meetings to discuss our progress but I'm not naive enough to believe that everyone buys into or even follows our procedures when they walk out the door." — Chief Technician

Question #4: What has been the biggest advantage of CLI?

• "I don't know. I'm an installer." — Installer

• "My leakage detector isn't going off like it used to. And it used to go off all the time. I don't seem to be going back to the same house so many times like I used to." — Technician

• "Nothing. Leakage is a royal pain." — Service Technician

• "Not an advantage but a surprise. Over 80 percent of the operators filed on time. We have been unable to follow up on only 130 of 31,000 community units." — John Wong, FCC

• "A definite reduction in trouble calls and a definite reduction in call backs on installs. I think my staff finally got the message when, after several warnings, I suspended one of my installers for a few days for loose F-connectors. Since then (about a year ago) it's gotten considerably better. I hated doing that (the suspension) but it seemed to get the message across that leakage is serious business. People pay more attention in the tech meetings now, too." — Chief Technician

• "It's given me a chance to do things besides just service calls. But a lot, I guess most, of the leakage repair I've done has ended up being a sort of service call. So now when I do a trouble call I think of it in terms of system maintenance rather than just a trouble call." — Service Technician

Are you wondering (or worried) that perhaps some of your personnel were part of the survey group? Interesting, isn't it? What would happen if everyone in your system were asked these four simple questions? Certainly, we would all like to think that the answers would be correct and similar, but would they really?

As CLI programs in cable systems industrywide have improved with new equipment, software and services, it is time that we took a good hard look at the heart of the leakage program — the people who make it happen. The best equipment available and the finest plans in the world can't help solve the leakage problem unless the field personnel are committed to the cause. Generally speaking, if your field personnel are not actively repairing and preventing leaks as a conscious part of their daily routine, they are probably unconsciously causing leaks.

One of the most disturbing aspects of the survey is the attitude from a large number of installers that they don't have any involvement in their system's leakage program. We all know, and it is a well-documented fact, that the greatest number of leaks occur between the tap and the TV set. It also is well-documented that the vast majority of these leaks are employee-created. Not intentionally, mind you. But still created. So, what's your system personnel's real understanding of CLI? Before you answer that question why don't you ask everyone that's involved in your leakage program? (This means ask everybody.)

And now, will the *real* leakage program please stand up! **BTB**

Effective leakage management without red ink

In the following article we will assume that everyone is, by now, familiar with the Federal Communications Commission's cable leakage requirements. We will further assume that everyone has spent a lot of time and money bringing their plants into compliance and is continuing to expend a lot of time and money maintaining the required degree of leakage integrity and the documentation that proves compliance. Since the annual proof of leakage integrity, using flyover or ground-based techniques, is a singular and easily quantified expense, we will further restrict this article to quarterly monitoring and repair strategies.

By Gil Becker
Director of Marketing
Intercontinental Cable Services Inc.

An effective program for leakage control must extract a cost in time and money. Some operators have a very good handle on just what those costs are — and it is significant. The time has come to relegate leakage management to the category of routine operations and start finding ways to decrease the impact on operating budgets.

Currently, there is little that can be done to reduce the time that it takes to repair a leak once it has been identified. However, increasing a plant's leakage integrity will reduce the time needed for repair activity, and this can be affected by the efficiency and effectiveness of the quarterly monitoring program.

Quarterly monitoring

Most operators are using a variation of one of the following two methods:

1) Each vehicle in the fleet is equipped with detection gear and all techs are responsible for leakage testing all the time while performing their regular duties.

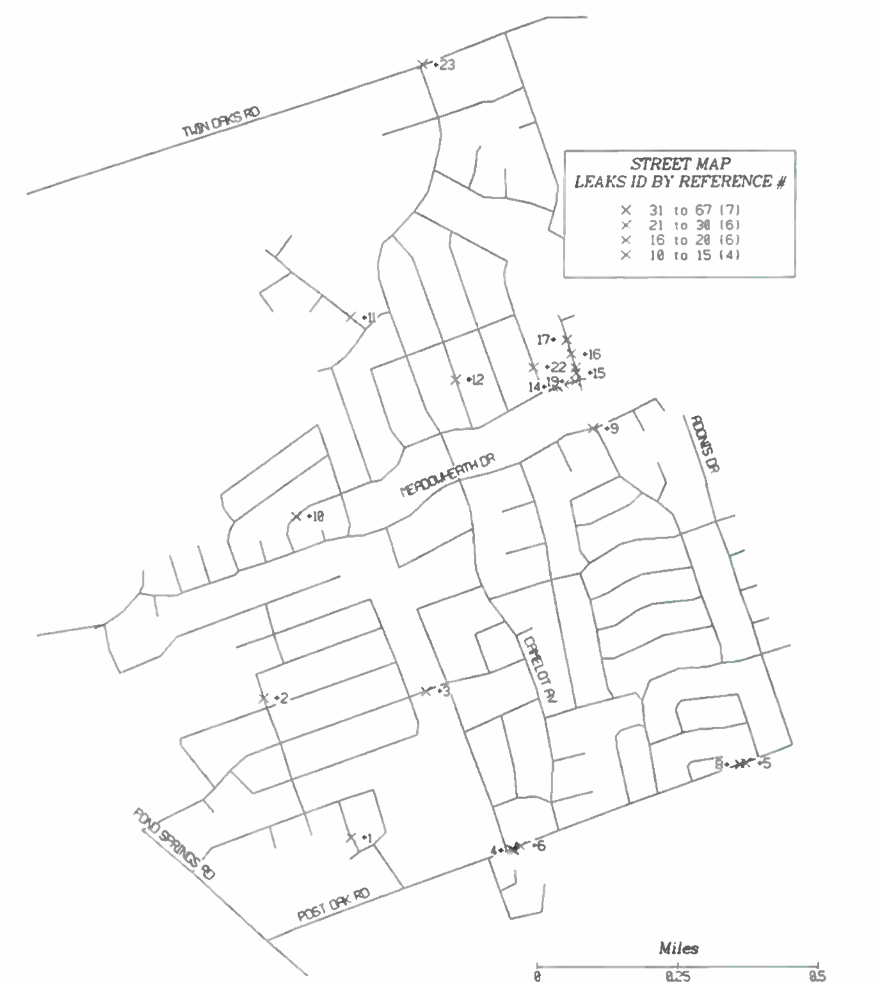
2) Designated personnel are responsible for testing their assigned areas at least once each quarter.

The FCC rules suggest that monitoring can be accomplished with the inherent driving of field personnel performing their regular work. While such a system can meet the letter of the requirement for having a "quarterly monitoring program," the primary concern of the operator, and the focus of the rules, is the elimination and control of plant RF leakage. A program that looks good on paper but fails to keep leakage below the 20 microvolt per meter level is still at risk. (A program that does control leakage below the 20 μV/m level makes the annual flyover or CLI drive-out a perfunctory exercise, and reduces the anxiety of a visit from the FCC.)

The following are some problems associated with programs that rely on "everybody checking for leakage all the time":

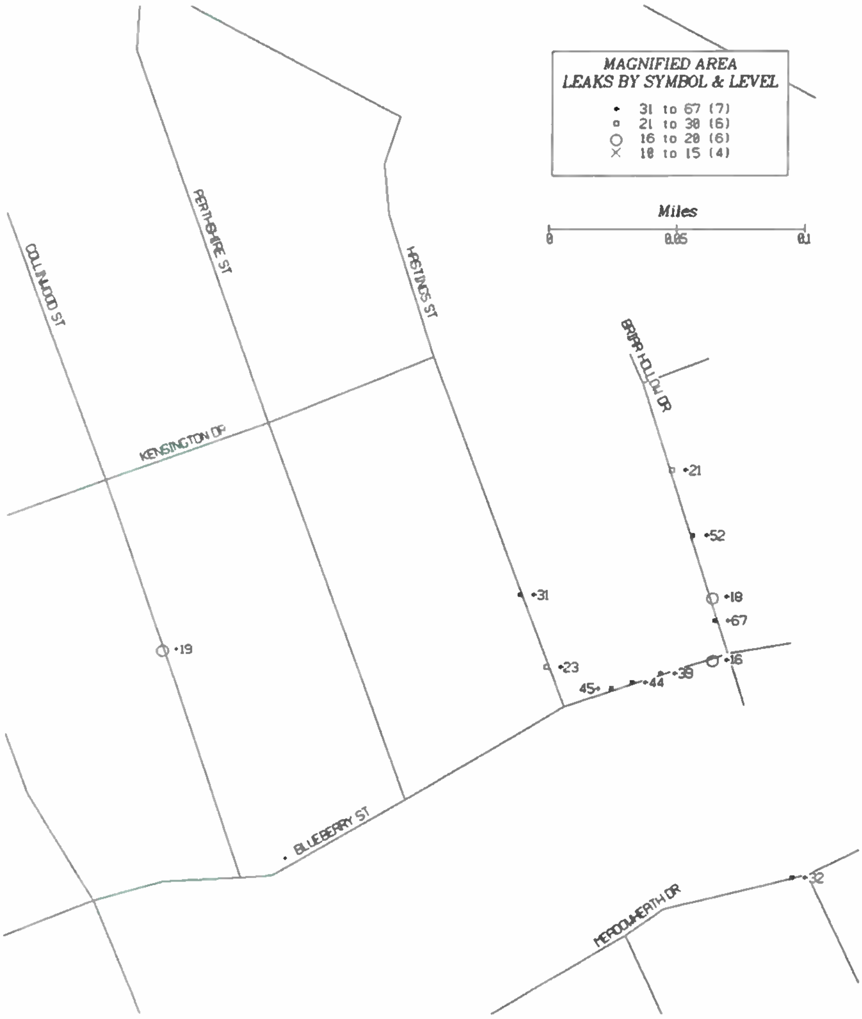
• There is a growing suspicion that the daily driving patterns of installers

Figure 1: Street map with hot spots by record number



This map is drawn with the MapInfo software. In addition to showing streets, this program can access a data base of information associated with the streets such as street names and address ranges. The legend box shows leakage records segregated into four ranges of intensity. It also shows the symbol used to identify the point on the map and the number of points in each intensity range. For example, the first range from 31 μV/m to 67 μV/m has seven points. Although "X" is used to identify all points in all ranges in this example, a variety of symbols can be used to identify different ranges of leakage intensity.

Figure 2: Magnified street map with leaks identified by symbol



This map is a magnification of one area in Figure 1 where a high density of leaks was discovered. Maps can be produced to any scale. Different symbols are used to ID leakage ranges.

and maintenance technicians are not random enough to ensure adequate coverage. Most drivers have preferred routes to and from particular areas of the plant, and time constraints placed on techs to be efficient in the performance of installations and service calls do not encourage meandering through cul-de-sacs even when they are in the area of scheduled work orders.

• Conscientious leakage location must take time away from other duties. Do you schedule fewer work orders so techs will have time to locate and record leakage? How much monitoring time is allowed for each day? How much is enough? The time needed for monitoring is in direct proportion to the number of leaks in the system because of the time it takes to define and record the locations. How much leakage is there? How do you know?

• Supervision is virtually impossible. The worst-case scenario is one in which techs are responsible for repairing leaks as they find them. Without independent verification, a tech who conscientiously locates and repairs leaks for eight hours cannot be differentiated from one who spends eight hours in a coffee shop but claims to have found and repaired multiple leaks. Eventually, the conscientious tech will catch heat for letting his other duties slide because of the time he claims to be spending on leakage, and may cease to spend time on leakage.

Most technical activities involve some degree of independent verification: a customer contact, an outage repaired, etc. If you didn't know the leak existed before it was fixed, how do you know it existed at all?

• Some leaks don't get reported. A tech on the way to correct an outage (or any one of many other activities) might decide to ignore a "small" leak, thinking that he'll come back and get it later, or since everybody is checking for leaks, that someone else will get it. What is the criteria for determining what "small" is?

• Some leaks get reported more than once. What if everyone does report the same leak, at different times and at slightly different locations? A leak in the easement between two streets could appear as two or three different leaks. How often are repair trucks rolled on false reports or reflected signals, which are frequently reported as multiple leaks?

The solution appears to be designated personnel for leakage monitoring. This is a hard concept to accept for many operators. Why tie up a trained technician just driving around writing down leakage? The cost fairly slaps you in the face.

While it is true that dedicating personnel to leakage monitoring draws attention to the cost of non-revenue producing work, the "everybody, all the time" method hides the cost, so it is harder to get a handle on it. There are costs regardless of the method used. Additional work = additional costs, period. If there is no cost for leakage management, there is no leakage management.

