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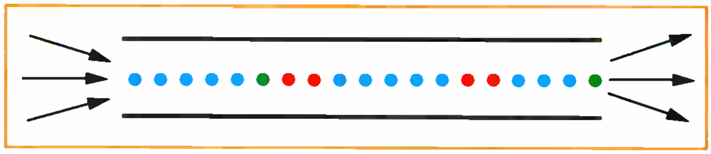

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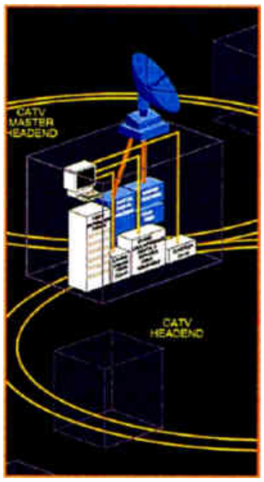

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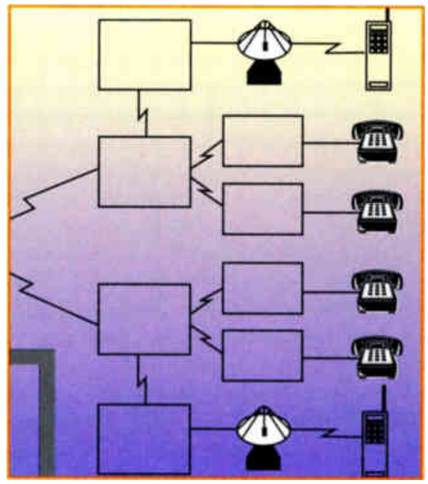

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EDITOR'S LETTER

Happy anniversary — me

On Oct. 2, 1972, TelePrompTer's Bill Rashka hired me to be camera operator in a north Idaho cable system's local origination studio. Thus began my career in this crazy industry, but believe me, it doesn't feel like it's been two decades. I was later climbing poles in that same system, and recall vividly the 12-channel single-ended plant serving the CATV customers in Lewiston, Idaho. The amps were Vikoa's Futura 12 series (remember those gold-colored housings?) and the taps were Craftsman Model 1900. My service van was called Unit 6.

A lot has happened in 20 years. A great family — of course it's sometimes hard to fathom that my oldest son is 16 and driving; a few more pounds around the middle; a hairline that's receded some; more gray hairs among those that remain; and like many in cable, I've been married more than once. There's even a modest "CATV" coffee cup collection in my office. But the best part of the past 20 years in cable is without question the friends I've made during that time.

Some have retired, a few have gone on to other industries, a couple have gone to that great headend in the sky, and most of the rest are in it for the long term. All of them have been an influence in one way or another. There's no way I could possibly list everyone here, but let me say to each of you — and you know who you are — thanks. As I reflect on my time in cable, it's easy to really appreciate the fact that our industry is like a big family. If I had it to do over again, I would.

There's no biz like cable biz

There truly is no other business quite like cable. Those who have made a career out of it realize that cable is addictive in its own sort of way. Once that bug bites, you're in it for good. Think about it: What other job provides an opportunity to work with all facets of communications? We deal extensively with signal transmission over coaxial cable, fiber optics, satellites and microwave. To a lesser degree, some of us work with twisted pair and over-the-air (MMDS, etc.). Consider, too, the variety of signals we deal with. Baseband video and

audio, TV, AM, FM and data. And ours is not a narrow field limited to one TV channel or radio frequency. Cable is truly a broadband communications medium. Where else can you work with 150 channels simultaneously? When compression arrives, that figure may be several hundred or more.

To those of you who have just started in cable, welcome to an industry that is full of challenges and changes. You'll find that the only constant is the constant change we enjoy. If someone had told me in 1972 that the system of the '90s would be operating at 1 GHz, I would have wondered what spaceship that person just stepped out of. After all, when I went to work in the Lewiston system, it hadn't been all that long since the plant had been upgraded from vacuum tube amplifiers to the solid-state Vikoa amps then in use. I think change is one of the great attractions that cable has to offer.

As I look forward to the next 20 years, it's fun to set some goals. Never one to be too serious, they include: a black satin MTV jacket; more coffee cups for my collection; and maple bars on donut day. Sorry, no fast sports cars. That'll have to wait until my kids are finished with college. (Besides, can you imagine the insurance with a 16-year-old son at home?) All kidding aside, though, perhaps the best goal would be to make the next 20 as good as the last 20.

Ronald J. Hranac
Senior Technical Editor


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LETTERS

Lightning strikes

I need to ask two questions about the engaging piece by Jack Riehle, on lightning in the April 1992 *Communications Technology*.

On page 41, it says that "As the thunderstorm matures, it reaches potentials of 108 volts, plus or minus an order of magnitude." Obviously something is undefined or misprinted. Please clear this up.

Second, the concept of a multipoint Dissipation Array. From several thousand feet, the entire array would intuitively appear to be a single point. I believe there are giant VanDeGraph generators available to judge the comparative efficiency of a single point dissipater vs. a multipoint dissipater. I buy everything in the article up to that relatively simple proof of performance.

In short, if the multipoint Dissipation Array does not have a significant advantage in terms of current flow over a single point, there is no advantage. The test is fairly simple, so where is the data?

Frederick M. Baumgartner
Engineering Manager, WTTV & WTTK-TV
Indianapolis, Ind.

Company response: Frederick Baumgartner has some interesting comments about the article, "What if you could prevent lightning damage?"

He mentions that page 41 states, "As the thunderstorm matures, it reaches charge potentials approaching 108 volts ... " This statement is in error. It should read, "As the thunderstorm matures, it reaches charge potentials approaching 10^8 (100 million) volts ... " (Editor's note: We apologize for this typographical error.)

Baumgartner then comments that a multipoint dissipater will produce no more current flow than a single point. Our lab simulator (or any other simulator), which produces a 100,000 volt electric field, shows that this is not correct. A single point, such as a Franklin air terminal, quickly goes into saturation and collects a strike. On the other hand, an array of points will not go into saturation but will generate an ion current that prevents strikes. The number of points and point spacing are two variables that are related to the amount of ion current. LEC can provide test data showing this.

Winn and his colleagues have measured electric fields from hot air balloons during storms and shown that they are inversely proportional to ion charge density. Mathematical models and the data collected by Winn are in close agreement. This infers that increasing the ion charge density above a protected area will decrease the electric field to such a level as to prevent strikes to that area. We can furnish technical papers on this subject to anyone who requests them.

Ralph L. Auer
Vice President — U.S. Marketing
Lightning Eliminators & Consultants Inc.

CATV suppliers report good year-end results

Both C-COR Electronics and Scientific-Atlanta reported improved financial results for the fiscal year ended June 26, 1992.

C-COR's revenues were up 59 percent for the year with a net income of $2.28 million on sales of $52.171 million. This compares to a net loss of $3.452 million for fiscal '91 on sales of $32.732 million. Earnings per share for fiscal '92 were 50¢.

S-A's sales for the year were $580.8 million, which is up 18 percent from the prior year. Net earnings of $16.3 million (70¢/share) compared to earnings of $1.1 million (5¢/share) in 1991.

In other economic news, Philips plans on adding 100 employees to its existing staff of 500 at the Manlius, N.Y., facility before year-end. The new positions in R&D, manufacturing engineering and the factory will accommodate production of new products and development of technology.

Cable feels hurricane's wrath

PEMBROKE PINES, Fla. — The devastating winds of Hurricane Andrew took their toll on the communications industry in southern Florida, and cable TV was no exception. Winds of 140 miles per hour ripped antennas and other electrical equipment from their foundations, hurling them hundreds of yards away. TV Ticket Cable of Miami reported, "Our antenna dishes are blown apart." Storer Cable of Miami said a few of its dishes dropped, but its tower stayed intact.

To complicate matters, companies like TV Ticket and Storer Cable could not mobilize trucks until Florida Power and Light completed the massive job of restoring all the downed power lines and transformers in Dade County. Florida Power and Light restricted travel because roads were not passable. Trees and other debris blocked roads, making it difficult for big trucks to maneuver. — *By Kathleen McKendrick*

Industry veteran Arthur Fink dies

Arthur Fink, a cable industry figure for at least 25 years, died in August. He was a labor lawyer for many years before getting involved in the communications industry. In the early '50s he was national sales manager for RMS Electronics. In 1972 he (along with Don Edelman) formed its CATV division. Fink, who was chairman and CEO, was instrumental in helping RMS go public on the American Stock Exchange. Through his contacts in the Far East, the firm was able to become a major supplier of concept components and associated hardware for the CATV industry.

Fink is survived by wife Edna, son Ken and daughter Barbara as well as grandchildren and great-grandchildren.

☛ Production Products Co. has a new distribution facility at 673 S. Cooley Dr., Suite 111, Colton, Calif. 92324. The telephone number is (714) 420-0110. In related news, PPC named Ronald Goodno western regional sales manager responsible for all sales/distribution operations for California, Arizona and Hawaii.

☛ Adelphia Cable in Ocean County, N.J., launched a relief effort for victims of Hurricane Andrew in south Florida. The effort has centered on the collection of food and clothing utilizing its three offices and technical service fleet of nearly 60 vehicles to collect items. With the cooperation of National Community Bank in Toms River, N.J., Adelphia also established a relief fund for monetary donations.

☛ TCI released a full economic report from economist Carl Ellis Hunt that confirms cable legislation now pending before Congress will raise cable rates, not lower them. Hunt estimates the bills could increase rates several dollars a month.

☛ BT&D Technologies is relocating its sales/marketing headquarters to 500 N. Walnut Road, Kennett Square, Pa. 19348, effective Sept. 21. The telephone is (215) 444-6888 and the fax is (215) 444-6868.

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Incentives awarded for SCTE certification

Three companies have been added to the list of the numerous firms in the cable TV industry that offer incentives for their employees who become certified in the Society of Cable Television Engineers' Broadband Communications Technician/Engineer (BCT/E) and/or Installer Certification Programs, which recognize the employees' demonstration of technical knowledge.

Cardinal Communications, an MSO based in Columbus, Ind., that serves over 80,000 customers through systems in Indiana and Kentucky, presents each of its employees who are certified in the BCT/E Program with a personalized SCTE jacket emblazoned with a set of BCT/E patches.

"Once one of our employees completes certification," says Al Orpurt, a regional technician with Cardinal's corporate engineering department and coordinator of this award program, "the chief technician of the system makes me aware and sends the certificate and ribbons. I order the jacket and patches from SCTE national headquarters, have the patches put on the jacket and give it to the general manager, who presents it to the employee."

These presentations are videotaped and incorporated into a video "magazine" that is sent to each of Cardinal's systems every month, according to Orpurt, who comments, "It's our way of congratulating them on a corporate and regional level. BCT/E certification is part of the education requirement for certain levels of technical placement in many of our systems. They must become certified within three years of their employment and maintain that certification.

"Our guys take a lot of pride in being in SCTE and we use it as an educational tool too," Orpurt states. "We were looking for an affordable award, and the jackets are very affordable to us, so we put a lot of value in this program. Our personnel appreciate the opportunity, and it's been a good way for us to give them an extra pat on the back."

Cochran Communications' Brad Egelhoff and Dale Paulus proudly wear the jackets they received in recognition of their certification in the SCTE's Installer Program.

Cochran Communications, a Cathedral City, Calif.-based firm specializing in construction, activation and installation for California and Arizona systems, also provides a personalized SCTE jacket to each employee who becomes certified at the

Engineer, Technician or Installer level. To date, it has awarded jackets to four of its employees.

"It helps keep the incentive going," says the company's office manager, Vicki Cochran, "and as long as they're learning, I'm comfortable with what they're doing to meet our customers' needs. They are putting in their own time, and they do it to improve themselves. We have a good bunch of guys. They're very devoted."

Of the company's 22 employees, four have been certified at the Installer level and four more are currently pursuing certification, three in the Installer Certification Program and one at the BCT/E Program's Technician level.

Gary Atwood, state engineer for TCI in Washington and an officer with the Society's Mount Rainier Chapter, announced he is offering a $100-per-category bonus to TCI employees in the state of Washington who pass BCT/E exams.

In further certification news, the Society is planning to produce a brochure about its BCT/E and Installer Certification Programs that would be aimed at managers. One area we would like to promote is how various systems and companies are utilizing incentives with these programs to encourage participation and successful completion of individual categories and/or the entire program.

If your system or company has any methods of job promotion, increased pay rates, achievement bonuses, rewards or other types of recognition it uses in conjunction with the BCT/E or Installer Certification Programs, please inform SCTE by contacting Director of Training Ralph Haimowitz. Call (704) 297-5423 or send him information at: Route 1, Box 290-D, Vilas, N.C. 28692.

Your information may help other SCTE members to obtain company incentives for their participation in these programs.

Update: Installer program

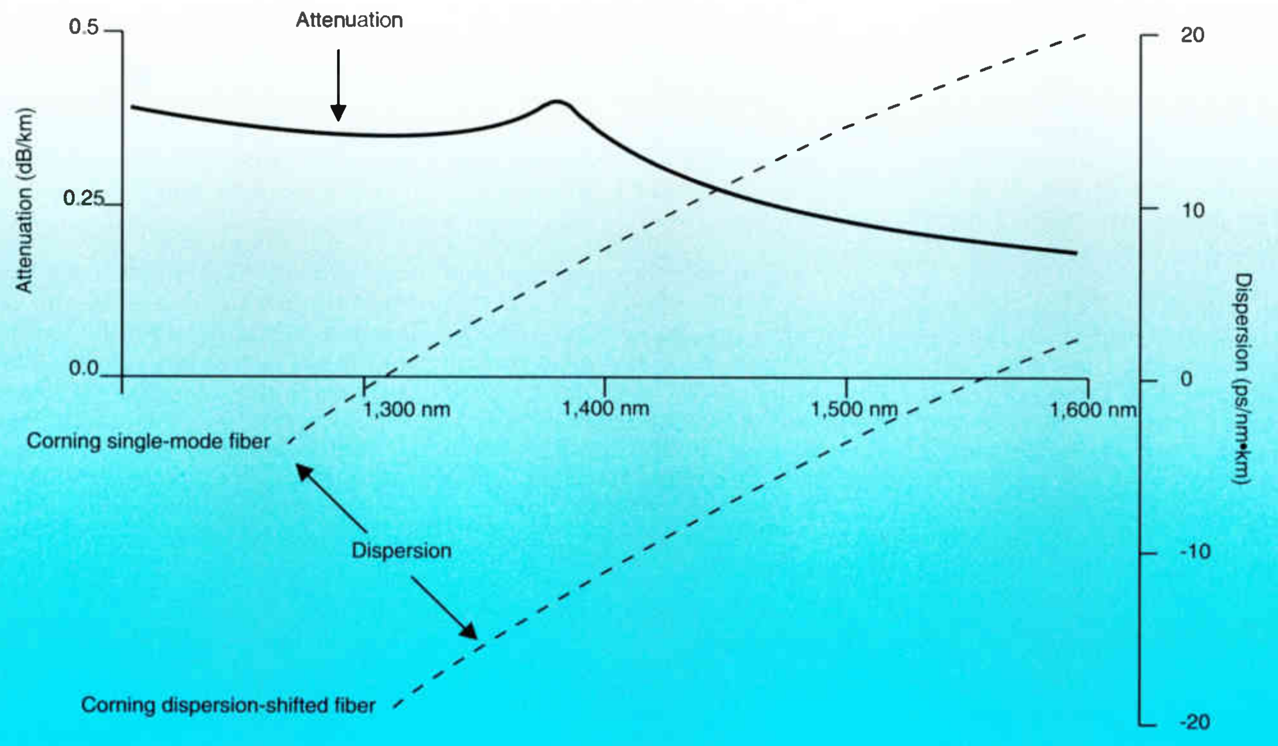
Between Jan. 1 and June 30 of this year, 293 Installer members have been certified in SCTE's Installer Certification Program through the Society's 73 chapters and meeting groups.

Since the certification program's introduction in 1989, the Society has offered a $5 rebate to chapters and meeting groups for each Installer member who becomes trained and fully certified in the program through their group. This rebate was offered as a means of reimbursing the groups for their training and testing efforts.

In further Installer Program news, the Society announced that Active members can now take the program's written examination without having to join as Installer members. Bypassing the $25 program registration, which also serves as the fee for Installer membership, Active members need only pay $10 to take the written exam if they so desire. (Retests also are $10.) Active members can become certified in the program upon the successful completion of the written and practical exams.

In addition, the Society currently is developing a policy for recertification in the Installer Certification Program. Watch future issues of the Society's monthly newsletter, *Interval*, for further announcements.

Figure 1: Fiber attenuation and dispersion



Dispersion-shifted fiber improves 1,550 nm systems economy, performance

By Douglas E. Wolfe
Senior Applications Engineer
Corning Inc.

As optical transmission in the 1,550 nm wavelength window gains momentum as a complement to 1,310 nm operation, fiber optimized for the longer wavelength region is proving to be the ideal medium for high data rate transmission over long distances.

So, it is logical that dispersion-shifted fiber (which offers designers new opportunities for improvements in system economy, performance and upgrade ability) has gained interest in the cable TV industry, especially for amplitude modulation (AM) video applications. This fiber type fully capitalizes on the potential link length improvements possible at 1,550 nm, eliminating the need for distortion compensation.

Backdrop

Transmission in the 1,550 nm wavelength operating region of fiber is attractive in that it offers the possibility of longer distances between the headend and nodes. Attenuation (the reduction in optical signal strength as a function of length) is at its lowest in this region of silica fiber. It is about 50 percent lower here than in the 1,310 nm window of single-mode fiber optimized at 1,310 nm. (See Figure 1.) So, by virtue of transmitting in the 1,550 nm region, the distance between amplifiers can be virtually doubled.

Several additional technological developments are boosting the appeal of fiber systems optimized at 1,550 nm. Distributed feedback (DFB) lasers now display operating characteristics comparable to those of 1,310 nm units. Optical amplifiers now are commercially available that could nearly eliminate concerns about attenuation and the system optical budget. They allow more receivers to be served by each laser and further increase link lengths, promising substantially lower cost per optical link. This technology boosts the power of the incoming 1,550 nm optical signal by as much as 13-15 dBm. (See Figure 2 on page 38.)

Dispersion impact on system performance

Precisely how far link lengths on standard fiber might be increased, however, depends on the application's sensitivity to another impediment to optical transmission: dispersion.

While the bandwidth of optical fiber for all practical purposes is restricted only by the lasers and receivers, transmission of an optical signal is distance-limited. Signal attenuation and

(Continued on page 38)

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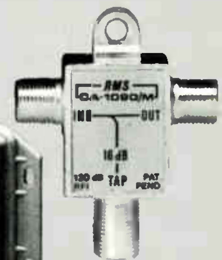

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Techniques for network compatible architectures

This article, which looks at some of the techniques we can use today to make use of network compatible architectures, is reprinted with permission from the "1992 NCTA Technical Papers."

By John Caezza
Products Specialist
Philips Broadband Networks, Inc.

The future for communication networks is bright. The emergence of fiber optics and the inevitability of HDTV, digital compression, personal communication networks (PCNs), near-video-on-demand (NVOD) and more will help ensure that bright future. As we look at our systems today, we have begun to ask ourselves if we are prepared for that future. Do we have a plan?

Figure 1: 550 MHz CAN

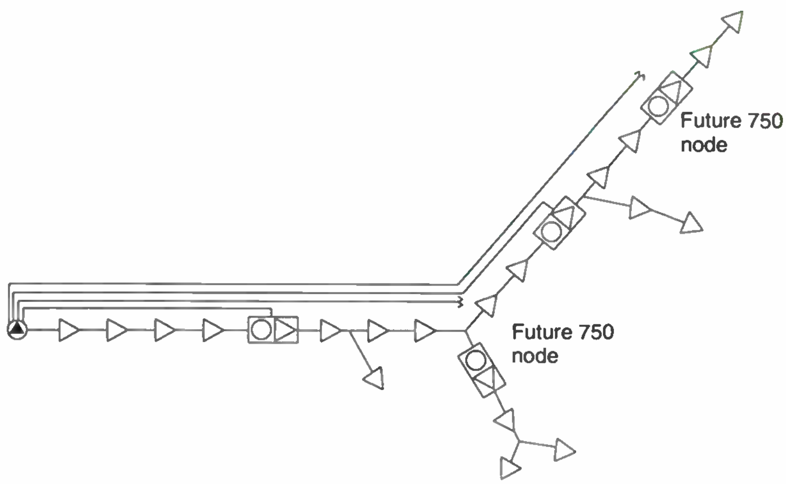
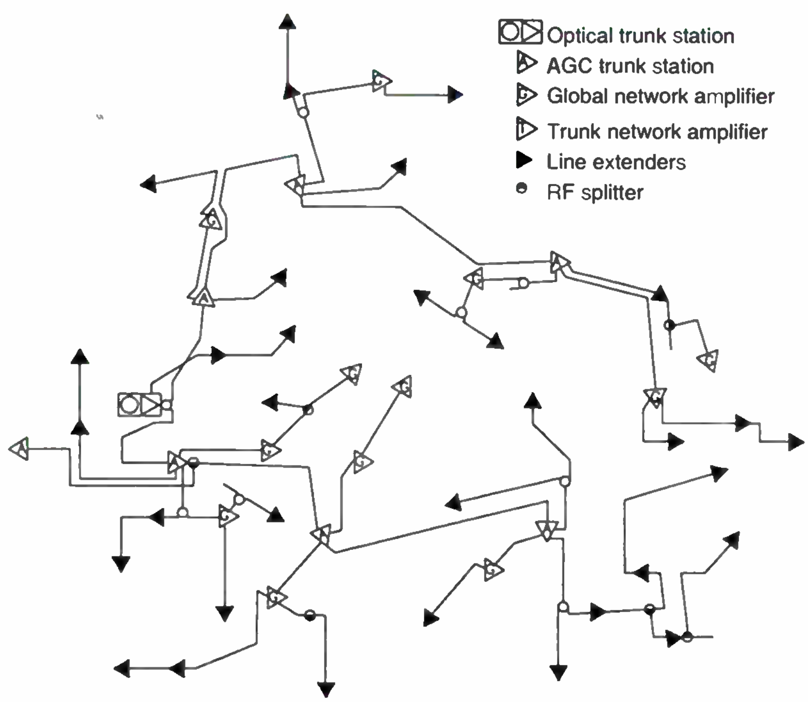


Figure 2



Where are we today?

As we begin to formulate our plan for the future, it's always a good idea to know where we are today. What are the system demographics? Total homes and homes per mile: Architec-tures will vary significantly depending on whether you have 40 homes per mile or 240 homes per mile. Ethnic diversity: If your market is segmented in such a manner that the primary language or language of preference is not English, then special segmented delivery may be of special concern. Occupational diversity: Not so much whether or not you are providing service to blue or white collar workers, but whether you service single family dwellings, private campuses (educational and industrial) or local institutions (business and governmental). Viewing diversity: the types of programs and the number of channels necessary to carry them.

Next, an inventory should be compiled on the equipment that is currently in the system and how it is configured. Most systems will consist of a variety of operational bandwidths and amplifier technologies. Understanding what is reusable in the upgrade and what components can be brokered is important because these can represent up to 10 percent of the rebuild costs. The existing architecture also should be reviewed (in most cases today it will be a tree-and-branch one) and as-built maps should be verified.

(Continued on page 42)

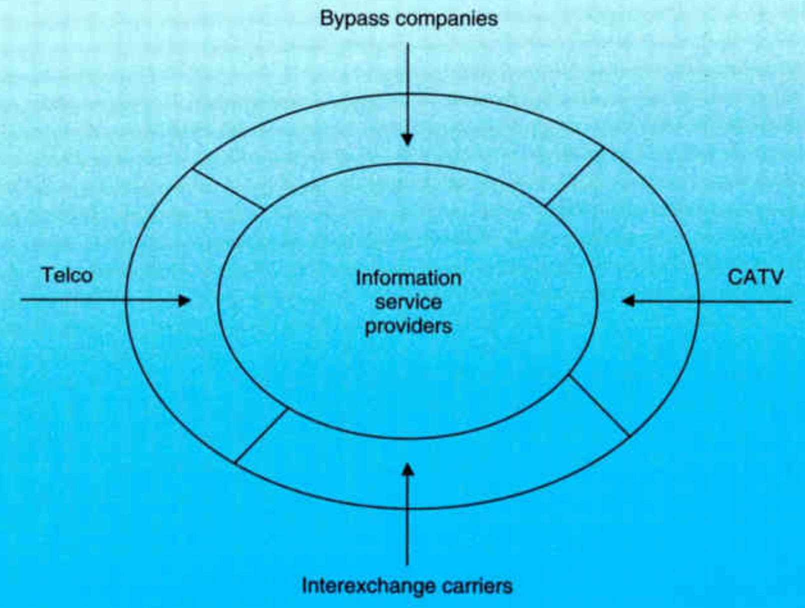
New cable system designs: Non-entertainment services

By John Holobinko
Vice President of Marketing and Strategic Planning
American Lightwave Systems

The goal of the CATV operator is continued revenue growth and profitability. The rate of growth in the number of premium entertainment video services per subscriber has currently subsided. At the same time, pay-per-view has had significant disappointments (e.g., the Olympics TripleCast) as well as successes. Re-regulation of the CATV industry appears highly probable, which bodes poorly for increasing monthly rates for traditional CATV video service. These are among the reasons that operators will be seeking alternative means of increasing revenues and decreasing operating costs in order to improve profitability.

Cable companies have always been highly leveraged compared to other communications service providers, and remain so today even after the sweeping financial changes of the last four years. The CATV new-build required hefty capital investment in plant and electronics before the first customer could be hooked up and income from subscribers flowed in. This means that any investment in plant or equipment has always required a high return on investment in order to be cost-justified.

Figure 1: Where is the market heading?



What re-reg will do

Re-regulation of the industry may paradoxically accelerate the evolution of the CATV system. In order to bolster revenues, increasing system basic penetration will represent an attractive opportunity without a high capital outlay.

However, this requires improving customer satisfaction and for this a more efficient cable system is necessary. Reducing service costs will improve cable system profitability and this also requires a highly reliable system. Lastly, re-regulation will force cable operators to seek non-entertainment business (such as data and voice bypass opportunities) much more aggressively. Current system topologies do not support many bypass applications easily. What is needed are CATV system designs that are cost-effective to implement today, yet provide a migration path to support the non-entertainment video, voice and data services of the future.

Revenue boosters

As an example, consider the following potential revenue opportunities:

- *Non-entertainment video*: local broadcast-quality video feeds to access carrier points of presence (POPS); two-way fully interactive regional distance learning systems; metropolitan area video conference systems; and local and regional government video services including judicial arraignment.
- *Data/voice*: T1 access/bypass links; Ethernet, WAN and FDDI systems; metropolitan area systems; image processing and library services; personal communication network (PCN) and microcell transport; basic telephony bypass; and future asynchronous transfer mode (ATM) systems.

Importantly, according to a number of research studies on the telephony system, the public network will carry as much data traffic as voice traffic by 1997. Clearly, data- and voice-related services will provide a major opportunity for incremental business to the CATV operator in the next five years.

In addition to the non-entertainment video and data/voice service potentials, consider the possibilities of video-on-demand services for movies, etc., which may be carried as highly compressed digital signals. The conclusion is that CATV providers are evolving into information service providers that will be competing with a wide variety of other information service providers as Figure 1 depicts.

The industry's direction

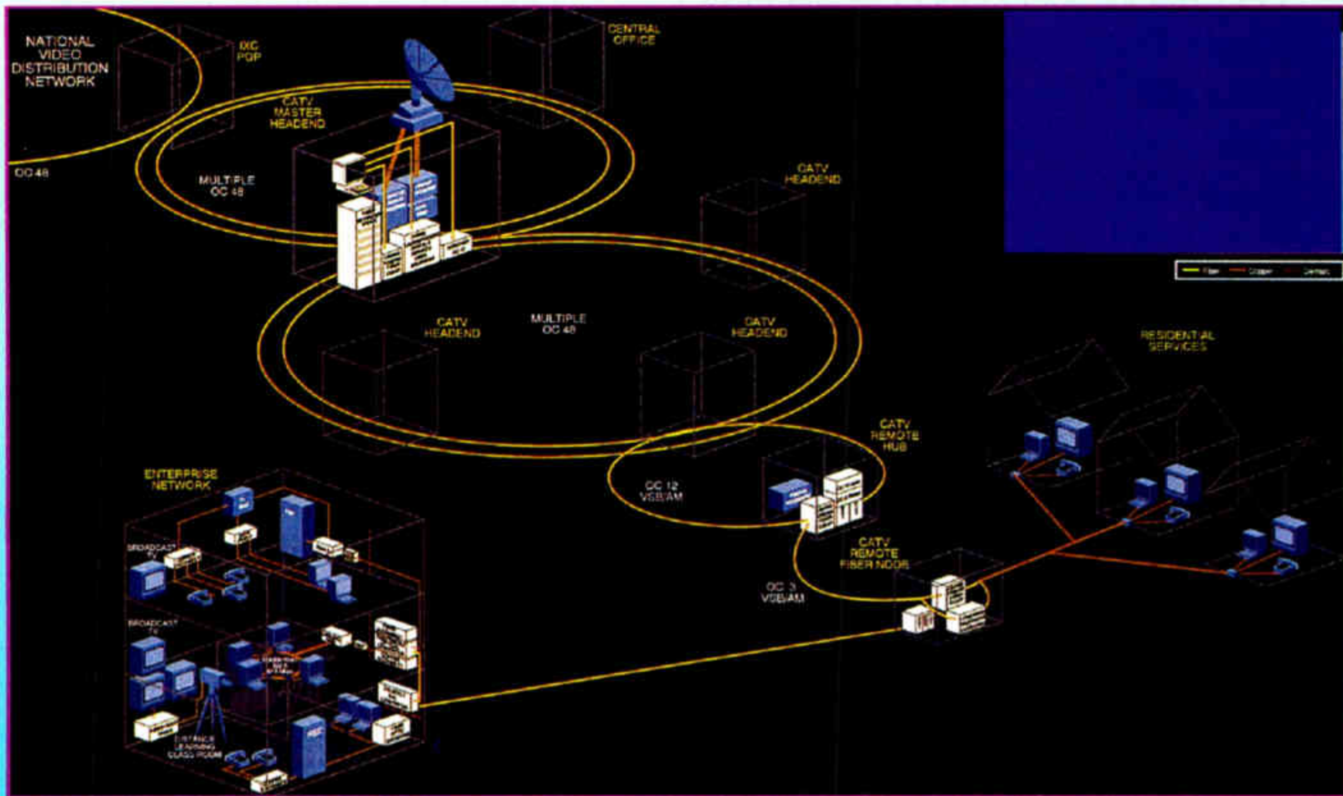
The challenge for the industry is to define system architectures that allow the addition of future services while at the same time providing improved picture quality and customer service at a no greater cost than rebuilding a traditional CATV system. The system of the future must be able to support the following:

1) A bidirectional communications medium that is highly reliable.

2) Multiple information types, formats and information transmission rates simultaneously on the same path.

3) Gateways to public networks and channel formatting necessary to meet

Figure 2: CATV's integrated system of the future



system compatibility standards such as SONET and ATM.

The new CATV system

Figure 2 depicts what such a system may look like. A backbone that interconnects multiple headends may consist of a number of high-speed digital fiber rings. Some of these fibers will carry uncompressed video channels that may be off-satellite, commercial insertion, local origination programming (such as a cable news channel), etc.

Other fibers will carry hundreds of compressed video channels that are for video-on-demand and other video-based services from central repositories conceivably located halfway across the United States. On these same fibers may be data and voice bypass channels that travel to and from customer sites and are linked to telephone operating company and alternate access carrier POPS. The need will exist for many of these channels to be compatible with public network standards such as SONET and transportation access methods such as ATM.

However, the cost and overhead of system compatibility must not be applied to channels that do not go outside the CATV regional system. Then the economic burden will preclude economic justification of such a system.

The CATV headend as we know it will change dramatically. In many cases it will no longer be necessary to vestigial sideband amplitude modulate (VSB/AM) baseband video and audio channels in the traditional sense, but rather translate the digital signal to a carrier in the high band of the system frequency spectrum. Simplification and automation of headends will improve system efficiency.

The use of VSB/AM fiber rings for downstream information from the headend will greatly improve system reliability. It will become economically possible sometime in the future to transmit signals over coaxial cable directly from fiber nodes to the subscriber with no other intermediate electronics.

At that time, the traditional CATV return path as we know it may disappear. Consider the current and future needs for the return path. Outside of a few institutional video channel applications, virtually all return path applications today are related to data-, telemetry- and voice-based services. The cost of format conversion to an analog carrier introduces an economic disadvantage on these channels. There may one day be only a digital return path from the customer and the fiber nodes to the headend.

What can we say with certainty about the CATV system of the future? It will be more efficient than today's systems based on the driving economic and capital requirements of the market. It will be flexible, so that it does not require a significant up-front economic burden in order to support future voice and data services. Lastly, it will provide compatibility to public networks in order to provide customer services that extend beyond the boundaries of the cable TV system.

In this future environment, traditional CATV equipment suppliers will probably focus themselves on compressed video and the signal processing of video-based services from the source to the subscriber. The need will exist for vendors that can provide complete application solutions to the video, voice and data transport requirements of CATV companies, both within the CATV system and public network.

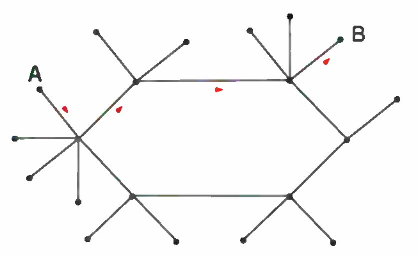
Perhaps in the final analysis, the only certainty is that CATV systems of the future are unlikely to look the same as the traditional systems of just one or two years ago. **CT**

Asynchronous transfer mode: Unifying video, voice and data

By George Lawton

An emerging new standard promises to unify video, voice and data communications at every scale from local to wide area networks — and eventually, international links. At every level of industry, from equipment vendors to the regional Bell operating companies (RBOCs), the push is on to make asynchronous transfer mode (ATM) the backbone of our future communications network. The attraction of ATM is that it will usher in a new age of interoperability between computers, communications and even consumer electronics.

Figure 1: Point-to-point



The benefits of ATM

ATM's two strengths are its ability to efficiently support the transport of diverse data types and its scalability. It can support different types of data, such as video, voice, images and computer files, because of its connection orientation and the way it breaks data into fixed-length 53 byte cells. Other multiplexing techniques are either not as bandwidth-efficient or cannot support real-time data, such as video.

ATM is connection-oriented (Figure 1) in that all cells travel the same route from one point to another during each communication. In a connectionless protocol, such as switched multimegabit data service (SMDS), cells are routed down any available path to their destination and do not necessarily follow the same route. At their destination, cells are reassembled in the same order in which they were sent. The variability in transmission rates sometimes causes distortion in real-time traffic.

Each ATM cell contains a 48 byte data payload and a 5 byte header that describes the cell and contains addressing information.

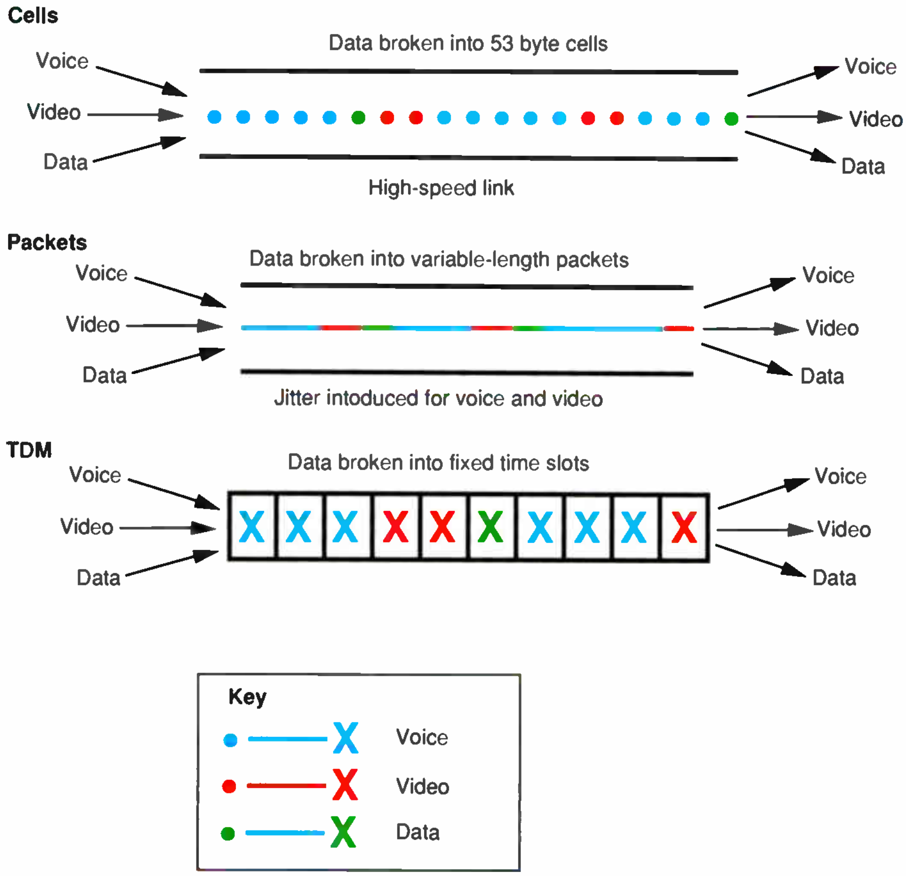
ATM's fixed length simplifies switching operations. Only the 5 byte header needs be stripped off and read for guiding the cells. This enables the switching mechanism to be moved completely into hardware. At each switching point, the cell is directed down one of two alternatives, much like a railroad car is directed down a track.

Although time division multiplexing (TDM) can support real-time data, it is not as efficient because it transmits space even when no data is being sent (such as a pause in a telephone conversation). Furthermore, it is not well-suited for variable-rate data transfers.

Packet switching techniques cannot multiplex isochronous data effectively because the variable-length nature of each packet makes it difficult to restore the original transmission in real time. Figure 2 shows cell relay vs. packet switching and TDM.

ATM's switching arrangement makes it optimal for both large and small networks, and at all speeds permitting scalability. It is scalable in that it can support communications at different speeds over the same network. For example, in a cable TV network, a single high-speed link carrying several "virtual channels"

Figure 2: Cell relay vs. packet switching and TDM



(Continued on page 50)

When you're lost, not even this will get you where you want to go.

The fact is, you need a map. Without one, you'll just be going in circles. At Jerrold, we know that even the most exciting technology isn't worth much if it leaves you feeling a little lost. That's why we created Starburst.

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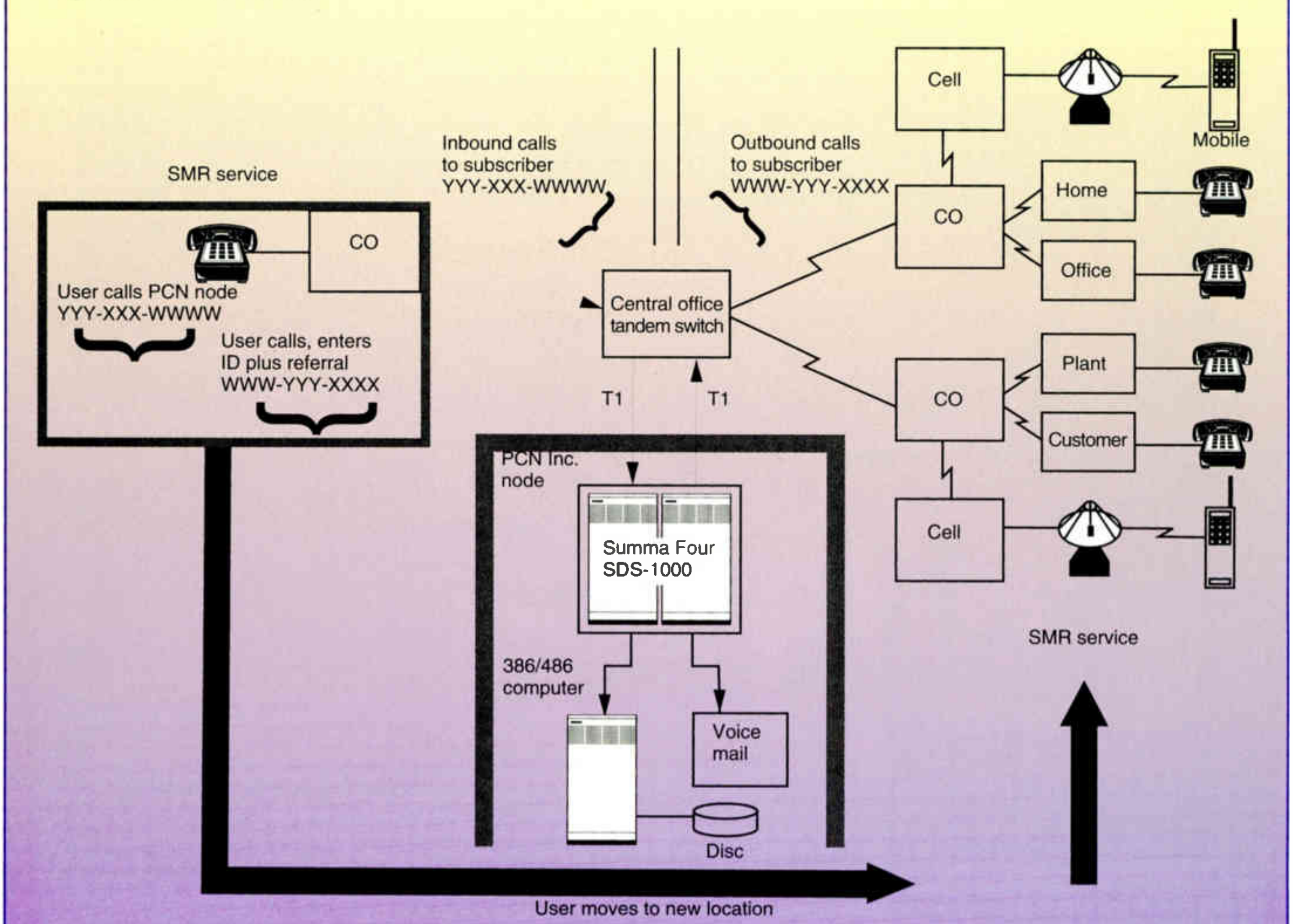
Reader Service Number 16

Figure 1: PCN service



Personal communications services — A service in search of a market

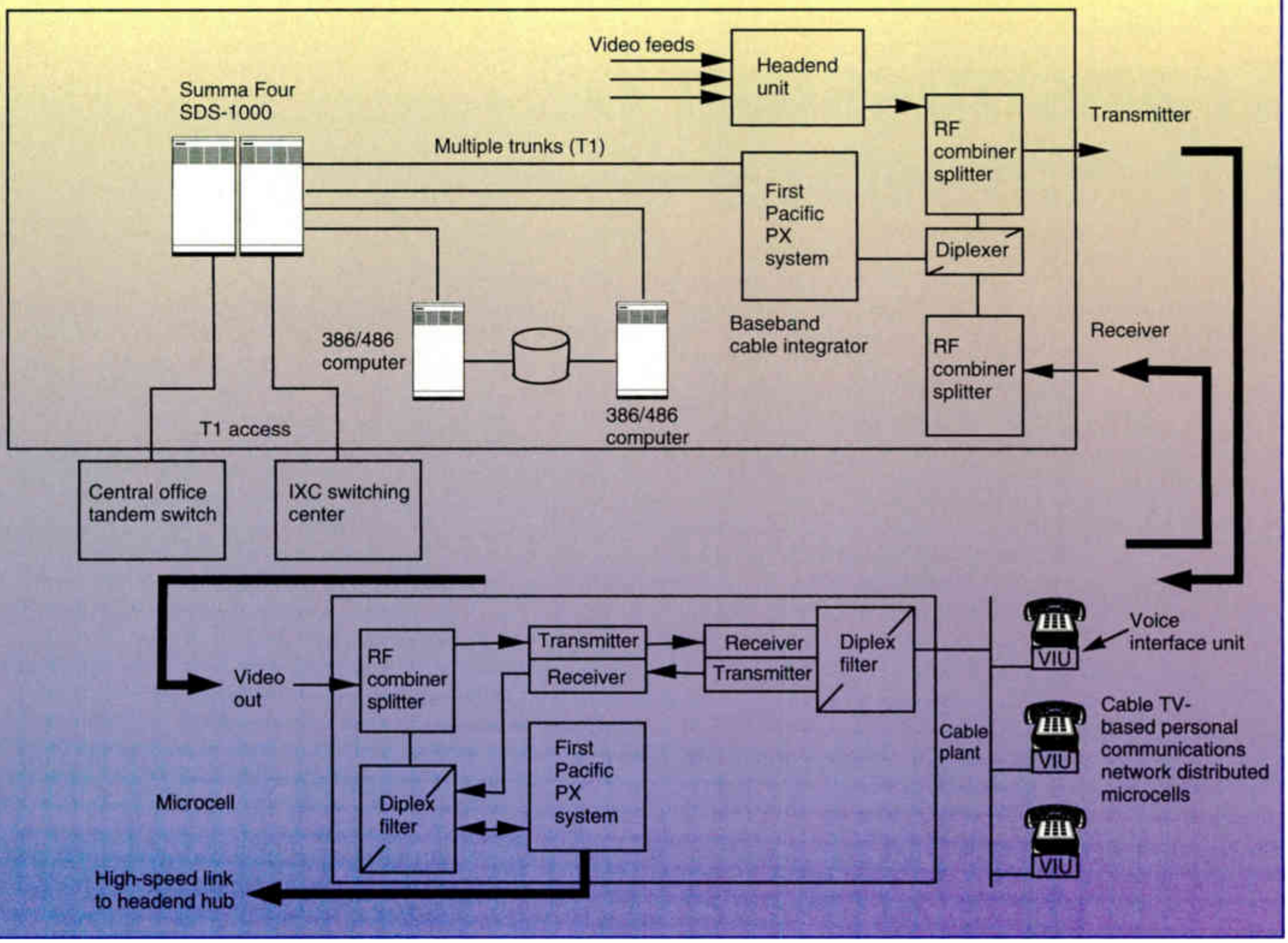
By Andres Llana Jr.
Consultant, Vermont Studies Group Inc.

Personal communications networks (PCNs) and personal communications services (PCSs) mean different things to different people. It is not a single service, but a series of services that can complement each other. Generically, PCNs imply a network that is used to support personal communications services via the application of wireless technology. CT-2 mobile handsets and the European Telepoint service have long implied PCN/PCS. Other PCSs include enhanced paging services, mobile order entry, enhanced Telepoint with two-way calling, wireless PBXs, as well as an array of in-the-home services delivered via a wireless communications link.

It's all in the eyes of the beholder

Old line PBX manufacturers view PCN/PCS as a generic form of wireless communications in the broadest sense. These include the larger PBX switch manufacturers such as AT&T, Ericson, Northern, NEC, Executone, as well as specialized telecommunications manufactures such as Motorola, Omnidata, Spectralink, Summa Four Inc., etc. All of these companies have or plan products to support some form of enhanced CT-2 mobile handset technology, wireless PBXs, wireless LANs or similar PCS technology. Present forms of wireless PBX technology are based upon Federal Communications Commission Part 15, which in ef-

Figure 2: Cable TV headend network integration center



fect allows installation of unlicensed private PCN arrangements.

In last December's FCC *en banc* hearing, one could not help but draw the conclusion that the commission envisions the operating companies emerging as the big players in the PCN/PCS market. This conclusion is perhaps conditioned by the extent of the infrastructure already held by the operating companies that could serve to support an emerging PCN market. In fact, many telcos licensed by the FCC to experiment with PCN/PCS have implemented experiments in the application of CT-2 cordless or wireless local loop technology.

In another camp of believers, the cellular providers are seen as having a lock on the PCS market because PCN/PCS is viewed as a sort of scaled down mobile service. In fact, some observers are of the opinion that the FCC commissioners may even view PCS as primarily a cellular franchise if PCS where to emerge as a CT-2 type mobile service. Like the telcos, some cellular companies have applied and been granted experimental PCN licenses. Both groups are now experimenting with outdated CT-2 technology!

All other considerations aside, as an industry, cable TV companies probably represent the most viable vehicle upon which to implement a cost-effective PCN/PCS product. With a domestic market penetration of close to 90 percent, it is obvious that the cable industry provides the ideal infrastructure for a mass market PCN service, a necessary ingredient for a viable PCS/PCN market.

How big is this market?

Arthur D. Little Co. invested a considerable amount of resources starting in the spring of 1991 working with 30 focus groups in a variety of markets throughout the United States. The findings indicate a market with a revenue stream potential of between $30 billion to $40 billion. Further, estimates indicate that once implemented, PCN/PCS providers could count on upwards of from 14 million subscribers growing to over 60 million after 10 years. Obviously the PCN/PCS market is on the minds of all of the players in the telecommunications industry. This includes both manufacturers and service providers (carriers). However, all that glitters is not gold. Many are the road blocks that stand in the way.

FCC delaying actions

A natural delay is presented in the form of standards that the FCC has made an issue. Standards are usually resolved through common agreement or a de facto process within industry and not the federal government. As for the issue of CT-2 handset standards, the United States may yet reap the benefit of a de facto standard that is already taking place in Europe. While some observers point to a time when we may be borne with a lifetime personal telephone number, industry will

(Continued on page 54)

Transmission of digital HDTV — Part 1

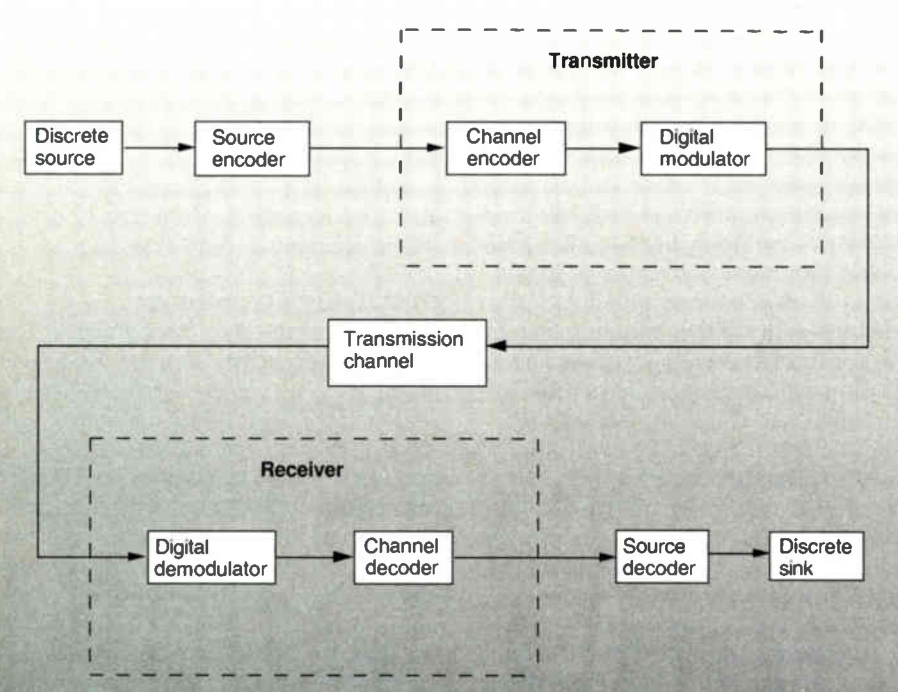
The following is copyright 1992 by CableLabs Inc. This installment of the article will cover fundamentals of digital communications systems.

By Majid Chelehmal, Ph.D.
Digital Systems Engineer
Cable Television Laboratories Inc.

Digital high definition TV (HDTV) has gained a considerable amount of attention in recent years because of its increased resolution, excellent picture and audio qualities, use of digital signal processing, low transmitter power and spectral efficiency. In addition, advances in VLSI technologies with increased processing speed and capabilities perform many diverse functions of a digital HDTV system.

A digital communications system conveys information in a digital format using signal processing, digital filtering, bandwidth compression, signaling, encryption and digital storage and/or transmission. Figure 1 shows a block diagram of a general digital communications system. A discussion of basic elements of a general digital communications system used for the transmission of digital HDTV follows.

Figure 1: Block diagram for a digital communications system



Discrete source

The discrete source contains information samples including video, audio, text and graphics in a raw format, which must be processed by the source encoder to remove redundancy. The source information rate R_S is defined as the average number of bits/second produced by the discrete source, which is the minimum attainable rate below which source distortion would result. Therefore, a source encoder must provide at least R_S bits/second to faithfully represent the discrete source. However, source encoders employing lossy compression techniques achieve a much lower rate than R_S with minimum perceptible distortions.

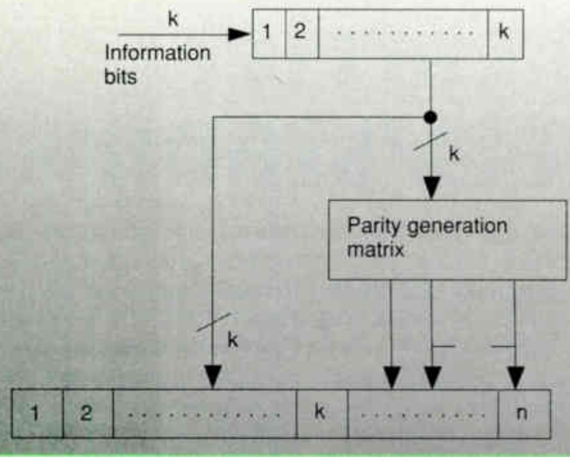
Source encoder/decoder

The source encoder performs functions necessary to minimize the discrete source rate for efficient storage or transmission over the channel by removing any redundancy that may exist in the source data. The technique applied by the source encoder to reduce redundancy is known as lossy data compression. The basic philosophy behind lossy data compression is to discard irrelevant information not noticeable to human observers. For example, the human eye is more sensitive to some spatial frequencies and less sensitive to others. Horizontal and vertical edges of an object are more noticeable than the diagonal edges. Moving details are less discernible than stationary details. The presence of certain frequencies in sounds obscures the perception of certain other frequencies. (This is known as frequency masking.)

The data compression process can be simplified by dividing a picture into square blocks and applying data compression to each block. Discrete cosine transform (DCT) is one of the most widely used data compression techniques. An important property of DCT is that most of the energy in a block is stored in a small number of low frequency coefficients. Thus, instead of storing an entire block, only a subset of the DCT coefficients are stored in a process called quantization.

The present HDTV video compression techniques are based on the DCT with motion compensation and predictive coding. Besides having spatial redundancies that can be removed by DCT, moving images also contain a considerable amount of temporal redundancy

Figure 2: Linear block coding



that can be exploited. This is accomplished with motion-compensated frame prediction using differential pulse code modulation (DPCM) on spatially correlated DCT blocks between adjacent frames.

The source decoder's role is to convert the compressed digital data into discrete data representing the reconstructed discrete source. In addition, the source decoder provides mechanisms for error concealment in case a transmission error has occurred.

Channel encoder/decoder

The channel encoder provides a mechanism for protecting data against transmission errors by appending error detecting and correcting information to the source information, thereby adding back some redundancy. Two of the most commonly used channel encoding techniques are linear block coding and linear convolutional coding.

In linear block coding (Figure 2), a parity generation matrix (PGM) is used to operate on k-bit input data blocks. The parity bits are calculated such that if errors occur in the k-bit blocks they can be easily detected and some of these errors also can be corrected. The code rate, defined as the ratio k/n, is a measure of the amount of redundancy introduced by the encoder.

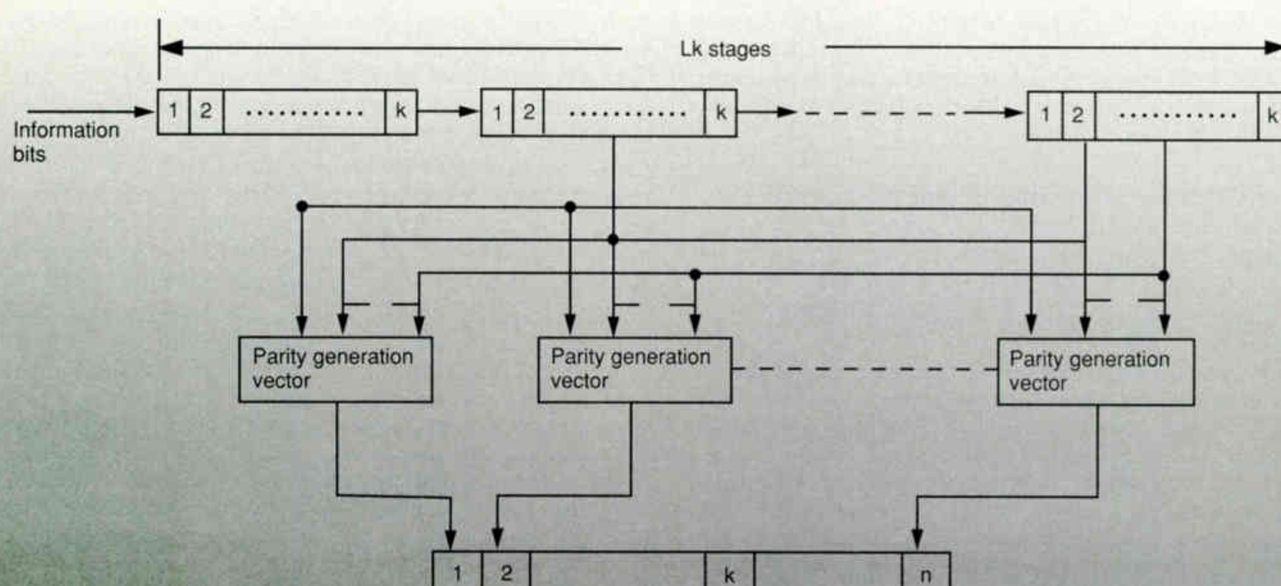
In linear convolutional coding (Figure 3), a k-bit input block of data generates an n-bit block (n>k) output using an Lk-bit shift register memory. Information data are shifted into and along the shift register k-bits at a time. Each of the n output bits are computed from a scalar product of an input shift register with a parity generation vector (PGV) of length Lk. Note that both present and previous k-bit information blocks are used in the parity check computation for a convolutional code, whereas block coding is "memoryless."