Extensive research and the experience of operators over the past two years have revealed the following costs associated with designated personnel for leakage monitoring. (No two cable systems are identical but the averages are based on a wide variety of operations.)

Assumptions: The average tech ($10 per hour plus benefits) in the average system (with one recordable leak per plant mile) will average three plant miles per hour, driving and logging leakage in a fully equipped service vehicle ($15,000). It will require approximately one minute of processing time for each leak logged (computer and hand entries, printing work orders, reports, etc.). This works out to $4.50 in salary and benefits, 75 cents in vehicle costs and 11 cents in processing costs per plant mile driven. This adds up to $5,360 in a 1,000-mile plant each quarter.

Is there a better way?

There is a less expensive method. What follows is a description of a pro-

Automated leakage monitoring vs. drive-out

Savings from quarterly monitoring by system

	Current method	LeakFinder	Savings
System A: 1,000 miles	$5,357.50	$830.00	$4,527.50
System B: 500 miles	2,678.75	415.00	2,263.75
System C: 100 miles	535.75	83.00	452.75
System D: 50 miles	267.88	41.50	226.38

These savings are derived from the following comparisons:

	Costs per day		Costs per mile		
	Current	LeakFinder	Current	LeakFinder	Difference
Miles per day	24	100			
Operator:					
Salary/hr. $10/$5	$80	$40	$3.33	$0.40	$2.93
Benefits 35%	$28	$14	$1.17	$0.14	$1.03
Vehicle:					
Cost $15,000/$10,000					
Depreciation	$15	$10	$0.63	$0.10	$0.53
Operations cost @ 12¢/mile	$2.88	$12	$0.12	$0.12	$0
Documentation: # leaks x process time x $6.75/hr. vs. ICS 1 hr./day	$2.70	$6.75	$0.11	$0.07	$0.04
Totals	$128.58	$82.75	$5.36	$0.83	$4.53

Assumptions:

Item	Current	LeakFinder
Plant miles per day	Average 3 miles per hour; log three leaks per hour.	Average 15 miles per hour; log all leaks automatically.
Operator	Technician $10 per hour.	Driver $5 per hour.
Vehicle	Service truck $15,000.	Compact $10,000.
Vehicle operations	Shown equal in comparisons but obvious advantages to the compact.	
Total miles driven	150 - 200% plant miles.	130% plant miles.
Equipment used	Truck-mounted and/or hand-held receiver and antennas; data log or voice recorder.	LeakFinder with antennas.
Documentation	Transcribe data from tech log to system log/computer, print work orders/reports. One minute of operator time per leak.	1 hour per day.

gram incorporating an automated leakage detection and recording system — The LeakFinder System — from Intercontinental Cable Services.

LeakFinder is being used by a number of MSOs in plants of various sizes with different levels of leakage integrity. It uses global positioning satellite (GPS) navigation technology to record the actual ground track during the drive-out and to identify those locations where RF signals are present. The result is leakage data collection that has third-party reliability. As an operator you have proof that the plant was actually driven and the dates and times of the testing. Even more important, repair technicians have a tool that will point them directly to the source of leakage.

Once collected by the automatic recorder, leakage data is imported to a desktop mapping program to produce maps for maintenance technicians to use in making repairs. Because repairs are done from maps instead of addresses, ambiguous identifications are eliminated. LeakFinder includes Mapping Information Systems' MapInfo software. This desktop mapping program ties geographic information to a data base, so that leakage data can be displayed with street name and address information, RF signal intensity and any other information that the operator wants to include, such as plant design. (See Figures 1 and 2.)

With the automated recorder it is not necessary to engage a highly trained technician in the monitoring process. An entry-level driver can do the job of collecting leakage information. Since the driver will not need to stop to deter-

(Continued on page 97)

Getting the most from your antenna system — Part 2

Part 1 (October 1991) explained how an antenna works, discussed the types of antennas commonly used and identified their advantages and disadvantages. Part 2 discusses the theory of propagation of electromagnetic waves in the atmosphere. This discussion will help the reader understand how interference occurs and the proposed methods of minimizing it. Interference will be covered in Part 3.

By Rick Murphy
President, Wade Antenna Ltd.

In order to understand how interference occurs, we must first understand how electromagnetic waves are affected as they travel through the atmosphere. A broadcast transmitting antenna used for over-the-air radio or TV transmission radiates the radio frequency energy horizontally more or less equally in all directions. This RF energy travels through the atmosphere in straight lines at the speed of light. The radiation pattern of the antenna can be represented by a circle around the antenna as shown in Figure 1 in last month's installment.

As the electromagnetic wave travels away from the antenna it spreads out vertically also. The vertical pattern can be divided into three segments. (See Figure 5.) The "sky wave" is that portion that is propagated at some angle above the horizon. There are no objects in the path of the sky wave and it is attenuated as the square of the distance as it travels upward into space (6 dB loss per doubling of the distance). The sky waves of the UHF and high VHF signals are only slightly affected by the ionosphere region and normally travel through into space. Occasionally these signals are reflected and return to earth at some distance from the transmitter. At UHF frequencies, this occurs infrequently. The sky wave of signals in the low VHF band up to Ch. 6 tend to be refracted more by the ionosphere due to their longer wavelength. Consequently, interference from distant stations is more of a problem at these frequencies.

Figure 6

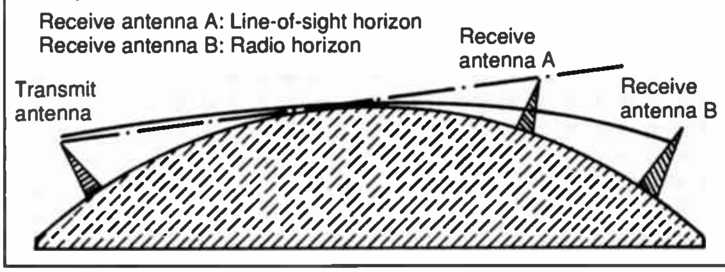
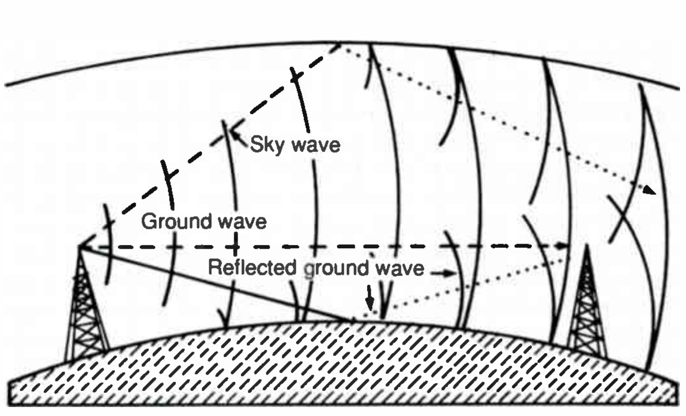


Figure 5

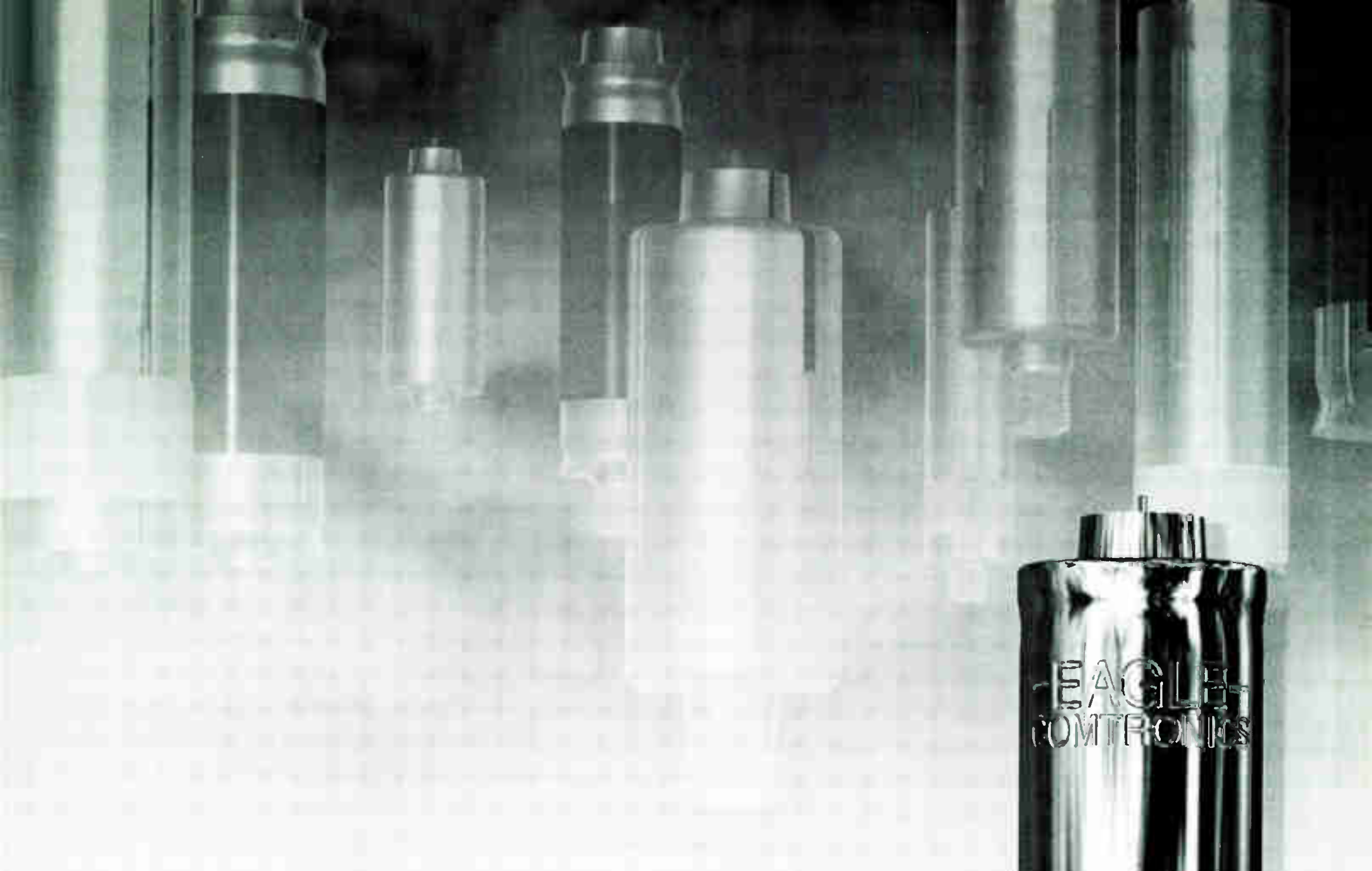


A second component of the electromagnetic wave is the "ground wave" that travels along the surface of the earth to the receiving antenna. It is the ground wave that is relied upon for reception of broadcast signals in most cases. As the ground wave travels outward from the transmitter it induces voltages in the earth and objects in its path such as receive antennas, trees, buildings, etc., all of which result in additional power loss. The ground wave losses are greater than the sky wave losses and are influenced by a number of factors including conductivity of the earth, number and type of objects along the surface, frequency of the wave and the distance from the transmitter. Calculation of these losses is more complicated and less accurate than the loss calculation for a wave in free space.

"In order to understand how interference occurs, we must first understand how electromagnetic waves are affected as they travel through the atmosphere."

Electromagnetic waves travel more or less in straight lines and at some distance from the transmitter. The ground wave just grazes the surface of the earth and continues on into space. A receiving antenna situated at the horizon is said to be in line of site of the transmitter. This line-of-sight distance can be increased by placing the receive antenna at some distance above ground.

It is common to assume that electro-



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magnetic waves travel at the speed of light. In fact, they travel at the speed of light only in free space. As the density of the medium through which the wave travels increases, the speed of the wave decreases. Except for the ionospheric region, the density of the atmosphere decreases with height until we reach the vacuum of outer space. Therefore, a ground wave travelling across the surface of the earth will travel at increased speed with increased height. This produces a bending of the wave and permits reception at a slight distance beyond the horizon. This distance is called the radio horizon. (See Figure 6.) When calculating the distance to the radio horizon it is normal to use four-thirds the radius of the earth.

A third component of the transmitted wave is radiated at a downward angle. The earth is a good reflector of electromagnetic waves and this third component is called the "ground reflected wave." At the point of reflection a phase shift occurs, placing the reflected wave 180° out of phase with the direct wave. At the receive antenna, the reflected wave and the direct wave could cancel resulting in no signal at the receiver input. In fact cancellation would only occur if the two signals were equal in strength and the path lengths were identical. The length of the two paths would be identical if the direct signal path just grazes the ground. Even then, there is normally considerable attenuation of the reflected signal at the point of reflection and only partial cancellation would occur.