A non-binary block code consists of a set of fixed-length code words in which the elements of the code words are represented by symbols (a group of bits). Among the various types of non-binary block codes, the Reed-Solomon codes are some of the most important for practical applications. One reason for the importance of these particular codes is their good minimum distance properties. A second reason for their importance is the existence of efficient hard-decision decoding algorithms, which make it possible to implement relatively long codes with more error correction capability for a given code rate, thus providing maximum error correction for minimum overhead.

Error detection and error correction codes can correct isolated or small bursts of errors. An effective method for dealing with burst error channels is to interleave the coded data in such a way that the bursty channel is transformed into a channel having independent errors. A block diagram of a system that employs interleaving is shown in Figure 4 (page 56). The encoded data are reordered by the interleaver and transmitted over the channel. At the receiver, the deinterleaver puts the data in proper sequence and passes it to the decoder. As a result of the interleaving/deinterleaving, error bursts are spread out in

(Continued on page 56)

Figure 3: Linear convolutional coding



FCC measurements: Visual and aural carrier frequencies/levels/stability

The following is the first in a four-part series of articles on Federal Communications Commission required measurements for cable TV. This first article discusses the requirements for receivability, aural carrier center frequency and level, and video carrier level and level stability.

By Rick Jaworski
Product Marketing Manager, Cable and RF Products
Tektronix Inc.

A new era in cable TV systems testing is about to begin. The recently passed FCC regulations call for increased levels of system performance that will certainly impact the way cable operators perform system maintenance and testing. The measurements themselves are not new to the industry. What is new are the higher levels of performance required, the frequency with which the measurements must be made, and the amount of documentation needed to satisfy the new regulations.

This article, and the ones that will follow in future issues, will help you better understand the new regulations. You'll discover not only what the numbers mean, but also how errors in the various parameters called out can affect picture quality, what might cause the errors, how to make the measurements, and what equipment is needed.

Receivability

Part (a) (1) of Section 76.605 of the Code of Federal Regulations simply states that subscribers' TV sets must be able to use the signal you supply. This is a "catch-all" requirement that replaces the rules specifying channel boundaries and set-top converter stability. If any channel you supply does not meet this requirement, chances are pretty good that some system component has failed catastrophically. Combining standard troubleshooting practices with a cable sweeper, spectrum analyzer or other video test equipment would be in order.

Visual and aural carrier levels and frequencies

Low video carrier level is probably the single largest source of subscriber complaints. A low signal is a noisy signal. On the other hand, too high a video carrier can overload a receiver, whether it is a set-top converter or a cable-compatible TV set, and cause other picture distortions.

Measuring visual carrier levels can be done in a couple of ways. The National Cable Television Association recommends using a precision step attenuator and freshly calibrated signal level meter (SLM). Alternately, a spectrum analyzer can be used. Since a copy of the NCTA's recommended practices sits on a bookshelf at nearly every headend, we'll cover how to use a cable TV spectrum analyzer, the Tektronix 2714 CATV Spectrum Analyzer in particular, to make these measurements.

As with the SLM method of carrier measurements, the spectrum analyzer should be run through its internal calibration procedure to ensure the accuracy of any measurements.

Measurement setup using the previously mentioned spectrum analyzer is simple. There are only two things to keep in mind: matching the impedance of your system to the spectrum analyzer's input and ensuring you don't overdrive its front end. The combined energy of all the channels in a cable system typically won't overdrive the spectrum analyzer with its preamp turned off, but the potential for expensive damage does exist. Always make sure the power level of your RF signal is within the input range of the spectrum analyzer.

Since the unit has a 75 Ω input impedance, and the overwhelming majority of systems are 75 Ω, a direct connection between the system and analyzer is possible in almost all cases. This eliminates the need for an impedance-matching pad and the signal level conversions required because of the pad.

The new FCC regulations specify that visual carrier levels must be no less than 0 dBmV at the subscriber terminal (TV set, VCR, etc.), but not so large as to overdrive receiving equipment. After adding 100 feet of coax to the tap to simulate an average drop, the signal level must be no less than 3 dBmV.

Visual carrier frequency is not one of the new measurements. In fact, it's one of the old measurements done away with in the new regulations. But it has to be measured anyway because you need it to calculate the aural carrier's frequency offset. *(Editor's note: Aeronautical frequency offsets are a separate technical requirement with which you still need to comply.)*

To measure the visual carrier level and frequency, center the visual carrier of the desired channel on the display. Initially, the spectrum analyzer's reference level should be set to around 10 dBmV and span/division to 200 kHz/division. The resolution bandwidth filter should be set to 100 kHz, and the sweep speed must be slow enough for the filters selected (about 200 ms/division).

Set the reference level so the top of the visual carrier falls within the top division of the display, and then switch to 1 dB/division for better level resolution. Once you have the visual carrier positioned for measurement, use the "max hold" function to make sure you capture the maximum amplitude of the carrier. Set the measurement cursor to the peak of the carrier and record the level and frequency.

Note that most older spectrum analyzers cannot measure frequency with the accuracy needed to satisfy the new regulations. Newer analyzers that feature built-in counters provide the frequency measurement accuracy you'll need.

While the measurement process just described is fairly straightforward, the 2714 reduces these steps to just a few keystrokes. You can press two or three front panel keys to center any channel on the display with the appropriate refer-

(Continued on page 60)

Reader Service Number 17

NCTA Engineering Committee meeting report

By Roger Pience
Director of Engineering, Science and Technology
National Cable Television Association

A meeting of the National Cable Television Association Engineering Committee was held Aug. 12-13, 1992, at the Westin Bayshore Hotel in Vancouver, British Columbia, Canada, with 57 engineers in attendance. Chairman Tom Jokerst kicked off the meeting by thanking gracious Canadian hosts, Alpha Technologies and Nexus.

Washington update

Following the formal start of the meeting, Wendell Bailey, vice president of science and technology, NCTA, gave his Washington update report: "The House version of a cable regulatory billed was passed by an overwhelming majority. This bill, HR-4850, is a companion bill to the Senate's S-12 with a variety of provisions that mirror S-12. However, several items were significantly different requiring a conference committee compromise before the combined bill can be sent to the president.

"Consumer device compatibility is one of those items where the bills differed, with the House bill being more cable industry-friendly. The House version did not have the scrambling prohibition issues as did the Senate version. Also, the House version had prohibitions against cable's disabling the remote control window feature of the set-top box, which disables a customer-owned 'universal remote' device.

"More importantly, the House version of the bill has said that the Federal Communications Commission shall promulgate rules that define cable compatibility and won't allow consumer electronic devices to be called cable-ready or cable-compatible unless the device meets certain minimum criteria. If the bill passes, it will be our job to help the FCC define cable-ready. The Electronic Industries Association is upset by this provision and has taken upon itself to be the FCC's advisor to what is cable-compatible. EIA's tactics so far have been to ram-rod past the joint NCTA/EIA committee and push its agenda forward.

"One other provision of the bill that may cause a certain amount of heartburn to some of the cable programmers is the equal program access provision," Bailey continued. "This particular item requires all cable programmers to sell their programming equally to all operators whether they are cable, MMDS, home satellite program packagers or DBS programmers. HR-4850 did not contain any retransmission consent language. The proposed retransmission consent provision mandated that cable operators seek and receive consent of a broadcaster before the broadcast channel could be carried on a cable system. This provision may have allowed the broadcasters to charge for the privilege of carrying their programming. The item was removed after much floor debate because the broadcaster may not always have the legal right to grant permission of retransmission consent.

"Now that the bills will be sent to conference committee (because of the dissimilarities between the Senate and House versions) there will be much back room horse trading by staffers before the actual committee sees the first draft of the compromise. Politically, it is to cable's advantage for the bill to come out of conference as late in the legislative calendar as possible. It is a little known fact that many bills are not voted upon because there is simply not enough time on the congressional calendar. The administration has recommitted itself to a veto of this bill. The most likely action of the president will be a pocket veto."

FCC technical standards

Bailey continued with comments on the FCC's status of the technical standards: "The NCTA and others filed petitions for clarification and reconsideration. Mainly the NCTA filed to remove the converter from some of the tests and to change certain language that was less than enlightening. The filing made by the NCTA and assisted by the 'engineers from hell' contained many exhibits, photographs and an affidavit from Bernie Lechner. The filing was very powerful and convincing at the commission because it was science and the commission sees very little pure science. Quite frankly the opponents were in awe, and telephoned to say so."

Bailey commented that most of the cable testing criteria are too stringent and even when exceeded, the subscriber cannot see the effect of degradation in his TV set.

Bailey also reported that the commission is in a quandary on how to state the changes in the rules. The FCC indicated that the excessive number of test points is an easy thing to fix and something will be done, but there was no indication of how much correction may be expected. John Wong had solicited several models of converters from operators and conducted his own tests.

There are two ways the commission may act on the changes:

1) *Circulation:* The commissioners individually review the changes and staff commentary and then return written opinions along with their vote. This information is then circulated among all the commissioners before the commission meeting where the final results are announced into the record.

2) *Full meeting:* This is the procedure where the staff person responsible for the regulation presents a report on the item along with recommendations. The commissioners may then question and debate the issue or send it back to staff for further action. Finally a vote is taken. The meeting is open to public observation.

Bailey further opined that the commission is reluctant to change rules that affect only a handful of systems, so we must wait and see what changes will be forthcoming.

HDTV tests

On the matter of HDTV, Bailey reported that the test dates have slipped again. This time 10 more days are required to complete the full slate of tests. The NCTA has commented on simulcast issues and feels the commission is wrong, much to the broadcast industry's dismay. The commission has decided to give HDTV broadcast channels only to those TV broadcasters now licensed.

Bailey believes that minorities and other ethnic groups that have been promised entry into the broadcasting field will "raise holy hell" because they have been left out of the process. The cable industry may have a significant problem because the commission has said that different programming from the NTSC channel may be broadcast in HDTV. Cable has a different definition of simulcast: The same program must be broadcast at the same day and time in two different formats. However, this also causes "heartburn" to cable because if we are made to carry both formats then there may be channel limitations and other more desirable programming may be dropped in order to accommodate the simulcast HDTV programming. The commission has mandated that all NTSC TV broadcasting will cease by the year 2008.

A special committee has been appointed by the FCC of about 25 people who are charged with reviewing the test data and deciding which proponent system to recommend for a national standard. Bailey, a member of this special committee, observed that once all the data is collected there may be nothing that the committee can do.

"The conclusions may be obvious," he said.

New business items were next on the agenda. A presentation was given by Marvin Blecher, Klein Gilhouse and Robert Warren of Qualcom Inc. Qualcom has developed new digital modulation schemes for data that can be very advantageous to cable systems.

Tom Hill of Tektronix presented a short tutorial on the color measurements required by the latest FCC technical standards. He regretted that the shipment of Tektronix's most recent book, *Television Measurements: NTSC Systems* had been delayed through customs and were not available to hand out. Arrangements were made to mail them to each meeting attendee.

Following lunch subcommittee reports were heard.

HDTV subcommittee

The HDTV subcommittee update came from Nick Hamilton-Piercy. It included information on ghost canceling, which is now a standard using the Philips pulse. A headend unit is currently under production. The timetable for delivery has not been announced. Wendell Bailey interjected that the ATSC is petitioning the FCC to make Line 19 (both fields) the recommended line for carriage of the ghost canceling pulse. TelSat Canada had recommended Line 10 for use by the ghost canceling pulse, but was rejected. Hamilton-Piercy stated that the subcommittee will test one of the ghost canceling production units when it becomes available.

Hamilton-Piercy continued his report with details on HDTV testing progress. Both General Instrument and Zenith have demonstrated over-the-air capability. The next phase of the HDTV selection has been the selection of a special 25-member panel to choose the system that will be recommended to the FCC, as Wendell Bailey reported earlier.

Brian James reported that the Advanced Television Research Consortium proponent system tests continue and schedule time has been extended and was expected to be completed by Aug. 14. The GI/MIT system will be tested in the next scheduled test period, which was slated to begin Aug. 28 and end about Oct. 23.

Hamilton-Piercy continued with re-

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ports of advanced and digital TV systems development progress in Europe. Thomson/Philips has withdrawn its system and HD-MAC is in its death throes. Here in this country, CableLabs' digital TV request for proposals has resulted in three responses. They were from GI, Scientific-Atlanta and AT&T. One of the important questions to be answered in the digital TV systems tests is the robustness of the signal inside the home with all of the microreflections caused by interconnection and consumer devices. Europe is now experimenting with orthogonal frequency division multiplex (OFDM) coding schemes. This modulation mode appears to be more rugged inside the home.

Satellite practices subcommittee

Norm Weinhouse reported that there were no operator switchover problems with Galaxy V.

"Two degree spacing is here," he said.

Gerry Kaplan of GE Americom reported that two new C-band satellites for the cable TV industry will be launched next month. C-3 will be parked at 131°WL and C-4 will be located at 135°WL. C-3 is replacing F1-R and the transition will begin at the end of December 1992 and end the first week of January 1993. The C-4 transition schedule is not as clean and concise as that of C-3. *(Editor's note: Both the C-3 and C-4 satellites were successfully launched.)*

Standards subcommittee

Dick Shimp fully intended to have a final draft version of the fiber-optic standard available for this meeting. However, upon compiling it, he realized that it was more detailed and complicated than either the EIA or ANSI versions. He therefore reduced the scope and has circulated it again for comment. It will be published in *Techline.*

Leakage subcommittee

Charles Cerino was not able to attend and faxed the following report and draft of the new charter for the leakage subcommittee:

The FCC is continuing to conduct inspections and in fact it is now beginning to ask for proof of the signal-to-noise test and service call policy and other provisions of the new rules. Frank Ragone and I met with the FCC enforcement branch to discuss some problems we have had with its inspections. A report on the visit follows the draft charter.

The following is the draft of the charter for the NCTA signal leakage subcommittee dated Aug. 12, 1992.

The functions of the NCTA Signal Leakage Subcommittee are as follows:

1) Inform and educate the cable TV industry about regulations and interpretations relating to the FCC Rules (47 CFR), Part 76, Cable TV Service, Subpart K, paragraphs 76.610 through 76.616 on signal leakage performance criteria.

2) Maintain a good working relationship with the FCC's Cable TV Branch personnel.

3) Take appropriate action to resolve related issues between the industry and the FCC when they occur.

4) Report all activity to the Engineering Committee.

The following is a wrap-up of the FCC/Comcast signal leakage Q&A meeting mentioned previously. Cerino and Ragone asked the questions, which were then answered by the FCC's Enforcement Division.

1) What magnitude of leak and/or

condition mandates a shutdown?

The Enforcement Division of the commission has two missions. One is to protect life. Therefore, safety comes first. The second mission is to enforce the regulations and ask for forfeitures if violations are found.

Mary Beth Richards, Enforcement Division chief, said that if the leak is severe enough to cause concern to safety, then the system should be shut down immediately until the EIC is satisfied that it is safe to continue operations. She also stated that a violation has to be one that is repeated for the commission to issue a fine.

(Cerino thinks that this is where the problem exists because the FCC must measure a violation on two different days. That means large leaks could continue for 24 hours or more with their knowledge that there could be a safety issue. Cerino hoped as a result of the meeting that the FCC will be modifying the policy to mandate to its field personnel that safety comes first.)

2) What is the notification process for a shutdown?

The commission believes that it can notify by phone and require shutdown. (Cerino asked that the FCC verify this with its own attorneys because cable counsel has advised that a written notification is the only legal way requiring the cable company to act. Cerino suggested that the NCTA lawyers follow up with the FCC attorneys to resolve this point of law.)

3) What are the conditions of a shutdown? All channels off? Aero navigation channels off? Aero navigation and communications off? Operation below 38.75 dBmV?

All aeronautical channels either off or reduced in operating level below 38.75 dBmV.

4) Can a "clean" inspected portion of plant continue to operate?

At this time the answer is no. However, the commission is struggling with this issue and one could probably plead the case with the EIC (if there were special circumstances) and receive some relief.

5) What is the procedure for monitoring and repairing leaks during a shut down?

The EIC can authorize the use of a channel or carrier at full level to allow the leakage detection equipment to operate.

6) What is the procedure for reinstatement of service?

When the EIC is satisfied that the system is not causing any more harmful interference, then it can issue the order to resume normal operations. Worst case, the EIC may require that a total CLI be performed by the system before operations can be resumed. Or, the EIC could send a staff engineer to reinvestigate the situation and if all was in order, then the OK to start up could be given.

7) A review of 18 FCC inspections of Comcast/Storer systems reveals a range of inspection techniques. Why is this so?

The FCC has been refining its inspection procedures and will continue to do so, which should make the inspections more uniform in the future. But because there are several regions, there most likely will be slight differences from area to area.

The FCC will be issuing a new form called a 325 Schedule A to take the place of the 325 Schedule 1 & 2. This form should be out by year-end '92.

8) What about timely correction of high level leaks that the FCC finds?

Everyone agreed that when safety is

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at issue, the leak should be fixed as soon as possible. However, if the leak is not so bad but in violation, then the FCC might not respond and continue to write citations regardless of the conditions of the rest of the plant. Politically, it wants to have a file of cases to show to the FAA when the leakage and frequency usage issues come up again in a few years. The FAA has claimed in the past that the FCC was not enforcing its own rules.

(According to Cerino, this meeting did cause the enforcement branch to review its procedure regarding cable TV plant inspections and has resulted in new procedures for conducting inspections issued to the EIC.)

Sound quality subcommittee

Ned Mountain was unable to attend the meeting and submitted his report via fax to Chairman Jokerst. The report follows:

"Thanks to CableLabs for an excellent job of collecting one month's worth of data on audio levels as observed and recorded on our 'calibrated' headend.

"I have done a preliminary analysis of the data and have sent my working group members a request to do the same. Since the issue is complex and sensitive, I want to get input from my working group prior to sharing my observations. My goal is to have comments from the working group received by Sept. 18 and to have a subcommittee meeting in Washington on the morning of Oct. 14."

EIA/NCTA committee

Doug Semon reported that the previous meeting of the joint EIA/NCTA engineering committee had been held in Boulder, Colo., on July 29, 1992.

IS6-A was presented to the full membership for a vote and was passed as a standard. There is a three-channel disclaimer that interference can be caused to certain TV sets that use these channels in the 9,060 MHz range for the first IF.

Semon admonished the group that there were no cable operators at these meetings and more participation by operators is needed. The joint EIA/NCTA committee took it upon itself to be the body that will define cable-ready and/or cable-compatible.

SCTE/NCTA subcommittee

Norrie Bush reported for Bill Riker that the Society of Cable Television Engineers Expo '92 was a great success and Expo '93 is scheduled for Orlando, Fla., in April. The NCTA is again invited to hold an Engineering Committee meeting in conjunction with Expo '93.

NIST subcommittee

Bruce Weintraub, new to the Engineering Committee, offered the following memo:

"On Aug. 6, I met with Bruce Fields and Charles Fenimore, the two people responsible for the management of the uses and testing of the Princeton Engine, a video processor.

"To call the Princeton Engine a video processor is somewhat akin to calling a Lotus Formula One simply a mode of transportation. It vastly underrates the capabilities of the computer.

"The main thrust of the Princeton Engine is to be able to evaluate a video signal, make adjustments to this applied signal and view the effect of these changes simultaneously with the applied video signal. In evaluating digital signals for example, different processing speeds of say 150 to 270 Mb/s may be applied and the component

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changes may be viewed as the speeds that are stepped through. Different processing speeds may be applied to separate portions of the video content and the effect viewed and/or stored for comparison against another method. Algorithms may be changed with easy documentation of the effect of the change. The unit can accept NTSC, D2, D3 or virtually any applied video signal. It will process up to six input signals and provide up to seven outputs in either digital or RGB formats.

"The engine will accept half of an HDTV signal for processing in its current configuration of 1,024 16 bit processors. According to Fields, it would require almost a full compliment of 2,048 processors to handle a full HDTV signal. In its current configuration, the Princeton Engine has a value of approximately $1.5 million and may be added onto at some future date.

"Use of the Princeton Engine has been granted to NIST by Sarnoff Labs for purposes of advancing testing and standards with industry and research. It also is being used in conjunction with University of Maryland in the testing of its DCTV algorithm. It is open to users to examine algorithms through real-time video processing. It may be used to test ideas, but it is not intended to become an inventor's sole tool.

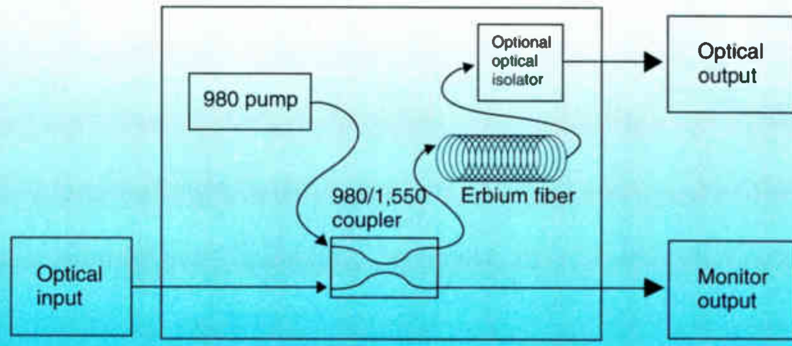
"Fields and Fenimore readily admit to a lack of expertise in the field of video itself, but they are more than willing to lend their expertise to establish the testing standards and/or test algorithms to prove or disprove their usefulness. They will not, however, be a part of a patenting process. Their charter with NIST prohibits such use of their capabilities. They wish to be considered a resource open to the CATV industry, available to resolve video technical issues. The strength of the engine is its general purpose — research. It will enable four users at a given time, and according to Fields, is currently vastly underused.

"They are open to a tour of their facility at the next Engineering Committee meeting in October in Washington, D.C. They have invited those who are interested to a workshop they are scheduling in early November. (It is tentatively scheduled for the 4th.)"

Tours

On Aug. 13, the Engineering Committee toured the Rogers Cablesystems' PCN trial site in a Vancouver shopping mall. The committee also toured the Alpha and Nexus facilities. **CT**

Figure 2: Optical gain block



Dispersion-shifted fiber

(Continued from page 14)

dispersion both impede the travel of the optical signal; the former through loss of optical power, the latter because of distortion.

In digital transmission, the effects of dispersion limit the transmission rates that reliably can be achieved on a single-mode fiber link. As the light transmits through the fiber, the pulses spread more and more, begin to overlap and become increasingly difficult for the receiver to distinguish. Ultimately, this may result in bit errors, requiring a reduction in the transmission speeds to keep the bit error rate (BER) within desired bounds.

In analog transmission, dispersion contributes to distortion of the analog waveform. This effect is particularly significant to cable TV systems since the complex nature of an AM video signal makes it very susceptible to any distortion impairment.

Analog distortions actually are the result of dispersion interacting with laser chirp. A small amount of laser chirp (the intermittent drifting of the laser's center wavelength) can significantly distort an AM video signal due to the presence of even moderate dispersion levels in the fiber.

Cable TV AM transmission is sensitive to the effects of dispersion in two ways. One type manifests itself as second order harmonics, another as intermodulation or "beats." Combined, they are commonly referred to as composite second-order (CSO) distortion, which appears on a TV monitor as rolling diagonal lines.

Since dispersion is higher in the 1,550 nm region of single-mode fiber optimized to operate at 1,310 nm, transmission in this window for the purpose of achieving longer link lengths will produce a picture quality that is somewhat inferior to 1,310 nm transmission.

This problem can be overcome, however, with the use of various electrical and optical dispersion-compensation techniques. Electrical compensation typically involves the use of predistortion circuits that create CSO distortion equal in magnitude to the laser output but opposite in sign in order to cancel it out. Optical compensation techniques typically offset the amount of dispersion in the system. fi

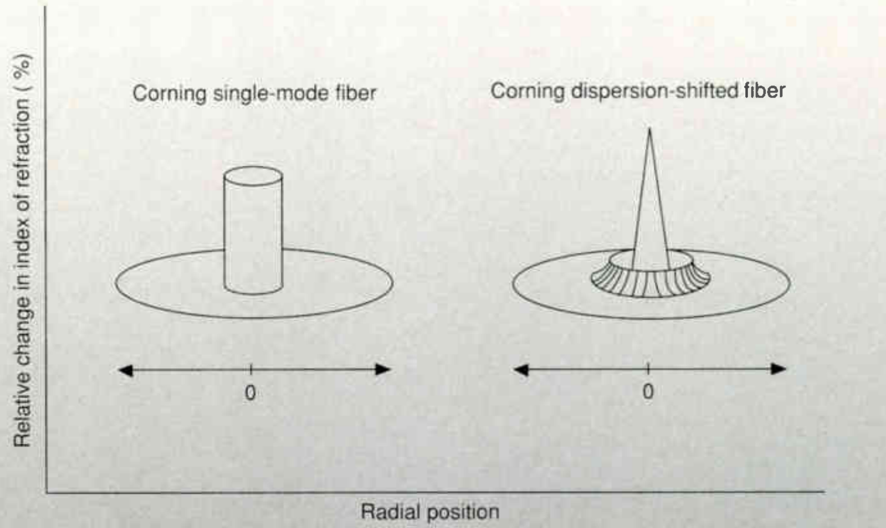
An obvious drawback with both, however, is that either technique reintroduces the distance limitations that 1,550 nm transmission proposes to eliminate in the first place. Electronic compensation, in addition, is inherently bandwidth-sensitive.

Dispersion-shifted fiber

The ideal alternative for the system designer would be a single-mode fiber that is optimized for 1,550 nm transmission. That is, a fiber that provides lowest attenuation and zero dispersion in this region.

The single-mode fiber design that has been used to date in cable TV systems provides lowest dispersion in the 1,310 nm operating window. With this fiber, link spans are limited by attenuation in the 1,310 nm window and by dispersion at 1,550 nm. The advantage of dispersion-shifted fiber is that it displays the lowest levels of each characteristic in the 1,550 nm window.

Figure 3: Refractive index profiles



Long-haul telephony installations and submarine cable installations, especially, have taken advantage of the unique transmission characteristics of dispersion-shifted fiber since it was made commercially available in 1985.

The technique for shifting the zero dispersion point in Corning fiber is based on segmenting the refractive index of the fiber core. (See Figure 3.) The refractive index profile represents the change in refractive index of the core glass relative to the cladding glass, and typically defines the fiber's transmission characteristics.

The change is achieved through intricate modifications in the concentration and location of the chemical dopants that are used to create the fiber core and cladding. The fiber is produced with the same outside vapor deposition (OVD) manufacturing process used for Corning's 1,310 nm single-

Attributes of 1,310 nm and dispersion-shifted fiber

	Corning single-mode fiber	Corning dispersion-shifted fiber
Attenuation		
@ 1,300 nm	0.35 dB/km	0.39 dB/km
@ 1,550 nm	0.19 dB/km	0.21 dB/km
Mode field diameter		
@ 1,300 nm	9.3 μm	6.5 μm
@ 1,550 nm	10.5 μm	8.1 μm
Zero dispersion wavelength	1,310 nm	1,550 nm
Dispersion slope	0.09 ps/nm²·km	0.08 ps/nm²·km
Dispersion		
@ 1,300 nm	≤3.5 ps/nm·km	~-19 ps/nm·km
@ 1,550 nm	~17 ps/nm·km	≤2.7 ps/nm·km

mode fiber. As a result, the two fibers display identical mechanical performance characteristics.

As with 1,310 nm single-mode fiber, this dispersion-shifted design yields an attenuation level at 1,550 nm that is about half of the 1,310 nm value. However, the higher dopant level required to change the refractive index profile produces slightly higher attenuation at 1,550 nm than 1,310 nm optimized fiber.

The higher level of attenuation lacks practical consequence, and is offset partially by reductions in attenuation induced by macro- and microbending that can occur during cabling, installation and handling of the fiber. The smaller mode-field diameter of Corning dispersion-shifted fiber (8.1 microns at 1,550 nm vs. 10.5 microns for its 1,310 nm single-mode fiber) combined with the difference in refractive index profile, results in this performance advantage.

The accompanying table compares the key specification attributes of Corning's 1,310 nm and dispersion-shifted fibers.

Cable TV applications

Tests gauging the performance of 1,310 nm fiber and dispersion-shifted fiber at 1,310 and 1,550 nm have demonstrated the technical viability of dispersion-shifted fiber. Beyond these results are the system design advantages of longer link lengths and the possibility of optical amplification that stem from operation in the 1,550 nm region.

Both fiber types can be used beneficially in cable TV systems. Dispersion-shifted fiber displays several advantages, however, although some performance trade-offs must be expected in acceptable carrier-to-noise ratio (C/N) and CSO levels.

AM video transmission at 1,310 nm over 1,310 nm fiber yields excellent CSO performance, but C/N degradation typically limits transmission distances to about 30 km.

In the 1,550 nm window, attenuation would permit the reach of cable TV links to be extended beyond 30 km. But this potential advantage is offset by the fact that dispersion in this region requires some type of CSO compensation beyond 4-5 km, depending on the system application.

Dispersion-shifted fiber, on the other hand, offers a more advantageous scenario, particularly in AM applications. In the 1,550 nm region, which now is optimized for minimum attenuation as well as dispersion, good CSO and C/N performances are achieved on links even beyond 40 km, without the need for distortion compensation or boosting of the signal power.

When utilizing dispersion-shifted fiber at 1,310 nm, good performance on links of 5-10 km can be achieved before CSO compensation might be considered. Somewhat longer links could be established, depending on laser performance. Adding typical CSO compensation also could achieve significantly longer distances between amplifiers. Even without compensation, however, this window could be used advantageously to provide "narrowcast" programming, a return signal path and other services with lower performance requirements.

In order to capitalize on the strengths of each fiber type, hybrid fiber-optic cable, comprising a predetermined mixture of 1,310 nm and dispersion-shifted fibers, could add functionality and cost-effectiveness to new system applications. The cable would be deployed for use in appropriate sections of the cable TV plant to provide separate transmission routes, optimized for both the 1,310 and 1,550 nm windows.

Dispersion-shifted fiber could be used with optical amplifiers to provide the lowest cost solution for video transport. Fiber optimized for 1,310 nm operation might be reserved for narrowcasting or other services using conventional 1,310 nm equipment.

Conclusion

The promise of 1,550 nm operation over dispersion-shifted fiber lies in the economic advantage of long link spans without the need for signal regeneration or noise artifact compensation. This is significant in AM operation, where transmissions are particularly sensitive to CSO distortion. Its performance in the 1,310 nm region also will support broadband and narrowband AM video transmission. **CT**

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Compatible architectures

(Continued from page 16)

Future requirements

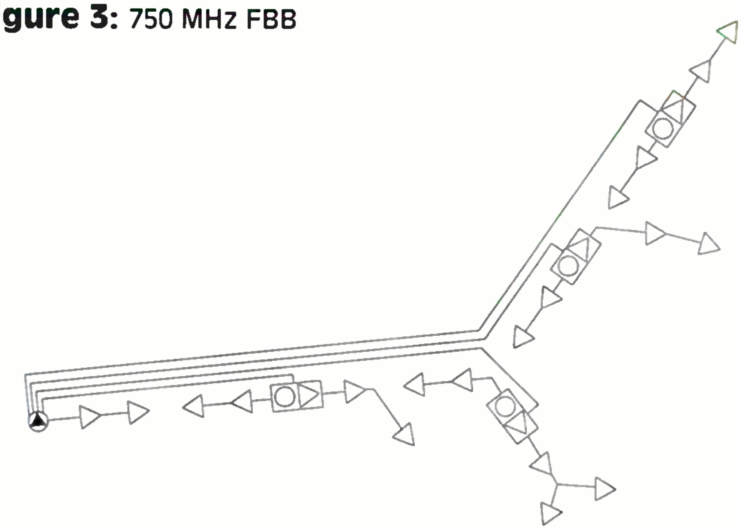
Now that we know where we are, we need to understand where we want to be. And where we want to be may consist of several phases or stops. Start by reviewing the system demographics and determining whether or not you are providing necessary services and communication conduits to the proper areas. Understand the application and impact technologies such as fiber optics, HDTV, interdiction and digital compression. Ask questions about how services such as NVOD, distance learning, inter- and intracampus communication, alternate access and PCN can be integrated into a network.

Implementation requirements

Define project implementation phases. The existing system may be 12 years old, use P3 cable and a combination of 330 and 450 MHz equipment, and provide 32 channels of basic programming and three premium services. Phase I of the project might expand the system to 550 MHz bandwidth and interdiction capabilities, and at the same time provide for data communications between local bank branches and intracampus data, voice and video communication for a local business. Phase II of the project might call for bandwidth expansion to 750 MHz and digital compression with HDTV, NVOD and PCN services. The portion of the band between 450 and 750 MHz will provide for the digital services while the band below 450 MHz will maintain its analog format. Further, existing cable and strand is to be used wherever possible to help contain costs and Phase II implementation should not require major construction efforts. A further requirement would call for existing bridger locations to be maintained.

Define the technical performance requirements and how they will apply to each phase of the project. Phase I may

Figure 3: 750 MHz FBB



require a 46 dB carrier-to-noise ratio (C/N), with distortions of greater than 53 dBc composite triple beat, 53 dBc composite second order and 50 dBc cross-modulation with tap levels of 15 dBmV. Phase II of the project will call for a 48 dB C/N for analog programming, 43 dB for digital programming, distortions as in Phase I and tap levels of 15 dBmV. Service areas for Phase II may not exceed 2,400 passings, which should allow for the implementation of NVOD and PCN. Note that tap levels do not have to change between Phase I and II even though the bandwidth expands since the digital signals will be more tolerant of a lower C/N.

Network implementation

With the existing system defined and the future requirements understood, we can now design a network that brings the two together. Experience has shown us that the design process requires beginning with the 750 MHz design (both coaxial and fiber) and then "underlaying" the 550 MHz design. This will hold true whether we are using fiber-to-the-feeder (FTF), fiber backbone (FBB), cable area network (CAN) or traditional coaxial architectures. This is extremely important to do if costs incurred between Phases I and II are to be maintained. Many networks will be a hybrid of several of these design techniques.

Figure 1 (page 16) shows an example of how the 550 MHz trunk design with future 750 MHz expansion capabilities might be implemented. This particular area has densities of 50 homes per mile. The 550 MHz fiber nodes will always be collocated at a 750 MHz node. This leads to a design that is less than optimal at 550 MHz from a spacing standpoint but is more than compensated by the ease at which 750 MHz is implemented.

Figure 2 (page 16) is an example of the distribution design architecture that makes use of a combination of trunk, network and line extender amplifiers. Again, amplifier locations are optimized for their 750 MHz performance, which detracts from the 550 efficiencies but is eventually recovered at the time of the 750 MHz upgrade.

Figures 3 and 4 (pages 42 and 46, respectively) show the final 750 MHz design implementations of the 550 MHz areas. In the backbone architectures the 750 and 550 MHz bridger locations are maintained at the original 330 MHz locations. The additional 750 MHz fiber nodes are added, trunk network amplifiers extend reach between original bridger locations and, where necessary, trunk station signal flow is reversed through a module upgrade.

Actual network implementation methods now need to be considered: whether or not the fiber for 750 MHz operation is placed in the system during Phase I or Phase II construction, and whether or not 750 or 550 MHz amplifiers are initially installed. The development of network amplifiers (also known as distribution amps, minitrunks or minibridgers) has helped provide valuable design tools to extend nodal reach while at the same time reducing active counts and improving network reliability. Today, most operators would opt to place the extra glass and wait until the 750 MHz amplifier technology matures. A year from now, costs may dictate that the 750 MHz amplifiers also be installed as part of Phase I with operation to 550 MHz.

Tables 1 and 2 (page 44) show some of the possible cost combinations that might be considered for the

Table 1: FTF upgrade cost analysis

	550 FTF, 750 design, 550 electronics	750 FTF upgraded from 550 FTF	750 FTF, 750 design, 750 electronics
Fiber ($/mile)			
Electronics	645	530	1,175
Cable	1,260	0	1,260
Construction	550	0	550
	$2,455	$530	$2,985
Coaxial ($/mile)			
Electronics	3,105	2,495	3,510
Cable	4,040	0	4,040
Construction	3,880	330	3,880
	$11,025	$2,825	$11,430

Table 2: Fiber backbone upgrade cost analysis

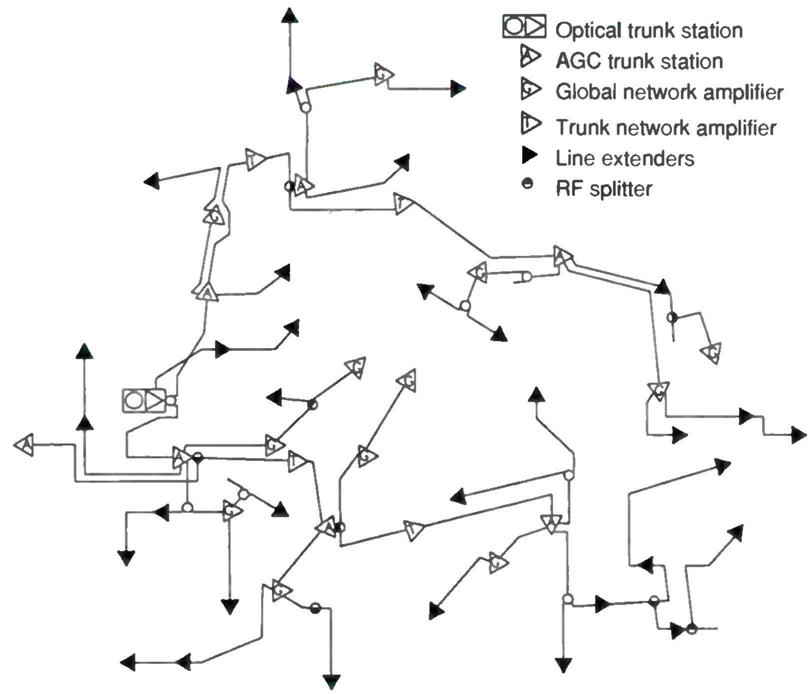
	550 FBB, 750 design, 550 electronics	750 FBB upgraded from 550 FBB	750 FBB, 750 design, 750 electronics
Fiber($/mile)			
Electronics	735	950	1,685
Cable	1,920	0	1,920
Construction	620	0	620
	$3,275	$950	$4,225
Coaxial ($/mile)			
Electronics	2,710	2,375	3,025
Cable	475	0	475
Construction	1,980	330	1,980
	$5,165	$2,705	$5,480

implementation of the two sample topologies. The first cost column represents a scenario where the system will be designed to 750 MHz but the fiber and RF electronics will only be installed for 550 MHz operation. All of the fiber will be installed but only the nodes required for 550 MHz operation will be installed. The second column represents the costs of upgrading that 550 MHz plant to full 750 MHz operation. The final column shows the costs of building the system with 750 MHz operational capabilities from the onset. Tables similar to this are useful in the process of deciding when and where to make network investments.

Summary

Much looms on the CATV horizon. Advances in both technology and services promise to continue through the decade. As an industry, we cannot afford to wait for the advances to slow or stabilize, for that will never occur and we will be passed by others. We must take advantage of what we know, apply it today and prepare for the future. We must develop a plan with contingen-

Figure 4



cies for the future and continue to move forward.

This article has attempted to shed some light on how we might attempt to do this. It makes no pretense of providing an exact solution for a utopian network but hopes to evoke some sort of thought and effort to those ends. **CT**

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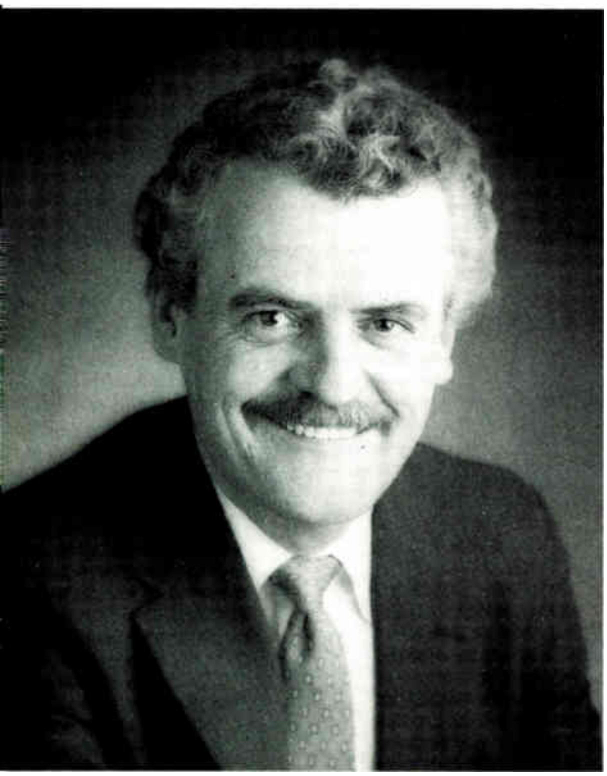

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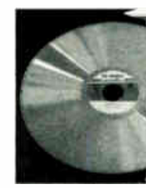

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Asynchronous transfer mode

(Continued from page 20)

could interface to a switch that could output each channel to a different subscriber and vice versa.

ATM's fixed-length cells offer a mechanism through which data of different speeds can be transmitted over a unified network in the home or office. Daniel Upp, vice president of technology development at Transwitch Corp., said that houses may eventually be equipped with information jacks into which computers, VCRs and even appliances could plug in to send and receive data.

Implementing the standard

In 1990 the International Telegraph and Telephone Consultative Committee (CCITT) chose ATM as the standard switching technique for transport within broadband ISDN wide area networks. Fred Sammartino, president of the ATM Forum, explained, "Several computer manufacturers and other industry players have realized in the last year that this ATM technology developed for the wide area is immediately applicable to the local area."

Last year, the ATM Forum began meeting to work through the remaining issues needed to make ATM network components interoperable at all scales. Sammartino said that completion of the standard is "accelerated by an aggressive schedule." Each month, representatives from over 50 member companies come together to hammer out details of the standard.

"In my entire 20-year career this is the most consensus I have seen toward a product," Sammartino said.

"ATM's rapid growth has been pushed by zealous computer manufacturers eager to cash in on its promise," said Upp. Unlike carrier-sponsored standards such as integrated services digital network (ISDN), the computer equipment manufacturers have taken the lead in pushing for standards and compatibility.

Upp said, "ISDN was too little too late. The carriers were thinking about switched networks. Meanwhile T1 mux manufacturers sprung up to displace them."

Several years behind schedule, a national ISDN is just coming on-line that will allow ISDN in different states to communicate.

Like ISDN, ATM faced a drawn-out standardization process through the CCITT. However, equipment manufacturers were so enthralled by ATM's capabilities that they created a special forum through which they could ensure compatibility between their ATM products.

Founding members of the ATM Forum include data equipment manufacturers such as Adaptive Corp. and Cisco Systems Inc. and voice network companies like Northern Telecom and U.S. Sprint.

"For the first time in a hundred years, datacom and telecom agreed," said Vern Little, product marketing manager at PMC-Sierra Inc.

"The strength of ATM development is due in large part to the diverse players from many industry segments," said Sammartino. Members of the forum include carriers like MCI, Sprint and AT&T, Bellcore and all seven RBOCs, PBX manufacturers like Northern Telecom, Fujitsu and Rolm, and computer companies like Apple, Sun, DEC and H-P.

Carrying the cells along

The forum has reached consensus on the physical layer specification and network management in a forum specification that was released in May. Work con-

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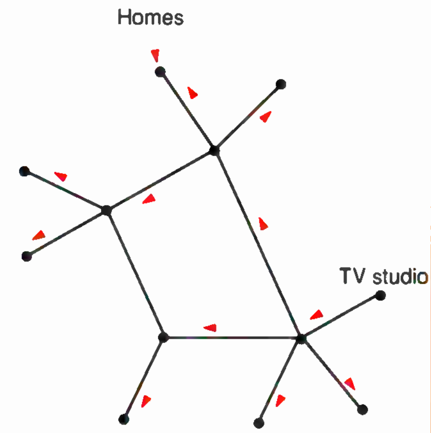
tinues on traffic specification and signaling for a final standard, which Sammartino believes will emerge by next year.

Currently the forum has agreed on four ATM physical layer specifications. Sammartino said an FDDI-like and Fiber-Channel-like interface can all be manufactured by off-the-shelf components. A DS-3-like interface provides easy integration into the existing telephone network.

Sammartino said that SONET is the preferred interface because of its low framing overhead and scalability. The SONET standard currently defines interfaces at speeds from 51.84 Mbits/s to 2.488 Gbits/s and eventually higher. Although there is no low-cost SONET chip that can be bought off-the-shelf today, the SONET-ATM User Network (Saturn) development group has begun pushing for this chip. Members include Sun, PMC-Sierra and over a dozen other interested parties.

PMC-Sierra, which specializes in chip sets for T1, T3, SONET and ATM networking systems, plans to have a working chip available by early 1993. According to Ralph Bennet, CEO of PMC-Sierra, "We see Saturn network compatibility in businesses, public carriers and subscriber loops becoming commonplace."

Figure 3: Multicasting



At the moment, all of these proposed interfaces operate at relatively high speeds. The T3-compatible interface supports the slowest speeds at 45 Mbits/s. Either slower-speed interfaces will be developed or the cost of high-speed connections will have to plummet before ATM-to-the-home is a cost-effective technology.

So far, a number of companies announced ATM components but these are all quite costly and will not necessarily be interoperable inside an expanded network. Fore Systems, Adaptive, TRW, Fujitsu, Ascom Timeplex, Ungerman Bass and BBN all have or plan to have ATM equipment available by next year. However, at over $5,000 a port, these networks have limited applications.

In the real world

Professor Jon Turner at Washington University in St. Louis has developed a broadband network called Zeus based on ATM technology. He is experimenting with a variety of multimedia applications, all of which require large bandwidth. His main aim was to find a way to distribute images, sounds and data around the campus without having to distribute a lot of paper.

In one application, users can scan through an on-line multimedia library and visualize faraway planets or scan images collected from the Viking Orbiter. In another application using a sectioning microscope, hundreds of thin "slivers" of some creature are scanned in to the network and processed by a supercomputer. A user anywhere on the network can get a visualization of the original uncut creature from any angle inside or out.

Although most ATM applications use point-to-point connections, Turner's

group is developing multicasting techniques that could be used for broadcasting a single signal to a variety of users. (See Figure 3 on page 52.) Eventually cable TV services could use this technology for selectively broadcasting to individual users. A cable provider could individually address each customer, providing a select blend of video, images or data.

The future

Sammartino said, "The deployment of ATM in LANs will drive WANs." Users will first upgrade their networks to overcome bottlenecks in the LAN. Once the carriers begin deploying ATM-based switches, users will be able to connect across the country at the same high quality as they connect across their office.

Sammartino speculated that ATM interface equipment in the $1,000 per port range could be available as soon as next summer, which would make it feasible for high-speed computer networks. Other analysts have speculated that ubiquitous ATM is 10 years away, at which point it will provide connections at every level, from inside houses to global communications. **CT**

PCN/PCS

(Continued from page 23)

have to first resolve the issue of a national PCN/PCS numbering plan. Taken altogether, the entire regulatory process coupled with the issue of standards could put the PCN/PCS market well into the late 1996-98 time frame. That is, if one accepts the premise of PCN/PCS as only a mobile handset-based service.

The regulatory wheels of the FCC grind slowly. However, there can be little doubt that market forces will eventually create a demand for PCSs in the United States. Who will dominate the market and what form services will take still remains the subject of some speculation. Certainly the type and extent of PCN services that will ultimately emerge depends a great deal upon what the consumer market will buy. And certainly the FCC's agenda for PCSs centered on the definition of services, technologies, spectrum and regulatory issues will in no way enhance the emergence of a market.

Perhaps the real issue is how to capitalize on a $30 billion to $40 billion PCN/PCS consumer market. Simple. Why not take advantage of the assets at hand that include existing infrastructure and established tariff products? Perhaps this could include the deployed cable TV infrastructure reaching into the estimated 90 percent of the nation's households — much of it supported by two-way capable cable and fiber.

In search of natural solutions — while we wait

Issues such as numbering plans, sufficient spectrum, CT-2 standards and regulatory matters need not provide a deterrent to emulating PCN/PCS services. Cable TV companies have the infrastructure and capabilities to support a viable PCS-like service with full access to the public network — all within existing regulations.

Why not use off-the-shelf hardware, software and special switching systems capable of integrating video, voice and data over available two-way video distribution systems to emulate PCN/PCS services? Systems are now available that, when properly integrated, will provide a cable company the ability to support a broad array of in-the-home services (not to mention value-added access into the public network).

Practical PCN/PCS solutions

PCSs are synonymous with a portable telephone number. PCN Inc., a Chicago-area software company, has developed an innovative way to emulate the concept of a "portable personal telephone." Its service utilizes tariff services within the public network, coupled with off-the-shelf garden variety hardware, to provide a personal telephone number fixed to a person and not a place. The system has effectively bypassed the pain associated with PCN/PCS licensing, spectrum allocation and numbering plans to provide one of the first viable PCN/PCS-like services in the United States.

Figure 1 on page 22 shows the system that has been designed to support these specialized services. Basically this service provides a subscriber with a telephone number that can given out to the subscriber's customers, clients, etc. Thereafter, a subscriber can be reached at any time through this special number. The operation is simple in concept. When a subscriber leaves his primary location, he calls the PCN Inc. service node to access his records stored in a customized data base. At that time, he simply enters the next telephone number at which he can be reached. Anyone wishing to call the subscriber can reach him through his PCN Inc.-assigned number — no matter where he travels on the public network.

The PCN Inc. system uses off-the-shelf hardware comprising a Summa Four SDS-1000 switch used to link the PCN controller (a 386/486 platform) and the local BOC tandem switching facility. The SDS-1000 functions as a high-capacity intelligent network server providing both incoming and outgoing telecommunications routing support. As well, it provides a direct link between the public network and the 386/486 computer platform's support communications software to handle the necessary protocol and information flow.

A pool of DID numbers are used to assign a customer a unique calling number. An incoming call detected by the SDS-1000 passes the DID number called to the computer, which then qualifies the customer and passes the call to special system software. The system files are used to match the incoming assigned subscriber number to the new location number that the subscriber has provided the PCN service node. The new number is used by the SDS-1000 to make an outgoing call to the "new" location supplied by the PCN subscriber. Presumably, the subscriber is at the new number and is reached by the calling party. In the event that a subscriber cannot be reached, the caller is then transferred by the SDS-1000 to a voice mail machine, which in turn accepts a message for the subscriber. Subscribers also can utilize PCN Inc. software (which works with the SDS-1000) to develop their own customized call-processing arrangements.

Taking it one step farther

A review of quarterly PCN/PCS experimenters' reports filed with the FCC suggest several technical approaches to provisioning PCN/PCS services over a two-way cable infrastructure. While the designers suggest two-way cable as the basis for the system, the expansion to fiber cable networks will provide a more viable approach for today's market.

Figure 2 (page 23) shows a fully integrated network deploying an SDS-1000 intelligent network interface, a two-way cable network PBX system (First Pacific) supporting an intelligent subscriber voice/data interface unit. The cable PBX system is actually an intelligent TDMA multiplexer that can be deployed in this network as microcell nodes linked to a headend or central processing hub. In this configuration, the cable PBX subsystem uses a band-splitting approach to distribute TV programming one way while handling two-way (voice/data) traffic in separate 6 MHz channels. A voice interface unit at the subscriber location supports a voice or data interface and provides all of the intelligence to support call supervision, ringing, battery, etc.

In support of a large subscriber base, multiple microcells would be established and linked to a hub location that would be linked directly to a switch like the one described previously. A switch serves a variety of functions that include: interface to an applications platform to support network administration functions (billing); network routing; incoming call management in support of specialized functions like in-home service ordering; incoming/outgoing call routing; routing into specialized or custom services such as a transportable telephone number service (discussed previously); voice mail; electronic mail; etc.

An easy migration

As we can see from these examples, a direct transition to a PCN/PCS-like service platform is possible with available technology. Further, such platforms can be constructed within the parameters of existing tariffs and spectrum allocations using off-the-shelf hardware and software solutions. While wireless PCN/PCS networks may require a bit more maturing before they can support affordable mass market services, there is a clear route for provisioning such services.

Obviously, there is little need to wait for resolution of standards and spectrum allocation as these issues alone could push a market-ready product 36 months or more into the future. Further, the U.K. Telepoint experience tells us that there is little market for still another mobile handset service. Certainly such a service by itself is not capable of exciting sufficient market revenues to support a viable PCN/PCS service. However, there are other direct market services that can be developed that would be perceived by consumers as providing good dollar value. For this reason, we should stop wasting time with technology that won't sell (CT-2 Plus mobile handsets) and look to other more useful services to offer the public. **CT**

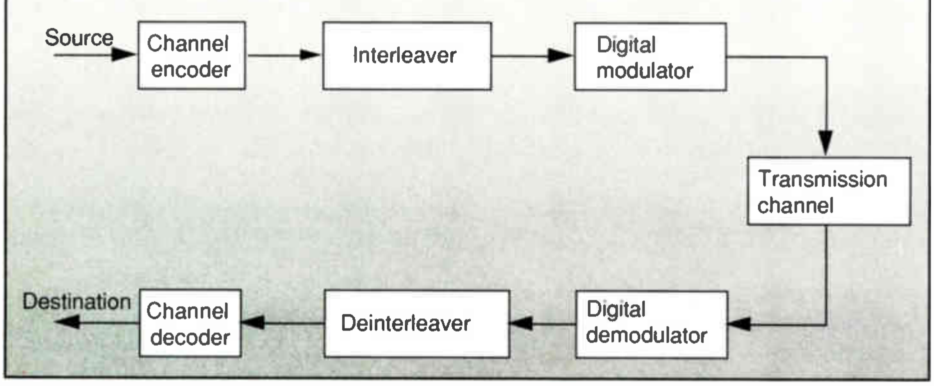


Figure 4: Diagram of a communications system employing interleaving for burst-error channel

Digital HDTV

(Continued from page 25)

time so that errors within a code word appears to be independent.

Another method for increasing the coding efficiency is to use concatenated block coding. A concatenated block code consists of two separate codes that are combined to form a larger code. Usually one code is selected to be non-binary and the other binary. The two codes are concatenated as illustrated in Figure 5. The non-binary code forms the outer code and the binary code forms the inner code.

The channel decoder extracts the digital information from coded information. Error detection and possible error correction also is performed by the channel decoder. The channel decoder performs the inverse operation of the channel encoder with more complexity used than the encoder, depending on the decoding algorithm used.

Digital modulator/demodulator

The digital modulator is the interface device that maps the digital information into analog waveforms suited to the characteristics of the (band-limited) transmission channel. The binary output of the channel encoder is converted into pulses of finite duration for transmission over the channel. At the receiver, the digital demodulator must convert these pulses back to binary 1's and 0's.

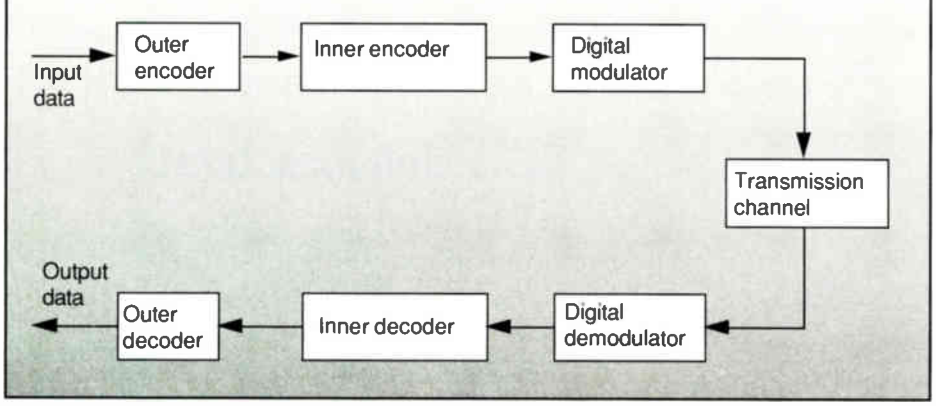


Figure 5: Diagram of a communications system employing a concatenated code

In choosing a transmission pulse shape, special considerations should be taken to limit the amount of intersymbol interference (ISI). ISI arises from non-flat frequency response and/or group delay response of the band-limited transmission channel. ISI results in spreading of the pulses in time such that the amplitude of a given pulse is influenced by the preceding and following pulses. ISI is a limiting factor in the band-limited transmission of digital pulses. With no ISI present, the transmitted pulse amplitudes will be at their optimal levels and the decision on a particular pulse amplitude would be simple to make. However, if ISI is present, a pulse amplitude may cross the decision thresholds and the wrong amplitude value selected.

Among the pulse shapes that minimize the transmission bandwidth and eliminate ISI is the Nyquist pulse shape. This pulse shape is best described by the fact that it has a frequency response with odd amplitude and even phase symmetry about one-half the symbol rate (Nyquist frequency). Depending on the amount of roll-off above the Nyquist frequency, a different pulse shape is obtained. A signal waveform generated using a Nyquist pulse has the property that at the sampling instant within each pulse interval, only the present pulse amplitude value is non-zero and all the other pulses values are zero at that time.

The modulator in a digital communications system may map a sequence of binary digits into a corresponding set of discrete amplitudes or a set of discrete phases or a set of discrete frequencies. The resulting signal waveform depends on the method by which the binary information sequence is mapped onto the modulated carrier wave. The modulation is represented by a vector in an appropriate signal space, such as discrete carrier amplitudes and/or phases at the sampling instant. If the modulator maps the information sequence into a corresponding set of discrete amplitudes, the modulation method is called pulse amplitude modulation (PAM) or amplitude shift keying (ASK).

The signal space or constellation diagram that represents PAM is illustrated in Figure 6 (on page 58) for $M = 2$, 4 and 8. We make two observations concerning the PAM signal space constellation. One is that the signal has a one-dimensional (vector) representation. Namely, that is the signal amplitude. Second, the signal points are selected to be symmetrical with respect to the origin.