An increase in the height of the receiver will increase the length of the reflected path (Figure 7), increasing the phase delay of the reflected signal beyond 180° toward 360° (in phase). A reflected path that is one-half wavelength longer would cause the two signals to be in phase and add, increasing the level at the receiver input above that that would be expected with normal free space loss. The increase in field strength is 6 dB each time the height of the antenna is doubled until the reflected path is one-half wavelength longer than the direct path. As the height is increased further, the level will decrease and increase again as the reflected signal moves in and out of phase with the direct signal. After the first maximum the change will be less than 6 dB per doubling of height.

Figure 7

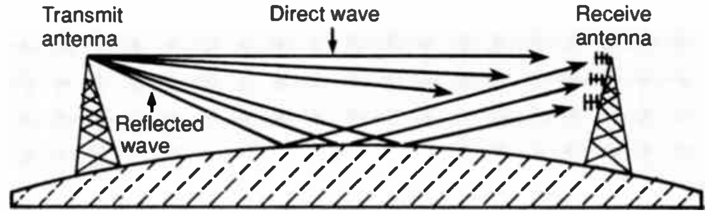
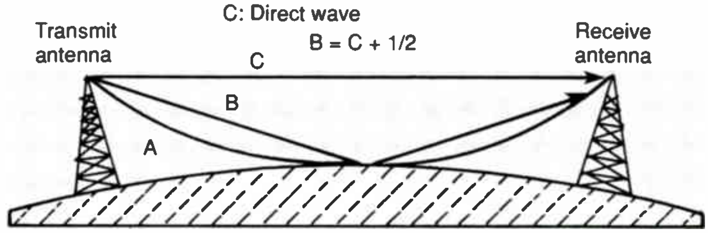


Figure 8



Fresnel zone

If we draw a curved line between the transmitter and receiver such that two straight lines drawn between the transmitter and receiver, and touching the curved line, are one-half wavelength longer than the direct line, the area within the curved line is called the "first Fresnel zone." (See Figure 8.) The height of this Fresnel zone at midpoint is equal to:

$$1{,}140\,(D/f)$$

where D is miles and f is MHz.

The height of the zone decreases when the distance is reduced or the frequency is increased. For a given frequency, if the height in feet (H_t) and distance (D) of the transmitter are known, the required height for a receive antenna (H_r) to place it at or above the first Fresnel zone can be determined by using the following formula:

$$H_r = (D \times 10^6)/(1.54 \times H_t \times f)$$

This calculation assumes smooth earth between the transmitter and receiver. Given a transmitter height of 1,000 feet, at 50 miles the optimum height of a receive antenna would be:

1) Ch. 2 = 587.6 feet
2) Ch. 13 = 153.7 feet
3) Ch. 14 = 68.9 feet

Received signal level

As we can see, reflections will add, in and out of phase with the direct wave, causing the actual received level to be quite different from the calculated level. If the terrain between the transmitter and receiver is known, a close approximation of the expected receive level can be obtained. However, the most accurate method of determining expected receive level is to take measurements at the proposed site with an antenna of known gain. To increase the accuracy, a number of measurements should be taken over a long period of time. **BTB**

Standby power supply testing

By Jud Williams
Owner, Performance Cable TV Products

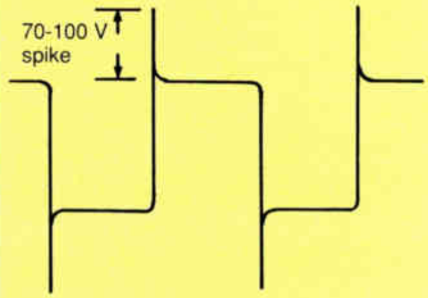
Usually, when cable TV standby inverters are tested, a pure resistive load such as a power resistor or a bank of light bulbs are used. This is OK for checking a power supply following a repair, but when it comes time to evaluate the performance of a power supply, more extensive tests must be made.

A pure resistive load does not subject an inverter to the real-life conditions of a cable system. A standby power supply actually sees a combination of loads: inductive, resistive and capacitive. Such combinations may result in power factors that are far from unity causing an inverter to react quite differently than when the load is purely resistive.

As an example, a highly inductive load such as the transformers in the various power packs and DC power supplies at the trunk stations and line extenders throughout the system causes the output of some inverters to develop a spike on the leading edge of the square wave output. This spike develops because the voltage is leading the current when applied to the load. This is due to the inductance of the transformer.

What this means is, during the first instant of time, as the leading edge of the square wave is developing, there is no load on the voltage, so no current is flowing. This "open circuit" condition allows the leading edge of the square wave to overshoot as shown in Figure 1. Typically, in an inductive circuit, the voltage "leads" the current (which also may be stated as the current "lagging" the voltage).

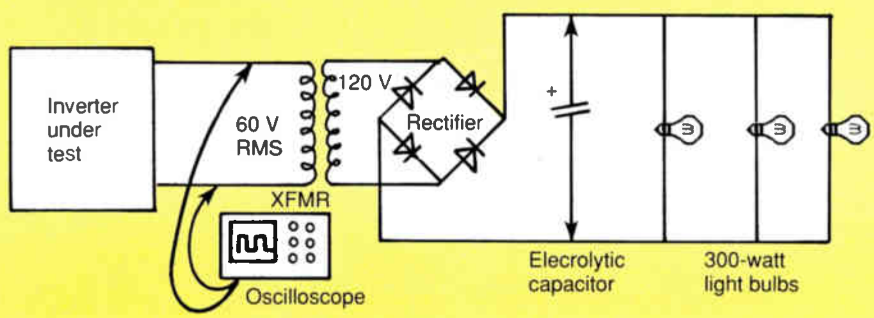
Figure 1: Inverter output waveform



The consequences of this is, when surge clamps are installed into a system, the spike generated by the standby will repeatedly trip the SCR in the surge protector, causing the system to shut down during standby. The surge protectors are equivalent to a near short circuit across the cable system for a full half cycle of the alternating current, once it has been triggered by a spike.

To check for this problem, a test setup may be assembled. It is comprised of a transformer, rectifier, resistor and capacitor as shown in Figure 2. An oscilloscope is essential in order to observe the output waveform of the

Figure 2: Power supply test setup



inverter under test. The ratings of the various components in the test setup should be compatible with the load conditions presented to the power supply being tested.

For example, if one were to test an inverter at 13 amperes, a step-up autotransformer with a 400 to 500 VA rating would be selected since its use would be intermittent. The rectifier should be rated in excess of the peak voltage put out by the transformer secondary and have adequate current rating. The resistor should be an adjustable power type. Remember that we are using a step-up transformer so that power rating of the resistor will be based on 120 volts RMS. A convenient alternative to the use of resistors are a bank of light bulbs. Three 300-watt bulbs in parallel will load the circuit in the illustration by about 13 amperes. The load may be reduced by unscrewing one or two of the bulbs so the effects of several load conditions may be observed.

An electrolytic capacitor with a value of several thousand microfarads completes the simulated CATV load. It represents the filter or charging capacitors in the power packs of the distribution modules. The presence of capacitance in parallel with the inductive and resistive loads will introduce other possible problems with the output waveform of the inverter. As complicated as it may sound, capacitance in an AC circuit will cause current to lead the voltage. This is contrary to the effects of inductance as previously described. So, as you can see, there are several competing load conditions affecting the performance of an inverter.

When observing the waveform of the complex load on an oscilloscope, it is best to zero in on the knee or intersection of the leading edge of the square wave where it becomes horizontal. This part of the signal should be expanded as much as possible as the spike or overshoot may be as short as one microsecond in duration and difficult to observe otherwise. Some spikes have an amplitude of 70 to 100 volts above the peak of the square wave. The existence of spikes generated by certain inverters may preclude the use of surge clamps in some cable systems. **BTB**

Readers wishing to ask questions or discuss the contents of this article are invited to call the author at (404) 475-3192 or write to P.O. Box 947, Roswell, Ga. 30077.

Leakage management

(Continued from page 91)

mine the leakage level and record the location, data collection will be faster — as much as 10 times faster.

Comparing the costs of the current drive-out method with the automated system is revealing: $5.36 vs. 83 cents, respectively, per plant mile for driving a 1,000-mile plant. (See accompanying table on page 91.)

It is not suggested that the responsibility for leakage control reside entirely in the hands of designated personnel. All technicians must be aware of the causes and cures for leakage. All installations and maintenance must be performed "leak free." And there should be an incentive for techs to fix leaks when they find them. You certainly don't want a mini-MMDS broadcast station to go uncorrected between drive-outs.

There are some additional benefits to the GPS-based technology. Because LeakFinder is not dependent on predigitized maps for navigation during the drive-out, it can be used as a mapping tool as well. Maps need to be continuously updated. With GPS this is easily accomplished. While LeakFinder is not designed as an engineering or survey tool, its accuracy is adequate for many locating functions that involve mapping and cable design. The MapInfo desktop mapping software can import maps from other CAD programs and will produce hard copies of the maps on a variety of plotters and laser or dot matrix printers.

Compliance with the leakage requirements, though, is the primary function of LeakFinder, which can perform both quarterly monitoring and annual testing. It was originally designed for flyover testing so operators could perform their own in-house aerial measurements, ground-based CLI testing and quarterly monitoring with the same basic equipment.

The time has come to control the costs of controlling leakage. To accomplish this goal, leakage management must be both effective and a routine part of system operations. Responsibility for leakage control can be shared; accountability is not. System operators have too much at stake to not have a verifiable monitoring program that allows them to know that leakage is being managed in a proactive manner that avoids reactive response to crisis situations. **BTB**

Intertec's series on telephony basics

By Ron Hranac
Senior Technical Editor

This month's "Lab Report" is departing a bit from the usual equipment evaluation. Instead, I'm going to review a useful four-volume set of books from the publishers of *Telephony* magazine. This collection provides a good introduction to the technical basics of the telephone industry. What with cable's interest in PCS/PCN technology and similar services, such an overview might be useful to introduce those unfamiliar with the telephone side of telecommunications to that industry's terminology and fundamentals of operation.

I purchased the set of four books from Intertec Publishing Corp. and proceeded to learn about telephone communications. (Reading is a great way to make those long airplane rides overseas a little more bearable.)

The books

When you order this particular four-volume set of books, here's what the UPS driver will bring to your office: *Telecom Basics* and *Transmission Basics*, two paperbacks both written by Jack Dempsey; another paperback, *Datacom Basics* by Stan Schatt; and a nice hardbound volume, *Telephony's Dictionary, Second Edition* by Graham Langley. But sit down when you pay for them. The four-volume set is $85 plus shipping and handling.

Telecom Basics, a 91-page introduction to data and voice communications, was written in 1988. It's companion, *Transmission Basics*, is an 83-page sequel that came out the following year. *Datacom Basics* came out in 1990, and is a stand-alone 57-page tutorial in basic data communications. This third volume, by the way, would be good study material for those preparing for the SCTE's BCT/E Category V examinations. The 402-page dictionary is vintage 1986, and provides definitions for 16,000+ telecommunications terms, including some CATV-related (more on this later).

"Telecom Basics"

The author of the first two books, Dempsey, spent 35 years in telecommunications. His career has included stints with IBM, Illinois Bell, Bell Labs, Western Electric, AT&T headquarters and Xerox. He has also spent time as senior national consultant to Interline, a subsidiary of US West. Dempsey writes in a way that is very easy to understand, and he uncomplicates some of the more complicated subjects.

I suspect that *Telecom Basics* was originally written for a generally non-technical audience, perhaps telecommunications managers who have little or no field experience. If that's the case, it succeeds at providing a good overview of basic telephony and telecommunications. For the more technical reader, the basic presentation may seem a little simplistic in places. Even so, the reader will finish the book with a useful foundation of terminology and concepts.

While Dempsey doesn't cover residential wiring and installations, he does describe in the first chapter how a phone works. (If you'd like to learn more about residential telephone installations, I suggest you pick up a copy of Radio Shack's third edition of *Installing Your Own Telephones*.) As you go through the book's background on telephone communications, you'll find some terms that have evolved into use in our industry.

For example, in Chapter 7, the book provides a background on telephone signaling. According to Dempsey, early in the history of the telephone industry, a distant operator would be alerted of a call between central offices not with a ringing bell as was done on individual phones, but rather with the triggering of a small latched door-like device on the switchboard called a "drop" (it would drop down over the appropriate switchboard jack when triggered). The term stuck, and even now the far end of a telephone circuit — such as a residential connection — is known as a drop in the telco world. Our own cable industry has adopted this term to describe the far end of our "circuits": subscriber drops.