The PAM carrier-modulated signal is a double sideband suppressed carrier (DSB-SC) signal and requires twice the channel bandwidth of the baseband signal for transmission. Alternately, we may use a single sideband (SSB) PAM where the spectrum of the signal is reduced by a factor of two in spectral width. Instead of using SSB, a vestigial sideband (VSB) PAM is more commonly used since SSB cannot transmit a DC component. The

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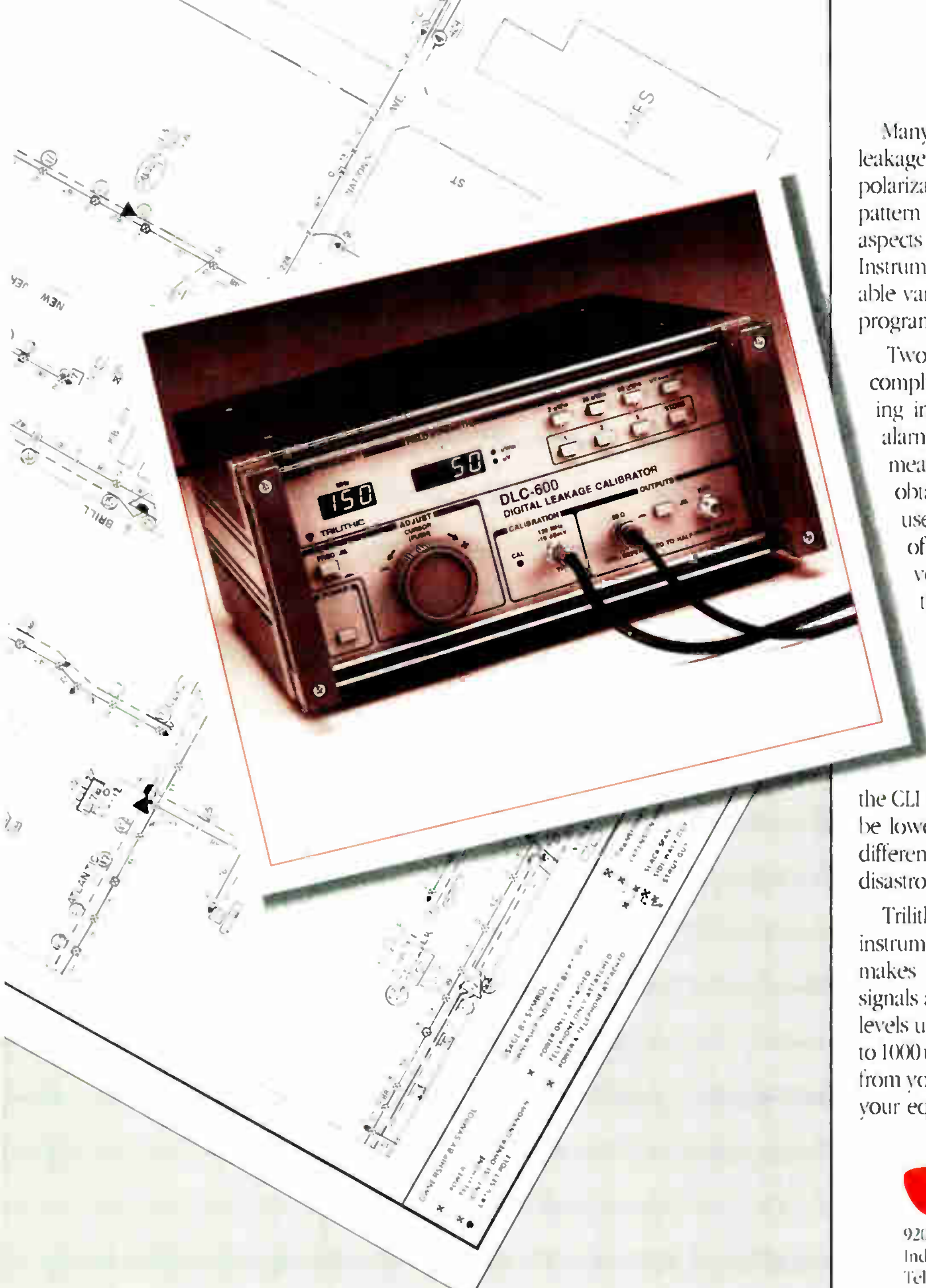

Many variables affect the accuracy of a signal leakage program. Some variables, such as leak polarization angle, distance correction and antenna pattern disruption, are difficult to control. Other aspects are more measurable and controllable. Instrument calibration is one of the more measurable variables and should be part of your leakage program.

Two classifications of instruments are used to comply with signal leakage regulations. Monitoring instruments include the products that only alarm in the presence of leakage fields. Absolute measurement instruments allow the operator to obtain an accurate measurement of the leak for use in computation of CLI figures. Both types of equipment need regular inspection to verify their conformance to stated specifications.

Inaccuracy in these instruments may have a dramatic effect on the system CLI figure. Inaccuracies in leakage measurements will directly translate into inaccuracies in CLI values. For example, if all measurements used in the calculation of the CLI were low by 3 dB, the CLI figure also would be lower than actual by 3. This could mean the difference between a favorable inspection or a disastrous one.

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Figure 6: Signal space diagram for digital PAM signals

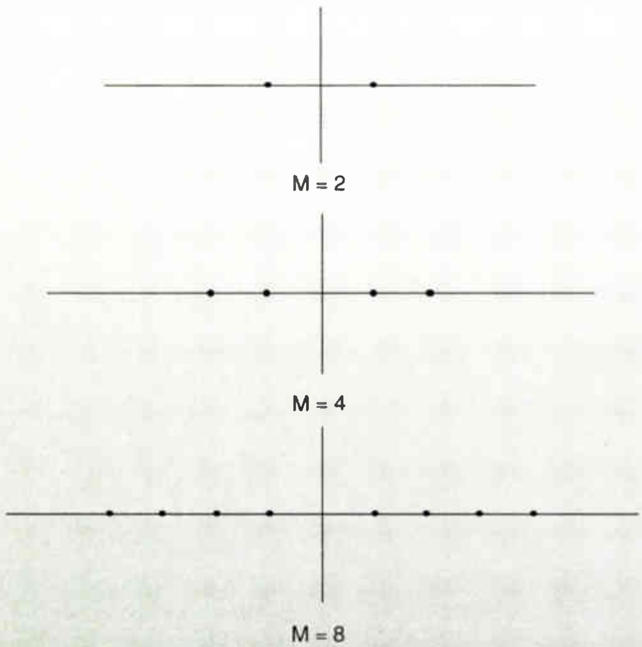
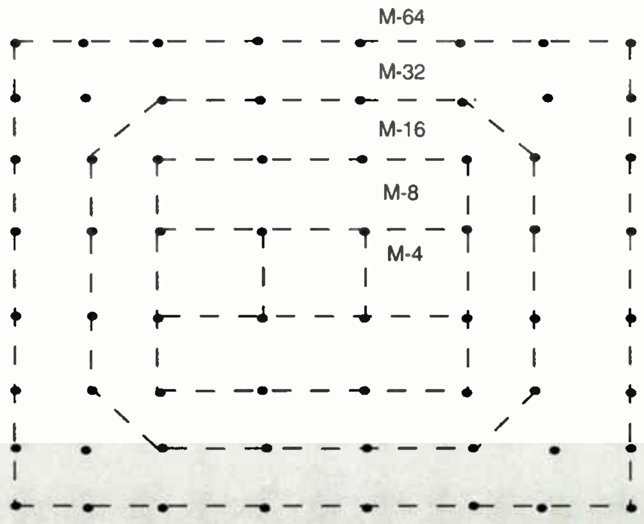


Figure 7: Several signal space diagrams for QAM



bandwidth efficiency of PAM/SSB also can be obtained by simultaneously impressing two independent symbol sequences on two quadrature carriers at the carrier frequency. The resulting modulation technique is called quadrature amplitude modulation (QAM). QAM signal waveforms are a form of combined amplitude and phase modulation. Several different constellation diagrams for QAM are illustrated in Figure 7 for M = 4, 8, 16, 32 and 64. We observe that the QAM signal waveforms result in rectangular signal space constellations when the amplitude values on the two quadrature carriers are equal.

At the receiving end of the digital communications system, the digital demodulator processes the channel-corrupted transmitted waveform and produces from each waveform a single number that represent an estimate of the transmitted data symbol.

Transmission channel

The transmission channel provides the data path between the source and the destination. The channel may be a twisted pair of wire, a coaxial cable, an optical fiber cable or free space over which the information is transmitted. Due to spectral limitations, the transmission channel possesses finite bandwidth, and the information-bearing signal often suffers amplitude and phase distortion as it travels over the band-limited channel. In addition, the signal power also decreases due to the attenuation of the channel. Furthermore, the signal is corrupted by unwanted, unpredictable signals such as noise and intermodulation products.

It is because of these limitations that extra efforts must be taken in designing systems that provide protection against such channel impairments. For the cable plant, impairments such as composite triple beat (CTB), composite second order (CSO) and microreflections causing ISI are the predominant factors. Therefore, in implementing a modulation scheme, these impairments must be taken into consideration to ensure reliable communication. Such techniques employed in the proposed digital HDTV systems will be covered in Part 2 of this article. **CT**

Author's note: I would like to thank C.K. Tanner and R.S. Prodan whose suggestions and criticisms have added significantly to the value of this article.

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FCC measurements

(Continued from page 26)

ence level, sweep speed and filter settings taken care of automatically. Measuring the amplitude and frequency of the visual carrier and aural carrier on any channel then requires only three more keystrokes.

To measure carrier levels and frequencies for every channel on your system, select the channel survey option from the "CATV/Applications" menu. Channel survey steps through each channel, performing visual and aural carrier level and frequency measurements. Results from the survey are stored in the analyzer's non-volatile memory as a file that can be viewed on the display, output to a printer or downloaded to a PC for report generation.

Aural carrier level and frequency

The aural carrier frequency must be 4.5 MHz ±5 kHz above the visual carrier frequency. This is not by any means a restrictive tolerance. Modern cable transmission equipment is typically much better than this. If a carrier were to stray beyond this limit, audible distortions might occur and the possibility of interference with adjacent carriers might increase.

Additionally, the aural carrier level must be between 10 dB and 17 dB below the visual carrier. This new allowable aural carrier level range is relaxed over the previous industry standard, with the old range being from 13 to 17 dB down. However, the new regulations also stipulate that the aural carrier must not interfere with the adjacent upper visual carrier, something that might happen when the aural carrier is only 10 dB down.

To center the channel you're measuring on the display, simply type the channel number on the front panel keypad. For the best signal level measurement accuracy using a spectrum analyzer, you must use the same RF attenuation for both the visual and aural carrier levels. So when moving the top of the aural carrier into the top division of the display, use only the reference level control; do not change the RF attenuator setting from the one you used during the visual carrier level measurement. Then switch back to 1 dB/division for better resolution. Set the sweep speed to 50 ms/division and span to 50 kHz/division and record the aural carrier amplitude and frequency. Subtract the aural carrier amplitude from the visual carrier amplitude, and subtract the visual carrier frequency from the aural carrier frequency. It's the differential results that are specified in the regulations, not absolute levels and frequencies.

Again, the aural carrier level and frequency values are determined automatically by the 2714 when using the embedded carrier measurement routine. If the aural carrier frequency is out of spec, look to the headend modulators for the problem. There's nothing in the transmission path that can cause a frequency shift between visual and aural carriers.

Stability

Making the visual and aural carrier measurements just discussed is fairly straightforward. Having to repeat the visual carrier level measurements twice a year, four times within a 24-hour period, at six or more points in the system (for systems with 1,000 or more subscribers), and on every video channel will be a significant undertaking.

The new visual carrier level stability requirements state that, in a 24-hour period, the visual signal level on each channel must not vary more than 8 dB. Further, no channel's visual carrier may be more than 3 dB above or below the carrier on an adjacent channel, and the difference between the highest and lowest visual carrier levels in a system may be no more than 10 dB. This 10 dB variation applies to systems with a 300 MHz upper frequency limit. For every 100 MHz above 300 MHz, the FCC gives you an additional 1 dB variation.

The 2714's channel survey application reduces these measurements to a few simple steps that take very little time: Connect the analyzer to the system, select the channel survey, and wait a couple of minutes for the results. If any problems surface during these tests, an automated sweep system would be an invaluable tool while identifying and isolating the fault.

Automation is the only answer

If you do some simple math, you'll find that a 1,000-plus-subscriber, 60-channel system is required to make 1,440 visual carrier level measurements two times a year. Then add to the basic level measurements all the calculations necessary to determine the variation in carrier levels, adjacent channel levels, and maximum visual carrier level differences in a system.

The sheer quantity of these required measurements and calculations cries out for automation. And these numbers don't include the four-plus channels on which you'll need to measure hum, coherent distortions, carrier-to-noise ratio and amplitude characteristic.

Microprocessor-controlled cable TV spectrum analyzers can be programmed to quickly step through these and many other RF measurements and log the data necessary to meet federal regulations. Without the level of automation they offer, it will be nearly impossible to perform the required tests on all but simple systems with very few channels. **CT**

October 1992

Testing and equipment usage

BACK TO BASICS

The training and educational supplement to Communications Technology magazine.

Rich Skiermont

Table of Contents

A tale of two TDRs

The following is a history, description and "back to basics" guideline for digital and waveform time domain reflectometers (TDRs).

By Duff Campbell
Vice President, Sales and Marketing
Riser-Bond Instruments

It was the best of times; it was the worst of times. Oops. Sorry, that's *A Tale of Two Cities*. This is the tale of two TDRs, although that first line does describe in a sense the story of TDRs, old and new.

Since World War II, the TDR has been a helpful but somewhat complicated and expensive troubleshooting tool. Because of today's very simplified and low cost models, the TDR is now enjoying renewed popularity.

The worst of times weren't really that bad, since even the oversized and overpriced TDRs of the past were cost-effective. However, today's models allow almost anyone from the first level technician to the highest level engineer to resolve cable problems faster and easier. Modern TDRs are helping to provide at least a better time, if not the best of times, when it comes to troubleshooting various cable systems.

TDRs are being used more extensively in all areas of telecommunications as well as many other industries utilizing cable. The high speed and very accurate results of a TDR make it a favorite among cable installers and maintenance personnel. It also is gaining popularity among power companies due to the non-destructive nature of the test. TDRs also have been developed for the testing of fiber-optic cable (OTDRs).

In the beginning

During World War II, Germany had miles of underground cable for communications purposes. A technique was needed to locate the breaks and loose connections in cables that could not be visually inspected. The TDR was invented for that purpose.

Whether the TDR is referred to as cable radar, pulse/echo, echometer or simply cable fault locator, the techniques used to locate cable faults are the same. This transmission and reflection technique is very similar to the radar used in ships and airplanes.

Figure 1: BNC-to-alligator clip probe

A TDR generates a signal that travels down the cable. When the signal reaches a cable fault (impedance change) or the end of the cable, all or part of the signal energy is reflected back to the instrument. The transmitted pulse and reflection(s) can be displayed and/or the transit time can be measured. The distance to the fault is then determined by how long it took for the pulse to make a round trip from the TDR to the fault and back again. The size and shape of the transmitted and reflected pulses indicates the size and type of the fault encountered.

Because of the pulse/reflection method of the instrument, the signal must travel down the cable, "see" a fault (or the end of the cable) and travel back to the instrument. If the signal is absorbed by a termination, no signal will return to the instrument and no readings will be displayed. For this reason, it is best if all equipment can be disconnected from the cable being tested.

Figure 2: Ringing in the baseline

Digital vs. waveform

Until the early 1980s, the waveform TDR was the only type available. The advent of very simplified digital numeric instruments has had a great impact on the popularity and usage of the TDR. A digital TDR is easier to operate and costs only a fraction of its more sophisticated counterpart, but is limited in both range and capability. It also will display only the distance to the fault.

Simplified digital TDRs bring with them both good news and bad news. The good news is that a digital TDR takes away all of the waveform interpretation. The bad news is that a digital TDR takes away all of the waveform interpretation. In other words, a digital model will many times suffice, but waveform models will always be needed for greater range, sensitivity and versatility.

Although there are many aesthetic differences, all TDRs operate on the same basic principle. Whether you use a traditional waveform instrument or a hand-held digital model, there are still rules to follow to help assure successful results with either type of instrument.

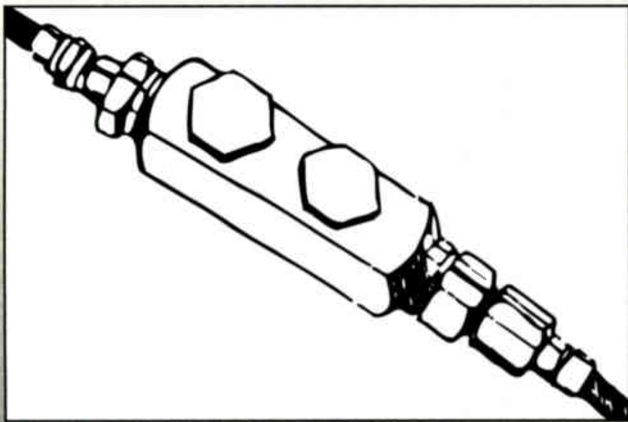
The golden rule for understanding any new piece of test equipment is: Read and understand the manual! This also is the rule most often broken. Perhaps it's human nature to find a shortcut. However, the shortcut usually ends up in added time and expense. This is especially true of the new simplified digital TDRs. They look so simple, why waste time reading the manual?

Don't forget the obvious

One of the most important and yet overlooked factors in using a TDR is simply the cable connection. Many times the success or failure of a test can depend on it.

As mentioned before, the TDR "looks" for a change in impedance. When the output pulse (a mixture of

Figure 3: Half-inch connector into a splice block



high frequency signals) of the TDR is transmitted onto a cable, the point of connection between the instrument and the cable will either pass the signal or reflect part of the signal depending on the quality of the connection. An operator may be fooled into false or inaccurate readings when, in reality, it was his own connection either causing (or masking) the problem.

The use of a BNC-to-alligator clip (Figure 1) probe (although quick and easy) causes an impedance mismatch at the point of connection. As shown in Figure 2, this type of connection may cause "ringing" in the baseline, which is hard to interpret and can mask smaller faults. A digital TDR (with no waveform) may be fooled into false triggering on the "ringing."

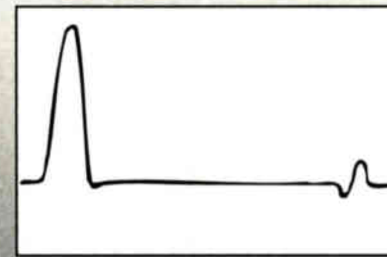
The proper way to make the connection is shown in Figure 3. By using a half-inch connector into a splice block into an entrance to an F-connector with a short piece of RG-59 to the TDR, a closed cable 75 ohm environment is maintained and the "ringing" (or false trigger) is eliminated (Figure 4), exposing smaller faults.

Remember to maintain a constant impedance. When testing 75 ohm cable, maintain a 75 ohm environment. When testing 50 ohm cable, maintain a 50 ohm environment, etc. Use connectors and adapters designed for the same impedance as the cable you are testing.

An important factor in assuring accuracy with a TDR is knowing the velocity of propagation (VOP) of a cable. VOP is the speed at which a signal will travel down the cable. The VOP of the cable is entered into the TDR to help "match" the instrument to the cable. A wide variety of cables and VOPs exist. If the VOP is wrong, the TDR distance reading also will be wrong. Refer to the cable manufacturer or your operator's manual for the correct VOP of the cable you are testing.

If a cable's VOP is unknown, it is possible to determine it. Begin by measuring a length (at least 100 feet) of undamaged cable identical to the type you wish to test. (The longer the cable, the more accurate the VOP obtained.) After connecting the TDR to the cable, if using a digital TDR, simply switch the range of the instrument to match the length being measured. Next, adjust the VOP switch until the digital readout displays 100 feet. If using a waveform TDR, adjust the waveform so that the output pulse and the reflected pulse (end of the cable) are on screen. Adjust the cursors on the leading edge of each reflection. Next, adjust the VOP switch until a 100-foot reading is obtained. The VOP has been determined.

Figure 4: Ringing in the baseline eliminated



Cable is "lossy." A signal is attenuated (loses strength) as it travels down the cable. Different cables have different loss factors or attenuation. For this reason, a TDR will test long lengths of some cables while it may test only short lengths of other cables.

Each TDR will have a variety of pulse widths that determines how large a signal or pulse is generated. The pulse width and the type of cable being tested determines how long a length of cable can be tested. Lengths of cable that can be tested may vary from as little as a few feet to over 50,000 feet. However, in reality, most tests will be from pedestal to pedestal, amplifier to amplifier, tap to tap, or alley to house.

Cutting down on mistakes

A TDR is the fastest, easiest and most accurate way to locate a cable fault. However, there are still factors that affect the accuracy of the test. Fortunately, there also are ways to reduce these errors.

VOP error, measurement error, map error, temperature, age, moisture, cable depth and cable snaking are just some of the factors that can cause problems in locating cable faults. By testing the cable from both ends, errors can be reduced or eliminated.

Using a cable locator and measuring wheel, determine the length and path of the cable being tested. Using the TDR, test the cable from both ends and record the distance readings. If the total of the two distance readings equals the measured length of the cable, the VOP is correct and the fault has been located. However, if the two readings total more (or less) than the measured length, additional steps can be taken to reduce the error.

If the total of the two readings is more than the measured length, change the VOP setting downward and retest. If the total is less than the measured length, change the VOP upward. For each change (upward or downward) in the VOP setting, retest the cable from both ends. Keep changing the VOP setting until the two readings equal the known (measured) length.

"(A) helpful hint when troubleshooting with a TDR is to always start in the shortest pulse width or range."

Testing a cable from both ends helps reduce error. It also can help uncover small or hidden faults. A fault contained relatively close to the instrument is easy to find. However, faults are sometimes located a long distance away.

If you test a cable from one end and cannot locate the problem, the fault may be too far away or too small for the TDR to locate. By testing from the opposite end, smaller partial faults can be located. The closer you can position yourself and the TDR to the problem, the easier it will be to find the fault(s).

A TDR pulse contains a blind spot or dead zone. If a fault is located in the first 5 to 15 feet of a cable, the fault is sometimes difficult to locate. Adding a length of cable between the instrument and the cable being tested can help uncover these hidden faults. Testing the cable from the opposite end also may help uncover the fault.

Another helpful hint when troubleshooting with a TDR is to always start in the shortest pulse width or range. Some TDRs have variable pulse widths or ranges to allow the testing of different lengths of cable. If you were testing a 2,000-foot length of cable, it would seem logical to switch your TDR to the largest pulse width or longest range, right? Wrong! Even though the cable is long, the fault may be contained only a few feet out. The fault would be masked by the large pulse.

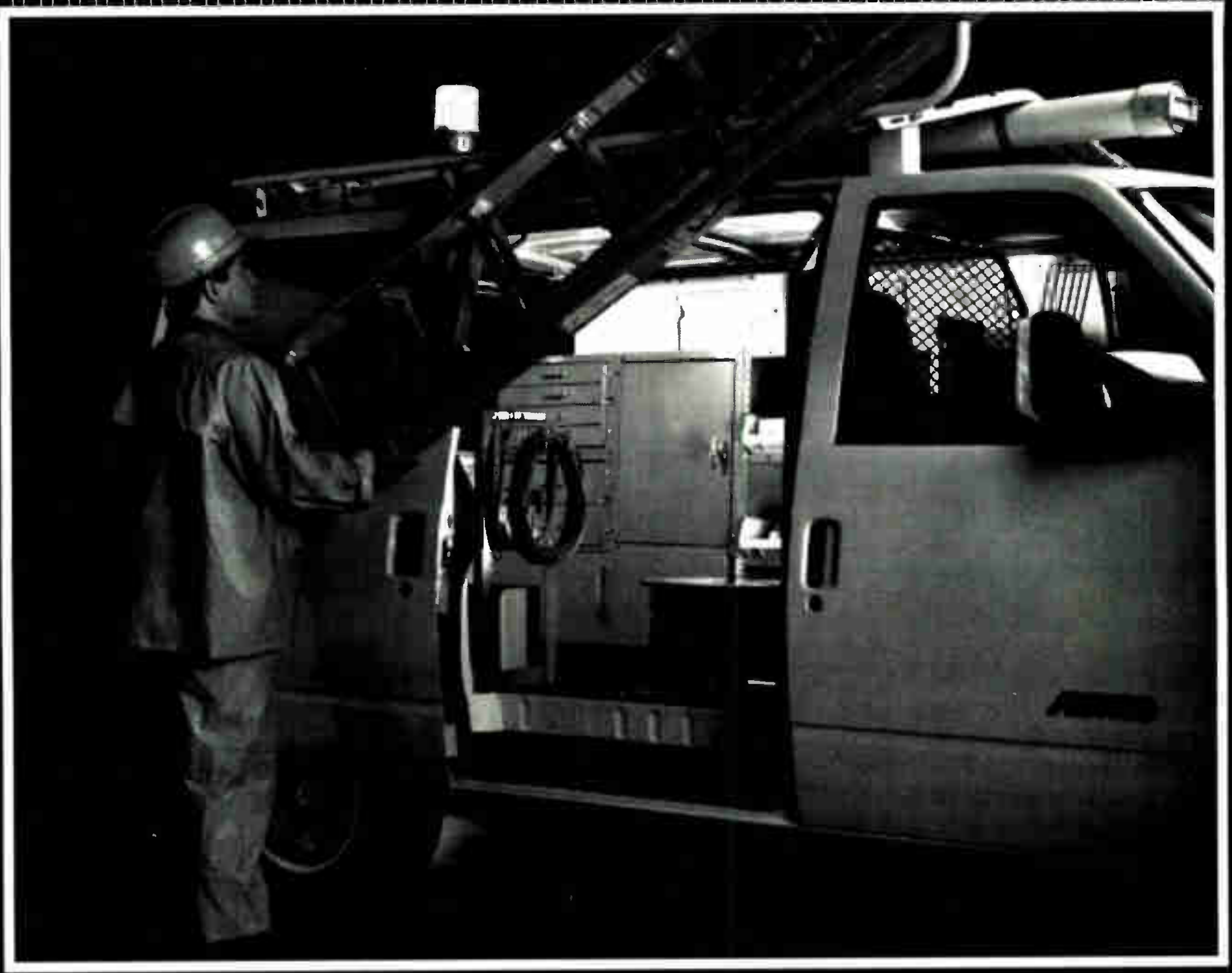
Always start in the shortest pulse width. If a fault is not seen, switch to the next larger pulse width and retest. Keep trying the next larger pulse width until the fault is located. If a fault is still not located, try testing from the opposite end and repeat the process.

Conclusion

Time and technology have greatly simplified today's test equipment, but nothing replaces experience and product knowledge. Familiarity develops versatility. The more you use an instrument, the more confident you become and the more successful you will be.

Whether you use a hand-held digital model or the more traditional waveform instrument or whether the equipment is old or new, use common sense, have a good understanding of the instrument and look for the obvious.

You cannot compromise in knowledge. To get to know something, you've got to study it. Experiment with your TDR in the shop, warehouse or out in the field. Test various type of cables and conditions. Learn what to expect before it happens. Getting to know your equipment better can make certain you enjoy the best of times rather than the worst. Thus, ends the tale. **BTB**



Spectrum analyzer basics

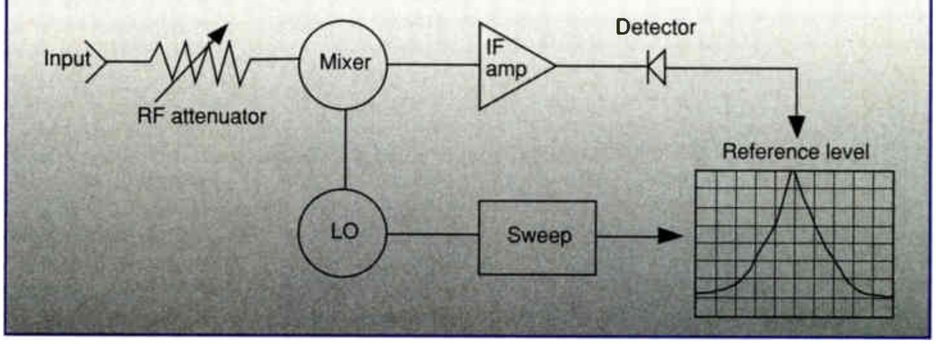
By Matthew P. Stanek
Technical Instructor
Time Warner Cable

Spectrum analyzers are one of the most useful test instruments available to cable TV engineers and technicians. A spectrum analyzer displays signal amplitude as a function of frequency (frequency domain information). From this information we can measure signal amplitude, carrier-to-noise ratio (C/N), and many different distortion parameters such as co-channel, cross-modulation and others. To successfully operate an analyzer, we must understand its makeup and controls. Although spectrum analyzers have become more advanced and more automated, the basic controls and the measurements we make have essentially stayed the same.

The super heterodyne spectrum analyzer (the kind used in cable TV), consists of an RF attenuator, low-pass filter, mixers, local oscillators, intermediate frequency (IF) amplifiers, a detector, a sweep generator and a cathode ray tube (CRT). Figure 1 is a simplified block diagram of a super heterodyne analyzer.