Cellular phone communications is briefly described in Chapter 8, but there is no mention of the newer developments in personal communications services. This, of course, is due to the fairly recent introduction of PCS/PCN technology relative to when *Telecom Basics* was written.

"Transmission Basics"

If you don't have any previous telephony background, then you should probably read *Telecom Basics* before plunging into *Transmission Basics*. While the concepts explained in this book are done in author Dempsey's easy-to-read style, some things will make more sense after having read the first book. And as with the first book, the material in *Transmission Basics* is presented for an audience that I assume to be generally non-technical. In spite of that, most readers will gain from what Dempsey has to say.

Transmission Basics is a good companion to *Telecom Basics*. Beginning with sound and decibels (yes, the phone companies have them, too), it progresses through wired communications systems. Some of the concepts presented in the first book are expanded upon here, also. After covering various carrier systems and carrier transmission facilities, Dempsey provides a basic overview of digital and baseband transmission. These do a nice job of preparing the reader for the next book in the set, even though that volume was written by a different author.

I didn't like the way figures were labeled in this book. In *Telecom Basics* drawings were labeled "Figure 3.3," etc. But in *Transmission Basics*, someone got carried away with a PC and labeled all drawings with things like "Figure CURFLOW." I found this confusing when referring to figures mentioned in the text. Aside from this, the book provided a lot of useful information.

I did chuckle at Dempsey's statement in Chapter 9 about fiber optics: "Fiber-optic cables are not too adaptable to analog carrier systems, and have little if any application with these systems." Of course, the cable industry has been using fiber to transmit analog signals (AM multichannel video) very successfully since late 1988. But then, it wasn't all that long ago that many in cable doubted the viability of using lasers designed primarily for digital signals to transmit AM over fiber.

"Datacom Basics"

Author Schatt — that's Dr. Schatt, with a couple of mas-

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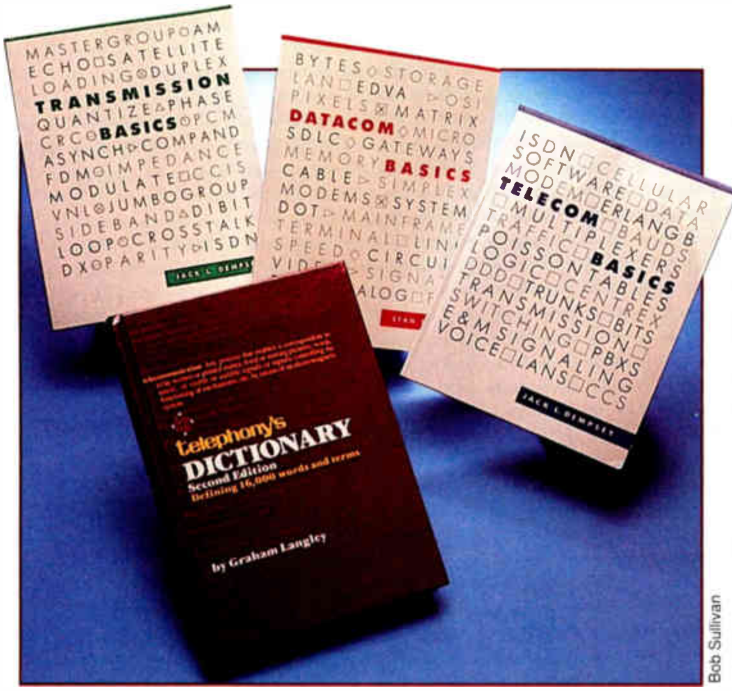


Bob Sullivan

ter's degrees in addition to a bachelor's degree — has mainframe, mini- and microcomputer experience, and has taught at several universities. He, too, has worked for AT&T, among other companies, and has published numerous books on data communications and computers. Schatt's style is similar to Dempsey's: very readable.

And like Dempsey, Schatt starts with the basics. He moves on to include computers and their peripherals, then tackles local area networks. After reviewing interconnect standards — those in the OSI (open system interconnect) model — he continues with multiplexing, ISDN and network management. I found that this book was more data communications-specific rather than telephone-related like the first two books. In fact, I think it would be a useful reference for the SCTE's BCT/E Category V ("Data Networking and Architecture"). Even so, reading the three books in the order I have reviewed them here is recommended.

"Telephony's Dictionary"

I don't think the first three books can be classified as reference books. They are really tutorials in telephone and data communications basics rather than true reference manuals. The dictionary, however, is a good reference book that is a nice addition to any technical library. Author Langley presents more than 16,000 telecommunications terms in this second edition (the first edition was printed in 1982).

I'll admit that I didn't sit down and read through this book in its entirety — it is a dictionary, after all. Even though the second edition is now five years old, its definition of cable TV is valid even today: "Previously called community antenna television (CATV). A communications system which distributes broadcast programs and original programs and services by means of optical fiber, coaxial cables or other cable facilities. In some cable TV systems there is provision for interactive (both way) working, including telephone service."

Not only are many telephone and CATV terms included, but so are electronic, broadcast, data, satellite and others. A nice feature is the appendix in the back of the book that includes acronyms and abbreviations, although in the appendix "CATV" is defined only as "community antenna television." I also noticed that "CARS" is defined as "community antenna relay service," a common — but technically incorrect — definition. (According to the FCC, CARS actually means "cable television relay service.")

All in all, though, the dictionary appears to be a pretty comprehensive reference.

Comments

If you are contemplating getting into telephone-related business or are just interested in learning more about the technical side of the telephone industry, I think you'll find these four books useful. The first three books will give you a good foundation in the terminology and concepts, and the dictionary will be a helpful reference.

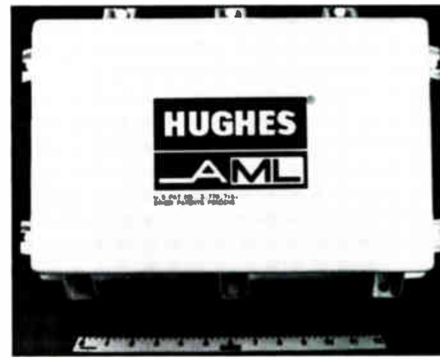
I thought the purchase price was a little on the high side, but considering the background these books can provide, you might treat them like a low-cost telephony course instead. They all are well-written and easy to understand, a pleasant change from some publications that require a Ph.D. to comprehend.

For more information, contact *Telephony*, Intertec Publishing Corp., 55 E. Jackson Blvd., Chicago, Ill. 60604. **CT**

FO light source

Sadel R&D announced its new miniature fiber-optic light source, the Sadelite s. It is pocket-sized and is said to be the perfect companion for the company's miniature fiber-optic power meter (the Sadelite m).

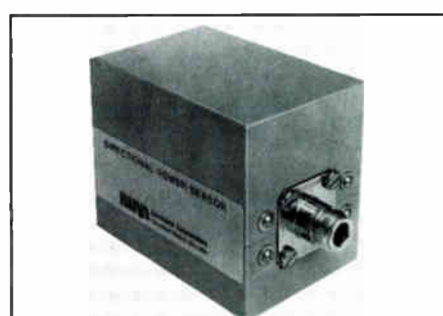
It is available in a dual channel LED or laser configuration. Peak wavelength for the LED is 850 nm or 1,300 nm ±20 nm and 1,310 or 1,550 nm ±30 nm for the laser. The LED output power level is -10 dBm (minimum LED output level is measured with 100/140 SMA connectored fiber). It is 4x3x1.25 inches and weighs 5 ounces. The product is shipped with two 8.4 volt batteries.
Reader service #141



Repeater

The Model AML-RPT-125 AML broadband repeater was introduced by Hughes. It is designed to let cable operators extend existing signal paths farther than was previously possible and to implement paths where direct line-of-sight transmission is obstructed.

All solid-state and on-frequency, the active repeater amplifies signals received from the primary microwave transmitter and re-transmits them to new or secondary cable hub sites. It may be tower-mounted, thus eliminating transmission line losses. In addition, it is compatible with all of the company's AML CARS-band microwave transmitters and receivers
Reader service #140



Power sensor

Bird Electronic Corp. made available its Thruline Model 4025 wideband precision directional power sensor for detecting 100 kHz-2.5 MHz forward/reflected RF power to 10 kW at ±3 percent of reading accuracy. It can be inserted anywhere in a 50-ohm transmission line for accurate evaluation of RF equipment under actual operating conditions.

It eliminates the need for attenuators and directional couplers that are normally required to perform precision RF measurements at higher power levels. The product is designed for use with all of the company's laboratory-grade Models 4420 and 4421 RF power meters and Model 4029 calibrators. It carries its own wideband calibration profile in non-volatile memory and corrects reading automatically according to input frequency.

Reader service #139

Underground power

Lectro introduced its Sub-Max underground ferroresonant power supply that is designed to operate below grade level. It has a heat sink design for maximum transformer life, flush to grade mounting in vaults, and performs to NEMA 6P specs (submerged in water). The range available is to 18 amps.

Features include stainless or aluminum cabinets, single or dual outputs, long-life LED visual indicators and plug-in input and output. No coax connections are required and an optional NEMA 6P external disconnect is available. The unit also has stainless steel auto torquing latches and self resetting breakers.

Reader service #138

Optical tester

Siecor's new OptiTest local loss test set for single-mode systems allows attenuation testing of mechanical or fusion splices or passive optical components without access to fiber end faces. The set uses a bidirectional transmission and receiving system to measure component loss within a fiber system. Light is launched on both sides of the splice to be measured by clipping on to the fiber. The signal crosses through the splice and is detected on the other side. The receiver provides power ratio measurements on each side of the object.

Unlike the company's conventional LID-System unit, the OptiTest set measures attenuation on a bend coupler basis, independent of coupling efficiencies. Attenuation can be measured on all passive optical components including fibers, fusion and mechanical splices, spitters, couplers and connectors. Designed for single-mode fibers and operating at 1,300 nm, the product provides accurate readings on most fibers without removing the fiber color coating.

Reader service #137

Fiber connector

Augat Communications Group introduced the GB series fiber-optic connector, a DIN47256-compatible connector system. It is suitable for a variety of applications and said to be especially ideal for CATV systems using AM laser sources.

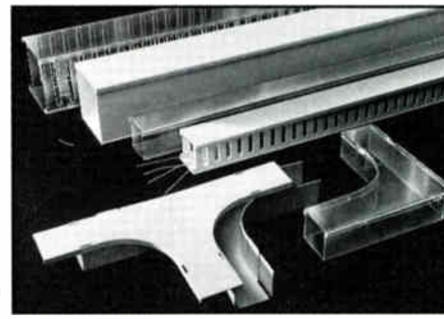
The connector has all-stainless alloy hardware and can be ordered in both single-mode and multimode styles. The single-mode product is available with a zirconia ceramic ferrule and the multi-

mode with a ceramic or stainless alloy ferrule. The ferrule is spring-loaded to isolate it from the effects of cable movement. The series is designed for use with 3 mm jacket/900 micron buffer single-mode cable. An interconnect also is available.
Reader service #136

Pointing chart

Pepperel Software made available its SATlookR satellite pointing chart that is customized to the particular ZIP code specified by the user. Site information for a particular ZIP code includes: latitude (degrees, minutes, decimal degrees); longitude (degrees, minutes, decimal degrees); magnetic deviation (decimal degrees); declination angle (decimal degrees); and polar angle (decimal degrees).

Standard satellite information for a particular ZIP code includes: name, location, true azimuth, magnetic azimuth, and elevation above the horizon. Satellite information unique to the product for a particular ZIP code includes: type (C/Ku); launch date (current/future); power levels (C/Ku watts); LNB rotation relative to the horizontal plane (required for a fixed-position satellite); and corrected angle between adjoining C/Ku satellites (true look angle between satellites). The product's information is for near-earth orbit geosynchronous satellites correcting the errors of many satellite pointing routines previously available.
Reader service #135



Fiber routing system

Panduit has added new orange PVC and clear polycarbonate duct and fittings to its Panduct line of wiring duct. The color distinguishes fiber easily from other communications wiring. Clear polycarbonate is designed for applications requiring a chlorine-free and low-smoke generating material. Its clear color aids in quick identification of fiber as well.