Signal processing is done at a single IF. The incoming signal is attenuated, mixed with the local oscillator (LO) creating the IF. The IF is amplified and passed to a peak detector. The detector output also is amplified, which causes a calibrated vertical deflection on the CRT. A sweep generator is used to synchronize the tuned frequency to the CRT horizontal deflection.

Figure 1: Super heterodyne analyzer



Major controls

The new generation of spectrum analyzers have traded in their old analog rotary control knobs for soft keys. In addition to the soft keys, there are marker functions, numeric input keys, automated test software and much more. But whether it's soft keys or knobs, the major front panel controls contained on an analyzer remain: the frequency control, span control, resolution bandwidth, sweep rate, reference level and the input attenuator control.

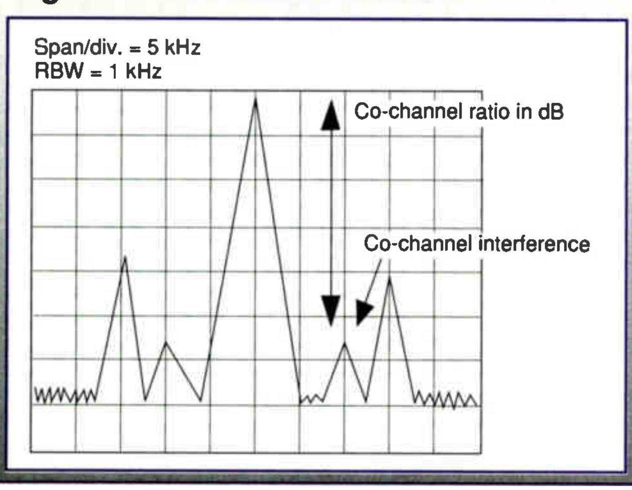
Frequency control

The frequency control determines the frequency reference. The selected frequency is displayed in the center of the CRT or on the first graticule depending on the mode of operation.

Span control

The span control sets the horizontal width of the frequency spectrum. The span width is read as span per division, which in turn determines the total frequency span across the display. If the span is set on 500 kHz/division, the CRT displays a spectrum of 5 MHz because the display is divided up into 10 horizontal and eight vertical graticules.

Figure 2: Co-channel interference



The analyzer has many span widths to choose from. There are two special span settings: "max span" and "zero span." The max span setting allows the analyzer to sweep across its entire frequency range. This will display the maximum input frequency range of a analyzer. In zero span the analyzer operates like a tunable oscilloscope displaying time domain information. This allows viewing of modulation on a carrier.

Resolution bandwidth

The resolution bandwidth control selects the analyzer's 3 dB bandwidth. The 3 dB bandwidth setting tells us how well closely spaced signals can be distinguished from each other. Resolution is determined by the IF filter bandwidth.

When determining resolution, there are other factors to consider such as the shape factor, filter type, LO stability and sideband noise. When selecting IF bandwidth, we must allow the detector enough time to fully respond to the amplitude of the incoming signal. The time required depends upon the IF filter.

To check for amplitude errors due to an incorrect sweep setting, slow down the sweep speed and look for amplitude variations. Most analyzers have a warning system to alert the operator when the sweep rate is too fast. The sweep control selects the sweep speed of the analyzer and is read as microseconds per division.

Reference level and input attenuation control

The reference level control varies the level of the signal necessary to produce a full screen deflection on the CRT. The input attenuation control allows us to select the amount of attenuation the signal encounters just after it enters the analyzer. This controls the level to the first mixer and lets us keep

high amplitude signals below the compression point, thus allowing us to measure their amplitudes accurately.

Compression is input overload caused by excessive levels at the first mixer. The operator can test for compression by inserting 10 dB of RF attenuation. If the display level changes other than 10 dB, the analyzer is in compression, resulting in an inaccurate measurement.

Amplitude measurements

There are two kinds of amplitude measurements: absolute and relative.

An absolute measurement is taken by placing the carrier at the reference level graticule, giving you a carrier at a known reference level. The absolute level is the graticule at which the analyzer has been calibrated, usually the top or second graticule.

A relative measurement is taken at a level below the reference graticule and is compared to the reference level or another carrier to derive its level.

To make an absolute amplitude measurement, the signal must be positioned on the reference line with the reference level control. The level of the signal is then determined by the position of the reference level control. When making amplitude measurements below the reference line, the inaccuracies can become an inhibiting factor due to but not limited to the CRT linearity and log amplifier fidelity.

Carrier-to-noise

The spectrum analyzer generates and amplifies noise. The noise is generated after the mixers in the IF amplifiers. This is important when measuring C/N. The RF input attenuator setting will affect the C/N measurement. C/N should be measured with the lowest RF input attenuation (without causing the analyzer to go into compression). The displayed noise will change with IF filter bandwidth changes. As you change the IF filter bandwidth you can observe the noise floor change 10 dB per decade of bandwidth change as indicated by the following formula:

Change in noise = $10\log(BW_2/BW_1)$

Where:
BW_2 = new resolution bandwidth
BW_1 = original resolution bandwidth

All spectrum analyzer noise is specified in reference to a specific bandwidth. An analyzer's lowest noise level is achieved with its narrowest resolution bandwidth. In C/N measurements noise is referenced to a 4 MHz bandwidth. To measure C/N, peak the carrier to the reference graticule using the reference level control. If you are using a tunable bandpass filter to limit the amount of noise or if you need to use a preamplifier to obtain minimum input requirements, you also will need to peak the carrier by tuning the bandpass filter. Select the lowest possible input attenuation without causing analyzer overload. Tune the analyzer to view the noise floor. Narrow the frequency span enough so only noise is visible on the CRT. Use the video filter to average the noise floor.

You also will need to check for low noise conditions, which will ensure that you are measuring the noise in the signal and not the noise floor of the analyzer. This is done by removing the input from the analyzer and observing the noise floor. The noise floor should drop at least 8 dB. If it doesn't, a correction factor supplied by the manufacturer is needed to correct for the noise contributed by the analyzer. C/N is the ratio between the carrier peak to the

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averaged noise. To convert the measured C/N ratio to a referenced 4 MHz bandwidth we use the following formula:

10log(4 MHz/selected resolution bandwidth multiplied by the detection error) + any errors caused by the IF amps

Where:
Manufacturer will provide you with the calculation numbers for these errors.

Co-channel

A spectrum analyzer is extremely helpful in measuring picture impairments. One type of interference is co-channel, which is caused by undesired channels on the same frequency as the desired channel being picked up through the antenna at the headend. When broadcast stations are using the same channel and are within pickup distance of each other, the Federal Communications Commission will call for a frequency offset of ±10 kHz to minimize interference.

When measuring co-channel, center the carrier of interest on the display. Set the span/division to 5 kHz and set the resolution bandwidth to 1 kHz. The operator will have to slow the sweep rate to ensure there is no scan loss. Therefore, the true amplitude of the signal is being displayed. The co-channel can be viewed two graticules either side of the center carrier, ± 10 kHz, as shown in Figure 2 (page 66).

A maximum frequency difference of 20 kHz can exist. The measurement is the difference in peak amplitude of the desired carrier to co-channel interference.

Direct pickup

If you are carrying a broadcast channel on its original frequency you may see a leading ghost caused by ingress or direct pickup due to the distribution delay. This is sometimes confused with co-channel.

Direct pickup on a channel carried within a standard frequency system, which provides a different network or other information (such as a character-generated channel on a local broadcast frequency), appears as moving bands across the screen. These bands are the high level horizontal sync tips from the interfering channel. The movement of these bands is dependent on the TV receiver's horizontal scan rate, which is synchronized to the selected signal but not usually synchronized to the interfering signal.

The visible effects from direct pickup in a harmonic related carrier (HRC) system are moving diagonal lines in the TV picture. The reason for this is the HRC frequency allocation is nearly 1.25 MHz below that of a standard system (which the broadcasters use).

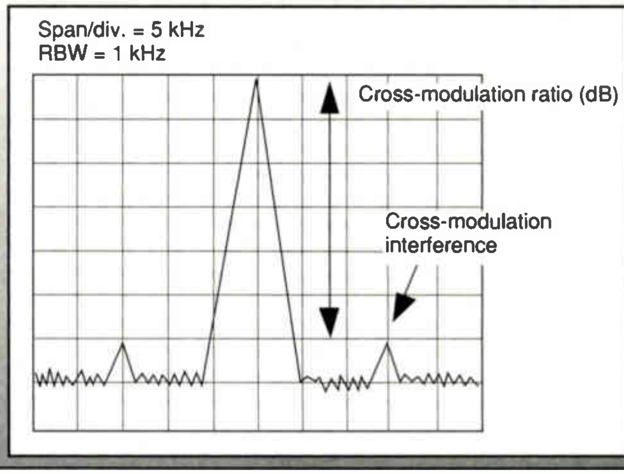
Therefore, any direct pickup will fall 1.25 MHz above the video carrier appearing as an intermodulation beat causing devastating picture impairments. Direct pickup also can be measured using a spectrum analyzer, unless the affected channel is a broadcast channel being carried on-channel. To measure direct pickup tune to the carrier of interest. Set the span/division control to 1 MHz and the resolution bandwidth to 100 kHz. Turn off the channel at the headend and measure the remaining interfering signal located on the same frequency as the carrier of interest you have selected.

Cross-modulation

Cross-modulation, or X-mod, is a form of third order distortion that is easily measured with an analyzer. However, this form of distortion does not result in new frequency products but in a form of compression causing information from one channel to be modulated on another. X-mod is caused by operating an amplifier in the non-linear portion of its characteristic curve.

To measure X-mod, an unmodulated carrier is needed. Tune to the unmodulated carrier of interest. Center the carrier. Set the span/division control to 5 kHz and the resolution bandwidth to 1 kHz/division. The operator will need to slow the sweep rate to ensure the true amplitude of the signal is being displayed, verifying there is no scan loss. Since unmodulated carriers have no sidebands, if any X-mod exists it can be measured at 15.734 kHz on either side of the carrier (approximately 3 graticules on either side of the center). An X-mod example is shown in Figure 3. When measuring X-mod, we express it in dB relative to 100 percent modulation. To express X-mod in a percent we use the following formula:

Figure 3: Cross-modulation



$$\% \text{ X-mod} = 10^{(\text{X-mod measured in -dB/20})} \times 100$$

Referring to Figure 3, we measure the X-mod to be -60 dB. Using the formula just given, we can calculate a percentage of X-mod to be 0.1 percent.

Many other measurements such as amplitude modulation, composite triple beat, depth of modulation, electromagnetic interference, frequency modulation, hum, second order and terrestrial interference can be made using a spectrum analyzer. The specifics of such material are beyond the scope of this article. For specific measurement information you should consult the operating manual for your analyzer. Also, there are a number of technical handbooks, manuals and various reference materials available from analyzer manufactures that can aid you in making these measurements.

No other single piece of test equipment can match the versatility and value of a spectrum analyzer. It is an essential piece of test equipment for the cable TV industry. **BTB**

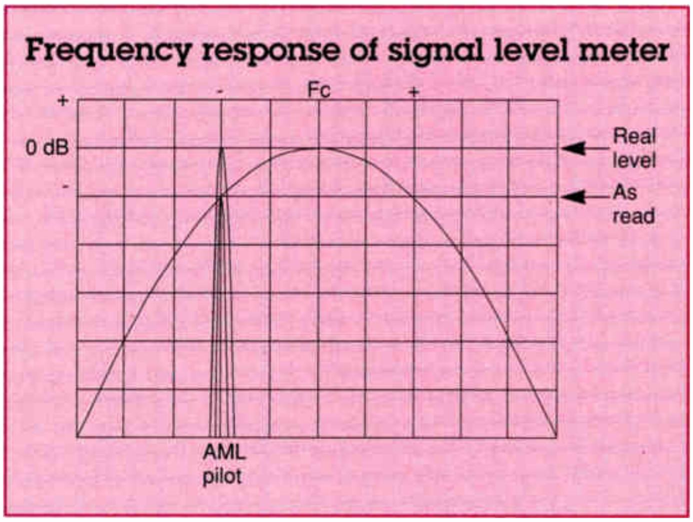
References

1) American Television & Communications Corp., *Tech II Training Manual*, 1982.
2) Hewlett-Packard, *Cable Television System Measurements Handbook*, January 1977.
3) Hewlett-Packard, *Operation and Service Manual, 853A Spectrum Analyzer*, August 1982.
4) Tektronix, *Spectrum Analyzer Fundamentals*, 1989.

A brief look at test equipment

By Dane Walker
Senior Systems Specialist
Hughes Aircraft Co.

Looking at the tests normally run on a cable system, it turns out that very little test equipment is needed. In most cases tests are being run with very little thought about the equipment being used. Frequently, the test equipment is used to only about 50 percent of its capacity, and anyone needing to go past that point is lost. This is a look at some of the different types of test equipment we use and what they do.



SLM function and use

The function of a signal level meter (SLM), whether it's been in service for years or one of the new types, is to measure peak signal level at a given frequency. *(Editor's note: Technically, an SLM measures the RMS value of the instantaneous sync peak of a visual carrier, or the RMS value of a CW carrier.)* The main difference is that the newer units do most measurements automatically, such as carrier-to-noise measurements and hum modulation, which the older units also can do, but with a great deal of user work. Get to know your SLM — it can do more than just measure level. But remember that what you measure is dependent on frequency.

Most of the newer units are also tuned via a preprogrammed synthesizer and, for that reason, may not tune non-standard frequencies. Take one of the new type meters and tune it to the pilot of an AML and read the level. Then adjust the XO to the end of its range. The level on the SLM appears to change. This is not actually due to a true change in level, but to the fact that the new frequency is starting to fall outside the frequency range of the meter as tuned. The accompanying figure shows the effect of an SLM frequency response to a signal on the skirt of its bandpass. Signal meters measure level at the frequency they are tuned to. If you change the frequency by more than 1 kHz you should retune the meter.

One other instrument used to measure levels is a spectrum analyzer. However, an analyzer costs many times the price of an SLM and when it comes to measuring levels, the SLM wins hands down (not to mention trying to climb a pole with a $35,000 analyzer). One thing to remember when using the SLM in an AML system, is that transmitter output power cannot be read directly due to the frequency involved. A special microwave test set can, however, downconvert the microwave signal to a VHF signal the SLM can read. The test set is calibrated as to conversion gain. By subtracting this number (around 12 dB) and 48.75 dB (conversion from dBmV to dBm) from the reading on the SLM, you will end up with the microwave level in dBm. Pick the proper instrument for the job and forget about the image of high-priced test equipment and you will get the job done.

VOMs and DVMs

The voltage relating to a video signal is, in fact, a very complex and high frequency AC voltage. But at the other end of the spectrum we also need to measure both AC and DC voltages. For this use a volt-ohmmeter (VOM) or a digital volt meter (DVM). They both measure voltage, current and resistance. The main differences are that the DVM will give better resolution (somewhere around .01 volts in the low voltage ranges) and it is direct-reading (which means we no longer have to search for the proper scale).

For example, when using an older analog VOM, a typical reading might be about 8 volts. With the DVM the reading is more like 8.12 volts. However, for most of what we do, a reading of 8 volts is just fine. I guess it is the same principle as having a digital watch — it is nice to know the time to the second, but within 5 minutes works for most of us. One of the confusing things about the old VOMs is all the scales, including a "dB" scale. This is very useful for doing a quieting test on two-way radios, but isn't really used in the world of cable TV.

In most cases the use of the instrument is very simple: select the thing you want to measure, set the scale (if needed), turn on the instrument, hook up the leads and read the meter. Sounds simple? It can be if you keep a few simple rules in mind:

1) When we measure voltage we are looking at the potential difference between two points, such as a hot lead to ground or a drop across a resistor; AC or DC it's the same.

2) Current is the flow of electrons through a wire or circuit, and for that reason the test requires the circuit to be broken and the meter to be placed in series, not parallel as in a voltage measurement.

3) Resistance is the measurement of opposition to the flow of current and is measured in ohms — it is a series measurement of a non-active circuit.

A word of caution: When using any of the auto-polarity DVMs, it is sometimes best to check in both polarizations, i.e., reverse the leads. In some cases a meter will not read the same in both directions, and what is thought to be a bad measurement may, in fact, be good or the other way around. If you find a problem like this, try using a good VOM and send the DVM out for repair. All test equipment is only as good as the person

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"Most of the newer (SLMs) are also tuned via a preprogrammed synthesizer and, for that reason, may not tune nonstandard frequencies."

using it. Read the manual and ask your fellow workers, but don't fall into the trap of thinking that because someone has been doing their job for five years or more that they have all the answers. In some cases they only do what they do because it's the way they were shown.

Frequency counters

With the requirements set forth in §76.612 of the FCC rules, we see a renewed emphasis placed on frequency measurements. The price of counters used in cable TV ranges from about $100 to over $7,000. Most of us ask, what is the difference, and is one as good as the other if both are calibrated? Like the DVM, all have a digital display. The big difference in price comes from accuracy — or better put, the accuracy of the time base over time and temperature, frequency response (how high in frequency it will read), sensitivity and resolution. Time base accuracy is expressed in what is known as parts-per-million (PPM). A high-quality counter will have a time base of better than one part in 10^{-7}, or another way of looking at it is that if the time base is 10 MHz, its normal acceptable frequency error would be within 1 Hz.

Very few counters will measure signals with modulation on them, and the ones that will generally have a lower accuracy time base. With this in mind, select a counter with the necessary accuracy for which you are measuring. Microwave systems require higher-accuracy counters than would normally be required for a cable TV system. In either case, the counter must be calibrated and traceable to a standards laboratory so the FCC is satisfied that the measurements made were done with properly maintained equipment.

Conclusions

We have taken a brief look at signal level meters, volt-ohmmeters and frequency counters and how they are used. The same instruments can be used in many other ways to give us useful data in maintaining our cable TV systems. Accurate recording of measurements can aid in troubleshooting and provide a baseline to use in assessing system degradation.

Talk to your fellow employees and ask for help if you are unsure of how a measurement relates to your system. Take the time to join a local SCTE chapter. You will find a number of people with a high level of expertise who are willing to help you. Keep current with the latest developments by reading various technical magazines in the field. Pick up a copy of *The ARRL Handbook* for amateur radio — it is loaded with basic data to help us better understand electronics and communications. Attend local seminars whenever possible, and keep asking questions. Follow these simple steps and you will find that errors in maintenance and troubleshooting due to improper use of equipment will be a thing of the past. **BTB**

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Tools and personal protective equipment — Part 1

By Michael H. Morris
President, Taylor, Morris & Associates

Frequently we pick up a tool, assume we know how to use it, assume that it's safe to use and then use it, perhaps in a manner that is not consistent with its intended purpose.

Although the Occupational Safety and Health Administration does not (generally) tell an employee how to use certain tools, it does provide guidelines and mandates that define the tools and personal protective equipment that cable TV employees frequently use and (by intent of the OSHAct) should be trained in respect to. The Telecommunication Standard, Title 29, Part 1910.268, defines specific regulations that apply to cable TV. Areas that are not covered under this standard are addressed in Parts 1910, 1910.12, and applicable standards contained in Part 1926 and other sections, acts and standards as may apply.

This article will address requirements in the Telecommunication Standard, Part 1910.268 (section headings A to S). This is a standard with which every cable TV technician and manager should be familiar. Elements of the standard cover (but are not limited to) the following: tools and personal protective equipment; ladders; pole climbers; body belts; gaffs; safety straps; hard hats; eye protection; aerial lifts; and the test methods that ensure the personal safety equipment you use is properly inspected and is in good condition.

As an example, OSHA does not tell you how to climb a utility pole. However, OSHA (through the Telecommunication Standard) tells you the general requirements and the specific requirements, including field tests, that your climbing and safety equipment must meet.

As an example (paraphrased for ease of reading), the entire body belt assembly, including the safety strap, shall be tested using one D-ring. The safety strap shall be attached to the D-ring, with the other end of the safety strap attached to a rigid support, a 250-pound "canvas" sack filled with sand shall be secured to the body belt that simulates the waist of a man and shall be dropped from a height of 4 feet, free fall.

The standard continues: "Failure of the body belt shall be indicated by any breakage or slippage sufficient to permit the bag to fall free from the body belt." Additional caveats that would remove the belt and safety strap from service would include the following: exposed rivets on the inside; belts not meeting American Society for Testing and Materials B117-64 (50-hour test); belts constructed before July 1, 1975 (unless they have passed extensive testing); belts less than 3 inches in width or less than 5/32-inch thick; and many more.

Pole climbers

So what does OSHA say about pole climbers? Part 1910.268, Section 3, clearly defines that pole climbers shall be inspected by a competent person before each day's use and a gaff cutout test performed at least weekly, when in use.

OSHA's test criteria includes, but is not limited to: "Pole climbers may not be used if the gaffs are less than 1-1/4 inches in length as measured on the underside of the gaff" and "fractured or cracked gaffs or leg irons, loose or dull gaffs, broken straps or buckles ... shall be corrected before the climbers are used."

No doubt discussions about when climbers should and should not be worn have been repeated over and over by technical people all over the country. Here is what OSHA says: "Pole climbers may not be worn when working in trees (specifically designed tree climbers shall be used for tree climbing), working on ladders, working in an aerial lift, driving a vehicle, nor walking on rocky, hard, frozen, brushy or hilly terrain."

Ladders

So what does OSHA say about ladders? Once again paraphrasing, the Telecommunication Standard says a competent person shall inspect and verify that the ladder is in good condition and adequately strong for its intended purpose. Ladders, in general, should be inspected before each use for mechanical problems including broken, cracked or missing steps; broken or cracked feet, rung locks or strand hooks; severely weathered or bleached fiberglass; severely peeling fiberglass; and other structural damage as may be visible. Additional inspection procedures can be found in your company safety inspection procedures as apply to ladders. If your company does not have a written policy concerning ladder inspection, the manufacturer of your ladder can provide you with appropriate inspection procedures.

Hard hat

OSHA addresses the use of hard hats and eye protection in extensive detail in various acts and standards. If you are working underneath a helicopter, you must have a chin strap on your hard hat. Generally, cable TV employees do not work under helicopters. Hence, your requirements are different.

Cable TV hard hats must meet the requirements of ANSI Z89.2-1971, "Safety Requirements for Industrial Protective Helmets for Electrical Workers, Class B." Hard hats shall be provided whenever there is exposure to possible high voltage electrical contact and the employer shall ensure that the head protection is used by employees. Meat cutter hard hats do not (normally) meet this requirement as they do not protect the wearer from high voltage contact. In other words, if your hard hat is not stamped with the ANSI code, it is not adequate.

Eye protection

All eye protection equipment (for the Telecommunication Standard) must meet the requirements of Title 29, Part 1910.133(a)(2) through (a)(6) and shall

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Made in America by Drake...a world leader in communication products since 1943 be provided. The employer shall ensure its use by employees where foreign objects may enter the eyes due to work operation such as (but not limited to) drilling, chipping, grinding, cleaning operations using compressed air, steam or sand blast, using stud drivers, tree pruning, handling battery cells and solutions, and any other activity that would create the possibility of foreign matter entering the eyes.

Who's your "competent person"?

Through the course of this article, we have used the phrase "a competent person shall inspect tools and personal safety equipment prior to each use." So, what does this phrase mean? The OSHAct defines a competent person as an individual that has demonstrated proficiency in the safe and healthy completion of various work tasks. CFR Title 29, Part 1910.268, states: "Employers shall provide training in the various precautions and safe practices described in this section and shall insure that employees do not engage in the activities to which this section applies until such employees have received proper training in the various precautions and safe practices required by this section."

To answer the question, a competent person has not only demonstrated safe and healthy completion of various work tasks, but also has been trained and/or has demonstrated experience in understanding the Telecommunication Standard and its application to cable TV.

Additional training required by the Telecommunication Standard, where appropriate, is:

1) Recognition and avoidance of dangers relating to encounters with harmful substances, and animal, insect or plant life;

2) Procedures to be followed in emergency situations; and

3) First-aid training, including instruction in artificial respiration.

Training, by its broadest definition, is a tool. Training is the most important tool that we have at our disposal. To best utilize that tool, each of you should be familiar with and understand the basics of the Telecommunication Standard and other acts and standards as required by OSHA.

That same word "training" comes up once more. Training is the best tool we have. The avoidance of training is akin to throwing away your most valuable tool. **CT**

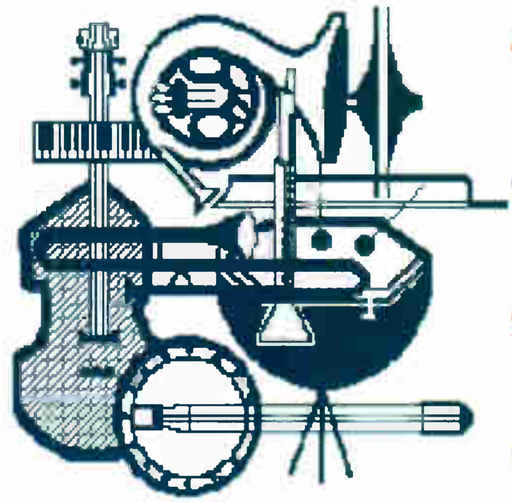
Planning your 1993 budget? Don't forget:

Society of Cable Television Engineers

Conference on

EMERGING TECHNOLOGIES

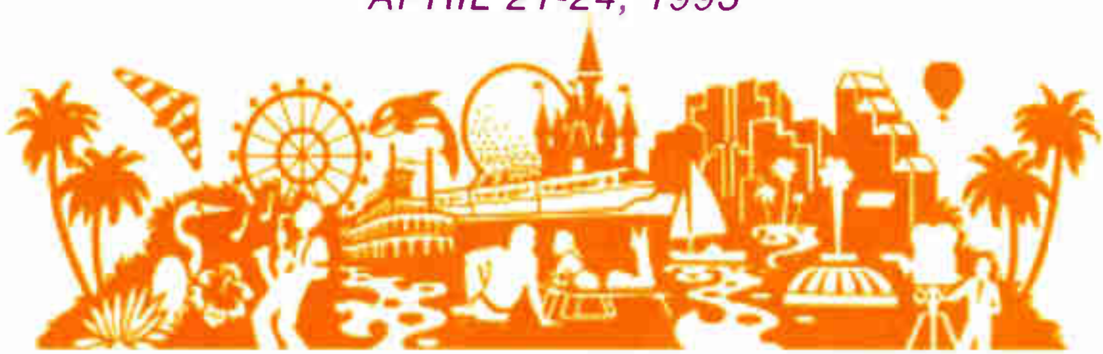
January 6-7, 1993
New Orleans Hilton Riverside
New Orleans, Louisiana



SOCIETY OF CABLE TELEVISION ENGINEERS

CABLE-TEC EXPO® '93

ORANGE COUNTY CONVENTION CENTER
ORLANDO, FLORIDA
APRIL 21-24, 1993



Registration fees for both seminars are $195 for SCTE members!
For further information, contact SCTE at (215) 363-6888.

Reader Service Number 1

Memories

By Frank J. Ragone

When I joined Jerrold in June of 1950, the company was producing two products: the MUL-TV apartment amplifier system and the consumer set-top signal booster. Hank Arbeiter, the chief engineer for Jerrold, informed me that we had a major installation in the Parkview Apartments, a four-building apartment complex in Collingswood, N.J., just a few miles from Philadelphia.

What necessity spawns

We first developed a new line of high output (1 volt) single-channel vacuum tube amplifiers, wall taps and other accessories, and started the installation. To enable us to set amplifier levels, check subscriber levels and check picture quality, we purchased a 10-inch Philco TV receiver and calibrated the IF-AGC voltage vs. signal level for each of the three local VHF channels (3, 6 and 10). We mounted two meters on top of the TV set, one for AGC voltage and the other for detector output reference. With the aid of a series of homemade attenuator pads and a commercially available toggle-switch variable attenuator, we were ready to meet the challenge and complete the big assignment.

For three or four days, Hank and I grunted, groaned, stumbled and two-stepped as we picked up the huge TV set, walked it in and out of the car, in and out of the four Parkview lobbies, in and out elevators, up and down hallways and in and out of apartments.

One morning, Hank and I faced each other and admitted that the most difficult part of the project was lugging the TV set around. We had to make that task easier. Since it was a large wooden cabinet, we decided to attach handles to the sides. We bought two large commercial handles and bolted one onto each side. We not only created the prototype of a signal level meter (SLM), but in just a few days, we made it a portable SLM!

The progress of the new MUL-TV system didn't seem to impress anyone. But the handles — wow! We received praise from everyone at the little factory, praise from the production manager and praise from the purchasing agent. We were even complimented by each of the four lobby guards, who noted that we no longer shuffled across the lobby but walked effortlessly through the doors and to the elevator.

Necessity is indeed the mother of invention. Wow — handles!

Vintage ghost cancellation

The architects for the Parkview Apartments provided cable conduit from the antenna site on the roof directly to the basement and a series of conduit risers from the basement past each apartment complex to the top floor. Thus, the TV signals could only be delivered from the antenna site to the basement and then back up to the top floor of the building.

> ***"Finally, if all else failed, we recommended rabbit ears."***

You guessed it. The signals delivered to the top floors were at typical levels, but direct pickup signal was at the strongest levels. Customers in the apartments facing Philadelphia complained of ghosting. Hank and I went back to Parkview and split the signal in the basement and installed four additional repeaters (one in each wing). While that helped to reduce the ghosting effect on the top floors, it didn't eliminate it.

Some of the 1950s vintage TV sets included sections of aluminum foil covering on the interior of the sets to prevent discoloration of the finely polished wooden cabinet due to the internal heat. The foil aggravated the ghosting problems. We discovered that by carefully orienting the TV sets, we could reduce the ghosting to acceptable levels. Of course, we had limited orientation range and cautioned the tenants not to change the "setting."

In other locations, we replaced the twin lead antenna connection to the tuner with a coaxial lead. Finally, if all else failed, we recommended rabbit ears.

Oddly enough, the tenants were so anxious to have TV signals, they accepted our ghost canceling recommendations. They didn't approach the wonderful ghost canceling circuits proposed for today's receivers, but I guess our one-on-one service sold the vintage techniques. (I know. Why didn't we convert the signals? That light bulb went on a few years later!) **CT**

Frank Ragone is vice president of engineering for Comcast Cable Communications, a Philadelphia-based MSO. Prior to joining Comcast in March 1982, he was vice president of engineering for Jerrold Electronics, where he was employed since June 1950.

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Reader Service Number 32

Spectrum analyzers

Tektronix announced its 2790 Series of ruggedized portable spectrum analyzers for applications requiring mid-range performance. The 2790 Series, with just four members, incorporates all of the performance features previously covered by nine spectrum analyzer models. It covers various frequency ranges from 100 Hz to 325 GHz with resolution bandwidths from 10 Hz to 3 MHz.

A logical front-panel layout reduces clutter with a combination of menus, soft controls and dedicated controls. The most commonly used functions, such as center frequency and marker placement, are tied to dedicated controls for direct and immediate access. Yet less often used features are still quickly and easily accessible through a menu system that is typically only two deep and never more than three deep. Additionally, menus and spectra are simultaneously displayed so that the effects of a menu selection can immediately be seen.

Reader service #180

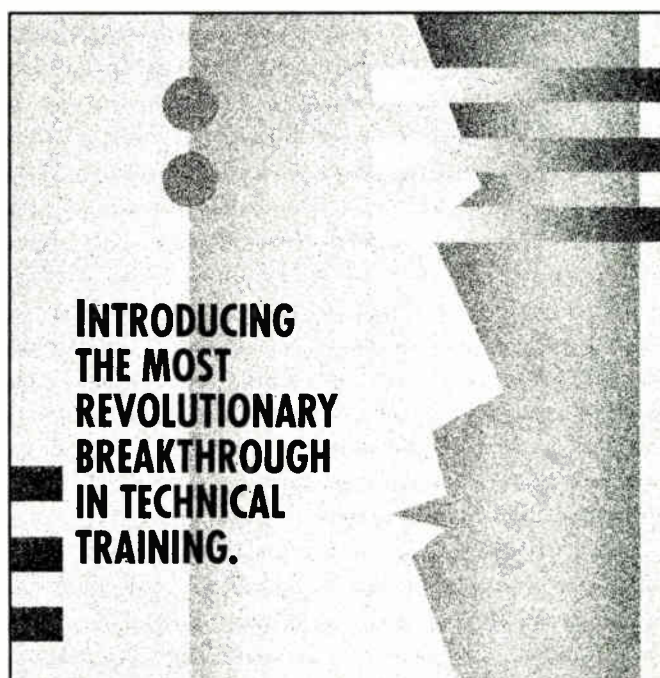
Fiber test software

Photon Kinetics introduced new software for its FiberCheck 5000 remote fiber test system, which enhances the system's versatility and range of applications. The system now features remote OTDR operation, automatic splice location, data base development, unattended automatic fiber testing and direct access to remote test units in field locations.

FiberCheck 5000 allows fiber network operators to remotely access optical fiber cables and perform a full range of fiber analysis operations from a single location. It reduces expensive network downtime by reporting cable faults with reference to specific landmarks so repair crews can be dispatched quickly to the precise fault location.

OTDR emulation capability allows a full range of fiber analysis for routine maintenance activities. OTDR emulation makes it possible for a single splicing technician with a laptop computer and modem to measure each splice during installation. At the same time the technician can develop complete, consistent network documentation that is stored in the FiberCheck 5000 system.

Reader service #209



Console

Winsted Corp. has introduced System/90, a contemporary design for Winsted consoles. System/90 provides flexibility in designing consoles of virtually any size and configuration for editing, production and security systems. The modular construction allows the system to be added to or rearranged as needed.

System/90 consoles feature extra-deep shelves, providing space for the largest SEF. Wraparound consoles are available to fit 45° or 90° corners. Newly designed bases provide comfortable carpeted foot rests. Console frames are of strong steel construction for mounting the heaviest electronics. A variety of optional accessories are available, including flat shelves, rack slide kits, power supplies, blank panels and more. Winsted offers sides and tops in every PMS color and will match a customer's color swatch or custom design the consoles to match any studio decor.

Reader service #208

European tap

Electroline Equipment Inc. unveiled SuperTap, a compact 1,000-MHz tap that can be used as a standard multitap or, with a change of faceplate, as an addressable tap. The SuperTap is compact and offers cable TV operators an addressable tap no bigger than a standard eight-port tap. The unit comes in three versions: a simple four-port unit that offers on-off control of each drop; a four-port A/B version that adds on-off control of a basic and premium tier; and an eight-port in a simple on-off configuration. All electrical specifications are identical to the earlier EAS multitap.

SuperTap offers a permanent subscriber drop with fully electronic connects and disconnects; is compatible with PAL, SECAM and NTSC today; is transparent to future high definition TV formats; and is compatible with digital compression, which can be added as a basic or enhanced tier.

Reader service #207

Light source

EXFO has introduced the FLS-210A, which the company claims is the first fiber-optic light source capable of transmitting light at up to three wavelengths. A single instrument can, for instance, transmit at 1,300 and 1,550 nm from one port in addition to providing visual fault location at 650 nm from another port. →

Numerous combinations of sources are possible: Users may choose from built-in LED or laser source options at 650, 780, 820, 850, 1,300 and 1,550 nm. Where outstanding stability is critical, thermo-electrically cooled lasers also are available. One, two or three independent sources may be installed in one single instrument.

The unit works with the FOT-900, FOT-900PC or FOT-90A FasTest compatible power meters to perform fully automated attenuation readings. When this automatic mode is activated, the meter at the receiving end stores attenuation readings without the user's intervention.

Reader service #206

Ground wire tag

Budco introduced an improved ground wire tag that offers better durability, strength and outdoor longevity, according to the company. Also, the company claims the polyethylene tag did not crack, blacken or noticeably fade after the equivalent of 10 years in an independent test lab, and will bend and twist without breaking.

The standard 1.5- by 3-inch orange or green tag has a black UV cured legend that is both weather and scratch resistant. Custom sizes, legends and colors are available. The proprietary blend of polyethylene is the standard at many telephone companies and is being introduced to the CATV market exclusively from Budco.

Reader service #205

LAN system

A new local area network (LAN) system from Zenith Electronics Corp. provides low-cost computer links over metropolitan cable TV systems.

According to the company, using broadband cable as a multimedia communications conduit enables LAN data to be transmitted across a coaxial medium and coexist with other services, including broadcast video, manufacturing networks, point-to-point data, telephone bypass, security, video teleconferencing and other value-added telecommunications services.

Zenith's cable data products have been enhanced to use standard sub-split radio frequency (RF) channels. The company claims its sub-split RF channel assignments allow CATV systems to extend Ethernet and Token Ring data service connectivity up to 30 miles for personal computers, mainframes, terminals and printers to homes, campuses and businesses.

Reader service #197

Drop wire clip

Erico Inc., manufacturer of Caddy fasteners, announced it has straightened out the inherent problems of drop wire installations. The new PCS1 drop wire clip locks into place without kinking, bending or deforming drop wires. This allows multiple clips to hang from a single drop wire without raising the ceiling grid.

The PCS1 attaches to #8 through #12 drop wire and provides support for 14-2 through 12-2 AC/MC, BX or communications cable up to .600 OD without having to trap the cable against the wire. This allows the installer to return and complete the installation by snapping the cable into the boot on the PCS1, eliminating the need to stand on a ladder and hold a cable in one hand while trapping it between the drop wire and fastener with the other hand.

Reader service #204

Audio system

Microwave Radio Corp. (MRC) has developed the DigiPro digital audio system, designed to provide CD-quality sound over existing or new video microwave links. The system is suitable for both studio-to-transmitter links (STLs) and multihop intercity relays.

DigiPro carries both the digital audio programs and a control channel on a single subcarrier. Using standard

CCIR subcarrier spacing, DigiPro effectively doubles the baseband capacity above video for audio programs. The latest technological improvements in adaptive coding and digital compression techniques are incorporated, including a signal-to-noise ratio of 86 dB or greater.

The system was developed to solve difficult broadcast audio problems such as audio signal degradation during signal fades and overall low audio quality. According to the company, the signal quality remains constant even during a deep path fade.

DigiPro encoders and decoders can be used for new and existing rack-mounted, fixed microwave radio systems. In fixed installations, the DigiPro system interfaces directly to the MRC model FLR and FLH Series radios via the composite input. It also can be used in existing microwave installations to replace analog subcarriers. The complete system includes a digital audio encoder and a digital subcarrier modulator for the transmit end; and a digital audio decoder and a digital subcarrier demodulator for the receive end. Each component is one standard EIA rack unit high (1.75 inches).
Reader service #200

Mini OTDR

The new FF-1300 Feature Finder by Laser Precision Corp. is a mini OTDR designed for testing and maintaining multimode fiber-optic cables. This test instrument features high resolution 850 nm optics, a high contrast LCD display, single button operation for both automated analysis and trace display, and up to eight hours of operation on rechargeable lead acid batteries. The unit automatically locates reflective or non-reflective events in fiber-optic cables and reports the location, loss and reflectance of the events. In addition, the unit features a trace display option, should further analysis of the data be required. Other options include print capability via the FF-105 printer option and data downloading using the FF-110 FF-View software package.
Reader service #199

Laser diode controller

ILX Lightwave has released the LDC-3752 high-power laser diode controller, the newest in its line of microprocessor-based controllers offering both current and temperature control in the same unit. The 6-amp, low noise current source features photodiode feedback for constant-light operation, as well as proven laser protection circuitry to extend laser lifetimes. The current source also features high stability and flexible modulation capability. The 44-watt, high-capacity temperature controller will drive TE modules from -99° C to +150° C with .01° C stability. It is designed for complete system integration with other equipment, offering a GPIB/IEEE 488.2 interface option.
Reader service #198

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.

☛ *Category V Review Course: Data Networking and Architecture* — Al Kuolas of American Cablesystems discusses digital data and methods of transmission, covering such topics as bits and bytes, parity bits, verification, formats of information, networking, modulation and multiplexing. Note that this updated version of T-1047 features a different instructor. (1 hr.) Order #T-1061, $35. **B-V**

☛ *Category VI Review Course: Terminal Devices* — William Cohn and Mike Long of Zenith Electronics Corp. discuss regulatory agencies and standards, signal levels, noise figures, locating the source of ingress, installation equipment and practices, converters, remote controls, interfacing with consumer equipment and emerging technologies. (1-1/2 hrs.) Order #T-1062, $45. **B-VI**

☛ *Category III Review Course: Transportation Systems* — Tom Strauss of Hughes Microwave provides a technical look at transportation systems, including the benefits and trade-offs of different methods. This program begins with a basic discussion of the decibel and then goes on to cover baseband video and its waveform, distortion, harmonics, ingress and satellite transmission. It also deals with microwave transmission and refraction, including AM and FM transmitters and receivers. (1 hr.) Order #T-1063, $35. **B-III**

Note: All tapes listed this month were videotaped at Cable-Tec Expo '88 in San Francisco. The appearance of the symbol **B-** indicates a videotape relating to a certain category (noted by Roman numerals **I-VII**) of the Broadband Communications Technician/Engineer (BCT/E) Certification Program. All videotapes are in color and available in the 1/2-inch VHS format only. They are available in stock and will be delivered approximately three weeks after receipt of order with full payment.

Shipping: Videotapes are shipped UPS. No P.O. boxes, please. SCTE pays surface shipping charges within the continental U.S. only. Orders to Canada or Mexico: Please add $5 (U.S.) for each videotape. Orders to Europe, Africa, Asia or South America: SCTE will invoice the recipient for additional air or surface shipping charges (please specify). "Rush" orders: a $15 surcharge will be collected on all such orders. The surcharge and air shipping cost can be charged to a Visa or MasterCard.

To order: All orders must be prepaid. Shipping and handling costs are included in the continental U.S. All prices are in U.S. dollars. SCTE accepts MasterCard and Visa. To qualify for SCTE member prices, a valid SCTE identification number is required or a complete membership application with dues payment must accompany your order. Orders without full and proper payment will be returned. Send orders to: SCTE, 669 Exton Commons, Exton, Pa. 19341 or fax with credit card information to (215) 363-5898.

A complete listing of publications and videotapes is included in the March 1992 issue of the Society newsletter, "Interval."

CALENDAR

1992

October

6: SCTE Badger State Chapter seminar, Installer exams to be administered, Greenfield, Eau Claire and Green Bay, Wis. Contact Gary Wesa, (414) 496-2040.

6: SCTE Music City Meeting Group seminar, digital compression, BCT/E exams to be administered in all categories at both levels, Stouffer Hotel, Nashville, Tenn. Contact Dale Goodman, (615) 244-7462.

6-7: SCTE Central Indiana Chapter seminar, BCT/E exams to be administered in all categories at both levels. Contact Gregg Nydegger, (219) 583-6467.

6-8: Mid-America Cable Show, Kansas City, Mo. Contact (913) 841-9241.

6-8: Philips mobile training seminar, Richmond, Va. Contact (800) 448-5171 (outside New York state) or (800) 522-7464 (in New York).

7: SCTE Ark-La-Tex Chapter seminar, antennas, BCT/E and Installer exams to be administered in all categories at both levels, Shreveport, La. Contact Robert Hagan II, (903) 758-9991.

7: SCTE Delaware Valley Chapter seminar, theft of service, security and customer retention, Williamson Restaurant, Willow Grove, Pa. Contact Lou Aurely, (215) 675-2053.

7: Tektronix seminar, how to evaluate your system, Portland Marriott, Portland, Ore. Contact Kathy Richards, (503) 627-1555.

8: SCTE Chesapeake Chapter seminar, BCT/E review, Holiday Inn, Columbia, Md. Contact Jennifer Wardrop, (410) 461-7017.

8: SCTE Satellite Tele-Seminar Program, *Anatomy of Professionalism*, to air from 2:30 to 3:30 p.m. ET on Transponder 14 of Galaxy I.

10: SCTE Rocky Mountain Chapter seminar, Installer and BCT/E exams to be administered, ATC Training Center, Denver. Contact Patrick Kelley, (303) 267-4739.

11: SCTE Cascade Range Chapter seminar. Contact Cynthia Stokes, (503) 230-2099.

13: SCTE Central Illinois Chapter seminar, BCT/E exams to be administered, UAE, Decatur, Ill. Contact Chuck Prosser, (309) 347-7071.

13: SCTE Desert Chapter seminar, system sweep and performance testing. Contact Chris Middleton, (619) 340-1312, ext. 258.

13-14: Atlantic Cable Show, Atlantic City, N.J. Contact (609) 848-1000. Also, SCTE BCT/E exams at both levels and Installer exams (written only) to be administered at this show. Contact SCTE national headquarters, (215) 363-6888.

13-15: Philips mobile training seminar, Hartford, Conn. Contact (800) 448-5171 (outside New York state) or (800) 522-7464 (in New York).

15: SCTE Central Indiana Chapter seminar, digital cable audio. Contact Gregg Nydegger, (219) 583-6467.

15: SCTE New England Chapter seminar, BCT/E exams to be administered. Contact James Kelley, (401) 943-7930, ext. 230.

17: SCTE Cactus Chapter seminar, Installer Certification. Contact Harold Mackey, (602) 352-5860, ext. 135.

17: SCTE Cascade Range

Planning ahead

Dec. 2-4: Western Cable Show, Anaheim, Calif. Contact (415) 428-2225.
Jan. 6-7: SCTE Emerging Technologies conference. Contact (215) 363-6888.
Feb. 24-26: Texas Cable Show, San Antonio, Texas. Contact (512) 474-2082.

Chapter seminar, BCT/E exams to be administered in all categories, Paragon Cable, Portland, Ore. Contact Cynthia Stokes, (503) 230-2099.
17: SCTE Golden Gate Chapter seminar, BCT/E exams to be administered, Viacom, Pleasanton, Calif. Contact Mark Harrigan, (415) 358-6950.
17: SCTE Inland Empire Chapter seminar, remote monitoring systems, measurement procedures, and BCT/E exams to be administered in all categories at both levels, Cavanaugh's Inn at the Park, Spokane, Wash. Contact Butch Boyd, (208) 667-5521.
19: SCTE Upstate New York Chapter seminar, compliance with New York state regulations, Four Seasons Restaurant, Amherst, N.Y. Contact William Grant, (716) 827-3880.
20-22: Philips mobile training seminar, Boston. Contact (800) 448-5171 (outside New York state) or (800) 522-7464 (in New York).
21: SCTE Appalachian Mid-Atlantic Chapter tour of two C-COR plants and the Cable Museum, C-COR Plant, State College, Pa. Contact Richard Ginter, (814) 672-5393.
21: SCTE San Diego Chapter seminar, BCT/E and Installer exams to be administered in all categories at both levels. Contact Kathleen Horst, (310) 831-4157.
21: Tektronix seminar, how to evaluate your system, Westin Seattle, Seattle. Contact Kathy Richards, (503) 627-1555.
22: SCTE Northern New England Meeting Group seminar, signal security and theft of services, Ramada Inn, Portland, Maine. Contact Bill DesRochers, (207) 646-4576.
23: Tektronix seminar, how to evaluate your system, Radisson (Denver South), Denver. Contact Kathy Richards, (503) 627-1555.
27-29: Philips mobile training seminar, Boston. Contact (800) 448-5171 (outside New York state) or (800) 522-7464 (in York).
28: SCTE Greater Chicago Chapter seminar, proof of performance, and BCT/E exams to be administered in all categories at both levels, Quality Hotel, Palatine, Ill. Contact Bill Whicher, (708) 362-6124.
28: SCTE Miss/Lou Chapter seminar, Baton Rouge, La. Contact Dave Matthews, (504) 923-0256, ext. 309.
29: SCTE New Jersey Chapter seminar, HBO uplink tour. Contact Jim Miller, (201) 446-3612.

November

3-5: Philips mobile training seminar, Bangor, Maine Contact (800) 448-5171 (outside New York state) or (800) 522-7464 (in New York).
4: Tektronix seminar, how to evaluate your system, Crystal City Marriott, Washington, D.C. Contact Kathy Richards, (503) 627-1555.
5: SCTE Great Plains Chapter seminar, BCT/E exams to be administered, Grand Island, Neb. Contact Jennifer Hays, (402) 333-6484.
5: SCTE Upper Valley Chapter seminar, video processing, Holiday Inn, White River Junction, Vt. Contact Matthew Alldredge, (802) 885-9317.

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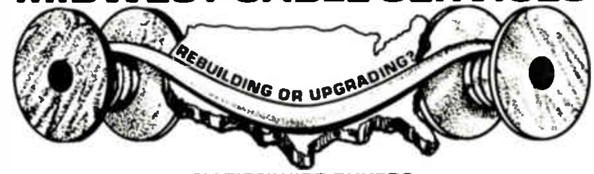

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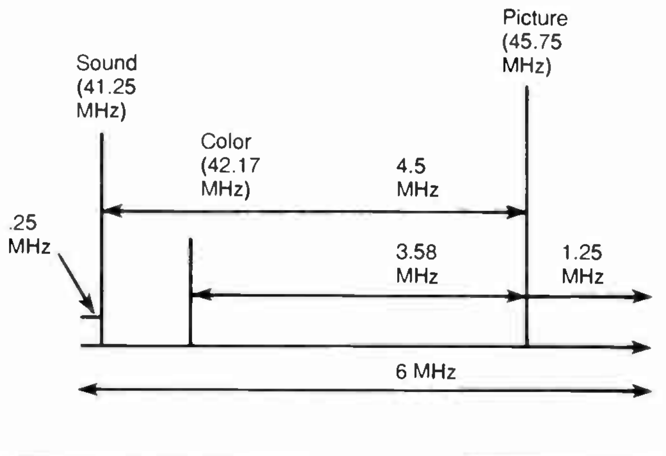
General information

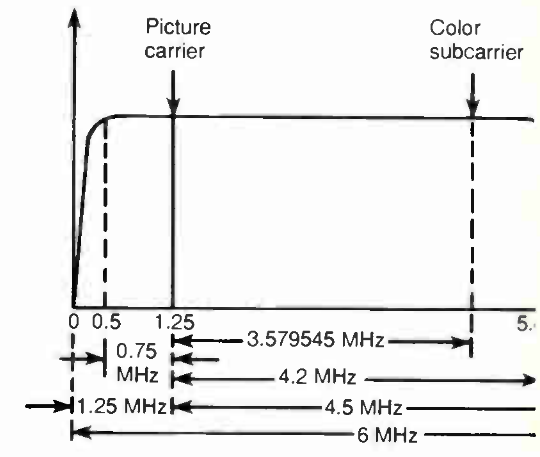
Channel bandwidth at RF: 6 MHz
Visual carrier location: 1.25 MHz (±1 kHz) above lower channel edge
Color subcarrier frequency: 3.579545 MHz (±10 Hz) above visual carrier
Sound carrier center frequency: 4.5 MHz (±1 kHz) above visual carrier
Scanning lines: 525 lines per frame, interlaced 2-to-1
Scanning sequence: horizontally from left to right, vertically from top to bottom
Horizontal scanning frequency: 15,750 Hz (monochrome), 15,734.264 Hz (color)
Vertical scanning frequency: 60 Hz (monochrome), 59.94 Hz (color)
Aspect ratio: 4 horizontal units, 3 vertical units

Per the new FCC requirements in §76.605 (11), (12) and (13), video baseband performance as measured at the *output* of hea
processing and modulating equipment shall not exceed the following:
Differential gain: 20 percent **Differential phase:** 10 degrees **Chrominance-to-luminance delay inequality:** 170 nanos

TV channel at IF



TV channel at RF



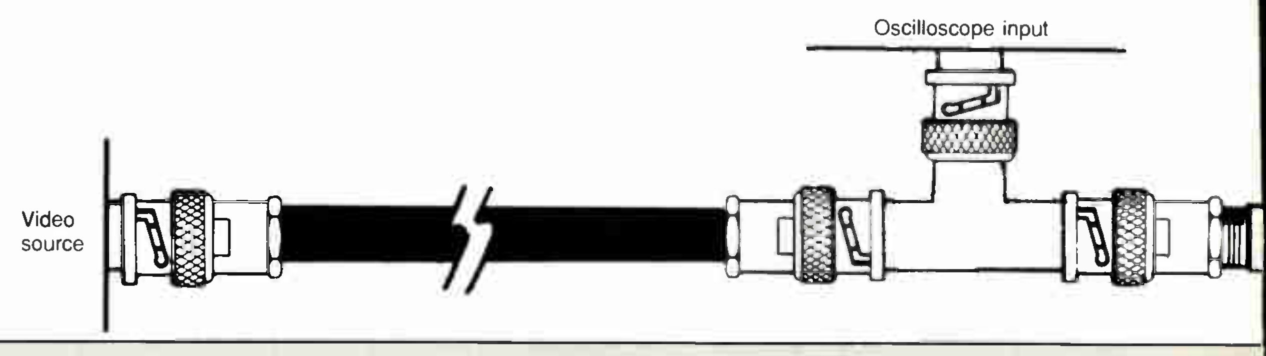
Measuring video with an oscilloscope

To make video measurements:
• Use an oscilloscope with at least 5 MHz bandwidth.
• Turn on the oscilloscope and let it warm up for 30 minutes. Check to make sure that all knobs are in the "CAL" position, and verify instrument calibration per the manufacturer's directions.
• Remove the oscilloscope probe from the input BNC connector (most probes are X10; the oscilloscope should be in the direct or X1 mode).
• Because the impedance of an oscilloscope is typically 1 million ohms or greater, a 75-ohm feedthrough termination must be used at the oscilloscope's input when measuring video. You can use a commercially made feedthrough termination or you can make your own with a BNC "T," a BNC-to-F adapter and a conventional 75-ohm F terminator (see figure). Install your 75 ohm feedthrough termination on the oscilloscope's input BNC connector and connect the video source being measured to the termination. If you don't use a 75-ohm feedthrough termination for this procedure, the oscilloscope will indicate a much higher video level than is actually present.
• Adjust the oscilloscope's controls to the following settings:

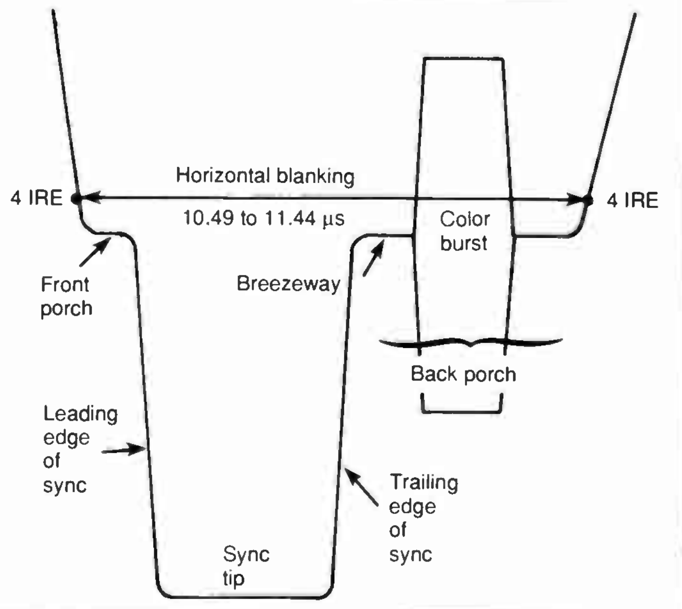
Vertical sensitivity (volts/division)	0.2 V
Sweep rate (time/division)	5 ms
Trigger	TV fie
Coupling	DC

(If your oscilloscope does not have field or ing, use line triggering. This will lock the ins 60 Hz AC power line.)
• Center the displayed video signal with the horizontal position controls. Then, using the tion control, adjust the position of the video oscilloscope CRT to align the sync tips wit near the bottom of the display.
• Adjust your video source until the oscillosc 1 volt peak-to-peak, or five vertical divisio sync tips to peak white (peak luminanc chrominance). Depending on the video so measuring, it may be necessary to install a ter at the input of the oscilloscope (befor feedthrough termination) to remove the energy for an accurate measurement of the nance amplitude.