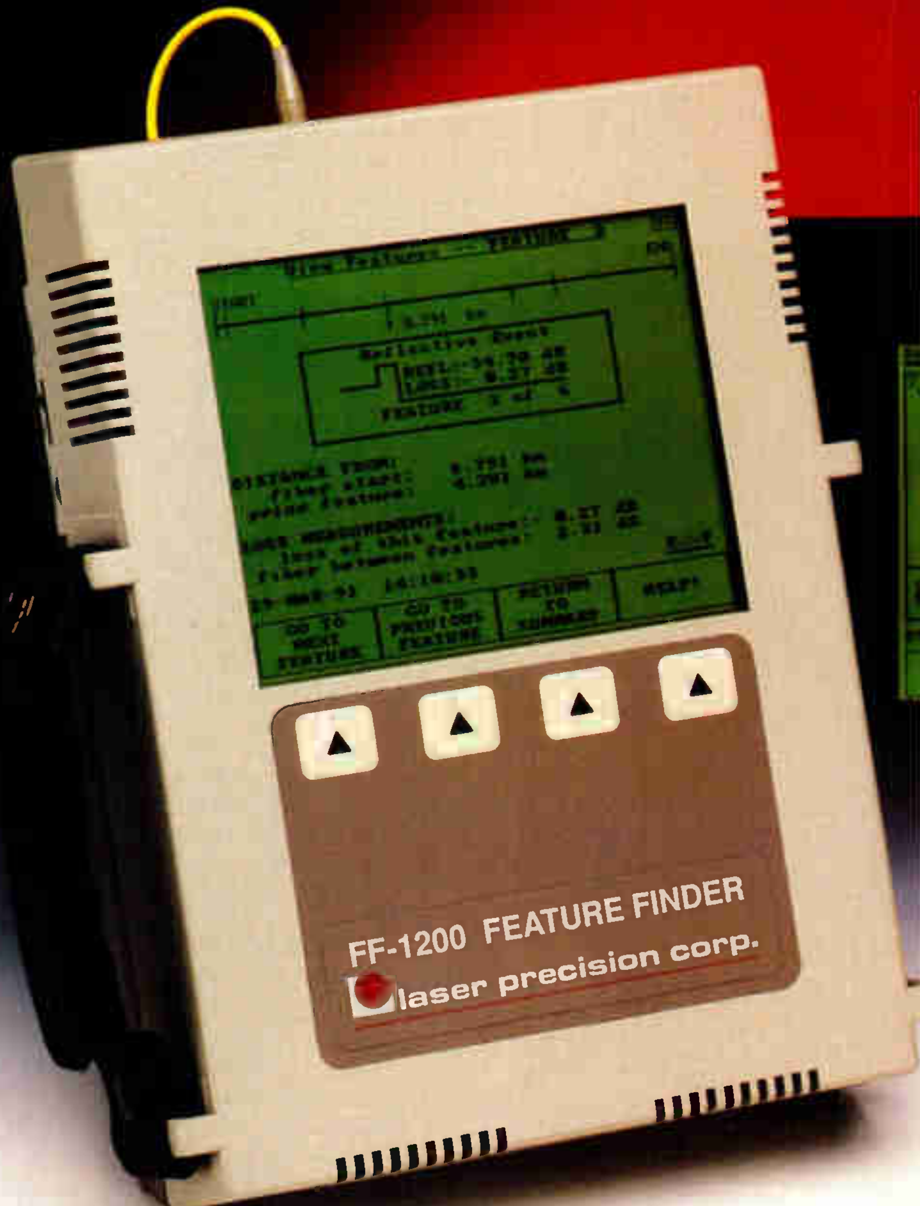
The products are available in 2x2-inch and 4x4-inch sizes in both solid wall Type S and slotted wall Type E versions. Both are offered in standard 6-foot lengths. In addition, right angle, tee and reducer fittings are available in both clear and orange color. They have a 3-inch bend radius for smooth transitions to prevent signal loss. Covers lock in place mechanically, but are said to be easily removed to allow for wiring revisions. Duct and fittings are available in a light gray color also.
Reader service #134

BTSC encoder

A new BTSC stereo encoder, the Model SE-1, was introduced by Leaming Industries. It was designed to provide high-quality BTSC stereo signals in headends with limited rack space, according to the company.

The unit accepts baseband left and

Accuracy... That's Traceable!



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Reader Service Number 58

right signals (usually from a VCII) and provides a BTSC composite baseband output. A Bessel-null test tone is built in for an accurate setup and front panel left and right audio level controls with peak flashers are provided. Each encoder is self-powered and up to three units may be racked onto one PMU401 panel mount (1 RU; 1-3/4 inches high).
Reader service #133

Bracket

The CATV trap sleeve bracket by Diamond Communication Products is made of steel and aluminium and is available in two- and four-sleeve versions. It is made to mount and balance up to eight trap sleeves to the strand with additional W brackets and an adapter plate.

Steel parts are galvanized to meet ASTM specifications A153 and B695. Nuts are supplied with external tooth lock washers to prevent loosening. The W bracket and adapter plate are supplied with captive mounting hardware and both have anti-rotational features and can be mounted to a slotted (optional) or standard tap bracket. The spring steel W brackets include a snap-in feature suitable for most trap security sleeves (7/8 to 1-1/8 inches in diameter). Windowed flanges on the brackets permit trap identification from the ground with clear trap sleeves.
Reader service #129

Coupling clamp

A new coupling clamp accessory for Fisher Research Laboratories' TW-6 pipe and cable locator transmitter was announced. It will energize lines for a 100 percent increase in tracing distance and is said to be substantially more efficient than the earlier clamp in transmitting a tracing signal to a wire or pipe that is within the clamp. Typical increased tracing distance is said to be 100 yards vs. 50 yards for the old clamp.

The two halves of the clamp are spring loaded shut and there is provision for mounting it on a hot stick with a 1/4-20 threaded mating lug. There also is a D-ring to attach a lanyard for opening the clamp when it is mounted on the end of a hot stick.
Reader service #130

ID bulletin

An updated brochure detailing Tyton's complete line of labeling, identification and bar-code products is available. The 28-page bulletin also describes the company's bar-coding software programs including the new Tag-Maker label printer and also the Tagprint II labeling software and tab tags.

The company's line of wire and cable identification and marking products are covered as well. These include the Shrink-Tag and Flex-Tag markers and the new static-free labels.
Reader service #121

Catalog

Pasternack Enterprises released its Catalog 1991B. It features a complete line of amplifiers, molded breakouts,

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Reader Service Number 60

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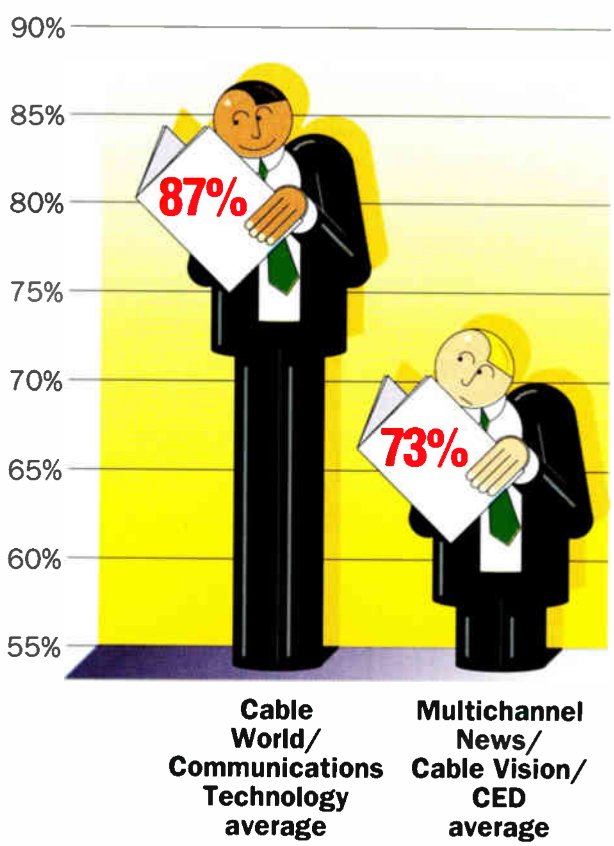
OVERALL QUALITY

Percentage of each publication's readers rating it an A or B in terms of overall quality

Source: Pensar Inc. survey of cable system engineers and technicians, June 1991



Reader Service Number 61

coaxial cable, coax switches, cutting tools, stripping tools, coax connectors, coax adapters, coax detectors and coax terminations. Also featured are patch cords, programmable attenuators, push-button attenuators, coax cable assemblies, waveguide adapters, twin axial adapters and connectors.

In addition, the catalog contains many new high power high frequency attenuators that use SMA, BNC and Type N connectors. Pricing on more than 2,500 items and technical information is included.

Reader service #132

Satellite mount

DH Satellite introduced its Gibralter Series III dual axis motorized mount that is a dual-powered azimuth/elevation with 36 V pulse sensors. It is available with the company's 3.3-, 3.6-, 4.2-, 4.5- and 5-meter spun aluminum antennas.

The product has an oil-impregnated bearing surface and increased bearing hub size of 36 inches. The 16-inch base also has been reinforced. An azimuth lockdown and an elevation lockdown for severe weather conditions is provided and there are several PC-compatible drive systems available for use with the series.

Reader service #128

Voltage tester

The Mini Volt Stik VT166 from Etcon Corp. was designed for checking voltages from 50 to 600 VAC. It indicates voltages without actual contact with the source, providing both audible and visual indications. The product features a positive battery check, a shirt pocket clip, a transparent housing allowing four-sided visual inspection, and comes complete with two A76 batteries.

The contact clip is held down as the voltage source is approached with the probe. The presence of any voltage is indicated by an audible beep and an LED light.

Reader service #118

Remote monitoring

CaLan introduced its Comet remote monitoring system product line that is usable with any broadband network and is said to enable CATV and LAN operators to locate and correct problems anywhere in the system from a remote location. Consisting of a variety of instrument-grade hardware and software, the line of products gathers information on the performance of the broadband network and automatically compares it with pre-established operating parameters to determine if the network is functioning properly.

Components include the workstation hardware and software, Comet Control Unit (CCU) data communications hardware, and the Auto Star remote monitoring modules. A communications loop exists between a PC workstation and the CCU hardware — both located at the headend — and the Auto Star modules remotely located throughout the network. Carrier level data gathered by the Auto Star is fed back through the CCU to the computer and information received is saved in memory and evaluated by the computer. Out-of-limit conditions trigger audio and visual alarms so corrective action can be taken. Further features include: frequency measurement range from 40-550 MHz, color spectrum analyzer display, storage and recall of network history, and simultaneous RF and phone line communications.

Reader service #119

→

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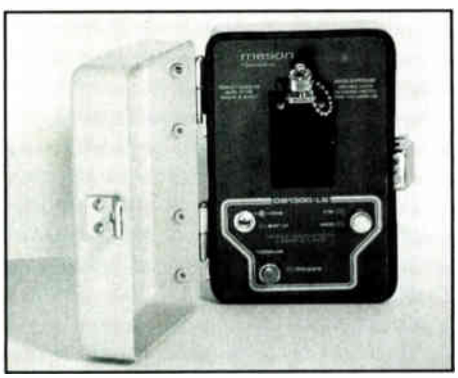
Reader Service Number 63

Ad insertion guide

The "new and improved" *Installation and Operation Guide* for Channelmatic's Adcart channel control unit (CCU) has 284 pages and 135 illustrations and is designed for ad insertion novices and seasoned pros alike. It explains the ad insertion process and provides and overview of the Adcart's capabilities. It leads the user through a step-by-step process of site preparation, installation and system configuration, daily operation of the system, maintenance and troubleshooting.

According to the company, the guide is well-organized and easy to use. It has a detailed table of contents and index and descriptive section headings, which provide fast and easy access to needed information. Contained in a single three-ring binder, with plenty of blank pages for operators' notes, the guide also is designed to accept information updates from the company as new system features are developed.

Reader service #110



Laser source

Meson Design & Development released its Model DB1300/LS laser source. It was designed for both short- and long-haul multimode and single-mode fiber runs. It can be used at continuous wave or modulated at frequencies of 30 Hz, 270 Hz or 2 kHz.

The product is powered from internal rechargeable NiCad batteries and comes with an AC adapter/battery charger. It injects a minimum of -10 dBm (typically -7 dBm) into single-mode fiber and is said to have excellent overall stability.

Reader service #115

Remote control

Jerrold announced beginning full-scale production of its Starcom remote control unit (Model TVRC) that features the ability to turn on and off and control the volume on most major brands of TV sets. It controls the company's Impulse 7000 and Starcom VI addressable converters and Starcom 7 plain converters. Additionally, it works with Starcom 450 model plain/pay/addressable models and, optionally, Digital Cable Radio tuners.

The unit handles all the functions of a standard Jerrold remote, including volume and mute control capabilities, direct channel access, favorite channel programming, last-channel recall, time-controlled programming, and parental access. Additionally, the product also is used to order PPV programming in a store-and-forward impulse system.

Reader service #120

RF switches

PECA unveiled two new 75-ohm SPDT coaxial switches. The DS-2E is an enhanced version of the company's DS-2 diode switch operating from 10 to 600 MHz, with less than 1 dB of insertion loss. The RS-2 is a relay version operating from DC to 600 MHz, with less than 0.5 dB of insertion loss.

Both switches have F-type connectors, isolation of greater than 75 dB and return loss loss better than 20 dB. The open port is self-terminating. The switches also can be controlled via TTL logic levels. The relay version is magnetically latched and thus consumes no quiescent state operating power.

Reader service #113

Time code converters

Two new products designed to improve any master clock system were introduced by ESE.

The ES-2695 is a SMPTE-to-ESE time code converter. It allows clock systems using SMPTE time code to drive as many as 100 of the more economical ESE clock slave family with a pair of wires, according to the company. The ES-2743A is an ESE-to-SMPTE time code converter (just the reverse of the ES-2695). This converter will allow the users of ESE clock systems to have a source of SMPTE time code

Reader service #112 (ES-2695), #111 (ES-2743A)

Off-premises technology in the U.K. context

The subject of off-premises technology has received a good deal of attention in the recent past. Within this magazine, a number of articles have been published describing, promoting and analyzing the benefits of various off-premises interdiction systems and advocating their use in "green field" or upgrade markets.

Quite naturally, these articles examined the situation from a U.S. viewpoint. This article aims to examine off-premises technology from the U.K. perspective because there are several considerations that must be taken into account in that marketplace. With such a considerable U.S. involvement in the U.K. CATV scene, these considerations also may be of interest to a U.S. audience.

By Dan Smart
Technical Advisor, Cabletime Ltd.

It is interesting to note that a form of off-premises technology was first proposed and patented in the United Kingdom in 1975. The technology has become known as switched-star. This term could be misleading in that it is used to describe not only the technology (i.e., the switch) but also the architecture (i.e., the star-configured network). Historically, however, the term switched-star is quite accurate since some early implementations of the technology did involve a switch, either in a semiconductor crosspoint matrix or earlier still in an electro-mechanical commutator.

The only remaining and most successful switched-star system is that implemented as an intelligent off-premises converter by Cabletime Ltd. This system has achieved a 40 percent market share in the United Kingdom. The reasons for this success have been described in detail elsewhere but summarized here as follows:

- Security of service without scrambling.
- Future-proofing of system (which means there is no need to re-engineer the secondary network when more channels are required).
- Interactive capability from the outset.
- Excellent VCR support.
- Efficiency of spectrum utilization on drops. (This allows additional revenue-producing services to be provided without expanding the drop bandwidth.)
- Minimum in-home equipment cost.

Some of these advantages are claimed now as benefits of other off-premises systems and this claim will be examined in the U.K. context.

U.K. special considerations

The special conditions that apply within the United Kingdom relate to the licensing arrangements governing the franchises and to the specification of the TV receivers and VCRs available to the general public.

First, the licensing authorities require that all new-build should be underground right up to the subscriber. Second, it is a requirement that the ducting should be laid out in a star configuration in order to facilitate future upgrade to a "switched" system even if, initially, a non-switched system is installed. In practice, this means that tree-and-branch systems are constructed as star-configured networks, with multitaps located at nodal points and thus bear no comparison to well-established U.S. practice.

A conventional tree-and-branch network construction is possible theoretically but would involve putting subscriber taps in underground chambers along the star-configured drop ducts. A more accurate classification of networks in the United Kingdom is therefore: 1) off-premises or switched networks, and 2) on-premises or non-switched networks.

The system operator is further encouraged to install or upgrade to a switched network by the granting of a longer license term — 23 as opposed to 15 years. Recent U.K. legislation has further enhanced this benefit in terms of the renewal of license conditions, whereby switched networks can obtain renewal of their Cable Authority license without payment o•f a levy to the U.K. Exchequer.

As far as the U.K. situation regarding TV receivers and VCRs is concerned, this can best be stated as follows:

1) There are no cable-ready TV sets or VCRs. The size and saturation of the U.K. market, together with the tendency of the public only to replace the equipment at greater than 10-year intervals, means that even if the incentive to produce cable-ready hardware existed, achieving a substantial penetration would take considerable time. A pan-European solution is virtually impossible due to the multiplicity of European broadcast formats. In any event, off-premises (switched) networks would benefit at least as well as on-premises systems from a significant penetration of such TV sets in to the U.K. market.

2) TV receivers and VCRs have UHF-only input capability, insufficient IF selectivity to accept adjacent channels and poor front-end linearity to avoid overloading with a large number of input signals. The older receivers often only have a limited number of channel selection buttons. A set-top converter, therefore, is always required. In the case of non-switched systems this device needs to have a front-end tuner to supplement the receiver front-end. In switched systems, a simple output block converter is sufficient since program selection is carried out in the street cabinet.

In order to overcome these shortcomings, a cable-ready receiver, suitable for operation in on-premises (non-switched) systems, would need to improve its performance specification in the following areas:

- Tuner linearity (in order to handle 60+ input signals at up to 10 dBmV).
- IF selectivity (in order to handle adjacent channel operation).
- EMC (in order to avoid direct pick-up of very powerful Band IV and V transmissions).
- Frequency range (in order to cope with continuous VHF and UHF coverage).
- Baseband interfaces (in order to provide input/output connections to a descrambling set-top unit).

In view of the restricted size of the market, these features are very likely to attract a substantial cost premium. On the other hand, in off-premises (switched) systems, none of the previous requirements are essential. A

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Reader Service Number 66

Progress report on outage reduction task force

Last October, Cable Television Laboratories set up a task force to study the problem of system outages. Headed by Bradley Johnston of Warner Cable Communications, the outage reduction task force established the following objectives:

- Defining the effect of outages on cable customers,
- Finding out what the outage performance of cable systems has been and developing better ways of tracking outages, and
- Finding out what causes outages and recommending ways to reduce them.

The two driving premises behind the task force's formation were:

1) Outages are a significant cause of customer dissatisfaction that lead to service downgrades and disconnects, and

2) Outages can be reduced to a level that is acceptable to customers.

The task force established working groups comprised of knowledgeable representatives from CableLabs-member MSOs, along with representatives of some manufacturers. These working groups are organized around the following aspects of the problem:

- Outage definition, detection and tracking
- System reliability modeling
- Protecting the headend and outside plant
- Plant powering

Each working group set about defining its objectives and then got down to work. At a July CableLabs conference in Breckenridge, Colo., these four working groups reported back on their activities to date. The bulk of this article summarizes their reports. First, though, let's consider an indication of the scope of the problem. Three major MSOs — Warner, Viacom and Jones Intercable — have recently conducted studies that shed light on the real extent and nature of the outage problem.

Warner research

A study by Warner Cable, released in February, related customers' satisfaction with their cable system against outages they had experienced. Those customers rated their system as "excellent" or "good" if they had experienced 0.6 or fewer outages per month. The breakdown of causes of outages at Warner during the first half of 1990 was:

- 25 percent or more: Equipment failure
- 15 percent: Cable problems
- 15 percent: Connector problems
- 15 percent: Loss of AC power or other power problems
- 13 percent: Nuisance fuse blowing

Warner came to the conclusion that outages could be reduced by 50 percent or more with minor changes in plant and equipment within a 12-month time frame. After that, even further improvements could be made by focusing on isolating trunk powering from commercial power and on improving equipment reliability.

Viacom research

Researchers at Viacom found that customers' appraisal of the quality of cable service, and their desire to downgrade, disconnect or switch to alternative services all correlated to their appraisal of the service they received. The most important component of customers' appraisal of service quality, it turned out, was outage performance, followed by such factors as customers' experience with repairs, with phoning the cable company and with the overall exhibited level of employee concern.

Reliability, defined as "the ability to provide what was promised, dependably and accurately," was the most important criterion of service quality, customers said.

Jones Intercable research

Outages not only fuel customer dissatisfaction, but they also are the cause of many costly side effects, researchers at Jones Intercable noted in a report made available to the task force last spring.

Even after service is restored following an outage, many problems continue to surface, requiring follow-up service calls. The frequent need to take apart housings and connectors in order to restore outages often breeds new problems. Repair personnel are at physical risk fixing outages because many of them occur during inclement weather.

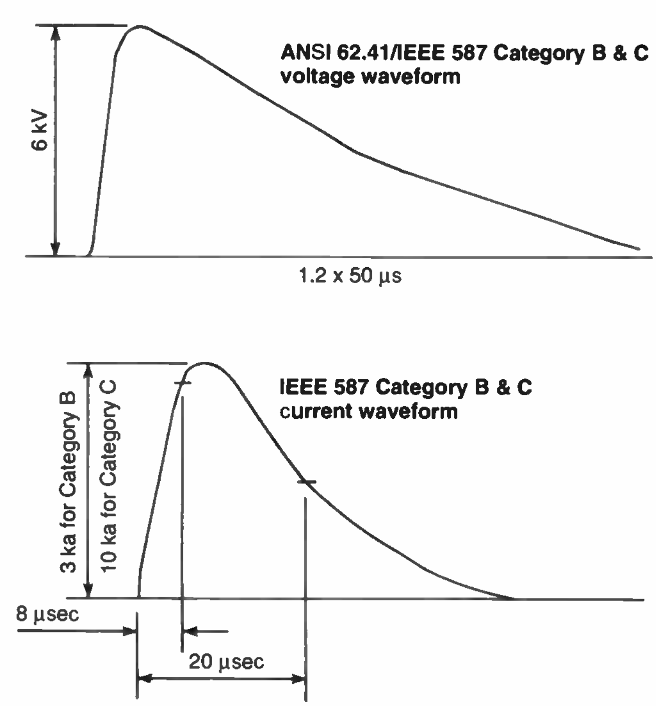
Working group findings

Participants at the July Breckenridge conference on "Expanding Cable's Future: Technical Strategy and Planning" heard from the outage task force's working groups about progress they had made in tackling the outage problem.

Outage definition and tracking

What is an outage? As a starting point for a rigorous attack on the prob-

ANSI/IEEE standard (C62.41-1980)



lem, a definition is critical. The working group on outage definition and tracking, chaired by Mike Miller of Viacom, derived this definition: "Loss of signal on one or more channels to two or more customers arising from a common cause."

The working group developed these criteria for any program for tracking outages. It should be accurate, reliable, not labor-intensive, use resources already in place, facilitate diagnostics, and provide comparative statistics across cable system lines.

The working group reported on telephone surveys that were taken at several MSOs, then aggregated to derive preliminary industrywide conclusions. This data confirmed that customers perceive an outage problem if they experience more than two outages in any three-month period. These customers' experience with outages correlated directly to their perception of service quality and of the value of cable service and with their interest in downgrading their level of service.

The important final stage in outage definition and tracking, this group reported, is to link the "external" standard of outage performance (that of customers) directly to an internal standard and tracking system, and finally, to establish internal performance goals that, if achieved, would lead directly to an improved customer appraisal of outage performance. Also, the group will work with billing and ARU vendors to develop the required detection and tracking system.

The group will pursue further research on other aspects of outages, in particular, the topic of single-channel outages: how customers react to them and what can be done to prevent them. Miller is conducting further research at Viacom on this issue.

System reliability modeling

A cable system outage model working group, chaired by Rob Moel of Paragon Cable, has been working to develop a system reliability model that can be used to assess how performance of various cable system components impacts outages and performance vis-a-vis customer expectations. Such a model, the group noted, can be used in system design just as carrier-to-noise and distortion models already are in use today.

Such a model was developed. Its output includes outage frequency and length of outages at different points in a cascade. The model answers questions about how many amplifiers in cascade yield acceptable reliability, about the role of powering strategies and standby power supplies, and about the extent to which deploying fiber optics will improve reliability.

The group's model was tested in five cable systems, Moel reported. The result: the model did, indeed, identify system differences that lead to differences in reliability performance.

Some conclusions from the development of the model are listed in the accompanying table. Summarizing these findings, task force Chairman Johnston stressed the importance of avoiding cascades of more than 25 amplifiers, and of avoiding power supply cascades (defined as the number of power supplies between the customer and the headend) of more than seven. He also stressed the importance of using reliable trunk amplifiers that require minimal use of fuses. "Get rid of most of the fuses, use them very minimally, and almost any fuse used should be slow-blow, not fast-blow."