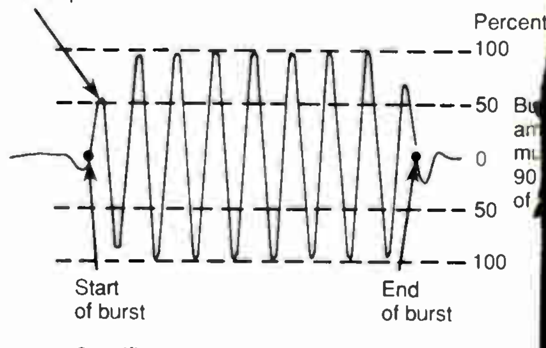
Connection to oscilloscope with homemade 75-ohm feedthrough terminati



Elements of horizontal sync



Burst characteristics



Compiled by Ron Hranac, Senior Technical Editor

Pull-out Wall Chart

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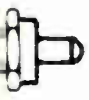

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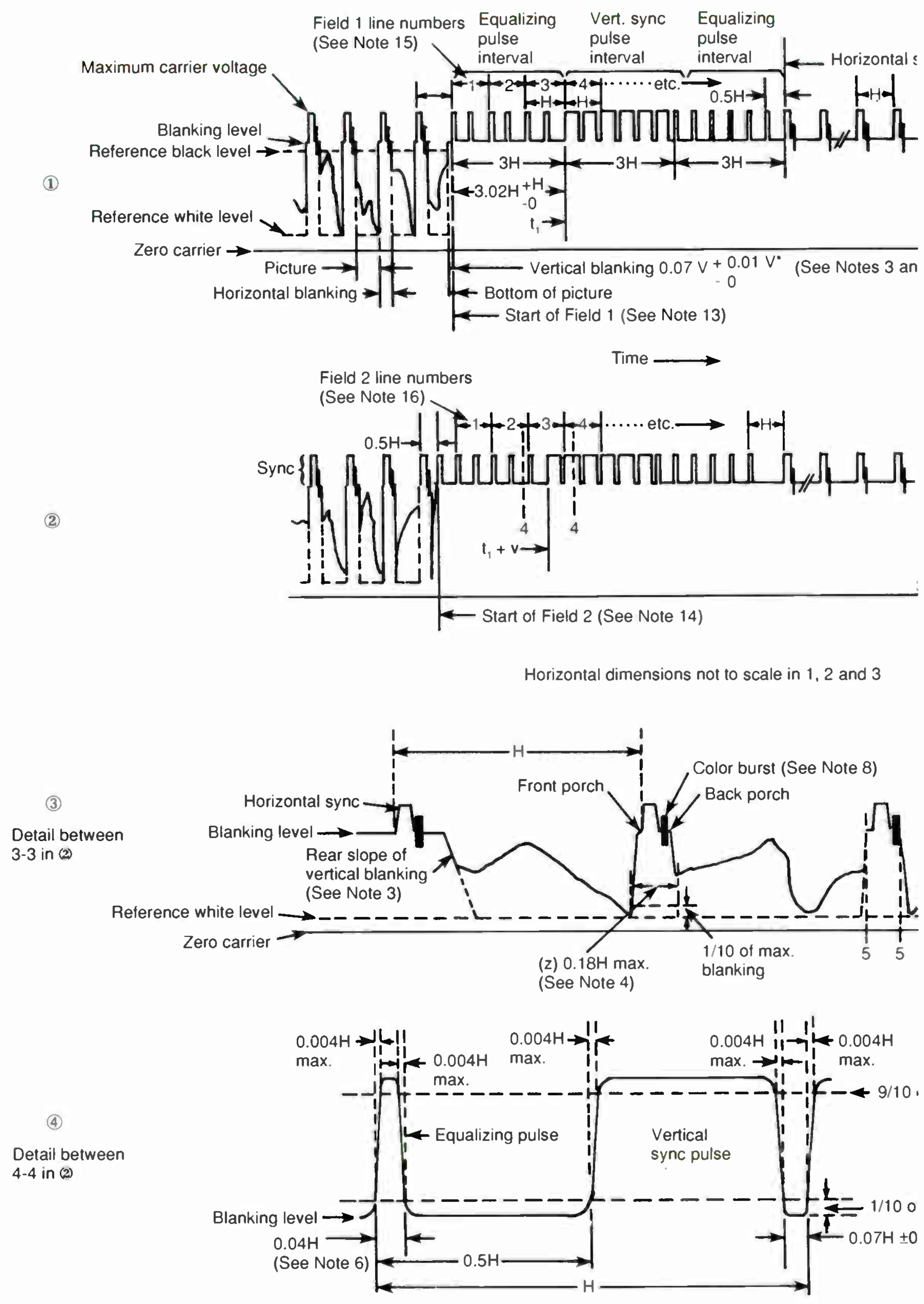
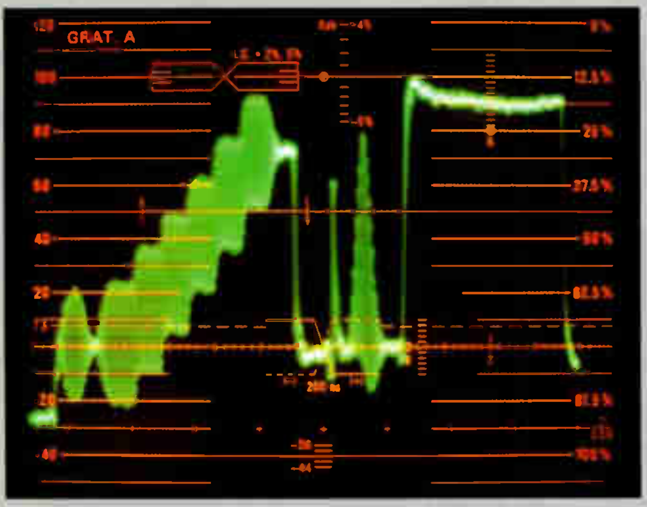
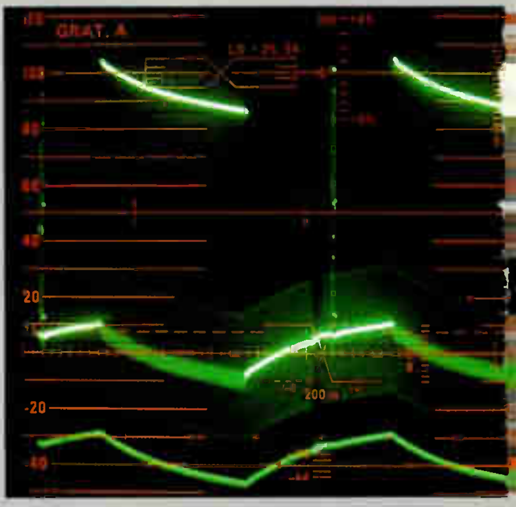
COMMUNICATION TECHNOLOG

FCC TV video/sync waveform for color transmis





Line time distortion manifests itself as tilt in line-rate (1-64 ms duration) video components such as the top of the 100 IRE bar, and is expressed as peak-to-peak tilt in IRE units or percentage of the bar amplitude. Line time distortion causes horizontal brightness variations in large picture details, and sometimes streaking or smearing.



Field time distortion results in til rate (64 ms-16 ms) video compon requires a field square wave or wi nal to measure. It is expressed as peak tilt in IRE units or percentage erence amplitude. Field time distort es vertical brightness variations in ture details.

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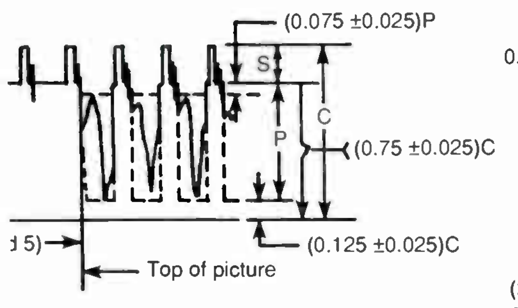

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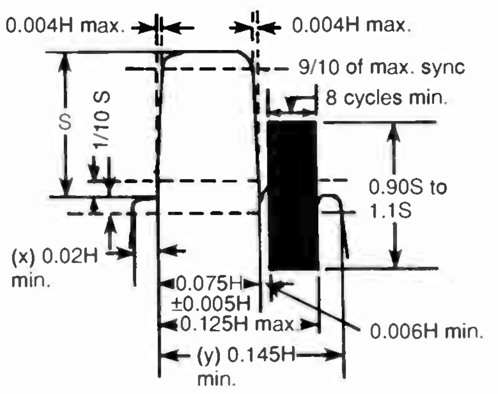

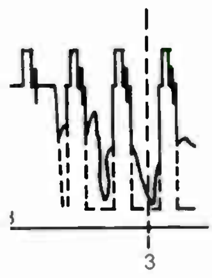

of max. sync

max. sync

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Notes

1) H = Time from start of one line to start of next line.
2) V = Time from start of one field to start of next field.
3) Leading and trailing edges of vertical blanking should be complete in less than 0.1H.
4) Leading and trailing slopes of horizontal blanking must be steep enough to preserve minimum and maximum values of (x + y) and (z) under all conditions of picture content.
*5) Dimensions marked with asterisk indicate that tolerance given are permitted only for long-time variations and not for successive cycles.
6) Equalizing pulse area shall be between 0.45 and 0.5 of area of a horizontal sync pulse.
7) Color burst follows each horizontal pulse, but is omitted following the equalizing pulses and during the brood vertical pulses.
8) Color bursts to be omitted during monochrome transmission.
9) The burst frequency shall be 3.579545 mc. The tolerance on the frequency shall be ±10 cycles with a maximum rate of change of frequency not to exceed 1/10 cycle per second per second.
10) The horizontal scanning frequency shall be 2/455 times the burst frequency.
11) The dimensions specified for the burst determine the times of starting and stopping the burst, but not its phase. The color burst consists of amplitude modulation of a continuous sine wave.
12) Dimension "P" represents the peak excursion of the luminance signal from blanking level, but does not include the chrominance signal. Dimension "S" is the sync amplitude above blanking level. Dimension "C" is the peak carrier amplitude.
13) Start of Field 1 is defined by a whole line between first equalizing pulse and preceding H sync pulses.
14) Start of Field 2 is defined by a half line between first equalizing pulse and preceding H sync pulses.
15) Field 1 line numbers start with first equalizing pulse in Field 1.
16) Field 2 line numbers start with second equalizing pulse in Field 2.

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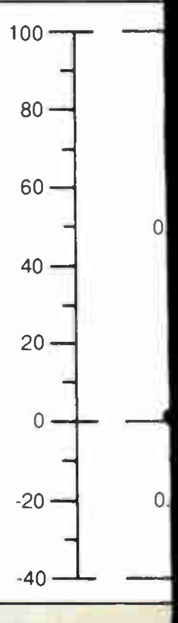
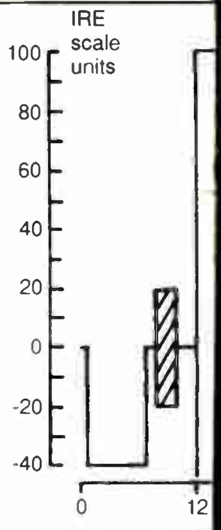
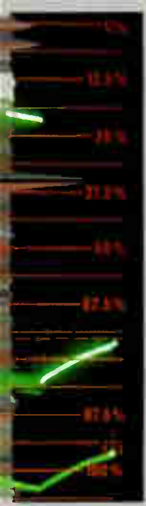


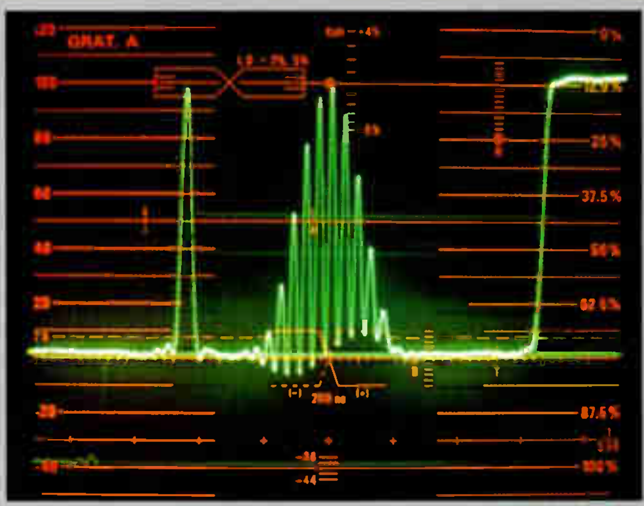
Test signa



Composite test sig
This contains a 12.5T pulse and mo ence is useful for s ments of short time can be an indicator and K Factor measu mine chrominance-t lated staircase differ



Courtesy Tektronix



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Chrominance-to-luminance gain inequality causes the baseline of the 12.5T pulse to have a concave or convex shape. It is expressed in IRE, percent or dB (after normalizing the pulse amplitude to 100 IRE). Chrominance-to-luminance gain inequality causes incorrect color saturation in the picture.

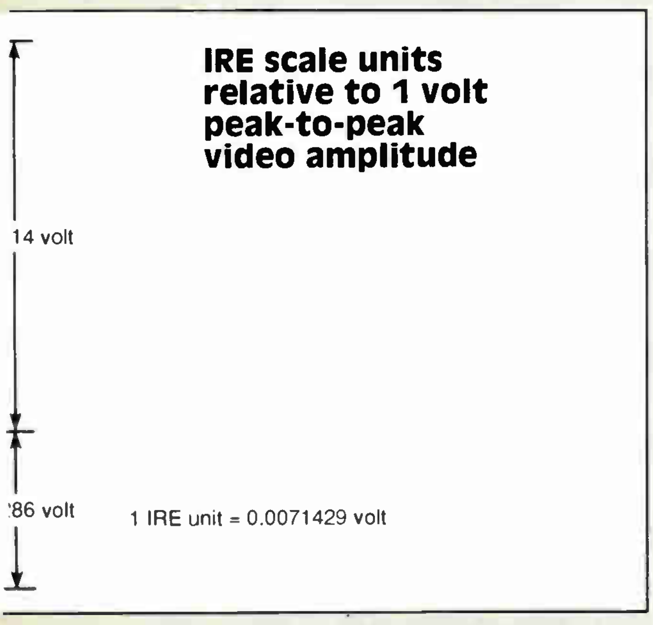
Chrominance-to-luminance delay inequality causes the 12.5T pulse baseline to have a sine wave shape. After normalizing the pulse amplitude to 100 IRE, the sine wave excursions can be converted to delay in nanoseconds using the accompanying nomograph (right). Chrominance-to-luminance delay inequality results in color smearing (sometimes called the "funny paper effect").

ls

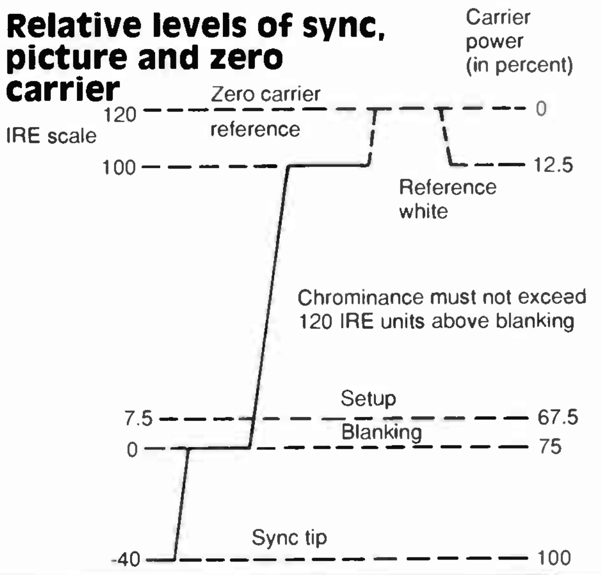
onitor IRE units and oscilloscope peak-to-peak voltages

) meter	Waveform monitor IRE units	Oscilloscope peak-to-peak voltage
ence	1	0.00714 volt
ontal sync amplitude	40	0.286 volt
burst amplitude	40	0.286 volt
)	7.5	0.054 volt
ı (blanking-to-peak white)	100	0.714 volt
video signal amplitude	140	1 volt

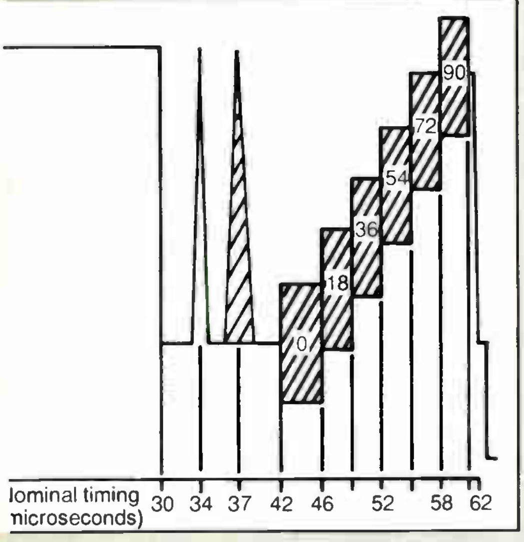
IRE scale units relative to 1 volt peak-to-peak video amplitude



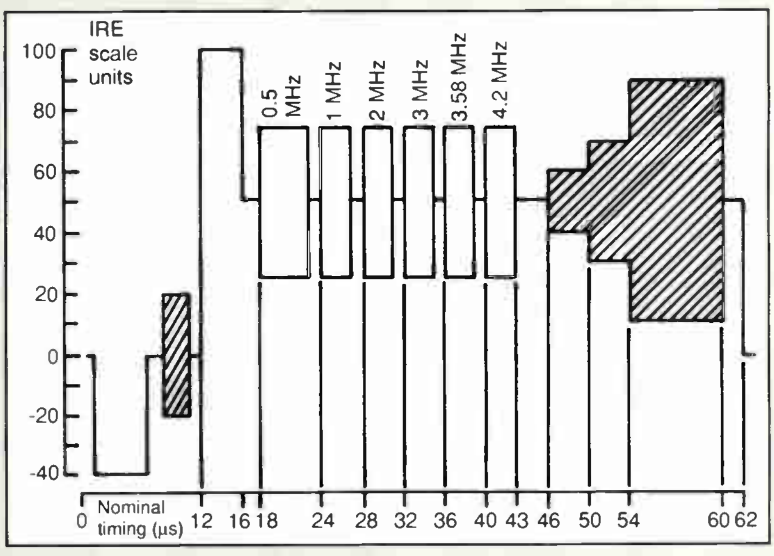
Relative levels of sync, picture and zero carrier



ls for measuring video distortions

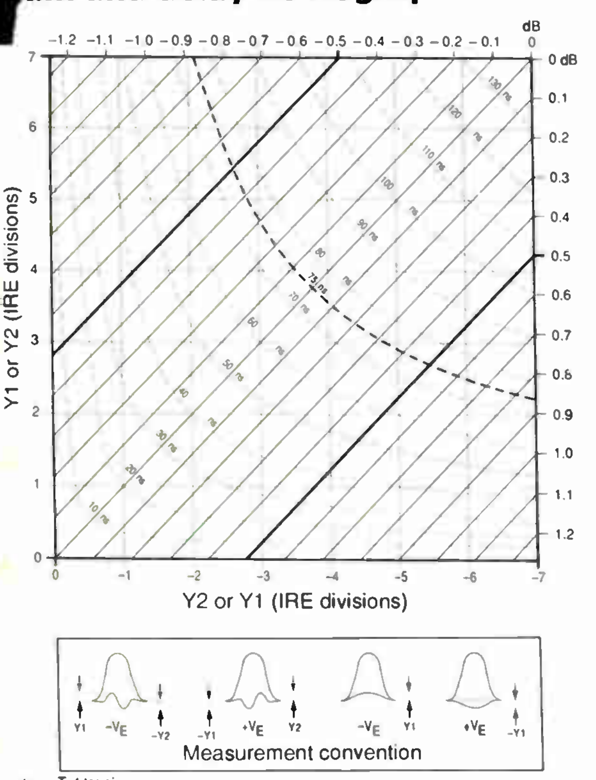


al
00 IRE white reference (bar), 2T pulse, ulated staircase. The 100 IRE white refer- tting video levels, and also for measure- nd line time distortions. The 2T pulse also of short time distortion (pulse-to-bar ratio ements). The 12.5T pulse is used to deter- -luminance gain and delay, and the modu- ntial gain and phase.



Combination test signal
This includes a 100 IRE white reference, multiburst and modulated pedestal. The white reference can be used to set video levels, and the multiburst is a good indicator of frequency response problems (gain-frequency distortion). The modulated pedestal is used to measure chrominance non-linear phase and gain, as well as chrominance-to-luminance intermodulation.

hrominance-to-luminance ain and delay nomograph



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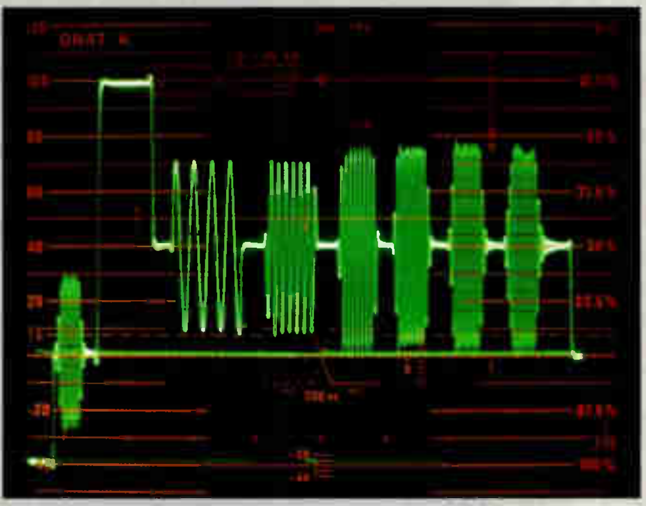

Gain-frequency distortion is a degradation of video frequency response, and can be seen as a variation in a multiburst signal's ideally flat packet amplitudes. It is expressed in dB, percent or IRE units relative to either the 100 IRE bar or some low frequency such as the 0.5 MHz packet. Gain-frequency distortion can cause other video distortions such as short, line, field and long time distortions and their visible effects in the picture.

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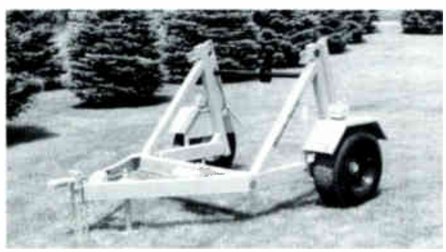

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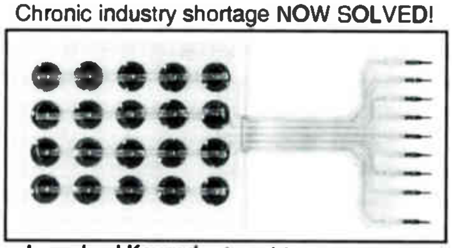

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SCTE's mission statement: Training, certification, standards

By Bill Riker
President, Society of Cable Television Engineers

The Society of Cable Television Engineers Planning Committee held a meeting March 23 in Exton, Pa., where the Society's national headquarters is located. Over the course of the meeting, with the help of professional facilitator Joseph Simonetta, the committee defined the goals of the Society as being "training, certification and standards."

Training

The primary goal of the Society is training CATV personnel in a variety of disciplines, from cable installation to safety. The following are some of the many programs SCTE offers.

Cable-Tec Expo — The Society combines its annual engineering conference with two days of technical workshops and exhibits to form a three-day program called Cable-Tec Expo. This show, which attracted 2,000 attendees this year, is the industry's only strictly technical national trade show and conference.

SCTE videotapes and publications — The Society is the industry's main source for technical training videotapes and publications at very reasonable costs. The Society's catalog is packed with materials that are needed in every cable system. (See "Bookshelf" on page 84 or look in the March 1992 issue of the Society newsletter, *Interval*, for more details and ordering information.)

Technical seminars — SCTE provides technical seminars and workshops, as well as Broadband Communications Technician/Engineer (BCT/E) testing, at most state and regional trade shows.

Technology for Technicians I and II — Technology for Technicians is a series of three-day training seminars developed by the Society's director of training and presented at various locations around the country to accommodate attendees. The original Technology for Technicians program is designed for installer/technicians and service technicians and ties in with the Installer Certification Program. Technology for Technicians II is for advanced technicians and covers spectrum analysis, signal leakage/cumulative leakage index (CLI) and system design theory.

Satellite tele-seminars — The Society provides one hour of technical training via satellite each month that can be downlinked and videotaped for educational purposes at the system level. Scheduled times are announced in *Interval* and *CT's* "Calendar" (page 86).

Local chapters and meeting groups — One of the most important services that the Society offers the industry is the training available through local SCTE chapters and meeting groups. This is the lowest cost training available anywhere. Most groups offer full-day seminars approximately six times a year.

Certification

In the area of certification, the Society currently offers the opportunity to be certified at three levels of expertise through its BCT/E and Installer Certification Programs. The BCT/E Program is the only program in the cable industry that tests and evaluates the technical knowledge and skills of CATV technicians and engineers, and certifies their abilities in seven categories, including headends, video and audio signals, coaxial trunk and fiber optics, distribution systems, data transmission and terminal devices (in the subscriber's home), plus engineering management and professionalism. Examinations are provided at both the Technician and Engineer levels.

The Installer Certification Program is designed for cable installers and installer/technicians, both in-house and contractor personnel. Training is provided through local SCTE chapters and meeting groups utilizing a manual written by top industry experts. A written examination is given to determine each applicant's level of knowledge in the performance of proper house drop installations. Practical training and performance examinations are given in drop cable preparation and F-fitting installation and signal level meter reading.

Standards

Thanks to the efforts of the Society's Engineering Committee and the five subcommittees that operate under its guidance, SCTE is getting into defining technical standards. The first such accomplishment was the standardization of the female F-port, which was developed after two years of effort by the Society's Interface Practices Subcommittee. Not only has this standard been accepted by SCTE and the U.S. cable industry, but is currently being considered by CENELEC as a standard for broadband communications connectors throughout Europe.

Other groups operating under the Engineering Committee include the CLI, Design and Construction, Emergency Broadcast System (EBS) and In-Home Cabling Subcommittees.

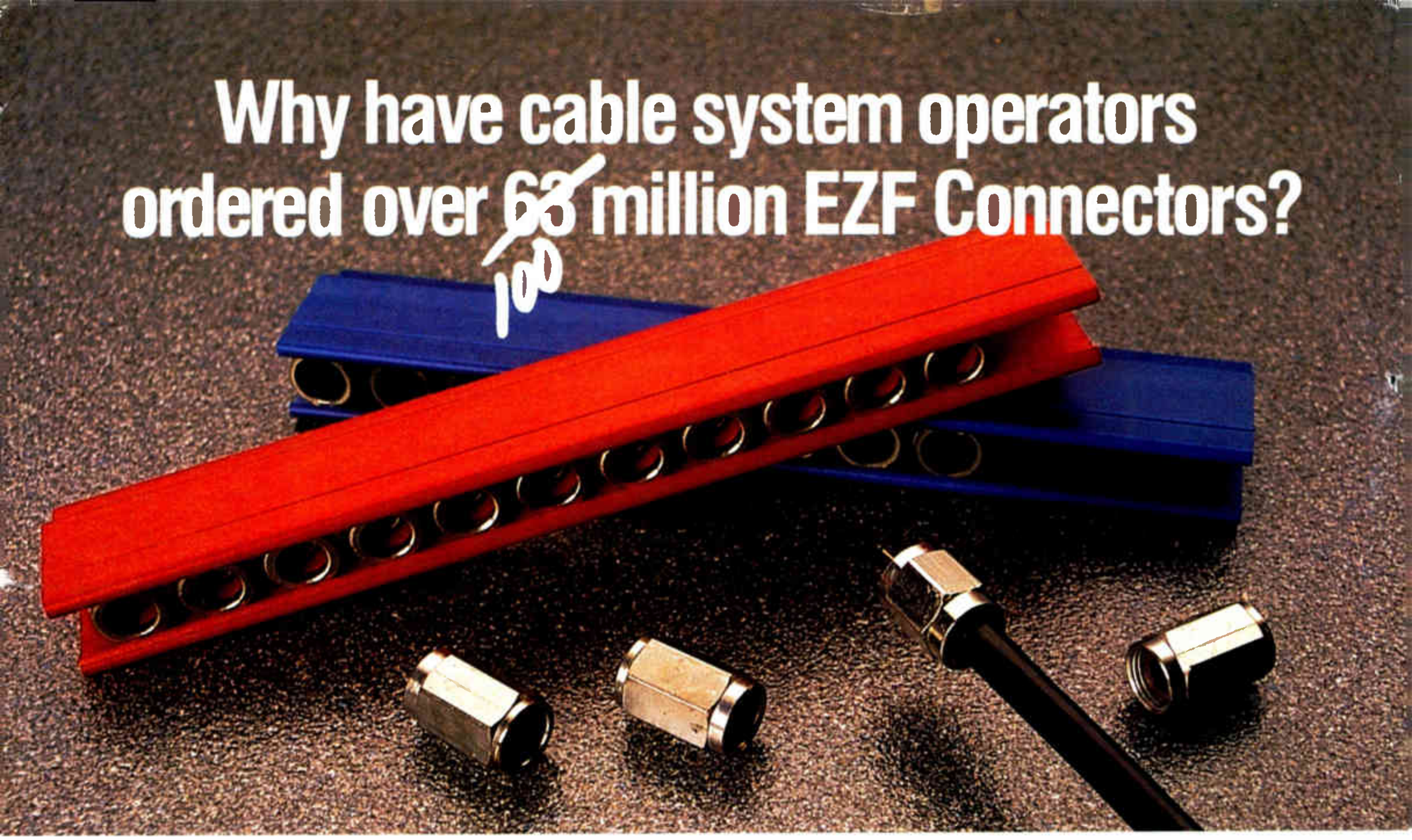
The CLI Subcommittee recommends educational training, reviews published materials and provides recommendations toward the possible compilation of an SCTE CLI handbook. It also reviews and reports on field problems through publication in *Interval*.

The EBS Subcommittee is working with the Federal Communications Commission in response to its pending Notice of Inquiry for EBS. Working groups operating under its auspices report on hardware alternatives and current local and regional EBS efforts.

The In-Home Cabling Subcommittee was formed to discuss cabling, architecture, passives, in-home amplification, connectors, test procedures and intrapremises cabling.

The Design and Construction Subcommittee deals with basic construction, fiber construction, design (including computer-aided drafting and engineering, makeready and mapping), upgrades and rebuilds.

"Training, certification, standards." These are more than three words — they comprise our mission statement. I believe we are well on our way to achieving these objectives, and therefore, we are achieving our mission. **CT**



Lower Maintenance Costs and Improved Customer Satisfaction

In both new builds and rebuilds, users of the EZF connector system are experiencing a dramatic reduction in drop related service calls. RF leakage trouble calls resulting from improper connector installation and corrosion are no longer the single most problem in a CATV system when the EZF connector system is used.

PROVEN: Fewer problems occur during installation

- One color-coded connector for each cable size minimizes connector selection problems.
- The cable is prepared for installation the same way every time with the EZF cable preparation tool.
- Only a 7/16 inch wrench is needed for installation.
- Cassette packaging facilitates proper installation and reduces connector loss.
- Immediate inspection for proper installation by installers and QC inspectors.

PROVEN: Fewer problems occur during service life

- A circumferential, environmental seal is automatically made at the connector/cable interface during installation.
- The EZF sealing sleeve supplied with the connector prevents moisture penetration at the connector/port interface.
- Material compatibility and corrosion resistance are ensured by specially selected and tested materials and platings.
- Rugged connector design and consistent installation quality contribute to reduced RF leakage and reliable performance.

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