Some conclusions from reliability modeling efforts

- Trunk amp cascades should range between 25 and 12 amplifiers. All things being equal, a cascade of 25 or more amplifiers will exceed 0.6 outages per month. On the other hand, reducing cascades to fewer than 12 amplifiers in cascade begins to show reduced effectiveness. Cascades over 30 amplifiers will be problematic. Trunk failure rates should not exceed 7 percent and line extender failure rates should not exceed 10 percent.
- The number of power supplies in cascade should be limited to seven. In most instances this will translate to four trunks per power supply. Hardening the trunk in this manner should reduce outages by 25 percent. Mixing standbys with standard supplies reduced outages by 30 percent. However, commercial power reliability cannot exceed 30 percent.
- Improving amplifier reliability, when coupled with cascade reduction, had a multiplicative effect on reliability improvement.

Protecting outside plant and headends

The report by Roy Ehman of Jones Intercable, chair of the working group on protecting outside plant and headends, reviewed current practices for grounding and bonding as a way of isolating voltage surges, transients and sheath currents from the CATV plant. His conclusion was that grounding and bonding beyond that stipulated by NEC, NESC and local regulations (about four per mile) will have marginal impact on reducing the longitudinal sheath currents that are the principal cause of active failures.

Various surge suppression devices — such as MOVs, avalanche diodes, crowbar circuits, gas tubes, etc. — were analyzed, Ehman reported. Specific recommendations are being prepared as to the environment in which these devices should survive.

The second major effort of this working group focused on the usefulness of the ANSI/IEEE standard C62.41-1980 test (see accompanying figure) for certifying manufacturers surge protection performance. Many devices respond differently to this test, so the issue is to characterize the environment to which these devices may be subjected. This working group is reviewing initial withstand tests, short duration impulse tests and life cycle performance tests.

Other findings of this working group, relating to headend and tower protection practices, are still under development.

Plant powering

The working group on plant powering, jointly chaired by Mark Bowers of CableSoft Engineering Services and David Eng of CableLabs, had as its mission the exploration of powering techniques that can reduce exposure to outages caused by loss of commercial power.

The working group found that the key items in power reliability are cascades of power supplies and reliability of commercial power. Design approaches are now available, the group reported, that can provide a 50 to 75 percent reduction of power supply cascades. Hardened trunk is a recommended practice when cascade reductions are mandatory. The use of higher voltages and extended (lowered) load voltages, while they provide a further extension in reach and an increase in supply placement flexibility, were not recommended by the working

"We are very comfortable that cable systems can more than meet customer expectations about outages."

group since hard trunk powering seems to provide most improvements needed in cascade reduction, and is more easily implemented.

The group also recommended working with the local electric utility to get a better understanding of the local electrical power distribution grid. Such a relationship aids the placement of CATV supplies, and yields useful insights into planned maintenance and emergency restoration work during outages. Specifically, such collaboration enables the cable operator to find out what spots in his system can be affected by high commercial power failure rates, and to move power from those spots to more reliable spots or be ready with standby units.

This working group also stressed the importance of standby powering in keeping critical commercial powering in service. Proper maintenance and in some cases status monitoring were used to improve this aspect of plant powering. Performance of presently available standby powering is less than acceptable and a task force chaired by Dave Franklin of ATC is being formed to address this issue, Johnston said.

Johnston's overview

In summarizing the task force's findings to date, Johnston stressed the importance of crowbar circuits, minimal use of fuses, limiting cascading of amplifiers and power supplies, and working with commercial power providers. In addition, he said once these structural issues are addressed, systems should not have a trunk failure rate exceeding about 7 percent.

He also stressed the need for systems to have an accurate, repeatable failure detection and tracking system. Such a system must take data from customer calls reporting outages and track that data historically and feed it to tech ops so problem locations can be attacked. That detection and tracking system must operate reliably 24 hours a day. Given the problems of local power supply reliability, Johnston said, the task force is setting up another working group to pursue the industry's need for reliable standby power units, which alert the operator before their batteries go down.

Overall, Johnston observed, "We are very comfortable that cable systems can more than meet customer expectations about outages. We know what needs to be done, and no major capital investments are required. What's required are rather straightforward things like fusing, voltage protection, power supply cascades, overall equipment reliability, and a good outage detection and tracking system — things that can be made right.

"It's going to take the industry a year or two to get all of this in place. But it's very comforting to see that outages are the single biggest complaint we receive from the consumer, and we have a pretty clear path to get the problem fixed."

Project timetable

The outage task force intends to issue detailed findings and recommendations from each of its six working groups, in monograph form, within the next few months. **CT**

The following is a listing of videotapes currently available by mail order through the Society of Cable Television Engineers. The prices listed are for SCTE members only. Non-members must add 20 percent when ordering.

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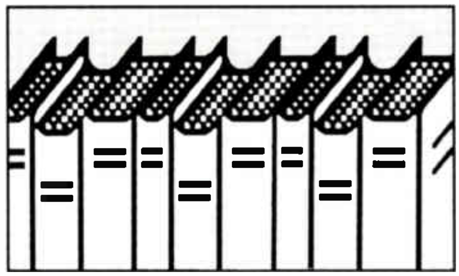

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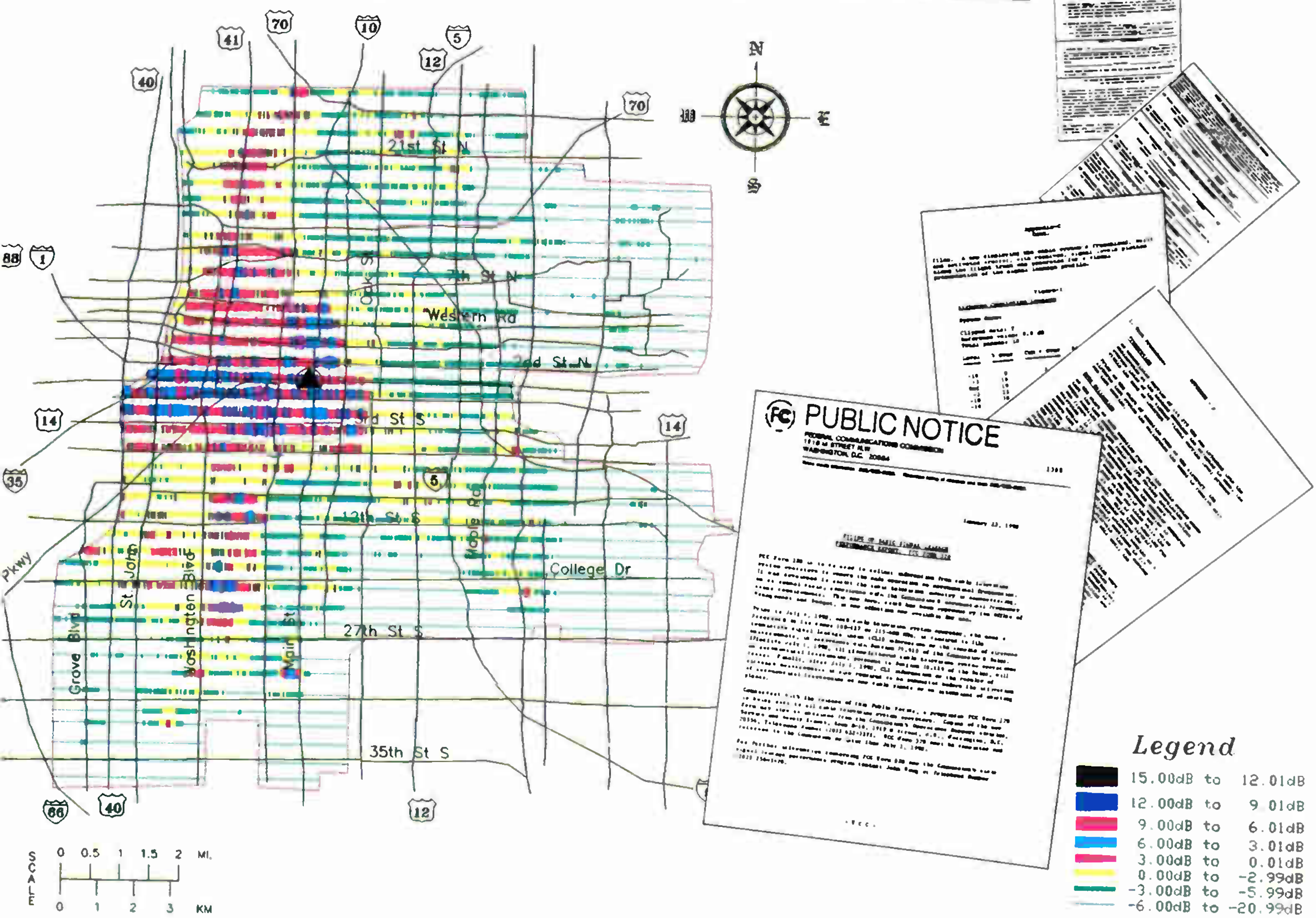

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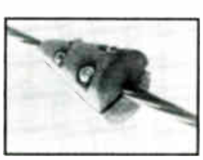

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November

7: SCTE Upper Valley Meeting Group seminar, winter plant maintenance, Holiday Inn, Whiteriver Junction, Vt. Contact Matthew Alldredge, (802) 885-9317.

9: SCTE Chaparral Chapter seminar, Albuquerque, N.M. Contact Joe Roney, (505) 761-6224.

9: SCTE Rocky Mountain Chapter, BCT/E exams to be administered in all categories at the technician and engineer levels. Contact Pam Nobles, (303) 792-3111.

9: SCTE Sierra Chapter, installer exams to be administered. Contact Eric Brownell, (916) 372-2221.

10-11: SCTE Old Dominion Chapter, Holiday Inn, Richmond, Va. Contact Margaret Davison-Harvey, (703) 248-3400.

12: SCTE Central Illinois Chapter, BCT/E exams to be administered in Categories II, V and VI at the technician and engineer levels. Contact John Heck, (309) 353-8777.

12: SCTE Chattahoochee Chapter, BCT/E exams to be administered in all categories at the technician and engineer levels. Contact Hugh McCarley, (404) 843-5517.

12: SCTE Desert Chapter seminar, BCT/E Category I, "Signal processing centers," and BCT/E testing in all categories to be administered at the technician level, Coco's, Palm Desert, Calif. Contact Chris Middleton, (619) 340-1312.

12: Fotec fiber seminar, Washington, D.C. Contact (800) 537-8254.

12-15: Siecor seminar, fiber installation, splicing, maintenance and restoration, Hickory, N.C. Contact Lynn Earle, (704) 327-5539.

13: SCTE Appalachian Mid-Atlantic Chapter seminar and BCT/E testing, Holiday Inn, Chambersburg, Pa. Contact Richard Ginter, (814) 672-5393.

13: SCTE Dixie Chapter seminar, Montgomery, Ala. Contact Richard Murphy, (205) 631-9681.

13: SCTE Golden Gate Chapter seminar, test equipment. Contact Mark Harrigan, (415) 785-6077.

13: SCTE Great Plains Chapter seminar, CLI and FCC rules and regulations, The Knolls, Lincoln, Neb. Contact Jennifer Hays, (402) 333-6484.

13: SCTE Hudson Valley Chapter seminar, satellite technology, the next generation of satellites and satellite proof-of-performance, Century House, Latham, N.Y. Contact Bob Price, (518) 355-3086.

13: SCTE Michiana Chapter seminar, Turners American, South Bend, Ind. Contact Russ Stickney, (219) 259-8015.

13: SCTE North Country Chapter seminar, BCT/E Category II, "Video and audio signals and systems," Sheraton Midway, St. Paul, Minn. Contact Rich Henkemeyer, (612) 522-5200.

13-14: NCTI OSHA compliance for CATV operators, Washington, D.C. Contact Michael Wais (303) 761-8554.

13-14: SCTE Big Sky Chapter, BCT/E and installer exams to be administered, Laurel, Mont. (13th), and Helena, Mont. (14th). Contact Marla DeShaw, (406) 632-4300.

14: SCTE Central California Chapter seminar, BCT/E Category V, "Data networking and architecture." Contact Deborah Abate, (408) 578-1790.

14: SCTE Greater Chicago Chapter seminar, audio/video. Contact Bill Whicher, (708) 438-4423.

14: SCTE Wheat State Chapter, BCT/E exams to be administered in Categories II, III, IV and VI at the technician and engineer levels. Contact Mark Wilson, (316) 262-4270.

14: SCTE Delmarva Meeting Group seminar, NTSC video and baseband video testing, optical TDRs and fault finders and BTSC stereo theory and test procedure, The Hub Steak and Lobster House, Dover, Del. Contact Linc Reed-Nickerson, (215) 825-6400.

14: Fotec fiber seminar, Atlanta. Contact (800) 537-8254.

14-15: SCTE Dakota Territory Chapter seminar, preparing for the Olympics, terminal devices and addressability, Pierre, S.D. (14th) and Bismarck, N.D. (15th). Contact Kent Binkerd, (605) 339-3339.

16: SCTE Golden Gate Chapter, installer and BCT/E exams to be administered in all categories at the technician and engineer levels. Contact Mark Harrigan, (415) 785-6077.

16: SCTE Oklahoma Chapter, BCT/E exams to be administered. Contact Arturo Amaton, (405) 353-2250.

16: SCTE Snake River

Planning ahead

Jan. 8-9: SCTE Fiber Optics Plus '92, San Diego. Contact (215) 363-6888.

Feb. 26-28: Texas Show, San Antonio. Contact (512) 474-2082.

May 3-6: National Show, Dallas. Contact (202) 775-3550.

June 14-17: Cable-Tec Expo, San Antonio, Texas. Contact (215) 363-6888.

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Industrial Technology

Chapter, installer and BCT/E exams to be administered in all categories at the technician and engineer levels. Contact Ron Kline, (208) 376-0230.
19: SCTE Gateway Chapter seminar. Contact Chris Cramer, (314) 949-9223.
19: SCTE New York City Chapter seminar, theft of service and fiber and powering of fiber-optics, Time Warner, Flushing, N.Y. Contact Rich Fevola, (516) 678-7200.
19: SCTE Penn/Ohio Chapter, installer exams to be administered. Contact Bernie Czarnecki, (814) 838-1466.
19-21: C-COR seminar, basic CATV theory, installation and maintenance, Columbia, S.C. Contact Kelly Jo Kerstetter, (800) 233-2267.
20: SCTE Ark-La-Tex Chapter, installer exams to be administered. Contact Robert Hagan II, (903) 758-9991.
20: SCTE Bluegrass Chapter seminar, BCT/E Category IV, "Distribution systems." Contact Liz Robinson, (606) 299-6288.
20: SCTE Cascade Range Chapter, installer exams to be administered. Contact Cynthia Stokes, (503) 230-2099.
20: SCTE Great Lakes Chapter seminar, subscriber relations. Contact Dennis Sartori, (800) 428-7596.
20: SCTE Iowa Heartland Chapter seminar, plant maintenance. Contact: Mitch Carlson, (309) 797-9473.
20: SCTE North Country Chapter, installer exams to be administered. Contact Rich Henkemeyer, (612) 522-5200.
20: SCTE Penn-Ohio Chapter seminar, regulatory environment for CATV, and CLI from the FCC's point of view, and BCT/E exams to be administered in all categories at the technician and engineer levels, Cranberry Motor Lodge, Warrendale, Pa. Contact Bernie Czarnecki, (814) 838-1466.
20: SCTE Piedmont Chapter, BCT/E exams to be administered in Categories I, III, VI and VII at the technician and engineer levels. Contact Rick Hollowell, (919) 757-0279.
20: SCTE Razorback Chapter, installer exams to be administered. Contact John Minginas, (501) 624-5781.
20-22: Western Show, Anaheim, Calif. Contact (415) 428-2225.
20-22: SCTE Desert Chapter technical sessions to be held in conjunction with the Western Show. Contact Chris Middleton, (619) 340-1312.
21: SCTE Appalachian Mid-Atlantic Chapter, installer and BCT/E exams to be administered in all categories at the technician and engineer levels. Contact Richard Ginter, (814) 672-5393.
21: SCTE Lake Michigan Chapter seminar on system design. Contact Grant Pearce, (616) 247-0575.
23: SCTE Golden Gate Chapter, BCT/E examinations to be administered in Categories I, II, III and IV, Pleasanton, Calif. Contact Mark Harrigan, (415) 785-6077.
27: SCTE North Country Chapter, BCT/E Categories II, III, V and VI and installer certification program (written and practical) examinations, Community Center, Edina, Minn. Contact Rich Henkemeyer, (612) 522-5200.
27: SCTE Sierra Chapter seminar on 1,550 nm fiber optics and fiber amplifiers, Community Center, Roseville, Calif. Contact Eric Brownell, (916) 372-2221.

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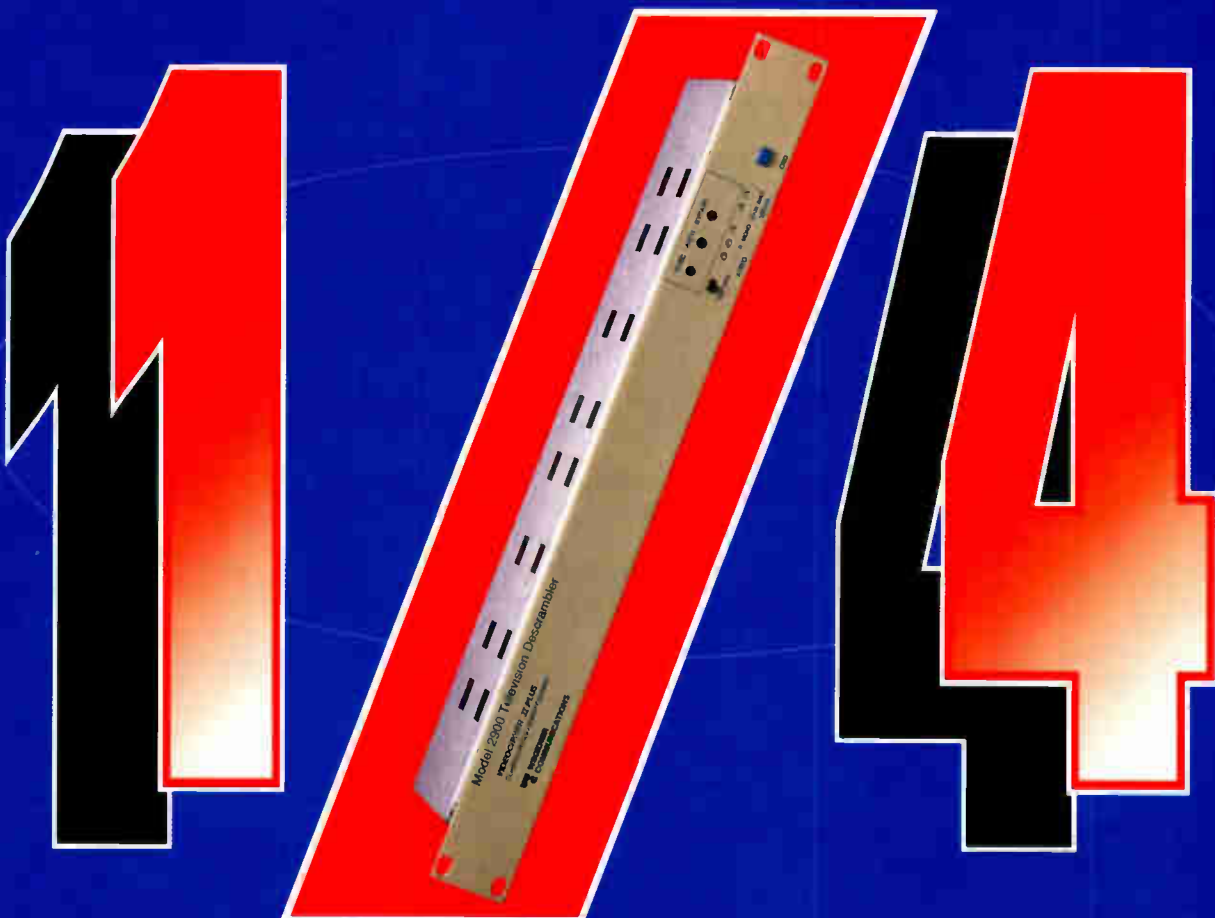

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SCTE speaker's bureau program

By Wendell Woody
President, Society of Cable Television Engineers

The Society of Cable Television Engineers is dedicated to developing, increasing and spreading theoretical and practical technical knowledge of cable TV and broadband communications systems to our members for the overall benefit of the industry. One of the most important ways the Society realizes its goals is when accomplished members and guests give technical presentations at national, regional and local seminars, including those held by our local chapters and meeting groups.

The SCTE speaker's bureau program is a means to bring identified capable speakers together with those charged with organizing and putting together technical training programs. It also provides product application exposure for our SCTE sustaining membership supporters.

Modify and expand

We are updating the present published listing of speakers and will modify the format of the revised edition. A section will be devoted to listing those speakers (tutors) available to address the individual BCT/E categories. There is a great demand for BCT/E training and review speakers now with the rapid growth of the Society's certification program. In addition, we desire to vastly expand the numbers of speakers cataloged in our revised edition, as well as increasing the variety of topics.

BCT/E categories

To ensure that those individuals conducting BCT/E tutorials are qualified in the subject matter and follow the outline for each category without compromising the testing program, SCTE has established a BCT/E tutor authorization procedure. Anyone interested in becoming a speaker (tutor) must meet the following criteria:

1) Complete and submit the BCT/E tutor application form.

2) Be a current dues-paying member of SCTE and have been a national member for the past three years.

3) Have successfully completed each of the categories applied for at the engineer level.

4) Be approved by the BCT/E program administration committee.

Fact sheet

How do you get listed and participate in the SCTE speaker's bureau? Merely obtain a speaker's bureau fact sheet and listing questionnaire form. They are available from the SCTE, 669 Exton Commons, Exton, Pa. 19341, (215) 363-6888 or FAX (215) 363-5898. Complete your form and return it to the Exton office.

Travel/locations

The Society now boasts 68 chapters and meeting groups. You can make yourself an available speaker to all of them by serving all 12 SCTE regions. On the other hand, you can limit your travels to a single region or a group of regions. A map showing the SCTE regions by numbered locations is part of the fact sheet.

Attention vendors

Most of the presentations needed are theoretical, practical technical knowledge, and product applications. Some instruction also may be product-specific. In either case, this program provides you with the opportunity to serve the Society and your industry, as well as your company. Your application engineers make excellent SCTE instructors. We need them cataloged in our published listing.

Attention members

Many of you give presentations at your local chapter but how about speaking at a neighboring chapter or new meeting group seeking speakers? Could you travel to all the chapters within your SCTE region? How about expanding and including adjacent regions? Perhaps you could speak in all SCTE regions in which your company operates systems. If you can at least handle a full region, *we need you* cataloged in our published listing! Remember, members who speak at Society-sponsored functions gain recertification units toward their continued certification under the BCT/E program.

Support the bureau

The speaker's listing encompasses people from all levels and trades who are part of our industry: cable operators, installers, technicians, design engineers, regional engineers, application engineers, sales engineers, Federal Communications Commission engineers, training institute personnel, trade publishers and writers ... plus we need you! If you are not part of this program or are not using it, now is the time to start.

SCTE bylaws revised

All SCTE national members were mailed a copy of the revised bylaws along with a ballot to vote your approval (or disapproval) of its adoption. Your immediate attention is required if you have not voted yet! The ballot must be received by Nov. 15, 1991.

The ballot also included a 1991 member survey form along with a membership information sheet. The data from this sheet will be used in the *1992 SCTE Member Directory and Yearbook* to properly list you, your address, telephone number and FAX number if available. Your timely response is appreciated.

Meeting the members

A very large group of the Badger State SCTE Chapter officers and board members participated in the technical sessions at the Wisconsin Cable TV Association conference. They were: Todd Parr, Gary Dixon, Bruce Wasleska, Al Actkinson, Jeff Berg, Matt Fargar, Jamie Lee, Bruce Morrissey, Pat Rafferty, Brian Revak and Bob Schaeffer.

The technical sessions for the Great Lakes Cable Expo in Detroit were SCTE-sponsored again this year. An excellent program was developed by Vic Gates, SCTE regional director. We also appreciate the assistance of his secretary, Terri Douglas from Metrovision. The local Great Lakes SCTE Chapter was most supportive and we acknowledge officers Daniel Leith, Rob Austin and Barry Houslander. **CT**

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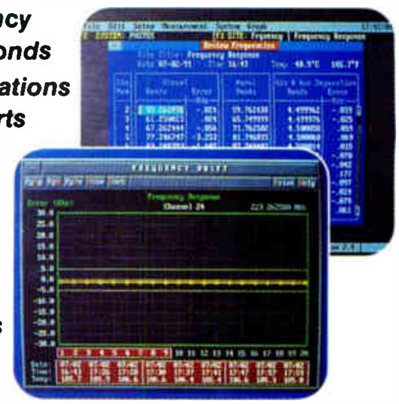

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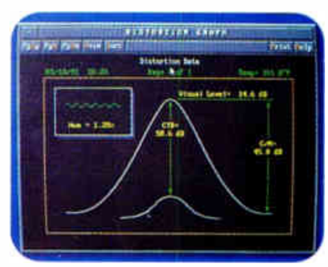

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